JOURNAL OF FIELD ORNITHOLOGY
Formerly BIRD-BANDING
A Journal of Ornithological Investigation

VOL. 55, NO. 2 SPRING 1984 PAGES 143–286

J. Field Ornithol., 55(2):143–150

SEX AND AGE DIFFERENCES IN FALL MIGRATION OF NORTHERN HARRIERS

BY KEITH L. BILDSTEIN, WILLIAM S. CLARK, DAVID L. EVANS, MARSHALL FIELD, LEN SOUCY, AND ED HENCKEL

The Northern Harrier (*Circus cyaneus*) has a rather protracted fall migration (e.g., Mueller and Berger 1961, Haugh 1972) characterized by peaks in late September–early October and in early November. Juveniles and adult female harriers leave the breeding grounds before adult males (Brown and Amadon 1968), and there are reports from both North America and Europe that adult females precede adult males on migration (Broun 1935, Watson 1977). Unfortunately, these sources fail to distinguish adult females from juveniles of both sexes (all are brown as opposed to the gray adult males), and it is possible that the many "females" recorded early in the season are juveniles. Support for this notion comes from Haugh (1972) who reported that during the fall of 1967 most of the early harrier migrants at Hawk Cliff, Ontario appeared to be young birds. We present data from 4 raptor banding stations in eastern North America showing that juvenile harriers migrate earlier than adults and at some locations juvenile males tend to migrate earlier than juvenile females.

METHODS

During the fall of 1971 through 1980, one or more of us operated banding stations at Cape May Point, New Jersey (WSC), Kittatinny Mountain, New Jersey (EH and LS), Hawk Cliff, Ontario (MF), and Duluth, Minnesota (DE) (Fig. 1). Detailed descriptions of these operations can be found in Clark (1976), Soucy (1976), Field (1970), and Rosenfield and Evans (1980). Harriers captured during the 10 seasons were aged and sexed by methods outlined in Hamerstrom (1968). A few birds were not processed completely, so sample sizes vary.

We used chi-square tests for goodness of fit and heterogeneity, *t*-tests and approximate *t*-tests, and product-moment correlation to analyze the data (Sokal and Rohlf 1969).

RESULTS

Of the 1256 harriers captured, 90% were juveniles (Table 1). Sex ratios of adults varied significantly from 1:1 only at Duluth, where more

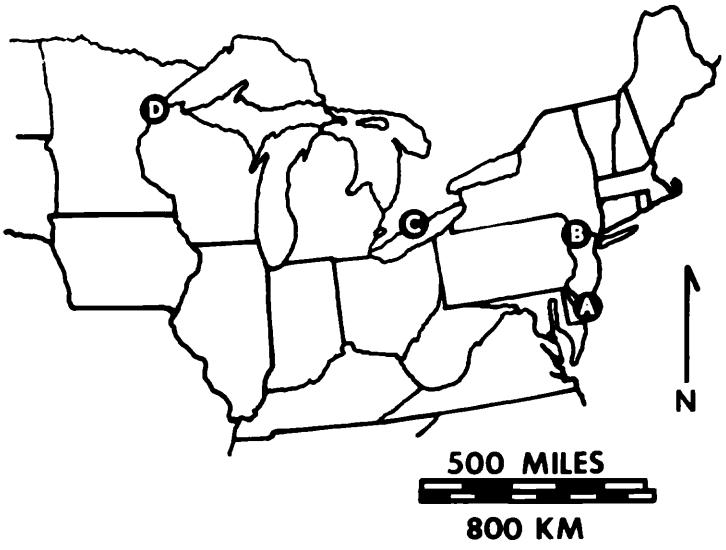

FIGURE 1. Banding station locations.

females were captured (1:3.3). Significantly more juvenile males than juvenile females were trapped at all locations except Kittatinny Mountain where the sample size was small (Table 1).

The mean capture date for migrating adult females preceded that for adult males at all locations except Kittatinny Mtn. (Table 2). Because the differences were not significant (Table 3), we lumped sexes and compared mean adult migration dates with mean juvenile dates. Juveniles preceded adults at all locations, although the difference was not significant at Duluth (Tables 2 and 3).

The mean and median capture date for migrating juvenile males preceded that for juvenile females at all 4 locations. There were too few data to test for a significant difference at Kittatinny Mtn., but at Cape May Point, despite extensive overlap in migration times, the difference was significant ($P < .01$). The difference was close to significance at Hawk Cliff ($.10 > P > .05$), but not at Duluth ($.50 > P > .40$) where the mean juvenile male migration date preceded that of juvenile females by only one day (Tables 2 and 3). On an annual basis, male precedence at Cape May Point was remarkably constant; both mean and median capture dates for juvenile males preceded those for juvenile females in each of 7 years in which at least 5 birds of each sex were captured. There was considerably greater variation at both Hawk Cliff, where mean female migration dates preceded mean male dates 3 times out of 10, and at Duluth, where mean female dates preceded mean male dates 3 times out of 8. At the latter 2 sites the extent of male precedence in a given year was positively correlated with percent of captured juveniles

TABLE 1. Age and sex of captured Northern Harriers.

