FALL 2000 RAPTOR MIGRATION STUDIES IN THE MANZANO MOUNTAINS OF CENTRAL NEW MEXICO

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INTRODUCTION

The Manzano Mountains raptor migration study in 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. in review). HawkWatch International (HWI) initiated standardized counts of the autumn raptor migration through this region in 1985, and began an extensive trapping and banding program at the project site in 1990. To date, HWI observers have recorded 18 species of migratory raptors at the site, with counts typically ranging between 4,000 and 7,000 migrants per season. The 2000 season marked the 16th consecutive count and the 11th consecutive season of trapping and banding conducted at the site by HWI. This report summarizes the 2000 count and banding results.

The Manzano project was 1 of 15 long-term, annual migration counts (12 fall, 3 spring) and 1 of 7 migration banding studies (6 fall, 1 spring) conducted or sponsored by HWI in North America during 2000. The primary objective of these efforts is to track long-term population trends of diurnal raptors throughout primarily western North America (see Smith and Hoffman 2000 for a comprehensive review of raptor migration monitoring in western North America). Raptors feed atop food pyramids, inhabit most ecosystems, occupy large home ranges, and are sensitive to environmental contamination and other human disturbances. Therefore, they serve as important biological indicators of ecosystem health (Cade et al. 1988; Bednarz et al. 1990a; Bildstein and Zalles 1995). Moreover, due to the remoteness and widespread distribution of most raptor populations, migration counts likely represent the most cost-effective and efficient method for monitoring the regional status and trends of multiple raptor species (Bednarz and Kerlinger 1989, Titus et al. 1989, Bildstein and Zalles 1995, Bildstein et al. 1995, Dunn and Hussell 1995, Dixon et al. 1998, Smith and Hoffman 2000).

The intensive counting and banding operations also provide valuable information about breeding and wintering distributions, migratory routes, migratory behavior, population demographics, mortality factors and longevity, morphometric variation, molt sequences and timing, and health assessments. This information enables us to better understand the life histories, ecology, status, and conservation needs of raptor populations in North America. In addition, these migration studies offer unique opportunities for the public to learn about raptors and the natural environment, and providing such opportunities is another important component of HWI's mission. Accordingly, since 1995 the Manzano field crew has included a trained educator dedicated to conducting environmental education programs at the site and facilitating interactions between visitors and the field biologists.

STUDY SITE

The project site is located in the Manzano Wilderness Area of the Cibola National Forest (Manzano Ranger District) near Capilla Peak, approximately 56 km south-southeast of Interstate 40 (34°42.25' N, 106°24.67' W; Figure 1). The primary observation post is located at an elevation of 2,805 m (9,195 ft) on a northwest-southeast facing outcrop of a limestone ridge. It is reached by walking up a 1.2 km trail from the main road leading up to Capilla Peak (FS 522). The predominant vegetation on the slopes of the ridge consists of Gambel oak (Q*uercus gambelli*), Douglas-fir (*Pseudotsuga menziesii*), White fir (*Abies concolor*), Ponderosa pine (*Pinus ponderosa*), Pinyon pine (*Pinus edulis*), New Mexico locust (*Robinia neomexicana*), and Bigtooth maple (*Acer grandidentatum*).

Three banding stations are distributed around the observation point within 0.25–1.5 km (Figure 1). **North** station, which has been operated full-time since 1990, is located 100 m east and 50 m north of the observation point at an elevation of 2,790 m. **South** station, which has been operated part to full-time since 1991, is located 1.4 km south of the observation point at an elevation of 2,745 m. **West** station,

which has seen full-time operation since 1991, is located 0.5 km southwest of the observation point at an elevation of 2,684 m.

Many factors make the Manzano Lookout well suited for observing consistent flights of migrating raptors during fall. Several mountain ranges to the north serve as leading lines (Mueller and Berger 1967), funneling raptors into the Manzanos. The Manzano Mountains also are a relatively narrow and well-defined north–south range, which creates beneficial updrafts and serves as a distinct flight path for migrating raptors. The Capilla Peak site provides an excellent source of thermal lift, with two other peaks located 10–15 km north of the observation site also attracting southbound migrants that benefit from strong ridge updrafts. The concentration effect of the Manzano range is further enhanced by the absence of parallel ranges nearby to serve as alternate flight paths.

METHODS

STANDARDIZED COUNTS

Two official observers, relieved or supplemented by other trained volunteers, conducted standardized daily counts of migrating raptors from a single, traditional observation site. Both official observers had one previous full-season of experience counting migratory raptors (see Appendix A for a complete history of observer participation). Visitors also frequently assisted with spotting migrants. Weather permitting, observations typically began by 0900 hrs Mountain Standard Time (MST) and ended by 1700 hrs MST.

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), 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 mean number of observers (official observers plus visitors who actively scanned for migrants for more than 10 minutes in a given hour) and visitors (all other guests) present during each hour.
6. Daily start and end times for each official observer.

The observers used high-quality 8–10x binoculars to assist in spotting and identifying birds. Clark and Wheeler (1987), Dunne et al. (1988), and Wheeler and Clark (1995) served as primary identification references. Assessments of wind speed, cloud type, cloud cover, and flight altitude followed guidelines published by the Hawk Migration Association of North America (HMANA). Assessments of thermal lift conditions as poor, fair, good, or excellent involved subjective evaluations of solar intensity, wind speed, and migrant behavior.

The observers classified as residents and excluded from daily counts any raptor that exhibited hunting, territorial display, or perching behaviors for extended periods. The observers occasionally recorded as

migrants birds that were not moving in a southerly direction, if such birds otherwise displayed migrant characteristics; i.e., continuous flight without stopping or substantially changing directions for several kilometers. Such birds may be dispersing juveniles or adults dispersing relatively short-distances from their nesting territories to favored wintering grounds in the same general region. However, we also know from recent satellite telemetry work that species such as Prairie Falcons and Ferruginous Hawks frequently "migrate" in non-standard directions to take advantage of favored post-breeding and wintering grounds (Watson and Pierce 2000, K. Steenhof personal communication).

The North trapping station lies a short distance in front of the count site. The observers identified and recorded all birds they saw trapped at North. To avoid double counting of trapped and released birds, the North banders used two-way radios to call observation upon release of a raptor to help the observers identify and avoid double-counting released raptors. In contrast, birds responding to the South and West trapping operations were largely ignored, except that birds trapped at these stations which the observers clearly had not seen were occasionally added to the count.

For purposes of examining long-term variation in annual counts, I manipulated the count data to standardize sampling periods and adjust for daily variation in observation effort and observer numbers. The seasonal effort and daily duration of observations can greatly affect count statistics (Hussell 1985, Kerlinger 1989, Bednarz et al. 1990b), and both have varied in the Manzanos during the course of the study, particularly during the first several years of observations. To standardize seasonal sampling effort, I defined a consistent annual sample period following conventions proposed by Bednarz and Kerlinger (1989) and Bednarz et al. (1990b). Specifically, I converted counts to passage rates on a daily basis (raptors/10 hours of observation) to adjust for daily variation in sampling effort. I then summed daily rates by Julian date across all years, and defined standardized passage periods for each species as the period during which 95% of migrants passed, eliminating approximately 2.5% from each extreme of the cumulative passage rate distributions. Because entire count days must be either included or excluded, the defined sample period for a given species often included >95% of the detected number of migrants. For some species, the sample periods defined in this way encompassed dates earlier or later than mean starting and ending dates for observations. In these cases, I further restricted the adjusted sample periods to between mean starting and ending dates for 1985–1999: 26 August – 2 November.

Recent analyses (HWI unpublished data; manuscript in preparation) suggested that passage rates documented at this site through 1999 increased significantly when the daily-average number of observers increased to two or more (observers included official and designated counters, plus qualified visitors that actively participated for more than 10 minutes in a given hour). Before 1989, a single official observer conducted all counts; thereafter, HWI implemented a standard system of two official observers. Designated observers and qualified visitors have participated in the counts throughout the study. I applied correction factors derived from these analyses to adjust for variation in observer numbers before examining patterns in the data.

After standardizing sample periods and adjusting daily counts for observer numbers (henceforth called "adjusted" counts), I calculated "adjusted" annual passage rates for each species (adjusted total count / total hours of observation for a given year * 100 = raptors/100 hrs). Using passage rates rather than counts as the index for analysis avoids potential biases caused by variation in sampling effort due to inclement weather and other unforeseeable events.

