

Brief report

Marsh Harrier *Circus aeruginosus* predation on artificial duck nests: a field experiment

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Received 7 November 2000, accepted 9 January 2001

1. Introduction

Predation has often been identified as a major cause of low nesting success of many ground-nesting birds (Angelstam 1986, Klett *et al.* 1988). Hence conservation planners need to identify the predator species responsible for nest depredation in order to develop strategies for reducing predation (Pasitschniak-Arts *et al.* 1998, Sargeant *et al.* 1998). Predators are usually determined by using indirect methods, since they are very rarely observed at depredated nests. However, the most commonly used method of predator identification, from depredated nest remains, often may be misleading (Lariviere 1999).

Across Europe, the Marsh Harrier *Circus aeruginosus* is frequently found eating eggs of larger ground-nesting birds (Cramp & Simmons 1979). In order to improve the knowledge on how certain predator species depredate duck nests, I studied the response of Marsh Harriers upon artificial duck nests through direct observations. The aim was to obtain data on i) the probability of nest depredation by harriers; ii) harrier behaviour at nests during depredation; and iii) the nest appearance after depredation, which could help to identify cues typically left by Marsh Harriers.

2. Study site and methods

I conducted the study on a 4.5 ha island on Lake Engure, Latvia, 57°15'N, 23°07'E, from 4–18 June 2000. The timing corresponds to the peak numbers of active duck nests in the area. In 2000, forty-two natural duck nests were found in the study area (*see* census methods in Blums *et al.* (1993)), of which only 5 (12%) were successful.

The Marsh Harrier is the dominant predator of duck eggs on Lake Engure. According to an earlier assessment, this species alone was responsible for 54% of all nest depredations (Opermanis *et al.* 2001). I estimate that the study area was visited by at least 8 different harrier individuals. Although harriers were not individually marked, 5 birds were recognizable by plumage (2 immature males, 1 adult male and 2 immature females). Additionally there were 3 adult females (once observed simultaneously), which I was not able to distinguish individually. Of these birds, only one pair (adult male and female) had a nest within a roughly 500 m radius around the observation site. The remaining harriers were likely non-breeders. However, some could have had nests at a greater distance away as the Marsh Harrier's maximum hunting distance from its nest well exceeds

the 500 m radius I was able to observe in detail (Schipper 1977). Judging from two nests, during the study period Marsh Harriers had small to half-grown nestlings.

Observations were done from a $1.8 \times 1.8 \times 2.0$ m blind mounted on the top of a 12 m high metallic tower, located nearly in the centre of the island. The four windows in the blind allowed observations in four directions. During each observation session, all windows, except the currently used one, were properly darkened.

For each session I placed a pair of simulated duck nests in the quite homogenous vegetation (ca. 15 cm tall) that surrounded the tower. Vegetation was dominated by grasses *Poaceae*, occasionally interspersed with reeds *Phragmites australis* and sedges *Carex* spp. Simulated nests were placed at least 10 m apart, 50–100 m from the tower. The location of each simulated nest was never repeated because nests that had been depredated and intact nests after the observation session were removed and placed in a different location at the next session. The direction of observation session was not repeated at least in 24 hours. These precautions were taken to maximally avoid the possibility that harriers could learn nest position, since each depredation case was taken as an independent observation.

Each nest contained 6 fresh eggs taken from natural depredated or abandoned duck nests. When duck eggs were not available in sufficient number, 1–3 white hen eggs were used instead in order to complete the 6-egg clutches. A comparison between sessions with only duck eggs ($n = 5$) and mixed duck and hen eggs ($n = 13$) showed no significant difference between depredation rates. Therefore, I am confident that the use of hen eggs did not affect the depredation rate, as could be expected, since hen eggs were slightly brighter and thus likely more conspicuous.

Eggs were openly placed in a nest-bowl made from natural duck nest material consisting of dry grasses and duck down. These artificial nests typically resembled natural nests of Mallard *Anas platyrhynchos*, Northern Shoveler *Anas clypeata* or Garganey *Anas querquedula*, if females were flushed and eggs not covered.

