SPRING 2005 RAPTOR MIGRATION STUDY IN THE SANDIA MOUNTAINS OF CENTRAL NEW MEXICO

HawkWatch International, Inc.
Salt Lake City, Utah

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INTRODUCTION

The Sandia Mountains raptor migration study 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 2005 season marked the 21st consecutive migration count conducted at the site. No banding occurred at the site in 2005 due to personnel limitations. This report summarizes the 2005 count results.

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 east of the main 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 8 May 2005. Before this season, primary observers Ken Babcock and Eileen Müller had three and one full-seasons of previous experience counting migratory raptors for HWI or its partners (see Appendix A for a complete history of observer participation). Octavio Cruz, who served primarily as the on-site education specialist for the project and had two seasons of prior migration counting experience in Mexico, also routinely assisted with the counts. Other local volunteers and visitors also occasionally assisted with the counts. Weather permitting, observations usually began between 0800 and 0900 hrs Mountain Standard Time (MST) and ended between 1700 and 1800 hrs.

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 hrs 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 2005 annual statistics against means and 95% confidence intervals for previous seasons, I equate significance with a 2005 value falling outside the bounds of the confidence interval for the associated mean.

RESULTS AND DISCUSSION

WEATHER SUMMARY

Compared to the last seven seasons, inclement weather severely hampered observations at an average level in 2004 (see Appendix C for daily weather summaries), with 4 potential days of observation entirely precluded and 4 days reduced to less than 4 hours of observation (1998–2004 averages of 4.3 and 3.1 days, respectively). However, the proportion of active observation days where fair skies prevailed was well below average (31% versus average of 49%), whereas an above-average proportion of days featured predominantly mostly cloudy to overcast weather (35% versus 25%). Transitional weather (i.e., conditions changed from fair to mostly cloudy or overcast during the day, or vice versa) prevailed on the remaining 34% of the active observation days, which was also above average (26%). Moreover, the proportion of active observation days that featured some rain and/or snow was above average (27% versus average of 20%) and the proportion of active days that featured some visibility reducing fog and/or haze was substantially above average (68% versus average of 35%). The high prevalence of fog/haze and general storminess resulted in significantly reduced estimates of average visibility (9 km to the east and 35 km to the west, compared to 1998–2004 averages of 75 and 82 km, respectively).

There was also a distinct shift toward stronger winds in 2005, with the proportion of days featuring predominantly light winds (<12 kph) the lowest in the past 8 years (51%, average 70%), the proportion featuring predominantly moderate winds (12–28 kph; 45%) the highest in the past 8 years (45%, average 26%), and an average proportion of days featuring predominantly stronger winds (4%, average 4%). In the Sandias, westerly winds usually prevail. In 2005, variable SW-NW winds prevailed on an above-average 37% of the active observation days (average 18%), with another 12% of days featuring such winds during a significant portion of the day (average 8%). In contrast, days where steadier W-NW winds prevailed were less common than usual (18%, average 29%), as were days where no prevailing wind direction applied (0%, average 11%).

The temperature during active observation periods averaged 11.3°C (the average of daily values, which in turn were averages of hourly readings), with hourly readings ranging from 1.0–19.7°C. The overall average was slightly below average (mean 12.1, range 9.1–15.5°C), and the maximum value was the second lowest recorded since 1998. The barometric pressure during active observation periods averaged 29.69 in Hg (average of daily values, which in turn were averages of hourly readings). The overall

average and the maximum hourly reading of 30.05 in Hg were both the highest recorded since 2001 (the period of record for this measure).

Good to excellent thermal-lift conditions predominated on a record-low 8% of the active observation days, compared to the 1998–2004 average of 58%.

In summary, compared to the previous seven seasons, although observer dedication and perseverance resulted in only an average number of missed observation periods, the weather during the 2005 season was more unsettled than usual and hampered by high prevalence of both rain/snow and visibility reducing fog/haze. The unsettled weather was accompanied by stronger than usual winds, with higher than usual variability of wind directions but still largely constrained to the SW to NW quadrant. The increased storminess, fog/haze, cool temperatures, and stronger winds also resulted in much poorer than usual thermal lift conditions during the season and significant reductions in average visibility.

OBSERVATION EFFORT

The observers worked on 67 of 71 possible days between 24 February and 5 May, which is the standard count period for the project. In addition, responding to a late wave of activity on the last two days of the standard count period, one observer continued to count during portions of three additional days, extending the overall 2005 count-period to 8 May. The number of observation days was a significant 5% higher than the 1985–2004 average of 69 ± 95% CI of 2.9 days, and the number of observation hours (611.5) was a significant 14% higher than average (534.5 ± 95% CI of 24.0 hrs). The 2005 average of 2.4 observers per hour (including official and guest observers; value is mean of daily values, which are in turn means of hourly values) also was a significant 15% above the 1985–2004 average of 2.1 ± 95% CI of 0.14 observers/hr.

FLIGHT SUMMARY

The observers counted 3,111 migrant raptors of 20 species during the 2005 season, with the total count a significant 24% below the 1985–2004 average and the lowest since 1988 (see Appendix D for daily count records and Appendix E for annual summaries). The count of Bald Eagles dropped to a record low of 4 birds (Appendix E). In contrast, the tally included only the fourth Mississippi Kite recorded at the site and the first Common Black-Hawk ever recorded at the site.

The 2005 flight was composed of 33% accipiters, 30% vultures, 12% buteos, 11% eagles, 9% falcons, 2% Ospreys, 1% harriers, and 2% unidentified raptors. These values represent a significantly below average proportion of vultures and significantly above average proportions of buteos, eagles, falcons, Ospreys, and unidentified raptors (Figure 2). The Cooper's Hawk was the most abundant species, followed by the Sharp-shinned Hawk, Golden Eagle, Red-tailed Hawk, and American Kestrel (Table 1).

Passage Rate Trends

Among 17 species seen in most years, adjusted passage rates were significantly above average only for Merlins and Peregrine Falcons, whereas passage rates were significantly below average for 11 species (Table 1, Figures 3–7). The 1985–2005 regression analyses of adjusted passage rates indicated highly significant ($P \leq 0.01$) linear increasing trends for Swainson's Hawks (Figure 5) and Peregrine Falcons (Figure 7), and marginally significant ($P \leq 0.10$) to highly significant quadratic trends for Turkey Vultures (Figure 3), Ospreys (Figure 3), Cooper's Hawks (Figure 4), Broad-winged Hawks (Figure 5), Ferruginous Hawks (Figure 5), and Merlins (Figure 7). These quadratic trends consistently track increasing patterns through the mid-to-late 1990s followed by recent stabilization or more commonly declines. Although not captured by significant regressions, passage rates of Northern Harriers, Bald Eagles, and American Kestrels also have shown declining trajectories since passage rates climbed to high

peaks for these and several other species in 1997/98 following a wet El Niño period. The recent declines shown by many species correlate with the onset of widespread drought throughout much of the interior West after 1998 (Hoffman and Smith 2003). Age-specific analyses also revealed a marginally significant linear decline for adult Northern Goshawks, but no long-term trend for immature goshawks (Figure 4).

Atypical weather also may have contributed to the generally low passage rates this season. Cold, snowy, and windy conditions were prevalent throughout March, with additional events well into April. Such conditions can hamper an observer's ability to remain alert and vigilant, and may reduce the detectability of migrants by affecting binocular stability and general visibility. The high prevalence of visibility reducing fog and haze, and attendant evidence of substantial reductions in average visibility, provide further evidence that detectability may have been an issue. On the other hand, however, strong winds and low thermal lift potential tend to keep migrants closer to ridgelines where they can take advantage of wind-driven updrafts and are more visible to observers, and increased cloud cover (absent a very low ceiling) tends to make migrants more visible to observers by providing a high contrast backdrop against the sky. Accordingly, the aggregate effect of the season's weather on migrant detectability (i.e., the proportion of the true migration that was actually sampled) may have been roughly neutral.

Age Ratios

Immature : adult ratios were above average for 7 of 10 species with data suited to comparisons, significantly so for all three accipiters, Broad-winged Hawks, and Bald Eagles (Table 2). The efficacy of comparisons for the latter two species is highly marginal due to low overall counts; moreover, in both cases the high age ratios were due to proportionally greater reductions in the number of adults tallied rather than high abundance of young birds. For the three accipiters, however, the high age ratios were due to both high counts of immature birds and low counts of adult birds. Fall 2004 migration counts from the nearby Manzano Mountains along the same flyway also indicated above average immature : adult ratios for the three accipiters; however, only for Northern Goshawks was this due to a higher than average count of immature birds (Smith 2005). Thus, it would appear that either adult survival has been declining disproportionate to the survival rate of immature accipiters or, perhaps more likely, the migration dynamics of adult accipiters has changed in such as way as to reduce their relative abundance on our southern Rocky Mountain migration counts over the past few years.

In contrast to the accipiters, the Golden Eagle was the only species to show a significantly below average immature/subadult : adult ratio in 2005, and the reduced ratio was due to a combination of low abundance of young birds and high abundance of adult birds (Table 2). Increasing migration activity among adults at lower latitudes in the interior West and attendant decreases in abundance of younger birds may be a sign of declining habitat quality and productivity among populations wherein adult eagles typically are largely sedentary (Hoffman and Smith 2003).

Seasonal Timing

The overall combined-species median passage date of 3 April was a significant 3 days earlier than average, and 9 of 14 species for which a comparison was possible showed significantly earlier than average timing in 2005 (Table 3). Only the Northern Goshawk and Prairie Falcon showed significantly later than average median passage dates in 2005. The combined-species distribution of seasonal activity illustrates the general pattern that applied to most species, with above average relative activity levels in March, generally below average activity levels in April, and then a late, modest surge of activity for many species during early May just as the count was shutting down (Figure 8). The extra three days of counting between 6 and 8 May yielded 22 additional birds on 6 May but only 5 birds total the following two days during reasonably good weather (Appendixes C and D). Thus, although there clearly was a modest wave of late activity during the first week of May, which involved several species, it did not appear to be sustained beyond the 6th. Moreover, no obvious reason for the generally depressed April

activity levels is apparent; inclement weather severely hampered only four days of observation in April and wind conditions were generally favorable for migration.