Location	No. of birds captured	No. (%) of birds in indicated sex/age class			
		Juv ♂	Juv ♀	Ad ♂	Ad ♀
Cape May Point, NJ[a,b]	415	218 (53)	137 (33)	31 (7)	29 (7)
Hawk Cliff, Ont.[a,b]	433[c]	248 (57)	163 (38)	11 (3)	10 (2)
Duluth, MN[a,b,d]	370	193 (52)	146 (39)	7 (2)	24 (6)
Kittatinny Mtn., NJ[a]	38	13 (34)	13 (34)	5 (13)	7 (18)
Overall[a,b]	1256	672 (54)	459 (36)	54 (4)	70 (6)

[a] Significantly more juveniles than expected assuming a 1:1 juvenile to adult ratio, χ^2 test for goodness of fit, $P < .05$.

[b] Significantly more juvenile males than expected, assuming a 1:1 sex ratio for juveniles, χ^2 test for goodness of fit, $P < .05$.

[c] The age of one individual was not determined.

[d] Significantly fewer adult males than expected assuming a 1:1 sex ratio for adults, χ^2 test for goodness of fit, $P < .05$.

that were males (Fig. 2). Although there was a great deal of intersexual overlap in capture dates at all 3 stations, the cumulative percentage of juvenile males trapped at both Cape May Point and Hawk Cliff preceded that for juvenile females throughout the fall migration.

DISCUSSION

We believe the disproportionate number of juveniles caught reflected a bias in capture vulnerability as well as in relative numbers of juveniles and adults passing our banding locations (e.g., Duncan 1981). Adults are more successful at prey capture than are juveniles (Errington and Breckenridge 1936, Bildstein 1978) and as such they are probably less vulnerable to capture than are the less efficient, and presumably more hungry, juveniles. We suggest the juvenile sex ratio may be skewed in favor of males because we used birds as lures. Adult male harriers take more avian prey than do adult females (Bildstein 1978). If this sex-dependent difference in prey choice extends to young of the year, juvenile males would be more vulnerable to capture at our stations.

Although our data for adults are limited, they indicate that while adult females preceded adult males on migration (Table 2), overall, juveniles of both sexes preceded adults. The latter appears to be the case in most species of hawks (Mueller and Berger 1967, 1968, Haugh 1972, Rosenfield and Evans 1980, Duncan 1981, Mueller et al. 1981) and agrees with Haugh's (1972) observations of harriers migrating past Hawk Cliff, Ontario during the fall of 1967.

While the overall difference is slight and there is considerable overlap, juvenile males migrated earlier than juvenile females at Cape May Point, and they tended to do so at Hawk Cliff. The interseasonal consistency with which this occurs at Cape May Point supports the notion that the shift is biologically significant. Why male precedence is less consistent

TABLE 2. Mean dates for Northern Harrier migration.

Sex and age class	Mean migration date ± SE in days (n) for indicated locality			
	Duluth	Hawk Cliff	Kittatinny Mtn.	Cape May Point
Juv ♂	17 Sep ± 1 (193)	25 Sep ± 2 (248)	24 Sep ± 6 (13)	8 Oct ± 1 (218)
Juv ♀	18 Sep ± 1 (146)	28 Sep ± 2 (163)	5 Oct ± 6 (13)	15 Oct ± 2 (137)
Ad ♂	3 Oct ± 10 (7)	28 Nov ± 9 (11)	21 Oct ± 6 (5)	8 Nov ± 3 (31)
Ad ♀	22 Sep ± 5 (24)	6 Nov ± 10 (10)	1 Nov ± 3 (7)	6 Nov ± 2 (29)
All Juv	17 Sep ± 1 (339)	26 Sep ± 1 (411)	1 Oct ± 4 (26)	11 Oct ± 1 (355)
All Ad	24 Sep ± 4 (31)	17 Nov ± 7 (21)	28 Oct ± 4 (12)	7 Nov ± 2 (60)

TABLE 3. Statistical comparisons of Northern Harrier migration dates.

