

A Comparison of Counts of Migrating Cooper's Hawks Seen at Hawk Mountain Sanctuary and Bake Oven Knob, Pennsylvania, 1961-2003.

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Introduction

The Cooper's Hawk (*Accipiter cooperii*) is a medium-sized accipiter with a long, rudder-like tail and relatively short, rounded wings. Cooper's Hawks are well-adapted to the quick, agile flight necessary to capture and kill their prey, which consist mainly of medium-sized birds and mammals. Although long known as a "quintessential woodland hawk" (Rosenfield and Bielefeldt 1993, pp. 1), in recent years Cooper's Hawks have expanded beyond forest habitats into suburban and even urban areas. Recent habitat expansion is likely due to several factors, including the growing number of backyard bird feeders, an increase in the number of trees in suburban and urban areas of suitable size for nesting, and reduced human persecution (Rosenfield and Bielefeldt 1993, Bildstein 2001).

Persecution of accipiters, including Cooper's Hawks, in eastern North America continued long after that of many other species of raptors. In Pennsylvania, for example, all species of diurnal birds of prey were protected by a state law in 1937, except accipiters, which were only protected in 1969 (Bildstein 2001). The lack of legal protection, coupled with negative perceptions of Cooper's Hawks as "bloodthirsty" and "destructive to wildlife" (Bildstein 2001) had devastating effects on the species, with banding recoveries suggesting first-year mortality due to shooting of 28-47% in 1929 to 1940, and 12-25% in 1946 to 1957 (Henny and Wight 1972). Breeding success and, possibly, adult survival of Cooper's Hawks also were negatively impacted by the widespread use of DDT in the northeastern United States in the late 1940s through early 1970s (Bednarz et al. 1990).

Although Cooper's Hawks are still listed as "Extirpated," "Endangered," "Threatened," or "of Special Concern" in several eastern states, organochlorine pesticides and human persecution are no longer the significant threats they once were. Suburban and urban habitats seem to be able to support increased numbers of resident Cooper's Hawks, and the species has recovered to levels similar to those of the latter 19th and early 20th centuries. Recent increases across the United States in the number of Cooper's Hawks observed at migration watchsites and at raptor rehabilitation facilities suggest that populations in the eastern United States have been increasing steadily since the 1970s (Bednarz et al. 1990, Rosenfield and Bielefeldt 1993, Bildstein 2001).

The Cooper's Hawk is partially migratory, with birds from eastern North America overwintering mainly in central and southern United States, and western individuals overwintering in central and southern Mexico (Rosenfield and Bielefeldt 1993). As is true of other raptors, Cooper's Hawks often concentrate along diversion and leading lines (*sensu* Berthold 2001) such as coastlines and mountain ranges, respectively (Kerlinger 1989). The Kittatinny Ridge in the central Appalachian Mountains of eastern Pennsylvania is one such leading line, and a number of migration watchsites have been established along the ridge, including Hawk Mountain Sanctuary and Bake Oven Knob. Although coastal migrations of Cooper's Hawks tend to be greater than inland flights, numbers of Cooper's Hawks seen at Appalachian watchsites often are substantial (Rosenfield and Bielefeldt 1993).

One ongoing question about raptor migration is the amount of time different migrants use leading lines, including the Kittatinny Ridge. Swartzentruber and Beck (2001) compared count data for Red-

tailed Hawks (*Buteo jamaicensis*) at Hawk Mountain Sanctuary and Bake Oven Knob and showed ridge adherence to be influenced by time of year, with increased adherence more likely later in autumn than earlier in the year for that species.

We analyzed the 1961-2003 count data from each site to see what, if any, population trends in Cooper's Hawks we could detect in migration counts. We also examined ridge adherence in the species, comparing annual counts of migrating Cooper's Hawks at Hawk Mountain Sanctuary and Bake Oven Knob from 1961 through 2003, and examined monthly counts from 1982 through 2001, a time period when the latter were available.