ENCOUNTERS WITH PREVIOUSLY BANDED BIRDS

Since last year's annual report, one additional Sandia-banded raptor has been encountered elsewhere. This female Sharp-shinned Hawk was banded as a second-year bird on 22 March 2003 and was later found dead of unknown causes near Albuquerque, New Mexico on 30 November 2004 ~11 km from the project site.

RESIDENT BIRDS

The usual resident pair of Golden Eagles (dubbed “Fred” and “Ethel”, with Ethel easily identified from year to year by several white or partially white secondaries and wing/tail coverts) was present throughout the season. The pair was first seen copulating on 2 March, with 18 copulation events witnessed through the remainder of the season; however, based on the degree to which Ethel was routinely out flying with Fred, the crew believed that no successful nesting occurred. For the second year in a row, a subadult eagle also was present in the territory for a short time early in the season.

Most resident Red-tailed Hawk activity this year occurred southeast of the count site in Tijeras Canyon and farther south. The first resident-bird sighting occurred on 9 March, with activity then continuing through the remainder of the season. At least one immature bird was confirmed. Unlike in previous years, no obvious resident dark or rufous morph birds were seen, and migrant-escorting behavior was generally not observed.

The first possible sighting of a resident Sharp-shinned Hawk occurred on 19 March, with the first confident sighting on 6 April and sightings then continuing through the remainder of the season. All confirmed age-specific sightings were of an immature (second year) bird. This bird's activity range encompassed a broad area around the count site. Resident Cooper’s Hawks seen this year included at least one immature (second year) bird and one adult. The first sighting occurred on 8 March along the ridgeline west of the count site, but one observer had previously observed wintering Cooper's Hawks in this area. Resident Cooper's Hawk sightings continued through the season, with an immature bird seen most frequently. No resident Northern Goshawks were recorded this year.

One American Kestrel was seen hunting to the east of the count site in early May, but no other obvious resident kestrel activity was noted this year. Similarly, unlike last year, no resident Prairie Falcon activity was noted, whereas resident Peregrine Falcons were again present. The first possible sighting of a resident peregrine occurred on 31 March, with regular activity beginning on 4 April and then extending throughout the season. The observers believed that the two birds involved included a second year bird and a full adult, who appeared to engage in courtship behavior in early May. As usual, their main activity center was the “shields” area above the count site.

Beginning on 12 April, groups of 3–5 Turkey Vultures were seen regularly patrolling the area, primarily along the ridge to the west of the project site but also occasionally higher up on the main ridge to the north and east of the count site.

This is a fairly typical resident assemblage for the project area, except for the lack of goshawk, kestrel, and Prairie Falcon sightings. It appears likely that the establishment of a Peregrine Falcon territory in the area several years ago has contributed to a reduction in kestrel and Prairie Falcon activity.

SITE VISITATION AND PUBLIC OUTREACH

As was also true in 2004, inclement weather reduced visitation to the site in 2005. Nevertheless, 413 individuals visited the project site during the season, which is 23% lower than in 2003 but 28% higher than in 2004. Most visitors originated in the Albuquerque metropolitan area or in other nearby communities. Other source areas included Arizona, Oregon, Washington, Montana, Connecticut, New Jersey, New York, Illinois, Indiana, Michigan, Massachusetts, Texas, England, France, and Finland. Visitors included nine organized groups (two others cancelled due to poor weather), including 38 kids and their chaperones from three scout troops, and 94 students and their teachers from six area school classrooms. A total of 74 family groups also visited the site. All guests were greeted and chaperoned by project education specialist Octavio Cruz, or in some cases HWI's New Mexico Education Intern, Melanie Keithley, who very often had previously introduced the participants to HWI and raptors through school and community programs in the Albuquerque metropolitan area.

In 2005, 653 hourly assessments of visitor disturbance resulted in the following ratings: 80% none, 15% low, 4% moderate, and 1% high. This low level of observer disturbance, despite a high rate of public visitation and interaction with the field crew at this site, is apt testimony to the benefits of staffing the crew with a full-time education specialist. Not only does this reduce unnecessary distraction of the official observers from their primary duty of tallying the migration, it also ensures an enriching experience for all guests.

ACKNOWLEDGMENTS

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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: 1985–2004 versus 2005.

	COUNTS			RAPTORS / 100 HOURS[1]		
SPECIES	1985–2004[2]	2005	% CHANGE	1985–2004[2]	2005	% CHANGE
Turkey Vulture	1444 ± 269.9	921	-36	458.3 ± 83.29	252.8	-45
Osprey	65 ± 12.6	64	-1	21.3 ± 3.92	17.1	-20
Northern Harrier	59 ± 6.4	44	-25	13.2 ± 1.46	8.4	-37
White-tailed Kite	0.1 ± 0.10	0	-100	–	–	–
Mississippi Kite	0.2 ± 0.16	1	+567	–	–	–
TOTAL KITES	0.2 ± 0.23	1	+400	–	–	–
Sharp-shinned Hawk	514 ± 111.5	390	-24	121.4 ± 24.25	88.4	-27
Cooper's Hawk	787 ± 128.4	486	-38	222.6 ± 33.13	118.7	-47
Northern Goshawk	12 ± 3.3	8	-33	2.4 ± 0.64	1.1	-57
Unknown small accipiter[3]	4 ± 3.6	44	+1000	–	–	–
Unknown large accipiter[3]	2 ± 2.0	7	+250	–	–	–
Unknown accipiter	68 ± 20.2	82	+21	–	–	–
TOTAL ACCIPITERS	1382 ± 198.6	1017	-26	–	–	–
Common Black-Hawk	0 ± 0.0	1	–	–	–	–
Broad-winged Hawk	6 ± 2.8	2	-68	1.4 ± 0.61	0.2	-86
Swainson's Hawk	54 ± 9.6	66	+23	19.9 ± 2.99	22.2	+12
Zone-tailed Hawk	2.2 ± 1.03	4	+82	0.5 ± 0.23	0.7	+43
Red-tailed Hawk	351 ± 57.9	282	-20	77.9 ± 10.75	54.8	-30
Ferruginous Hawk	13 ± 2.0	6	-52	2.6 ± 0.44	1.1	-58
Rough-legged Hawk	0.5 ± 0.30	1	+100	–	–	–
Unidentified buteo	11 ± 4.4	16	+42	–	–	–
TOTAL BUTEOS	438 ± 68.5	378	-14	–	–	–
Golden Eagle	367 ± 74.0	348	-5	72.4 ± 13.37	60.7	-16
Bald Eagle	15 ± 3.5	4	-74	4.2 ± 0.91	1.1	-74
Unidentified eagle	0.7 ± 0.57	0	-100	–	–	–
TOTAL EAGLES	383 ± 76.1	352	-8	–	–	–
American Kestrel	207 ± 40.5	163	-21	53.0 ± 9.54	37.1	-30
Merlin	9 ± 3.2	20	+120	2.0 ± 0.70	4.0	+100
Prairie Falcon	24 ± 4.5	21	-11	4.6 ± 0.86	4.7	+2
Peregrine Falcon	41 ± 12.9	62	+52	8.1 ± 2.47	11.8	+46
Aplomado Falcon	0.1 ± 0.10	0	-100	–	–	–
Unknown small falcon[3]	0.0 ± 0.0	7	–	–	–	–
Unknown large falcon[3]	0.8 ± 1.5	3	+300	–	–	–
Unknown falcon	2 ± 1.0	0	-100	–	–	–
TOTAL FALCONS	283 ± 52.2	276	-3	–	–	–
Unidentified raptor	41 ± 15.4	58	+42	–	–	–
GRAND TOTAL	4094 ± 578.7	3111	-24	–	–	–

[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: 1990–2004 versus 2005.

	Total and Age-classified Counts								Imm. : Adult	
	1992–2004 Average			2005			% Unknown Age		Ratio	
	Total	Imm.	Ad.	Total	Imm.	Ad.	1992–2004[1]	2005	1992–2004[1]	2005
Northern Harrier	58	12	32	44	5	15	27 ± 4.4	55	0.46 ± 0.229	0.33
Sharp-shinned Hawk	515	56	276	390	81	129	35 ± 4.4	46	0.21 ± 0.058	0.63
Cooper's Hawk	818	71	520	486	120	162	29 ± 6.3	42	0.14 ± 0.037	0.74
Northern Goshawk	12	3	7	8	8	0	24 ± 9.9	0	0.47 ± 0.146	>8
Broad-winged Hawk	8	0.4	5	2	1	1	25 ± 12.2	0	0.17 ± 0.261	1.00
Red-tailed Hawk	386	60	262	282	47	173	16 ± 3.6	22	0.25 ± 0.073	0.27
Ferruginous Hawk	13	1	6	6	1	1	47 ± 11.9	67	0.74 ± 0.785	1.00
Golden Eagle	386	186	118	348	120	173	22 ± 8.7	16	1.76 ± 0.529	0.69
Bald Eagle	15	7	6	4	3	1	10 ± 7.9	0	1.32 ± 0.469	3.00
Peregrine Falcon	51	12	29	62	14	33	20 ± 7.2	24	0.44 ± 0.134	0.42

[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 2005 with a comparison of 2005 and 1990–2004 average median passage dates.