Sex and age class	Significance of differences[a] in migration dates at indicated locality			
	Duluth	Hawk Cliff	Kittatinny Mtn.	Cape May Point
Ad vs Juv	$P < .10$	$P < .001$	$P < .001$	$P < .001$
Ad ♂ vs Ad ♀	n.s.	n.s.	n.s.	n.s.
Juv ♂ vs Juv ♀	n.s.	$P < .10$	n.s.	$P < .01$

[a] Results of *t*-tests.

at Hawk Cliff and Duluth is unclear. Geography may be important. For example, Hawk Cliff and Duluth are inland while Cape May Point is on the coast, and it may be that male precedence is a coastal phenomenon. On the other hand, the difference may reflect a latitudinal effect, with the southernmost station (Cape May Point) showing a significant difference, the intermediate station (Hawk Cliff) approaching significance, and the northernmost station (Duluth) showing no significant difference. This may mean that although juveniles of both sexes begin migration at the same time, females migrate more slowly than males. Another possibility is that recently fledged males begin to migrate earlier than their female sibs. Bildstein (unpubl. data) found that for harriers he watched at 8 nests in central Wisconsin, males left the nest area about 3–4 days earlier than females. However, Beske (1982), working at 3 nests in the same area, failed to detect any sex-related difference in the dispersal of harrier young from nests. Yet another possibility is that because both Duluth and Hawk Cliff are within the breeding range of harriers, while Cape May Point is on the southern fringe, some of the birds captured at the former stations were dispersals rather than true migrants.

Although male precedence is less consistent at both Hawk Cliff and Duluth, this inconsistency appears to be related to the ratio of juvenile males to juvenile females captured. When the ratio declines toward unity, the time shift in migration disappears. While we are uncertain of reasons for this phenomenon we suggest one possible scenario. If the above-mentioned adult male preference for avian prey does extend to juvenile males, the earlier fall migration of juvenile males may be due to migration of their passerine prey base. Juvenile females would be able to remain north longer as they would be less dependent on avian prey and more dependent on microtine prey. The lack of a sex dependent shift as the ratio of juvenile males to juvenile females approaches unity may indicate the occurrence of low vole years. During these years, juvenile females, as well as juvenile males, would migrate early as a result of an inadequate prey base, and both would be vulnerable to capture because voles were limiting. Previously, Rosenfield and Evans (1980) suggested that the juvenile female Sharp-shinned Hawk (*Accipiter striatus*) migrates earlier than juvenile males because of a difference in the rel-

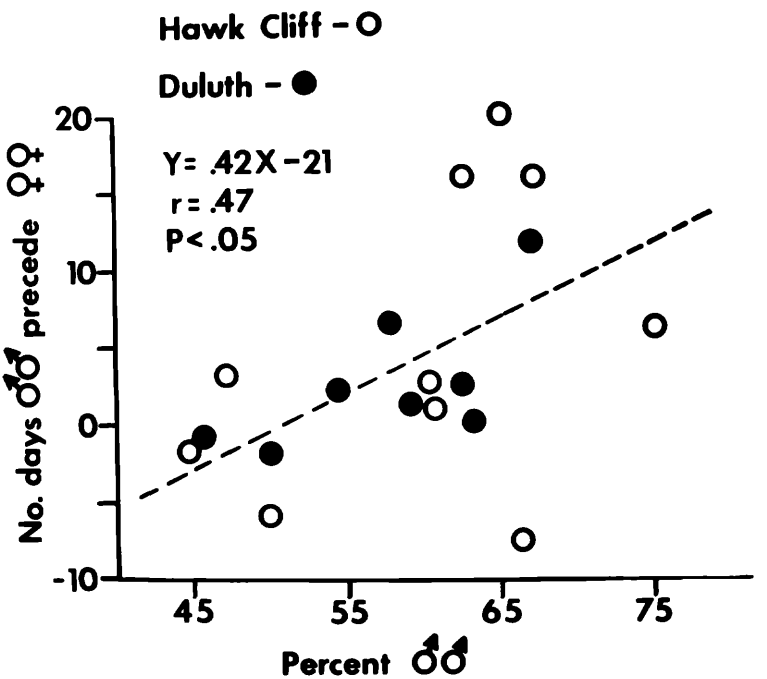

FIGURE 2. Relationship between the number of days juvenile male mean migration date precedes the juvenile female mean and the percent of juveniles captured that were males.

ative availability of their prey bases. Similarly, Marquiss (1980) suggested that in Scotland young male Hen Harriers (*C. c. cyaneus*) dispersed farther from their nest sites than did female counterparts because they had a harder time finding suitable abundant prey.

