Population status, biology and ecology of the Maral, *Cervus elaphus maral*, in Golestan National Park, Iran

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Abstract. The habitat and population characteristics of the Maral, *Cervus elaphus maral* Gray, 1850, were studied in Golestan National Park, Iran, from 1975 to 2003 (but more intensively from 1976–1978) in the three vegetation types present; Caspian deciduous forest, transition zone, and steppe. Forest meadows and the transition zone were the preferred habitats. Hahn's census method and pellet group counts gave a population number of 1897–2096 Marals during 1976–1978. Since then the population size has declined, to 500 in 2003. The average Maral group size was 4.6. The sex ratio among adults was 27 stags per 100 hinds. The number of calves produced per 100 hinds was 28. The annual mortality rate was 13.9% and life expectancy was 6.7 years. The decline of the Maral population in Golestan National Park was correlated with a similar trend in the Maral population in the Caspian forest (Hyrcanian region). Illegal hunting, road kill and livestock grazing have been identified as the major factors which affect the Maral population adversely.

Kurzfassung. Im Golestan-Nationalpark, Iran, wurden zwischen 1975 und 2003 (intensiv von 1976 bis 1978) die Habitatansprüche und die Populationsdynamik des Rotwildes (Maral), *Cervus elaphus maral* Gray, 1850, in den drei dort vorhandenen Vegetationstypen vergleichend untersucht: Kaspische Laubwälder, Übergangszone und Steppe. Waldwiesen und die Übergangszone wurden als Habitate bevorzugt. Auf Grundlage der Zählmethode von Hahn und der Zählung von Nahrungresten konnte in der Periode von 1976–1978 eine Populationsgröße von 1897–2096 Stück Rotwild ermittelt werden. Die Population verringerte sich bis 2003 auf etwa 500 Tiere. Die durchschnittliche Gruppengröße betrug 4.6; das Geschlechterverhältnis betrug bei Alttieren 27 männlichen Hirschen zu 100 Hirschkühen. Die Anzahl der Kälber pro 100 Hirschkühe betrug 28, die jährliche Mortalität 13,9% und die durchschnittliche Lebenserwartung 6,7 Jahre. Die Entwicklung der Population im Golestan-Nationalpark korreliert mit einem fast gleichen Trend, der bei der Rotwildpopulation in den Kaspischen Wäldern (Hercynische Region) zu beobachten ist. Illegale Jagd, Verkehrsopfer und Beweidung durch Haustiere wurden als die wichtigsten Faktoren erkannt, die die Rotwildpopulation negativ beeinflussen.

Key words. Maral, *Cervus elaphus maral*, population, threats, conservation, Golestan National Park, Iran, Middle East.

Introduction

The range of the Maral or Persian Red Deer (*Cervus elaphus maral* Gray, 1850) includes the Caspian provinces of northern Iran, Crimea, Turkey, and the Caucasus. In Iran, it is one of the most sought-after big game animals, and its population has suffered greatly from hunting. Its population is further decreasing, as its natural habitats are being reduced in size and degraded in quality.

The distribution of the Maral in Iran is known to coincide with suitable habitats in the Caspian Forest, from its eastern extremity in Golestan National Park (GNP) to the border with Azerbaijan in northwestern Iran. Despite its importance as a big game animal, very

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limited information is available on the species in Iran. The existing literature includes JAMSHEED (1976), ETEMAD (1985) and ZIAIE (1996), mainly containing species description and morphology; BINDERNAGAL (1978), KIABI (1978, 1983, 2000), KIABI et al. (1997), and AMOOZADEH (2002), mainly discussing Maral abundance, distribution and food habits; and TAJBAKHSH & JAMALI (1995) on hunting and trophies. We report here on the results of a long-term study of the Maral in Golestan National Park, which aimed at estimating the population size, structure and development, evaluating the quality and condition of the Maral population in all major habitats, identifying factors detrimental to Maral habitats and populations, and understanding the past and present distribution pattern of the species in Iran.

The Golestan National Park was the first area in Iran to be designated as a national park. It is located in the provinces of Golestan, Khorasan and Semnan, and extends from 37°31'N to 37°16'N, and from 56°17'E to 55°43'E. The terrain is mountainous with an altitude varying between 380 and 2410 m. The park covers about 91,895 ha. (MAJNOONIAN et al. 1999).