In order to avoid the same birds revisiting re-

cently depredated nests, the sessions were short (mean 185 min, range 155–240 min). I recorded the number of harrier flights over the nests and the depredation cases. The 'flight' was recorded when a soaring harrier crossed the airspace over an artificial nest within a 5 m horizontal radius, regardless of whether it spotted the nest or not. Distance evaluation was arbitrary, however, before each session I calibrated my sense of distance according to measured items in front of the tower. When evaluating distance, a correction (adding up to 5 m) was done according to the harrier flight height: the higher the flight of bird, the larger the estimated distance. 'Depredation case' was recorded if the shell of at least one egg was broken.

Depredated nests were examined immediately after the harrier departed. If a harrier at nest was disturbed by another harrier intending to continue egg consumption at the same nest, the latter was scared away by clapping hands. Usually nest examination took about 10 minutes and this period was excluded when estimating the total exposure of artificial nests. For each depredation case I recorded time (rounded up to the nearest minute), total time a predator spent on the nest, harrier sex and age, number of eggs cracked and amount of egg contents consumed. The last was estimated with precision to one-fourth of egg contents. Consequently, if out of 6 eggs, only 2 were three-fourths eaten and one was one-fourth eaten, I stated that the total amount was 1 egg and three-fourths (1.75). It was not possible to obtain better estimates because some amount of yolk frequently leaked into the nest during the predation process. Seven depredation cases were recorded on videotape allowing more detailed examination of harrier behaviour.

The period of daylight (i. e. approximately from 03.30 to 21.30) was divided into three equal parts in order to detect possible differences in harrier activity and consequently nest survival among different periods of the day (Table 1).

I used Spearman Rank Correlation, χ^2 test and the Mann-Whitney *U*-Test in SPSS 10.0.5 software package (SPSS Inc. 1999). All tests were two-tailed.

3. Results and discussion

Total observation time was 5764 nest-minutes, or 96.1 nest-hours divided in 18 separate sessions. During this period, 55 artificial nests were set up (including those replaced after depredation) and 21 depredation cases by Marsh Harriers were observed (Table 1). No other predator species depredated the artificial nests.

Average hourly nest predation probability (modified from daily probability according to Mayfield (1975)) was 0.22 and the probability that a harrier would cross the airspace from which the nest could be spotted was 0.69. Although the hunting activity of harriers was slightly higher in the morning and the evening, and nest depredation rate decreased from morning to evening (Table 1), the shifts in nest finding rate (nests approached vs nests depredated) among different day periods were not significant ($\chi^2_2 = 2.18$, $P > 0.05$). However, there were significant differences in hunting activity between sexes ($\chi^2_2 = 6.08$, $P < 0.05$): males clearly were more active and depredated more nests in morning hours while females were more active and depredated more nests at midday and in the evening. There were no differences in the nest finding rate between the sexes ($\chi^2_1 = 0.21$ with Yates correction, $P > 0.05$).

Nest depredation occurred after 31.8% of the total number of flights over nests. However, this figure may be biased, because some harriers may have spotted a nest at first arrival, but could not land on it because of mobbing by terns, waders or other harriers. Apparently, soon after they returned to the area, re-found the nest and committed the depredation. Therefore, these harrier appearances,

first and second flights, often cannot be regarded as independent observations. On the other hand, the finding rate of artificial nests, if generalised to natural nests, may be overestimated since artificial nests may not match with the characteristics of natural nest sites (Guyn & Clark 1997), which leads to increased predation probability by avian predators (Angelstam 1986, Willebrand & Marcstrom 1988, Andren 1992).

Harriers spent on average 25.1 minutes on duck nests (SE = 2.47, $n = 21$). While on the nest, in only 5 cases harriers were apparently disturbed by another harrier. These cases were also included in the calculations, since the disturbance should be regarded as a natural factor occurring regularly. Harriers consumed on average 1.9 eggs (SE = 0.20, $n = 21$) and on average cracked 3.3 eggs (range 1–5, $n = 21$) per depredation case.

