

SPRING 2009 RAPTOR MIGRATION STUDY IN THE SANDIA MOUNTAINS OF CENTRAL NEW MEXICO



**HawkWatch International, Inc.
Salt Lake City, Utah**



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SPRING 2009 RAPTOR MIGRATION STUDY IN THE SANDIA MOUNTAINS OF CENTRAL NEW MEXICO

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INTRODUCTION

The Sandia Mountains Raptor Migration Project in north-central New Mexico is an ongoing effort to monitor long-term trends in populations of raptors using the southern portion of the Rocky Mountain migratory flyway (Hoffman et al. 2002, Hoffman and Smith 2003). HawkWatch International (HWI) initiated standardized counts of the spring raptor migration through this region in 1985, and began a trapping and banding program at the project site in 1990. To date, HWI observers have recorded 22 species of migratory raptors at the site, with counts typically ranging between 3,000 and 5,000 migrants per season. The 2009 season marked the 25th consecutive migration count at the site and this report summarizes the results of that effort. We did not conduct a banding operation at the site in 2009, but do report here on previously banded birds that were encountered during the past year.

STUDY SITE

The Sandia Mountains form a 41-km long ridge that runs north–south just east of Albuquerque in north–central New Mexico (35°05'12" N, 106°25'57" W; Figure 1). The study site is located at the southern end of the range within the Sandia Wilderness Area of the Cibola National Forest (Sandia Ranger District). The site is about 3 km north of Interstate 40 and Tijeras Canyon, and 18 km east of downtown Albuquerque. The site is reached by a steep, 2.5-km spur trail that originates at the U.S. Forest Service Tres Pistolas Canyon fence. The observation post, located at 2,196 m elevation, provides an expansive view of the Manzano Mountains to the south, the western plains, and northern Tres Pistolas Canyon. This season, one banding station (Upper Station) was situated ~1.0 km northeast of the observation post.

One-seeded juniper (*Juniperus monosperma*), mountain mahogany (*Cercocarpus montanus*), shrub live oak, (*Quercus turbinella*), tree cholla (*Opuntia imbricata*), and banana yucca (*Yucca baccata*) are the predominant plant species near the lookout, which is typical of the Upper Sonoran life zone. Ponderosa pine (*Pinus ponderosa*) and Gambel oak (*Quercus gambelii*) also occur at higher elevations.

METHODS

Two official or designated observers conducted standardized daily counts of migrating raptors from a single traditional observation site between 24 February and 5 May 2009. Official observer James Butch served as the lead counter for this year's effort, having gained one full season of previous experience elsewhere in the HWI network. This was official observer Andrew Eberly's first season of migration counting experience. On-site Interpreters Hillary Holt (first half of the season) and Christine Brissette, also routinely assisted with the count when not engaged in public outreach efforts. All official crew members received pre-season and on-site training from HWI's SW Monitoring Coordinator, Mike Neal, and veteran HWI and Sandias observers Roger Grimshaw and Ken Babcock provided further training and supplemented their efforts throughout the season. Other local volunteers and visitors also occasionally assisted with the counts. Weather permitting, observations usually began between 0800 and 0900 H Mountain Standard Time (MST) and ended between 1700 and 1800 H.

Data gathering and recording followed standardized protocols used at all HWI migration sites (Hoffman and Smith 2003). The observers routinely recorded the following data:

1. Species, age, sex, and color morph of each migrant raptor, whenever possible and applicable (Appendix B lists common and scientific names for all species, information about the applicability of age, sex, and color morph distinctions, and two-letter codes used to identify species in some tables and figures).
2. Hour of passage for each migrant; e.g., the 1000–1059 H MST.

3. Wind speed and direction, air temperature, percent cloud cover, predominant cloud type(s), presence of precipitation, visibility, and an assessment of thermal-lift conditions, recorded for each hour of observation on the half hour.
4. Predominant direction, altitude, and distance from the lookout of the flight during each hour.
5. Total minutes observed and the mean number of observers present during each hour (included designated observers plus volunteers/visitors who actively contributed to the count [active scanning, pointing out birds, recording data, etc.] for more than 10 minutes in a given hour), recorded on the hour.
6. A subjective visitor-disturbance rating (none, low, moderate, high) for each hour, recorded on the hour.
7. Daily start and end times for each official observer.

Calculation of “adjusted” (to standardize sampling periods and adjust for incompletely identified birds) passage rates (migrants counted per 100 hours of observation) and analysis of trends follows Hoffman and Smith (2003). In comparing 2009 annual statistics against means and 95% confidence intervals (CI) for previous seasons, we equate significance with a 2009 value falling outside the bounds of the confidence interval for the associated mean.

RESULTS AND DISCUSSION

WEATHER SUMMARY

Similar to the last few seasons, the weather was relatively mild in 2009 (see Appendix C for daily weather summaries), with no days entirely precluded and 3 days severely hampered (i.e., reduced to less than 4 hours of observation) by inclement weather (1998–2008 averages of 3.7 and 2.7 days, respectively). This was only the second season in the past decade when no full weather days occurred. The proportion of active observation days that featured predominantly fair skies also was below average in 2009 (38% vs. 1998–2008 average of 45%), however, whereas the proportion of active days that featured transitional skies (i.e., conditions changed from fair to mostly cloudy or overcast during the day, or vice versa) matched the average (31 vs. 31%), and the proportion of days that featured mostly cloudy to overcast skies was above average (31% vs. average of 24%). Nevertheless, again testifying the relatively mild nature of this season’s weather, the number of active days that featured some rain or snow (11%) also was below average (18%). In addition, the proportion of active observation days that featured substantial visibility reducing fog/haze was well below average (15% vs. average of 34%) and resulted in significantly higher than average visibility, both to the east (91 vs. average of 66 km) and to the west (89 vs. 78 km).

Similar to the past two seasons, light winds (<12 kph) were substantially less common than average in 2009, prevailing on a record low 39% of the active observation days compared to the 1998–2008 average of 65%, whereas moderate winds (12–28 kph) prevailed on a record high 54% of the active observation days (average 32%), and stronger winds also were more common than usual (7% vs. average of 4% of the active days). The increased consistency and strength of the winds likely contributed to the increased visibility recorded in 2009. In the Sandias, W–NW and more variable SW–NW winds are the most common wind-direction patterns, with the prevalence of W–NW winds averaging 26% of the active observation days across the last decade and the prevalence of SW–NW winds averaging 20% of the active days. In 2009, W–NW winds prevailed on a below average 18% of the active days, whereas SW–NW winds prevailed on a record high 45% of the active days. Days that featured SW–NW winds for a significant portion of the day in combination with either periods of calm/variable winds (4% vs. average

of 3%) or NE–SE winds (7% vs. average of 3%) also were more prevalent than usual. SE–SW winds also were noticeably more common than usual, occurring on 6% of the active days (average 2%). Most other, typically uncommon (i.e., generally averaging <5% of the active days) wind patterns occurred less often than usual in 2009.

The temperature during active observation periods averaged 11.8°C (the average of daily values, which in turn were averages of hourly readings), with hourly readings ranging from -1.8 to 22.4°C. The overall mean was slightly below the 1985–2008 average of 12.5°C and the minimum and maximum fell well within the previously observed range of variation. The barometric pressure during active observations averaged 30.02 in Hg (the average of daily values, which in turn were averages of hourly readings), with hourly readings ranging from 29.62 to 30.33 in Hg. The overall mean was only slightly lower than the 2001–2008 (the period of record for these data) average of 30.05 in Hg and the minimum fell within the range of previously observed values; however, the maximum tied last year's low mark.

Good to excellent thermal-lift conditions prevailed on an average 47% of the active observation days.

In summary, compared to the last 11 seasons, although overall cloud cover was relatively high, the 2009 season featured less stormy, rainy, snowy, and foggy/hazy conditions than usual, which together contributed to above-average visibility; near average temperature and barometric pressure regimes; above-average winds speeds and a record high prevalence of SW–NW winds but well below average prevalence of steadier W–NW winds; and average thermal-lift conditions.

OBSERVATION EFFORT

The observers worked on all 72 possible days between 24 February and 5 May, the standard count period for the project. The number of observation days was a marginally significant 3% above the 1985–2008 average of $69 \pm 95\%$ CI of 2.5 days, and the number of observation hours (542.24) nearly matched the long-term average (543.68 ± 22.96 hrs). The 2009 average of 3.2 observers per hour (including official and guest observers; value is mean of daily values, which are in turn means of hourly values) was a record high and significant 49% above average (2.1 ± 0.13 observers/hr), due primarily to the dedication of local volunteers.

FLIGHT SUMMARY

The observers counted 3,171 migrant raptors of 18 species during the 2009 season, with the total count significantly below average (Table 1; and see Appendix D for daily count records and Appendix E for annual summaries). The Cooper's Hawk count dropped to a new record low of 451 individuals, with 1985 and 2005 the only other years when the total for this species was <500 birds (Appendix E). No other record low or high counts occurred in 2009 for commonly encountered species.

The 2009 flight consisted of 38% accipiters, 28% vultures, 15% buteos, 7% falcons, 7% eagles, 2% Ospreys, 1% harriers, and 1% unidentified raptors. These values represent significantly below average proportions of vultures and eagles, but significantly above average proportions of accipiters, buteos, and Ospreys (Figure 2). The Turkey Vulture was the most commonly encountered species, followed by the Sharp-shinned Hawk, Cooper's Hawk, Red-tailed Hawk, Golden Eagle, and American Kestrel; all other species comprised <3% each of the total count (Table 1).

Passage Rates and Long-term Trends

Among 17 species seen in most years, adjusted passage rates were significantly above average only for Sharp-shinned Hawks and Swainson's Hawks, whereas passage rates were significantly below average for 8 of the 15 remaining species (Table 1, Figures 3–7). Regression analyses of adjusted passage rates through 2009 indicated a marginally significant ($0.05 < P \leq 0.10$) linear increasing trend for Swainson's

Hawks (Figure 5), marginally significant linear declining trends for Northern Goshawks at the species level (Figure 4) and Bald Eagles (Figure 6; recent drop), marginally significant quadratic (i.e., second-order polynomial) trends for Cooper's Hawks (Figure 4) and Golden Eagles (Figure 6), and significant ($P \leq 0.05$) to highly significant ($P \leq 0.01$) quadratic trends for Turkey Vultures and Ospreys (Figure 3), Broad-winged and Ferruginous Hawks (Figure 5), and American Kestrels, Merlins, and Peregrine Falcons (Figure 7). Age-specific analyses further revealed a highly significant linear decline for adult Northern Goshawks, but no long-term trend for immature goshawks (Figure 4). In all cases, the quadratic trends tracked increasing patterns through at least the mid-to-late 1990s, followed by recent stabilization or more commonly declines. The increasing patterns from the late 1980s through the late 1990s correlate with a wet El Niño period, with the subsequent stabilizing or declining patterns corresponding to onset of widespread drought throughout much of the interior West after 1998 (Hoffman and Smith 2003, Smith et al. 2008). Several species have shown slight upswings in the past 2–3 years, which may correlate with improving winter-snowpack and general moisture conditions in portions of the central Rocky Mountain and northern Intermountain regions; however, the 2009 passage rates dropped again for several of these species. In most cases, passage rates of these species swung upward slightly according to the previous fall's count in the nearby Manzano Mountains (Smith and Neal 2009). In combination, these data suggest that overwinter survival was below average for many of these species in 2008/2009.