I also recently completed a comprehensive analysis of long-term trends in counts from HWI's four longest-term migration sites, including the Manzanos (HWI unpublished data—manuscript in preparation). For the Manzanos, the analyses involved linear and quadratic regressions examining trends in annual passage rates between 1985 and 1999. Reference to significant trends indicates $P \leq 0.05$.

I also compare 2000 annual statistics against means ± 95% confidence intervals (CI) for previous seasons. Here, I equate significance with a 2000 value falling outside of the 95% CI for the associated

mean. I limit most comparisons of age and sex statistics to 2000 values versus means for 1992–1999, because pre-1992 class data have not yet been computerized.

TRAPPING AND BANDING

Rotating crews of 1–3 trappers and processors operated each trapping station, with crew size depending on trapper experience levels, characteristics of the station, and the flight volume. The crews generally trapped between 0800–0900 and 1600–1700 hrs MST. Capture devices included mist nets, remotely triggered standard bow nets (Meng 1963, Austing 1964), remotely triggered surge bow nets, and dho-gaza nets (Clark 1971). Each banding station typically operates 3–5 bow nets, 1 surge bow net, 2–4 dho-gazas, and 1–2 mist nets. Trappers lure migrating raptors into the capture stations from camouflaged blinds using live, non-native Rock Doves (*Columba livia*; hereafter called pigeons), Ringed Turtle-doves (*Streptopelia risoria*), and House Sparrows (*Passer domesticus*) attached to lure lines manipulated from the blinds. Unless already banded, all captured birds were fitted with a uniquely numbered USGS Biological Resources Division aluminum leg band. Processors identified species, subspecies, sexes, and ages using morphological characteristics described in the U.S. Bird Banding Laboratory (BBL) Manual, Clark and Wheeler (1985), Wheeler and Clark (1995), and Hoffman et al. (1990). Processors also recorded a series of standard morphometric, health, and molt data for each bird. Unless chosen to be outfitted for satellite telemetry, all birds were released within 45 minutes from the time of capture.

RESULTS AND DISCUSSION

WEATHER

The 2000 fall season featured an unusually high proportion of days hampered by inclement weather (see Appendix C for daily weather summaries). Excessive fog, rain, and snow precluded 14 entire days of observation (including forcing closure of the season three days earlier than usual on 2 November), restricted observations to less than five hours on another six days, and hampered observations on another 13 days. Most of the problematic weather occurred in October and November. In the end, the number of days and hours of observation ranked the lowest since the first year of the study (Appendix D). Compared to the last three years, 2000 also featured high proportions of days with at least moderate winds (>12 kph) and with southeasterly to southwesterly winds, and relatively fewer days with west to northwest winds.

OBSERVATION EFFORT

The observers worked on 57 of 71 possible days between 27 August and 5 November (Table 1). The number of observation days and hours (434.33) are both significantly lower than average (11% and 14%, respectively) due to inclement weather. The 2000 average of 2.1 observers per hour (including official and guest observers; value is mean of daily values, which are in turn means of hourly values) is 7% lower than average, but the difference is not significant (1985–1999 mean = 2.2 ± 95% CI of 0.22 observers/hr).

FLIGHT SUMMARY

The observers counted 4,307 migrant raptors of 17 species during the 2000 season (see Appendix D for daily count records and Appendix E for annual summaries). Counts reached record highs for Northern

Goshawk (42) and Zone-tailed Hawk (3), but reached record or near-record lows for Northern Harrier (38), Swainson's Hawk (19), Ferruginous Hawk (3), and American Kestrel (397) (Appendix E).

The number of observers averaged slightly lower than the long-term mean; however, the adjustments to standardize for two observers throughout the season reduced the raw counts overall (compare values in Table 1 and Appendix E) because the number of observers exceeded two on several peak migration days.

Based on adjusted counts, the 2000 flight was composed of 64% accipiters, 15% buteos, 12% falcons, 5% vultures, 3% eagles, 1% harriers, and <1% Ospreys and unidentified raptors. The 2000 season featured a higher than average proportion of accipiters and lower than average proportions of buteos, vultures, and harriers (Figure 2). As usual, Sharp-shinned and Cooper's Hawks were the two most abundant species, followed by Red-tailed Hawks and American Kestrels (Table 1, Appendix E).

Adjusted passage rates were significantly higher than average for 8 of 18 species seen this season (Sharp-shinned Hawk, Cooper's Hawk, Northern Goshawk, Zone-tailed Hawk, Bald Eagle, Merlin, Prairie Falcon, and Peregrine Falcon), significantly lower than average for 5 species (Turkey Vulture, Northern Harrier, Broad-winged Hawk, Ferruginous Hawk, and American Kestrel), and not significantly different from average for the remaining 5 species (Osprey, Golden Eagle, and Swainson's, Red-tailed and Rough-legged Hawks; Table 1, Figures 3-8). It is important to note here that the significantly lower than average number of observation hours may have led to inflated passage rates. Cooper's Hawks, Bald Eagles, and Merlins showed higher than average counts and passage rates, but only the passage rate difference was statistically significant, suggesting that the indication of a high passage rate may be the spurious result of lower overall effort. Otherwise, the adjusted counts and passage rates suggested similar conclusions. It is noteworthy that, despite near-record low observation effort due to the high prevalence of inclement weather, only a few species showed significantly lower than average counts and passage rates. This is consistent with the results of analyses by Allen et al. (1996), which showed that annual variation in the frequency of cold fronts can dramatically affect within-season flight patterns, but did not appear to influence variation in annual counts at Hawk Mountain in Pennsylvania.

The 1985–1999 regression analyses showed significant linear increasing trends in passage rates for Turkey Vulture, Osprey, Swainson's Hawk, Merlin, Prairie Falcon, and Peregrine Falcon; a significant linear decreasing trend for Ferruginous Hawk; a significant quadratic trend for Red-tailed Hawk, with an accelerating increasing trend evident since 1991; and no distinct long-term trends for all other species. Low to moderate passage rates in 1999 and 2000 temper indications of increasing trends for Turkey Vulture, Osprey, Swainson's Hawk, and Red-tailed Hawk (Figures 1, 3, 4). In contrast, although passage rates also dropped in 1999 and 2000 for Merlin, Prairie Falcon, and Peregrine Falcon, relatively strong increasing trends are still indicated for these species (Figure 8). Similarly, the record low passage rate for Ferruginous Hawks in 2000 continues to emphasize a steep declining trend for this species (Figure 4). In addition, both Sharp-shinned and Cooper's Hawks have shown increasing trends since 1990, when passage rates for both species dropped to record lows, and the 2000 season extended the recovery trend for both species (Figure 2). It is also noteworthy that the adjusted passage rate for Northern Goshawks—a species of conservation concern—reached a record high this season due to elevated numbers of both immature and adult birds (Figure 2).

Sharp-shinned, Cooper's and Red-tailed Hawks showed significantly higher than average immature : adult ratios, and in all cases the increase was at least partly due to higher than average numbers of immature birds, suggesting that productivity was relatively high for these species in the Rocky Mountains during 2000 (Table 2). Thus, high juvenile recruitment is one possible explanation for the higher than average passage rates of Sharp-shinned and Cooper's Hawks; however, this factor does not help explain the high passage rates of Northern Goshawks, Bald Eagles, and Peregrine Falcons, which all showed average to below average age ratios (Table 2). Slightly below average age ratios could have contributed to the significantly below average passage rates for Northern Harriers and Broad-winged Hawks.

However, it is important to note that all age-specific comparisons, except those for Golden and Bald Eagles, are confounded by significant variation in the proportions of birds classified by age (Table 2), and so must be considered with caution.

There were no distinct multi-species patterns of variation in seasonal timing in 2000 (Tables 3), other than common adjustments in timing within October related to birds' passing through between storms (Figure 9).

RESIDENT AND NON-SOUTHBOUND RAPTORS

This season, local birds included a pair of Prairie Falcons, a pair of Golden Eagles, and at least one pair of local Red-tailed Hawks that are probably permanent residents. In addition, the offspring of at least one family of Sharp-shinned Hawks were seen regularly around the project site until early September; one local male kestrel was seen in late August; and one immature Peregrine Falcon was seen hunting in the area in early September.

The observers recorded only one Golden Eagle as a northbound migrant this season.

TRAPPING EFFORT

The crews operated at least one banding station on 50 of 56 days between 2 September and 27 October, with effort totaling 119 station days and 791 stations hours (see Appendix F for daily trapping records in 2000 and Appendix G for annual summaries). These effort values rank low to moderate for the study (Appendix G).