Material and methods

An 18-month study of the Maral was started in Golestan National Park in November 1976, and was able to build on some findings from an earlier 4-month-investigation during summer 1975. Some observations from the rutting seasons of 1982, 1989, 1995, 1997, 2001, 2003 and population estimations in late autumn 1982, 1989, 1995, 1997 also provided some insights into the population of *Cervus elaphus maral*.

The deer cruise-line technique developed by HAHN (1949) was one of two methods used to enumerate the Maral herd. Transects were laid out randomly in each of the major vegetation types. The length of the transects varied because of the topography. Prior to the census, the distances from which the Maral could be seen were measured by pacing at right angles on each side of the centre line at 100-metre intervals along the transect. The average of these visibility distances multiplied by the length of the transect gave the area censused.

With the second method, a survey was conducted each autumn and winter. These were accomplished between 27 November and 12 December, 1976; 1 to 12 March, 1977; 1 to 12 November, 1977; and 7 to 19 February, 1978. Two counts also were made each spring and summer following the same routes. These were completed between 4 April and 3 May, 1977; 30 May to 9 June, 1977; 27 August to 8 September, 1977; and 13 to 24 September, 1977. Maral observed on the transects were tallied according to size and age criteria (Tab. 1). Specimens for which sex and age could not be determined with certainty were placed in an unclassified category.

In each of the two census methods, population densities were computed by averaging the density estimates on all the transects used. Transects were distributed so that all parts of the densely populated range were represented. They were spaced more than 3 km apart, however, to prevent counting a Maral more than once. All census routes followed existing trails in order to reduce noise caused by the observer. From a statistical standpoint, locating transects randomly throughout each area being censused would have been desirable. Because of noise created by an observer crashing through the vegetation, however, that procedure would have reduced the numbers of Maral seen and seriously biased the results. Moreover, clearing new paths would have modified the vegetation pattern.

The assumptions had to be accepted that: (1) the sample counts were equivalent to random samples and (2) the number of Maral observed equalled the total number of Maral present along the transects surveyed. The analysis of variance for the deer counted was calculated on the basis of the number of Maral seen per 1000 ha. Because the standard deviation of counts within a month tended to vary in proportion to the average monthly Maral count, the variate transformation $Y = \log (X + 73.10)$ was calculated and used in the analysis.

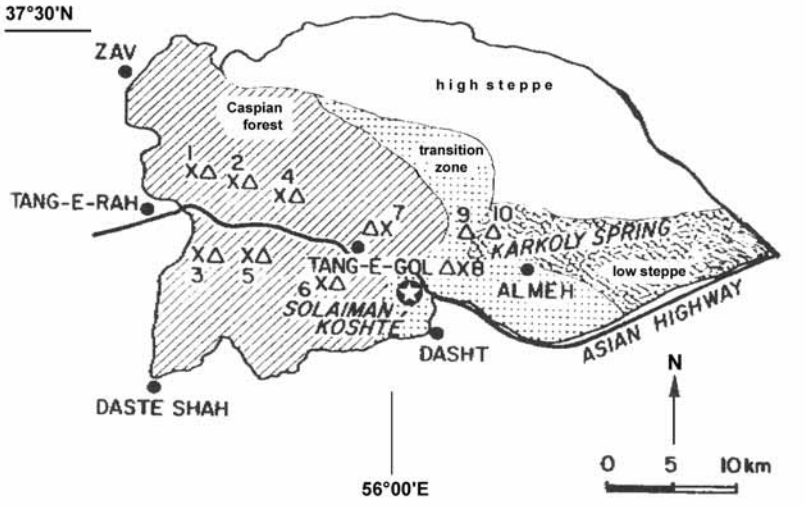

Fig. 1. Major vegetation types in the Golestan National Park. Crosses show the study areas no. 1–8 (population transects), trinangulars the study areas 1–10 (pellet-group counts), and the star the Solaiman-Koshté wintering site.

Binoculars were used for the counts, and care was taken not to disturb the animals. Most observations were near dawn and dusk when Maral were most active. Notes were also made on other animals and their signs that were seen. This was in an effort to determine possible competition and other interactions with the Maral.

Pellet-groups were counted as an alternative method to determine Maral density in 1977-78. A 4 m^2 circular plot was used. Sample plots were distributed randomly in areas of high-intensity use, where it has been found to be more efficient. Pellet-group counts were conducted only in autumn since the lush vegetation growth in spring and summer tended to hide pellet-groups during these seasons. Pellet-group counts were also carried out in late winter and early spring at a few wintering grounds.

