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SUCCESSFUL CAPTIVE BREEDING OF AMERICAN ROUGH-LEGGED HAWKS

by
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ABSTRACT. Three pairs of American Rough-legged Hawks (*Buteo lagopus*) were placed together at the Macdonald Raptor Research Centre in March 1974. A 16L:8D photoperiod regime was begun in April. The pair with the greatest exposure to outside disturbance and the most equal temperaments laid five fertile eggs over a period of ten days. Copulation was seen 19 times preceding the first oviposition, 15 times between the first and fifth ovipositions, and 27 times following egg-laying. All eggs were artifically incubated at 37.5°C, 50 to 60 percent humidity. Four hatched. The chicks, two of each sex, were hand-raised successfully.

Procedure

On 25 March 1974 three adult pairs of American Rough-legged Hawks (*Buteo lagopus*), all zoo birds originating from northern Canada, were introduced into breeding pens designated G, I, and J. These pens varied only in size, availability of perches, and exposure to the outside. All were constructed of particle board with floors of loose coarse gravel of 1.5 cm pebbles (Fig. 1). Each had an access door from a central hall with an observation port of 10-by-15-cm one-way glass. Mirrors, placed so that the birds could not see themselves, were installed to facilitate observations of the nest platforms. Pens G and I were 6.5x3.5x2.5 m (length x width x height) with an opening approximately 4 m^2 covered by 2.5 cm galvanized wire grid at one end of the pen. Pen J was twice the width.

A nest platform 2.6x1.8x1.8 m was provided in each pen in a corner opposite the opening and about 1.5 m from the floor. Perches consisted of stumps, stripped fir trees, and logs running the full length of the openings and the nest platforms.

Pens I and J were exposed to a field where eagles were tethered. Pen G faced a kennel of several noisy dogs and a road heavily traveled by pedestrians and vehicles.

With the exception of one melanistic male in pen G, all birds were of the medium phase.

All birds except the females in pens I and J had dispositions similar to wild individuals. The two calmer females had been handled occasionally, but seemed not to be imprinted on humans. The tame females were paired with the wildest males in hopes that the latter would eventually settle down more in captivity. With the exception of the males in pens I and J, which were obtained in the fall of 1973, all birds had been unsuccessfully paired with different mates in 1973. During the nonbreeding seasons of 1973 and 1974, the females and males were held in separate wintering quarters.

Nesting material, provided in fairly copious amounts, consisted of scrub-tree branches and long grasses, both fresh and dry.

A basin of fresh water for bathing and drinking was available to all birds. Food consisted of laboratory rats and six-week-old chickens provided ad lib in hopes that the birds would be stimulated to lay clutches of maximum size (Brown and Amadon 1968). Except during egg-laying, the pairs were disturbed only once a day for feeding, watering, and occasional introduction of nest material. With one exception (to be discussed later) none of the birds were removed from their pens during the breeding season.

Natural daylight was supplemented by artificial lighting to simulate light conditions at 62° north latitude at the same time of year (table 1). Artificial lighting in the pens consisted of one 200-watt incandescent bulb recessed near the middle of the ceiling. The larger pen (J) had two such lights evenly spaced. Dimmers and nightlights were not used.

Because of other commitments, observations were more extensive than intensive. The birds were observed once or twice daily for two- to three-hour periods two days a week during the pre-egg-laying period and five days a week during and after egg laying.

Pre-egg-laying Behavior

Pen G. Breeding activity of the male was first observed on 6 May. Head-bobbing actions and flights back and forth in the pen were frequent. Occasionally the perched male leaned toward the female with wings half-opened or offered a twig broken from the tree. He used either a foot or his beak to offer nest material, but his mate did not respond in either case. Any time she approached him, he became excited. At one point he leaped onto her back as if to copulate, but both fell to the ground.

At this stage both birds made repeated efforts to leap straight up into the air from their perches. Since much of the courtship of this species is aerial (Bent 1937), perhaps these were courtship flight attempts.

On 10 May much nest material had been carried to the nest platform. Only the male was seen active in nest building. The first two copulations occurred on 13 May within 20 minutes of each other.

In most cases, the birds faced the window and copulated on the log perch; only one copulation took place on the tree perch. Just prior to most copulations the male would sidle to and fro on the window log perch. Once the male was seen gently pawing the female's breast before climbing onto the almost horizontal back of the submissive female. In general, the female's tail was raised to the left and the male's tail was lowered to the left. The female held her wings low and bent out; the male flapped for balance. High-pitched squeals were emitted by the male, and as he climbed down a strangled squawk was given by the female. The entire act usually lasted about 8 to 10 seconds.

On 19 May the male leaped onto his mate's back three times before successful copulation took place. Nineteen copulations were observed prior to oviposition. Six incomplete attempts were noted through the season. Copulations occurred at all times of day.

Both birds were generally active after copulation, often flying to each other's side and issuing a variety of calls. Frequently the male uttered whistling noises slurred downward; the female often gave a short-syllabled clucklike "nar-nar" call. A common defensive call used by both sexes was a "kee-eer" with the last syllable slurred downward, similar to that of a Red-tailed Hawk (*Buteo jamaicensis*). Defensive behavior by the male was noted on 23 May when he flew at the observation window. Only once were the birds actively disturbed by the barking dogs outside their pen.

Finally, on 26 May, the female refused to leave an egg-laying posture even upon our entry into the pen. We left quickly.

Pen I. Although this pair failed to breed, behavioral attitudes are of interest. On 7 May upon being approached by the male, the female gaped at him as if in fear or threat. He advanced no closer. The male was extremely active throughout the season, literally running around, arranging twigs in a rather sloppy attempt to build a nest on the ground, and calling as often as 100 times in 42 minutes. His calls varied from soft "mews" increasing to high-pitched whistles slurred downward to a shrill scream.

This male exhibited strong territorial behavior and, on occasion, attacked the keepers. In contrast, the female was docile and paid little attention to the male's activities. The one time she showed brief interest in fresh green grass placed in the pen excited the male greatly.

The male bowed to her several times during the season; she failed to respond. The most puzzling behavior exhibited by the male, however, was what appeared to be a masturbatory act carried out on rat carcasses immediately upon their introduction into the pen as food for the birds. His actions and vocalization were identical to that of the Pen G male during normal copulation. This behavior was observed on many occasions.

With the exception of slight nest construction and pseudoincubation by the female on August 12, no further breeding activities occurred in this pen.

Pen J. The situation in this pen was similar to that in Pen I. An active male built a well-organized nest on the platform. On 2 June he attempted a food transfer to the female without success. On two occasions, 31 May and 15 June, the female was seen on the nest in an incubation posture. She was observed arranging twigs on the nest only once.

At this stage, on 4 June, the females in Pens I and J were interchanged. In Pen I both birds exhibited a gaping response to each other. Then the male chased the female around the pen while uttering "cheep" calls. The female, extremely nervous, chittered back at him. The male and female in Pen J were mutually aggressive on the nest ledge almost immediately upon meeting and chased each other around the pen. The male, normally an extremely shy and excitable bird, attacked the nervous female even in the presence of a keeper. The females were returned to their respective cages within the hour.

From this point on, only the pair in Pen G will be considered in this paper.

Egg-laying Behavior

On 27 May, at 0930 hours, the female, which appeared to be in an incubation posture upon our entry, moved to the tree while we discovered and marked the first egg. Later, with high-pitched cries similar to those made during copulation, the male dropped a rat in front of her on the nest. The female responded with a soft clucking of two syllables.

The second, third, fourth, and fifth eggs were discovered and marked on 29 and 31 May, and on 2 and 5 June, respectively. Copulation was noted fifteen times during the egg-laying period. Much addition and rearrangement of nest material also occurred during this period. As egg laying progressed, the male became more aggressive towards the keepers, attacking in several instances.