TRAPPING AND BANDING SUMMARY

The 2000 capture total of 963 birds included 10 species, 960 newly banded birds, and 3 recaptures of birds previously banded in the Manzanos (Table 4, Appendix G). The 2000 effort raises the total number of birds captured since project inception to 10,915, including 20 recaptures of Manzano-banded birds and 17 foreign recaptures (i.e., birds originally banded elsewhere and subsequently recaptured in the Manzanos; Appendix G). Sharp-shinned and Cooper's Hawks accounted for 51% and 34% of the total captures, respectively, followed by Red-tailed Hawks (8%), American Kestrels (3%), and Northern Goshawks (2%). Each of the remaining five species accounted for less than 1% of the total.

The 2000 combined-species capture total, capture rate, and capture success were all within 15% and not significantly different from the relevant long-term means; however, examination of species-specific data indicated several noteworthy variations (Table 4). Capture success was particularly high for Northern Harriers, suggesting that the few harriers seen this year were unusually vulnerable to capture. Both the capture total and rate were particularly high for Northern Goshawks, but capture success remained about average, indicating that the capture rate simply kept pace with elevated abundance. All measures of efficiency, but especially capture rate and success, were higher than average for Red-tailed Hawks and Merlins. Given a slightly below average count, these statistics suggest that both trapper efficiency and species vulnerability were higher than average this season for red-tails. In contrast, the increases for Merlin partly reflect higher counts, but high capture success indicates that trapper efficiency and/or species vulnerability also were higher than average. The capture rate for Golden Eagles was high, despite an average capture total and success, suggesting that trapper efficiency was high for this species. Lastly, despite elevated counts for both species, capture success was low for Prairie Falcons and all measures of capture efficiency were low for Peregrine Falcons, suggesting that the large falcons were less susceptible to capture this season (Table 4).

Compared to the counts, banding yields unique and substantial sex–age specific data only for Sharp-shinned Hawks, Cooper's Hawks, and American Kestrels. The 2000 and long-term average immature : adult capture ratios for Sharp-shinned and Cooper's Hawk (Table 5) show the same patterns as the age ratios derived from the count data (Table 2; significantly higher than average in 2000), whereas the capture data indicate that sex ratios for these two species were slightly but not significantly below average in 2000 (Table 5). These data provide additional support for the contention that productivity was generally good for the smaller accipiters in 2000. In contrast, for American Kestrels, both the immature : adult and female : male ratios were significantly below average (Table 5; count data also indicated a 30% below average sex ratio), suggesting that this species experienced poor productivity during 2000 with survival of young females particularly low.

ENCOUNTERS WITH PREVIOUSLY BANDED BIRDS

Recaptures—The 2000 captures included three recaptures of birds originally banded in the Manzanos (Table 6), which brings the total number of Manzano recaptures since 1990 to 20 birds (Appendix G). The 2000 recaptures included 2 Sharp-shinned Hawks and 1 Cooper's Hawk, all originally banded as hatch-year birds in 1998.

Foreign Encounters—Six raptors originally banded in the Manzanos were encountered elsewhere in 2000 (Table 7), which brings the total foreign encounters since 1990 to 65 birds (Appendix G). One female Cooper's Hawk was recaptured and released during its northbound (spring) migration at the HWI Sandia site two years after being banded as an adult bird in the Manzanos. This brings the total number of exchanges between the two projects to 31 birds, which is strong testimony to the fact that the two sites lie along the same flyway and that both inter-season and inter-annual flyway fidelity are high. Three other Manzano-banded Cooper's Hawks were recovered dead during 2000, two in New Mexico and one in southwestern Mexico. The female bird found dead near Chama, New Mexico in June 2000 was particularly noteworthy, having reached at least nine years old. According to BBL records, the oldest wild Cooper's Hawk documented through banding reached an age of 12 years and 9 months (a bird banded by HWI in 1981 in the Goshute Mountains, Nevada). One Sharp-shinned Hawk and one Northern Goshawk also were recovered in 2000, one and two years after banding, respectively. The goshawk recovery is especially noteworthy because it is the first foreign encounter ever documented for a goshawk banded in the Manzanos. It discovery dead of unknown causes 8 months after banding just 28 miles north of the project site suggests that the bird was of local origin.

SITE VISITATION

For the fifth consecutive year, the 2000 Manzano field crew included a full-time on-site educator. The educator welcomed people to the site, answered questions about HWI scientific and education projects, made presentations on raptor biology, and assisted visitors in spotting and identifying migrant raptors. Highlights for visitors are usually the opportunity to see hawks up-close. Educators often retrieve banded birds before release and show them to visitors.

Overall, the visitation level in 2000 was 15–20% lower than the 1992–1999 average, largely because of the effects of inclement weather and an attendant reduction in group field trips. However, the hourly visitation rate during active observations actually averaged 15% higher than the long-term mean, indicating that visitation was good when the weather cooperated. Moreover, despite the reduction in overall activity, our visitor logs still recorded 588 individual visits to the site, with visitors originating in 15 states. Aside from individuals and families, six education and community groups (school children and scout groups), ranging in size from 3 to 25 people, made their way up to the site for organized field trips. A new USDA Forest Service Conservation Education Grant helped fund participation of two of these groups. Interacting with visitors, affording them an opportunity to experience field research first hand,

and instilling in them a passion for raptors is one of the most rewarding aspects of HWI's migration projects. It is therefore very gratifying to see the proportion of repeat visitors grow each year.

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Table 1. Observation effort and adjusted annual counts and passage rates by species: 1985–1999 versus 2000.

	1985–1999[1]	2000	% CHANGE	1985–1999[1]	2000	% CHANGE
Start date	26-Aug ± 1.6	27-Aug				
End date	2-Nov ± 1.3	2-Nov				
Observation days	64 ± 2.7	57	-11			
Observation hours	502.65 ± 29.123	434.33	-14			
SPECIES	COUNTS			RAPTORS / 100 HRS		
Turkey Vulture	420 ± 135.1	213	-49	132 ± 38.8	69	-48
Osprey	25 ± 6.5	25	-2	8 ± 1.8	8	+6
Northern Harrier	64 ± 12.6	38	-41	13 ± 2.3	9	-32
Sharp-shinned Hawk	1338 ± 204.3	1544	+15	332 ± 49.0	444	+33
Cooper's Hawk	827 ± 128.6	904	+9	239 ± 31.4	294	+23
Northern Goshawk	14 ± 3.9	41	+195	3.2 ± 1.00	10.5	+234
Unidentified accipiter	99 ± 20.9	28	-72	29 ± 6.4	9	-69
TOTAL ACCIPITERS	2278 ± 303.1	2517	+10	508 ± 63.2	653	+28
Broad-winged Hawk	6 ± 1.8	3	-46	2.0 ± 0.61	1.2	-38
Swainson's Hawk	608 ± 836.0	11	-98	227 ± 310.3	4	-98
Red-tailed Hawk	609 ± 84.4	561	-8	136 ± 17.4	146	+7
Ferruginous Hawk	14 ± 2.6	3	-79	3.1 ± 0.58	0.8	-76
Rough-legged Hawk	0.2 ± 0.22	0	-100	0.04 ± 0.044	0.00	-100
Zone-tailed Hawk	0.5 ± 0.37	3	+555	0.1 ± 0.07	0.7	+704
Unidentified buteo	15 ± 4.6	2	-87	3.4 ± 1.07	0.5	-85
TOTAL BUTEOS	1252 ± 841.7	580	-54	258 ± 178.6	134	-48
Golden Eagle	117 ± 16.5	111	-5	26 ± 4.1	28	+8
Bald Eagle	4 ± 1.4	5	+42	0.7 ± 0.27	1.2	+64
Unidentified Eagle	0.6 ± 0.74	1	+81	0.1 ± 0.16	0.2	+107
TOTAL EAGLES	121 ± 16.4	117	-3	25 ± 3.99	27	+8
American Kestrel	497 ± 53.2	358	-28	142 ± 16.5	112	-21
Merlin	23 ± 7.4	26	+11	6 ± 1.9	8	+33
Prairie Falcon	18 ± 5.4	28	+53	4 ± 1.1	7	+73
Peregrine Falcon	32 ± 13.7	46	+42	8 ± 3.0	12	+55
Unidentified falcon	2 ± 1.1	1	-37	0.4 ± 0.28	0.3	-26
TOTAL FALCONS	572 ± 65.5	459	-20	130 ± 15.2	116	-11
Unidentified raptor	41 ± 15.5	3	-93	11 ± 3.8	1	-91
GRAND TOTAL	4775 ± 997.5	3955	-17	974 ± 204.3	911	-7

[1] Mean ± 95% confidence interval (CI).