Age Ratios

Immature : adult ratios were below average in 2009 for 6 of 9 species with data suited to comparisons, but significantly so only for Sharp-shinned Hawks, Northern Goshawks, and Red-tailed Hawks (Table 2). For Northern Goshawks, the count of immature birds (0) was below average, suggesting that low productivity in 2008 and/or low overwinter survival of juveniles may have contributed to the results; however, these results must be considered speculative due to low sample sizes (Table 2). For Sharp-shinned Hawks, the count of identified immature birds was average, whereas the count of identified adults was well above average, suggesting that high overwinter survival of adults was the primary reason for the low age ratio. For Red-tailed Hawks, the count of immature birds was below average and the count of adults was above average, suggesting that the low age ratio reflected a combination of low recruitment/overwinter survival of immature birds and high overwinter survival of adults.

Seasonal Timing

In contrast to the past three seasons when the overall timing of the flight was significantly earlier than average, the overall combined-species median passage date of 7 April 2009 was a non-significant 1 day later than average (Table 3). At the species level, however, only 4 of 17 species for which a comparison was possible showed later than average median passage dates in 2009 and the difference was significant only for Turkey Vultures and Ospreys (Table 3). In contrast, 11 species showed significantly earlier than average median passage dates in 2009. The combined-species distribution of seasonal activity illustrates a distinct shift in activity from the second half of March to early April (Figure 8); however, this shift primarily reflects the situation for the most abundant migrant, the Turkey Vulture. For most other species, the earlier-than-average median passage dates did not reflect distinct overall shifts in the seasonal distributions of activity, but rather one or two prominent, early spikes in activity followed by significant reductions in proportional activity levels during some portion of the latter half of the species-specific passage patterns. Age-specific comparisons revealed no further insight except for indicating that the species-level indication of early passage for Peregrine Falcons was driven by substantially early than usual passage of adults (19 days earlier than average), whereas immatures peregrines were actually slightly later than average (Table 4).

ENCOUNTERS WITH PREVIOUSLY BANDED BIRDS

No recoveries of birds previously banded in the Sandia Mountains occurred during 2008 or as of early June in 2009.

RESIDENT BIRDS

The 2009 resident raptor community included a typical assemblage for the site.

The crew recorded a single resident, adult Red-tailed Hawk on the first day of count, 24 February, and first recorded a pair together on 5 March. Observations of these birds diminished during April when they were seen together or observed singly only a handful of times, suggesting that they had begun a nest and the female was mostly at the nest incubating. During this time, the crew often observed up to three second-year (SY; still in immature plumage) Red-tailed Hawks kiting and hunting in the area with little opposition, but after April when adult activity increased again, only a single SY bird remained in the area. The crew usually observed the adults kiting and hunting in front of observation and to the southeast, mostly heading northwest along the ridge east of the of the observation point.

A pair of adult Golden Eagles resided in the area throughout the season. Early in the season, the crew often observed these birds carrying nesting material and engaged in courtship rituals. Then during the first half of April, they rarely saw the two birds together, suggesting that they may have initiated a nest. After that though, they often saw the pair together again, mostly circling over the White and Red Cliffs north of and above the observation point, heading out across the valley in front of observation or out toward the lowlands west of observation, and frequently escorting migrants though the area. On 12 March, the crew observed the pair cooperatively hunting a Wild Turkey on the slope immediately west of the observation point.

The crew recorded apparently resident Prairie Falcons on 28 February, 15 March, and 27 March, and a pair of resident Peregrine Falcons was present throughout the season. They frequently observed the peregrines hunting cooperatively above the “shields” north of observation and thought the pair may have nested behind “shield 3,” which if true means they usurped the typical nesting area for the resident pair of Golden Eagles. Throughout the season, the pair aggressively escorted and stooped on all species of migrants, becoming progressively more aggressive during the last few days of count, possibly indicating the presence of nestlings.

During the spring migration season, a pair of Coopers Hawks nested in the Monticello neighborhood near the trailhead to the site. On 12 March, 22 April, and 3 May, the crew observed individual birds that they did not record as migrants due to their non-migratory flight direction, presumably heading back towards the nesting territory in the neighborhood several hundred meters below the observation point. Similar situations occurred with two Sharp-shinned Hawks seen on 18 and 31 March heading in non-standard directions. On 20 and 22 April, an immature Cooper’s Hawk with a missing tail feather perched next to the owl and began vocalizing, perhaps suggesting that a previous offspring of the resident pair had returned to the area.

The crew first observed a group of resident Turkey Vultures on 8 April. After that, groups of up to five and occasionally six birds were the norm, routinely seen patrolling all around the area from the east to west ridges. On 15 April, a pair of vultures spent much of the day very low over the ground under shield 1, possibly inspecting potential nest sites.

SITE VISITATION AND PUBLIC OUTREACH

Our 2009 visitor logs recorded 252 individuals comprising 113 parties, with an additional 35 students and teachers not formally recorded on the visitor logs, bringing the total visitation to 287 individuals plus repeat visitors not recorded multiple times. The majority of visitors originated in New Mexico, with six

other states represented: Indiana, Washington, Kentucky, Pennsylvania, California, and Massachusetts. Most of the individual, non-student visitors were familiar with HWI from visits in past years, including a consistent group of regular visitors who came numerous times throughout the season. Organized groups visited from the Bosque School (7th grade; five classes) and Central New Mexico Audubon Society. Before their visit to the site, HWI affiliate Melanie Keithley introduced the Bosque students to raptor monitoring in their classroom. On the day of the field trip during their walk up to the site and at the site, the on-site crew further introduced them to wilderness ethics, desert and raptor ecology, and additional aspects of HWI programs.

The overall level of visitation this season was below average for the past decade (2001–2008 totals ranging from 323–550+ visitors), largely due to our specifically de-emphasizing recruitment of larger organized groups in order to better conform to U.S. Forest Service standards for wilderness-area management.

In 2009, 549 hourly assessments of visitor disturbance resulted in the following ratings: 71% none, 21% low, 7% moderate, and <1% high. This is a relatively high level of “disturbance” as rated by the official observers, despite the total number of visitors being below average for the period when we have kept such visitor-disturbance records (since 2001). The goal of having a dedicated Site Interpreter as a full-time member of the field crew is to provide visitors with a rich, educational experience while helping to minimize unnecessary distraction of the observers. Apparently either the nature of visitors or the nature of the official observers rendered the combination less effective than usual in this regard.

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Table 1. Annual raptor migration counts and adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) annual passage rates by species in the Sandia Mountains, NM: 1985–2008 versus 2009.

SPECIES	COUNTS			RAPTORS / 100 HOURS ¹		
	1985–2008 ²	2009	% CHANGE	1985–2008 ²	2009	% CHANGE
Turkey Vulture	1,368.3 ± 240.8	898	-34	428.1 ± 75.44	290.7	-32
Osprey	64.8 ± 10.8	61	-6	20.9 ± 3.33	21.0	0
Northern Harrier	58.1 ± 5.6	47	-19	13.1 ± 1.32	10.6	-19
White-tailed Kite	0.04 ± 0.08	0	-100	0.01 ± 0.02	0.0	–
Mississippi Kite	0.17 ± 0.15	0	-100	0.03 ± 0.03	0.0	–
TOTAL KITES	0.21 ± 0.20	0	-100	–	–	–
Sharp-shinned Hawk	493.8 ± 96.4	572	+16	114.7 ± 20.55	151.7	+32
Cooper's Hawk	762.3 ± 110.9	451	-41	213.1 ± 28.56	133.9	-37
Northern Goshawk	11.0 ± 2.9	4	-63	2.2 ± 0.57	0.9	-58
Unknown small accipiter ³	37.3 ± 40.7	179	+381	–	–	–
Unknown large accipiter ³	4.4 ± 2.1	9	+106	–	–	–
Unknown accipiter	71.6 ± 19.0	4	-94	–	–	–
TOTAL ACCIPITERS	1,352.5 ± 169.8	1,219	-10	–	–	–
Common Black Hawk	0.04 ± 0.08	0	-100	0.0 ± 0.01	0.0	–
Broad-winged Hawk	5.9 ± 2.3	5	-15	1.3 ± 0.52	1.1	-15
Swainson's Hawk	53.1 ± 8.5	53	0	19.6 ± 2.61	22.9	+17
Zone-tailed Hawk	2.3 ± 0.9	4	+78	0.4 ± 0.19	0.7	+65
Red-tailed Hawk	342.8 ± 49.8	373	+9	74.5 ± 9.40	81.8	+10
Ferruginous Hawk	11.4 ± 2.0	12	+5	2.4 ± 0.43	2.4	+1
Rough-legged Hawk	0.50 ± 0.26	1	+100	0.2 ± 0.11	0.4	+93
Unidentified buteo	13.6 ± 4.5	34	+150	–	–	–
TOTAL BUTEOS	429.7 ± 58.5	482	+12	–	–	–
Golden Eagle	345.6 ± 67.0	216	-37	67.4 ± 12.38	40.1	-40
Bald Eagle	13.6 ± 3.4	6	-56	3.7 ± 0.87	1.4	-61
Unidentified eagle	0.71 ± 0.52	0	-100	–	–	–
TOTAL EAGLES	359.9 ± 69.1	222	-38	–	–	–
American Kestrel	196.3 ± 35.7	143	-27	49.7 ± 8.54	35.9	-28
Merlin	9.8 ± 3.0	10	+2	2.1 ± 0.62	2.2	+7
Prairie Falcon	24.9 ± 4.2	19	-24	5.0 ± 0.85	4.0	-21
Peregrine Falcon	46.1 ± 12.0	44	-5	9.3 ± 2.35	9.0	-3
Aplomado Falcon	0.04 ± 0.08	0	-100	0.01 ± 0.02	0.0	–
Unknown small falcon ³	1.4 ± 1.7	5	+264	–	–	–
Unknown large falcon ³	3.3 ± 2.4	1	-69	–	–	–
Unknown falcon	2.9 ± 1.1	2	-30	–	–	–
TOTAL FALCONS	281.5 ± 44.4	224	-20	–	–	–
Unidentified raptor	41.5 ± 13.4	18	-57	–	–	–
GRAND TOTAL	3,956.5 ± 507.8	3,171	-20	–	–	–

¹ Based on data truncated to standardized, species-specific sampling periods and adjusted for incompletely identified birds.

² Mean ± 95% CI.

³ Designations used regularly for the first time in 2002.

Table 2. Annual raptor migration counts by age classes and immature (second-year birds for most species, all non-adults for eagles) : adult age ratios for selected species in the Sandia Mountains, NM: 1990–2008 versus 2009.

	TOTAL AND AGE-CLASSIFIED COUNTS						IMM. : ADULT			
	1990–2008 AVERAGE			2009			% UNKNOWN AGE		RATIO	
	TOTAL	IMM.	AD.	TOTAL	IMM.	AD.	1990–2008 ¹	2009	1990–2008 ¹	2009
Northern Harrier	58	10	30	47	7	25	32 ± 5.9	32	0.41 ± 0.19	0.28
Sharp-shinned Hawk	490	55	260	572	53	340	36 ± 4.9	31	0.24 ± 0.06	0.16
Cooper's Hawk	781	74	472	451	55	268	32 ± 6.6	28	0.19 ± 0.07	0.21
Northern Goshawk	11	3	5	4	0	3	24 ± 8.6	25	1.03 ± 0.66	0.00
Broad-winged Hawk	7	0.4	4	5	0	3	29 ± 12.6	40	0.20 ± 0.24	0.00
Red-tailed Hawk	368	59	247	373	45	263	17 ± 3.5	17	0.26 ± 0.06	0.17
Ferruginous Hawk	12	2	5	12	2	5	43 ± 10.8	42	0.87 ± 0.64	0.40
Golden Eagle	355	164	120	216	123	70	20 ± 7.2	11	1.56 ± 0.46	1.76
Bald Eagle	13	6	6	6	3	3	10 ± 7.6	0	1.25 ± 0.45	1.00
Peregrine Falcon	56	12	29	44	8	15	25 ± 8.0	48	0.43 ± 0.11	0.53

¹ Mean ± 95% confidence interval. For age ratios, note that the long-term mean immature : adult ratio is an average of annual ratios and may differ from the value obtained by dividing long-term average numbers of immature and adult birds. Discrepancies in the two values reflect high annual variability in the observed age ratio.