Because of inconsistent observation, the actual onset of serious incubation was not determined. The female appeared to settle with great care on the first egg laid. On 29 May, with two eggs laid, she apparently incubated all day. However, on 30 May, with the exception of two sitting periods of 24 and 4 min by the male, very little incubation was noted. The next day the male was observed incubating three eggs for 16 min, now and then emitting a "mewing" call and rearranging nest material. He readily left the nest at the female's arrival. Although the eggs were uncovered at least twice for periods of up to 6 min, it was assumed (on the basis of other observations) that serious incubation had begun with the third egg laid, if not at the beginning of the clutch.

On 10 June in an attempt to "double-clutch" the birds (induce them to lay a second clutch upon removal of the first), all five eggs were taken and placed in an incubator with very little protest from the parents. No more eggs were laid. The failure of recycling may be attributable to the inexperience of the birds or to human interference. However, one must rule out lateness of season, since Bent (1937) noted eggs laid as late as 13 July in Arctic Canada. In our conditions, light was maintained constant and temperatures were still rising in June.

Although the birds copulated again one hour after their eggs were removed, there was a noticeable difference in the behavior associated with the fourteen copulations seen during the post-egg-laying period as compared to the pre-egg-laying period. The birds did not copulate less frequently, but simply did so less enthusiastically. For example, rather than eagerly climbing onto the female's back, the male would slowly position himself for copulation. The calls emitted during the act were not as loud as before. By 21 June the foreplay leading to copulation lessened. In one instance the male attempted copulation with one of his feet on the perch. Previously, introduction of new nest material into the pen would occasionally stimulate the birds to copulate. On two occasions prior to removal of the eggs the birds copulated upon our exit from the pen. After 23 June neither of these factors stimulated the birds. Finally, on 12 July, the male fell off the female while attempting copulation. From then on no breeding activities were observed.

Incubation, Hatching, and Hand-rearing

The color and sizes of Rough-legged Hawk eggs, and the clutch size, were as described by Bent (1937). Only the fifth egg laid in Pen G was paler and smaller than Bent described.

Upon their removal on 10 June the eggs were immediately placed in a forced-air Marsh Farms Roll-X incubator, with an automatic turner cycling every hour and a grid designed for quail eggs. This small grid, used primarily for Kestrel (*Falco sparverius*) eggs, did not turn the larger Rough-legged Hawk eggs. Thus we placed the eggs at a 10° angle on the small end and turned them by hand four times a day. The temperature at the middle height of the eggs was maintained at 37.5°C; humidity was kept at approximately 50-60 percent.

The eggs weighed 51.6, 52.7, 50.2, 49.8, and 44.7 gm (in order of laying) on 29 June. Candling was not feasible because of the thickness and color of the eggshells.

The first four eggs pipped two days prior to hatching. Upon pipping, they were placed in a hatcher, a second Marsh Farms Roll-X incubator with the automatic turner switched off and both grids inverted so that the 0.6 cm mesh was on top. A layer of crinolin was placed over the mesh for sanitary purposes and to prevent the chicks' legs from slipping through the mesh. The temperature was maintained at 37.0°C. The humidity was raised to between 80 and 90 percent to prevent drying of membranes.

The first chick hatched on 5 July, followed by the second and third chicks on 6 July. The fourth chick hatched the next day, and the fifth failed to hatch. Examination of the fifth egg revealed an embryo about 2 cm long. This nearly synchronized hatch seems to point toward a delayed onset of serious incubation as discussed above.

Assuming that incubation began with the first egg laid, the mean incubation period was 37 days. This is much higher than the 28 days reported by Burns (1915) for natural incubation, though Burns does not mention his sample size.

No assistance was given to the pipping chicks. Within 24 hours of hatching each chick was placed for two weeks in a homemade styrofoam brooder with heating tape and a small wire mesh set over a pan of water. During that period, the temperature was decreased gradually from 32.2°C to room temperature. When they were between two and four weeks of age, the birds were kept in a cardboard box lined with excelsior. Between four and five weeks of age, a polyethylene swimming pool 1.3 m in diameter lined with wood shavings, with the sides low enough to allow them to defecate out of the nest, served well.

With the exception of the fourth chick, fed on the second day, all were fed on the first day as soon as their down was dry and fluffy and they could lift their heads. This usually occurred within six hours of hatching. The begging call can be described as a rising, high-pitched whistle. Food for the first two or three days consisted of halves of day-old mice and was offered to them with blunt forceps. Occasionally feeding could be stimulated by an imitation of the whistle call. Afterwards they were fed day-old cockerels (excluding the down and legs) and adult mice (excluding fur) thoroughly mashed in a Waring blender. As the chicks grew older, the food was mashed less and less and more feathers and fur were included. Through ten days of life, the chicks were fed four times a day. From the eleventh day they were fed only three times a day. Young with pin feathers starting to show, at just over three weeks of age (Fig. 2), were feeding themselves on bite-size pieces of adult mice and day-old chicks. At four weeks of age the birds were supporting themselves on their feet rather than on their tarsi. At just over four weeks of age they were given larger chunks of food to tear up twice a day. Three days later the oldest chick frequently left the artificial nest and was soon followed on later dates by its nest mates. At five weeks the birds were tearing up three whole day-old chicks apiece each day. A few days later all the chicks were released into a large pen and given a water bath and low branches on which to climb. By this time each bird was fed three to four chicks or a whole rat daily.

At hatching, the chicks were covered with white down which later was replaced with a buffy white down. One exception was the third oldest chick whose second down was dark grey. The oldest chick was a medium-phase female, the second a melanistic male (Fig. 3), the third a medium-phase female, and the youngest a medium-phase male. Their weights during the hand-rearing period are shown in figure 4. The only difficulty encountered in hand-rearing the young was between 2½ and 3½ weeks of age. They all contracted rhinitis, commonly referred to as "the snurts." This condition was due to exposure to rather cold nights with possible drafts. The symptoms included aphagia, excessive sneezing, and crusty deposits about their nares. We cured them by placing them in a room kept at around 22°C and giving them 2 ml oral doses of 4.59 percent nitrofurazone twice daily for about three days, followed by gradually decreasing doses. We have since learned that nitrofurazone might cause sterility (Cooper pers. comm.) and therefore advise against its use.

Acknowledgments

We gratefully acknowledge the assistance of Alison Bentley, Alison Hackney, and Mike Amos for their care of the young birds and the recording of observations of adult breeding behavior. Toni Bird provided valuable secretarial help, and Walter Kosyanoff's photographic assistance is acknowledged. We thank the Orsainville Zoo and the Lafontaine Park Zoo for supplying birds and the Quebec Department of Education for financial assistance.

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Table 1.
Photoperiod Schedule Used on
American Rough-legged Hawks in 1973 and 1974.

Date		Photoperiod	
1973	Jan. 1	natural daylight	
	Apr. 1	16 L:8D	no twilight
	Sept. 1	natural daylight	
1974	Mar. 25	13L:11D	no dawn; no twilight
	Mar. 27	13½L:10½D	no dawn; no twilight
	Mar. 30	14L:10D	no dawn; no twilight
	Apr. 1	14½L:9½D	no dawn; no twilight
	Apr. 9	15L:9D	no dawn; no twilight
	Apr. 15	15½L:8½D	no dawn; no twilight
	Apr. 30	16L:8D	no dawn
	Sept. 6	natural daylight	

Figure 1. The light-phased female settles upon her eggs as her melanistic mate stands guard in Pen G.

Figure 2. Three-week-old Rough-legged Hawk losing second coat of down as feathers push out of their sheaths.

Figure 3. On the left is shown the fledged melanistic male Rough-legged Hawk and on the right, one of the two medium-phase females.