Table 2. Adjusted counts by age class and immature : adult ratios for selected species: 1992–1999 versus 2000.

	Total and Age-classified Counts								Immature : Adult Ratio	
	1992–1999 Average			2000			% Unknown Age			
	Total	Imm.	Adult	Total	Imm.	Adult	1992–1999[1]	2000	1992–1999[1]	2000
Northern Harrier	74	40	17	38	23	12	24 ± 6.6	8	2.4 ± 0.75	1.9
Sharp-shinned Hawk	1414	539	670	1544	844	644	15 ± 3.4	4	0.8 ± 0.18	1.3
Cooper's Hawk	933	333	458	904	475	398	16 ± 3.6	3	0.7 ± 0.15	1.2
Northern Goshawk[2]	14	6	6	41	19	18	19 ± 9.4	8	1.1 ± 0.43	1.1
Broad-winged Hawk	6	1	3	3	0	1	34 ± 26.9	67	0.1 ± 0.14	0.0
Red-tailed Hawk	696	240	371	561	262	273	12 ± 2.4	5	0.7 ± 0.17	1.0
Ferruginous Hawk	12	4	3	3	1	0	39 ± 15.5	67	1.9 ± 1.27	≥1
Golden Eagle[2]	117	67	32	111	67	32	15 ± 5.2	11	2.6 ± 0.74	2.1
Bald Eagle	4	3	1	5	3	2	7 ± 14.3	0	3.3 ± 2.53	1.5
Peregrine Falcon	50	15	20	45.7	14	26	24 ± 19.3	12	1.0 ± 0.73	0.5

[1] Mean ± 95% CI. 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 average numbers of immatures and adults. Discrepancies in the two values reflect high annual variability in the observed age ratio.

[2] Long-term averages cover the entire study period: 1985–1999.

Table 3. Observation-range, bulk passage, and median passage dates by species for 2000, with comparisons of 2000 and 1985–1999 average median passage dates.

Species	2000				1985–1999
	First Observed	Last Observed	Bulk Passage Dates[1]	Median Passage Date[2]	Median Passage Date[2,3]
Turkey Vulture	27-Aug	16-Oct	1-Sep – 6-Oct	9-Sep	15-Sep ± 3.1
Osprey	1-Sep	6-Oct	21-Sep – 6-Oct	22-Sep	17-Sep ± 1.7
Northern Harrier	30-Aug	26-Oct	8-Sep – 19-Oct	1-Oct	2-Oct ± 2.1
Sharp-shinned Hawk	27-Aug	2-Nov	11-Sep – 15-Oct	25-Sep	29-Sep ± 1.5
Cooper's Hawk	28-Aug	27-Oct	10-Sep – 6-Oct	23-Sep	26-Sep ± 1.5
Northern Goshawk	3-Sep	26-Oct	14-Sep – 19-Oct	14-Oct	3-Oct ± 5.7
Broad-winged Hawk	16-Sep	23-Sep	16-Sep – 23-Sep	–	26-Sep ± 4.2
Swainson's Hawk	31-Aug	18-Oct	1-Sep – 5-Oct	16-Sep	20-Sep ± 4.1
Red-tailed Hawk	27-Aug	2-Nov	10-Sep – 20-Oct	1-Oct	3-Oct ± 2.6
Ferruginous Hawk	15-Oct	18-Oct	15-Oct – 18-Oct	–	3-Oct ± 5.0
Zone-tailed Hawk	21-Sep	22-Sep	21-Sep – 22-Sep	–	–
Golden Eagle	31-Aug	2-Nov	27-Sep – 27-Oct	14-Oct	13-Oct ± 2.1
Bald Eagle	19-Oct	2-Nov	19-Oct – 2-Nov	27-Oct	21-Oct ± 0.7
American Kestrel	27-Aug	20-Oct	9-Sep – 13-Oct	22-Sep	21-Sep ± 2.1
Merlin	12-Sep	25-Oct	19-Sep – 19-Oct	6-Oct	9-Oct ± 4.1
Prairie Falcon	27-Aug	18-Oct	5-Sep – 6-Oct	23-Sep	23-Sep ± 3.6
Peregrine Falcon	28-Aug	27-Oct	6-Sep – 12-Oct	23-Sep	23-Sep ± 2.0
All species	27-Aug	2-Nov	9-Sep – 15-Oct	23-Sep	26-Sep ± 1.1

[1] Dates between which the central 80% of the flight passed.

[2] Date by which 50% of the flight had passed; values are given only for species with annual counts ≥5 birds.

[3] Mean of annual values ± 95% CI in days. Means were calculated only for species with ≥3 years of annual counts ≥5 birds.

Table 4. Capture totals, rates, and successes: 1991–1999 versus 2000.

	Capture Total		Capture Rate[1]		Capture Success (%)[2]	
Species	1991–1999[3]	2000	1991–1999[3]	2000	1991–1999[3]	2000
Northern Harrier	5 ± 3.1	5	0.4 ± 0.25	0.6	5 ± 2.8	13
Sharp-shinned Hawk	553 ± 146.7	495	55.1 ± 8.14	62.5	32 ± 3.1	29
Cooper's Hawk	394 ± 104.7	330	39.8 ± 6.08	41.7	33 ± 4.5	33
Northern Goshawk	5 ± 1.3	16	0.6 ± 0.19	2.0	38 ± 14.9	38
Broad-winged Hawk	0.1 ± 0.22	0	0.01 ± 0.016	0.0	1 ± 1.6	0
Red-tailed Hawk	59 ± 17.0	76	6.0 ± 1.45	9.6	8 ± 1.7	13
Zone-tailed Hawk	0.1 ± 0.22	0	0.01 ± 0.016	0.0	10 ± 19.6	0
Golden Eagle	4 ± 0.7	4	0.4 ± 0.05	0.5	3 ± 0.6	3
American Kestrel	44 ± 17.5	25	4.5 ± 1.65	3.2	7 ± 2.1	6
Merlin	4 ± 2.4	8	0.4 ± 0.21	1.0	10 ± 4.9	30
Prairie Falcon	4 ± 2.4	3	0.4 ± 0.20	0.4	16 ± 4.3	10
Peregrine Falcon	5 ± 2.4	1	0.5 ± 0.24	0.1	8 ± 2.3	2
All Species	1077 ± 280.5	963	108.2 ± 15.51	121.7	22 ± 2.9	24

[1] Captures / 100 station hours.

[2] Number of birds captured / number of birds observed. The combined-species value was calculated excluding Ospreys, Turkey Vultures, Swainson's Hawks, Rough-legged Hawks, Ferruginous Hawks, and unknown raptors from the count totals. Species-specific values were calculated after birds identified only to genus were allocated across possible species in proportion to the relative abundance of birds identified to those species.

[3] Mean of annual values ± 95% confidence interval.

Table 5. Capture totals by sex and age (HY = hatching year; AHY = after hatching year), female : male capture ratios, and immature : adult capture ratios for selected species: long-term means versus 2000.

		Female		Male		Female : Male	Immature : Adult
Species	Year	HY	AHY	HY	AHY	Ratio	Ratio
Sharp-shinned Hawk	1991–1999	154	133	142	80	1.3 ± 0.13	1.4 ± 0.30
	2000	158	103	182	52	1.1	2.2
Cooper's Hawk	1991–1999	86	104	87	88	1.1 ± 0.13	0.9 ± 0.18
	2000	78	78	101	73	0.9	1.2
American Kestrel	1990–1999	11	1	20	6	0.7 ± 0.12	5.2 ± 1.14
	2000	3	3	9	8	0.3	1.1

Table 6. Recaptures of previously banded birds in the Manzano Mountains during 2000.

Species	Sex	Band #	Banding Site	Banding Date	Banding Age[1]	Recapture Date	Recapture Age[1]
Sharp-shinned Hawk	F	1523 – 73184	Manzano Mts., NM	22-Sep-98	HY	14-Sep-00	TY
Sharp-shinned Hawk	M	1162 – 39252	Manzano Mts., NM	13-Sep-98	HY	30-Sep-00	TY
Cooper's Hawk	F	1705 – 35035	Manzano Mts., NM	04-Sep-98	HY	21-Sep-00	TY

[1] HY = hatch year; TY = third year.

Table 7. Foreign encounters during 2000 with birds banded in the Manzano Mountains.

