

**FALL 2003 RAPTOR MIGRATION STUDY
NEAR CORPUS CHRISTI, TEXAS**



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



April 2004

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INTRODUCTION

The Corpus Christi Raptor Migration Project in southern Texas is an ongoing effort to monitor long-term population trends of raptors using this southern portion of the Gulf Coast migratory flyway (Smith et al. 2001). During fall 2003, HawkWatch International (HWI) conducted the seventh consecutive, full-season migration count at Hazel Bazemore County Park near Corpus Christi. Previously, volunteers conducted peak-season counts at this “Coastal Bend” site each year between 1988 and 1996, following protocols of the Hawk Migration Association of North America (HMANA). The December 1997 issue of the HMANA Journal of Hawk Migration Studies includes a summary of these counts. Since HWI began full-season counts at the site in 1997, 30 species of raptors have been observed migrating through the project area. Annual counts have ranged from roughly 440,000 to 992,000 migrants, with Broad-winged Hawks (see Appendix A for common and scientific names of all raptor species observed at the site) comprising 87–95% of the total count each year. This report summarizes the count results from the 2003 season.

The Corpus Christi project was 1 of 14 long-term, annual migration counts conducted or sponsored by HWI in North America during 2003. The primary objective of these efforts is to track long-term population trends of diurnal raptors throughout primarily western North America (Smith and Hoffman 2000, Hoffman and Smith 2003). Raptors feed atop food pyramids, inhabit most ecosystems, occupy large home ranges, and are sensitive to environmental contamination and other human disturbances. For these reasons, they serve as important biological indicators of ecosystem health (Bildstein 2001). Moreover, due to the remoteness and widespread distribution of most raptor populations, migration counts represent one of the most cost-effective and efficient methods for monitoring the regional status and trends of multiple raptor species (Bednarz and Kerlinger 1989, Titus et al. 1989, Dunn and Hussell 1995, Dixon et al. 1998, Zalles and Bildstein 2000, Hoffman and Smith 2003).

STUDY SITE

The nine-county area around Corpus Christi is commonly called the Coastal Bend. This includes Aransas, Refugio, San Patricio, Nueces, and Kleberg counties along the coast, and Goliad, Bee, Live Oak, and Jim Wells counties to the west. The Texas coast runs from the northeast to the southwest between the Louisiana border and Corpus Christi Bay, then shifts to a north–south direction. Hazel Bazemore Park (HBP) is approximately 27 km west of Corpus Christi Bay near the town of Calallen (27°52'3.0"N, 97°38'30.1"W; Figure 1). This geographic location is ideal for monitoring the autumn raptor migration through the region. Past records show that this is a major migration path for Broad-winged Hawks (Rappole and Blacklock 1985).

The HBP monitoring site is situated at an elevation of 28 m above mean sea level, which is the highest elevation along the coast in a four-county area. The park sits on the southern bank of the Nueces River at a horseshoe bend where the river changes from a southeast to north–northwest flow. The watch site offers clear visibility through a 105° arc from the northeast to the west, but the view to the east is restricted by topography at a similar elevation. The Nueces River bottomlands feature a transitional riparian forest. Characteristic plants include hackberry (*Celtis* spp.), Mexican ash (*Fraxinus berlandieriana*), anacua (*Ehretia anacua*), black persimmon (*Diospyros texana*), chittimwood (*Bumelia lanuginosa*), and cedar elm (*Ulmus crassifolia*). Many species of raptors use this forested area for nocturnal roosting during migration (Rappole and Blacklock 1985). Open farmland predominates to the north and south, open ranchland to the west. Corpus Christi Bay, which is an industrial and urbanized area, lies to the east.

METHODS

Three official or designated observers, routinely assisted by numerous local volunteers, conducted daily counts of migrant raptors from a single traditional observation site at HBP. On-site project coordinator Joel Simon served as one of the official observers, which he has done most years since 1997, and provided supervision and training for the other observers and volunteers (see Appendix B for a complete history of official observer participation). This was the first full-season of raptor migration counting for both of the other two official observers. Official observer Ricardo Perez had received previous migration-monitoring training as an environmental education intern at Hawk Mountain Sanctuary in Pennsylvania, and over the past couple of years has been working to build a similar migration-monitoring program in his home country of El Salvador. Official observer Taylor Ellis had gained previous migration-watching experience on his own in his home state of Florida. Several other experienced local volunteers routinely assisted with the count, as they have done since the project's inception.

The official observer(s) assigned a specific task to each actively participating individual to maximize accuracy of the counts and ensure quality participation by all interested volunteers. Counters were responsible for counting large flights of raptors, usually Broad-winged Hawks. Spotters were responsible for scanning the sky for both large flights and single raptors, and notifying the counters of their sightings. Other individuals were responsible for scanning through large flights of Broad-winged Hawks and recording occurrences of other species. Other volunteer assignments included keeping up with the visitor log, taking weather observations when the primary observer was too busy with counts, and serving as data recorder on busy days.

