

Breeding Success and Nest Characteristics of Golden Eagle *Aquila chrysaetos* in Western Iran

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Abstract: Territory occupancy and reproductive success of nesting Golden Eagle (*Aquila chrysaetos*) were monitored in Hamadan province in western Iran during 2011-2013. The mean clutch size was two eggs and the hatching success was 76.98%. Occupancy rate averaged 70% and was very stable in three years. Annual mean percentage of laying pairs (or laying rate) was 100, productivity (mean number of fledglings per pair) was 1 (SD = 0.0), and success rate was 100, without significant variations over the study period. A total of 26 fledglings were produced during the three-year period in seven active nests.

Keywords: Golden Eagle, occupancy, productivity, western Iran.

Introduction

The Golden Eagle (*Aquila chrysaetos*) is distributed throughout the northern hemisphere, primarily between 20° and 70° N latitudes (WATSON 1997, ISAACS 2011). Golden Eagles have been observed throughout north and western Iran and their nesting has been documented (MANSOORI 2013).

Mating, egg-laying and fledging timing in the Golden Eagle are variable depending on the locality (WATSON 2010). The recorded clutch size ranges from 1 to 4 eggs, although more often is two (WATSON 2010). The incubation period lasts from 41 to 45 days (GORDON 1955, FERGUSON-LEES, CHRISTIE 2001, WATSON 2010) and fledging occurs at 66 to 75 days of age (COLLOPY 1984, WATSON 2010). Golden eagles traditionally hunt open and unwooded areas (BROWN, WATSON 1964, WATSON 1992).

Cape hare (*Lepus capensis*) and Chukar (*Alectoris chukar*) are the common food sources available to breeding Golden Eagle in western Iran during the nesting season.

Western Iran, particularly the Iranian provinces of Hamadan and Kurdistan, due to its wide grasslands and plains with high density and diversity of rodents, is one of the most important areas for the breeding Golden Eagle in the country. Until now, no detailed study has been done on the breeding biol-

ogy of the Golden Eagle in Iran. In the present study, the breeding biology of the Golden Eagle in western Iran was described.

Material and Methods

The study area is located in the Province of Hamadan (Western Iran), around the city of Hamedan (34°11'58" to 35°14'55"N, 48°16'87" to 48°59'03"E), a territory occupied mainly by grasslands and plains with elevations ranging from 1741 to 2498 m a.s.l. The climate is temperate; annual rainfall ranges 318 mm, and a mean temperature of 11.3°C. The most common vegetation types are scrub communities (*Acantholimon* spp., *Amygdalus* spp., *Astragalus* spp., *Berberis integerrima*, *Rhus coriari*, and *Alhagi* spp.).

In 2011-2013, the ten nests found were monitored during the three breeding seasons. The habits and breeding behaviour were investigated using a pair of binoculars. The nests were also studied by video-recording through the mounted videocamera recorder.

The terminology used to describe occupancy and reproductive parameters is based on recommendations from STEENHOF (1987), MCINTYRE (2002),

and MORNEAU *et al.* (2012). It was assumed that all incubating birds had eggs. The laying pairs that produced ≥ 1 fledgling were considered successful pairs (STEENHOF 1987). Productivity is the mean number of fledglings per pair and production is the total count of fledglings (STEENHOF 1987).

Surveys were conducted using 4WD vehicles or on foot from February to late June 2011-2013. The surveys focused on cliffs. In the course of the survey each year, all known nests within each nesting area were checked in order to determine their occupancy, content, and the number of the eagles present. The young birds were aged according to MATHIEU (1985).

Chi-square analysis was used to test for differences in the occupancy rate, laying rate, and success rate among the years. Analysis of variance (ANOVA) was used to test for differences in the mean brood size among the years. All tests were considered significant at the 0.05 level.

Results

The Golden Eagles clearly selected cliffs, which were farther away from roads and houses. The height of the nesting cliffs was from 8 m to 90 m. The dimensions of the nest place were 2.5 m in length and 1.5 m in width. The structure of the nests was made mainly of thick and large woods lined with tuft of grass roots, wool and large pieces of cloth. The nesting areas ($n=10$) were monitored annually (Table 1), for three years, from 2011 to 2013. The nests were video recorded for 441 hr during the three years. Three of the nesting territories were unoccupied throughout all three survey years. Unoccupied nests were likely related to owner-occupied nests.

The mean first-egg date was calculated as 5-7 March. The clutches were completed on 9-11 March. The mean clutch size was 2 eggs. The incubation began in early March and ended within 21-24 April. The length of the incubation was 42-44 days. The females brooded the young, while the males supplied food for the females and nestlings. In the fifth week, the nestlings were able to feed themselves. The young fledged during the last week of June at 63-70 days of age, and left the nest when they were 85-86 days old. During our observations, the adults brought prey to the nest once every 5-6, hr approximately 1-2 times a day.