Mueller and Berger (1968:436) have proposed a somewhat different explanation for the earlier migration of the juvenile male Goshawk (*A. gentilis*) at Cedar Grove, Wisconsin. They hypothesized that in the fall as prey becomes increasingly more limiting, " . . . the smaller juvenal males are more easily displaced from an inadequate winter range than either the larger, juvenal females or the adults of either sex." They suggested that competition for food among the age and sex classes, rather than the more direct effect of prey availability, is responsible for the observed sex differences in juveniles. Which hypothesis better explains the sex-dependent differences we observed in juvenile harriers awaits determination of the prey caught by juvenile males and females as well as observations of behavioral interactions among individuals of the 4 age and sex classes. Presumably, the increased hunting prowess of adult harriers, which should enable them to support themselves on lower prey bases, explains why adults migrate later than the juveniles.

SUMMARY

Ninety percent of 1256 Northern Harriers captured at Cape May Point, New Jersey, Kittatinny Mountain, New Jersey, Duluth, Minnesota, and Hawk Cliff, Ontario were juveniles. Juvenile harriers migrated earlier in the fall than adults of both sexes. Despite considerable overlap, juvenile males migrated earlier than juvenile females, but the difference was not significant inland.

ACKNOWLEDGMENTS

We thank the many banders and banding assistants who helped operate the banding stations, as well as those individuals and groups that supported our research, and Jerome A. Jackson and 2 anonymous referees for helpful comments on an earlier draft of this paper.

LITERATURE CITED

BESKE, A. E. 1982. Local and migratory movements of radio-tagged juvenile harriers. Raptor Research 16:39–53.

BILDSTEIN, K. L. 1978. Behavioral ecology of Red-tailed Hawks, Rough-legged Hawks, Northern Harriers, American Kestrels, and other raptorial birds wintering in south central Ohio. Ph.D. dissert., The Ohio State University, Columbus.

BROUN, M. 1935. The hawk migration during the fall of 1934, along the Kittatinny Ridge in Pennsylvania. Auk 52:233–248.

BROWN, L., AND D. AMADON. 1968. Eagles, hawks and falcons of the world. McGraw-Hill, New York.

CLARK, W. S. 1976. Cape May Point raptor banding-station—1974 results. North Am. Bird Bander 1:5–13.

DUNCAN, B. W. 1981. Cooper's Hawks banded at Hawk Cliff, Ontario, 1971–1980. Ontario Bird Banding 14:21–32.

ERRINGTON, P. L., AND W. J. BRECKENRIDGE. 1936. Food habits of Marsh Hawks in the glaciated prairie region of north central United States. Am. Midl. Nat. 17:831–848.

FIELD, M. 1970. Hawk-banding on the northern shore of Lake Erie. Ontario Bird Banding 6:52–69.

HAMERSTROM, F. 1968. Ageing and sexing harriers. Inland Bird Banding 40:43–46.

HAUGH, J. R. 1972. A study of hawk migration in eastern North America. Search 2:1–60.

MARQUISS, M. 1980. Habitat and diet of male and female Hen Harriers in Scotland in winter. Br. Birds 73:555–560.

MUELLER, H. C., AND D. D. BERGER. 1961. Weather and fall migration of hawks at Cedar Grove, Wisconsin. Wilson Bull. 73:171–192.

———, AND ———. 1967. Fall migration of Sharp-shinned Hawks. Wilson Bull. 79:397–415.

———, AND ———. 1968. Sex ratios and measurements of migrant Goshawks. Auk 85: 431–436.

———, ———, AND ALLEZ. 1981. Age, sex, and seasonal differences in size of Cooper's Hawks. J. Field Ornithol. 42:112–126.

ROSENFIELD, R. N., AND D. L. EVANS. 1980. Migration incidence and sequence of age and sex classes of the Sharp-shinned Hawk. Loon 52:66–69.

SOKAL, R. R., AND F. J. ROHLF. 1969. Biometry. W. H. Freeman and Co., San Franciso.

SOUCY, L. J., JR. 1976. Raptor report—Kittatinny Mountains. North Am. Bird Bander 1:108–113.

WATSON, D. 1977. The Hen Harrier. Poyser, Berkhamsted, United Kingdom.

Department of Biology, Winthrop College, Rock Hill, South Carolina 29733 and *Baruch Institute For Marine Biology, USC* (KLB); *7800 Dassett Ct.,*

Annandale, Virginia 22003 (WSC); *2928 Greysolon Rd., Duluth, Minnesota 55812* (DLE); *89 Elm St., St. Thomas, Ontario, Canada* (MF); *1390 White Bridge Rd., Millington, New Jersey 07946 (LS), and RD 1, Box 1380, Mt. Bethel, Pennsylvania 18343* (EH). Received 18 Feb. 1983; accepted 13 Oct. 1983.