Weather permitting, observations typical began by 0800 hrs and ended by 1600 hrs Central Standard Time (CST). The observers routinely recorded the following data:

1. Species, age, sex, and color morph of each migrant raptor, whenever possible and applicable (Appendix A 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). The observers generally tallied raptors only by species, because the demands of counting during peak flight periods usually precluded paying close attention to details other than species identification. High flight altitudes also frequently limited the attainable detail. Because of these limitations, we do not focus attention in this report on the age, sex, or color-morph data.
2. Hour of passage for each migrant; e.g., the 1000–1059 hrs CST.
3. Wind speed and direction, air temperature, percent cloud cover, predominant cloud type(s), presence or 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 for each hour, recorded on the hour.
7. Daily start and end times for each official observer.

Otherwise, data gathering and recording followed standardized protocols used at all HWI migration sites (Hoffman and Smith 2003). In comparing 2003 annual statistics against means and 95% confidence intervals (mean \pm 95% CI) for 1997–2002, I equate significance with a 2003 value falling outside of the 95% CI for the associated mean.

RESULTS AND DISCUSSION

WEATHER

During 2003, inclement weather (i.e., excessive rain and/or fog) entirely precluded observations on 7 days and severely restricted observations (≤ 4 hrs) on another 3 days (see Appendix C for daily weather summaries). The average number of days of no observations during the previous six years was 4.3 (range 0–9) and the average number of severely hampered days was 3.0 (range 0–9), indicating that weather was more of a problem in 2003 than most years, with 1998 the only previous year with more total days hampered by weather (18; largely due to two major tropical storms, Charlie and Frances). Rain and/or thunderstorms occurred on 15% of the active observation days in 2003, compared to 10–19% from 1997–2002. Ten individual storm/rain events between early September and early November contributed to the reduced observation periods. Otherwise, mostly cloudy to overcast skies predominated on 21% of the active observation days, transitional weather (i.e., skies changed from primarily fair to mostly cloudy or overcast during the day) on 50%, and predominantly fair skies prevailed on 29% of the active days. The comparative 1997–2002 averages for these values are 34%, 39%, and 27%, respectively, indicating a more active weather pattern in 2003 than during most previous seasons. Moreover, visibility reducing fog and/or haze occurred during at least portions of 78% of the active observation days, which is considerably higher than the 1997–2002 average of 49%. This also translated to below average visibility estimates, which in 2003 averaged 9 km to the east and west compared to 1997–2002 averages of 10.5 and 11.5 km, respectively.

Light winds (< 12 kph) prevailed on 55% of the active days and moderate winds (12–28 kph) on the remainder; the comparative 1997–2002 averages are 77% light, 21% moderate, and 1% strong, indicating that the increased weather activity also translated to more wind than usual. In terms of wind directions, variable NE to E winds were more common than usual (prevailed on 22% of the active days; average 6%), while variable N to NE (5% 2003, 16% average), E to SE (5% 2003, 11% average), and SE to S (5% 2003, 21% average) winds were less common than usual.

Daily-average (mean of hourly readings) temperatures averaged 29.0°C and ranged from 16.0 to 33.9°C, which is a typical temperature profile for the site. Daily-average (mean of hourly readings) barometric pressure averaged 29.87, ranging from 29.60 to 30.13, which is slightly lower than long-term average and maximum.

In 2003, only 18% of the active observation days received a median thermal lift rating of good to excellent, compared to the 1997–2002 average of 37%. This difference likely reflects primarily the higher prevalence of moderate winds in 2003.

In summary, the 2003 season featured more unsettled and inclement weather than most years, a much higher prevalence than usual of visibility hampering fog and haze, higher average wind speeds and correspondingly poorer thermal lift conditions, and a high prevalence of NE to E winds as opposed to more northerly or southerly winds.

OBSERVATION EFFORT

Observations occurred on 86 of 93 possible days between 15 August and 15 November (see Appendix D for daily count records). The number of observation days and hours (643.0) were 4% and 7% lower, respectively, than the 1997–2002 averages of $89 \pm 95\%$ CI of 2.7 days and 693.1 ± 44.92 hours of observation per season. The 2003 average of 3.7 observers per hour (includes official and guest observers; value is mean of daily values, which are in turn means of hourly values) was significantly higher than the 1997–2002 average of 3.2 ± 0.45 observers/hr.

MIGRATION SUMMARY

The observers counted 727,900 migrating raptors of 26 species during the 2003 season (Table 1). Broad-winged Hawks comprised 95% of the total count. Species that comprised 3% or more of the remainder included Turkey Vulture (56%), Swainson's Hawk (14%), Mississippi Kite (15%), and Sharp-shinned Hawk (3%). Buteos, vultures, and kites were the predominant species groups (Figure 2). With Broad-winged Hawks excluded, the proportions of kites and falcons were significantly above average in 2003, whereas the proportions of all other species were near average.

A highlight of the season was the first Hook-billed Kite ever recorded at the site. Undoubtedly the same bird was seen on two consecutive days by multiple observers. Curiously, the HWI crew at Smith Point, Texas on Galveston Bay also recorded the first Hook-billed Kite for that sight during the 2003 fall migration (Smith 2004). With breeding in the U.S. restricted to a very limited portion of far southern Texas (Wheeler 2003), these birds do not represent migrants in the classic sense of long-distance, north-south fall movements. Nevertheless, the sightings reflect dispersal across at least 150 km to Corpus Christi and several hundred kilometers to Smith Point, and are particularly noteworthy because of their extra-limital nature. The species is a relatively new breeder in the U.S. (Wheeler 2003) and these new sightings may be an indication that the species northward expansion from Mexico is continuing. In addition, northward late summer and early fall dispersals are well documented for some southern U.S. populations of other raptor species, such as for immature Bald Eagles (Buehler 2000) and Red-tailed Hawks (Bloom 1985, HWI satellite tracking data—see www.hawkwatch.org).