Table 3. First and last observed, bulk passage, and median passage dates by species for migrating raptors in the Sandia Mountains, NM in 2009 with a comparison of 2009 and 1985–2008 average median passage dates.

SPECIES	2009				1985–2008
	FIRST OBSERVED	LAST OBSERVED	BULK PASSAGE DATES ¹	MEDIAN PASSAGE DATE ²	MEDIAN PASSAGE DATE ^{2,3}
Turkey Vulture	18-Mar	4-May	26-Mar – 24-Apr	7-Apr	03-Apr ± 1.2
Osprey	21-Mar	3-May	1-Apr – 26-Apr	15-Apr	13-Apr ± 1.4
Northern Harrier	3-Mar	5-May	18-Mar – 21-Apr	5-Apr	06-Apr ± 1.7
Sharp-shinned Hawk	25-Feb	5-May	25-Mar – 29-Apr	13-Apr	18-Apr ± 1.9
Cooper's Hawk	24-Feb	5-May	20-Mar – 25-Apr	7-Apr	10-Apr ± 1.0
Northern Goshawk	7-Mar	30-Mar	–	–	05-Apr ± 5.2
Broad-winged Hawk	24-Apr	27-Apr	24-Apr – 27-Apr	25-Apr	23-Apr ± 2.5
Swainson's Hawk	31-Mar	3-May	8-Apr – 27-Apr	15-Apr	17-Apr ± 1.5
Zone-tailed Hawk	28-Mar	24-Apr	–	–	11-Apr ⁴
Red-tailed Hawk	24-Feb	5-May	5-Mar – 21-Apr	23-Mar	25-Mar ± 1.1
Ferruginous Hawk	8-Mar	25-Apr	8-Mar – 21-Apr	18-Mar	18-Mar ± 5.1
Rough-legged Hawk	2-Mar	2-Mar	–	–	–
Golden Eagle	24-Feb	5-May	1-Mar – 24-Apr	22-Mar	20-Mar ± 3.2
Bald Eagle	27-Feb	18-Apr	27-Feb – 18-Apr	28-Feb	08-Mar ± 3.7
American Kestrel	28-Feb	5-May	20-Mar – 24-Apr	8-Apr	12-Apr ± 1.6
Merlin	7-Mar	4-May	7-Mar – 3-May	2-Apr	07-Apr ± 4.8
Prairie Falcon	1-Mar	23-Apr	1-Mar – 31-Mar	14-Mar	20-Mar ± 3.2
Peregrine Falcon	25-Feb	5-May	8-Mar – 29-Apr	3-Apr	11-Apr ± 2.6
All species	24-Feb	5-May	17-Mar – 25-Apr	7-Apr	06-Apr ± 1.2

¹ Dates between which the central 80% of the flight passed the lookout; calculated only for species with counts ≥5 birds.

² Date by which 50% of the flight passed the lookout; calculated only for species with counts ≥5 birds.

³ Mean of annual values ± 95% confidence interval in days; calculated using only data for years with counts ≥5 birds.

⁴ Data for 2000 only.

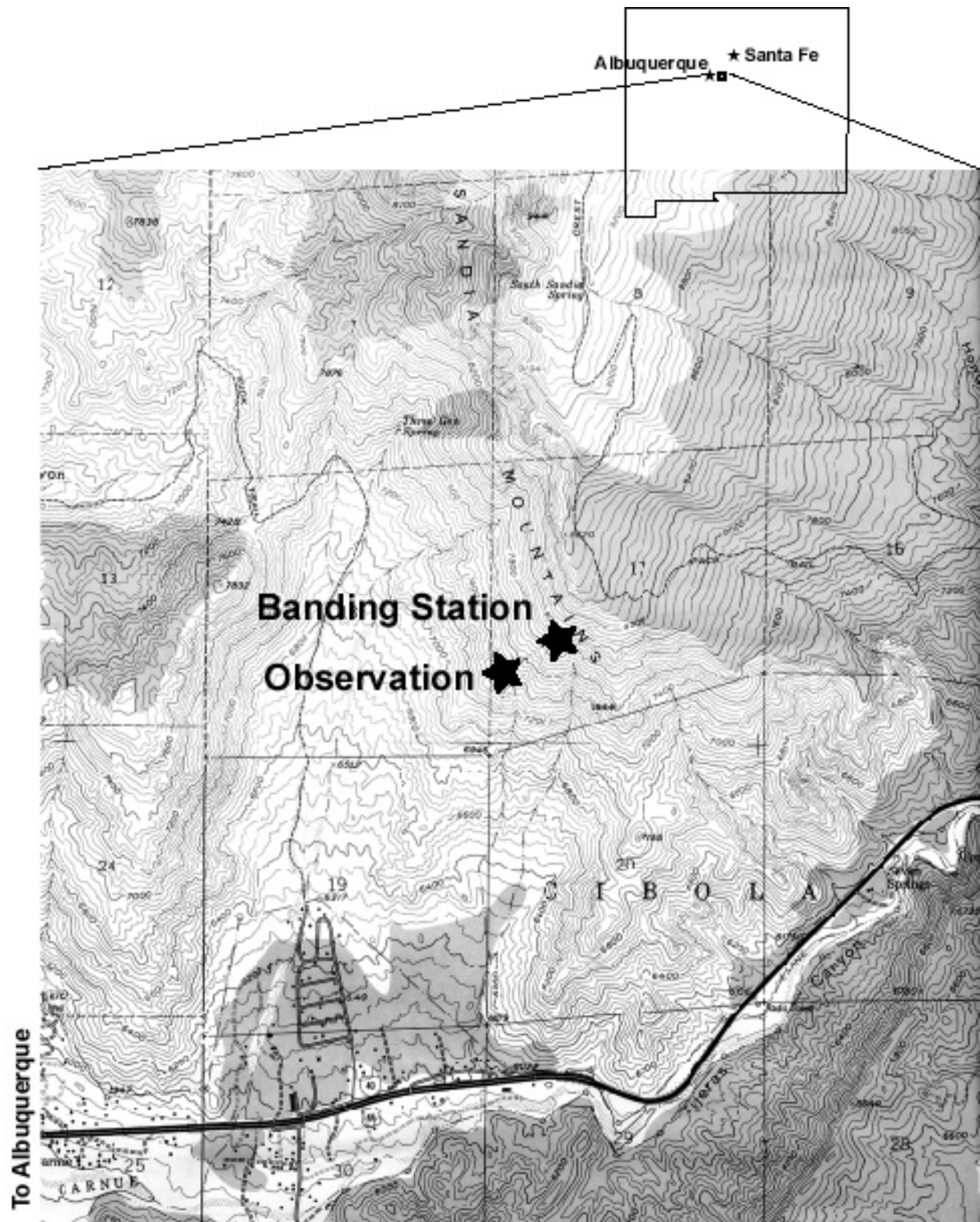


Figure 1. Map of Sandia Mountains Raptor Migration Project study site.

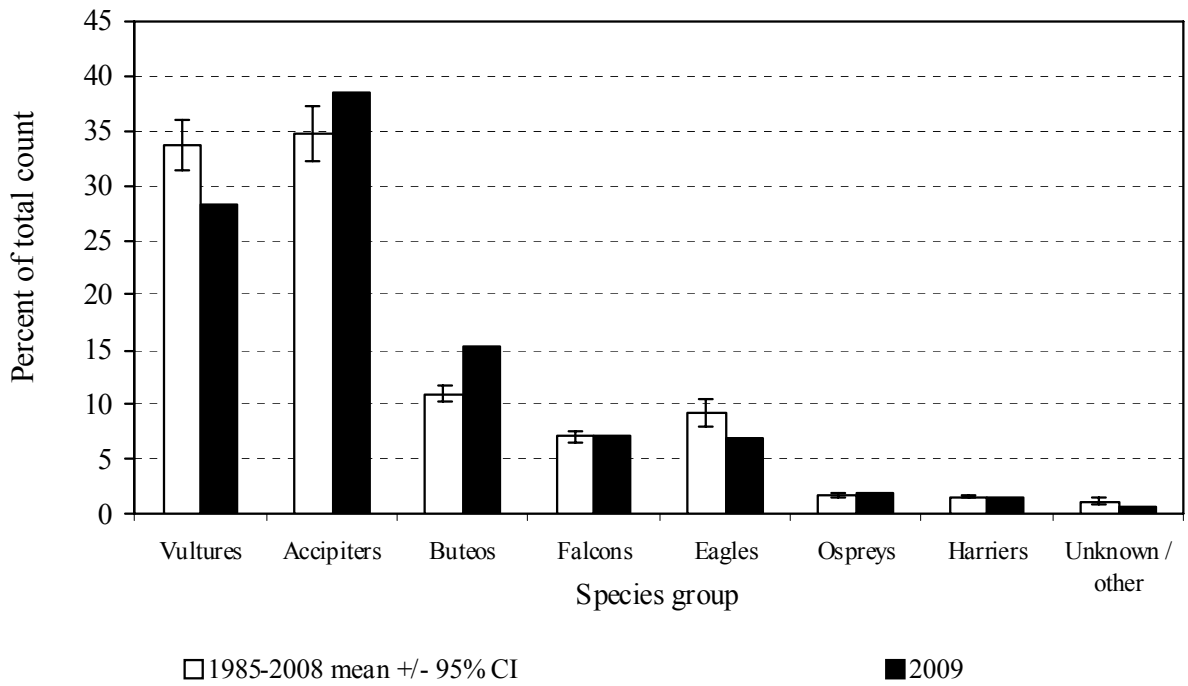


Figure 2. Spring raptor-migration flight composition by major species groups in the Sandia Mountains, NM: 1985–2008 versus 2009.

