

American Hawkwatcher

Published by the Wildlife Information Center, Inc.

December 1999

No. 25



Featured In This Issue

The 1999 Autumn Hawk Count
at Bake Oven Knob

Comparison of Red-shouldered
Hawk Counts at Hawk Mountain
and Bake Oven Knob

A Comparison of Red-shouldered Hawk Autumn Migration Counts at Hawk Mountain Sanctuary and Bake Oven Knob, Pennsylvania, 1982-1998

by Michael A. Jacobson and Wendy Potter

Introduction

Migrating diurnal raptors have been identified and their numbers recorded at more than a dozen watchsites along the central Appalachian Mountains of southeastern New York, northeastern New Jersey, and eastern Pennsylvania. Organized yearly counts of the raptors have occurred at Hawk Mountain Sanctuary, east of Kempton, Pennsylvania, since 1934 and at Bake Oven Knob, west of Slatington, Pennsylvania, since 1961 (Broun 1949, Heintzelman 1982, Bednarz et al. 1990).

The Red-shouldered Hawk (*Buteo Lineatus*) is one of 16 species of diurnal raptors and New World vultures seen at the two watchsites (Heintzelman 1975). The eastern population of Red-shouldered Hawks, *B.l. lineatus*, breeds from southern Canada south to Oklahoma, Arkansas, Tennessee, and South Carolina (Crocoll 1994). The northern part of this population is migratory (Crocoll 1994). In its migratory range, the species is a mid-distance, partial migrant with most individuals usually traveling between 300 and 1500 km one way each autumn (Kerlinger 1989).

Red-shouldered Hawks typically migrate alone or in small flocks of three or more birds (Kerlinger 1989). Red-shouldered Hawks migrate along inland ridges as well as in coastal areas (Heintzelman 1975, Laurie and Jenkins 1985, Dunne and Sutton 1986). Although the species engages in short water crossings (<25 km) (Kerlinger 1989), most individuals tack into the wind to remain over land and to avoid passage over larger bodies of water (Palmer 1998). At eastern fall watchsites where Red-shouldered Hawks are seen regularly, the species rarely comprises more than 1% of the total flight of raptors (Table 1).

Table 1 Percent of total flight of raptors that is Red-shouldered Hawks at several autumn migration watchsites (reported counts taken from Zalles and Bildstein, 2000)

Watchsite	State or Province	Years of Observation	Ave. Number of RSHA per Year	% of Total Flight
Lighthouse Point	Connecticut	13 (1980-1992)	94	0.5
Mt. Tom	Massachusetts	12 (1980-1991)	4	0.1
Southeast Michigan Raptor Research	Michigan	9 (1989-1997)	396	0.4
Cape May Point	New Jersey	10 (1980-1992)	472	0.7
Montclair Hawkwatch	New Jersey	13 (1980-1992)	131	0.5
Mahogany Rock Mt.	North Carolina	7 (1986-1992)	3	0.1
Cranberry Marsh	Ontario	6 (1990-1995)	83	0.8
Holiday Beach	Ontario	19 (1974-1992)	874	1.3
Bake Oven Knob	Pennsylvania	17 (1982-1998)	105	0.9
Hawk Mountain	Pennsylvania	62 (1934-1995)	263	1.4
Santee Coastal Reserve	South Carolina	2 (1995-1996)	1	0.3
East River Mountain	West Virginia	17 (1974-1991)	5	0.3

Migrating populations of Red-shouldered Hawks move south from September through December, with immature birds migrating somewhat earlier than adults (Crocoll 1994). At Hawk Mountain Sanctuary, the middle 50% of the Red-shouldered Hawk flight passes between 16 October and 3 November each year, dates that appear typical for other watchsites in the northeastern United States (Haugh 1972)