A second highlight of the season was the second sighting of an Aplomado Falcon (see Appendix E for annual count summaries). Like the Hook-billed Kites, these falcons represent birds dispersing over unusual distances from natal areas in southern Texas, southeastern New Mexico, and northern Mexico. For the Aplomado Falcon, however, the sightings clearly testify to the success of the reintroduction efforts dedicated to recovery of this endangered species (Keddy-Hector 2000).

Interannual Count Trends and Regional Comparisons

Record high counts were recorded for Ospreys, Zone-tailed Hawks, Crested Caracaras, American Kestrels, and Merlins (Appendix E). Conversely, record low counts were recorded for White-tailed Kites and Red-shouldered Hawks, and other species seen previously but not in 2003 include Northern Goshawk, Rough-legged Hawk, Short-tailed Hawk, and Common Black Hawk. The 2003 Broad-winged Hawk count was an insignificant 1% below the 1997–2002 average (Table 1). The combined-species count excluding Broad-winged Hawks was 11% higher than average, but this difference is not statistically significant (Table 1).

Among 24 species observed in most years, seven showed significantly above-average passage rates in 2003 (Osprey, Mississippi Kite, Cooper's Hawk, Zone-tailed Hawk, Crested Caracara, American Kestrel, and Merlin), two showed significantly below-average passage rates (White-tailed Kite and Red-shouldered Hawk), and rates were within the bounds of typical variation for 15 species (Table 1). Seven years is too short of a period to warrant detailed attention to long-term trends. Nevertheless, a cursory examination of apparent patterns in annual passage rates is instructive. Species showing distinct increasing patterns over the period of record include Swallow-tailed and Mississippi Kites, Cooper's Hawks, Swainson's Hawks, probably American Kestrels at least recently, and Crested Caracaras (Figures 3–6). Other potentially increasing species include Turkey Vulture, Osprey, and Peregrine Falcon.

Aside from recent downturns likely related to the widespread drought that has plagued much of the West since 1998, Turkey Vultures, Ospreys, Cooper's Hawks, Swainson's Hawks, and Peregrine Falcons have generally shown mostly increasing patterns across the West since the 1980s (Hoffman and Smith 2003). Data from Smith Point, Texas also suggest recent increasing patterns for Swallow-tailed and Mississippi Kites and Swainson's Hawks, as well as possible increasing patterns for Turkey Vultures and Crested Caracaras (Smith 2004). In contrast, trend indicators for American Kestrels are decidedly mixed,

including across HWI's western migration network (Hoffman and Smith 2003) and in comparing Corpus Christi and Smith Point data in Texas. Corpus Christi posted a record high count for American Kestrels in 2003 (extending a fairly steady increasing trend), whereas Smith Point posted a record low count for kestrels in 2003 (no distinct longer term trend). Reasons for such discrepancies are unclear at this time, but likely reflect a combination of effects related to weather and wind patterns, and differences in source populations (Smith et al. 2001). Future multivariate modeling of the count and auxiliary data from both projects that accounts for confounding variables such as weather and variation in observation effort, as well as careful comparisons of trends from the different sites likely will be necessary to produce robust assessments of underlying regional population trends.

Elsewhere around the Gulf Coast, in the Florida Keys the overall southbound count was 5% below the 1999–2002 average for that site; however, record high counts were recorded for Swallow-tailed Kites, Broad-winged Hawks, and Peregrine Falcons (HWI unpublished data). In Veracruz, Mexico, along the far southwestern Gulf Coast, the overall count (data from two count sites combined) was the third highest since the project began in 1993 (HWI, Hawk Mountain Sanctuary, and Pronatura Veracruz unpublished data). Among the four most common species, counts were slightly below average for Broad-winged Hawks, well above average for Turkey Vultures and Mississippi Kites, and rose to a new record high of ~1.2 million Swainson's Hawks! Among the second tier of common species, counts were average for Ospreys but well below average for Sharp-shinned Hawks, Cooper's Hawks, and American Kestrels.

Seasonal Timing

The timing of Broad-winged Hawk flight activity in 2003 showed a typical pattern, with the median passage date of 26 September only 1 day later than average (Table 3) and roughly 90% of the activity occurring during the last 10 days of September (Figure 3, Appendix D). The combined seasonal activity pattern for all other species also showed a typical pattern (Figure 3). At the species level, Turkey Vultures, Sharp-shinned Hawks, and Cooper's Hawks showed significantly later than average median passage dates (Table 3) due to atypically concentrated activity in mid-to-late October. In contrast, all five commonly observed falcon species (including Crested Caracaras) were earlier than average, in most cases due to atypically high concentrations of activity in late September, with the differences significant for all but Prairie Falcons (Table 3). All other species showed average timing in 2003.