	2005				1990–2004
Species	First Observed	Last Observed	Bulk Passage Dates[1]	Median Passage Date[2]	Median Passage Date[2, 3]
Turkey Vulture	13-Mar	5-May	24-Mar – 9-Apr	1-Apr	04-Apr ± 1.3
Osprey	22-Mar	5-May	28-Mar – 30-Apr	11-Apr	13-Apr ± 1.7
Northern Harrier	4-Mar	5-May	13-Mar – 22-Apr	4-Apr	07-Apr ± 2.0
Mississippi Kite	22-Mar	22-Mar	–	–	–
Sharp-shinned Hawk	26-Feb	7-May	29-Mar – 1-May	14-Apr	19-Apr ± 2.1
Cooper's Hawk	27-Feb	8-May	29-Mar – 1-May	12-Apr	11-Apr ± 1.1
Northern Goshawk	3-Apr	5-May	3-Apr – 5-May	27-Apr	03-Apr ± 4.4
Common Black-Hawk	2-Apr	2-Apr	–	–	–
Broad-winged Hawk	30-Apr	5-May	–	–	23-Apr ± 3.0
Swainson's Hawk	2-Apr	6-May	8-Apr – 5-May	14-Apr	17-Apr ± 1.7
Zone-tailed Hawk	12-Apr	30-Apr	–	–	11-Apr ± 0.0
Red-tailed Hawk	27-Feb	6-May	8-Mar – 15-Apr	23-Mar	25-Mar ± 1.3
Ferruginous Hawk	18-Mar	26-Apr	18-Mar – 26-Apr	22-Mar	19-Mar ± 5.9
Rough-Legged Hawk	24-Mar	24-Mar	–	–	± 0.0
Golden Eagle	26-Feb	5-May	4-Mar – 16-Apr	17-Mar	21-Mar ± 3.8
Bald Eagle	2-Mar	1-Apr	–	–	08-Mar ± 4.0
American Kestrel	12-Mar	6-May	6-Apr – 1-May	13-Apr	12-Apr ± 1.9
Merlin	12-Mar	5-May	24-Mar – 30-Apr	4-Apr	09-Apr ± 4.5
Prairie Falcon	27-Feb	22-Apr	1-Mar – 14-Apr	27-Mar	19-Mar ± 3.8
Peregrine Falcon	26-Feb	3-May	18-Mar – 30-Apr	8-Apr	12-Apr ± 3.0
All species	26-Feb	8-May	17-Mar – 28-Apr	3-Apr	06-Apr ± 1.4

[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.

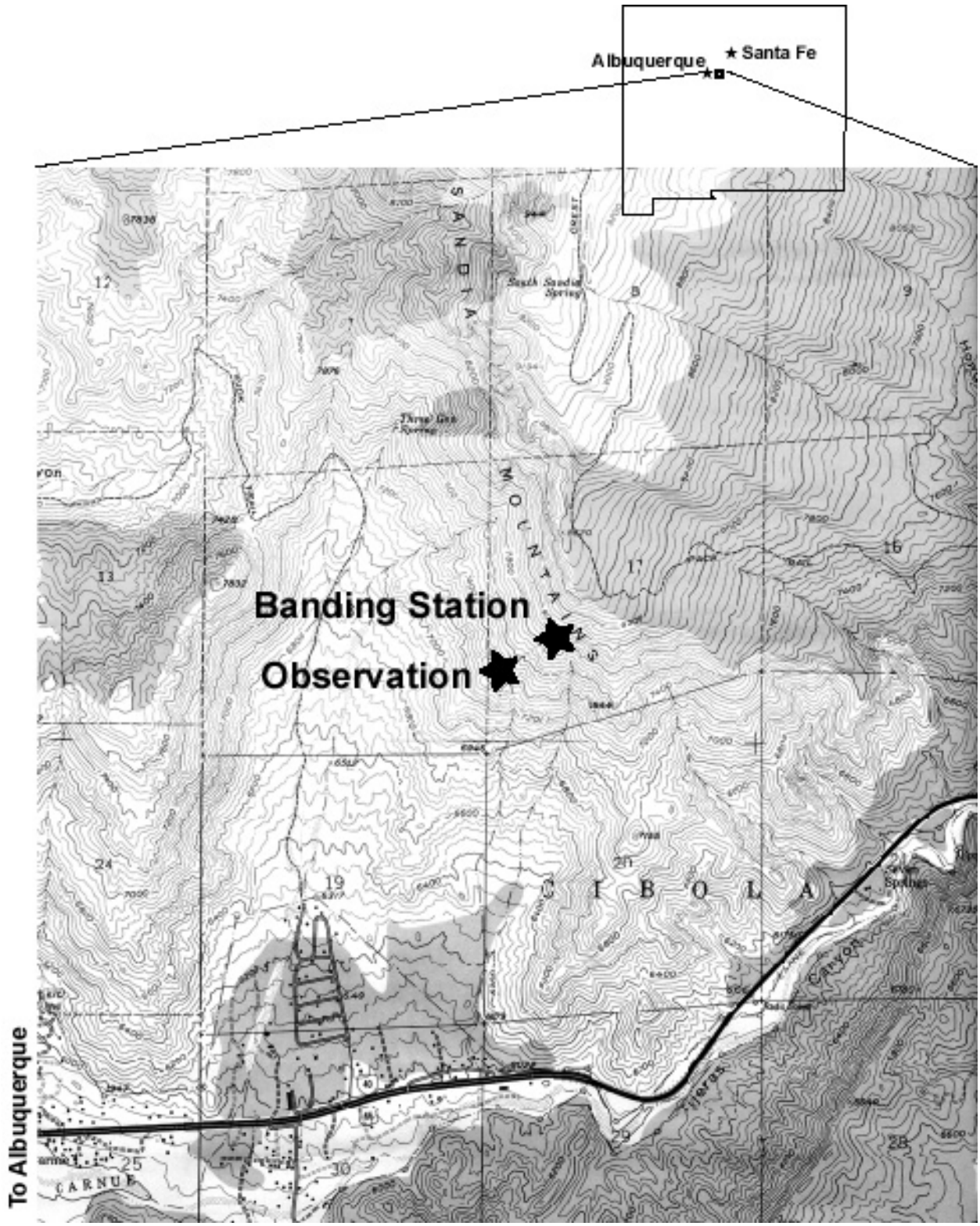

Figure 1. Map of Sandia Mountains Raptor Migration Project study site.

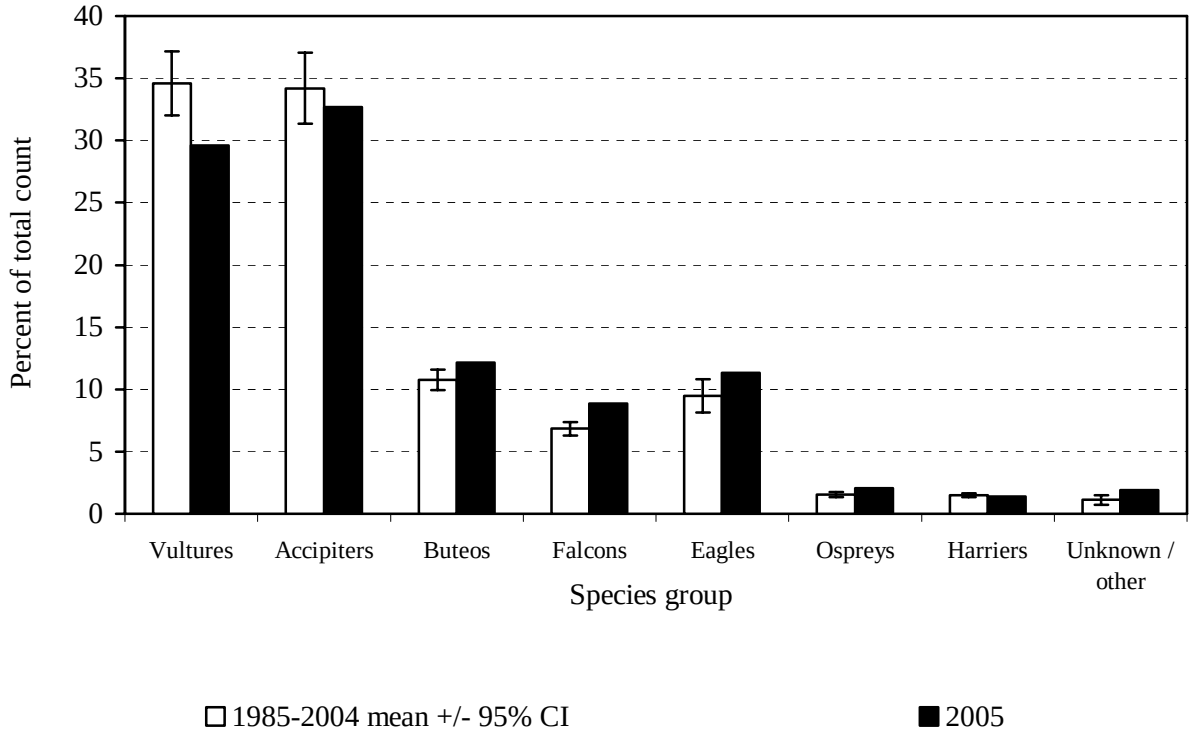

Figure 2. Spring raptor-migration flight composition by major species groups in the Sandia Mountains, NM: 1985–2004 versus 2005.

