

SOME OBSERVATIONS ON THE BEHAVIOR OF CAPTIVE BALD EAGLES BEFORE AND DURING INCUBATION

by

P. Naomi Gerrard¹, Stanley N. Wiemeyer² and Jonathan M. Gerrard¹

Abstract

Preincubation and incubation behavior were studied in two pairs of captive Bald Eagles. During the preincubation period, perching together, nest building and repairs, copulation, mutual billing and stroking, courtship feeding, and pseudoincubation were observed and described, and the frequency was quantitated. During incubation, activities concerned with nest maintenance, nest relief, and feeding were observed and quantitated. The time the Bald Eagles left the eggs exposed during incubation varied significantly with changes in the ambient temperature and wind velocity. A significant correlation was found between the average time the eggs were left exposed (min/h) and the wind chill index, with eggs being exposed least when the cooling power of the air was the greatest.

Introduction

With increasing interest in captive propagation of Bald Eagles (*Haliaeetus leucocephalus*) and other raptors as a means of aiding declining wild populations (Hancock 1973, Cade 1974, Maestrelli and Wiemeyer 1975), there is a need for better understanding of preincubation and incubation behavior. Such behavior in Bald Eagles has been briefly described by Herrick (1934), Broley (1952), and Retfalvi (1965) in wild birds and in captive birds in a review by Hancock (1973). For some other raptors, more detailed documentation is available (Willoughby and Cade 1964, Fyfe 1972, Grier 1973, Wrege and Cade 1977). In the present investigation, we have made use of the opportunity provided by the captive breeding of Bald Eagles at Patuxent Wildlife Research Center (Maestrelli and Wiemeyer 1975) to evaluate at close range certain aspects of the early phase of their nesting cycle.

Methods

Three pairs of Bald Eagles were caged in three identical adjoining pens as described by Maestrelli and Wiemeyer (1975). Two of these pairs were used for the present study. Each pen had screened sides and top, with translucent fiberglass roofing over the nest area. The eagles were fed through small doors at the front of the pen usually between 08:00 and 10:00. A mirror above each nest made it possible to see the eggs in the nest from the front of the pens.

Detailed observations, with little disturbance to the birds, were made on the 2 pairs from 19–24 March 1973 from a blind about 120 m southeast of the pens. The observations usually extended from dawn to dusk with periodic ½-hour or 1-hour breaks. From the blind, the view of the nests and upper perches was good, but because of the intervening pens, the lower perches and floor were out of sight. We used a 45× spotting scope and 7 × 35 binoculars. Written minute-by-minute records were kept of observations. Wind direction and estimated speed were recorded hourly.

History of the Birds

Pair I had been together since December 1969. The female was obtained from Ala-

¹954 15th Ave. S.E., Minneapolis, MN 55414

²U.S. Fish and Wildlife Services, Patuxent Wildlife Research Center, Laurel, Maryland 20811.

bama where she was found injured beneath a high voltage line, when she was, by plumage, about three years of age. The male was obtained as a nestling from Alaska. In 1971, at least two eggs were laid with the one which was intact when examined after 56 days of incubation being infertile. In 1972 this pair successfully incubated three fertile eggs, but unfortunately two newly hatched eaglets died after an April ice storm, and the third egg failed to hatch. In the spring of 1973, this pair again built a nest and were seen copulating. The female laid eggs on 26 February, on 1 March, and on about 5 March. Our observations occurred during mid-incubation from 19–24 March 1973. Further details of the history of this pair and their success in raising young eagles in 1973 are published elsewhere (Maestrelli and Wiemeyer 1975).