RESIDENT AND LOCAL RAPTOR ACTIVITY

The pair of resident White-tailed Hawks that had successfully raised young four of the past five years were present all season, however, no young birds were seen this year. A pair of adult Red-shouldered Hawks was present all season, with a juvenile bird first noticed during the first week of September. The close interaction of these individuals led us to believe it was a family group. The only other local species that were present all season were Turkey and Black Vultures. The total number of vultures exhibiting resident behavior varied during the season, but likely comprised 12–15 Turkey Vultures and 20–25 Black Vultures.

A single adult Swainson's Hawk was present at the beginning of the season and was joined by another adult in early September; neither was observed after the third week of September. Species that set up wintering territories near the site included Red-tailed Hawks, which began appearing in early September and by the end of the season included two adults and one juvenile; American Kestrels, which began appearing in early September and by the end of the season included one male and one female; Ospreys, which began appearing in early September and by the end of the season included two adults; a Sharp-shinned Hawk that appeared in late September; a Cooper's Hawk that appeared in early October; and a Northern Harrier that appeared in mid-October.

VISITOR PARTICIPATION AND PUBLIC OUTREACH

During the 2003 season, 728 individuals visited the site, which is only slightly lower than in 2002. Visitors originated from 16 states, Canada, and Great Britain. As usual, visitation was highest during the sixth annual *Celebration of Flight* event (404 visitors), held at the site in late September to correspond to peak Broad-winged Hawk flights. This year for a change, the birds cooperated very nicely, with a flight of more than 100,000 birds on the peak event day! Programs put on at the site during the event by HWI Science Director, Dr. Jeff Smith, and local Project Coordinator, Joel Simon, reached about 300 visitors.

In 2003, 702 hourly assessments of visitor disturbance resulted in the following ratings: 99% none and 1% low. This continued very low level of visitor disturbance experienced by the official observers is apt testimony to the benefits of having a large cadre of highly dedicated and knowledgeable local volunteers regularly available to assist with the count and facilitate visitor interactions.

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Table 1. Fall counts and passage rates by species for migrating raptors at Hazel Bazemore Park near Corpus Christi, Texas: 1997–2002 versus 2003.

SPECIES	COUNTS			RAPTORS/100 HOURS		
	1997–2002 ¹	2003	% Change	1997–2002 ¹	2003	% Change
Black Vulture	525 ± 360.8	241	-54	74.1 ± 49.5	37.5	-49
Turkey Vulture	21,726 ± 13,388	22,900	+5	3,095 ± 1,907	3,561	+15
TOTAL VULTURES	22,251 ± 13,566	23,141	+4	3,170 ± 1,930	3,599	+14
Osprey	132 ± 35.2	199	+51	19.4 ± 6.2	30.9	+60
Northern Harrier	171 ± 67.9	100	-42	24.8 ± 9.6	15.6	-37
Hook-billed Kite	0 ± 0.0	1	–	0.0 ± 0.0	0.2	–
Swallow-tailed Kite	23 ± 17.9	22	-4	3.3 ± 2.6	3.4	+3
White-tailed Kite	4 ± 1.6	1	-73	0.5 ± 0.3	0.2	-71
Mississippi Kite	5,865 ± 2,268	9,753	+66	843.3 ± 313.1	1,517	+80
TOTAL KITES	5,892 ± 2,282	9,776	+66	847.1 ± 315.1	1,520	+79
Sharp-shinned Hawk	1,165 ± 331.3	1,193	+2	170.5 ± 52.8	185.5	+9
Cooper’s Hawk	574 ± 228.3	1,083	+89	81.8 ± 30.7	168.4	+106
Northern Goshawk	0.3 ± 0.4	0	-100	0.0 ± 0.1	0.0	-100
Unknown accipiter	287 ± 73.7	344	+20	41.4 ± 10.9	53.5	+29
TOTAL ACCIPITERS	2,079 ± 388.9	2,620	+26	301.3 ± 56.8	407.5	+35
Harris’ Hawk	12 ± 6.8	6	-50	1.7 ± 0.9	0.9	-45
Red-shouldered Hawk	69 ± 17.4	26	-62	9.8 ± 2.3	4.0	-59
Broad-winged Hawk	693,298 ± 184,484	684,815	-1	101,810 ± 32,072	106,503	+5
Swainson’s Hawk	5,432 ± 4,249	5,633	+4	800.1 ± 606.2	876.0	+9
White-tailed Hawk	6 ± 3.5	6	+9	0.8 ± 0.5	0.9	+17
Zone-tailed Hawk	2 ± 1.8	7	+282	0.3 ± 0.2	1.1	+323
Short-tailed Hawk	0 ± 0.7	0	-100	0.0 ± 0.1	0.0	-100
Common Black Hawk	0 ± 0.3	0	-100	0.0 ± 0.0	0.0	-100
Red-tailed Hawk	172 ± 60.3	192	+12	24.7 ± 8.1	29.9	+21
Ferruginous Hawk	3 ± 4.3	1	-68	0.4 ± 0.6	0.2	-65
Rough-legged Hawk	1 ± 1.3	0	-100	0.1 ± 0.2	0.0	-100
Unidentified buteo	128 ± 110.0	71	-45	17.9 ± 15.0	11.0	-38
TOTAL BUTEOS	699,122 ± 185,755	690,757	-1	102,666 ± 32,287	107,427	+5
Golden Eagle	1 ± 1.1	2	+50	0.2 ± 0.2	0.3	+67
Bald Eagle	2 ± 1.2	1	-33	0.2 ± 0.2	0.2	-29
Unknown eagle	0.2 ± 0.3	0	-100	0.0 ± 0.0	0.0	-100
TOTAL EAGLES	3 ± 2.4	3	0	0.4 ± 0.3	0.5	+9
Crested Caracara	11 ± 6.2	21	+94	1.5 ± 0.9	3.3	+114
American Kestrel	454 ± 170.9	860	+90	66.3 ± 25.9	133.7	+102
Merlin	27 ± 4.5	57	+110	3.9 ± 0.7	8.9	+125
Prairie Falcon	11 ± 8.9	15	+43	1.5 ± 1.2	2.3	+57
Peregrine Falcon	139 ± 53.6	169	+21	20.4 ± 8.1	26.3	+29
Aplomado Falcon	0.2 ± 0.3	1	+500	0.0 ± 0.0	0.2	+572
Unknown falcon	52 ± 29.2	47	-10	7.5 ± 3.9	7.3	-2
TOTAL FALCONS	685 ± 211.7	1,149	+70	99.9 ± 32.1	180.9	+81
Unidentified raptor	1,652 ± 1,552	133	-92	252.6 ± 249.2	20.7	-92
GRAND TOTAL	731,941 ± 172,913	727,900	-1	107,375 ± 30,723	113,204	+5