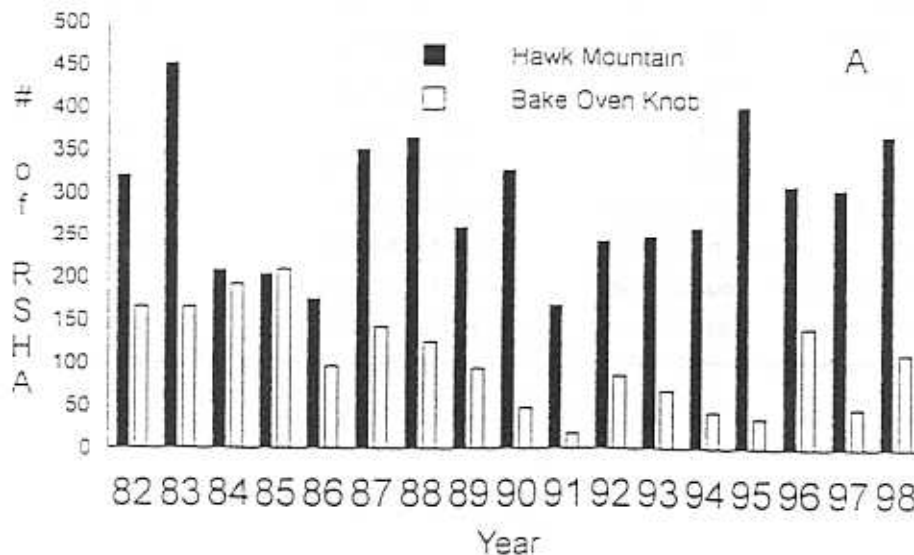
Here we present and compare counts of Red-shouldered Hawks migrating at Hawk Mountain Sanctuary and Bake Oven Knob from 1982 through 1998.

Methods

Hawk Mountain Sanctuary (40 degrees 38'N, 75 degrees 59'W) is a mountaintop watchsite in eastern Pennsylvania, on the 300 km long northeast-to-southwest Kittatinny Ridge, the easternmost ridge in the region's central Appalachian Mountains. The site is 40 km west-northwest of Allentown, Pennsylvania, and 40 km north of Reading, Pennsylvania. Migrating raptors have been identified and recorded as they fly past the Sanctuary's North Lookout (elevation 467 m) each autumn since 1934. For 1982 through 1998, counts were made daily, weather permitting, from 15 August through 15 December, with daily coverage usually beginning at 0800 and ending at 1700. Counters used binoculars and, sometimes, telescopes to help find and identify raptors to species as they moved south or southwest past the North Lookout (Bednarz et al. 1990, Allen et al. 1995, Bildstein 1995). Average annual count effort for 1982-1998 (Figure 1) at Hawk Mountain was 955 hours (sd = 90, range = 795-1158)(Figure 1).

Bake Oven Knob (40 degrees 44'N, 75 degrees 44'W) is another mountaintop watchsite along the Kittatinny Ridge, 26 km east-northeast of Hawk Mountain Sanctuary (Heintzelman 1975). Autumn hawk counts have been conducted there continuously since 1961. Bake Oven Knob is 14 km west of Slatington, Pennsylvania, and 32 km northwest of Allentown, Pennsylvania. Three principal rocky outcroppings (mean elevation 473 m) are used as count sites at Bake Oven Knob. The main lookout is the South Lookout, from which it is possible to see birds migrating along both sides of the ridge. The North Lookout (formerly called the Point) is used on days with strong winds with a northerly component. For 1982 through 1998, counts were made for approximately 7 hours per day on most days between 0900 to 1600. Average annual count effort for 1982-1998 at Bake Oven Knob was 395 hours (sd = 106, range = 117-546)(Figure 1).

At both sites, most Red-shouldered Hawks are seen in October and November (53% and 43% at Hawk Mountain and 59% and 38% at Bake Oven Knob, for October and November respectively). Because of this, and because of large difference in sampling effort before October and after November between these two sites, we have restricted our analysis of rates of passage to the months of October and November.