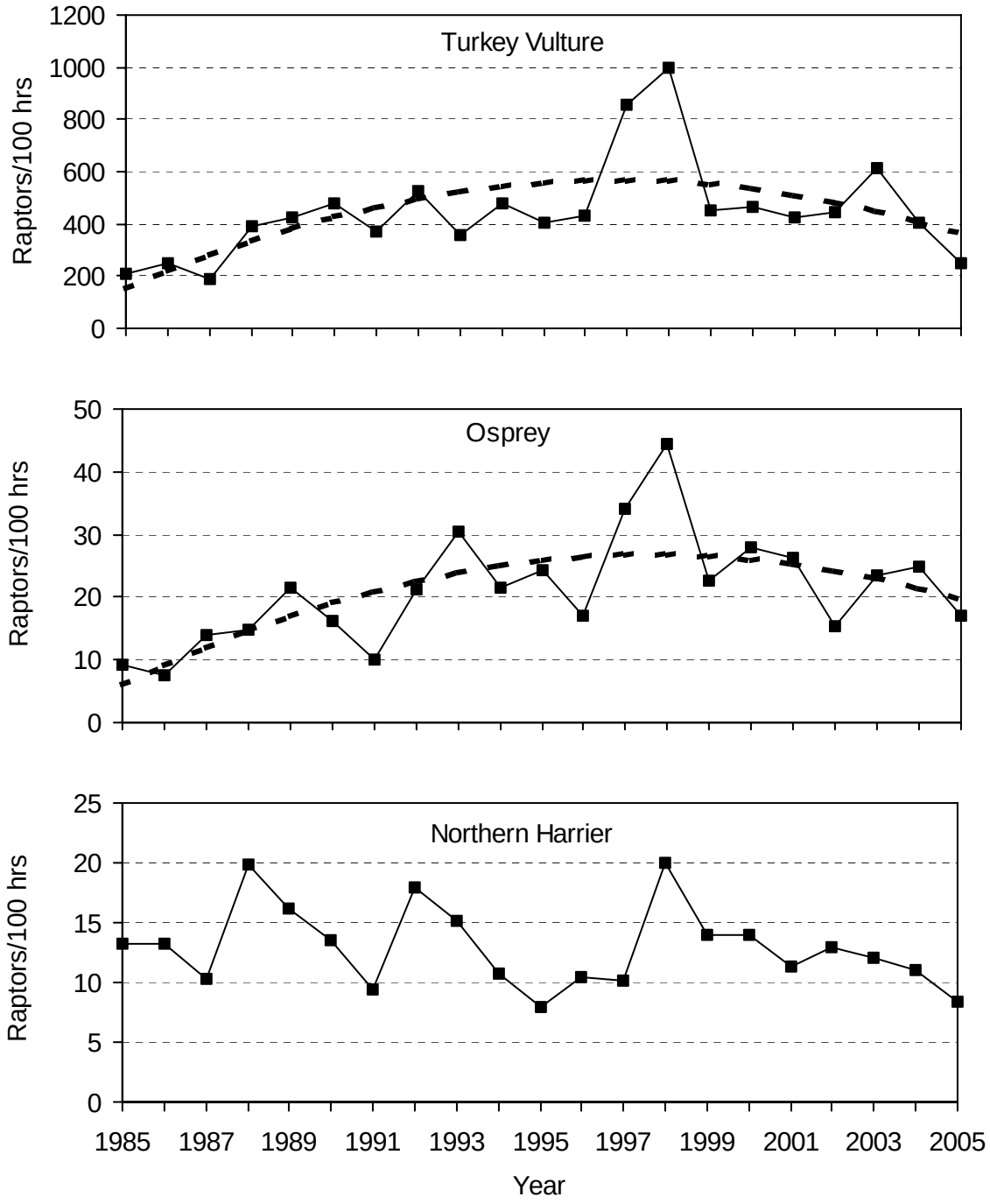

Figure 3. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) spring-migration passage rates for Turkey Vultures, Ospreys, and Northern Harriers in the Sandia Mountains, NM: 1985–2005. Dashed lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

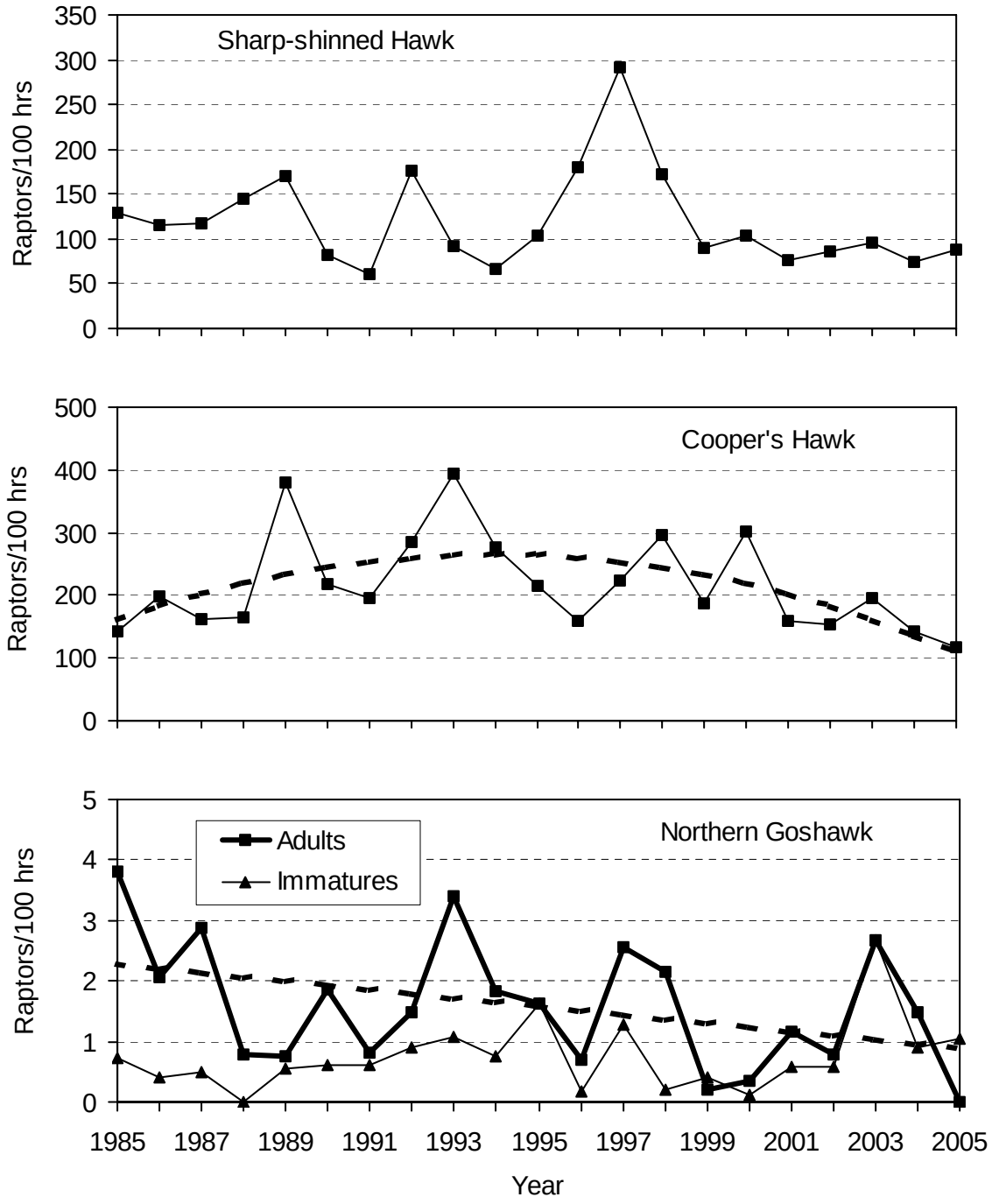

Figure 4. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) spring-migration passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks in the Sandia Mountains, NM: 1985–2005. Dashed lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

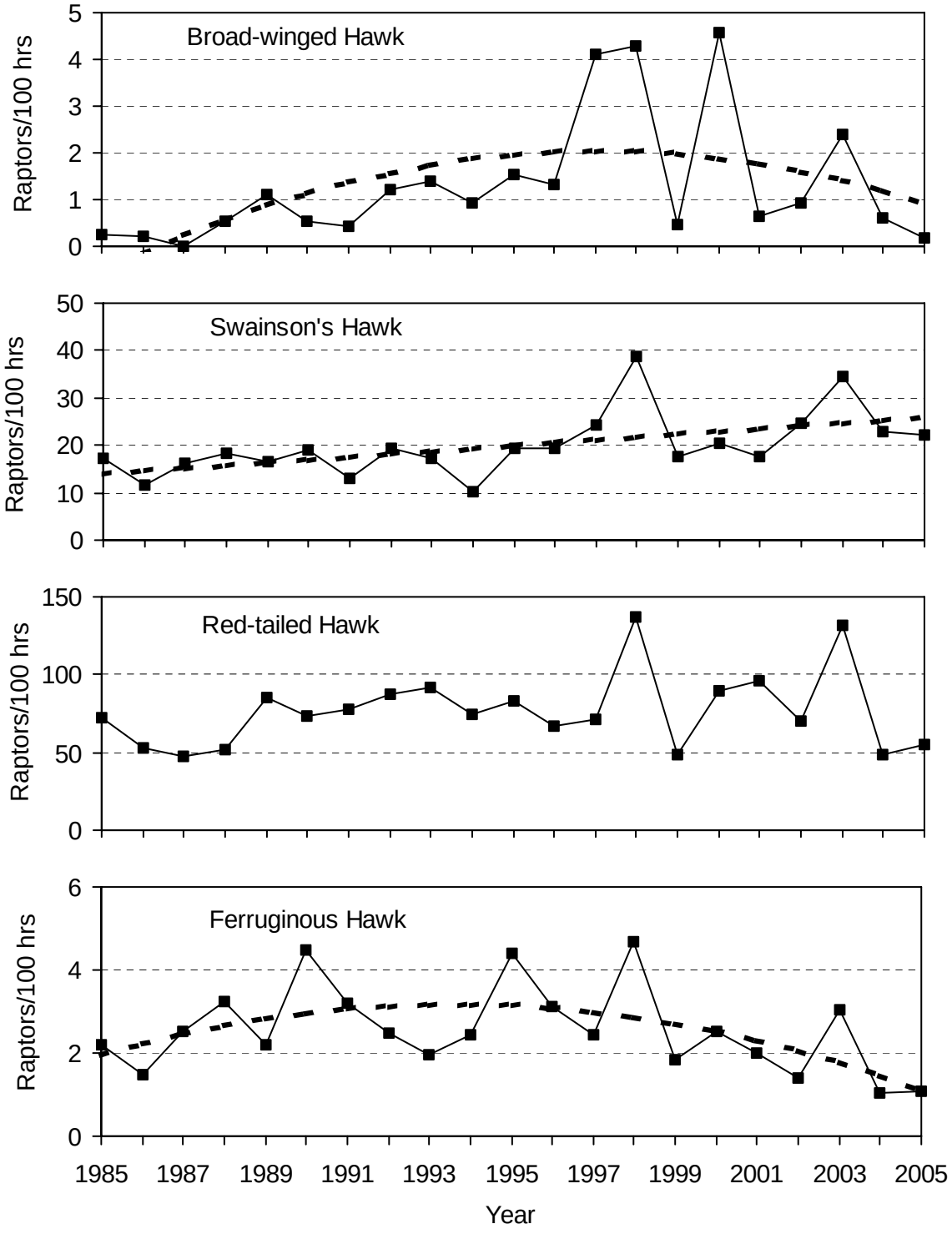

Figure 5. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) spring-migration passage rates for Broad-winged, Swainson's, Red-tailed, and Ferruginous Hawks in the Sandia Mountains, NM: 1985–2005. Dashed lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