¹ Mean ± 95% confidence interval.

Table 2. First and last observed, bulk-passage, and median-passage dates by species for migrating raptors at Hazel Bazemore Park near Corpus Christi, Texas in 2003, with a comparison of 2003 and 1997–2002 average median passage dates.

SPECIES	2003				1997–2002
	FIRST OBSERVED	LAST OBSERVED	BULK PASSAGE DATES ¹	MEDIAN PASSAGE DATE ²	MEDIAN PASSAGE DATE ^{2,3}
Black Vulture	27-Sep	12-Nov	24-Oct – 11-Nov	4-Nov	27-Oct ± 8.4
Turkey Vulture	22-Sep	15-Nov	14-Oct – 5-Nov	27-Oct	20-Oct ± 5.4
Osprey	18-Aug	15-Nov	7-Sep – 16-Oct	26-Sep	28-Sep ± 2.6
Northern Harrier	27-Aug	14-Nov	26-Sep – 1-Nov	15-Oct	11-Oct ± 8.9
Hook-billed Kite	26-Sep	26-Sep	–	–	–
Swallow-tailed Kite	16-Aug	26-Sep	16-Aug – 14-Sep	27-Aug	24-Aug ± 3.6
White-tailed Kite	15-Oct	15-Oct	–	–	04-Oct ± 8.8
Mississippi Kite	15-Aug	15-Oct	17-Aug – 5-Sep	31-Aug	29-Aug ± 4.0
Sharp-shinned Hawk	5-Sep	15-Nov	28-Sep – 27-Oct	14-Oct	08-Oct ± 5.9
Cooper's Hawk	25-Aug	13-Nov	26-Sep – 24-Oct	14-Oct	07-Oct ± 5.0
Harris' Hawk	8-Sep	27-Oct	8-Sep – 27-Oct	26-Sep	30-Sep ± 11.6
Red-shouldered Hawk	17-Aug	1-Nov	17-Aug – 15-Oct	27-Sep	01-Oct ± 11.9
Broad-winged Hawk	20-Aug	13-Nov	22-Sep – 30-Sep	26-Sep	25-Sep ± 2.6
Swainson's Hawk	16-Aug	13-Nov	14-Oct – 14-Oct	14-Oct	10-Oct ± 5.7
White-tailed Hawk	17-Aug	1-Nov	17-Aug – 1-Nov	24-Sep	22-Sep ± 10.8
Zone-tailed Hawk	19-Sep	15-Oct	19-Sep – 15-Oct	26-Sep	25-Sep ⁴
Red-tailed Hawk	24-Aug	15-Nov	22-Sep – 4-Nov	14-Oct	20-Oct ± 12.4
Ferruginous Hawk	29-Sep	29-Sep	–	–	05-Oct ⁴
Golden Eagle	15-Oct	16-Oct	–	–	–
Bald Eagle	26-Sep	26-Sep	–	–	–
Crested Caracara	16-Aug	1-Nov	20-Aug – 1-Nov	23-Sep	15-Oct ± 7.6
American Kestrel	27-Aug	12-Nov	22-Sep – 15-Oct	30-Sep	04-Oct ± 3.8
Merlin	14-Sep	5-Nov	22-Sep – 15-Oct	25-Sep	01-Oct ± 5.3
Prairie Falcon	13-Sep	15-Oct	23-Sep – 14-Oct	30-Sep	02-Oct ± 6.9
Peregrine Falcon	5-Sep	4-Nov	22-Sep – 14-Oct	27-Sep	01-Oct ± 2.5
Aplomado Falcon	19-Aug	19-Aug	–	–	–
ALL SPECIES	15-Aug	15-Nov	22-Sep – 1-Oct	26-Sep	26-Sep ± 2.6

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

² Date by which 50% of the flight had passed the lookout.