Overall, the mean annual occupancy rate averaged $70\% \pm 0.00\%$, without varying significantly among the three years ($X^2_{(1)} = 0$, $P > 0.05$). The annual mean laying rate in our study area was $100.0 \pm 00.00\%$ ($X^2_{(1)} = 0.00$, $P > 0.05$). The annual mean

productivity was 1.0 ± 0.0 (no significant difference, $X^2_{(1)} = 0.00$, $P > 0.05$) (Table 1). Two nests contained two fledglings each in 2011 and 2012 and one nest in 2013. The success rate did not vary ($X^2_{(1)} = 0.00$, $P > 0.05$). The annual mean brood size averaged 1.24 ± 0.45 fledglings per successful pair and did not vary significantly in different years ($F_{2,18} = 0.23$, $P > 0.05$) (Table 1). A total of 26 fledglings were produced during the three-year period.

Discussion

Little is known about the breeding biology and distribution of the Golden Eagle in Iran, and new data on the egg-laying phenology, growth rates and breeding success are important for shedding light on the life-history strategies and conservation needs of this bird.

Clearly, Golden Eagles have most probably been breeding in the study area for a long time. It generally takes two or more survey years to identify completely all nesting territories and territorial pairs in an area (PHILLIPS, BESKE 1990, MCINTYRE, ADAMS 1999, MORNEAU *et al.* 2012). In our study, most of the nests were located towards east, perhaps because of the intense sunlight and heat to avoid it.

The occupation of the nests for several consecutive years indicates at least a stable population. The occupancy rates of eagles in our study were stable. The mean occupancy percentage (70%) was higher than that (56.7%) observed by MORNEAU *et al.* (2012) and lower than the same variable reported for Denali National Park, Alaska, by MCINTYRE (2002), where 75% of the nesting territories monitored for ≥ 10 years were occupied throughout all the years. The difference may be partly assigned to the reduction in the number of preys, such as rabbits, the habitat destruction by humans and insecurity for the Golden Eagle.

The egg-laying rates found in this study (annual mean = 100%) are slightly higher than the values observed in other areas studied, such as Idaho (annual mean = $70.0 \pm 15.5\%$; STEENHOF *et al.* 1997), Denali National Park, Alaska (annual mean = $62.1 \pm 19.5\%$; MCINTYRE, ADAMS 1999) and Northeastern Québec, Canada (annual mean = $48.0 \pm 19.9\%$; MORNEAU *et al.* 2012).

The mean annual productivity obtained (1.0 ± 0.0 fledgling/pair) is higher than the values observed in several other studies, for example, in: Scotland ($0.78-1.08$ fledgling/pair; KOCHERT *et al.* 2002); the Alps ($0.29-0.95$ fledgling/pair; PEDRINI, SERGIO 2001b); Denali National Park, Alaska (0.66 fledgling/pair; MCINTYRE, ADAMS 1999); Sweden (0.64

Table 1. Reproductive characteristics of the Golden Eagle in western Iran, 2011-2013

Parameters	Year		
	2011	2012	2013
Nesting territories examined	10	10	10
Nesting territories occupied	7	7	7
Occupancy rate (%)	70	70	70
Pairs with eggs	7	7	7
Laying rate (%)	100	100	100
Hatching rate (%)	83.33	71.43	76.19
Pairs with fledglings	7	7	7
Success rate (%)	100	100	100
Productivity (mean \pm SD)	1.0 \pm 0.0	1.0 \pm 0.0	1.0 \pm 0.0
Production	9	9	8
Mean brood size (mean \pm SD)	1.28 \pm 0.49	1.28 \pm 0.49	1.14 \pm 0.38

fledgling/pair; TJERNBERG 1983; and 0.68 fledgling/pair; MOSS *et al.* 2012); the Northwest Territories, Canada (0.63 fledgling/pair; POOLE, BROMLEY 1988); and the Northeastern Québec, Canada (0.49 fledgling/pair; MORNEAU *et al.* 2012). In our study, high

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productivity in Iran is possibly related to the stability of a favorable climate, small population of the Golden Eagle on a broad territory, high number of preys, such as Cape Hare and Chukar, in the area and the easier hunting. BOUTIN *et al.* (1995), MCINTYRE, ADAMS (1999), and MCINTYRE (2002) suggested that reproductive success of Golden Eagles is influenced by the fluctuating numbers of the prey available to eagles early in the nesting season.

In summary, the general knowledge on the ecology and biology of the Golden Eagle in Iran remains incomplete, and further study on the diet composition, age structure of the population, and survival would provide a basis for improving its conservation status, particularly through helping in the early detection of some negative population trends. The main threats to the Golden Eagles in Iran appear to be the habitat destruction and illegal hunting for using in falconry.

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