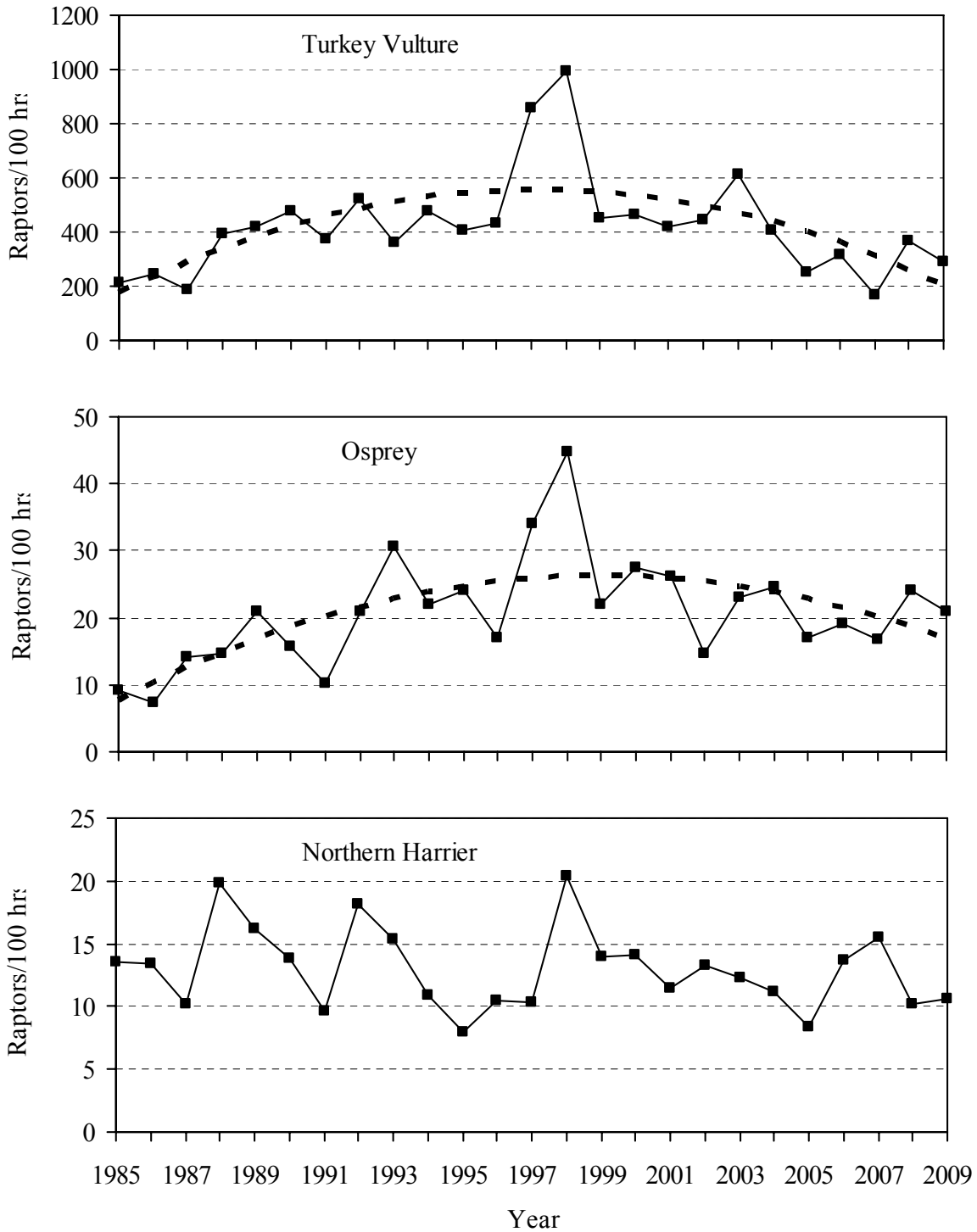


Figure 3. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) spring-migration passage rates for Turkey Vultures, Ospreys, and Northern Harriers in the Sandia Mountains, NM: 1985–2009. Dashed lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

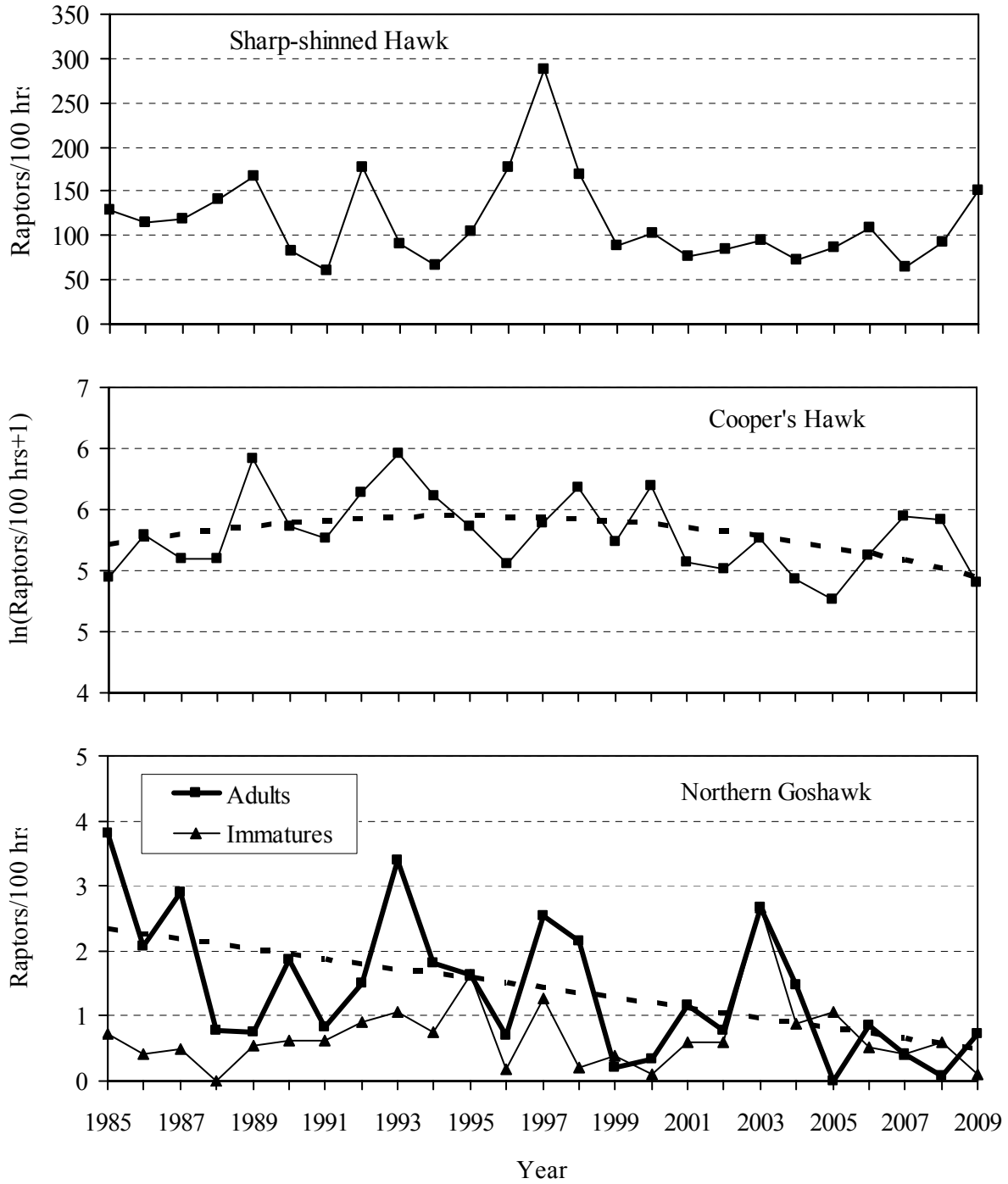


Figure 4. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) spring-migration passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks in the Sandia Mountains, NM: 1985–2009. Dashed lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

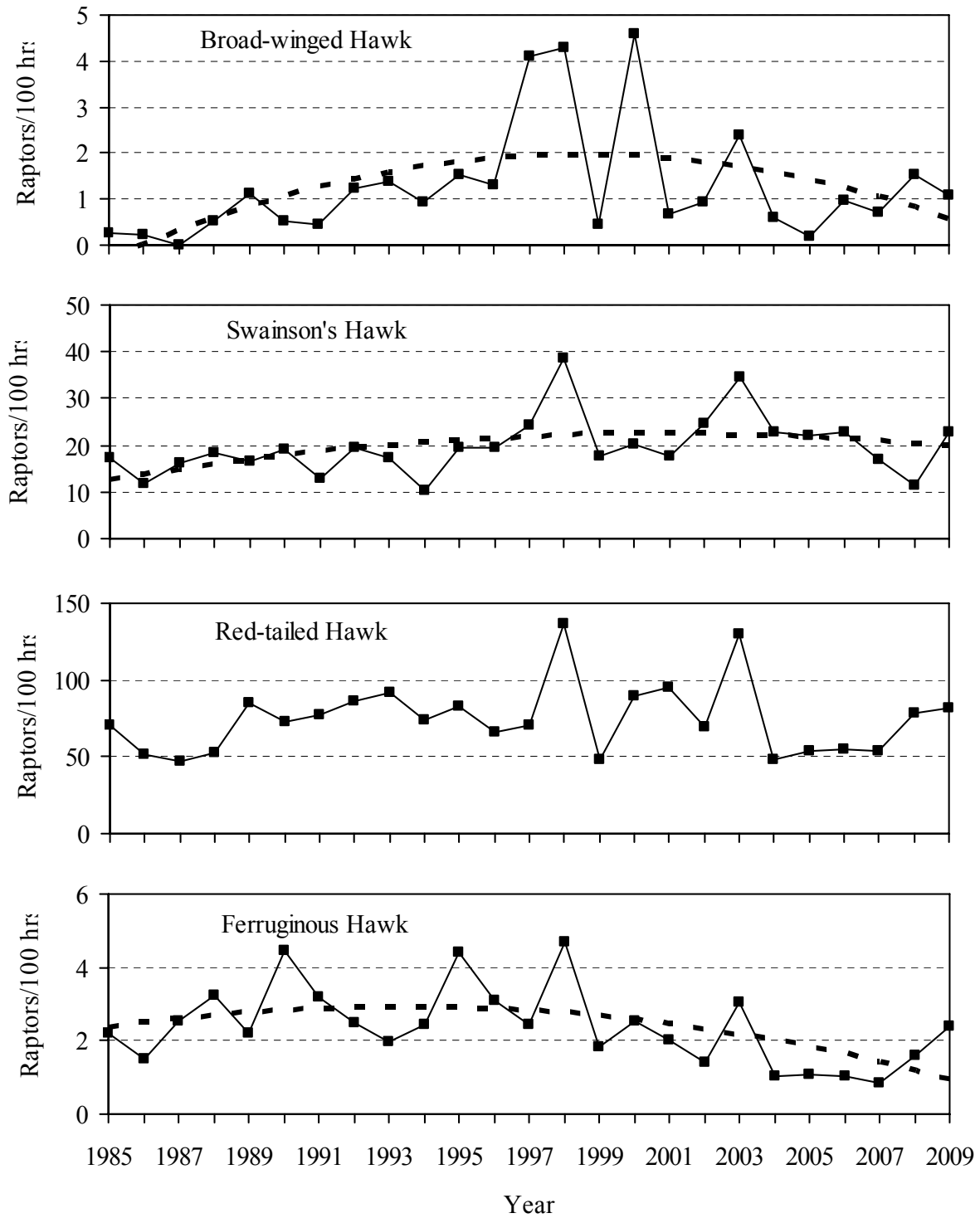


Figure 5. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) spring-migration passage rates for Broad-winged, Swainson's, Red-tailed, and Ferruginous Hawks in the Sandia Mountains, NM: 1985–2009. Dashed lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