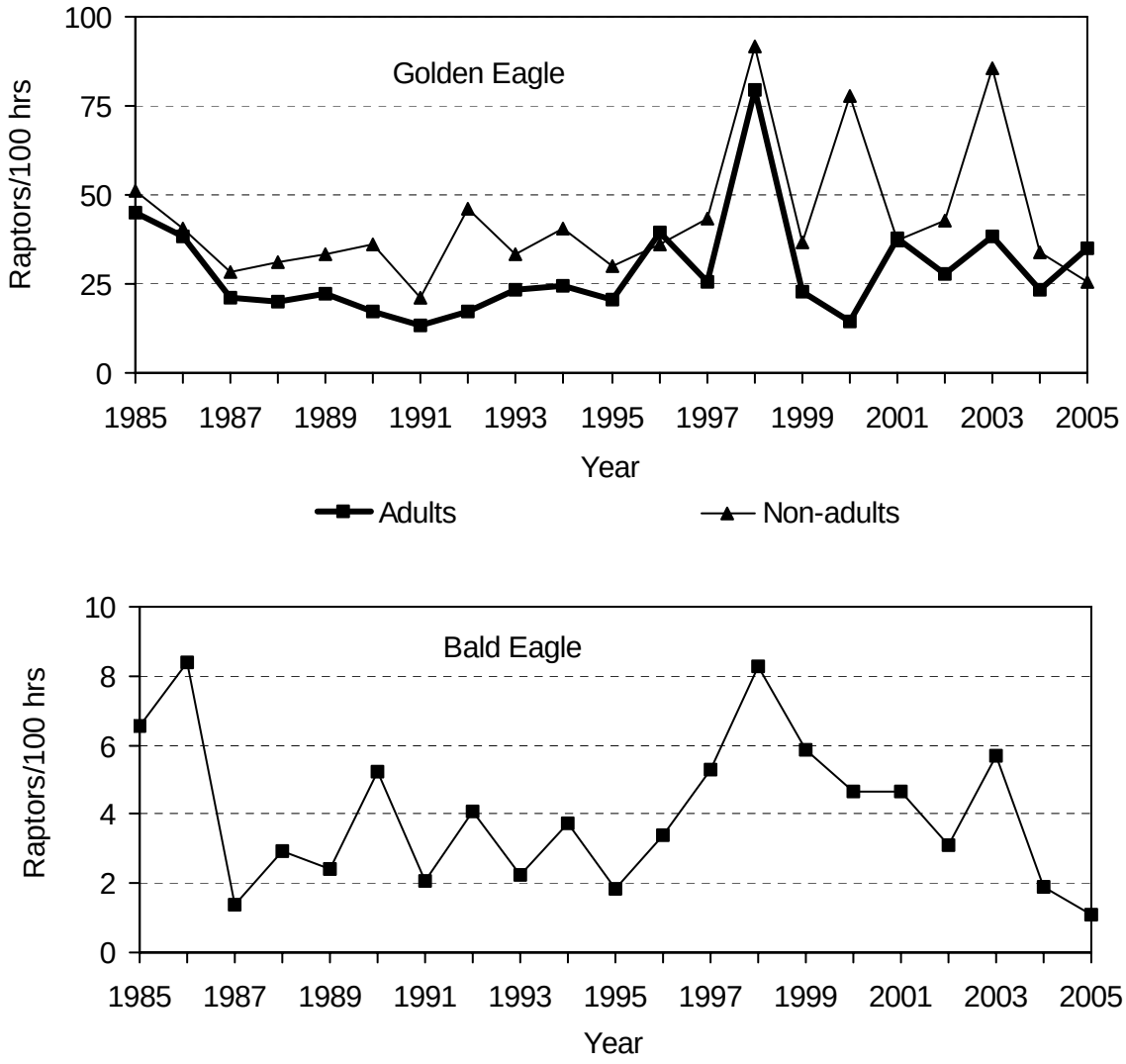

Figure 6. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) spring-migration passage rates for Golden and Bald Eagles in the Sandia Mountains, NM: 1985–2005. Dashed lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

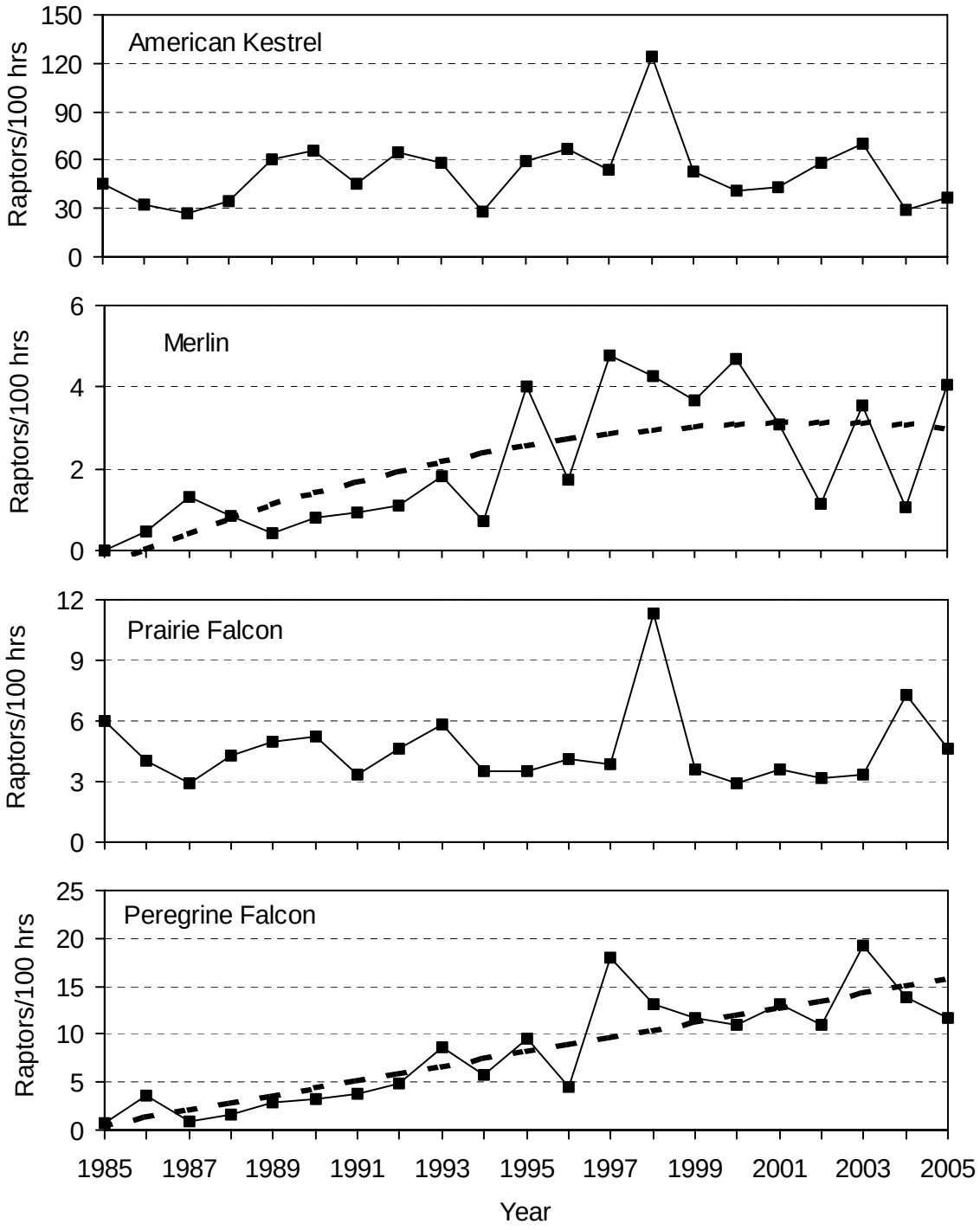

Figure 7. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) spring-migration passage rates for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons in the Sandia Mountains, NM: 1985–2005. Dashed lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