Band #	Species	Sex	Banding Age[1]	Banding Date	Encounter Date	Encounter Age[1]	Encounter Location	Distance (km)	Status
1705 – 12253	CH	F	AHY	29-Sep-92	13-Jun-00	$\geq 10^{th}$ yr	Chama, NM	198	found dead
1705 – 27061	CH	F	SY	02-Oct-94	30-Apr-00	8^{th} yr	Nocupetaro, Michoacán, MX	1553	shot
0804 – 04369	CH	M	HY	10-Oct-99	Jul 2000	SY	Taos, NM	180	found dead
2206 – 55504	NG	M	HY	26-Sep-99	07-May-00	SY	Tijeras, NM	28	found dead
1523 – 73160	SS	F	HY	19-Sep-98	26-May-00	TY	Valle de Allende, Chihuahua, MX	719	found dead
1705 – 40098	CH	F	AHY	12-Oct-98	04-Apr-00	ATY	Sandia Mts., NM	34	captured/released

[1] HY = hatch year; SY = second year; TY = third year; AHY = after hatch year; ATY = after third year.

Figure 1. Map of Manzano Mountains study site location.

Figure 2. Fall flight composition by major species groups: 1985–1999 versus 2000.

Figure 3 Adjusted annual passage rates for Turkey Vultures, Ospreys, and Northern Harriers: 1985–2000.

Figure 4. Adjusted annual passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks: 1985–2000.

Figure 5. Adjusted annual passage rates for Broad-winged Hawks and Swainson's Hawks: 1985–2000.

Figure 6. Adjusted annual passage rates for Red-tailed Hawks and Ferruginous Hawks: 1985–2000.

Figure 7. Adjusted annual passage rates for Golden and Bald Eagles: 1985–2000.

Figure 8. Adjusted annual passage rates for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons: 1985–2000.

Figure 9. Combined-species passage volume by 5-day periods: 1985–1999 versus 2000.

Appendix A. History of official observer participation in the Manzano Mountain raptor migration study: 1985–2000.

1985 Single observer throughout, shared duty: Gary Cress (0)[1], Jim Daly (1), Allen Hale (1)

1986 Single observer throughout: Jim Daly (2)

1987 Single observer throughout: Jim Daly (3)

1988 Single observer throughout: Gordon Vickrey (1)

1989 Two observers during peak 3/4 of the season, one observer otherwise: Brett Ewald (2), Tim Menard (0)

1990 Two observers during peak 3/4 of the season, one observer otherwise: David Curson (0), Gary Cress (1)

1991 Two observers throughout: Eric Meyer (1), Tylan Dean (0)

1992 Two observers throughout: Eric Meyer (3), Jessie Jewell (0)

1993 Two observers throughout: Jessie Jewell (2), John Haskell (0)

1994 Two observers throughout: Jessie Jewell (4), Jeff Ogburn (1)

1995 Two observers throughout: Jessie Jewell (6), Jeff Ogburn (2)

1996 Two observers throughout: Jessie Jewell (8), Sean O'Connor (3)

1997 Two observers throughout: Jeff Ogburn (4), Sean O'Connor (4)

1998 Two observers throughout: Dan Rossman (1), Lawry Sager (0)

1999 Two observers throughout: Jason Beason (4), Lawry Sager (1)

2000 Two observers throughout: Jorge Canaca (1), Laura Lutz (1)

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[1] Numbers in parentheses indicate previous full seasons of observation experience.

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

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
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 accipiter	*Accipiter* spp.	UA	U	U	NA
Red-shouldered Hawk	*Buteo lineatus*	RS	A I U	U	NA
Swainson's Hawk	*Buteo swainsoni*	SW	U	U	D L U
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	A I U	U	D L U
Zone-tailed Hawk	*Buteo albonotatus*	ZT	A I U	U	NA
Unknown buteo	*Buteo* spp.	UB	U	U	D L U
Golden Eagle	*Aquila chrysaetos*	GE	A 2 1 I/S U[4]	U	NA
Bald Eagle	*Haliaeetus leucocephalus*	BE	A 3 2 1 I/S 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	M U	NA
Prairie Falcon	*Falco mexicanus*	PR	U	U	NA
Peregrine Falcon	*Falco peregrinus*	PG	U	U	NA
Unknown falcon	*Falco* spp.	UF	U	U	NA
Unknown raptor	Falconiformes	UU	U	U	NA

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

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

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

[4] Golden Eagle age codes: A = adult - no white in wings or tail; 2 = plumage class 2 - no white patch in wings, obvious white in tail; 1 = plumage class 1- white wing patch visible below, small wing patch may be visible above, bold white in tail; I/S = unknown age immature or subadult - obvious white in tail, wings not adequately observed

[5] Bald Eagle age codes: A = adult - completely white head and tail; 3 = plumage class 3 -head mostly white, with osprey-like dark eyeline; 2 = plumage class 2 - dark head, light belly, and/or upside-down white triangle on back; 1 = plumage class 1 - dark head, breast, and belly; I/S = unknown age immature or subadult - dark or mottled head, other plumage features not adequately observed.

Appendix C. Daily observation effort, visitation, weather, and flight-summary (complete, unadjusted data) records: 2000.

Date	Obs. Hours	Average Obsrvrs / Hour	Average Visitors / Hour	Sky Condition[1]	Thermal Lift[2]	Wind Speed[3]	Wind Direct.[4]	Avg. Temp. (°C)	Avg. Visib. E (km)	Avg. Visib. W (km)	Flight Dist.[5]	Raptors / Hour
27-Aug	7.00	1.9	1.1	pc-mc	2	1	sw-wsw	25.3	92	92	2	1.7
28-Aug	6.50	2.0	0.0	pc-ovc, ts/rain	3	3	sw-se	23.3	81	94	2	1.7
29-Aug	6.00	2.3	0.5	mc/ovc, rain	4	3	se-ssw	21.2	72	78	2	1.0
30-Aug	7.25	2.4	1.4	pc-mc	3	5	ssw-sw	19.8	92	92	1	2.6
31-Aug	7.50	2.0	0.0	clr	3	3	sw	18.1	91	90	2	4.0
01-Sep	7.50	2.0	1.4	mc	2	2	sw-w	19.9	99	94	2	3.3
02-Sep	8.50	1.9	5.0	pc	2	2	sw-wsw	22.2	96	96	2	3.8
03-Sep	8.00	2.5	5.8	clr-mc	3	2	sw	21.6	90	85	2	11.6
04-Sep	8.00	2.4	4.5	clr-mc	3	1	sw	24.2	100	100	2	3.5
05-Sep	7.50	2.0	0.0	clr-pc	3	3	ssw-sw	21.3	78	78	2	3.2
06-Sep	7.75	2.0	0.3	clr-pc	2	4	ssw-sw	23.9	73	73	1	8.9
07-Sep	3.25	2.0	0.0	pc-ovc/rain	2	1	ssw-sw	25.6	70	60	2	8.0
08-Sep	6.00	2.0	2.0	pc-ovc, haze/PM rain	3	3	ssw-sw	21.0	52	52	2	4.2
09-Sep	7.50	2.0	2.0	clr-pc	2	3	sw-w	19.9	82	82	1	11.3
10-Sep	8.00	2.0	5.6	clr-pc	2	3	wsw-w	20.1	100	100	2	7.3
11-Sep	8.50	1.9	1.3	clr/haze	2	2	sw-wnw	16.5	83	83	2	7.1
12-Sep	8.50	2.0	0.2	clr/haze	2	1	sw, nw	20.8	79	79	2	7.6
13-Sep	8.50	2.0	0.8	clr-pc, haze	3	2	sw	21.4	90	90	2	11.2
14-Sep	9.00	2.0	1.4	clr-pc, haze	1	1	ne-e	22.6	85	85	2	22.9
15-Sep	9.00	2.0	1.4	clr-mc	2	1	sw-wsw	19.5	96	93	2	15.1
16-Sep	9.00	1.9	2.3	pc/haze	2	1	w	28.5		72		11.2
17-Sep	9.00	1.0	2.3	clr-mc, haze	2	2	sw	22.0	91	91	2	9.2
18-Sep	6.50	2.0	0.0	clr-mc, haze/PM rain	2	2	wsw-w	19.1	79	73	2	13.1
19-Sep	9.50	2.0	0.4	clr	2	2	sw	15.7	92	92	2	7.8
20-Sep	0.00											
21-Sep	6.25	2.0	0.7	clr-ovc	3	3	sw	15.5	81	63	2	24.2
22-Sep	9.50	2.0	3.8	mc-ovc	2	3	sw	15.5	87	83	2	29.2
23-Sep	9.50	1.8	5.0	pc-mc	2	4	ssw	16.3	95	94	2	25.4
24-Sep	8.50	1.9	5.8	clr	3	3	wnw	6.7	100	97	2	5.4
25-Sep	8.50	1.8	0.0	clr	3	0	w	9.7	100	100	3	26.2
26-Sep	9.50	1.9	2.7	clr	3	2	ssw	12.7	90	85	2	9.5
27-Sep	8.50	2.0	3.6	clr-pc	2	0	w	16.2	100	100	2	7.5
28-Sep	9.00	2.6	0.0	pc-mc	2	1	w	16.5	87	95	2	12.0
29-Sep	8.50	2.9	2.2	mc-ovc, rain AM	3	2	wsw-w	18.0	89	85	3	8.1
30-Sep	8.50	2.0	14.8	pc	2	2	ssw	17.1	100	100	3	10.1
01-Oct	9.75	4.0	11.1	clr	2	2	sw-wnw	17.1	100	100	2	10.1
02-Oct	9.75	1.9	4.3	clr-pc	1	2	sw-w	20.1	100	100	1	10.8
03-Oct	8.50	2.9	3.7	clr-pc	1	2	sw	16.8	100	100	2	7.9
04-Oct	3.50	1.8	1.5	ovc/rain	3	2	s	13.8	50	52	1	2.0
05-Oct	9.00	2.0	5.5	clr	2	0	wsw-nw	11.9	100	100	2	6.6
06-Oct	9.00	1.9	9.0	ovc/fog-clr	2	1	sse-sw	14.3	66	88	3	16.8
07-Oct	4.50	2.8	4.4	ovc/fog, rain PM	4	3	se-sse	9.3	0	30	1	0.2
08-Oct	0.00											