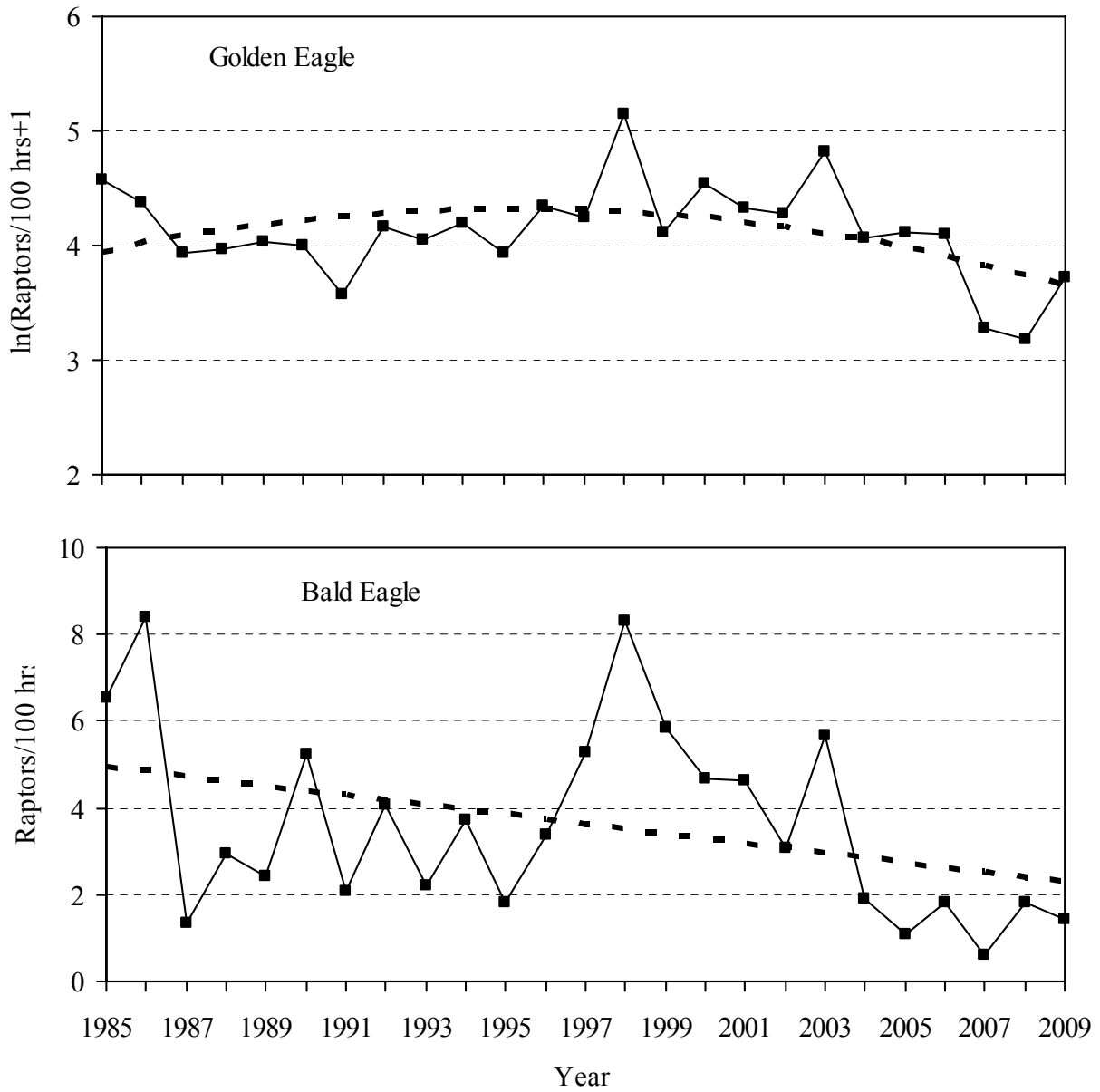


Figure 6. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) spring-migration passage rates for Golden and Bald Eagles in the Sandia Mountains, NM: 1985–2009. Dashed lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

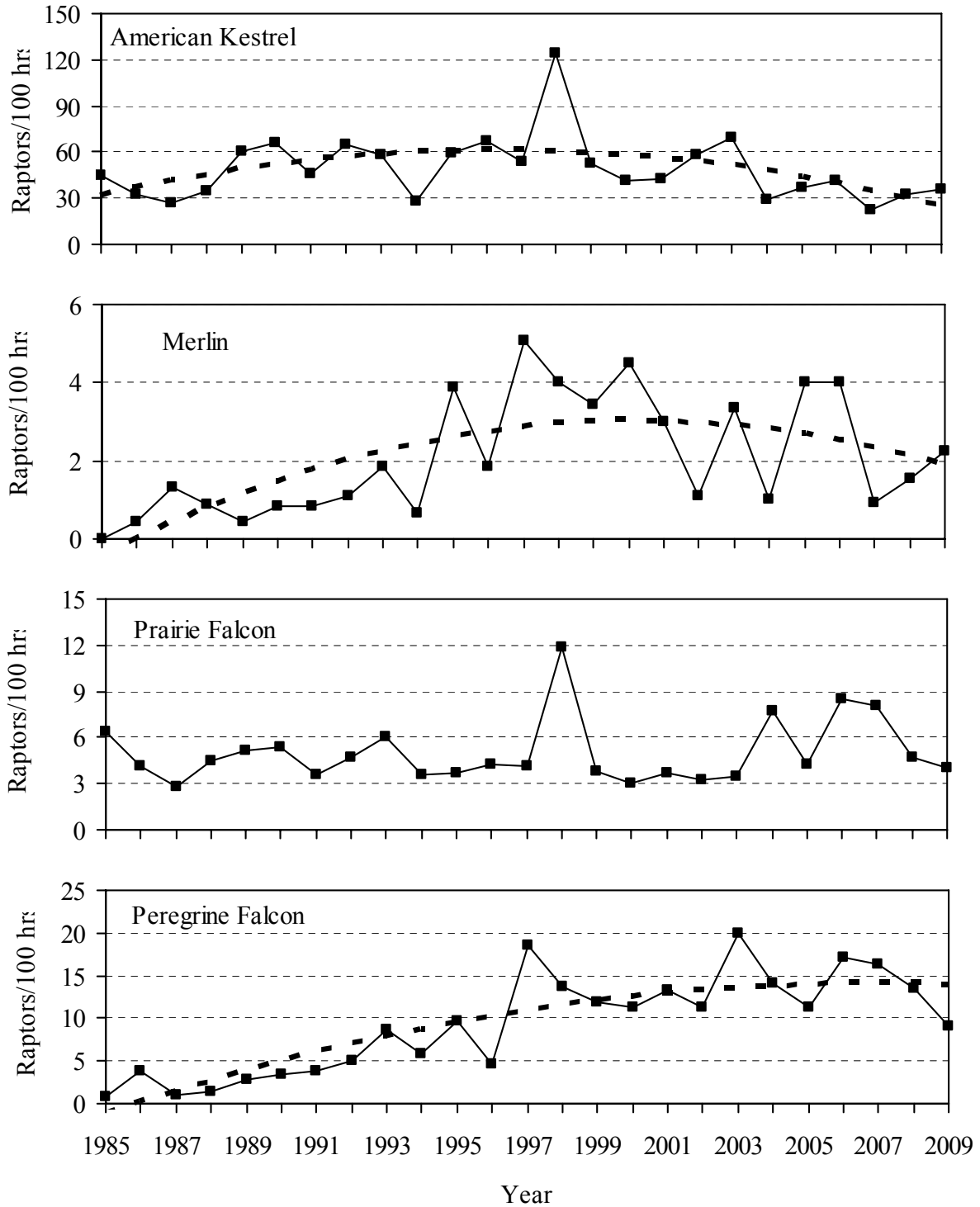


Figure 7. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) spring-migration passage rates for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons in the Sandia Mountains, NM: 1985–2009. Dashed lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

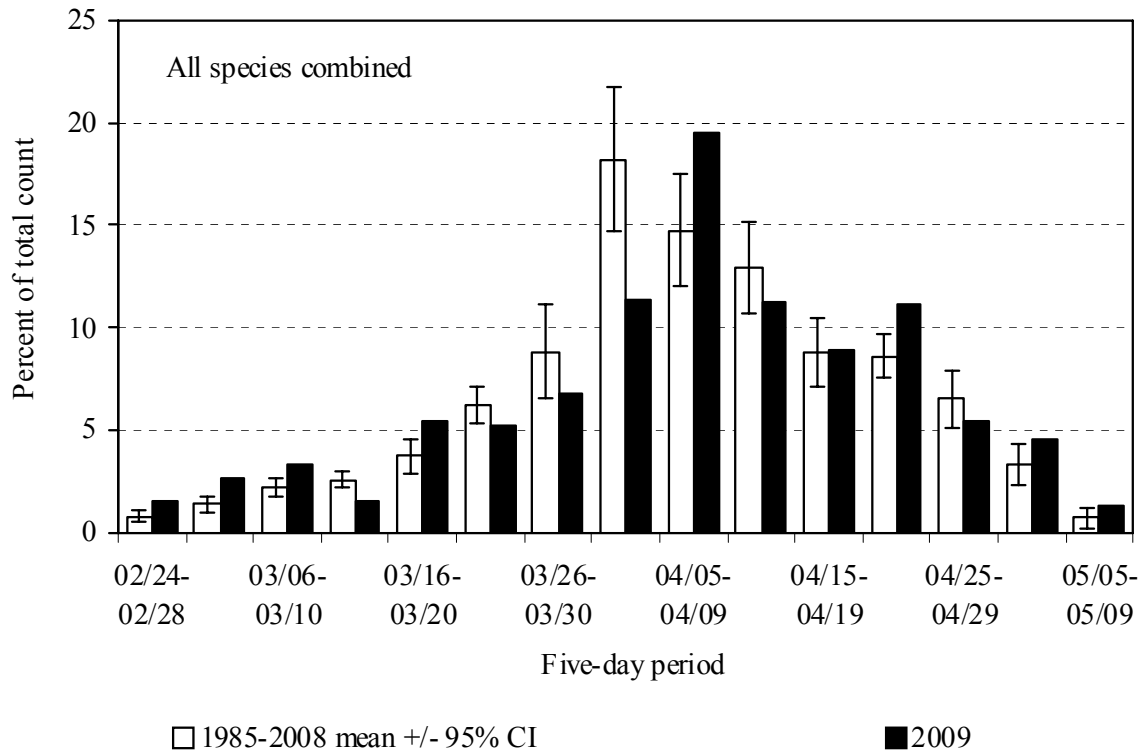


Figure 8. Combined-species, spring-migration passage volume by five-day periods for raptors in the Sandia Mountains, NM: 1985–2008 versus 2009.

Appendix A. History of official observer participation in the Sandia Mountains Raptor Migration Project: 1985–2009.

- 1985 Single observer throughout: Jim Daly–primary (1), Penny Rodefer (0)¹
- 1986 Single observer throughout: Jim Daly (3)
- 1987 Single observer throughout, rotating crew: LisaBeth Daly (2), Tom Davis (0), Bill Howe (0), Gordon Vickrey (0), Ann Cole (0)
- 1988 Single observer throughout: Gordon Vickrey (1)
- 1989 Single observer throughout, two observers during 30-day peak period: Rick Watson–primary (0), Rich Besser (0), Ann Cole (1), LisaBeth Daly (2), Gordon Vickrey (3)
- 1990 Single observer throughout, two observers during 30-day peak period: LisaBeth Daly–primary (3), Joe Kelly (0)
- 1991 Single observer throughout, two observers during 30-day peak period: LisaBeth Daly–primary (4), Eric Meyer (0)
- 1992 Two observers throughout: LisaBeth Daly (5), Mark Cantrell (1), Eric Meyer (2)
- 1993 Two observers throughout: LisaBeth Daly (6), Jessie Jewell (1), Daniel Perry (1)
- 1994 Two observers throughout: Jessie Jewell (3), Daniel Perry (3)
- 1995 Two observers throughout: Jessie Jewell (5), Tim Meehan (0), Sherry Swanson (0)
- 1996 Two observers throughout: Jessie Jewell (7), Sherry Swanson (1), Aaron Barna (0)
- 1997 Two observers throughout: Aaron Barna (2), Sean O’Connor (3)
- 1998 Two observers throughout: Jerry Liguori (11), Brian Sullivan (10)
- 1999 Two observers throughout: Jason Beason (3), Nikos Vulgares (2)
- 2000 Two observers throughout: Nikos Vulgares (3), Sue Vulgares (1)
- 2001 Two observers throughout: Craig Fosdick (4), Allison Cebula Benedict (0)
- 2002 Two observers throughout: Craig Fosdick (6; full season), Geoff Evans (1; first two weeks and later substitute), Rigo Mendoza-Rebolledo (2; full-time after first two weeks)
- 2003 Two observers throughout: Bob Diebold (4), Teresa Lorenz (1)
- 2004 Two observers throughout: Ken Babcock (1), Dane Ferrell (1)
- 2005 Two observers throughout: Ken Babcock (3), Eileen Müller (1), Octavio Cruz (2)
- 2006 Two observers throughout: Alberto Martinez (3), Ingrid Verhoeckx (0), and Ken Babcock (4; support/substitute throughout)
- 2007 Two observers throughout: Graeme Davis (0), Shawn Thietten (0), and Ken Babcock (4+; support/substitute throughout)
- 2008 Two observers throughout: Kevin Payne (0), Carissa Turner (0), Ken Babcock (4+; support/substitute throughout), Mike Neal (6+; training + last 8 days), Jason Bjork (+; last 8 days)
- 2009 Two observers throughout: James Butch (1), Andrew Eberly (0), Roger Grimshaw (4+; support/substitute throughout), and Ken Babcock (5+; support/substitute throughout)

¹ Numbers in parentheses indicate previous full seasons of raptor migration observation experience.