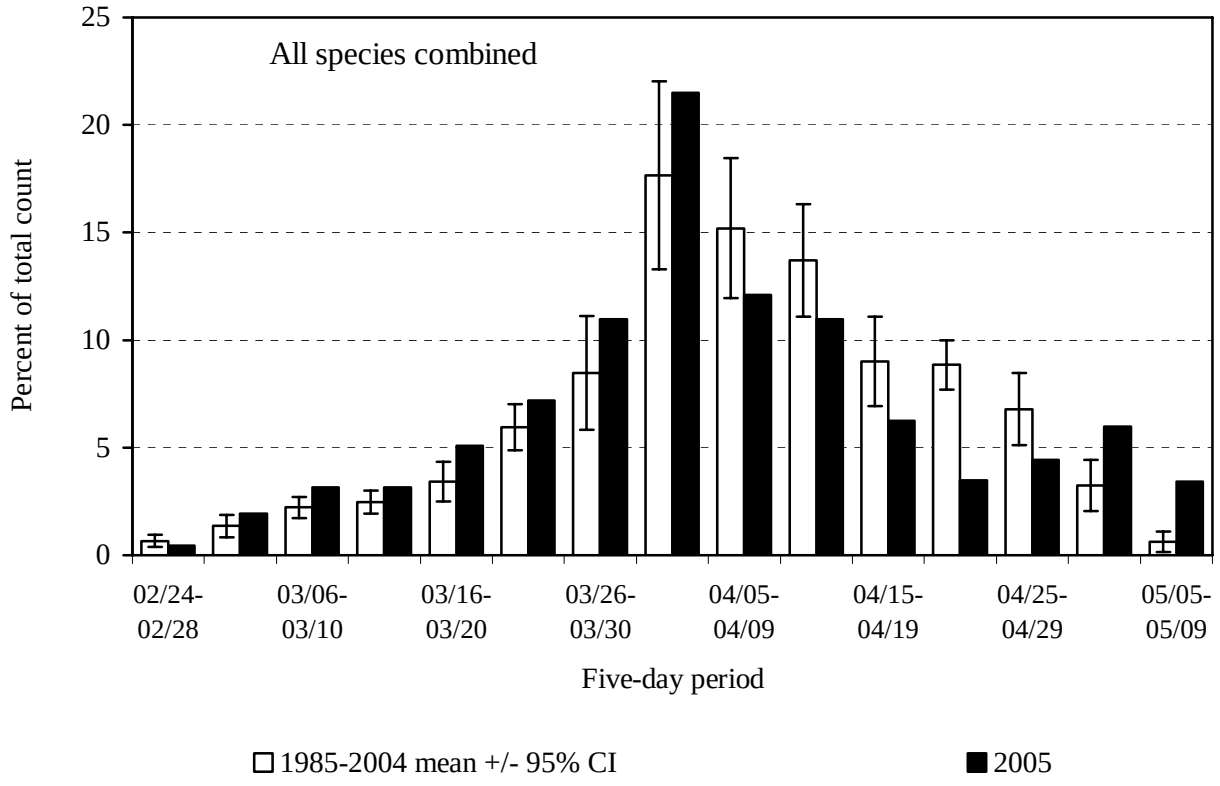

Figure 8. Combined-species, spring-migration passage volume by five-day periods for raptors in the Sandia Mountains, NM: 1985–2004 versus 2005.

Appendix A. History of official observer participation in the Sandia Mountains Raptor Migration Project: 1985–2005.

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)

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[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	*Cathartes aura*	TV	U	U	NA
Osprey	*Pandion haliaetus*	OS	U	U	NA
Northern Harrier	*Circus cyaneus*	NH	A I Br U	M F U	NA
White-tailed Kite	*Elanus caeruleus*	WK	U	U	NA
Mississippi Kite	*Ictinia mississippiensis*	MK	A I U	U	NA
Sharp-shinned Hawk	*Accipiter striatus*	SS	A I U	U	NA
Cooper's Hawk	*Accipiter cooperii*	CH	A I U	U	NA
Northern Goshawk	*Accipiter gentilis*	NG	A I U	U	NA
Unknown small accipiter	*A. striatus* or *cooperii*	SA	U	U	NA
Unknown large accipiter	*A. cooperii* or *gentilis*	LA	U	U	NA
Unknown accipiter	*Accipiter* spp.	UA	U	U	NA
Common Black-Hawk	*Buteogallus anthracinus*	CB	A I U	U	NA
Broad-winged Hawk	*Buteo platypterus*	BW	A I U	U	D L U
Swanson's Hawk	*Buteo swainsoni*	SW	U	U	D L U
Zone-tailed Hawk	*Buteo albonotus*	ZT	A I U	U	NA
Red-tailed Hawk	*Buteo jamaicensis*	RT	A I U	U	D L U
Ferruginous Hawk	*Buteo regalis*	FH	A I U	U	D L U
Rough-legged Hawk	*Buteo lagopus*	RL	U	U	D L U
Unknown buteo	*Buteo* spp.	UB	U	U	D L U
Golden Eagle	*Aquila chrysaetos*	GE	I, S, NA, A, U[4]	U	NA
Bald Eagle	*Haliaeetus leucocephalus*	BE	I, S1, S2, NA, A, U[5]	U	NA
Unknown eagle	*Aquila* or *Haliaeetus spp.*	UE	U	U	NA
American Kestrel	*Falco sparverius*	AK	U	M F U	NA
Merlin	*Falco columbarius*	ML	AM Br	AM U	NA
Prairie Falcon	*Falco mexicanus*	PR	U	U	NA
Peregrine Falcon	*Falco peregrinus*	PG	A I U	U	NA
Aplomado Falcon	*Falco femoralis*	AF	A I U	U	NA
Unknown small falcon	*F. sparverius* or *columbarius*	SF	U	U	NA
Unknown large falcon	*F. mexicanus* or *peregrinus*	LF	U	U	NA
Unknown falcon	*Falco* 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: 2005.

Date	Obs. Hours	Obsrvr / Hour[1]	Median Visitor Disturb[2]	Predominant Weather[3]	Wind Speed (kph)[1]	Wind Direction	Temp (°C)[1]	Barom. Press. (in Hg)[1]	Median Thermal Lift[4]	Visib. West (km)[1]	Visib. East (km)[1]	Median Flight Distance[5]	Birds / Hour
24-Feb	4.25	3.0	0	ovc	16.6	e-se	2.3	29.79	4	15	30	-	0.0
25-Feb	6.00	3.0	0	ovc, PM snow	20.9	se	2.4	29.90	4	8	14	-	0.0
26-Feb	8.50	3.0	0	ovc, fog	3.5	calm, sw	6.6	29.82	3	17	17	2	0.6
27-Feb	8.50	2.8	0	mc, AM haze, scat snow	8.7	wnw-nw	8.5	29.85	3	18	46	2	0.7
28-Feb	8.75	2.8	0	clr-pc, haze	15.1	w-nw	9.9	29.89	4	15	45	2	0.3
1-Mar	8.75	2.9	0	pc-ovc, scat snow	13.5	wnw-nw	7.7	29.83	4	10	35	2	0.6
2-Mar	9.25	2.7	0	clr-pc, midday haze	11.1	w-nw	10.9	29.69	3	18	55	2	1.9
3-Mar	8.00	2.0	0	pc-ovc, PM fog/snow	11.7	wsw-wnw	9.3	29.67	4	6	34	2	2.0
4-Mar	8.75	1.9	0	mc-ovc, haze	3.5	ese-se/calm	12.9	29.73	2	8	18	2	2.2
5-Mar	5.50	1.8	0	ovc, AM fog/rain	12.7	ese-se	6.9	29.82	4	8	12	2	0.4
6-Mar	2.00	1.0	0	ovc, fog/rain	5.8	se, sw	5.3	29.78	4	2	2	-	0.0
7-Mar	9.00	2.0	0	clr, haze	8.1	calm, w-nw	12.0	29.73	2	11	44	3	1.8
8-Mar	9.00	2.9	0	clr-ovc	15.4	calm/var, wnw-nw	12.0	29.68	3	12	53	2	2.2
9-Mar	9.50	2.9	0	clr	9.1	calm/se, wsw-nw	13.9	29.89	3	12	49	2	3.3
10-Mar	9.00	2.0	0	clr, AM haze	7.8	se/var, wsw-nnw	16.4	29.74	3	12	50	2	3.4
11-Mar	9.50	2.0	0	clr, haze	10.0	wnw/var, sw-w	13.3	29.92	3	14	29	2	2.8
12-Mar	10.00	2.6	1.5	clr	18.9	sw-nw	15.8	29.63	3	15	48	2	3.0
13-Mar	9.00	3.4	0	clr-ovc, PM ts	13.2	sw-nw	13.5	29.51	4	9	41	2	4.6
14-Mar	2.00	2.0	0	ovc, snow	22.3	ne-ese	1.0	29.43	4	2	2	-	0.0
15-Mar	0.00			snow									
16-Mar	4.75	2.0	0	clr, haze	19.4	w-nw	2.6	29.64	4	15	17	2	4.4
17-Mar	8.75	3.1	1.5	clr-ovc	14.5	sw	9.0	29.50	4	13	38	2	5.0
18-Mar	9.50	2.9	0	pc-ovc	17.9	sw-nw	7.6	29.48	4	9	32	2	4.4
19-Mar	9.00	3.1	0	ovc, fog/snow	3.9	sw-w	7.0	29.62	4	10	23	2	2.3
20-Mar	9.75	2.9	0	ovc, fog/haze/rain/snow	14.1	sw-nw	7.2	29.47	4	6	18	2	3.1
21-Mar	9.50	1.9	0	clr-ovc, scat snow	30.5	wnw-nw	5.0	29.46	4	8	54	2	1.9
22-Mar	9.75	2.3	1	clr-ovc	13.3	sw-wnw	8.4	29.66	4	11	46	3	5.1
23-Mar	9.25	3.1	0	mc-ovc	12.0	sw-wnw	10.9	29.42	4	8	44	2	8.8
24-Mar	9.00	1.9	1	mc-ovc	18.3	sw-nw	7.3	29.52	4	8	46	2	6.9
25-Mar	8.75	1.0	0	ovc, fog/snow	5.5	nw/calm, sw	4.7	29.52	4	4	8	3	1.5
26-Mar	2.25	1.4	0	ovc, fog/snow	16.0	sw, ese-se	2.0	29.57	4	1	2	-	0.0
27-Mar	9.75	3.2	0	clr, haze	17.8	wnw-nw	7.8	29.75	4	9	25	2	7.3
28-Mar	9.75	1.9	0	ovc	6.0	sw-w	13.8	29.51	4	7	27	4	24.8
29-Mar	9.00	1.5	0	ovc, AM fog/snow	24.6	sw-nw	3.6	29.31	4	4	19	2	1.9
30-Mar	8.25	2.0	0	ovc, haze	23.7	sw-nw	3.8	29.42	4	7	21	2	1.3
31-Mar	9.50	1.9	0	clr-ovc, PM fog/snow	10.6	sw-nw	5.1	29.70	4	7	37	2	5.4
1-Apr	10.25	3.9	0	clr, haze	7.4	sw-calm/var	8.4	30.05	4	10	43	2	20.4
2-Apr	10.50	4.4	0	clr	6.5	sw-wnw	12.8	29.82	3	10	50	2	22.1
3-Apr	10.25	3.3	1	ovc-pc, haze	5.1	sw-wsw	15.6	29.72	4	7	38	2	10.0
4-Apr	9.50	2.0	0	pc-ovc, PM haze	11.6	sw/var	16.6	29.54	4	8	32	2	7.9
5-Apr	9.00	2.0	0	clr-pc, haze	32.6	w-nw	9.0	29.69	4	6	20	2	2.0
6-Apr	10.50	2.5	0	clr-pc, haze	4.7	sw-wnw	13.4	29.99	3	8	40	2	9.9
7-Apr	10.75	2.9	0	clr-pc, haze	4.3	se-sw	16.4	29.93	3	8	40	2	9.0
8-Apr	10.17	2.9	0	ovc-clr, haze	15.8	sw/var	17.2	29.48	3	14	20	2	10.6
9-Apr	9.17	2.4	0	clr-ovc, haze	15.4	sw-wsw	13.0	29.30	4	6	33	2	5.3
10-Apr	3.00	2.0	0	ovc, snow	22.0	wsw-nw	3.8	29.30	4	3	27	2	1.0
11-Apr	9.25	2.0	0	clr	26.5	wnw-nw	6.7	29.56	4	10	49	2	3.0
12-Apr	11.00	2.3	0	clr-pc, haze	6.3	sw-wnw/var	13.6	29.78	3	8	42	2	9.8
13-Apr	11.00	2.8	0	clr-pc, haze	4.8	se/calm, sw, se	18.8	29.85	2	8	35	2	9.5