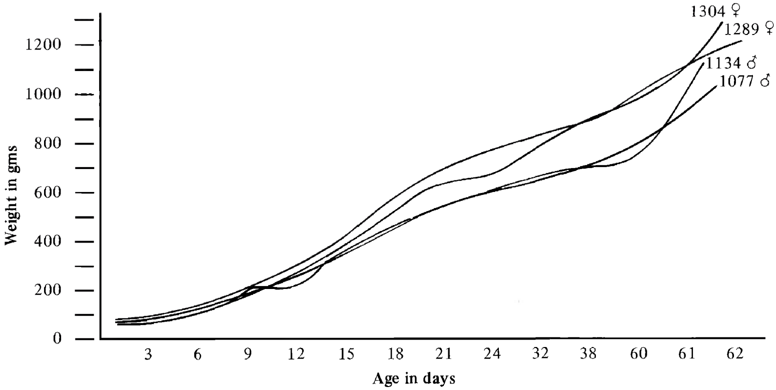

Figure 4. Graph of growth weights of the four Rough-legged Hawk chicks. Note the leveling-off of all curves at 2½ weeks of age when the chicks contracted rhinitis.

AN EVALUATION OF TECHNIQUES FOR CAPTURING RAPTORS IN EAST-CENTRAL MINNESOTA

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ABSTRACT. To meet the objectives of a study, several species of raptors had to be trapped on a 9,880-hectare study area of heterogenous habitat types. Bal-chatri, mist net, Swedish Goshawk, and automatic bow-net traps (and combinations of these traps) were used in several general habitat situations. Mist nets combined with a baited bal-chatri or tethered bait were most successful in capturing birds, and the bal-chatris alone and mist nets alone were next most effective. Trapping was found to be most productive in deciduous upland habitats where an opening in the canopy or break in the understory occurred. Trapping along a woodlot-field edge was also effective. Strigiformes were most often trapped just before sunrise or just after sunset, while falconiformes were most often captured in the late morning and late afternoon. Trapping was least efficient from December to February. A different trap type from that used in the initial capture is often most effective for recapturing raptors. Maintenance of healthy bait animals and frequent trap checks are emphasized.

Introduction

This paper presents results from a combination of methods used to capture and recapture Great Horned Owls (*Bubo virginianus*), Barred Owls (*Strix varia*), Red-tailed Hawks (*Buteo jamaicensis*), and Broad-winged Hawks (*Buteo platypterus*) on a 9,880-hectare study area in east-central Minnesota. Additional information regarding the capture of Saw-whet Owls (*Aegolius acadicus*), Long-eared Owls (*Asio otus*), Goshawks (*Accipiter gentilis*), Red-shouldered Hawks (*Buteo lineatus*), and a Harrier (*Circus cyaneus*) are included.

We found no data quantifying the results of trapping that employed a combination of techniques on a specific study area; however, there have been numerous papers describing various traps and techniques for capturing birds of prey (Berger and Mueller 1959; Ellis 1975; Gromme 1937; Hamerstrom 1963; Meng 1963, 1971; Nicholls 1973; Robards 1967; Stewart et al. 1945; Tordoff 1954). Several falconry books also provide historical information on techniques used for catching raptors (Beebe and Webster 1964; Mavrogordato 1974; Peeters and Jameson 1970). Other papers have been concerned with the effectiveness of particular types of traps and methods by improving an old design (Henderson 1962, Kirsher 1958, Ward and Martin 1968, Whitman 1960). Data useful in assessing the utility of a particular trap for a particular species (Berger and Mueller 1959, Ellis 1975, Hamerstrom 1963, Henderson 1962, Kirsher 1958, Robards 1967, Stewart et al. 1945) or for a particular situation (Clark 1971, Ellis 1975, Berger and Hamerstrom 1962, Berry 1971, Hamerstrom 1963, Meng 1971, Nicholls 1973, Stewart et al. 1945) can be helpful to researchers designing studies which involve the capture of birds of prey.

The Study Area

The study was conducted on the Cedar Creek Natural History Area (93° 12'E, 45°24'N) in a variety of habitats including oak uplands, mixed deciduous and coniferous uplands, white cedar (*Thuja occidentalis*) lowlands, tamarack (*Larix laricina*) lowlands, deciduous shrub lowlands, marshes, and open fields. Nicholls and Warner (1972) described these habitats in more detail and provided a general phenology for the study area. For the purpose of analyzing trapping data the following habitats were recognized: (1) deciduous opening (a break in the canopy of a deciduous upland woods at least 6 m in diameter); (2) deciduous trail (a break in the understory of a deciduous upland woods at least 3 m by 3 m that may be an actual trail through the woods); (3) field-woods edge; (4) deciduous-conifer trail (opening or trail like #2 but through a mixed deciduous-conifer upland); (5) deciduous-conifer opening (an opening in the canopy like #1 except in a mixed deciduous-conifer upland); and (6) open field.

Methods

Several trap types and combination of traps were used during the study. Trap types included (1) two-shelf 121-mm mesh, 12-m-long mist nets (Nicholls 1973); (2) modified bal-chatri traps (berger and Hamerstrom 1962, Ward and Martin 1968) of either a 0.7-square-cm hardware cloth cage, 10 cm x 20 cm, or a 2.5-cm chicken-wire cage, 25 cm x 35 cm, for mouse or pigeon bait, respectively; (3) Swedish Goshawk traps (Meng 1971); and (4) a modified automatic bow-net (Tordoff 1954). Trap combinations included putting a bal-chatri or tethered bait or decoy in front of a line of one to three mist nets, or in a V formed by two mist nets or in the middle of a triãngle of mist nets. The triangle was formed by stringing one net lengthwise and staking another in a V shape, with the open end of the V against the lengthwise net. A baited bal-chatri was placed under the trigger mechanism of the automatic bow-net.

Trap placement in 1971-1972 was based on the valuable advice of Nicholls (pers. comm.) and Hamerstrom and Hamerstrom (pers. comm.). During 1972-1973 we reduced the total number of trap sites and altered locations because of our experience from the previous field season. Generally, traps were placed in areas where raptors had been observed in the habitats described. Nets were placed at the edges of openings or perpendicular to trails (see Nicholls 1973) and on field-woods edges. Bal-chatris, Swedish Goshawk traps, and the bow-net were placed in fields or on field-woods edges. Bal-chatris were also dropped from vehicles near perched or soaring raptors in the manner described by Berger and Mueller (1959).

Pigeons (*Columba livia*) were frequently used as bait because of ease of maintenance and their heartiness (Berger and Hamerstrom 1962). We also used brown and white laboratory mice (*Mus musculus*); hooded and white laboratory rats (*Rattus norvegicus*); game-farm Ring-necked Pheasants (*Phasianus colchicus*); domestic rabbits (*Oryctolagus cunniculus*); gerbils (*Meriones unguiculatus*); and Starlings (*Sturnus vulgaris*) and Common Grackels (*Quiscalus quiscula*) obtained from pest-control programs. Decoy animals (Hamerstrom 1963, Anderson and Hamerstrom 1967) included Great Horned Owls and Red-tailed Hawks obtained from a raptor rehabilitation program (Fuller et al. 1974). Tethered pigeons and decoy animals were secured by leather jesses about their legs. Bait and decoy animals were given food and water at the trap site and were returned to holding cages at least two times each day depending on temperature and precipitation conditions. All traps were closed down during periods of extended or severe precipitation or when ambient temperatures fell below 10°F. These conditions were judged too stressful for bait and decoy animals, as well as for raptors if they should be trapped. Traps were checked every four hours or more frequently depending on weather conditions.

Results and Discussion

Trapping results using the various methods are presented in table 1. The combination of mist nets plus bal-chatri was most successful in terms of numbers captured and trap days per capture. The mist net with tethered bait was as efficient as mist nets plus bal-chatri but resulted in fewer total captures. The bal-chatri alone was next most productive both in terms of captures and efficiency. The mist net alone ranked only slightly below the bal-chatri. We captured only two birds in the Swedish Goshawk trap and were unsuccessful with limited use of the bow-net. Calculation of correlation coefficients (Clarke 1969) for trap days and captures provided no significant correlation between the two.