Appendix C. continued

Date	Obs. Hours	Average Obsrvrs / Hour	Average Visitors / Hour	Sky Condition[1]	Thermal Lift[2]	Wind Speed[3]	Wind Direct.[4]	Avg. Temp. (°C)	Avg. Visib. E (km)	Avg. Visib. W (km)	Flight Dist.[5]	Raptors / Hour
09-Oct	0.00											
10-Oct	0.00											
11-Oct	3.25	1.4	0.0	ovc/fog/rain	4	3	sw	12.0	0	55	2	8.9
12-Oct	4.00	2.0	0.0	ovc/fog/rain	3	5	s	11.7	33	57	2	7.0
13-Oct	7.50	2.8	1.0	ovc/fog-clr	2	3	sw	8.3	82	91	2	33.7
14-Oct	9.00	1.7	3.6	pc-mc	2	1	sw	8.4	100	100	2	20.9
15-Oct	9.00	2.8	5.2	pc	3	1	s-ssw	10.2	100	96	1	18.6
16-Oct	8.50	2.0	0.0	clr-mc	2	2	sw-wsw	9.8	100	85	2	6.6
17-Oct	8.50	1.9	0.8	clr-pc	2	0	n-ne	8.4	100	100		5.5
18-Oct	9.00	1.8	0.7	pc-mc	2	0	ene, sw	9.0	96	95	3	6.7
19-Oct	9.00	2.0	1.7	pc-ovc	2	3	sw	8.5	100	79	3	4.4
20-Oct	8.50	1.8	1.0	clr-pc	2	2	ene	11.3	100	100	2	6.1
21-Oct	3.33	2.4	0.0	ovc/fog	4	0	none	11.5	25	3		0.0
22-Oct	0.00											
23-Oct	0.00											
24-Oct	0.00											
25-Oct	2.75	2.0	0.0	pc	2	3	sw	8.0	75	75	1	4.7
26-Oct	8.00	2.0	0.0	clr-pc	2	1	s-ssw	7.9	100	98	3	3.6
27-Oct	7.00	2.0	0.0	ovc, rain PM	3	2	sse, e	8.1	73	76	2	5.1
28-Oct	0.00											
29-Oct	0.00											
30-Oct	0.00											
31-Oct	0.00											
01-Nov	6.00	2.0	0.0	mc	3	4	sw-w	0.0	100	96	3	0.7
02-Nov	7.00	2.0	1.4	pc	3	1	sw	1.8	100	100	3	2.0

[1] 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 = thunder storms; ss = snow storms; h = haze.

[2] Average of hourly ratings 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.

[3] Average of hourly categorical ratings: 0 = less than 1 km/h; 1 = 1–5 km/h; 2 = 6–11 km/h; 3 = 12–19 km/h; 4 = 20–28 km/h; 5 = 29–38 km/h, etc.

[4] Predominant wind direction during day: var = variable, all others are abbreviations of combinations of cardinal directions.

[5] Average of hourly line-of-sight ratings estimating 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 raptor counts for 2000 (complete unadjusted data).

	Observ.	Species[1]																							Raptors
Date	Hours	TV	OS	NH	SS	CH	NG	UA	BW	SW	RT	FH	ZT	UB	GE	BE	UE	AK	ML	PR	PG	UF	UU	Total	/ Hour
27-Aug	7.00	2	0	0	2	0	0	0	0	0	3	0	0	0	0	0	0	4	0	1	0	0	0	12	1.7
28-Aug	6.50	2	0	0	1	3	0	0	0	0	4	0	0	0	0	0	0	0	0	0	1	0	0	11	1.7
29-Aug	6.00	2	0	0	1	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	6	1.0
30-Aug	7.25	6	0	1	4	3	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	0	0	19	2.6
31-Aug	7.50	11	0	0	5	4	0	0	0	1	3	0	0	0	2	0	0	2	0	1	1	0	0	30	4.0
1-Sep	7.50	4	1	0	6	5	0	0	0	1	6	0	0	0	0	0	0	2	0	0	0	0	0	25	3.3
2-Sep	8.50	3	0	0	14	5	0	0	0	3	2	0	0	0	0	0	0	5	0	0	0	0	0	32	3.8
3-Sep	8.00	46	0	0	16	17	1	1	0	2	4	0	0	0	1	0	0	4	0	0	1	0	0	93	11.6
4-Sep	8.00	1	0	1	14	8	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	1	28	3.5
5-Sep	7.50	1	0	1	11	3	1	0	0	0	5	0	0	0	1	0	0	0	0	1	0	0	0	24	3.2
6-Sep	7.75	16	0	0	14	13	1	0	0	0	12	0	0	0	0	0	0	11	0	0	2	0	0	69	8.9
7-Sep	3.25	9	0	0	9	4	0	1	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	26	8.0
8-Sep	6.00	2	0	1	9	8	0	0	0	1	0	0	0	0	1	0	0	3	0	0	0	0	0	25	4.2
9-Sep	7.50	18	0	0	17	15	0	0	0	0	10	0	0	0	0	0	0	23	0	1	1	0	0	85	11.3
10-Sep	8.00	1	0	0	21	12	0	0	0	0	9	0	0	0	1	0	0	13	0	0	1	0	0	58	7.3
11-Sep	8.50	0	0	1	26	21	0	0	0	0	9	0	0	0	0	0	0	2	0	0	1	0	0	60	7.1
12-Sep	8.50	14	0	1	18	15	0	1	0	0	6	0	0	0	0	0	0	6	1	2	1	0	0	65	7.6
13-Sep	8.50	9	0	2	33	15	0	1	0	1	17	0	0	0	0	0	0	14	0	3	0	0	0	95	11.2
14-Sep	9.00	18	0	1	75	73	4	4	0	0	17	0	0	0	0	0	0	14	0	0	0	0	0	206	22.9
15-Sep	9.00	6	0	0	73	38	0	0	0	0	10	0	0	0	1	0	0	8	0	0	0	0	0	136	15.1
16-Sep	9.00	7	0	0	35	28	0	2	1	1	17	0	0	0	0	0	0	9	0	1	0	0	0	101	11.2
17-Sep	9.00	7	0	0	24	25	1	1	0	1	11	0	0	0	0	0	0	11	1	1	0	0	0	83	9.2
18-Sep	6.50	1	0	2	46	20	0	0	0	0	7	0	0	0	1	0	0	6	0	0	2	0	0	85	13.1
19-Sep	9.50	3	0	0	18	18	1	0	0	0	6	0	0	0	1	0	0	22	1	1	3	0	0	74	7.8
20-Sep	0.00																								
21-Sep	6.25	5	9	2	63	52	0	1	1	1	10	0	2	0	0	0	0	2	0	0	3	0	0	151	24.2
22-Sep	9.50	2	4	1	100	58	0	2	0	0	34	0	1	0	1	0	0	67	2	0	5	0	0	277	29.2
23-Sep	9.50	2	3	0	103	97	1	1	1	0	17	0	0	0	1	0	0	6	1	3	5	0	0	241	25.4
24-Sep	8.50	1	2	0	20	14	0	0	0	0	4	0	0	0	0	0	0	4	0	0	1	0	0	46	5.4
25-Sep	8.50	2	0	0	102	100	1	0	0	0	16	0	0	0	0	0	0	1	0	1	0	0	0	223	26.2
26-Sep	9.50	1	0	1	41	29	0	0	0	0	10	0	0	0	0	0	0	3	0	2	3	0	0	90	9.5
27-Sep	8.50	1	0	2	20	24	1	0	0	0	6	0	0	0	2	0	0	7	0	0	0	0	1	64	7.5
28-Sep	9.00	2	0	1	32	47	3	0	0	5	9	0	0	0	1	0	0	5	1	2	0	0	0	108	12.0
29-Sep	8.50	5	0	0	23	18	0	0	0	0	13	0	0	0	2	0	0	5	2	0	1	0	0	69	8.1
30-Sep	8.50	2	0	0	36	21	1	0	0	0	5	0	0	0	2	0	0	16	1	0	2	0	0	86	10.1
1-Oct	9.75	1	0	1	38	16	1	0	0	0	15	0	0	0	3	0	0	18	1	3	1	0	0	98	10.1
2-Oct	9.75	4	0	2	48	18	0	1	0	0	13	0	0	0	4	0	0	14	0	1	0	0	0	105	10.8
3-Oct	8.50	0	1	0	25	13	2	0	0	0	11	0	0	0	4	0	0	6	1	1	3	0	0	67	7.9
4-Oct	3.50	0	0	0	4	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	7	2.0
5-Oct	9.00	0	0	2	33	11	1	1	0	1	2	0	0	0	3	0	0	4	0	0	1	0	0	59	6.6