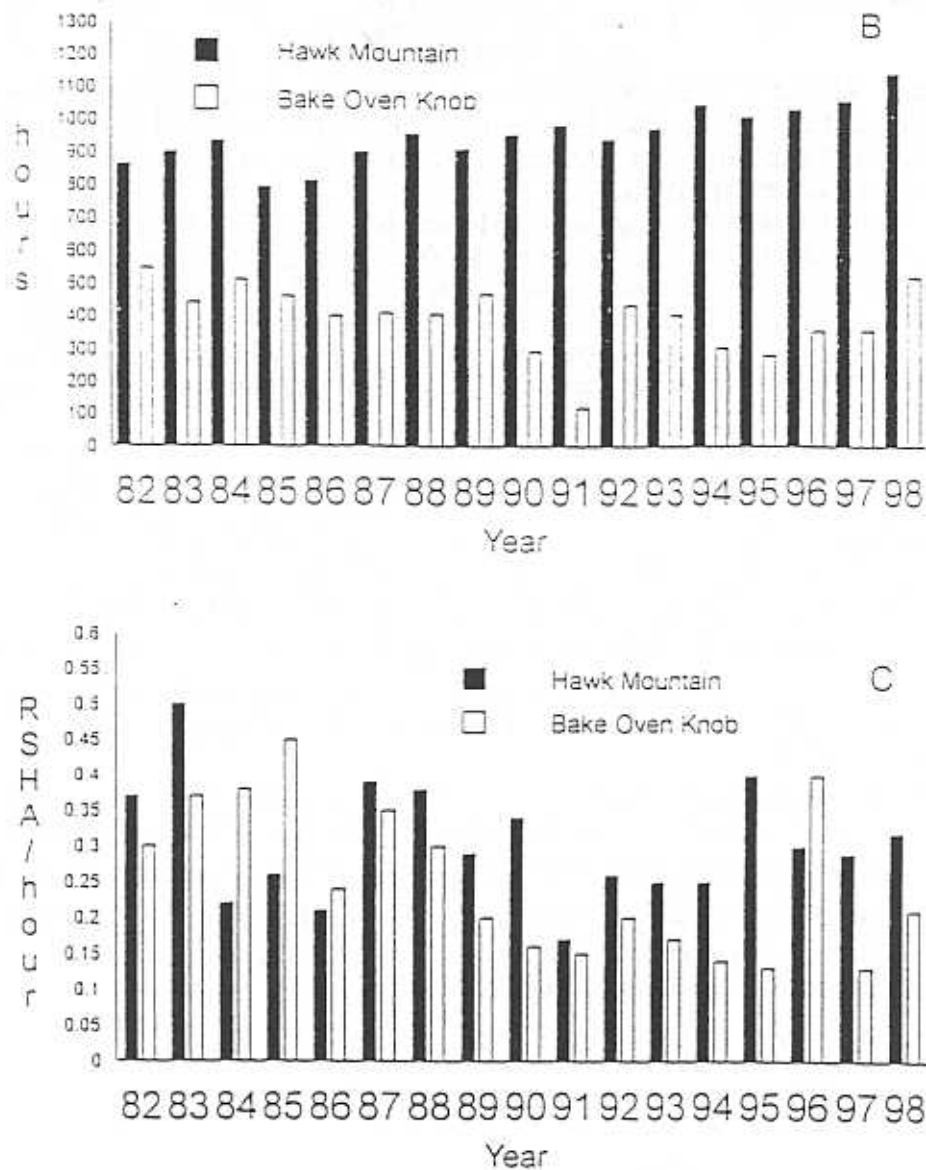


Figure 1. A. Average annual counts of Red-shouldered Hawks; B. average annual count effort; and C. average hourly rates of passage of Red-shouldered Hawks at Hawk Mountain Sanctuary and Bake Oven Knob, Pennsylvania, 1982-1998.

We log-transformed the average hourly rates of passage of Red-shouldered Hawks to stabilize variance, and then analyzed separately, count data for October and November combined (October-November), October alone, and November alone using simple linear regression and 2-way-ANOVA with PROC GLM (SAS Institute 1990). Site (Hawk Mountain Sanctuary and Bake Oven Knob) and year (1982 through 1998) were the two main effects on average hourly rates of passage tested in our GLM model. We also looked for an interaction effect of site by year.

Results

An average 292 Red-shouldered Hawks were seen at Hawk Mountain Sanctuary (sd = 81, range = 168-451), and an average 104 Red-shouldered Hawks were seen at Bake Oven Knob (sd = 58, range = 17-209) annually. Hawk Mountain Sanctuary counts outnumbered those of Bake Oven Knob in every year except 1985.

The average annual rate of passage was 0.31 birds per hour at Hawk Mountain Sanctuary (sd = 0.08, coefficient of variation = 25%, range = 0.17-0.50), and 0.25 birds per hour at Bake Oven Knob (sd = 0.11, coefficient of variation = 44%, range = 0.13-0.45) as shown in Figure 1.

For October-November, Hawk Mountain averaged 0.59 Red-shouldered Hawks per hour, (sd = 0.17, coefficient of variation = 29%, range = 0.32-1.00), and Bake Oven Knob averaged 0.43 Red-shouldered Hawks per hour (sd = 0.17, coefficient of variation = 29%, range = 0.32-1.00).

For October, Hawk Mountain averaged 0.61 Red-shouldered Hawks per hour, (sd = 0.25, coefficient of variation = 44%, range = 0.23-1.23), and Bake Oven Knob averaged 0.40 Red-shouldered Hawks per hour (sd = 0.20, coefficient of variation = 50%, range = 0.13-0.88).

For November, Hawk Mountain averaged 0.57 Red-shouldered Hawks per hour, (sd = 0.28, coefficient of variation = 46%, range = 0.14-1.10), and Bake Oven Knob averaged 0.50 Red-shouldered Hawks per hour (sd = 0.27, coefficient of variation = 54%, range = 0.19-1.20).