An index of habitat use by the Maral was calculated from pellet-group deposition over the three major habitat types plus forest meadows. Moran's utilization index (MORAN 1973) was used to compare pellet-group deposition between habitat types. Habitat use was measured in winter and in summer.

Results and disussion

Population densities

Maral densities per 1000 hectares were calculated by the Hahn method for each vegetation type and season (Tab. 2). Combining these densities with the areas of each cover type yielded an overall number of 1,897 Maral present on average during the 18-month study period in the entire park (Tab. 3).

Tab. 1. Size categories of Maral hinds and stags, Golestan National Park, Iran, 1976–1978. Adopted from DE NAHLIK (1974). [1]Brow = The lower point on the antler, sometimes called the first antler. [2]Bey = The second point or tine of a stag's antlers. [3]Trey = The third point or tine of the antler. [4]Fork = The two points at the extremity of the antler in the form of a fork. [5]Crown = The uppermost cluster of three points of a red deer head, if they form a crown.

1. Hinds	
Calf	Spotted
Very young hinds (yearlings)	Smaller in the shoulder than the older animals; in a herd, yearlings normally trail behind the most recent calf which follows the mother. Up to the age of 2 years, the short length of the head, which assumes full size by the age of 2½ years, is a good indicator of age.
Young, but fertile hinds	Age 3-5 years, head and body start to fill in.
Fully-mature hinds	Body looks sturdy and well-filled, ears appear firm and fully responsive to animal reflexes. Animals normally will not show their ribs other than perhaps at the end of winter. Age 6-10 years.
Old hinds	The neck gets thinner. The ribs are visible through the skin for most of the year. The entire head appears longer and more emaciated. The ears become flabby. Age >10.
2. Stags	
Calf	Spotted
Spike stag - yearling	Small head, short body, long ears, simple antlers without brow[1] and trey[3] tines. Up to 2 years.
Young but fertile stags	Antlers with beys[2] and brow[1] tines. Trey[3] fertile stags are about to fork[4]. 2–5 years old.
Fully-mature stags	The body looks sturdy and well-filled, antlers develop a crown[5]. 6-10 years old.
Old stags	Antlers deteriorate, tines are shortened, crown disappears. >10 years old.

When variance in the number of Maral seen per 1000 ha. of land was appraised, there was an evident tendency (Fig. 2) for the standard deviation of counts within a season to vary in proportion to the average seasonal Maral count. Transforming the data (Tab. 2) by the variate Y = log (X + 73.10) [based on HARTLEY et al. (1955): Y = log (X +a/b)], differences in deer densities between seasons, areas, and their interactions (Tab. 4) were indicated to be highly significant.

Using the fecal pellet-group data with a defecation rate of 10 pellet-groups per day for red deer (RINEY 1957), the mean autumn population estimate was 2096 deer (Tabs. 4–5).

Herd composition

The average Maral group size in the park was 4.6±1.1 (Tab. 6). Female deer outnumbered males by more than 3 to 1. The average sex ratio observed among adults was 27 stags : 100 hinds (Tab. 6). If the cumulative herd-size frequencies were transferred to a normal probability scale and plotted against numbers per group, then the frequency distributions, if normal, would form a straight line. In fact, the data form approximate straight lines between points 3-12 and 12-18.

The data from the Chamois (*Rupicapra rupicapra*) and the Red Deer (*Cervus elaphus*) were found to be bimodal (CAUGHLEY 1976b). The present data and those populations indicate that group size does not affect the urge of an animal to join the group.

Tab. 2. Maral densities as determined by the HAHN transect method, in Golestan National Park, 1976-1978. The figures give the number of animals per 1000 ha.

	autumn 1976	winter 1977	spring 1977	spring 1977	summer 1977	summer 1977	autumn 1977	winter 1978
Caspian deciduous forest								
Adnasad – Chamishlee	12	41	13	8	10	10	6	64
Late – Khodagholi	0	36	7	14	15	10	11	35
Forest meadows								
Afralee – Alidalj	32	78	18	24	70	70	46	34
Khandooshan	91	89	52	122	74	111	66	76
Bozaghan	6	170	64	89	40	8	44	108
Takhte' – Korda	5	29	24	61	27	27	8	33
Savarbaghi – Aghsoo	39	44	29	14	48	15	29	60
Transition zone								
Charangine-ridge and upper Karkoly valley	74	17	99	38	126	47	85	56
Average	**35**	**63**	**38**	**46**	**51**	**37**	**37**	**58**

Tab. 3. Average Maral population densities as determined by the HAHN transect method, Golestan National Park, Iran, 1976-1978. * Area adjacent to transition zone (1.5 km wide); ** Not surveyed by the Hahn method. Observations of the Maral over the 15-month period, however, showed that 5.8% of all deer seen were in the steppe-border area (see Tab. 14).