Methods

Hawk Mountain Sanctuary (HMS) (40°38'N, 75°59'W) was founded in 1934 as the world's first refuge for birds of prey. The Sanctuary is 10 km west of Kempton, PA, in northern Berks and southern Schuylkill counties. HMS has conducted a count of migrating raptors at the North Lookout every year since 1934, except for 1943-1945 (Bednarz et al. 1990). The mean annual count efforts from 1961-2003 and 1982-2001 were 776 hours ($sd = 207$, range = 315-1105), and 942 hours ($sd = 96$, range = 769-1105) respectively. Migratory raptors are counted at HMS from August 15 through December 15 from 0800 to 1700 EST each day, weather permitting (Bednarz et al. 1990).

Counts of migrating raptors were initiated at Bake Oven Knob (BOK) (40°44'N, 75°44'W) in 1961 by Donald S. Heintzelman (Heintzelman 1975). BOK is on State Game Lands 11 km west of Slatington, PA, in northern Lehigh County. Counts at BOK are conducted from one of three sites depending upon the weather, South Lookout, North Lookout, and North Side, all of which are within 0.2 km of each other. The mean annual count efforts from 1961-2003 and 1982-2001 were 429 hours ($sd = 188$, range = 36-801), and 449 hours ($sd = 165$, range = 117-801), respectively. Migratory raptors are counted at BOK from August 15 through the Sunday after Thanksgiving, from 0830 to 1630 EST each day, weather permitting (Kunkle 2002).

HMS and BOK are 26 km apart on the Kittatinny Ridge, the 300 km-long southernmost ridge line of the central Appalachians of eastern Pennsylvania. Both HMS and BOK extend observation hours beyond the minimum daily time period during times of peak migration and under certain weather conditions. Counters at both sites identify raptors using binoculars and sometimes telescopes as the migrants pass the lookouts (Bednarz et al. 1990, Kunkle 2002). Both sites have increased the number and consistency of their observation hours over their years of operation.

Counts at the two sites were compared using regression analysis. To evaluate ridge adherence, we compared counts from Bake Oven Knob with those from Hawk Mountain Sanctuary for the months of September, October and November, and compared them using Pearson's correlation coefficient. To identify trends in the monitored population of Cooper's Hawks, we regressed log-transformed counts for each site against time, interpreting the slope of the regression line as an estimate of the rate of change in the counts.

Results

The mean hourly rate of passage of Cooper's Hawks at HMS was 0.45 birds per hour from 1961 through 2003, and 0.63 birds per hour from 1982 through 2001. From 1982 through 2001 rates of passage were 0.27 in September, 1.69 in October and 0.21 in November (Tables 1 and 2, Figure 1).

The mean hourly rate of passage of Cooper's Hawk at BOK was 0.31 birds per hour from 1961 through 2003, and 0.40 from 1982 through 2001 (Table 1). From 1982 through 2001 rates of passage were 0.27 in September, 0.79 in October and 0.09 in November (Tables 1 and 2, Figure 1).

Overall counts increased at both sites over the time interval we analyzed. The increase was 4.9% per year at HMS and 4.3% per year at BOK (Figure 4).

Annual rates of passage between the two sites were correlated during both 1961 – 2003 and 1982

– 2001 (Figure 2). Monthly rates of passage were significantly correlated ($P=0.05$) during September and October, but not in November (Figure 3).

Table 1. Summary statistics for hours of observation and hourly rates of passage of Cooper’s Hawk at Hawk Mountain Sanctuary and Bake Oven Knob, Pennsylvania, 1961-2003.