There were no statistically significant differences in the time spent on nests and the number of eggs eaten between the sexes (Mann-Whitney *U*-Test; time: $U = 28.5$, $P > 0.05$; eggs: $U = 28.5$, $P > 0.05$). However, immature birds ($n = 7$) spent significantly more time on nests ($U = 18.5$, $P < 0.05$) than adults ($n = 14$) and there was also slight evidence that immatures consumed more egg contents than adult birds ($U = 23.0$, $P = 0.056$). Neither the time spent on nests nor the amount of egg contents eaten correlated with the time elapsed from sunrise (time: $r_s = 0.01$, $P > 0.05$; eggs $r_s = 0.07$, $P > 0.05$). As could be expected, the correlation between time on nests and eggs eaten was highly significant ($r_s = 0.90$, $P < 0.001$).

The whole depredation activity took place at the nest. Soon after landing, harriers started to lift eggs with their bills and drop them on other eggs,

Table 1. Marsh Harrier foraging activity and success on artificial duck nests. Abbreviations: depredation done by m = male, f = female.

Time of day	Nest minutes	Flights over nests			Flights per hour	Predation cases			Predation cases per hour
		m	f	total		m	f	total	
3.30–9.30	1446	11	7	18	0.75	5	3	8	0.33
9.31–15.30	1704	3	14	17	0.60	0	7	7	0.25
15.31–21.30	2614	10	21	31	0.71	1	5	6	0.14
3.30–21.30	5764	24	42	66	0.69	6	15	21	0.22

Fig. 1. Immature Marsh Harrier female on artificial duck nest. Eggs were lifted one by one and dropped onto other eggs in order to break them. Photograph: Aivars Petriņš.



presumably to break the shells (Fig. 1). Then they used their bills to penetrate into the egg interior and sip out the yolk, which took the majority of time. With time, sipping intensity became lower until sipping completely stopped. Before leaving the nest, birds usually spent some time preening or cleaning their bills. One immature female, after consuming 3.25 eggs, fell asleep until she was disturbed by another harrier.

Remains of all cracked eggs (69 from 21 nests) were found in the nest-bowl on undisturbed nest material. No egg was transported away from the nests. An exception was one individually recognizable immature male who twice depredated simulated nests and in both cases he threw whole eggs out of the nest, back into the nest and again out just before leaving. It was unclear if this behaviour was an element of a game or the bird tried to make the nest more obvious when returning afterwards.

Eggshells were usually opened laterally at crack sites. Edges of the holes were sharp and only rarely bent inwards. Hole shape was irregular, curved and often prolonged. A particular sign was that egg contents were rarely (19 out of 69) consumed completely.

This study showed that openly situated artificial duck nests in an area frequently visited by harriers, despite the presence of a Common Tern *Sterna hirundo* colony (closest tern nest was ca 150 m from the observation site) and breeding active waders (Oystercatcher *Haematopus*

ostralegus, Lapwing *Vanellus vanellus*, Black-tailed Godwit *Limosa limosa* and Redshank *Tringa totanus* all had nests in the periphery of the tern colony), had no chances to survive a day, not even for ca 4 hours. Therefore, any disturbance causing female ducks to leave nests may be disastrous taking into account Marsh Harriers alone. Another important finding is that, although I described typical cues left by harriers at simulated duck nests, harriers always left the nests before all egg contents were consumed, thus providing an excellent opportunity for other predators, including other harriers, to locate the nest and continue the depredation. As a result of these repeated and multi-predator visits, the possibility that a researcher can determine the predator type originally responsible for nest depredation decreases with time. Although this may be overcome by more frequent nest monitoring, such a strategy may cause other problems, e.g. impact on vegetation near a nest leading to increased depredation rates (Elser & Grand 1993).

To what extent can the above findings be extrapolated to natural duck nests? The conclusions would seem to be valid regarding harrier behaviour during the predation process and nest appearance after depredation when eggs were fresh. The data on the probability of Marsh Harrier appearance in an area with a high density of breeding ducks also give a realistic impression about potential threats to natural duck nests. However, a similar generalisation is likely difficult regarding

the nest finding probability by harriers of natural nests, since there are many factors which make natural nests different from artificial ones in spite of researchers' efforts (Guyn & Clark 1997).