Vegetation type	Area in ha.	Average Maral density per 1000 ha.	Population size per vegetation type
Caspian Deciduous Forest	34,100	19	648
Forest Meadows	3,400	55	187
Transition Zone	14,000	68	952
Steppe Border*	4,500	**	110*
Open Steppe	35,895	0	0
TOTAL	**91,895**	**20.6**	**1,897**

Reproduction and mortality rates

The first calls of rutting males started as early as September 2, and continued through until October 5. The number of females gathered by a breeding stag varied from 2 to 19. There was an average of 10 hinds per harem in the transition vegetation zone and 5 hinds per breeding stag in the Caspian deciduous forest.

Gestation in Red Deer has been reported to last about 8 months (DE NAHLIK 1974). In the park, it was confirmed that gestation lasted approximately from September 2, when the rutting season started, to May 10 when the calving season began, i.e. a total of 250 days.

Single calves were the rule. Only two instances of twins were seen. In 1977 the first report of a newborn calf was May 10. From the monthly distribution of 16 births between the years 1840 and 1870 published by ZUCKERMAN (1953), the mean date of birth and standard error were determined, as explained by CAUGHLEY (1976b), to be 30 June ± 2 days. The number of calves produced per 100 hinds based on summer data was 28 (Tab. 6).

Fig. 2. Maral, *Cervus elaphus maral*, stag in velvet, in Arasbaran Protected Area, where it has been introduced from Mazandaran. Photograph taken in 2003 by SEHHATI.

Despite limited available data from the summer of 1975, a comparison between the population numbers in 1975 and 1977 was made (Tab. 7). Census results for September 20 through until September 30 were available for comparison and the Mann-Whitney U-test (ELLIOTT 1977) was computed. The U values of 5 and 10 suggest that the two populations were not different in density at the 5% level of significance. In order to gain at least an approximate measure of some Maral population characteristics, it may be assumed that the population is stationary. If so, therefore, population mortality rate and life expectancy can be derived from the ratio of juveniles to adults. Where j is the number of 0–1 year-old animals in a sample of n individuals drawn from a stationary population immediately after a restricted annual season of births, the population annual mortality rate is equal to the proportion of juveniles (j/n) and life expectancy in years is (2n-j) / 2j (CAUGHLEY 1977a). Based on summer data (Tab. 7), the park Maral had an annual mortality rate of 13.9% and a life expectancy of 6.7 years.

Seasonal use of habitat

Utilization index values (Tab. 8) indicated that Marals have both winter and summer preferences for meadows in the Caspian deciduous forest. It is interesting that 5.8% of all animals were recorded in steppe vegetation (Tab. 9). Their pellets were found even in the Almeh Valley, 3-4 km from the woodland.

Maral appear to have been numerous on the Caucasian steppes during the Pliocene (VERSESHCHAGIN 1967) and to have had a more widespread range then than today. During

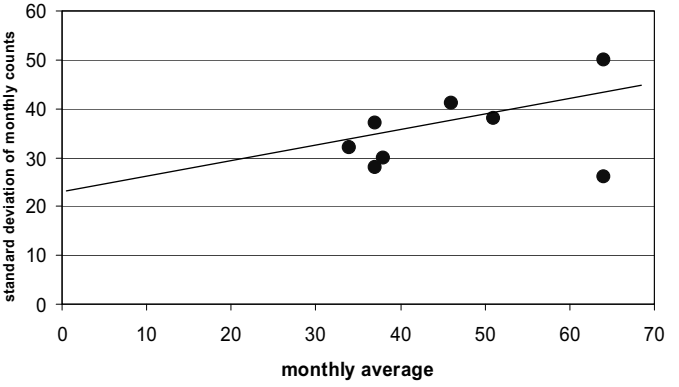

Fig. 3. Regression of standard deviations on the average monthly Maral count, Golestan National Park, Iran, 1976–78.