³ Mean of annual values ± 95% confidence interval in days; unless otherwise indicated, values are given only for species with annual counts ≥5 birds for ≥3 years.

⁴ Data for 1999 only.

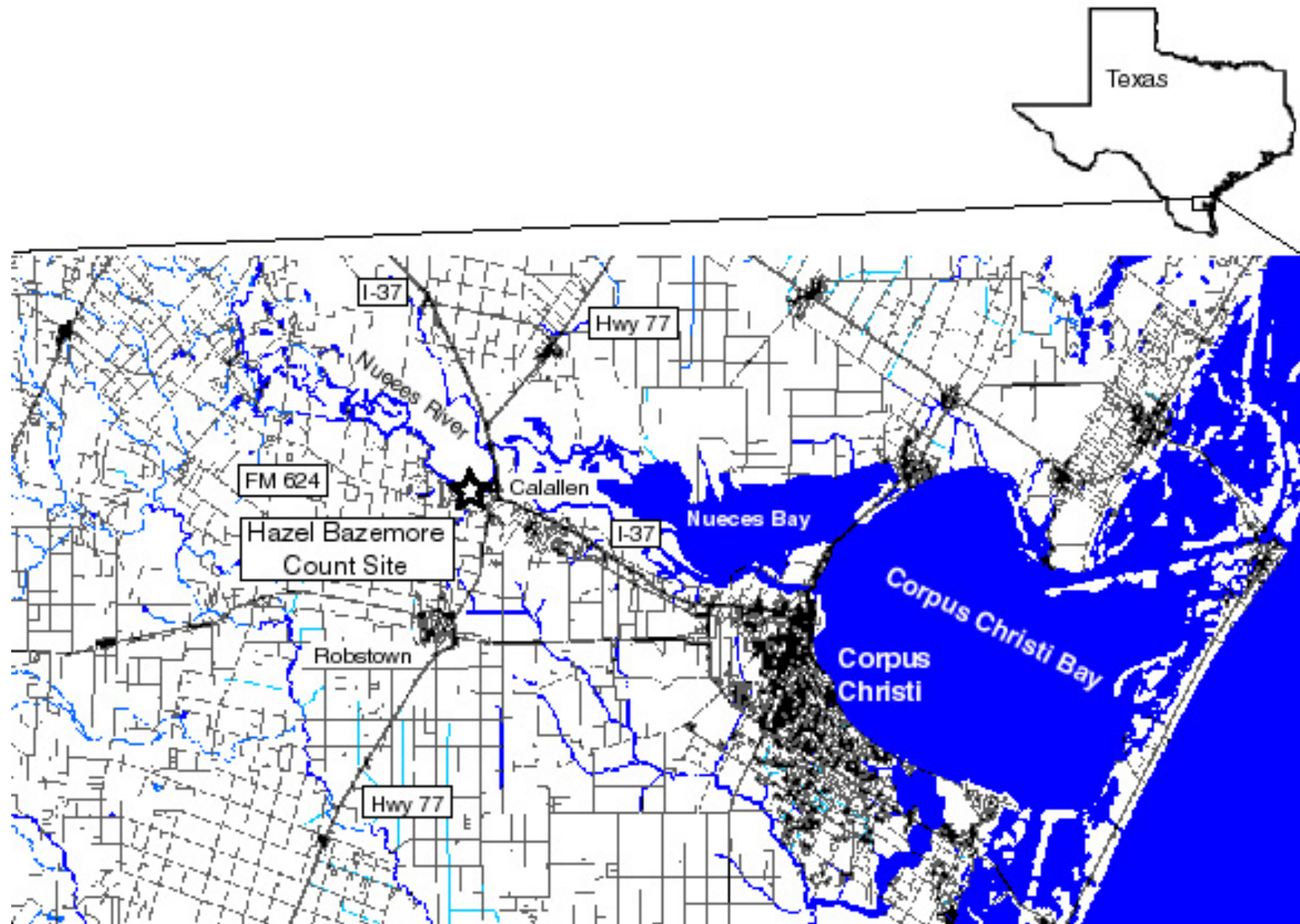


Figure 1. Location of Hazel Bazemore County Park count site near Corpus Christi, Texas.