Table 1
Captures by Trap Type

				Captures by Species									
Trap	Days Used	Tot. Capt.	D/C	GHO	BO	LEO	SWO	RT	BW	RS	GH	CH	HA
Mist	#279	11	25		5		2	1	2			1	
	% 20	12			24		67	5	15			6	
Mist	#191	17	11		1	1		4	5	1		4	1
Teth.	% 13	18			5	100		18	38	20		25	100
Mist	#327	30	11		11		1	9	3	2	2	2	
B.C.	% 23	32			52		33	41	23	40	50	13	
Mist	# 91	7	13	3				1		1	1	1	
Dec.	% 6	8		43				5		20	25	6	
B.C.	#324	14	23	1	2			3	3	1	1	3	
	% 23	15		14	10			14	23	20	25	19	
Swed.	#182	2	91	1				1					
Gos.	% 13	2		14				5					
Bow-	# 34												
net	% 2												
Hand*	#	12		2	2			3				5	
	%	13		29	10			14				31	
Total	1428	93		7	21	1	3	22	13	5	4	16	1

*Hand-capture data not included in total trap days or days per capture calculations.

GHO = Great Horned Owl
BO = Barred Owl
LEO = Long-eared Owl
SWO = Saw-whet Owl
RT = Red-tailed Hawk
BW = Broad-winged Hawk
RS = Red-shouldered Hawk
GH = Goshawk
CH = Cooper's Hawk
HA = Harrier

The capture of each species by trap type is also presented in table 1. Again the combinations of mist net plus either bal-chatri or tethered bait gave the best results. The bal-chatri alone appeared to be more efficient for falconiformes than for strigiformes when compared to other methods. Great Horned Owls were used effectively as decoy animals in efforts to trap other Great Horned Owls. Hawks trapped by this means were caught incidentally to the efforts directed at Great Horned Owls. However, the attacks by hawks on Great Horned Owls flushed during the day (Dunstan and Harrell 1973, Murphy et al. 1969) and the success of this owl as a decoy (Hamerstrom 1963) suggest that this technique can be widely applied. Barred Owls would probably avoid a Great Horned Owl decoy because of apparent interspecific conflicts which occur between these two species (Fuller et al. 1974). No Barred Owls were available as decoy animals. Mist nets with bal-chatris and mist nets alone were most effective for capturing Barred Owls. These same two techniques were used successfully to capture Red-tailed and Broad-winged Hawks though these species were trapped with a variety of trap types.

An important point to note here and to bear in mind throughout the discussion is that our trapping efforts were restricted to a study area, and the densities of all species on the area were not equal. These differences in density are reflected in the "total capture by species" row of table 1. For example, Barred Owls and Red-tailed Hawks were more numerous on the area, and therefore more likely to be trapped, than Great Horned Owls or Broad-winged Hawks. Additionally, our efforts were concentrated on these four species. These data cannot be viewed as the result of an experiment, or random sample, designed to test the effectiveness of all trap types in all habitat types on all species.

When trapping on a specific study area, trap placement is an important consideration. Table 2 presents data concerning capture success in the six habitat types in which we trapped. There was no significant correlation between the number of days we trapped in a habitat and the number of captures. The deciduous uplands appear to be suitable habitats for trapping nearly all species, and traps placed under openings in the canopy of a deciduous upland resulted in the greatest number of raptors caught. Traps along trails or openings in the understory in deciduous upland produced the most efficient trapping in terms of trap days per capture. Great Horned Owls, though not trapped in the uplands, were known to use these habitats and openings. These owls and two Goshawks were trapped at field-woods edges or in fields. The woodlots, in these cases, were deciduous uplands. The trapping data for three of the Great Horned Owls and three of the Goshawks reflect the logistics of our winter trapping. It was easier to set traps near access roads or trails when the snow was deep. These trails most frequently ran along the edges of woodlots. In light of this bias it appears that all species use deciduous woodlots, except the Long-eared Owl, which is known to use coniferous and field habitats in the upper midwest (Christenson and Fuller 1975, Nicholls 1962).

The importance of openings and edges is further emphasized by trapping results from the mixed deciduous-conifer opening habitat. Raptors apparently use openings and trails to their advantage in several ways. First, these breaks in the habitat provide pathways of unobstructed flight—particularly for the Barred Owl (Nicholls 1973). Secondly, edges and openings furnish effective hunting perches for the sit-and-wait type of predator with relatively unobstructed view and flight path toward the prey. The raptor is also afforded some protection from inclement weather and predators. Though bait or decoy animals would seem visible in the open-field situation, these sets did not prove productive. The mixed deciduous-coniferous trail habitat was probably not trapped enough to yield conclusive results.

Table 2
Captures by Habitat Type

Hab.	Days Used	Tot. Capt.	D/C	Captures by Species										
				GHO	BO	LEO	SWO	RT	BW	RS	GH	CH	HA
Decid.	#371	32	11		10		3	6	5	3		4	11
Open	% 26	40			53		100	32	38	60		36	100
Decid.	#140	19	7		5			5	5		1	3	
Trail	% 10	23			26			26	38		25	27	
Field/	#323	18	18	4	2			5	2	1	2	2	
Woods	% 23	22		80	11			26	15	20	50	18	
Decid.	#157	8	17		2			2	1	1		2	
Conif.	% 11	11			11			11	8	20		18	
Open.													
Decid.	# 56	1				1							
Conif.	% 4					100							
Trail													
Field	#381	3	127	1				1			1		
	% 27	4		20				5			25		
Total	#1428	81		5	19	1	3	19	13	5	4	11	1

*See Table I for key.

Long-eared Owls are uncommon on the Cedar Creek Natural History Area; therefore, the single capture is not unusual. Saw-whet Owls are nesting residents on the area and generally use cedar and tamarack lowland-mixed/deciduous-coniferous upland edges at that time (Forbes and Warner 1974, Nicholls pers. comm.). The three birds we captured were all trapped in deciduous uplands in March. These observations agree with other reports on habitat use by Saw-whet Owls during spring migration (Catling 1971). Goshawks are winter visitors on the area, utilizing a variety of habitat types. Red-shouldered Hawks did not nest on the area during this study, but successful Red-shouldered Hawk nesting does occur along nearby rivers (Malone, Christenson, and Fuller unpublished data), and we have observed nesting attempts adjacent to lakes. All Red-shouldered Hawks captured on the Cedar Creek Natural History Area were immature birds, either from the previous year (and therefore probably not attached to a nesting territory) or young of the year.

The Harrier is not an uncommon bird; two pair nested on the area. The Harrier trapped, an incubating female, was taken in deciduous opening about 200 m from her nest. The bird was flushed twice from the triangular mist net and bal-chatri (pigeon bait) set. Each time she "helicoptered" off the trap and up over the top of the nets. The third time we rushed the net, and she flew into it and was captured. With the exception of a Swedish Goshawk trap set 30 m from her nest, no efforts were made to trap nesting Harriers. Observations on this female and another female with young showed that these birds were fairly restricted in their movements, often flying over and perching in woodland habitats adjacent to the nesting marsh. Successful efforts to trap Harriers are described by Hamerstrom (1963) and Berger and Hamerstrom (1962).