Pair II had also been together since December 1969. The female came from Passamaquaddy Bay, Maine, as a bird of the year in June 1966. The male was taken from Alaska as a nestling in 1962 and was hand raised at the Center (Stewart 1970). This male was partly crippled, being unable to fully extend his wings. In 1971 the female laid at least one egg during the first week of April on the partially exposed nest platform (little nest material had been added to the man-made nest). Copulation was not observed, but both adults took part in incubation. The egg broke by 26 April. In 1972 the female laid two eggs, the first on 31 March. The adult had added dry grass to the nest, thus improving it from the previous year. Both adults again participated in incubation and became aggressive towards humans after the first egg was laid. Both eggs had broken by 23 April; it was not known if they were fertile. In 1973, during the week before the observations reported in this paper, this pair of adults had been observed adding sticks to the nest. During our study, 19–24 March, this pair exhibited preincubation behavior. The female laid two eggs; the first on 26 March. The eggs were incubated until 7 May when they were removed from the nest. No embryonic development was detected in either egg.

Preincubation Behavior—Pair II

Perching together

During 6 days of observations, Pair II adults were observed perching side by side (within 3 feet of one another) on 35 occasions for 619 minutes during daylight hours. On 3 of the 4 evenings when we observed until dusk, the 2 eagles remained perched together until it was too dark to see. On 16 of the 35 occasions when the two eagles perched together, behavior preliminary to and sometimes including copulation was observed. During the periods of perching that were not associated with copulation or copulation preliminaries, they often looked at each other, sometimes called to one another, but mostly napped, looked around, or preened.

Copulation

Behavior preliminary to and/or including copulation was observed on 16 occasions (fig. 1). Seven of these occurred between 07:00 and 9:00. The rest were scattered throughout the remainder of the day. The behavior always began with a period of perching side by side. After having perched together for 1 to 32 minutes (mean = 17.5 min) one bird approached the other. The female approached first 8 of 16 times. She lowered her head, spread her wings slightly, and moved toward the male, opening and closing her beak appearing to call. Usually this calling was inaudible from the blind. When heard, it was a single, soft, high-pitched note repeated several times, very different from calls used on other occasions. She would then move her head near his wing

and nudge him (fig. 1a). When the male made the approach he hopped near her and then edged closer, sometimes calling in a similar fashion (fig. 1b). Following the initial approach by the female, the male called, then flapped his wings and moved his tail up and down (usually lowering his body and hitting the perch with his tail). When the initial approach was made by the male, the female positioned herself with feet further apart, head lowered, and wings slightly apart (bowing), ready for the male to mount her (fig. 1c). On 10 of 16 occasions, the copulation preliminaries proceeded no further.

On 6 occasions the male stepped with balled feet onto the female's shoulder and then onto her back flapping his wings and calling loudly as he did so. On 4 of these occasions, he stepped across her back and perched on the other side of her. Twice he stayed on her back several seconds lowering his body until it was flush with her back. Her tail went up and his went down (fig. 1d). He seemed to have great difficulty in maintaining his position on her back because of his inability to completely extend his wings and the resulting difficulty with flapping and flying. The first time the complete sequence was seen, the male appeared to fall off her back and land on the perch. He immediately remounted and stayed on her back longer than before, but again appeared to fall off, this time landing on the ground.

After preliminary or complete copulation behavior, the eagles remained perched next to one another 0 to 37 minutes (mean = 9.4 min). Either immediately or after a short period of perching together, the male or female or both usually (9 of 16 times) went to the nest and arranged nest material. On 6 occasions one or both birds spent considerable time preening.

Nest-associated activities

The male spent 722 minutes of 51 complete hours of observations on the nest (mean = 14.2 min/h; range 0–47 min). The female spent 621 minutes on the nest (mean = 12.2 min/h; range 0–60 min). For 70 minutes the eagles were on the nest together (mean = 1.4 min/h; range 0–14). The female spent more time in incubation posture (pseudoincubation—there were no eggs at this time) than the male. She averaged 7.7 min/h (range 0–33 min) while he averaged only 2.6 min/h (range 0–40 min). The male spent more time (total 89 min; mean 1.7 min/h; range 0–6 min) arranging sticks and grasses on the nest than the female (total 56 min; mean = 1.1 min/h; range 0–19 min).