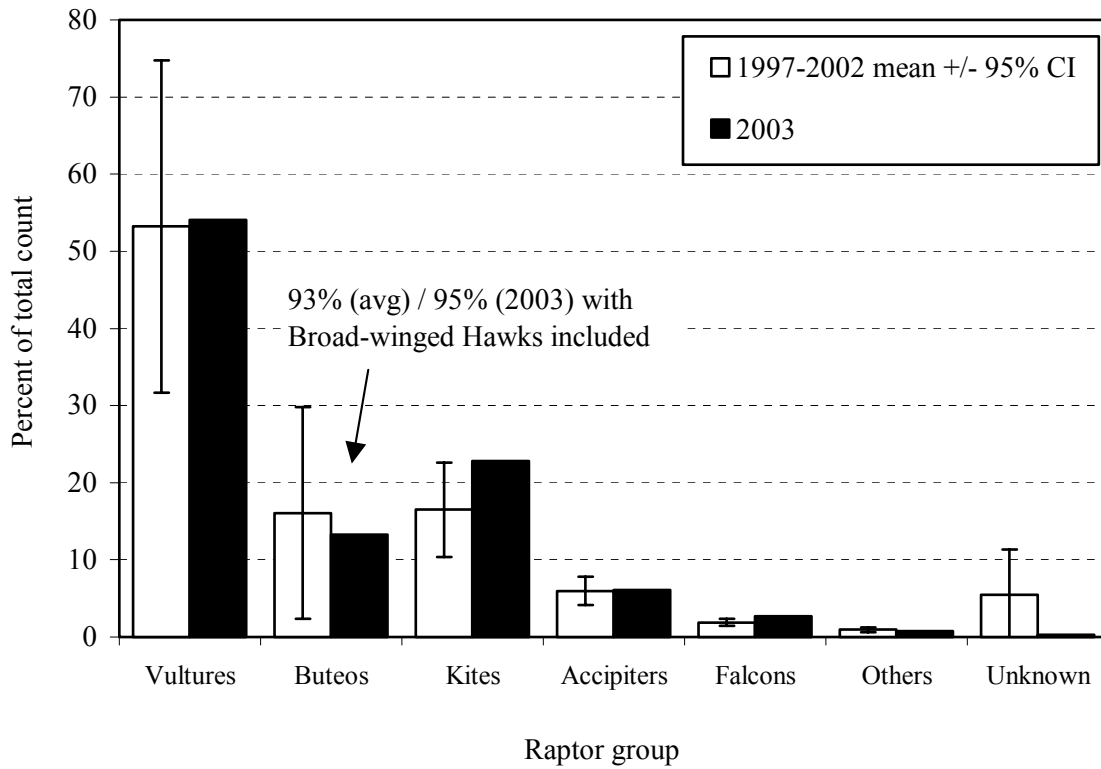


Figure 2. Composition of the fall raptor migration by species groups at Hazel Bazemore Park near Corpus Christi, Texas: 1997–2002 versus 2003.