One of the objects of the study at the Cedar Creek Natural History Area was to monitor the movements and activity patterns of both diurnal and nocturnal raptors. Therefore our traps were generally set 24 hours a day. Figure 1 presents the capture distribution by time of day. Since our traps were checked as infrequently as once each four hours, a capture time of 0600 may represent a bird that actually entered the trap at 0200. As might be expected, most of the owl captures occurred during the night, dawn, and dusk periods. Two owl-capture peaks occur: predawn and postdusk. Hawks were trapped during the day, exhibiting capture peaks in late morning and late afternoon. Mueller and Berger (1973) found falconiformes were trapped with equal frequency throughout the day during fall migration. We have no comparative data for hawks during September, October, and November. It is possible that seasonal differences in behavior account for the different trapping results.

The results of our trapping by season are presented in table 3. As seen from the trap days per capture, our efficiency was low in January and December. Our effort was also substantially reduced during these months, but calculation of a correlation coefficient resulted in no significant correlation between the number of trap days per month and the number of captures.

Table 3

Trapping Efforts and Success by Month

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	T-C
GHO			1		1	1						2	5
BO	2	1	2	1	1	2	3	3	2	1		1	19
LEO								1					1
SWO			3										3
RT			2	4	2	6	4	1					19
RS			1	1		1	1	1					5
GH		1	2								1		4
CH			1	5	1	3	1						11
HA					1								1
BW				1	4	4	2	1	1				13
Total	2	2	12	12	10	17	11	7	3	1	1	3	81
Trap Days	95	44	213	228	156	178	208	106	67	21	15	97	1428
TD/C	48	22	18	19	16	11	19	15	22	21	15	32	

Nine raptors were recaptured one or more times during the study (not including captures by hand). Table 4 illustrates that the time of capture varies considerably from capture to recapture, whereas most birds were retrapped in the same or similar habitat associations. The type of trap involved in recaptures was often different from that successful in first-trapping the bird. The Great Horned Owl was initially captured with a pigeon in a bal-chatri. Tracks in the snow revealed that the set had been struck and dragged prior to being checked at 2200 and again at 2400. At 0100 the owl was found caught in the nooses—the same bird that was recaptured three months later. Radio-location data (Fuller and Tester 1973) showed that this bird had had numerous opportunities to go after pigeons in bal-chatri sets during the three-month interval prior to recapture. It was not until a mist net with a Great Horned Owl decoy was set adjacent to the woodlot where this owl's nest was that he was recaptured. Similarly, Barred Owl #725 often perched around an opening in which a mist net was set. This bird had been captured in a mist net but was not retrapped until the first night a pigeon in a bal-chatri was added to the set. These data suggest that attempts to recapture raptors be undertaken with a different type or combination of trap types.

Table 4

Capture-Recapture Data

An #	Sp[a]	Date	Time	Hab[b]	Trap[c]	B/D[d]
719	GHO	12-10-71	0130	6	5	P
		03-10-72	0330	3	4	GHO
717	BO	12-08-71	0615	3	5	P
		05-25-72	0340	1	1	–
		09-27-72	2100	1	3	P
720	BO	06-28-72	1930	2	1	–
		07-19-72	0530	2	1	–
		08-08-72	2100	3	3	P
		03-06-73	–	2	3	P
725	BO	07-06-72	2215	1	1	–
		08-03-72	0615	1	3	P
831	GH	02-21-73	1630	3	4	P
		03-15-73	0830	3	3	GHO
813	RT	04-24-72	1745	2	5	P
		07-07-72	1115	1	2	–
836	RT	04-04-73	1800	3	4	GHO
		07-10-73	1100	2	3	P
808	CH	04-06-72	1730	3	5	P
		06-29-72	2100	1	4	GHO
812	CH	04-24-72	1015	2	5	P
		04-26-73	–	1	3	P

[a] See Table 1

[b] 1 = deciduous open
2 = deciduous trail
3 = field/woods
4 = deciduous/coniferous woods
5 = deciduous/coniferous open
6 = field

[c] 1 = mist net
2 = mist net and tethered pigeon
3 = mist net and bal-chatri
4 = mist net and decoy
5 = bal-chatri

[d] bait/decoy
P = pigeon

Our incomplete data for bait type used during successful captures and our bias with the use of pigeons make analysis of success with different bait animals impractical. All species captured were represented by cases when the bait animal was a pigeon. It is doubtful that the Saw-whet Owl was attempting to capture the pigeon, but it is not unreasonable to assume that other species were attracted by pigeons. If one is more concerned about capturing species like Cooper's Hawks, more efficiency might be obtained with smaller bait animals.

Some general considerations regarding use of trap types are worth mentioning here. There are positive and negative aspects of the use of any of these traps. The main considerations in trapping for our study were ability to trap several species within a limited area in several habitat types and the necessity to use traps which did not require constant vigilance. The bal-chatri is fairly effective and easily transported and placed, but birds sometimes break the nooses or escape from them. Mist nets should be set up in a situation providing a dark background to camouflage the net. Also, protection fro the wind is desirable because when the "bag" of the net is blown by the wind, raptors may "bounce" off the net. The combination of mist net and baited bal-chatri appears to increase the capture efficiency above either of these types used separately (see table 1). This efficiency may be due to several circumstances: (1) birds may be attracted to an area by the bait and trapped in the net while flying by; (2) they may be trapped when going in on the bait; or (3) they may be trapped in the net after an encounter with the baited bal-chatri.

The mist net plus tethered bait was as efficient as the mist net plus bal-chatri. The advantage of the bait method may be that birds reluctant to go in on the "foreign" wire trap are attracted to the more natural-appearing tethered pigeon. A disadvantage is that if the bird is not netted, it may take the bait and escape. One might try adding a noose carpet (Anderson and Hamerstrom 1967) to this combination for increased efficiency. The maintenance of nooses, whether on a bal-chatri or noose carpet, is time-consuming.

One automatic bow-net was used to a limited extent. This technique, using either tethered bait or bait in a bal-chatri, could be very useful (see Matray 1974) because it is easily transported and set up, and, if camouflaged, it is inconspicuous. One would have to use a hoop large enough to capture the largest bird likely to be caught. Also, the apparatus would have to be staked down and a safety latch used so the raptor could not escape under the frame or hoop. The Swedish Goshawk trap is easily set, and bait animals can be left in it continually when food, water, and some shelter are provided. It was not very efficient for our study of resident birds, however. Such birds become familiar with their surroundings and its contents (Southern 1970, Nicholls 1973). The framework of the Swedish Goshawk trap may dissuade resident birds from attempting to obtain the bait. Where raptors are attracted to unusual concentrations of prey, such as on game farms (Meng 1971), or during periods when winter visitants or dispersing birds are in an area, the Swedish Goshawk trap may be very effective.

Finally, we wish to make some suggestions regarding raptor trapping in general. Once trap types have been chosen and made ready for the field, one must have a supply of bait and/or decoy animals and adequate facilities for their maintenance. As Berger and Hamerstrom (1962) have emphasized, healthy bait animals are essential for good trapping. The bait animals should be checked frequently in the field and replaced regularly depending on the environmental conditions. Similarly the traps should be checked as frequently as possible. When trapped or bait birds are exposed to direct sunlight, wind, or precipitation, they may undergo stressful conditions. Added to this problem is the struggle captured raptors or bait birds put up in efforts to escape.

Raptors may injure themselves in mist nets. We had one Goshawk and several Barred Owls that upon release would not fly and showed signs of wing injuries. Subsequent examination revealed no broken bones or other serious injuries, but the birds had obviously strained their wing muscles. Raptors may also pierce their bodies with their talons while trying to escape. In struggles to free themselves they may attract other raptors to the trap. We had several multiple captures; Berger and Hamerstrom (1962) also report multiple captures. Thus the potential for one raptor to prey on another exists, and trapped raptors are also vulnerable to mammalian predators. All this points to the need for frequent trap checks. Raptors can be removed from the trap and held safely for some time before processing (Fuller 1975). When capturing birds by hand from the nest or roost, care must be taken not to leave a scent trail for mammalian predators, such as raccoons (*Procyon lotor*), to follow. Napthalene crystals can be used to cover one's scent. They may also be spread around the tethered bait or bait animal in a bal-chatri to discourage mammalian predation.