For October-November, the GLM model was significant ($p = 0.001$, $r^2 = 0.41$) with a weak site effect ($p = 0.06$), no year effect, and a significant site-year interaction ($\beta_{\text{year} \cdot \text{site}} = -0.05$, $p = 0.04$). Overall, this suggests a decline in rate of passage of Red-shouldered Hawks at Bake Oven Knob, but not at Hawk Mountain.

The model also appeared to be significant for October ($p < 0.01$, $r^2 = 0.29$). The average hourly rate of passage of Red-shouldered Hawks in October was significantly greater at Hawk Mountain Sanctuary than at Bake Oven Knob ($\beta_{\text{site}} = 0.40$, $p = 0.01$). There was also a significant year effect in October ($\beta_{\text{year}} = -0.04$, $p = 0.02$), suggesting that the rates of passage declined from 1982 through 1998 during this month. The year*site interaction was not significant.

The November model was not significant ($p = 0.51$)

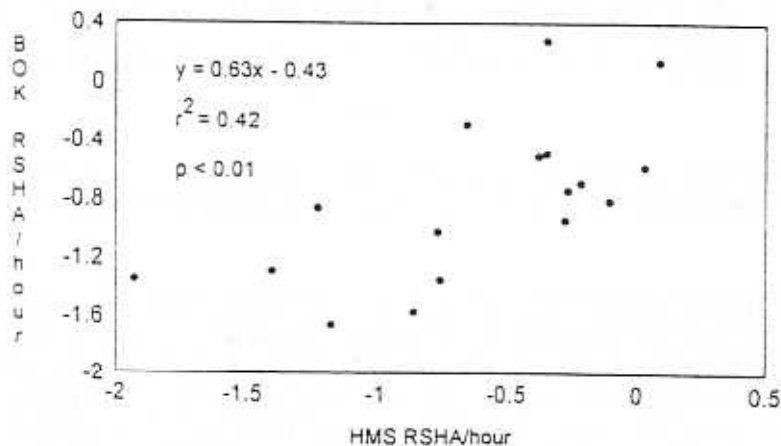


Figure 2. Correlation between November rates of passage of Red-shouldered Hawks at Hawk Mountain Sanctuary (HMS) and Bake Oven Knob (BOK), Pennsylvania, 1982-1998. Correlation in October-November and October rates of passage were not significant.

We found no inter-annual correlation between October-November ($p = 0.50$) or October ($p = 0.16$) rates of passage of Red-shouldered Hawks at the two sites. We did, however, detect a significant inter-annual correlation in November rates of passage of Red-shouldered Hawks at Hawk Mountain Sanctuary and Bake Oven Knob ($p < 0.01$, $r^2 = 0.42$, slope estimate = 0.61, intercept estimate = -0.43)(Figure 2).

Discussion

From 1982 through 1998, Hawk Mountain Sanctuary recorded an average three times more Red-shouldered Hawks than Bake Oven Knob. Although more Red-shouldered Hawks were seen at Hawk Mountain, probably because of the greater count effort at that site, differences in the rates of passage at the two sites suggest that more Red-shouldered Hawks migrate within view of Hawk Mountain Sanctuary's North Lookout than the lookouts at Bake Oven Knob.

In comparing counts at two nearby sites along the same migration flyway, two possibilities exist. The two sites could record the same number of birds, or they could record different numbers of birds. The latter is true of Hawk Mountain Sanctuary and Bake Oven Knob counts of Red-shouldered Hawks. That Hawk Mountain reports significantly greater passage rates of Red-shouldered Hawks than Bake Oven Knob suggests that for this portion of the Kittatinny Raptor Corridor, Red-shouldered Hawks build in number along the ridge as more and more individuals traveling from north to south across eastern Pennsylvania are intercepted and diverted by the ridge.

Hawk Mountain recorded significantly greater rates of passage of Red-shouldered Hawks than Bake Oven Knob in the month of October, but not for November. Furthermore, rates of passage were correlated between the two sites in November, but not in October. This suggests a change in the migration behavior of the Red-shouldered Hawk as its season progresses.