Appendix C. continued

Date	Obs. Hours	Obsrvr / Hour[1]	Median Visitor Disturb[2]	Predominant Weather[3]	Wind Speed (kph)[1]	Wind Direction	Temp (°C)[1]	Barom. Press. (in Hg)[1]	Median Thermal Lift[4]	Visib. West (km)[1]	Visib. East (km)[1]	Median Flight Distance[5]	Birds / Hour
14-Apr	9.75	1.8	0	pc-mc, haze	4.6	sw-w/calm/var	18.7	29.70	3	7	47	2	9.9
15-Apr	10.25	2.7	0	clr-mc, haze	10.2	se, sw-wnw, se	19.6	29.83	3	7	36	3	7.1
16-Apr	6.25	4.6	0	clr-ovc, haze, AM fog, PM rain	21.1	ene-se	14.1	29.94	4	4	15	2	3.4
17-Apr	7.25	3.9	1	clr-ovc, haze	4.8	sw-wsw	15.3	29.89	3	7	33	2	5.7
18-Apr	9.50	2.9	0	clr-mc, haze	5.2	sw-wsw	18.6	29.70	2	8	34	3	3.6
19-Apr	9.00	2.0	0	clr, haze	11.5	sw-w, sse	19.0	29.55	2	9	37	3	2.8
20-Apr	9.75	2.0	0	clr, haze	14.4	sw-wnw	18.2	29.66	3	9	42	2	2.3
21-Apr	8.67	1.7	0	clr, haze	19.9	wsw-nw	14.5	29.84	4	10	57	2	2.3
22-Apr	9.25	2.2	0	pc-ovc, haze	11.4	e-s/var	18.0	29.94	3	8	53	2	3.7
23-Apr	9.25	2.9	0	clr-pc, haze	11.8	e-se, sw-wsw	15.8	29.87	3	8	35	2	3.0
24-Apr	5.00	1.8	0	ovc, AM fog, PM ts/rain	7.8	sw-wnw	10.5	29.53	4	6	23	2	0.8
25-Apr	9.50	2.9	0	ovc, fog/rain/snow	19.3	w-wnw	8.4	29.52	4	5	21	2	1.2
26-Apr	10.00	2.3	0	ovc-pc, AM fog	8.9	wsw-wnw	13.5	29.71	3	9	52	2	3.2
27-Apr	10.25	2.5	0	pc-ovc	11.3	sw-wnw	14.3	29.70	4	7	50	3	5.9
28-Apr	8.50	2.0	0	ovc, haze	17.9	sw-nw	13.6	29.63	4	8	41	2	1.9
29-Apr	9.00	2.0	0	mc-ovc	20.8	wsw-nw	11.3	29.62	4	10	53	2	2.1
30-Apr	10.25	1.9	0	clr-ovc	11.3	sw-w	13.7	29.80	3	9	51	2	5.8
1-May	9.50	2.9	1.5	ovc	10.9	se, sw/var	16.8	29.78	3	7	50	2	8.1
2-May	4.50	1.0	0	ovc	30.2	ese	6.2	29.82	4	7	28	-	0.0
3-May	7.50	1.9	0	clr-ovc, haze, PM fog/rain	6.1	sw-wsw/var	13.1	29.79	3	7	26	2	3.7
4-May	9.50	1.9	0	pc-mc, haze, AM fog	12.7	wsw-wnw	13.7	29.88	3	9	30	2	2.3
5-May	9.25	1.9	0	mc-ovc, haze, PM rain	6.8	se-sw	19.7	29.87	3	7	23	2	8.5
6-May	5.25	1.0	0	pc-ovc, haze	8.6	wsw, se	18.3	29.74	3	5	25	2	4.2
7-May	4.50	1.0	0	mc-ovc	15.2	sw-nw	14.0	29.66	3	6	57	2	0.9
8-May	4.00	1.0	0	clr	23.8	wnw	12.8	29.69	4	8	60	2	0.3

[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: 2005.

		Species[1]																														Birds
Date	Hours	TV	OS	NH	WK	MK	SS	CH	NG	SA	LA	UA	BW	SW	ZT	CB	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	AF	SF	LF	UF	UU	Total	/ hour
24-Feb	4.25	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
25-Feb	6.00	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	0.0
26-Feb	8.50	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	5	0.6
27-Feb	8.50	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	6	0.7
28-Feb	8.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	3	0.3
01-Mar	8.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	5	0.6
02-Mar	9.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	14	1	0	0	0	2	0	0	0	0	0	0	18	1.9
03-Mar	8.00	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	16	2.0
04-Mar	8.75	0	0	1	0	0	1	3	0	0	0	0	0	0	0	0	8	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	19	2.2
05-Mar	5.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	2	0.4
06-Mar	2.00	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	0.0
07-Mar	9.00	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	5	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	16	1.8
08-Mar	9.00	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	9	0	0	0	7	0	0	0	0	1	0	0	0	1	0	0	20	2.2
09-Mar	9.50	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	11	0	0	2	15	0	0	0	0	0	1	0	0	0	0	0	31	3.3
10-Mar	9.00	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	4	0	0	0	21	0	0	0	0	0	0	0	0	0	0	1	31	3.4
11-Mar	9.50	0	0	0	0	0	1	3	0	0	0	1	0	0	0	0	6	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	27	2.8
12-Mar	10.00	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	7	0	0	0	20	0	0	1	1	0	0	0	0	0	0	0	30	3.0
13-Mar	9.00	6	0	4	0	0	1	1	0	0	0	0	0	0	0	0	12	0	0	0	16	0	0	0	0	0	0	0	1	0	0	0	41	4.6
14-Mar	2.00	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	0.0
15-Mar	0.00																																	
16-Mar	4.75	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	1	0	0	0	0	1	21	4.4
17-Mar	8.75	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	14	0	0	0	24	0	0	0	0	1	3	0	0	0	0	0	44	5.0
18-Mar	9.50	0	0	0	0	0	1	2	0	0	1	0	0	0	0	0	13	1	0	0	18	1	0	0	0	1	2	0	0	0	0	2	42	4.4
19-Mar	9.00	9	0	0	0	0	3	2	0	0	0	0	0	0	0	0	4	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	21	2.3
20-Mar	9.75	7	0	0	0	0	1	2	0	0	0	1	0	0	0	0	13	0	0	0	5	0	0	0	0	0	1	0	0	0	0	0	30	3.1
21-Mar	9.50	2	0	0	0	0	1	0	0	0	0	1	0	0	0	0	6	0	0	0	6	0	0	0	0	0	2	0	0	0	0	0	18	1.9
22-Mar	9.75	20	3	0	0	1	1	3	0	0	0	0	0	0	0	0	9	2	0	1	10	0	0	0	0	0	0	0	0	0	0	0	50	5.1
23-Mar	9.25	27	1	2	0	0	4	4	0	1	0	0	0	0	0	0	26	1	0	0	6	0	0	4	0	0	0	0	0	1	0	4	81	8.8
24-Mar	9.00	38	0	2	0	0	3	3	0	1	0	0	0	0	0	0	9	0	1	0	1	0	0	0	1	0	1	0	0	0	0	2	62	6.9
25-Mar	8.75	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	13	1.5
26-Mar	2.25	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
27-Mar	9.75	25	1	2	0	0	3	10	0	0	0	0	0	0	0	0	14	1	0	0	11	0	0	0	0	2	2	0	0	0	0	0	71	7.3
28-Mar	9.75	200	2	1	0	0	8	6	0	0	0	1	0	0	0	0	9	0	0	0	5	1	0	1	2	0	3	0	1	0	0	2	242	24.8
29-Mar	9.00	1	1	0	0	0	4	6	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	17	1.9
30-Mar	8.25	1	0	0	0	0	2	5	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	11	1.3
31-Mar	9.50	38	0	0	0	0	1	7	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	51	5.4
01-Apr	10.25	141	3	2	0	0	9	13	0	1	0	4	0	0	0	0	8	0	0	0	16	1	0	3	2	0	1	0	0	0	0	5	209	20.4
02-Apr	10.50	143	4	4	0	0	17	36	0	0	0	0	0	1	0	1	5	0	0	0	6	0	0	3	2	1	4	0	1	0	0	4	232	22.1
03-Apr	10.25	36	1	1	0	0	20	20	1	0	0	5	0	1	0	0	6	0	0	0	3	0	0	1	1	0	0	0	0	0	0	6	102	10.0
04-Apr	9.50	33	6	2	0	0	7	17	0	1	0	0	0	0	0	0	2	0	0	1	2	0	0	0	1	0	2	0	0	0	0	1	75	7.9
05-Apr	9.00	13	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	18	2.0
06-Apr	10.50	32	2	2	0	0	14	21	0	0	2	7	0	0	0	0	0	0	0	1	1	0	0	17	1	1	0	0	1	0	0	2	104	9.9
07-Apr	10.75	5	1	0	0	0	11	29	0	1	1	7	0	4	0	0	11	0	0	0	6	0	0	16	1	1	0	0	1	0	0	2	97	9.0
08-Apr	10.17	32	3	2	0	0	16	20	0	1	0	2	0	6	0	0	11	0	0	1	1	0	0	12	0	0	1	0	0	0	0	0	108	10.6
09-Apr	9.17	17	1	0	0	0	7	9	0	0	1	2	0	0	0	0	2	0	0	0	3	0	0	3	1	1	1	0	0	0	0	1	49	5.3

Appendix D. Daily observation effort and spring raptor migration counts by species in the Sandia Mountains, NM: 2005.