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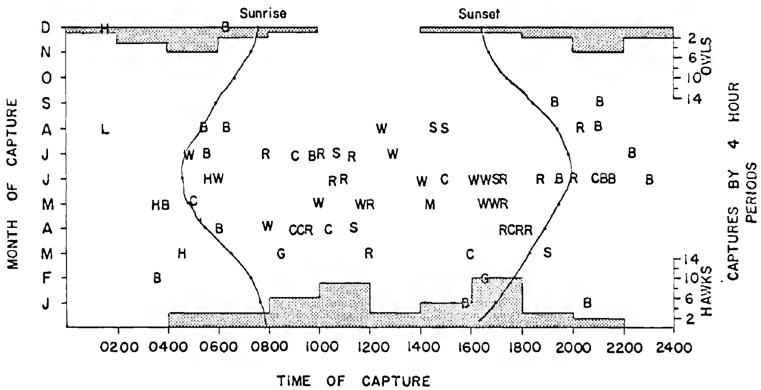

H = Great Horned Owl
B = Barred Owl
L = Long-eared Owl
S = Red-shouldered Hawk
M = Harrier
C = Cooper's Hawk
G = Goshawk
R = Red-tailed Hawk
W = Broad-winged Hawk

Figure 1. Capture Distribution of Species by Time of Day

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TETHER PLATFORMS–AN IMPROVED TECHNIQUE FOR RAPTOR FOOD HABITS STUDY

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ABSTRACT. Newly designed platforms were used to tether young raptors for food habits studies. The major advantage of platforms over ground tethering was a reduced mortality of tethered young. The tether platform also facilitated collection of pellets and prey remains. Information on the construction and placement of the platform and care of the tethered young is provided. A bimodal peak was observed in the daily feeding routine of hawks in Illinois.

Introduction

Many raptor food habits studies have utilized the technique of Errington (1932) to collect prey items. Tethered young can provide data considerably beyond the normal fledging data. Depending upon the disposition of individual adult birds, Red-tailed Hawks (*Buteo jamaicensis*) will feed their tethered young four to six weeks after the normal fledging period. Great Horned Owls (*Bubo virginianus*) have been known to care for their tethered owlets for eight to ten weeks after the time they normally fledge (Errington 1932).

One major disadvantage of tethering is that mortality of the young is increased. Errington (1932) stated in his description of the technique that "the investigator must reconcile himself to some mortality among his tethered raptors." Frances Hamerstrom (pers. comm.) has stated that mortality losses as high as 50 percent can be expected. A principal cause of mortality in tethered young is predation. Luttich et al. (1971) and McInvaille and Keith (1974), in studies of tethered Red-tailed Hawks and Great Horned Owls in Alberta, reported losses of young in excess of 35 percent. Some of this mortality was due to predation, the primary predator being other Great Horned Owls. In more southern latitudes, such as the locations of the present studies in Wisconsin and Illinois, mammalian predators as well as Great Horned Owls were considered a significant threat to tethered young. Studies documenting the extent of losses of young tethered on the ground from areas other than Alberta are lacking.

Two independent investigations of raptor food habits began in 1972. One study was initiated by the Wisconsin Department of Natural Resources, Farm Wildlife Research Group, in southern Wisconsin. The other study was conducted in north-central Illinois under the supervision of the Department of Wildlife Ecology, University of Wisconsin, Madison. Both investigators attempted to improve upon the tethering technique described by Errington (1932) by using specially constructed tether platforms. Since the platforms used in the two studies were developed independently, the designs were different. In this paper we describe a single platform which combines the better features of both designs.

Materials and Construction

The tether platform was mounted over a framed underhanging screen. The platform was also framed with 1" x 3" and 2" x 4" oil-stained fir or pine lumber, with a base of 4-foot wooden lath. Oil stain protected the lumber from the elements and served as a preservative and camouflage. Platform size was dependent upon the number of young being tethered. The following details pertain to one- and two-bird platforms. The outside dimensions (OD's) of a one-bird platform were 4' x 4', and the OD's of a two-bird platform were 4' x 6' (Fig. 1).

The underhanging screen (Fig. 2) was made of 1" x 3" lumber stock nailed together on edge with OD's corresponding to the one- or two-bird platform size. A 4' x 4' or 4' x 6' section of 0.25-inch galvanized wire mesh covered the bottom of the wooden frame, forming, with the lath base and the frames, a large shallow box with a screened bottom. The framed screen was attached to the underside of the platform by small screw eyes and wire and caught materials falling through the slotted floor of the platform (Fig. 3).

Platforms were mounted on trees or poles. The frame of the tree-mounted platform was constructed of 1" x 3" and 2" x 4" stock, and the extended 2" x 4" side was nailed to the tree. The pole-mounted platform was similar but supported by four wooden or fiberglass poles.

For a one-bird platform, a 4-foot section of 1" x 3" lumber was nailed on the bottom centers of the opposite 1" x 3" stock, forming an anchoring base for the tethered bird. A two-bird platform required two anchoring bases, centered 20 inches from the two edges. The remaining area on either side of the tether base was filled with spaced wooden laths. The spacing between laths varied from 0.25" near the anchor base to 1" near the outside edge of the platform frame. These spaces permitted pellets and partially consumed pieces of prey to fall through; they also provided good footing for the tethered bird and temporarily held fresh prey brought in by parent birds (Fig. 4).

A wooden apple crate was nailed to the platform for each tethered young to provide shelter from the hot afternoon sun and severe storms. For maximum protection the open end of the boxes faced southeast. The shelter may also have provided a measure of protection from avian predators.

Results and Discussion

Placement of Platform. The tether platform was placed 5 feet off the ground and close to the nest site. Although hunger cries of the young probably assist the parent birds in locating their offspring, we believe it is important to place the platform so that it can easily be seen by the adult birds. Initial acceptance of the platform-tethered birds is enhanced if the young are readily visible. Platforms should be located where they will be free from unwanted human disturbance; small clearings or woodlot edges provide ideal placement sites.

The approach by parent birds should be considered carefully when placing the tether platform. This factor is critical when two or more nestlings are tethered. One of our birds starved, perhaps because adults continually approached from one end of the platform. We feel that proper platform placement would encourage adults to carry food to the middle of the platform, between the tethered offspring. Both young then have equal opportunity to feed. Shrub and small tree obstacles along the front or long edge of the platform were removed to facilitate approach. As a precautionary measure, the tethered raptors were interchanged from one anchoring base to the other at each visit.

Tethering and Care of Young. Young birds are tethered to a 0.25" x 3" eyebolt running through the center point of the anchor bases. Two nuts locked together allow the eyebolt to turn freely. Aylmeri jesses using 0.32" brass grommets and two no. 8 ball-bearing swivels (Sampo, Inc., Barneveld, NY) were attached to a 3/8" connecting link with a third swivel fitted into the eyebolt (Fig. 5). The connecting link permitted quick and safe removal of a bird from the platform for weight measurements, plumage checks, and the collection of other information. The three-swivel design eliminated twisting and binding of jesses. If more than one young is tethered, tether lengths should be adjusted to allow the maximum movement while keeping the birds separated. However, the length of the jesses must be short enough to prevent tethered young from falling over the edge of the platform. Jess oiling (or replacement) and adjustments to maintain a stable platform were the only maintenace services required.

The platforms were visited biweekly to collect food habits data and to check on the condition of the tethered young. Stable or increasing body weights indicated that the adults were providing sufficient food. Supplemental feeding (fresh or frozen road kills) were occasionally used when weight losses were evident. Before release, birds showing low weights (15 to 20 percent loss) received supplemental feeding for a week in order to build up their strength.