Behavior relating to arranging nest material and assumption of incubation posture was very similar to that of pair I (see below) with 2 exceptions. First, pair II adults spent more time poking and jabbing in the center of the nest with their beaks. Second, pair II adults were much less consistent in their behavior during assumption of incubating posture. Pair I adults invariably arranged nest material and/or poked in the nest center, then rocked from side to side as they settled into the nest to incubate, and then pulled twigs and branches around them to form the nest cup. The pair II adults often left out one or more steps in this sequence.

Billing and mutual stroking

Billing (pecking at each other's beaks), and stroking each other were observed 10 times. Billing alone occurred 5 times, and stroking accompanied billing on the remaining occasions. During stroking episodes, the female was observed to stroke the male with her beak on his back and breast, while the male stroked the female on her head, neck, and shoulder. All but two of these episodes occurred before 08:00 or after 17:00.

Feeding

Feeding was seen on 4 days. Once the male carried a fish to the nest where both adults ate together. Usually the male went down to feed first, followed by the female.

Incubation Behavior—Pair I

Incubation

Pair I was observed for 55.5 hours, of which 48 hours were complete hourly periods. At least one adult was on the nest 99.5 percent of the time, and the eggs were incubated 98.0 percent of the time (table 1). When the weather was cold and the wind stronger, the incubating adult sat low in the nest with head pulled in near the body and feathers fluffed out. On warmer days with little wind, the adults sat higher in the incubating position.

The amount of time the eggs were left exposed varied with both ambient temperature and wind velocity. The eggs were left exposed significantly longer (Mann-Whitney $U = 390$; $p < 0.05$) when the air temperature was greater than 7.2°C (mean 1.72 min/h)

Table 1. Captive Bald Eagle Nest Activities—Pair I

Activity	Time spent—mean min/ ¹		
	Male	Female	Both together
Incubating eggs	16.6	42.0	—
Poking in the nest, moving eggs, and/or arranging nest material	1.0	1.2	—
Total time spent on the nest	18.3	43.3	2.2

¹Based on 55.5 h of observation.

than when the air temperature was equal to or below 7.2°C (mean = 0.56 min/h). When the wind velocity was less than 16.2 km/h, the eggs were left exposed an average of 2.17 min/h, whereas with higher wind velocities the eggs were left exposed only 0.64 min/h; the difference is significant (Mann-Whitney $U = 444$; $p < 0.05$).

The length of time the eggs were left exposed was also related to the wind chill index (fig. 2). The time the eggs were left exposed was highly variable within a small range of wind chill index values. There was, however, a significant linear correlation ($r = 0.977$; $p < 0.05$) between the wind chill index values averaged for each 100 unit wind chill interval and the average time (min/h) the eagles left the eggs exposed.

Arranging nest materials

Both adults carried materials up to the nest. These varied from large sticks to grasses. Large sticks were usually brought to the nest by the relieving adult. After arranging the sticks on the nest, the adult then took over incubation. Several times both adults worked together in placing a large stick. Almost invariably there was some poking in the nest just before assuming the incubation posture in the nest relief sequence. This poking consisted of a gentle probing into the nest cup, similar to that seen by us (NG and JMG) when a Red-tailed Hawk was shifting its eggs. On some occasions grasses and twigs in

the nest may also have been arranged during this process. On two separate occasions, a very different action was seen. the adult pecked hard and rapidly into the nest center in a manner similar to a woodpecker hammering on a tree. We (NG and JMG) have also observed this behavior in the wild and suspect that it may represent an effort to alter an uncomfortable bulge in the nest or to drain a wet spot which has developed in the nest. Almost immediately after settling to incubate, the adults reached out and using a raking action with their beaks pulled twigs and straw into a mound surrounding the body. This raking action to build up the nest cup lasted from several seconds to several minutes every time an adult settled onto the eggs.