Period	Hours of observation		Cooper’s Hawk per hour	
	Hawk Mountain Sanctuary	Bake Oven Knob	Hawk Mountain Sanctuary	Bake Oven Knob
1961-2003 All season	776 ± 207 (315 - 1105) [27%] ^a	429 ± 188 (36 - 801) [44%]	0.45 ± 0.27 (0.09 - 1.01) [60%]	0.31 ± 0.17 (0.03 - 0.69) [55%]
1982-2001 All season	942 ± 96 (769 - 1105) [10%]	449 ± 165 (117 - 801) [37%]	0.63 ± 0.21 (0.19 - 1.01) [34%]	0.40 ± 0.13 (0.16 - 0.63) [33%]
September	270 ± 26 (222 - 319) [10%]	158 ± 48 (51 - 263) [30%]	0.27 ± 0.14 (0.07 - 0.53) [51%]	0.27 ± 0.17 (0.06 - 0.60) [60%]
October	278 ± 21 (247 - 315) [8%]	160 ± 53 (24 - 262) [33%]	1.69 ± 0.65 (0.46 - 3.18) [38%]	0.79 ± 0.30 (0.35 - 1.29) [37%]
November	222 ± 39 (148 - 313) [18%]	87 ± 45 (27 - 170) [52%]	0.21 ± 0.10 (0.06 - 0.39) [47%]	0.09 ± 0.05 (0.02 - 0.21) [54%]

^aMean ± Standard Deviation (Range) [Coefficient of Variation %].

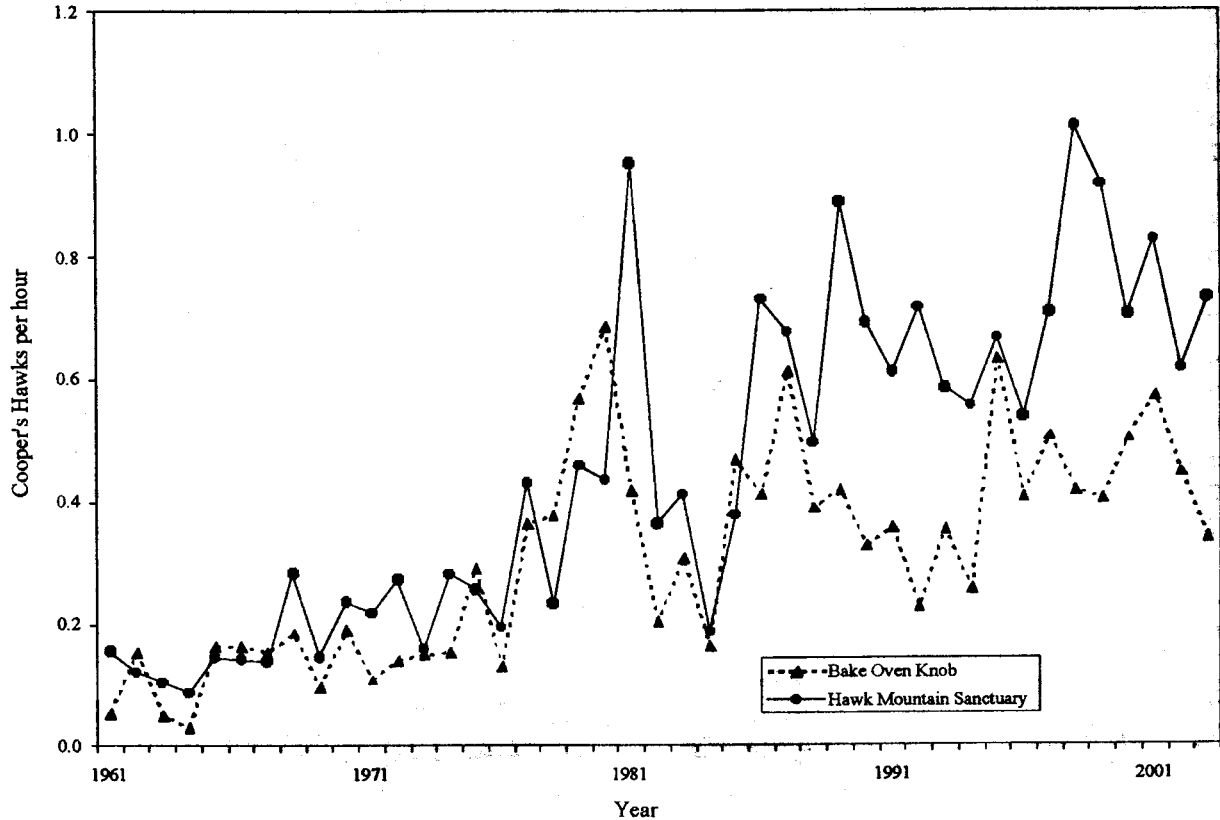


Figure 1. Hourly rates of passage of Cooper’s Hawk at Hawk Mountain Sanctuary and Bake Oven Knob, Pennsylvania, 1961 – 2003.