Adults will not continue to feed the young indefinitely. If the young are still tethered when amounts of food brought to the platform decline, the tethered birds should be released. Body weight of the young provides an index to amount of food delivered. Day-to-day fluctuations in body weight are common, but if a bird loses 25 percent of its body weight, it should be released. Ideally, tethered young should be released prior to any weight loss. All birds at one site should be released together to avoid the possibility of parental desertion of any young still tethered. In our studies, all tethered young were released by mid-July.

Collection of Data. Great Horned Owl pellets are an accurate, durable, and easily collected source of food habits data. Therefore, the frequency of visits to owl platforms was dependent on the necessity to check body weights. Although Craighead and Craighead (1956), Fitch, Swenson, and Tillotson (1946), and Seidensticker (1970) determined Red-tailed Hawk food habits from pellet examinations alone, prey remains and gullet samples can provide additional data (Errington 1932). Since prey is often completely consumed and food passes through the gullet in a matter of hours, daily visits to tethered Red-tailed Hawks are advisable. It is important to remove any evidence of prey items from the platform after each visit. A wire brush worked well for cleaning the platform, thus reducing the chance of recounting a piece of fur or feather in subsequent visits.

During 1973 in our Illinois study, we attempted to determine if visits to Red-tailed Hawk tether sites during a particular time of day would yield greater numbers of food items. Five tether sites involving 12 tethered young were visited 2 to 3 times daily. Visit times were varied. The time of arrival at each nest site was recorded to the nearest hour, and the presence and number of identifiable prey remains on the platform or in the gullet were noted. Prey remains found during one visit were marked and left at the site, and their presence was recorded during subsequent visits. If the young birds had not been fed prior to the visit, prey remains were often absent since small prey items were often entirely consumed.

Both the percentage of successful visits and number of prey items per visit increased sharply between 1100 and 1300 hours. A lesser peak occurred between 1500 and 1600 (Fig. 6). Fitch, Glading, and House (1946), working from blinds, found that the highest intensity of feeding among Cooper's Hawks (*Accipiter cooperii*) was from 0900-1100 and from 1500-1700. The authors hypothesized that these times corresponded to increased prey activity periods. The data from Illinois also indicated that Red-tailed Hawks concentrate their feeding of nestlings during certain times of the day when prey can be most efficiently collected.

Mortality of Tethered Young. The Illinois study involved 18 young Red-tailed Hawks and 3 Great Horned Owls. One Red-tailed Hawk died of starvation (a 6 percent loss). There were 3 siblings tethered at this site; the other 2 maintained their weight and fledged successfully. No problems developed at two other platforms on which 3 young had been tethered.

The amount of data collected at each site was directly proportional to the number of tethered young. It was therefore advantageous to tether more than 2 siblings, but the risk factors (starvation, cannibalism) became important considerations.

From a total of 60 tethered young raptors (26 Red-tailed Hawks and 34 Great Horned Owls) in the Wisconsin study, 11 birds (or 18 percent) died of starvation. However, in the spring of 1974, with supplemental feeding and rotation of tethered birds on the platform, the starvation rate was only 6 percent (1 out of 18).

Exposure losses occurred (2 of 60) when nestlings were placed on the platform too early. The adult raptors did not brood their offspring once tethered to the platform. Nestlings less than four weeks old apparently do not have sufficient plumage growth to protect them from adverse weather conditions. Handling and cannibalism were other causes of mortality (1 each). In both studies combined, only one bird tethered on a tree-mounted platform was lost to mammalian predation.

Radiotelemetry was used in the Wisconsin study to compare survival and behavior of tethered and nontethered raptor fledglings. There were no discernible differences in survival after the release of tethered young. For the first seven to ten days after fledging or after release from the tether platforms, both groups were very inactive. During the following two-week period, however, birds which had been tethered tended to be less active than their nontethered counterparts. Also, the formerly tethered birds avoided the investigator when approached with telemetry equipment.

Summary

The major advantage of platforms over ground tethering is a reduced mortality of tethered young. In addition to reducing mortality, the tether platform provides an efficient means of collecting pellets and prey remains. Data is also increased by preventing the adults from removing uneaten prey from the site, a practice previously reported for Red-tailed Hawks (Fitch, Swenson, and Tillotson 1946). Finally, the platforms are easily cleaned at each visit, which helps prevent duplication of data on subsequent visits.

Acknowledgments

The authors wish to acknowledge Reynold W. Zeller, Frances Hamerstrom, Alan Beske, and Deann De La Ronde Wilde for their field assistance and valuable advice. The Wisconsin segment work was financed by Federal Aid in Fish and Wildlife Restoration Project W-141-R. The Illinois work was funded by a grant from the Max McGraw Wildlife Foundation, Dundee, Illinois.

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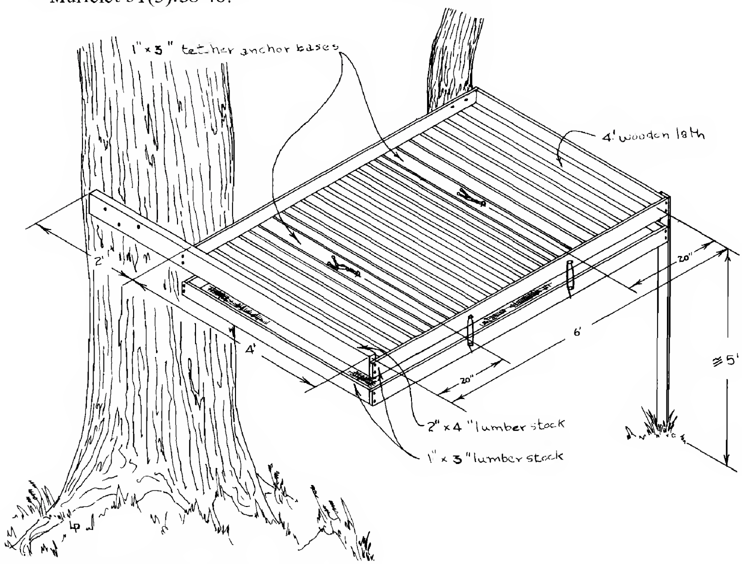

Fig. 1. A two-bird tether platform on a tree

Fig. 2. The platform and the underhanging screen

Fig. 3. The retractable underhanging screen catches prey remains and pellets

Fig. 4. The platform floor of spaced wooden laths and tether anchoring bases

Fig. 5. The three-swivel tethering system with connecting link

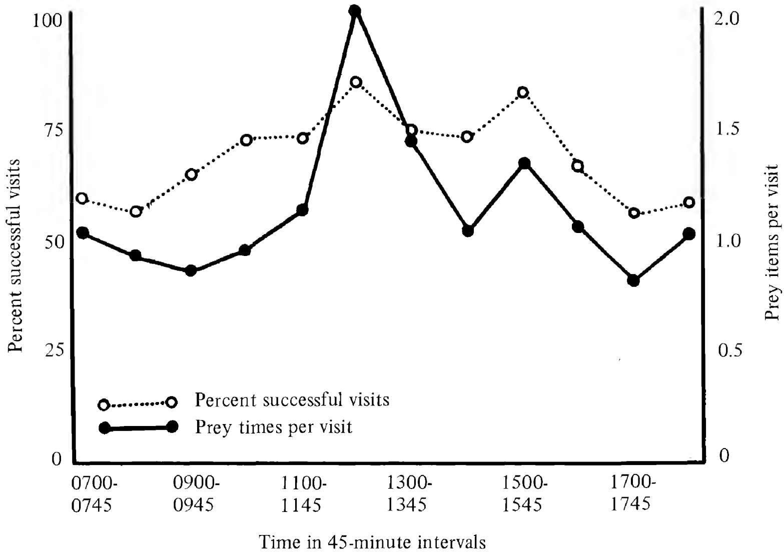

Figure 6. Prey remains and gullet samples collected from tethered Red-tailed Hawks.