Like other Buteos, Red-shouldered Hawks rely on external sources of energy to help power their migrations, including both slope and thermal soaring (Broun 1949, Heintzelman 1975, Kerlinger 1989). Of the two types of soaring, slope soaring should keep migrating hawks along the ridge for longer periods. As autumn progresses, and as solar energy wanes with each passing day, opportunities for thermal soaring decrease substantially while opportunities for slope soaring remain relatively constant. Thus, we expect Red-shouldered Hawks to exhibit proportionately more slope soaring and, therefore, to show greater ridge adherence in November than October, hence the correlation in the rates of passage at the two sites in November, but not October. Additional support for the results described await an analysis of October and November migration counts of Red-tailed Hawks at the two sites.

Acknowledgments

We thank Hawk Mountain Sanctuary and The Wildlife Information Center for sponsoring our internships and providing the count data for this project. This paper could not have been written without critical editorial input of K. L. Bildstein and D. R. Kunkle, nor without the comments and statistical help of M. W. Miller. We thank D. S. Heintzelman and all the other dedicated hawk counters at Bake Oven Knob and Hawk Mountain Sanctuary who have donated their time and effort over the years to document the spectacular autumn hawk migration.

Michal Jacobson and Wendy Potter were interns at Hawk Mountain Sanctuary and the Wildlife Information Center, respectively, at the time this paper was written. This was a cooperative project of Hawk Mountain and the Wildlife Center and is Hawk Mountain Sanctuary contribution to science number 82.

Literature Cited

- Allen, P.E. L. Goodrich, and K.L. Bildstein
1995 Hawk Mountain's Million Bird Data Base. *Birding*, 27:24-32.
- Bednarz, J.C., D. Klem, Jr., L.J. Goodrich, and S.E. Senner
1990 Migration Counts of Raptors at Hawk Mountain, Pennsylvania, as Indicators of Population Trends, 1954-1986. *Auk*, 107:96-109.
- Bildstein, K.L.
1998 Long-term Counts of Migrating Raptors: A Role for Volunteers in Wildlife Research. *Journal of Wildlife Management*, 62:435-445.
- Broun, M.
1949 *Hawks Aloft: The Story of Hawk Mountain*. Dodd and Mead, New York, NY.
- Crocoll, S.T.
1994 Red-shouldered Hawk (*Buteo Lineatus*). In *The Birds of North America*, No. 107 (A. Poole and F. Gill, eds.), Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists Union.
- Dunne, P.J. and C. Sutton
1986 Population Trends in Coastal Raptor Migrants Over Ten Years of Cape May Point Autumn Hawk Counts. *Records of New Jersey Birds*, 12:39-43.
- Haugh, J.R.
1972 A Study of Hawk Migration in Eastern North America. *Search*, 2: 1-60.
- Heintzelman, D. S.
1975 *Autumn Hawk Flights: The Migrations in Eastern North America*. Rutgers University Press, New Brunswick, NJ.
1982 The 1982 Autumn Hawk Count at Bake Oven Knob, Pennsylvania. *American Hawkwatcher*, 5: 1-6.
1986 *The Migrations of Hawks*. Indiana University Press, Bloomington, IN.
- Kerlinger, P.
1989 *Flight Strategies of Migrating Hawks*. University of Chicago Press, Chicago, IL.
- Laurie, P. and N.C. Jenkins
1985 Autumn Hawk Migrations at Fort Johnson, Charleston, South Carolina. Pp. 355-360 in *Proceeding of the Fourth Hawk Migration Conference* (M. Harwood, ed.). Hawk Migration Association of North America, Rochester, NY.
- Maransky, B., L. Goodrich, and K. Bildstein
1997 Seasonal Shifts in the Effects of Weather on the Visible Migration of Red-tailed Hawks at Hawk Mountain, Pennsylvania, 1992-1994. *Wilson Bulletin* 109:246-252.
- Palmer, R. S.
1988 Red-shouldered Hawk. Pp. 413-429 in *Handbook of North American Birds*, vol. 4 (R.S. Palmer, ed.). Yale University Press, New Haven, CT.
- SAS Institute
1990 *SAS/STAT User's Guide*, version 6, fourth edition, volume 2, GLM - Varcomp. SAS Institute, Inc., Cary, NC.
- Zalles, J.I. and K.L. Bildstein
2000 *Raptor Watch: A Global Directory of Hawk Migration Sites*. Hawk Mountain Sanctuary Association, Kempton, PA; BirdLife International, Cambridge, UK.

Note: Hawk Count data for this paper were obtained from the Hawk Mountain data base and from the published Bake Oven Knob hawk counts from 1982 through 1997 as cited in the previous article.

--Michael A. Jacobson, Hawk Mountain Sanctuary, 1700 Hawk Mountain Road, Kempton, PA 19529; Wendy Potter, Wildlife Information Center, Inc., PO Box 198, Slatington, PA 18080.