Table 2. Hours of observation, numbers of Cooper's Hawk seen, and hourly rates of passage of Cooper's Hawk at Hawk Mountain Sanctuary and Bake Oven Knob, Pennsylvania, 1961-2003.

Year	Hawk Mountain Sanctuary ^a			Bake Oven Knob ^b		
	Hours of Observation	Numbers of Cooper's Hawks	Cooper's Hawks per hour	Hours of Observation	Numbers of Cooper's Hawks	Cooper's Hawks per hour
1961	665	104	0.16	36	2	0.06
1962	636	77	0.12	116	18	0.16
1963	710	74	0.10	155	8	0.05
1964	686	60	0.09	258	8	0.03
1965	683	100	0.15	353	58	0.16
1966	575	82	0.14	363	60	0.17
1967	546	76	0.14	362	56	0.15
1968	511	145	0.28	349	65	0.19
1969	754	111	0.15	488	48	0.10
1970	445	105	0.24	604	116	0.19
1971	315	69	0.22	591	65	0.11
1972	418	114	0.27	654	93	0.14
1973	508	81	0.16	652	99	0.15
1974	531	150	0.28	539	83	0.15
1975	490	126	0.26	472	138	0.29
1976	557	109	0.20	531	70	0.13
1977	536	231	0.43	381	139	0.36
1978	656	153	0.23	378	143	0.38
1979	732	336	0.46	197	112	0.57
1980	857	374	0.44	175	120	0.69
1981	794	756	0.95	260	109	0.42
1982	826	301	0.36	546	112	0.21
1983	850	351	0.41	441	136	0.31
1984	905	170	0.19	511	84	0.16
1985	769	291	0.38	461	216	0.47
1986	778	568	0.73	401	165	0.41
1987	869	588	0.68	412	252	0.61
1988	925	458	0.50	410	160	0.39
1989	885	786	0.89	469	197	0.42
1990	928	642	0.69	293	96	0.33
1991	946	578	0.61	117	42	0.36
1992	924	662	0.72	435	99	0.23
1993	959	561	0.58	405	144	0.36
1994	1030	573	0.56	303	78	0.26
1995	965	643	0.67	279	176	0.63
1996	994	535	0.54	355	145	0.41
1997	1015	718	0.71	357	181	0.51
1998	1105	1118	1.01	521	218	0.42
1999	1022	937	0.92	730	296	0.41
2000	1058	745	0.70	745	375	0.50
2001	1087	898	0.83	801	459	0.57
2002	973	599	0.62	782	350	0.45
2003	928	678	0.73	767	263	0.34

a - HMS unpublished data.

b - BOK web site (www.wildlifeinfo.org).