Tab. 4. Maral densities as found through fecal pellet-group counts in Golestan National Park, Iran, in autumn 1976 and autumn 1977. Open steppe, where no marals have been recorded, is not included in the average value. Number of Maral per 1000 hectares = (No. of pellet-groups/1000 ha) / (No. of days since heaviest leaf fall × 10 groups/day/Maral). The heaviest leaf fall was recorded on 19 November, 1976 and on 16 November, 1977.

	Deer per 100 hectares	
	Autumn 1976	**Autumn 1977**
Caspian deciduous forest		
Adnasad – Ghamishlee	11	23
Late' – Khodagholi	11	10
Gharangine – Jangle	32	22
Forest meadows		
Afralee – Alidali	14	50
Khandooshan	26	25
Bozaghan	24	40
Takhte – Korda	63	25
Sararbaghi - Aghsoo	42	29
Transition zone		
Charangine - ridge and upper Karkoly Valley	73	79
Steppe – transition zone ecotone		
Takhte' - Almeh	39	52
Open steppe	0	0
Average	**33.5**	**35.5**

recent times, the major causes of Maral reduction, according to VERSESHCHAGIN (1967), appear to have been a combination of competition from livestock and indiscriminate hunting. It is possible that stag hunts by horsemen forced the Maral to retreat into the forests where they were out of reach of mounted hunters. Today in spring and summer deer tend to migrate from forests to the open steppe, in order to escape from blood-sucking insects (VERSESHCHAGIN 1967).

Tab. 5. Maral population densities as determined from fecal pellet-group counts, Golestan National Park, Iran, autumn 1976, 1977.

Vegetation type	Area in ha.	Average Maral density per 1000 ha.	Population for vegetation type
Caspian Deciduous Forest	34,100	18	714
Forest Meadows	3,400	34	116
Transition Zone	14,000	76	1,064
Steppe-Border	4,500	45	202
Open Steppe	35895	0	0
Total	**91,895**	**22.8**	**2,096**

Tab. 6. Proportions of size categories from eight counts of Maral between November 1976 and April 1978 in the Golestan National Park, Iran. Y. Mature = Young Mature; F. Mature = Fully Mature.

	Numbers Seen	Stags				Hinds				Calves
		Yearling	Y. Mature	F. Mature	Old	Yearling	Y. Mature	F. Mature	Old	
September 1975	136	.05	.03	.07	.02	.28	.10	.23	.10	.12
Autumn 1976	138	.10	.15	.07	.00	.27	.18	.22	.00	.01
Winter 1977	1,617	.03	.06	.07	.04	.17	.27	.28	.08	.00
Spring 1977	300	.05	.03	.03	.01	.21	.25	.11	0	.31
Summer 1977	357	.04	.05	.07	.05	.15	.27	.19	.04	.14
September 1977	900	.04	.05	.07	.04	.15	.27	.19	.05	.14
Autumn 1977	209	.06	.04	.08	.01	.18	.33	.22	.00	.08
Winter 1978	174	.01	.01	.06	.01	.30	.47	.13	.01	.00
Total 1975–1978	**3,833**	**.04**	**.05**	**.07**	**.03**	**.18**	**.27**	**.23**	**.05**	**.08**

Tab. 7. Comparison of the Maral population of Golestan National Park in 1975 and 1977. *Where the calculated levels of U exceed the tabulated values of U, the mean levels of the two samples are accepted as being identical. U is not significant, therefore, at the 5% level of significance.

	September 1975	September 1977
Proportions of Size Categories:		
• Calves	.12	.14
• Hinds	.71	.66
• Stags	.17	.20
Marals seen per census	17, 8, 68	81, 72, 2, 22, 18
Mann-Whitney U-test:*		
R1, 2	11	25
U1, 2	5	10
N1, 2	3	4

Fig. 4. Maral in Golestan National Park (photograph by R. A. GHAEMI).

Shrub abundance seemed to be the most important vegetative factor associated with high pellet-group density, and mixed trees and shrubs was the vegetation type most preferred by the Maral (Tab. 10). The number of pellet-groups was considerably higher where numerous shrubs were associated with trees than where plots contained trees and few or no shrubs.