Appendix B. Common and scientific names, species codes, and regularly applied age, sex, and color-morph classifications for all diurnal raptor species observed during spring migration in the Sandia Mountains, NM.

COMMON NAME	SCIENTIFIC NAME	SPECIES CODE	AGE ¹	SEX ²	COLOR MORPH ³
Turkey Vulture	<i>Cathartes aura</i>	TV	U	U	NA
Osprey	<i>Pandion haliaetus</i>	OS	U	U	NA
Northern Harrier	<i>Circus cyaneus</i>	NH	A I Br U	M F U	NA
White-tailed Kite	<i>Elanus caeruleus</i>	WK	U	U	NA
Mississippi Kite	<i>Ictinia mississippiensis</i>	MK	A I U	U	NA
Sharp-shinned Hawk	<i>Accipiter striatus</i>	SS	A I U	U	NA
Cooper's Hawk	<i>Accipiter cooperii</i>	CH	A I U	U	NA
Northern Goshawk	<i>Accipiter gentilis</i>	NG	A I U	U	NA
Unknown small accipiter	<i>A. striatus</i> or <i>cooperii</i>	SA	U	U	NA
Unknown large accipiter	<i>A. cooperii</i> or <i>gentilis</i>	LA	U	U	NA
Unknown accipiter	<i>Accipiter</i> spp.	UA	U	U	NA
Common Black Hawk	<i>Buteogallus anthracinus</i>	CB	A I U	U	NA
Broad-winged Hawk	<i>Buteo platypterus</i>	BW	A I U	U	D L U
Swanson's Hawk	<i>Buteo swainsoni</i>	SW	U	U	D L U
Red-tailed Hawk	<i>Buteo jamaicensis</i>	RT	A I U	U	D L U
Ferruginous Hawk	<i>Buteo regalis</i>	FH	A I U	U	D L U
Rough-legged Hawk	<i>Buteo lagopus</i>	RL	U	U	D L U
Zone-tailed Hawk	<i>Buteo albonotus</i>	ZT	A I U	U	NA
Unknown buteo	<i>Buteo</i> spp.	UB	U	U	D L U
Golden Eagle	<i>Aquila chrysaetos</i>	GE	I, S, NA, A, U ⁴	U	NA
Bald Eagle	<i>Haliaeetus leucocephalus</i>	BE	I, S1, S2, NA, A, U ⁵	U	NA
Unknown eagle	<i>Aquila</i> or <i>Haliaeetus</i> spp.	UE	U	U	NA
American Kestrel	<i>Falco sparverius</i>	AK	U	M F U	NA
Merlin	<i>Falco columbarius</i>	ML	AM Br	AM U	NA
Prairie Falcon	<i>Falco mexicanus</i>	PR	U	U	NA
Peregrine Falcon	<i>Falco peregrinus</i>	PG	A I U	U	NA
Aplomado Falcon	<i>Falco femoralis</i>	AF	A I U	U	NA
Unknown small falcon	<i>F. sparverius</i> or <i>columbarius</i>	SF	U	U	NA
Unknown large falcon	<i>F. mexicanus</i> or <i>peregrinus</i>	LF	U	U	NA
Unknown falcon	<i>Falco</i> spp.	UF	U	U	NA
Unknown raptor	Falconiformes	UU	U	U	NA

¹ Age codes: A = adult, I = immature (HY), Br = brown (adult female or immature), U = unknown age.

² Sex codes: M = male, F = female, U = unknown.

³ Color morph codes: D = dark or rufous, L = light, U – unknown, NA = not applicable.

⁴ Golden Eagle age codes: I = Immature: juvenile or first-year bird, bold white wing patch visible below, bold white in tail, no molt; S = Subadult or older immature: white wing patch variable or absent, obvious white in tail and molt or tawny bar visible on upper wing; NA = Not adult: unknown age immature/subadult; A = Adult: no white in wings or tail; U = Unknown.

⁵ Bald Eagle age codes: I = Immature: juvenile or first-year bird, dark breast and tawny belly; S1 = young Subadult: Basic I and II plumages, light belly, upside-down triangle on back; S2 = older Subadult: Basic III plumage, head mostly white with osprey-like dark eye line and dark band on tail; NA = Not adult: unknown age immature/subadult; A = Adult: includes near adult with dark flecks in head and dark tail tip, and adult with white head and tail; U = Unknown.

Appendix C. Daily observation effort, visitor disturbance ratings, weather records, and flight summaries for the Sandia Mountains Raptor Migration Project: 2009.

DATE	OBS. HOURS	OBSRVR / HOUR ¹	MEDIAN	PREDOMINANT WEATHER ³	WIND	WIND DIRECTION	TEMP (°C) ¹	BAROM.	MEDIAN	VISIB.	VISIB.	MEDIAN	BIRDS / HOUR
			VISITOR DISTURB ²		SPEED (KPH) ¹			PRESS. (IN HG) ¹	THERMAL LIFT ⁴	WEST (KM) ¹	EAST (KM) ¹	FLIGHT DISTANCE ⁵ / HOUR	
24-Feb	8.00	6.0	0	clr	11.6	sw-nw	14.1	29.87	30.17	3	100	91	2
25-Feb	8.00	5.0	1	clr-pc	10.6	sw-nw	15.4	29.81	30.11	2	98	88	2
26-Feb	8.00	3.0	0	pc-mc	18.8	sw-nw	12.5	29.71	30.01	3	95	89	2
27-Feb	8.00	4.0	0	clr-pc	13.9	sw-wnw	11.3	29.69	30.00	2	100	94	2
28-Feb	8.00	3.0	0	clr, PM haze	9.5	ene, se, s-sw	8.3	29.98	30.29	3	100	90	2
29-Feb	8.00	3.0	0	pc-ovc	5.8	ws-wnw	11.1	30.03	30.33	3	95	81	2
1-Mar	8.00	2.9	0	mc	4.4	ws-wnw	16.1	29.92	30.22	2	94	83	2
2-Mar	8.00	3.0	0	pc-ovc	14.8	wnw-nw	15.8	29.85	30.16	3	93	90	2
3-Mar	8.00	3.0	0	ovc	10.1	sw-w	15.3	29.78	30.08	4	83	86	2
4-Mar	8.00	3.0	0	mc-ovc, PM blowing dust	24.5	ws-wnw	12.9	29.75	30.05	4	72	67	2
5-Mar	8.00	2.9	0	ovc, PM haze	5.5	ws-w	10.5	29.70	30.01	4	91	77	2
6-Mar	8.00	3.0	0	clr	23.3	sw-nw	6.3	29.56	29.86	3	96	88	2
7-Mar	7.83	4.1	1	pc-mc	8.9	sw-wsw	9.1	29.73	30.03	3	100	98	2
8-Mar	3.00	2.0	0	ovc	7.0	wnw-nw	5.3	29.61	29.91	4	60	58	2
9-Mar	8.00	2.0	0	clr-mc	25.4	wnw-nw	5.9	29.71	30.01	3	95	93	2
10-Mar	8.00	2.0	0	pc-ovc, haze	30.9	ene-se	4.3	29.79	30.09	4	88	81	2
11-Mar	8.00	2.0	0	clr-ovc	4.3	var, sw-wsw	8.5	29.76	30.06	3	99	93	2
12-Mar	6.50	2.7	0	ovc, fog/snow	32.0	ene-se	-0.9	29.68	29.98	4	13	15	-
13-Mar	8.00	4.0	0	ovc-mc, PM haze	7.3	w-nw	3.9	29.65	29.95	4	58	58	2
14-Mar	8.00	3.3	0	clr-pc	22.3	wnw-nw, sw	7.0	29.71	30.01	2	98	98	2
15-Mar	8.00	3.1	0	clr	16.0	w-nw	11.6	29.91	30.22	2	100	100	2
16-Mar	8.00	3.0	0	clr	15.9	w-nw	14.5	29.90	30.20	1	100	98	2
17-Mar	8.00	3.0	0	clr-pc	8.6	se, ws-wnw	18.1	29.88	30.18	1	100	99	2
18-Mar	8.00	3.0	0	clr-pc, AM haze	14.8	se, w, se	14.1	29.87	30.18	3	79	81	1
19-Mar	8.00	2.8	0	ovc, haze	6.0	sw-nw	17.4	29.82	30.12	3	97	81	2
20-Mar	8.25	4.9	0	pc-mc	5.6	sw-nw	18.4	29.81	30.11	2	99	98	2
21-Mar	8.00	4.1	1	ovc-clr	8.8	sw-nw	16.3	29.65	29.96	3	99	93	2
22-Mar	8.00	3.7	0	ovc-clr	26.9	ws-wnw	7.1	29.50	29.80	3	99	93	1
23-Mar	8.00	3.0	0	clr	20.0	sw-nw	6.5	29.64	29.95	3	100	100	2
24-Mar	8.00	3.3	1.5	clr-pc	16.3	sw-wnw	8.3	29.58	29.89	3	100	99	2
25-Mar	8.00	2.0	0	ovc, PM snow	21.1	sw-wnw	7.1	29.32	29.62	4	86	80	2
26-Mar	4.00	2.0	0	ovc-mc, AM fog/snow	19.6	nw	-1.8	29.56	29.87	4	64	52	2
27-Mar	8.00	3.6	1	clr	19.4	w-nnw	5.9	29.66	29.96	3	100	100	2
28-Mar	8.25	3.4	0	ovc	12.5	sw-wnw	11.0	29.50	29.80	3	99	100	2
29-Mar	8.00	3.8	0	ovc-clr	40.3	ws-wnw	-0.6	29.50	29.80	4	93	91	2
30-Mar	9.25	5.1	0	clr	18.8	ws-wnw	6.8	29.60	29.91	3	100	98	2
31-Mar	6.00	2.0	0	ovc, PM snow	25.0	sw-wnw	4.9	29.34	29.65	4	84	84	1
1-Apr	8.00	3.0	0	clr	24.3	ne, sw-wnw	7.1	29.60	29.90	3	100	100	2
2-Apr	8.50	3.3	0	clr-mc	11.0	sw/var	15.3	29.39	29.69	2	100	99	2
3-Apr	8.00	3.8	0	clr-pc	18.6	sw-w	5.4	29.46	29.77	4	100	95	2
4-Apr	8.08	3.5	1	clr-pc	15.1	sw-wnw	5.6	29.87	30.18	2	100	100	2
5-Apr	8.00	3.3	0	clr	6.8	se, sw-w	10.9	29.98	30.28	2	100	95	2
6-Apr	8.25	6.0	0	clr	9.3	sw-wsw	14.8	29.89	30.19	2	100	100	2
7-Apr	8.25	3.3	0	ovc-pc	18.4	sw-wsw	17.8	29.62	29.92	3	100	100	2
8-Apr	8.00	3.0	0	clr-pc	35.1	w	9.1	29.57	29.87	4	100	100	2
9-Apr	8.00	4.4	2.5	clr-ovc	24.0	se-sse	13.6	29.69	29.99	4	100	100	2
10-Apr	8.00	6.0	0	clr	11.6	sw-nw	14.1	29.87	30.17	3	100	91	2