		Species[1]																														Birds
Date	Hours	TV	OS	NH	WK	MK	SS	CH	NG	SA	LA	UA	BW	SW	ZT	CB	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	AF	SF	LF	UF	UU	Total	/ hour
10-Apr	3.00	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1.0
11-Apr	9.25	4	5	1	0	0	3	8	1	0	0	2	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	28	3.0
12-Apr	11.00	11	4	5	0	0	17	30	0	1	0	2	0	4	1	0	6	0	0	0	9	0	0	12	1	0	0	0	0	0	0	5	108	9.8
13-Apr	11.00	5	1	0	0	0	17	22	0	0	1	9	0	6	1	0	6	0	0	0	4	0	0	28	0	2	2	0	0	0	0	1	105	9.5
14-Apr	9.75	6	4	4	0	0	20	25	0	0	1	3	0	13	0	0	1	0	0	2	7	0	0	3	0	2	2	0	0	0	0	4	97	9.9
15-Apr	10.25	14	0	1	0	0	10	15	0	0	0	6	0	2	0	0	6	0	0	3	2	0	0	12	0	0	0	0	0	0	0	2	73	7.1
16-Apr	6.25	1	3	1	0	0	1	4	0	1	0	0	0	2	0	0	0	0	0	2	1	0	0	1	3	0	1	0	0	0	0	0	21	3.4
17-Apr	7.25	1	2	0	0	0	8	11	0	4	0	0	0	5	0	0	2	0	0	0	4	0	0	0	0	0	4	0	0	0	0	0	41	5.7
18-Apr	9.50	4	0	0	0	0	7	11	1	1	0	2	0	2	0	0	1	0	0	0	1	0	0	4	0	0	0	0	0	0	0	0	34	3.6
19-Apr	9.00	4	1	0	0	0	10	4	0	0	0	0	0	0	1	0	1	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	25	2.8
20-Apr	9.75	2	1	0	0	0	4	3	0	0	0	2	0	3	0	0	1	0	0	0	2	0	0	1	0	0	3	0	0	0	0	0	22	2.3
21-Apr	8.67	1	3	0	0	0	5	3	0	0	0	1	0	0	0	0	1	0	0	0	4	0	0	1	0	0	0	0	0	0	0	1	20	2.3
22-Apr	9.25	3	0	2	0	0	7	6	0	1	0	0	0	0	0	0	3	0	0	1	1	0	0	7	0	1	1	0	1	0	0	0	34	3.7
23-Apr	9.25	6	0	0	0	0	6	6	0	0	0	4	0	0	0	0	1	0	0	0	3	0	0	1	0	0	0	0	0	1	0	0	28	3.0
24-Apr	5.00	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	4	0.8
25-Apr	9.50	1	0	0	0	0	5	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	11	1.2
26-Apr	10.00	2	0	0	0	0	13	9	0	0	0	0	0	0	0	0	2	1	0	0	2	0	0	1	0	0	2	0	0	0	0	0	32	3.2
27-Apr	10.25	5	0	1	0	0	28	13	1	2	0	1	0	1	0	0	2	0	0	0	2	0	0	1	0	0	2	0	0	0	0	1	60	5.9
28-Apr	8.50	0	1	0	0	0	10	1	0	0	0	1	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	16	1.9
29-Apr	9.00	0	1	0	0	0	10	4	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	19	2.1
30-Apr	10.25	0	5	1	0	0	14	12	0	3	0	0	1	2	1	0	3	0	0	0	4	0	0	7	1	0	4	0	0	0	0	1	59	5.8
01-May	9.50	8	0	0	0	0	9	21	2	6	0	1	0	0	0	0	3	0	0	0	4	0	0	17	1	0	2	0	0	0	0	3	77	8.1
02-May	4.50	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
03-May	7.50	0	1	0	0	0	10	6	1	0	0	3	0	1	0	0	0	0	0	1	2	0	0	0	0	0	1	0	0	0	0	2	28	3.7
04-May	9.50	0	0	0	0	0	6	10	0	1	0	1	0	2	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	22	2.3
05-May	9.25	3	2	2	0	0	18	19	1	14	0	6	1	7	0	0	1	0	0	0	2	0	0	2	1	0	0	0	0	0	0	0	79	8.5
06-May	5.25	0	0	0	0	0	4	6	0	1	0	2	0	4	0	0	3	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	22	4.2
07-May	4.50	0	0	0	0	0	1	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0.9
08-May	4.00	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	0	0	1	0.3
Total	611.51	921	64	44	0	1	390	486	8	44	7	82	2	66	4	1	282	6	1	16	348	4	0	163	20	21	62	0	7	3	0	58	3111	5.1

[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: 1985–2005.

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Mean
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	23-Feb	22-Feb	22-Feb	22-Feb	26-Feb	24-Feb	19-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	5-May	5-May	3-May	5-May	5-May	8-May	5-May
Days of observation	73	78	69	65	56	61	83	84	75	69	67	68	70	68	66	67	67	67	69	65	73	70
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	476.50	543.17	527.75	590.00	552.92	611.51	538.18
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	832.7	685.1	624.0	937.8	586.2	508.7	753.8
Turkey Vulture	641	814	559	1070	1380	1322	1246	1785	1327	1463	1217	1552	2531	3245	1427	1305	1328	1227	2128	1285	921	1419
Osprey	27	24	39	38	64	38	34	70	100	67	71	62	103	138	67	76	81	38	79	77	64	65
Northern Harrier	55	59	42	71	72	50	46	85	75	46	35	55	47	94	62	56	52	55	59	55	44	58
White-tailed Kite	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Mississippi Kite	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	<1
TOTAL KITES	0	0	2	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	<1
Sharp-shinned Hawk	473	476	435	498	664	283	294	807	428	280	448	905	1280	772	386	391	311	337	459	372	390	508
Cooper's Hawk	454	709	521	498	1277	620	718	1050	1562	956	771	655	836	1157	670	922	556	506	797	561	486	772
Northern Goshawk	22	14	14	4	6	10	7	12	24	12	16	5	18	12	3	2	9	7	31	12	8	12
Unknown small accipiter[1]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0	8	6	2	44	12
Unknown large accipiter[1]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	1	5	7	3
Unknown accipiter	90	56	88	70	123	65	59	201	95	55	61	73	70	5	30	96	90	16	3	6	82	68
TOTAL ACCIPITERS	1039	1255	1058	1070	2070	978	1078	2070	2109	1303	1296	1638	2204	1946	1089	1411	967	875	1297	958	1017	1364
Common Black-Hawk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	<1
Broad-winged Hawk	1	1	0	2	5	2	2	6	7	4	7	7	19	20	2	19	3	4	12	4	2	6
Swainson's Hawk	47	32	41	43	38	40	42	60	52	30	50	61	59	114	45	50	43	54	111	62	66	54
Zone-tailed Hawk	1	2	0	3	5	4	2	3	1	0	0	0	3	2	2	10	1	3	3	0	4	2
Red-tailed Hawk	280	241	183	182	357	289	353	390	461	325	377	356	338	662	220	353	451	321	663	224	282	348
Ferruginous Hawk	11	8	11	13	9	18	16	12	11	12	20	17	11	23	7	11	12	7	17	5	6	12
Rough-legged Hawk	0	2	0	1	1	0	0	0	1	0	0	0	0	1	0	1	0	1	2	0	1	1
Unidentified buteo	6	4	10	9	40	3	15	32	5	5	14	9	6	2	15	21	10	1	3	14	16	11
TOTAL BUTEOS	346	290	245	253	455	356	430	503	538	376	468	450	436	824	291	465	520	391	811	309	378	435
Golden Eagle	441	432	213	205	255	218	198	338	300	310	255	441	352	897	304	417	391	366	689	307	348	366
Bald Eagle	20	37	5	7	7	13	18	17	9	12	7	14	22	27	18	13	18	12	23	6	4	15
Unidentified Eagle	4	0	0	1	0	0	4	2	0	0	0	0	0	0	2	0	1	0	0	0	0	1
TOTAL EAGLES	465	469	218	213	262	231	220	357	309	322	262	455	374	924	324	430	410	378	712	313	352	382
American Kestrel	147	127	96	118	225	209	182	275	250	112	226	308	233	497	198	143	165	205	299	128	163	205
Merlin	0	2	5	3	2	3	4	5	9	3	18	10	24	19	15	19	14	5	17	5	20	10
Prairie Falcon	29	27	17	16	23	21	21	28	33	16	17	23	19	59	18	13	20	16	20	35	21	24
Peregrine Falcon	5	18	6	7	13	13	20	25	47	26	47	27	91	72	56	49	64	52	105	73	62	42
Aplomado Falcon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	<1
Unknown small falcon[1]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0	0	0	7	1
Unknown large falcon[1]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0	0	3	3	1
Unknown falcon	2	0	5	2	5	2	5	3	3	0	0	1	7	1	4	0	6	2	0	0	0	2
TOTAL FALCONS	183	174	129	146	268	248	232	336	342	157	308	369	374	648	291	225	269	280	441	244	276	283
Unidentified raptor	44	27	54	45	82	65	45	142	29	28	53	30	14	7	10	0	94	49	6	0	58	42
ALL SPECIES	2800	3112	2346	2906	4653	3288	3331	5348	4830	3762	3710	4611	6084	7826	3561	3968	3721	3293	5533	3241	3111	4047

[1] Designations used regularly for the first time in 2002.