Nest relief

Both adults took turns incubating the eggs, with the female taking a much larger share of incubation during the day. However, male and female each incubated 2 or 4 nights for which we have observations. Thirty-nine changeovers were seen. During most changeovers (31) an adult continued to incubate until its partner arrived on the nest edge. When the incubating adult stood up and stepped to the nest edge the relieving adult balled its feet and stepped into the nest center, perhaps walking around the nest a bit first, and arranged nest material or poked in the nest cup. After arriving at the nest center, the relieving adult poked gently into the nest cup, grasped a stable nest branch which it used as a pivot, rocked its body from side to side, and settled into the nest. After settling into the incubation posture, the eagle formed the nest cup.

Eight times the eagle on the nest left before its mate arrived on the nest edge. This happened when the incubating adult had been on the nest for longer than 2 hours or when the weather was warm. Sometimes when the incubating adult had been on the nest for a long time, it stood up, turned about, poked into the nest and then assumed the incubating posture again in exactly the same manner as after nest relief. This routine of gently poking into the nest, settling into the nest with side-to-side rocking, and raking nest material toward the body was seen 50 to 55 times in 55.5 hours of observations.

Lying together in the nest

During 3 occasions near sundown, both eagles lay side by side in incubating posture on the nest. Two of these episodes lasted 3 minutes each, and the third lasted 20 minutes. While lying together, the eagles engaged in billing and stroking each other with their beaks.

Feeding

When caretakers brought food to the pen, the female incubated the eggs, and the male called while flying near the nest. The male then perched and continued calling until the caretaker had left the area, then went down to the ground for food. Three times he fed first and went up to the nest; the female then went down to feed. The male carried food up to the nest for the female on two occasions. She then ate it on the nest while he took over incubation.

Discussion

This investigation was not intended as an exhaustive study of Bald Eagles before and during incubation, but rather as a preliminary investigation into this phase of the species' life history. One must be wary of drawing conclusions from the activities of captive birds. Observations in the wild (Herrick 1934, Retfalvi 1965, N. Gerrard and J. M. Ger-

ard unpub. obs.) suggest, however, that many of the behavior patterns in the wild are similar, yet more complicated. Thus wild birds engage in courtship flights, cooperative hunting, and territorial defense, in addition to the behavior patterns described here.

Perching together is an important preincubation activity in wild Bald Eagles (Retfalvi 1965, N. Gerrard and J. M. Gerrard unpub. obs.) just as it was in this study on captive birds. Precopulation and copulation behavior in wild Bald Eagles is also similar to that reported here (N. Gerrard and J. M. Gerrard unpub. obs.). We suspect, however, that the large proportion of incomplete copulation sequences seen in pair II was caused to a considerable degree by the nearly crippled condition of the male. The nature of the female Bald Eagle solicitation display is similar to that seen in large falcons where body position (head bowed, wings slightly apart) and calling are important (Fyfe 1972, Wrage and Cade 1977). As with other raptors, Bald Eagles use distinctive calls during copulation which are not used at other times (Mueller 1970, Fyfe 1972, Wrage and Cade 1977). Bald Eagles appear to be different from Prairie Falcons in that the male initiated the copulation sequence as often as the female whereas in the Prairie Falcon it was almost always the female which initiated the sequence (Fyfe 1972).

Sitting in incubating posture on a nest without eggs, pseudoincubation, as observed in this captive pair, also occurs in wild eagles (N. Gerrard J. M. Gerrard unpub. obs.) and has been observed in some African eagles (Brown 1955). Since the status of a breeding area on early nesting surveys is often judged by the presence of an adult in incubating posture (Whitfield et al 1974), the count may be high because some such birds may not have eggs. The relative roles of the male and female in preincubation activities are noteworthy and show that male eagles, as with other raptors (Hamerstrom and Hamerstrom 1972), can and do participate in nest building and in pseudoincubation.

Incubation behavior of the captive Bald Eagles was also similar to that which has been observed in the wild. The sequence of poking in the nest, grasping a branch, settling low into the nest rocking from side to side, and then raking nest materials toward the body to form the nest cup, was exactly the same as we (N. G. and J. M. G.) have seen with wild Bald Eagles in Saskatchewan. Others have written abbreviated descriptions of this behavior in Bald Eagles (Herrick 1934, Retfalvi 1965, Golden Eagles (Grier 1973), and Red-tailed Hawks (Hamerstrom and Hamerstrom 1972).