Appendix C. continued

DATE	OBS. HOURS	OBSRVR / HOUR ¹	MEDIAN	PREDOMINANT WEATHER ³	WIND	WIND DIRECTION	TEMP (°C) ¹	BAROM.	MEDIAN	VISIB.	VISIB.	MEDIAN	BIRDS / HOUR
			VISITOR DISTURB ²		SPEED (KPH) ¹			PRESS. (IN HG) ¹	THERMAL LIFT ⁴	WEST (KM) ¹	EAST (KM) ¹	FLIGHT DISTANCE ⁵	
11-Apr	2.25	3.0	0	ovc, PM snow	31.0	se-sse	4.0	29.58	29.88	4	33	51	3
12-Apr	7.00	2.7	0	ovc, AM rain/snow	26.1	w-wnw	3.1	29.59	29.89	4	66	79	2
13-Apr	8.00	3.3	1.5	clr-pc	6.3	wsw-wnw/var	13.1	29.77	30.08	1	100	100	2
14-Apr	8.00	3.4	0	mc-ovc	8.0	se-sw	17.8	29.64	29.95	2	99	100	2
15-Apr	8.00	2.6	0	mc	14.8	se-sw	15.1	29.55	29.86	3	100	100	2
16-Apr	8.00	4.2	1	pc, AM haze	12.9	wsw-wnw/var	6.9	29.61	29.92	2	98	97	2
17-Apr	1.00	2.0	0	ovc, snow	14.7	wsw-nw	-1.3	29.61	29.91	4	3	1	-
18-Apr	8.25	2.8	2	ovc-clr	25.9	w-nw	6.4	29.76	30.06	3	96	96	2
19-Apr	8.00	2.6	2.5	clr-mc	8.3	e-se, w-wnw	13.3	29.98	30.29	2	100	100	2
20-Apr	8.50	4.0	1	clr-pc	12.1	sw-wnw	17.5	29.96	30.26	2	100	100	2
21-Apr	8.00	2.9	0	clr	10.1	sw-wnw	20.1	29.92	30.22	1	100	100	2
22-Apr	8.00	2.8	0	clr-ovc	9.5	sw-wnw	21.4	29.81	30.11	1	100	100	2
23-Apr	8.00	3.1	0	pc-mc	14.6	sw-wnw	21.4	29.72	30.03	2	90	93	2
24-Apr	8.00	3.3	1	clr-mc	14.4	sw-wnw	19.5	29.72	30.03	2	100	100	2
25-Apr	8.00	4.4	0	mc-ovc	8.4	sw-nw, ene	19.6	29.66	29.96	2	100	100	2
26-Apr	8.00	2.0	0	clr-pc	20.5	sw-wsw	13.4	29.62	29.92	2	100	100	2
27-Apr	8.00	2.0	0	clr-ovc	7.1	sw-w	15.6	29.79	30.09	1	100	100	2
28-Apr	8.00	3.3	0	ovc	12.0	se	20.6	29.79	30.09	3	99	99	2
29-Apr	8.00	2.0	0	clr	10.8	sw-w	20.6	29.76	30.07	2	100	99	2
30-Apr	8.00	2.0	0	clr-pc	7.4	sw-wsw	21.3	29.82	30.13	1	100	100	2
1-May	8.00	2.0	0	mc-ovc	7.9	sw-w	22.4	29.81	30.11	2	100	97	2
2-May	5.08	2.9	0	ovc, ts/rain	14.2	sw	14.2	29.71	30.01	3	88	75	2
3-May	8.00	2.6	1	ovc-pc	23.5	w-nw	16.5	29.77	30.07	3	100	100	2
4-May	8.00	2.4	1.5	pc-ovc	20.8	wsw-nw	19.5	29.72	30.03	2	100	100	2
5-May	8.00	3.9	0	mc, haze	12.3	sw-w	21.6	29.72	30.02	2	100	93	2

¹ Average of hourly records.

² Median hourly visitor-disturbance rating (subjective assessment by observers): 0 = none, 1 = low, 2 = moderate, 3 = high.

³ Predominant sky condition during day: clr = clear (0-15% cloud cover); pc = partly cloudy (16-50% cover); mc = mostly cloudy (51-75% cover); ovc = overcast (76-100% cover); ts = thunderstorms.

⁴ Median hourly rating concerning prevalence of lift-generating thermals, based on subjective assessments of solar intensity, wind speeds, and migrant behavior: 1 = excellent, 2 = good, 3 = fair, 4 = poor.

⁵ Median hourly rating concerning line-of-sight distance of flight from observation site: 1 = close, detection and identification possible with naked eye; 2 = moderate, detection possible with naked eye, but binoculars needed for identification; 3 = far, binoculars needed for both detection and identification; 4 = distant, birds detected and identified only with excellent binoculars or spotting scope and by experienced observers.

Appendix D. Daily observation effort and spring raptor migration counts by species in the Sandia Mountains, NM: 2009.

DATE	OBSERV. HOURS	SPECIES ¹																											TOTAL	/HOUR				
		TV	OS	NH	WK	MK	SS	CH	NG	SA	LA	UA	CB	BW	SW	ZT	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	AF			SF	LF	UF	UU
24-Feb	8:00	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	6	0.8
25-Feb	8:00	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	12	1.5
26-Feb	8:00	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	6	0.8
27-Feb	8:00	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	6	0.8
28-Feb	8:00	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	8	3	0	0	0	0	0	0	0	0	0	0	1	20	2.5
29-Feb	8:00	0	0	0	0	0	1	1	0	2	0	0	0	0	0	0	0	0	0	1	5	0	0	0	0	0	0	0	0	0	0	0	16	2.0
01-Mar	8:00	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	17	1.8
02-Mar	8:00	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	27	3.4
03-Mar	8:00	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	16	2.0
04-Mar	8:00	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	12	1.5
05-Mar	8:00	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	1	0	0	0	25	3.1
06-Mar	8:00	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	27	3.4
07-Mar	7:83	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	43	5.5
08-Mar	3:00	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	5	1.7	
09-Mar	8:00	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0.8	
10-Mar	8:00	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0.8
11-Mar	8:00	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	14	1.8
12-Mar	6:50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
13-Mar	8:00	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	1	13	1.6
14-Mar	8:00	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	16	2.0
15-Mar	8:00	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	18	2.3
16-Mar	8:00	0	0	2	0	0	4	5	1	0	1	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	35	4.4
17-Mar	8:00	7	0	2	0	0	5	3	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	51	6.4
18-Mar	8:00	0	0	1	0	0	7	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	16	2.0
19-Mar	8:00	15	0	0	0	0	7	8	0	1	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	54	6.8
20-Mar	8:25	1	1	5	0	0	7	12	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57	6.9
21-Mar	8:00	4	0	0	0	0	1	2	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	19	2.4
22-Mar	8:00	7	0	0	0	0	1	5	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	21	2.6
23-Mar	8:00	11	0	0	0	0	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	2.8
24-Mar	8:00	28	1	0	0	0	2	4	0	1	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	47	5.9
25-Mar	8:00	31	0	0	0	0	9	8	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	69	8.6
26-Mar	4:00	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	7	1.8	
27-Mar	8:00	11	1	0	0	0	4	4	0	2	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	34	4.3
28-Mar	8:25	39	1	3	0	0	9	9	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	85	10.3
29-Mar	8:00	4	1	0	0	0	4	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	2.4
30-Mar	9:25	44	0	0	0	0	8	14	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	81	8.8
31-Mar	6:00	14	4	1	0	0	16	15	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	71	11.8

Appendix D. continued

DATE	OBSERV. HOURS	SPECIES ¹																											TOTAL	/HOUR				
		TV	OS	NH	WK	MK	SS	CH	NG	SA	LA	UA	CB	BW	SW	ZT	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	AF			SF	LF	UF	UU
01-Apr	8.00	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	3	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	6	0.8
02-Apr	8.00	38	0	1	0	0	16	21	0	0	0	0	0	0	0	0	6	0	1	5	0	0	0	0	0	0	0	0	0	0	0	89	11.1	
03-Apr	8.50	57	0	0	0	6	9	0	3	0	0	0	0	0	0	0	6	1	0	5	0	0	0	1	0	0	2	0	1	0	0	95	11.2	
04-Apr	8.00	5	2	0	0	6	6	0	1	0	0	0	0	0	0	0	2	0	0	3	0	0	0	0	0	0	0	0	0	0	0	25	3.1	
05-Apr	8.08	36	3	7	0	0	28	20	0	2	0	0	0	0	1	1	10	0	0	3	0	0	0	12	0	0	0	0	1	0	0	125	15.5	
06-Apr	8.00	88	3	3	0	0	22	26	0	6	1	0	0	0	2	0	10	1	1	2	0	0	0	19	0	0	0	0	0	0	0	184	23.0	
07-Apr	8.25	58	1	4	0	0	17	25	0	1	0	0	0	0	1	0	6	0	0	5	0	0	3	0	0	0	0	0	1	0	1	123	14.9	
08-Apr	8.25	51	1	1	0	0	61	14	0	6	0	0	0	0	1	0	5	0	0	2	1	0	4	1	0	1	0	0	0	0	1	150	18.2	
09-Apr	8.00	9	1	0	0	0	9	7	0	4	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	2	0	0	0	0	0	35	4.4	
10-Apr	8.00	30	1	0	0	0	8	15	0	15	0	0	0	0	2	0	2	0	0	1	0	0	8	0	0	0	0	0	0	0	1	83	10.4	
11-Apr	2.25	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.4		
12-Apr	7.00	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3	0.4		
13-Apr	8.00	59	2	3	0	0	17	18	0	17	1	0	0	0	1	0	9	0	0	4	1	0	1	0	0	1	0	0	0	0	1	135	16.9	
14-Apr	8.00	31	3	2	0	0	27	23	0	10	0	0	0	0	14	0	9	0	2	6	0	0	3	0	0	1	0	0	0	0	3	134	16.8	
15-Apr	8.00	22	6	2	0	0	18	10	0	6	0	0	0	0	4	0	1	0	2	1	0	0	1	0	0	2	0	0	0	0	0	75	9.4	
16-Apr	8.00	4	2	0	0	0	4	10	0	0	1	0	0	0	0	0	3	0	0	0	0	0	1	0	0	2	0	0	0	0	0	27	3.4	
17-Apr	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	
18-Apr	8.25	43	5	0	0	0	1	1	0	3	0	0	0	0	0	0	1	0	1	6	1	0	0	0	0	1	0	0	0	0	1	64	7.8	
19-Apr	8.00	13	2	0	0	0	27	19	0	12	0	2	0	0	2	0	1	0	0	5	0	0	31	0	0	0	0	0	0	0	1	115	14.4	
20-Apr	8.50	21	1	0	0	0	43	23	0	12	0	0	0	0	1	0	5	0	0	5	0	0	1	0	0	0	0	0	0	0	0	112	13.2	
21-Apr	8.00	7	0	3	0	0	20	16	0	7	0	0	0	0	3	1	6	1	0	6	0	0	4	0	0	0	0	0	0	0	0	74	9.3	
22-Apr	8.00	4	1	1	0	0	14	3	0	7	0	0	0	0	3	0	4	0	3	3	0	0	2	1	0	0	0	0	0	0	1	47	5.9	
23-Apr	8.00	8	3	0	0	0	25	10	0	14	0	0	0	0	1	0	1	0	1	2	0	0	2	0	1	1	0	0	0	0	0	69	8.6	
24-Apr	8.00	20	2	0	0	0	11	5	0	2	0	0	0	0	2	1	4	0	1	1	0	0	2	1	0	0	0	0	0	0	0	53	6.6	
25-Apr	8.00	7	4	0	0	0	11	7	0	5	0	0	0	1	7	0	5	1	0	1	2	0	1	0	0	1	0	0	0	0	0	53	6.6	
26-Apr	8.00	1	3	0	0	0	3	1	0	1	0	0	0	0	1	0	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	16	2.0	
27-Apr	8.00	11	0	2	0	0	2	3	0	2	0	0	0	0	2	2	0	1	0	1	0	0	2	0	0	2	0	0	0	0	0	30	3.8	
28-Apr	8.00	16	1	0	0	0	7	9	0	7	0	0	0	0	2	0	0	0	0	1	0	0	3	0	0	2	0	0	0	0	0	49	6.1	
29-Apr	8.00	6	1	0	0	0	7	0	0	1	0	0	0	0	0	0	3	0	1	2	0	0	1	0	0	1	0	0	0	0	23	2.9		
30-Apr	8.00	6	0	0	0	0	1	1	0	1	0	0	0	0	2	0	2	0	0	1	0	0	1	0	0	0	0	0	0	0	0	17	2.1	
01-May	8.00	3	0	0	0	0	4	2	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	2	0	0	0	0	15	1.9		
02-May	5.08	1	2	0	0	0	3	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	2.0	
03-May	8.00	10	1	0	0	0	10	3	0	8	0	0	0	0	1	0	3	0	0	1	0	0	0	0	1	0	0	0	0	0	0	38	4.8	
04-May	8.00	15	0	0	0	0	19	9	0	9	0	0	0	0	0	0	5	0	0	6	0	0	1	1	0	0	0	0	0	0	0	65	8.1	
05-May	8.00	0	0	1	0	0	17	10	0	3	0	0	0	0	0	0	2	0	0	3	0	0	4	0	0	1	0	0	0	0	0	41	5.1	
Total	542.24	898	61	47	0	0	572	451	4	179	9	4	0	5	53	4	373	12	1	34	216	6	0	143	10	19	44	0	5	1	2	18	3171	5.8