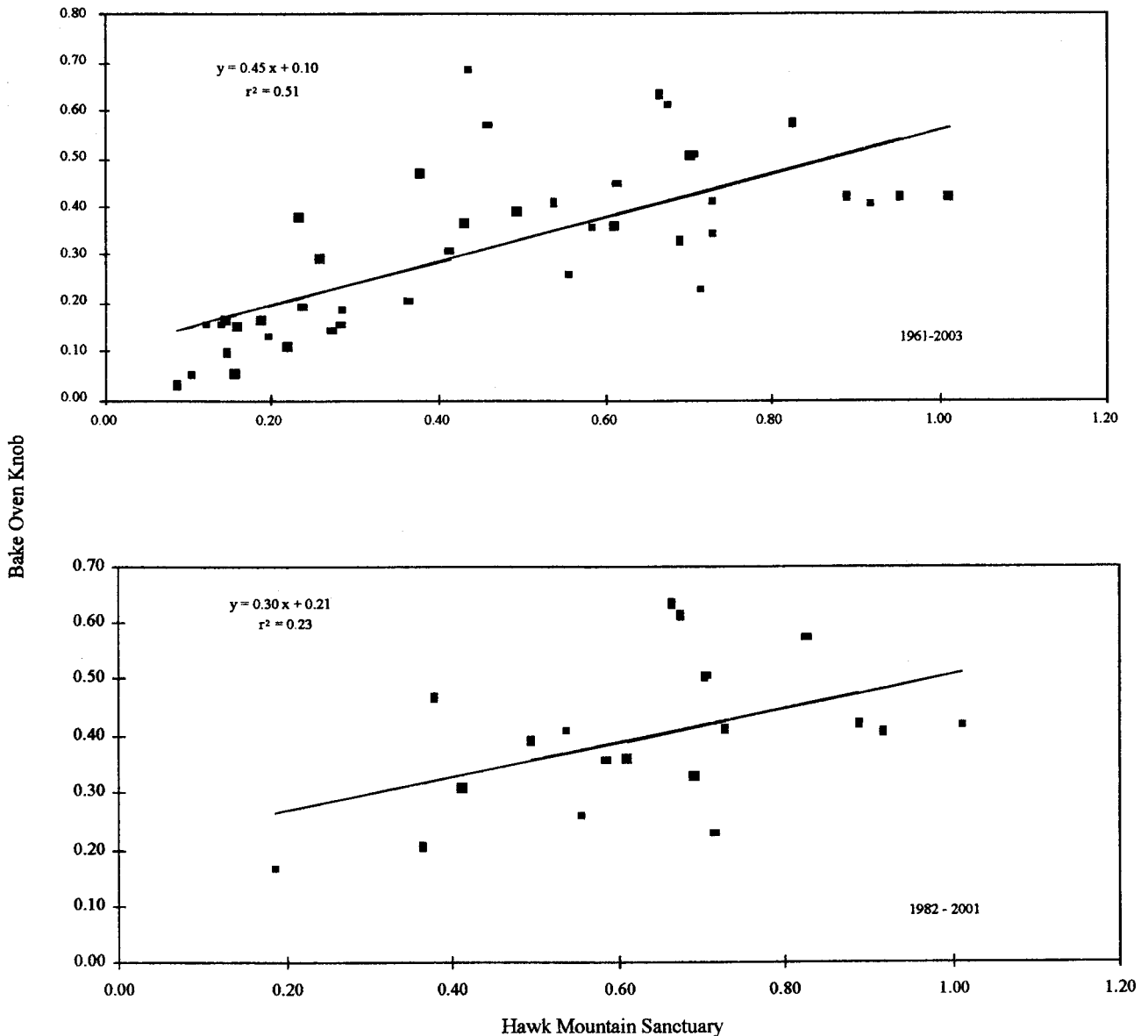


Figure 2. Relationship of annual passage of Cooper's Hawks seen at Hawk Mountain Sanctuary and Bake Oven Knob, Pennsylvania, 1961 – 2003 (top), 1982 – 2001 (bottom).

Discussion

Counts of Cooper's Hawks increased 4.9% annually at Hawk Mountain Sanctuary and 4.3% annually at Bake Oven Knob for the years 1961-2003 (Figure 4). Data from the U.S. Fish and Wildlife Service's Breeding Bird Survey and Christmas Bird Counts also show increased numbers of Cooper's Hawks in the northeastern United States and eastern Canada during this time period.

We believe that the increase is primarily due to two simultaneous events: federal protection of Cooper's Hawks and bans on the widespread use of DDT in the early 1970s (Bildstein 2001, Bednarz et al. 1990). Bednarz et al. (1990) reported a negative trend in Cooper's Hawk populations from 1934 to 1972, but a positive trend from 1973-1986, after the ban on DDT and protection of raptors came into effect.