B OOK REVIEW

BIRDS OF PREY IN EUROPE

Maarten Bijleveld. New York: Macmillan Press, 1974.
263 pp., 2 plates.

In recent years there has been a plethora of books on birds of prey. However, this new publication by Maarten Bijleveld is a brilliantly researched history of the decline of European raptors, not a glossy-papered coffee-table saga.

The first chapter, devoted to an account of the persecution of avian predators during the eighteenth, nineteenth, and twentieth centuries, makes frightening reading. For example, in one small area in Germany no less than 624,087 raptors were destroyed between 1705 and 1800. This needless slaughter continued unabated into the nineteenth century. The aristocracy firmly believed that all birds with hooked beaks were vermin and had to be eliminated to protect pheasants raised for shooting. During the two world wars, when gamekeepers were called up, a significant increase in the local populations of birds of prey on estates was apparent.

Most European ornithologists are aware and ashamed of the relentless persecutions of the past but believe that toxic chemicals and their residues are the chief causes of the decline of predators during the latter half of this century. The author is a realist and points out that toxic chemicals are by no means the sole threat to our birds of prey. Falconers, egg thieves, gamekeepers, and pigeon fanciers all exact a toll on the survivors despite the conservation laws. The lesson we must all learn from this book is that the massacre continues and must be halted if raptors are not to be completely exterminated. Legislation is often openly flouted, and birds are shot on the slightest pretext. We cannot afford any further inroads into the remaining stocks of these superb birds.

Bijleveld deals with the thirty-seven species of diurnal European birds of prey individually, showing their status in each of the major countries of Europe. Only the Steppe Eagle (*Aquila nipalensis*), considered by some an Asiatic species, is omitted. A further chapter is devoted to conservation legislation in the various countries and how well or badly it is enforced. The weakest chapter is one on the future of birds of prey, bleak as it may be. Not enough credit is given to research efforts in breeding avian predators in captivity. The new techniques ably pioneered at Cornell University, in Canada, and elsewhere will soon be tried in Europe and should prove beneficial.

The layout and format of this book are faultless although it is expensive by English standards. Mention must be made of the bibliography, which runs to 37 pages of small print. In general, the book is an important contribution to the history of ornithology, worthy to take its place beside such excellent recent works as J. J. Hickey's *Peregrine Falcon Po ula-tions* (Madison, Milwaukee, and London: University of Wisconsin Press, 1969).

ON THE RECOGNITION OF OFFSPRING BY RAPTORS

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Introduction

Postupalsky and Holt (1975) reported the results of placing two Bald Eagle (*Haliaeetus leucocephalus*) chicks, whose nest had been destroyed, into two other Bald Eagle nests. Each of the latter nests already had a single eaglet of about the same age as the introduced chicks. Within about four weeks both the introduced and the original eaglets fledged and, at subsequent observations, appeared quite healthy. The adults at the two foster nests were never observed to show aggressive behavior towards the introduced eaglets. Postupalsky and Holt (1975:19) suggest that this "further supports the view that raptors, in contrast to colonial breeders, such as gulls, have not evolved an ability to recognize their own offspring." In this paper, I describe two observations of Osprey (*Pandion haliaetus*) behavior that indicate that Ospreys may be capable of recognizing their own young. Both the observations described below were made in Mathews County, Virginia.

Observations

On 10 August 1975 a Virginia Commission of Game and Inland Fisheries warden brought a young Osprey, which had been found with one foot caught in a pound (fishing) net, to Dr. Mitchell A. Byrd at the College of William and Mary. The newly fledged bird apparently had been trying to catch fish from the net and had become entangled. The bird handled the foot awkwardly, but it was not broken. The bird was kept at the College of William and Mary until it had regained the normal use of its foot. The age and origin of the bird were determined from the U.S. Fish and Wildlife Service aluminum band and three plastic color bands which had been placed on it a few weeks earlier.

On 14 August 1975 Barbara Warren and I returned the bird to its nesting area, a lighted navigational aid near New Point Comfort. The nest itself had been torn down by the Coast Guard after the chicks had fledged. I placed the chick on the railing of the structure and left the immediate vicinity. The chick whistled many times over the course of about four minutes. About five minutes after the chick was left at the nest site, the chick's parents and two siblings (the latter identified by the color bands they were wearing) appeared over the woods on the shore about one-half kilometer away. The four birds flew directly to the nest site, with the two adults in the lead, and all four landed on the railing beside the third chick. There were other Ospreys in the area which did not respond to the lone chick's whistling. This observation suggests that Osprey adults may be capable of recognizing their chicks by sound. Individual recognition based on sound (*e.g.,* Ramsey 1951, Evans 1970) is commonplace enough in birds for such speculation to be unsurprising.

A second series of observations relates only indirectly to the question of whether or not raptors are capable of recognizing their own young, but it does suggest that Ospreys have recognitional abilities with which they are not generally credited. Skutch (1976:314) cites similar examples for a variety of avian species.

On 16 and 20 July 1975 I visited a nest on a navigational aid in Davis Creek to weigh the single chick in that nest. On both occasions the parents were unusually aggressive towards me; the male Osprey "chased" and dove at my boat for nearly ten kilometers after I left the nest. Since it was my general practice to visit that nest as my last stop on the way back to the boat ramp in the East River, I usually passed near this nest once before I actually visited it. On 28 July 1975, during the first passage past this nest, the male Osprey met the boat about two kilometers from the nest; he dove at the boat continuously until we were two kilometers on the other side of the nest. We were never within one kilometer of the nest on that passage. On the return trip, when I was about two kilometers from the nest, the male appeared and began diving at the boat. He followed the boat to the nest where I weighed the chick. Afterwards the male dove at the boat and "chased" it nearly twelve kilometers to the East River.

The exact series of behaviors, including being met by the male any time the boat approached within two kilometers of the nest regardless of whether or not we were headed for the nest, was repeated on two subsequent dates (4 and 14 August 1975). On the latter date the chick had fledged and was not at the nest. Despite the apparent hostility directed at my boat, in about 13 hours of observing that nest from the shore, I never saw any such reaction to the many other boats which passed that beacon.

Discussion

I have tried to show that there is some reason to suspect that Ospreys might be capable of recognizing their own young. Postupalsky and Holt (1975) have demonstrated that Bald Eagles, like many other raptors (including Ospreys [Kennedy 1971, Postupalsky and Holt 1975], will not drive away unfamiliar chicks placed in their nests. The significance of the observations of Postupalsky and Holt (1975) seems to be, not that raptors fail to recognize their own young, but that even if raptors are capable of recognizing their own young they do not react aggressively towards strange young. Their reaction may be due to the infrequency of times when raptors in natural situations are confronted with strange and hungry chicks. With gulls (*e.g.*, Tinbergen 1967) and other birds which frequently encounter and often drive away strange chicks, one can speculate that there has been selection for aggressive behavior towards strange chicks to promote the survival of the parent's own chicks and to avoid the wasteful (in terms of natural selection) feeding of unrelated chicks. Raptors apparently have never had occasion to evolve that behavior. Thus, as Postupalsky and Holt (1975) have pointed out, foster parent programs have real potential for the propagation of threatened and endangered species of raptors.

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As approved by the Board of Directors at the annual meeting in Boise last November, the 1976 meetings will be held at Ithaca, New York, home of Cornell University, with Dr. Tom Cade serving as local chairman. Cosponsoring organizations include the Laboratory of Ornithology and the Peregrind Fund. The meetings will commence on Friday, October 29, and run through Monday, November 1. The Ramada Inn in Ithaca will serve as conference headquarters, with some activities planned for the Laboratory of Ornithology at Sapsucker Woods. A call for papers and other details will be forthcoming in an announcement brochure to be mailed to all members in the near future.

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