Meanwhile, waterfowl managers need improved knowledge on how to identify duck nest predators from nest remains. This study, therefore, was useful in showing that direct observations in certain conditions may be appropriate for improving this knowledge. Thus, I would like to encourage that similar experiments should be conducted with simulated nests in other conditions (e.g. with incubated eggs) and, whenever possible, the response of other predator species should be examined.

Acknowledgements: I thank Aivars Petriņš for the high quality harrier photograph. I am grateful to T. Albrecht, A. Auniņš, P. Blūms, O. Keiņš, A. Mednis, P. E. Rasmussen, L. Stejskalova, M. Šalek, J. Vīksne and two referees for useful comments on earlier drafts of this paper. The study was financed by Latvian Council of Science grant No. 01.0342.

Selostus: Ruskosuohaukka maassapesivien lintujen munien predaattorina: tekopesäköe Latviassa

Pesäpredaation on todettu olevan eräs tärkeimmistä maassapesivien lintujen pesimämenestykseen vaikuttavista tekijöistä. Ruskosuohaukan on havaittu hyödyntävän maassapesivien lintujen munia eri puolilla Eurooppaa. Kirjoittaja tutki tekopesien avulla: 1) kuinka suuri todennäköisyys pesällä on joutua ruskosuohaukan ravinnoksi, 2) miten ruskosuohaukka käyttäytyy saalispesällä ja 3) millaisia merkkejä ruskosuohaukka jättää saalislajien pesälle syödessään munia? Tutkimus tehtiin 4.5 hehtaarin kokoisella latvialaisella saarella, Engure järvellä, vuonna 2000. Aiempien tutkimusten mukaan ruskosuohaukka aiheutti 54 % sorsien pesätuhoista ko. alueella. Vuonna 2000 ainoastaan 12 % sorsien pesinnöistä alueella onnistui. Tutkimusalueella saalisti kaikkiaan kahdeksan ruskosuohaukkaa, joista yksi ruskosuohaukkapari pesi tutkimusjärvellä. Kirjoittaja käytti tekopesäkokeissa sekä hylättyjä sorsanmunia että kananmunia. Tekopesiä tarkkailtiin kaikkiaan 5764 minuuttia. Kyseisenä aikana seurattiin 55

tekopesää. Ruskosuohaukan aiheuttamaa predaatiota havaittiin 21 tekopesällä. Pesäpredaation määrä ei eronnut pelkästään sorsanmunia sisältävien pesien ja sekä sorsan- että kananmunia sisältävien pesien välillä. Vaikka ruskosuohaukan saalistus oli aktiivisempaa iltaisin, laski pesäpredaation määrä iltaa kohti. Koiraat saalistivat aktiivisimmin ja tuhosivat pesiä enemmän aamulla, kun taas naaraat olivat aktiivisempia keskipäivällä ja illalla. Ruskosuohaukka vietti saalistuksen kohteeksi joutuneella pesällä keskimäärin 25.1 minuuttia. Esiakuiset linnut viettivät tekopesällä enemmän aikaa kuin aikuiset yksilöt. Kirjoittaja esittää artikkelissa kuvauksen ruskosuohaukan käyttäytymisestä pesällä kuvan kera (ks. Kuva 1). Ruskosuohaukka jätti jäännökset kaikista käyttämistään munista pesille. Ruskosuohaukka söi yleensä vain osan munan sisällöstä, vain 19 muna 69:stä oli käytetty kokonaan. Yhtään muna ei kuljetettu pesän ulkopuolelle eikä pesämateriaalia sekoitettu. Tulokset viittaavat siihen, että avoimesti sijaitsevat maapesät ovat alttiita ruskosuohaukan saalistukselle. Kaikenlainen häiriö, joka johtaa naarassorsan poistumiseen pesältä, voi olla kohtalokas ruskosuohaukan saalistusalueella sijaitsevalle sorsapesyeelle. Kirjoittaja muistuttaa, että tekopesiin kohdistuva predaatio voi erota luonnonpesiin kohdistuvasta predaatiosta. Vesilintukantojen ylläpitämiseksi tarvitaan lisätutkimuksia mm. sorsalintujen pesätuhoihin vaikuttavista tekijöistä eri alueilla.

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