¹ See Appendix B for explanations of species codes.

Appendix E. Annual observation effort and raptor migration counts by species (unadjusted data) in the Sandia Mountains, NM: 1985–2009.

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Start date	17-Feb	11-Feb	15-Feb	16-Feb	2-Mar	24-Feb	14-Feb	11-Feb	7-Feb	19-Feb	22-Feb	25-Feb	10-Feb	24-Feb	24-Feb
End date	13-May	9-May	10-May	9-May	30-Apr	6-May	10-May	11-May	5-May	5-May	5-May	5-May	7-May	5-May	3-May
Days of observation	73	78	69	65	56	61	83	84	75	69	67	68	70	68	66
Hours of observation	540.28	581.47	501.40	452.57	459.92	411.33	614.00	601.08	582.50	511.17	524.17	604.75	551.33	547.00	516.92
Raptors / 100 hours	518.2	535.2	467.9	642.1	1011.7	799.4	542.5	889.7	829.2	736.0	707.8	762.5	1103.5	1430.7	688.9
RAPTOR COUNTS															
SPECIES															
Turkey Vulture	641	814	559	1070	1380	1322	1246	1785	1327	1463	1217	1552	2531	3245	1427
Osprey	27	24	39	38	64	38	34	70	100	67	71	62	103	138	67
Northern Harrier	55	59	42	71	72	50	46	85	75	46	35	55	47	94	62
White-tailed Kite	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Mississippi Kite	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0
TOTAL KITES	0	0	2	0	0	0	0	0	1	0	0	0	1	0	0
Sharp-shinned Hawk	473	476	435	498	664	283	294	807	428	280	448	905	1280	772	386
Cooper's Hawk	454	709	521	498	1277	620	718	1050	1562	956	771	655	836	1157	670
Northern Goshawk	22	14	14	4	6	10	7	12	24	12	16	5	18	12	3
Unknown small accipiter ¹	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unknown large accipiter ¹	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unknown accipiter	90	56	88	70	123	65	59	201	95	55	61	73	70	5	30
TOTAL ACCIPITERS	1039	1255	1058	1070	2070	978	1078	2070	2109	1303	1296	1638	2204	1946	1089
Common Black-Hawk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Broad-winged Hawk	1	1	0	2	5	2	2	6	7	4	7	7	19	20	2
Swainson's Hawk	47	32	41	43	38	40	42	60	52	30	50	61	59	114	45
Zone-tailed Hawk	1	2	0	3	5	4	2	3	1	0	0	0	3	2	2
Red-tailed Hawk	280	241	183	182	357	289	353	390	461	325	377	356	338	662	220
Ferruginous Hawk	11	8	11	13	9	18	16	12	11	12	20	17	11	23	7
Rough-legged Hawk	0	2	0	1	1	0	0	0	1	0	0	0	0	1	0
Unidentified buteo	6	4	10	9	40	3	15	32	5	5	14	9	6	2	15
TOTAL BUTEOS	346	290	245	253	455	356	430	503	538	376	468	450	436	824	291
Golden Eagle	441	432	213	205	255	218	198	338	300	310	255	441	352	897	304
Bald Eagle	20	37	5	7	7	13	18	17	9	12	7	14	22	27	18
Unidentified Eagle	4	0	0	1	0	0	4	2	0	0	0	0	0	0	2
TOTAL EAGLES	465	469	218	213	262	231	220	357	309	322	262	455	374	924	324
American Kestrel	147	127	96	118	225	209	182	275	250	112	226	308	233	497	198
Merlin	0	2	5	3	2	3	4	5	9	3	18	10	24	19	15
Prairie Falcon	29	27	17	16	23	21	21	28	33	16	17	23	19	59	18
Peregrine Falcon	5	18	6	7	13	13	20	25	47	26	47	27	91	72	56
Aplomado Falcon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unknown small falcon ¹	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unknown large falcon ¹	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unknown falcon	2	0	5	2	5	2	5	3	3	0	0	1	7	1	4
TOTAL FALCONS	183	174	129	146	268	248	232	336	342	157	308	369	374	648	291
Unidentified raptor	44	27	54	45	82	65	45	142	29	28	53	30	14	7	10
ALL SPECIES	2800	3112	2346	2906	4653	3288	3331	5348	4830	3762	3710	4611	6084	7826	3561

Appendix E. continued

Start date	2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		Mean	
	23-Feb	5-May	22-Feb	5-May	22-Feb	3-May	22-Feb	5-May	26-Feb	5-May	24-Feb	8-May	24-Feb	5-May	24-Feb	5-May	24-Feb	5-May	24-Feb	5-May	20-Feb	5-May
End date	67	67	67	67	69	67	69	69	65	65	73	70	70	70	65	65	72	71	71	71	69	69
Days of observation	476.50	543.17	527.75	527.75	590.00	527.75	590.00	590.00	552.92	552.92	611.51	621.42	621.42	621.42	509.42	509.42	615.75	542.24	542.24	543.68	543.68	543.68
Hours of observation	832.7	685.1	624.0	624.0	937.8	624.0	937.8	937.8	586.2	586.2	508.7	596.9	596.9	596.9	449.9	449.9	643.6	584.8	584.8	730.0	730.0	730.0
Raptors / 100 hours	RAPTOR COUNTS																					
TURKEY VULTURE	1305	1328	1227	1227	2128	1227	2128	1285	1285	921	1151	1151	1151	496	496	1395	898	898	898	1368	1368	1368
Osprey	76	81	38	38	79	38	79	77	77	64	70	70	70	44	44	85	61	61	61	65	65	65
Northern Harrier	56	52	55	55	59	55	59	55	55	44	69	69	69	61	61	50	47	47	47	58	58	58
White-tailed Kite	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mississippi Kite	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
TOTAL KITES	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Sharp-shinned Hawk	391	311	337	337	459	337	459	372	372	390	540	540	540	209	209	436	572	572	572	494	494	494
Cooper's Hawk	922	556	506	506	797	506	797	561	561	486	677	677	677	574	574	824	451	451	451	762	762	762
Northern Goshawk	2	9	7	7	31	7	31	12	12	8	8	8	8	4	4	4	4	4	4	11	11	11
Unknown small accipiter ¹	-	0	8	8	6	8	6	2	2	44	29	29	29	177	177	32	179	179	179	37	37	37
Unknown large accipiter ¹	-	1	1	1	1	1	1	5	5	7	7	7	7	5	5	6	9	9	9	4	4	4
Unknown accipiter	96	90	16	16	3	16	3	6	6	82	35	35	35	74	74	171	4	4	4	72	72	72
TOTAL ACCIPIERS	1411	967	875	875	1297	875	1297	958	958	1017	1298	1298	1298	1043	1043	1473	1219	1219	1219	1353	1353	1353
Common Black-Hawk	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Broad-winged Hawk	19	3	4	4	12	4	12	4	4	2	5	5	5	2	2	7	5	5	5	6	6	6
Swainson's Hawk	50	43	54	54	111	54	111	62	62	66	68	68	68	33	33	31	53	53	53	53	53	53
Zone-tailed Hawk	10	1	3	3	3	3	3	0	0	4	4	4	4	0	0	2	4	4	4	2	2	2
Red-tailed Hawk	353	451	321	321	663	321	663	224	224	282	296	296	296	223	223	398	373	373	373	343	343	343
Ferruginous Hawk	11	12	7	7	17	7	17	5	5	6	6	6	6	4	4	8	12	12	12	11	11	11
Rough-legged Hawk	1	0	1	1	2	1	2	0	0	1	0	0	0	1	1	0	1	1	1	1	1	1
Unidentified buteo	21	10	1	1	3	1	3	14	14	16	20	20	20	25	25	40	34	34	34	14	14	14
TOTAL BUTEOS	465	520	391	391	811	391	811	309	309	378	399	399	399	288	288	486	482	482	482	430	430	430
Golden Eagle	417	391	366	366	689	366	689	307	307	348	351	351	351	124	124	132	216	216	216	346	346	346
Bald Eagle	13	18	12	12	23	12	23	6	6	4	7	7	7	2	2	6	6	6	6	14	14	14
Unidentified Eagle	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	1	1
TOTAL EAGLES	430	410	378	378	712	378	712	313	313	352	358	358	358	126	126	141	222	222	222	360	360	360
American Kestrel	143	165	205	205	299	205	299	128	128	163	181	181	181	75	75	147	143	143	143	196	196	196
Merlin	19	14	5	5	17	5	17	5	5	20	22	22	22	4	4	8	10	10	10	10	10	10
Prairie Falcon	13	20	16	16	20	16	20	35	35	21	47	47	47	33	33	23	19	19	19	25	25	25
Peregrine Falcon	49	64	52	52	105	52	105	73	73	62	97	97	97	62	62	69	44	44	44	46	46	46
Aplomado Falcon	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unknown small falcon ¹	-	-	0	0	0	0	0	0	0	7	1	1	1	2	2	1	5	5	5	1	1	1
Unknown large falcon ¹	-	-	0	0	0	0	0	3	3	3	4	4	4	10	10	6	1	1	1	3	3	3
Unknown falcon	0	6	2	2	0	2	0	0	0	0	3	3	3	9	9	9	2	2	2	3	3	3
TOTAL FALCONS	225	269	280	280	441	280	441	244	244	276	355	355	355	195	195	263	224	224	224	282	282	282
Unidentified raptor	0	94	49	49	6	49	6	0	0	58	9	9	9	39	39	70	18	18	18	41	41	41
ALL SPECIES	3968	3721	3293	3293	5533	3293	5533	3241	3241	3111	3709	3709	3709	2292	2292	3963	3171	3171	3171	3957	3957	3957

¹ Designations used regularly for the first time in 2002.