The two consecutive winter seasons during which studies were carried out differed considerably from each other with respect to the depth and persistence of snow. It seems that snowfall depths of about 45 cm seriously impeded the movements of Maral. Two days after a snow of more than 45 cm., Marals had moved to the Solaiman Koshte wintering ground (a transition vegetation type), at a lower elevation.

Maral stags tended to associate with hinds mainly during the rutting season. For most of the year they lived in segregated herds. Although it has been known (DARLING 1937) that stags leave the hinds after the rut and move to different home ranges, it has evidently not been published that such spatial segregation occurs on common winter ranges. Stags outnumbered hinds in winter at high elevations (Tab. 11, Upper Karkoly Valley) and are thought to be more abundant at other seasons as well. This type of habitat segregation has also been recorded for wapiti (FLOOK 1970) and bighorn sheep (GEIST & PETOCZ 1977). In winter, the females and young stayed at lower elevations where the weather was milder, snow-free days were more frequent, and grasses were more abundant. As GEIST & PETOCZ (1977), CLUTTON-BROCK et al. (1982) and KREBS (2001) have pointed out, it is possible that spatial segregation of the sexes benefits hinds and calves and, therefore, maximizes herd reproductive fitness.

Tab. 8. Comparative seasonal utilization of habitat types by Marals as indicated by pellet-group abundance, Golestan National Park, 1976–1978. *Utilization index (U.I) = % pellet-groups in type / % area occupied by type.

	Average pellet-groups per ha.		% Area	Winter % pellet	Summer % pellet	Winter U-I*	Summer U-I*
	Winter	Summer					
Caspian Deciduous Forest	44	84	37.1	78.2	27.6	2.1	0.7
Forest Meadows	29	539	3.7	6.9	18.4	1. 8	5.0
Transition Zone	18	426	15.2	11.3	47.4	0.7	3.1
Steppe-Transition Zone	6	245	4.9	3.5	6.3	0.7	1.2
Open Steppe	0	0	39.1	0	0	0	0

Tab. 9. Observations of Marals in Golestan National Park, 1976–1978, by vegetation type. A = autumn, W = winter, S = spring, Su = summer. * See Tab. 3.

	Number of Marals				Percentages of Marals				Total	
	A	W	S	Su	A	W	S	Su	1976	1977
Caspian Deciduous Forest	21	416	21	70	5.4	21.0	5.6	5.0	528	12.8
Forest Meadows	178	1424	175	535	46.1	71.8	46.7	38.4	2312	55.8
Transition Zone	165	136	143	615	42.8	6.8	38.1	44.1	1059	25.6
Steppe	22	8	36	175	5.7	0.4	9.6	12.5	241	5.8*
TOTAL	386	1984	375	1395	100.0	100.0	100.0	100.0	4140	100.0

Tab. 10. Relations between Maral pellet-groups and vegetation density (numbers of trees, shrubs, and herbs per ha.) in Golestan National Park, 1976-1978. [1]75% *Quercus castanaefolia* and 25% other species. – [2]50% *Quercus castanaefolia*, 20% *Colutea persica*, 20% *Prunus caspica*, and 10% other species. – [3]45% *Bromus* sp., 25% *Agropyron trichophorum*, 10% *Medicago* sp., and 20% other species.

Mean pellet-groups per plot	No of trees per ha.[1]	No. of shrubs per ha.[2]	Kg. herbs per ha.[3]
0.6	0-25	216	529
0.8	26-50	362	451
3.2	51-75	412	286
4.9	76-100	448	255
1.3	101-125	232	107
1.2	126-150	132	78

The present status and conservation of the Maral population in GNP

After the 1979 revolution in Iran, a new era for wildlife and national parks and protected areas began. With so many fire arms in the hands of the people, along with shortcoming in law enforcement by the Department of Environment (DOE), most natural and protected areas experienced tremendous illegal hunting, overgrazing by livestock, wood cutting, habitat alteration and degradation, man-made fire, and poaching. The Golestan National Park was no

Fig. 5. Maral calf in Ghorogh (Golestan Province). Photograph by Miss Soheila Rezaie JAM.

exception to this. In the meantime, the population of Iran has almost doubled in 25 years, from 36 million in 1978 to 68 million in 2004. Local people who live close to the park never liked the way the park staff (as well as DOE staff) behaved toward them. Waiting for an opportunity for revenge (!), they deliberately set fire to the very ancient and precious evergreen *Juniperus* trees and to grassland in the steppe portions of the park, and constantly and deliberately chased the large animals back and forth causing great stress and disturbance to the poor creatures. Of course, their hatred does not justify these acts of violence.