Appendix D. continued

	Observ.	Species[1]																					Raptors	
Date	Hours	TV	OS	NH	SS	CH	NG	UA	BW	SW	RT	FH	ZT	UB	GE	BE	UE	AK	ML	PR	PG	UF	UU	Total	/ Hour
6-Oct	9.00	23	5	3	35	26	0	1	0	0	41	0	0	1	4	0	0	4	3	2	3	0	0	151	16.8
7-Oct	4.50	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.2
8-Oct	0.00																								
9-Oct	0.00																								
10-Oct	0.00																								
11-Oct	3.25	0	0	0	11	5	0	5	0	0	4	0	0	0	3	0	0	0	0	0	0	0	1	29	8.9
12-Oct	4.00	0	0	0	12	2	0	0	0	0	8	0	0	0	2	0	0	1	1	0	2	0	0	28	7.0
13-Oct	7.50	0	0	2	137	26	1	3	0	0	14	0	0	0	10	0	0	53	3	0	3	0	1	253	33.7
14-Oct	9.00	0	0	2	137	9	1	0	0	0	25	0	0	0	12	0	0	0	0	1	1	0	0	188	20.9
15-Oct	9.00	0	0	0	63	12	3	2	0	0	54	1	0	1	18	0	0	9	3	1	0	0	0	167	18.6
16-Oct	8.50	1	0	1	33	10	1	0	0	0	4	0	0	0	2	0	0	3	1	0	0	0	0	56	6.6
17-Oct	8.50	0	0	1	17	7	6	0	0	0	13	0	0	0	2	0	0	0	1	0	0	0	0	47	5.5
18-Oct	9.00	0	0	1	18	7	4	0	0	1	19	2	0	0	5	0	1	1	0	1	0	0	0	60	6.7
19-Oct	9.00	0	0	2	12	1	2	0	0	0	18	0	0	0	2	1	0	1	1	0	0	0	0	40	4.4
20-Oct	8.50	0	0	2	17	2	2	0	0	0	20	0	0	0	7	0	0	1	1	0	0	0	0	52	6.1
21-Oct	3.33	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
22-Oct	0.00																								
23-Oct	0.00																								
24-Oct	0.00																								
25-Oct	2.75	0	0	0	3	0	0	0	0	0	7	0	0	0	2	0	0	0	1	0	0	0	0	13	4.7
26-Oct	8.00	0	0	1	9	1	2	0	0	0	12	0	0	0	2	1	0	0	0	0	0	1	0	29	3.6
27-Oct	7.00	0	0	0	5	1	0	1	0	0	17	0	0	0	9	2	0	0	0	0	1	0	0	36	5.1
28-Oct	0.00																								
29-Oct	0.00																								
30-Oct	0.00																								
31-Oct	0.00																								
1-Nov	6.00	0	0	0	1	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	4	0.7
2-Nov	7.00	0	0	0	7	0	0	0	0	0	4	0	0	0	2	1	0	0	0	0	0	0	0	14	2.0
Total	434.33	241	25	38	1698	984	42	29	3	19	591	3	3	2	115	5	1	397	27	30	49	1	4	4307	9.9

[1] See Appendix B for explanation of species codes.

Appendix E. Fall migration observation periods and raptor count totals (complete, unadjusted data) by year and species for the Manzano Mountains, New Mexico: 1985–2000

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Mean
Start date	6-Sep	23-Aug	25-Aug	29-Aug	28-Aug	27-Aug	27-Aug	25-Aug	25-Aug	25-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	26-Aug
End date	2-Nov	31-Oct	4-Nov	31-Oct	31-Oct	31-Oct	5-Nov	5-Nov	5-Nov	2-Nov	8-Nov	5-Nov	5-Nov	5-Nov	5-Nov	2-Nov	2-Nov
Days of observation	50	63	66	61	63	66	67	71	66	65	71	59	68	65	70	57	64
Hours of observation	343.33	464.50	517.92	453.08	489.75	510.75	524.58	537.25	489.67	508.75	560.00	461.67	565.08	559.58	553.77	434.33	498.38
Raptors / 100 hours	843.2	863.9	758.6	772.3	955.4	494.6	825.6	946.3	2429.2	966.5	832.9	1545.9	1044.8	1594.2	873.1	991.6	1046.1
SPECIES	RAPTOR COUNTS																
Turkey Vulture	74	118	283	466	178	295	176	268	601	430	636	640	563	1116	637	241	420
Osprey	10	14	19	13	22	12	24	26	31	38	53	33	47	44	14	25	27
Northern Harrier	28	36	78	78	59	27	66	69	48	97	72	64	69	133	69	38	64
Sharp-shinned Hawk	956	1300	1622	1118	1834	688	1080	1540	1193	1415	1519	2174	1872	2585	1212	1698	1488
Cooper's Hawk	531	881	679	604	929	471	1105	961	944	1054	907	1205	1018	2025	1069	984	960
Northern Goshawk	21	20	7	6	14	3	8	16	27	30	11	9	9	19	14	42	16
Unknown accipiter	78	104	119	111	121	120	156	117	266	118	44	147	76	107	51	29	110
TOTAL ACCIPITERS	1586	2305	2427	1839	2898	1282	2349	2634	2430	2617	2481	3535	2975	4736	2346	2753	2575
Broad-winged Hawk	2	2	7	10	5	2	5	5	1	7	7	4	5	14	12	3	5.7
Swainson's Hawk	27	33	44	3	16	9	58	344	7301	67	32	867	679	572	194	19	642
Red-tailed Hawk	513	527	457	486	604	329	577	667	566	707	519	771	803	1151	733	591	625
Ferruginous Hawk	14	15	17	20	16	13	19	25	17	13	13	4	13	10	8	3	14
Rough-legged Hawk	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	0.3
Zone-tailed Hawk	0	0	0	0	0	0	0	2	0	1	1	0	1	2	0	3	1
Unknown buteo	21	12	11	16	4	19	30	11	31	22	9	11	3	28	5	2	15
TOTAL BUTEOS	577	589	536	536	646	372	689	1054	7916	817	581	1657	1504	1778	953	621	1302
Golden Eagle	133	123	86	67	85	52	124	119	120	172	136	151	145	115	159	115	119
Bald Eagle	2	0	1	1	3	4	7	4	7	9	4	0	3	4	3	5	4
Unknown Eagle	0	0	0	4	0	4	0	0	0	0	0	0	0	0	0	1	0.6
TOTAL EAGLES	135	123	87	72	88	60	131	123	127	181	140	151	148	119	162	121	123
American Kestrel	421	755	426	385	677	409	728	704	520	582	584	905	455	742	525	397	576
Merlin	2	16	17	12	18	9	10	28	24	24	42	48	42	56	14	27	24
Prairie Falcon	13	7	8	12	19	9	14	17	27	22	18	19	19	58	38	30	21
Peregrine Falcon	14	15	7	10	15	5	21	18	31	37	49	60	67	116	64	49	36
Unknown falcon	4	0	1	0	3	5	3	1	0	1	0	1	0	12	2	1	2
TOTAL FALCONS	454	793	459	419	732	437	776	768	602	666	693	1033	583	984	643	504	659
Unknown raptor	31	35	40	76	56	41	120	142	140	71	8	24	15	11	11	4	52
TOTAL	2895	4013	3929	3499	4679	2526	4331	5084	11895	4917	4664	7137	5904	8921	4835	4307	5221

Appendix F. Daily trapping effort and capture totals by species: 2000.