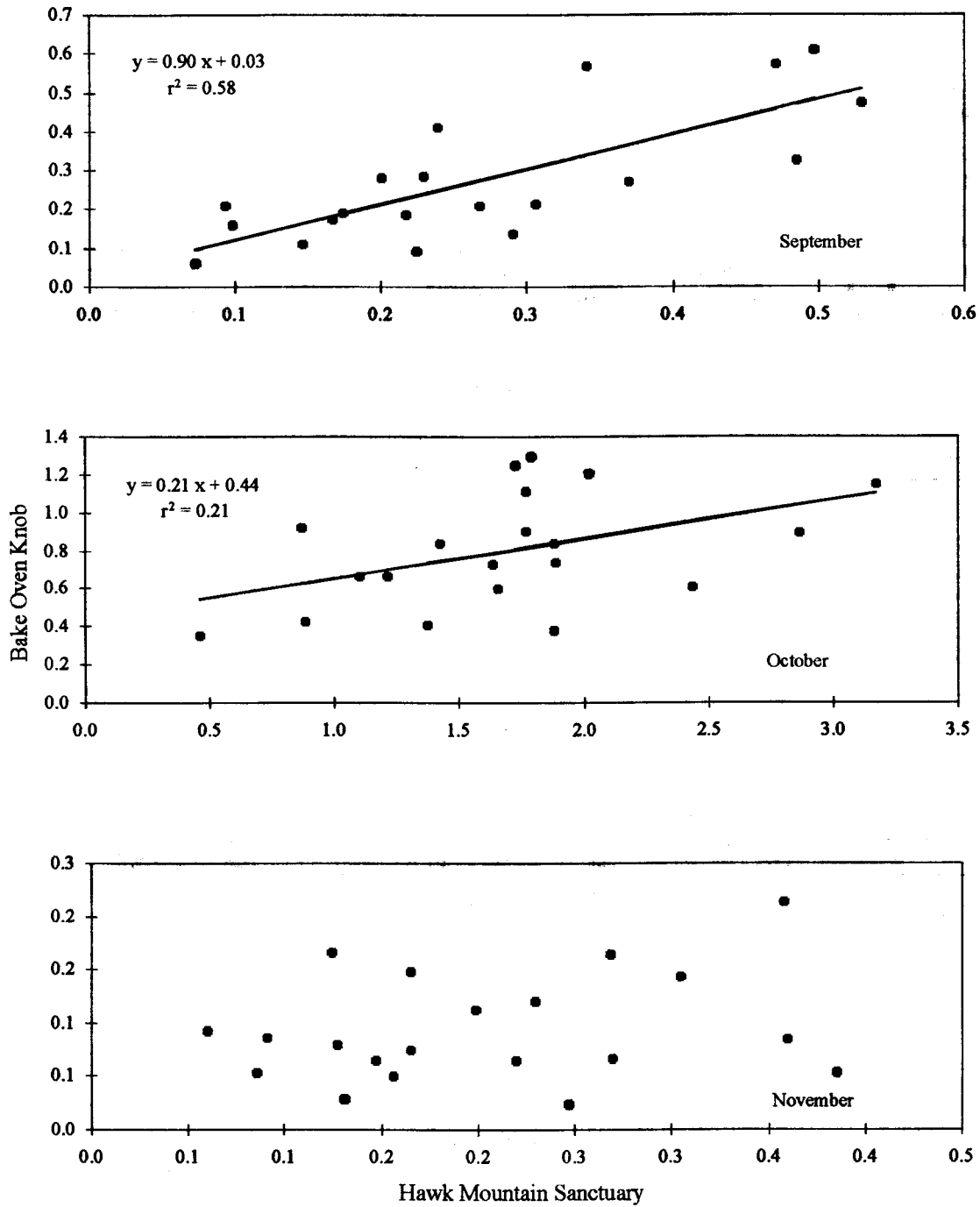


Figure 3. Relationships of hourly rates of passage of Cooper's Hawks seen at Hawk Mountain Sanctuary and Bake Oven Knob, Pennsylvania, (top) September, (middle) October, (bottom) November, 1982 - 2001. No significant relationship found for November ($P = 0.42$).