In addition there were some natural disasters, such as two consecutive summer floods (2001 and 2002) which left many bodies of humans and game animals buried in the sediments of the downstream Gorgan Rud River Dam outside the park, destroying large portions of the wildlife habitats alongside the highway going through the park and resulting in a decline of the wildlife population. Road kill plays an important role as a mortality factor for larger mammals such as Maral, Wild Boar (*Sus scrofa*) and Leopard (*Panthera pardus*) (KIABI et al. 2002).

It seems that in spite of its large size as well as its shy and secretive nature, the Maral (mainly larger stags and older hinds) is an easy target for the local and other riflemen. Many isolated calves (newly born) have been captured and sold or kept in captivity. Many of these misfortunes for the Maral population have escaped the notice of the game wardens. The Maral population therefore is declining drastically (Tab. 12).

Tab. 13 shows the great reduction in the Maral population in its major present and former habitats. The main causes are illegal hunting and livestock overgrazing in these areas. Observation of the movements of the Maral reveals the importance of the present so-called corridors in Golestan National Park. The lack of a protected corridor has reduced the interchange between populations, and has lead to an increase in the road kill numbers of Maral

Tab. 11. Relative distribution of Maral stags and hinds in wintering areas in winter 1977 and 1978, Golestan National Park, Iran (n = 1984, including repeated observations).

	Approx. altitudes (m)	Stags (%)	Hinds (%)
Caspian Deciduous Forest			
Gharange Jangle	1500	17.07	3.97
Golestan - Golshan	500	2.44	20.90
Forest Meadows			
Afralee - Adnasad	1000	4.88	15.92
Khandooshan	500	0	3.48
Bozaghan	1000	4.88	20.90
Takhté – Korda	1500	7.32	17.91
Transition Zone			
Tunnell Solaiman Koshte'	1500	2.44	16.94
Upper Karkoly Valley	2000	60.97	
TOTAL	--	**100.00**	**100.00**

Tab. 12. Population development of Maral in Golestan National Park, between 1982 and 2003.

	Maral population estimation	
	Counts during rutting seasons	Counts during late autumn
1982	1000-1500	1200-1500
1989	800-1000	1000-1500
1995	900-1000	900-1200
1997	500-900	600-1000
2001	500-600	–
2003	400-500	–

Tab. 13. Comparison of the size of the Maral population in various areas of Iran, 1977 and 2003. The figures were provided by R. A. GHAEMI, M. JAHANSHAHI & B. KIABI for Golestan province, by D. AMOOZADEH for Mazandaran province, by DOE staff of Guilan and Tehran for Guilan province, and by A. SASSANI, Y. SHAHBAZI & R. A. GHAEMI for Arasbaran. *7 Marals were transferred from Ghorogh (Golestan province) to Arasbaran in 1995 by A. SASSANI. The site formerly was one of the major Maral habitats.

Locality	1977 estimates	2003 estimates
Golestan National Park	1900-2100	400-500
Lowe (Golestan province)	150-250	10-15
Minoodasht (Golestan province)	300-500	20-30
Aliabad (Golestan province)	300-400	15-20
Jahan Nama (Golestan province)	400-500	50-60
Kordkoy (Golestan province)	200-300	15-20
Mazandaran province	300-500	100-150
Guilan province	200-400	50-60
Arasbaran (East Azarbaijan)	Extint	15*

and other larger woodland mammals in the park. The protection of a corridor can act as a population-assisting link (BEIER & NOSS 1998, HADDAD et al. 2000).

Protection may be needed in surrounding areas to the same degree as within the national parks themselves (KIABI 1978, KIABI et al. 1993). For example, a park located in the middle of intensive land use or human settlement is most difficult to maintain. Conflicts between internal and external values may become extreme, particularly where animal movements out of the park are concerned (BINDERNAGEL 1978).

The existing Asian Highway is the main reason for different intrusions and for habitat fragmentation. The most deleterious activities are the illegal hunting of large mammals, the conversion of surrounding areas of the park for agriculture, and the construction and development of man-made landscapes. These activities threaten park integrity and lead it towards becoming an isolated island (MAJNOONIAN et al. 1999).

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