Date	Station Hours	Species[1]										Total	Captures / stn hr
		NH	SS	CH	NG	RT	GE	AK	ML	PR	PG		
2-Sep	10.75	0	4	0	0	2	0	0	0	0	0	6	0.6
3-Sep	7.50	0	4	8	1	1	0	0	0	0	0	14	1.9
4-Sep	16.75	0	5	2	0	0	0	0	0	0	0	7	0.4
5-Sep	15.50	0	1	1	0	0	0	0	0	0	0	2	0.1
6-Sep	15.00	0	7	7	0	1	0	0	0	0	0	15	1.0
7-Sep	11.25	0	7	5	0	0	0	0	0	0	0	12	1.1
8-Sep	7.00	0	4	3	0	0	0	0	0	0	0	7	1.0
9-Sep	13.00	0	9	8	0	1	0	1	0	0	0	19	1.5
10-Sep	10.50	0	7	4	0	5	1	2	0	0	0	19	1.8
11-Sep	12.00	0	5	8	0	3	0	0	0	0	0	16	1.3
12-Sep	6.50	0	10	6	0	1	0	0	0	0	0	17	2.6
13-Sep	4.25	0	11	12	0	2	0	0	0	0	0	25	5.9
14-Sep	6.25	0	22	16	1	3	0	1	0	0	0	43	6.9
15-Sep	12.00	0	23	14	0	1	0	2	0	0	0	40	3.3
16-Sep	12.50	0	18	11	0	3	0	1	0	0	0	33	2.6
17-Sep	10.50	0	12	16	0	1	0	1	0	0	0	30	2.9
18-Sep	21.00	0	11	6	0	5	0	0	0	0	0	22	1.0
19-Sep	20.67	0	10	4	1	0	0	5	2	0	0	22	1.1
20-Sep	0.00												
21-Sep	13.25	0	16	16	0	0	0	0	0	0	0	32	2.4
22-Sep	23.50	0	35	27	0	1	0	1	0	0	1	65	2.8
23-Sep	21.00	0	19	30	0	3	0	0	0	1	0	53	2.5
24-Sep	24.25	0	4	6	0	2	0	0	0	0	0	12	0.5
25-Sep	15.25	0	34	24	0	0	0	0	0	0	0	58	3.8
26-Sep	22.00	0	12	11	0	1	0	0	0	0	0	24	1.1
27-Sep	16.00	0	7	4	0	3	0	3	0	0	0	17	1.1
28-Sep	24.00	0	8	14	0	1	0	0	0	0	0	23	1.0
29-Sep	23.00	0	9	4	0	2	1	1	1	0	0	18	0.8
30-Sep	23.75	0	8	9	0	2	0	3	1	0	0	23	1.0
1-Oct	23.50	1	5	4	0	4	0	0	0	1	0	15	0.6
2-Oct	19.75	1	9	4	0	1	0	0	0	0	0	15	0.8
3-Oct	23.75	0	10	8	0	0	0	0	0	0	0	18	0.8
4-Oct	23.92	0	2	1	0	0	0	0	0	0	0	3	0.1
5-Oct	22.50	1	8	4	0	0	0	1	0	0	0	14	0.6
6-Oct	13.50	0	12	7	0	8	0	0	0	0	0	27	2.0
7-Oct	20.00	0	0	0	0	0	0	0	0	0	0	0	0.0
8-Oct	0.00												
9-Oct	0.00												
10-Oct	7.00	0	3	0	0	0	0	0	0	0	0	3	0.4
11-Oct	13.25	0	2	0	0	0	0	0	0	0	0	2	0.2
12-Oct	24.25	0	3	0	0	2	0	0	0	0	0	5	0.2
13-Oct	21.08	1	22	5	1	0	0	2	0	0	0	31	1.5

Appendix F. continued

Date	Station Hours	Species[1]										Total	Captures / stn hr
		NH	SS	CH	NG	RT	GE	AK	ML	PR	PG		
14-Oct	20.25	1	33	7	1	2	0	0	0	0	0	44	2.2
15-Oct	23.25	0	17	4	2	2	2	0	1	0	0	28	1.2
16-Oct	23.75	0	17	2	0	1	0	1	1	0	0	22	0.9
17-Oct	17.75	0	8	3	3	3	0	0	0	0	0	17	1.0
18-Oct	18.50	0	8	3	3	5	0	0	0	1	0	20	1.1
19-Oct	18.00	0	9	0	1	2	0	0	1	0	0	13	0.7
20-Oct	15.75	0	2	1	1	1	0	0	0	0	0	5	0.3
21-Oct	2.50	0	0	0	0	0	0	0	0	0	0	0	0.0
22-Oct	0.00												
23-Oct	0.00												
24-Oct	7.50	0	1	1	0	0	0	0	1	0	0	3	0.4
25-Oct	0.00												
26-Oct	6.75	0	0	0	1	1	0	0	0	0	0	2	0.3
27-Oct	6.00	0	2	0	0	0	0	0	0	0	0	2	0.3
Total	791.42	5	495	330	16	76	4	25	8	3	1	963	1.2

[1] See Appendix B for explanation of species codes.

Appendix G. Annual summaries of banding effort and capture totals by species: 1990–2000.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	TOTAL	MEAN
Start date	28-Aug	5-Sep	31-Aug	3-Sep	1-Sep	4-Sep	2-Sep	31-Aug	29-Aug	31-Aug	2-Sep		31-Aug
End date	27-Oct	29-Oct	30-Oct	24-Oct	25-Oct	31-Oct	19-Oct	28-Oct	29-Oct	16-Oct	27-Oct		25-Oct
Blinds in operation	1	3	3	3	3	4	4	4	3	3	3		3.1
Trapping days	47	54	57	50	48	53	45	54	58	46	50		51.2
Station days	47	95	131	120	121	136	132	151	165	93	119		119.2
Station hours	511	693	967	889	926	1041	1030	1211	1353	664	791.42		928.4
SPECIES	CAPTURE TOTALS												
Northern Harrier	1	2	2	3	9	2	1	8	14	0	5	47	4.3
Sharp-shinned Hawk	125	262	589	430	502	493	778	612	987	321	495	5594	508.5
Cooper's Hawk	102	195	335	374	353	310	460	427	772	323	330	3981	361.9
Northern Goshawk	1	7	6	6	7	1	5	3	6	6	16	64	5.8
Broad-winged Hawk	1	0	0	0	0	0	0	0	1	0	0	2	0.2
Red-tailed Hawk	11	18	61	55	83	50	50	46	112	56	76	618	56.2
Zone-tailed Hawk	0	0	0	0	0	0	0	0	1	0	0	1	0.1
Golden Eagle	1	3	4	4	4	4	6	4	5	2	4	41	3.7
American Kestrel	10	13	42	14	59	28	92	32	75	44	25	434	39.5
Merlin	1	0	2	4	1	1	11	6	7	2	8	43	3.9
Prairie Falcon	2	1	3	5	3	1	3	5	13	6	3	45	4.1
Peregrine Falcon	2	1	2	1	4	2	5	7	12	8	1	45	4.1
All Species	257	502	1046	896	1025	892	1411	1150	2005	768	963	10915	992.3
Captures / 100 hours	50.3	72.4	108.2	100.8	110.7	85.7	137.0	95.0	148.2	115.7	121.7	1145.6	104.1
Recaptures	0	0	1	1	2	2	1	2	4	4	3	20	1.8
Foreign recaptures	2	1	1	1	2	0	5	1	2	2	0	0	1.5
Foreign encounters	0	2	2	3	6	6	7	8	13	12	6	65	5.9