A previous comparison of HMS and BOK count data for Red-tailed Hawks (*Buteo jamaicensis*) suggested that ridge adherence was influenced by time of year, with increased adherence more likely in late autumn than earlier in the year (Swartzentruber and Beck, 2001). The highest correlation in the number of Cooper's Hawks seen at the two sites occurred in September and was lowest in November, suggesting reduced ridge adherence later in the season for Cooper's Hawks.

Kerlinger (1989) discusses the different ways migrating hawks fuel their migrations. Soaring migrants such as Red-tailed Hawks appear to change their migration behavior as the season progresses (Maransky et al. 1997). In September, when thermal energy is widely available, many Red-tailed Hawks take advantage of widespread opportunities for thermal soaring. Later in the season, as thermals become less available, migrating Red-tailed Hawks spend more time slope soaring along the Kittatinny Ridge (Maransky et al. 1997, Swartzentruber and Beck, 2001). On the other hand, Cooper's Hawks do not soar as much as Red-tailed Hawks, but tend to rely more on powered flight and fuel their journeys by feeding extensively en route (Rosenfield and Bielefeldt 1993).

We suggest that greater ridge adherence in Cooper's Hawks earlier in the season is due to the fact that in September and October, when migrating passerines are common along the ridge, Cooper's Hawks are attracted to the corridor more so than in November, when migrating passerines are less common there (see Woodrey and Chandler 1997 for the migratory timing of passerines at a similar latitude). If this is true, the Kittatinny Ridge functions as a leading line for Red-tailed Hawks and Cooper's Hawks for different reasons. Red-tailed Hawks are apparently attracted to the ridge because of the opportunities it provides for saving energy via slope soaring, whereas Cooper's Hawks may be attracted because of the opportunities it provides for gaining energy in the form of songbird prey.

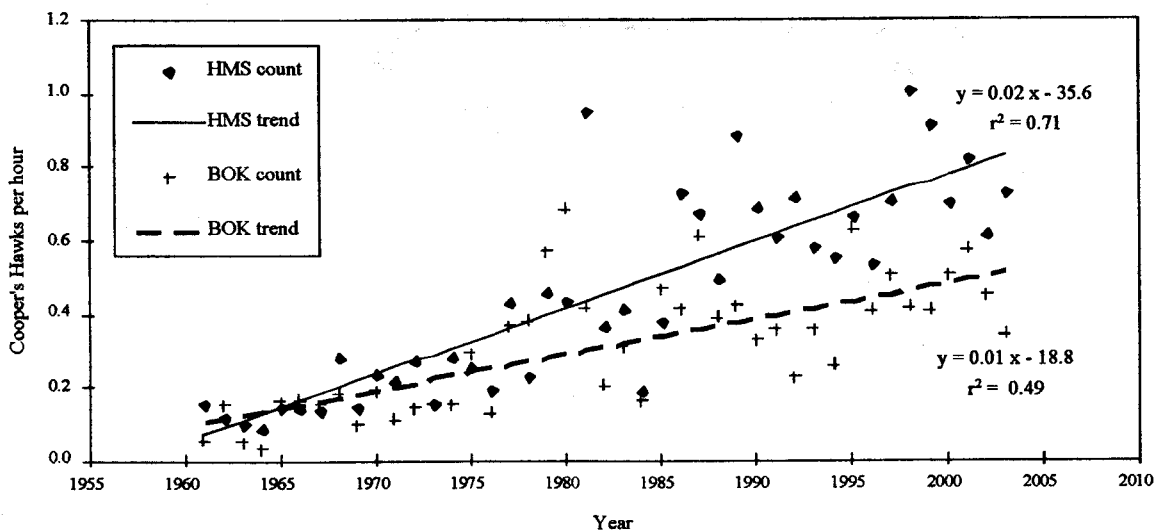


Figure 4. Trends in counts of Cooper's Hawks at Bake Oven Knob (BOK) and Hawk Mountain Sanctuary (HMS) 1961 - 2003.

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