Our observations that the eagles changed position with associated poking in the nest (probably turning the eggs—Herbert and Herbert 1965) approximately once per hour can be compared to time-lapse photographic observations of Enderson et al. 1972, showing that Peregrine Falcons shifted their position an average of every 34 minutes. These findings may conflict with the statement that birds of prey rarely stand and turn their eggs (Brown and Amadon 1968, p. 111). A possible explanation for this discrepancy lies in Brown's (1955) observations that the response of an eagle to a human intruder is to sit tight and low on the nest. More recent observations in the wild have confirmed Brown's and show that eagles which are disturbed by the presence of an observer react by sitting more closely on the eggs and moving the eggs less frequently (J. M. Gerrard, N. Gerrard, D. W. A. Whitfield and W. J. Maher pers. comm.).

The significant correlation between length of time the eggs were left exposed and the wind chill index suggests that Bald Eagles have the ability to adjust the length of time that the eggs are exposed in relation to the cooling power of the air. Huggins in 1941 showed the effects of wind and air temperature to cool eggs in the wild. The present paper provides quantitative evidence that eagles can adjust to the environmental condi-

tions to regulate egg cooling. Such an ability had been suggested earlier for Song Sparrows by Nice (1937). It is probable that this ability is more important to birds nesting in cold climates. In this regard it is interesting to compare the Bald Eagle, which spent only 2% of the time off the eggs, with the Verreaux's eagle in Africa, which was observed to spend 6.6% of the time off the eggs (Rowe 1947). It is hoped that increased understanding of details such as these in the behavior of Bald Eagles and other raptors during the preincubation and incubation periods will aid in the captive propagation of these species and in the management of raptors in the wild.

Acknowledgments

We thank Frances Hamerstrom and Rey Stendell for reviewing the manuscript and providing helpful comments on it. John R. Maestrelli provided information on observations that were made before the week of intensive observations discussed herein.

Literature Cited

- Broley, M. J. 1952. *Eagle Man*. Pelligrini and Cudahy, New York.
- Brown, L. 1955. *Eagles*. Michael Joseph Ltd., London.
- Brown, L., and D. Amadon. 1968. *Eagles, hawks and falcons of the world*. McGraw-Hill, New York.
- Cade, T. J. 1974. Plans for managing the survival of the Peregrine Falcon, p. 89-104. In F. N. Hamerstrom Jr., B. F. Harrell, and R. R. Oldendorff, eds. *Management of raptors*. Raptor Research Foundation Inc., Vermillion, South Dakota.
- Enderson, J. H., S. A. Temple, L. G. Swartz. 1972. Time-lapse photographic records of nesting Peregrine Falcons. *Living Bird* 11:113-128.
- Fyfe, R. 1972. Breeding behavior of captive and wild Prairie and Peregrine Falcons. *Raptor Research Supplement* C43-C52.
- Grier, J. 1973. Techniques and results of artificial insemination with Golden Eagles. *Raptor Research* 7:1-12.
- Hamerstrom, F., and F. Hamerstrom. 1972. A male Hawk's potential in nest building, incubation, and rearing young. *Raptor Research* 6:144-149.
- Hancock, D. 1973. Captive propagation of Bald Eagles *Haliaeetus leucocephalus*: A review. *International Zoo Yearbook* 13:244-249.
- Herbert, R. A., and K. G. S. Herbert. 1965. Behavior of Peregrine Falcons in the New York City region. *Auk* 82:62-94.
- Herrick, F. H. 1934. *The American Eagle*. D. Appleton-Century Co., New York.
- Huggins, R. A. 1941. Egg temperatures of wild birds under natural conditions. *Ecology* 2:148-157.
- Maestrelli, J. R., and S. N. Wiemeyer. 1975. Breeding Bald Eagles in captivity. *Wilson Bulletin* 87:45-53.
- Mueller, H. C. 1970. Courtship and copulation by a hand-reared Broad-winged Hawk. *Auk* 87:580.
- Nice, M. M. 1937. Studies in the life history of the song sparrow. I. Linnaean Society of New York, Transactions 4:1-247.
- Olendorff, R. R. 1971. Falconiform reproduction: a review. part I. The prenestling period. *Raptor Research No. 1*. Vermillion South Dakota. p. 111.
- Retfalvi, L. I. 1965. Breeding behavior and feeding habits of the Bald Eagles (*Haliaeetus leucocephalus* L.) on San Juan Island, Washington. M. F. thesis, University of British Columbia, Vancouver.

- Rowe, E. G. 1947. The breeding biology of *Aquila verreauxi* Lesson. Part I. Ibis 89:387-410.
- Stewart, P. A. 1970. Weight changes and feeding behavior of a captive reared Bald Eagle. *Bird Banding* 41:103-110.
- Whitfield, D. W. A., J. M. Gerrard, W. J. Maher, and D. W. Davis. 1974. Bald Eagle nesting habitat, density, and reproduction in central Saskatchewan and Manitoba. *Canadian Field-Naturalist* 88:399-407.
- Willoughby, E. J., and T. J. Cade. 1964. Breeding behavior of the American Kestrel (sparrow hawk). *Living Bird* 3:75-96.
- Wrege, P. H., and T. J. Cade. 1977. Courtship behavior of large falcons in captivity, *Raptor Research* 11:1-46.

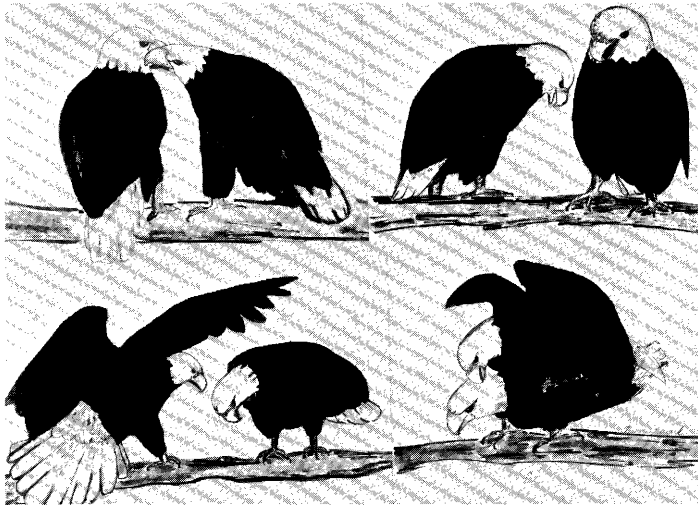


Figure 1.—Copulation behavior in Bald Eagles: a. female approaches male; b. male approaches female; c. male flaps wings and pumps tail while female bows; d. male mounts female.

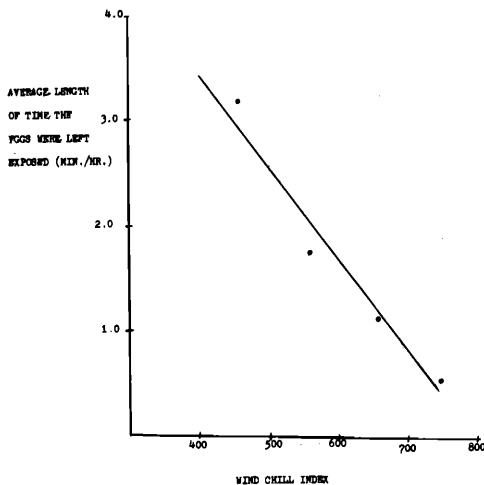


Figure 2.—The time Bald Eagle eggs were left exposed versus wind chill index. Dots represent individual hourly values; squares represent average wind chill index for each 100 unit interval with corresponding average time eggs were left exposed for that 100-unit interval for average values $r = 0.977$; $P < 0.05$).