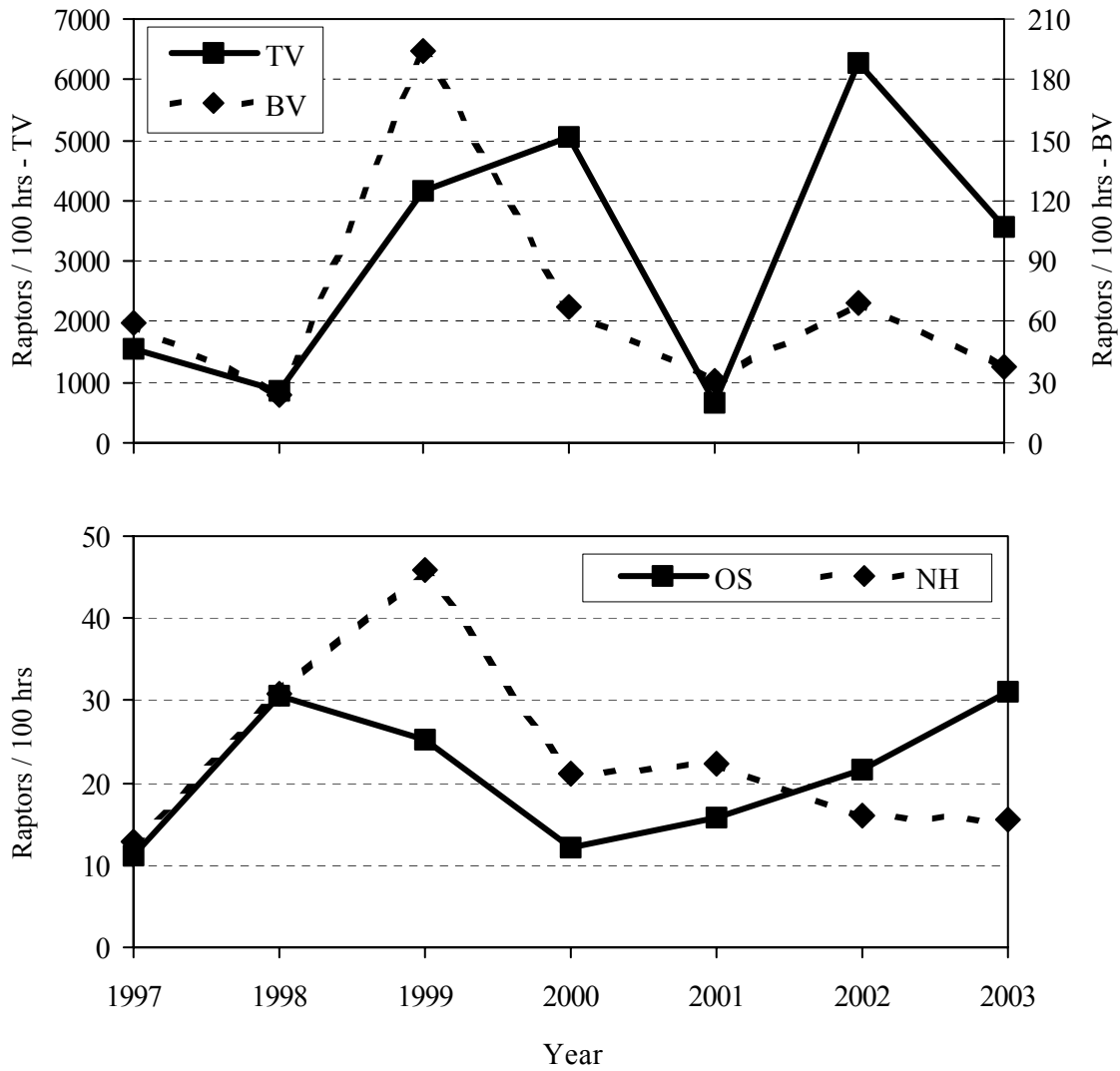


Figure 3. Annual fall-migration passage rates of Turkey and Black Vultures, Ospreys, and Northern Harriers at Hazel Bazemore Park near Corpus Christi, Texas: 1997–2003.

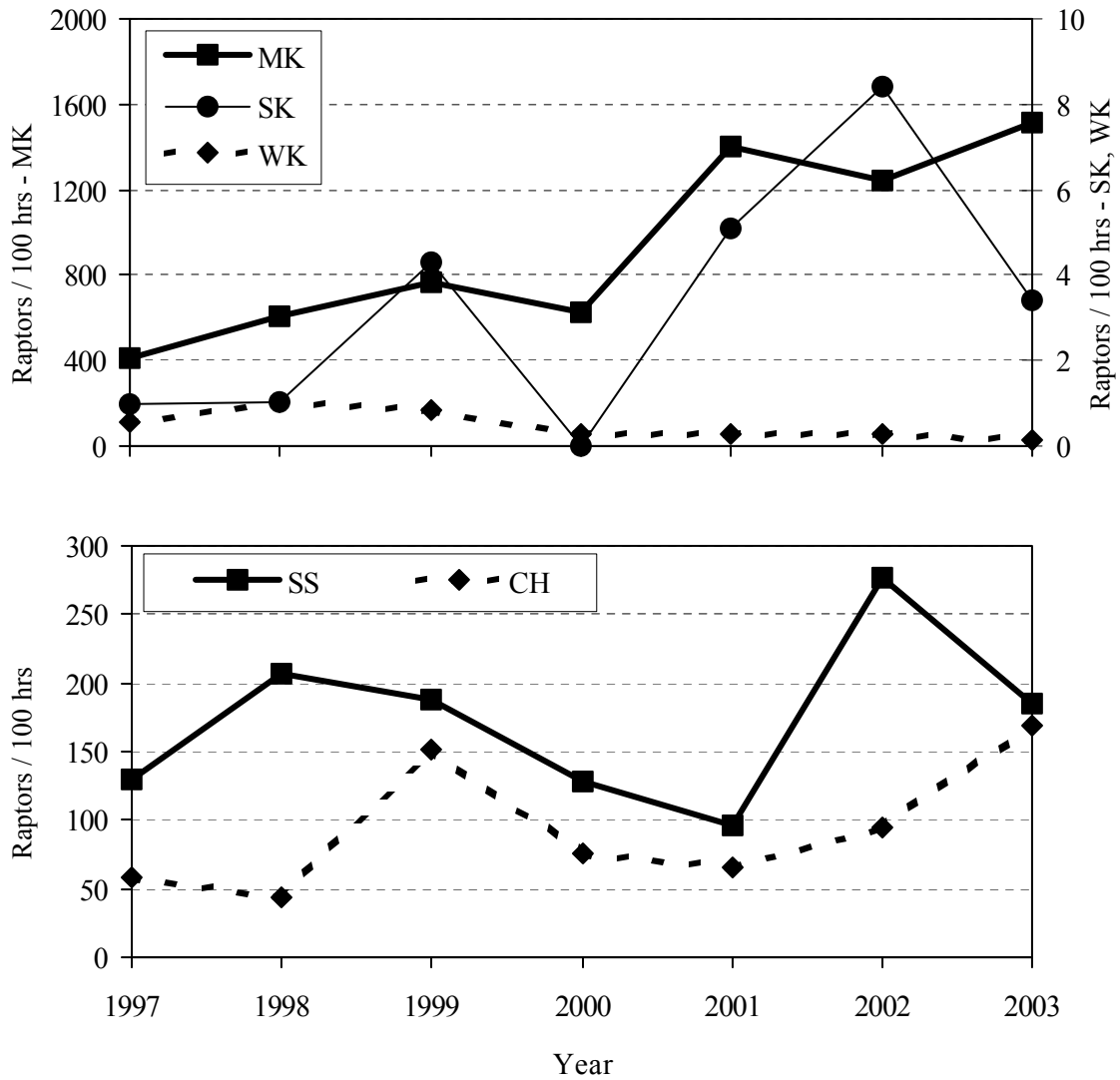


Figure 4. Annual fall-migration passage rates of Mississippi, Swallow-tailed and White-tailed Kites, and Sharp-shinned and Cooper's Hawks at Hazel Bazemore Park near Corpus Christi, Texas: 1997–2003.

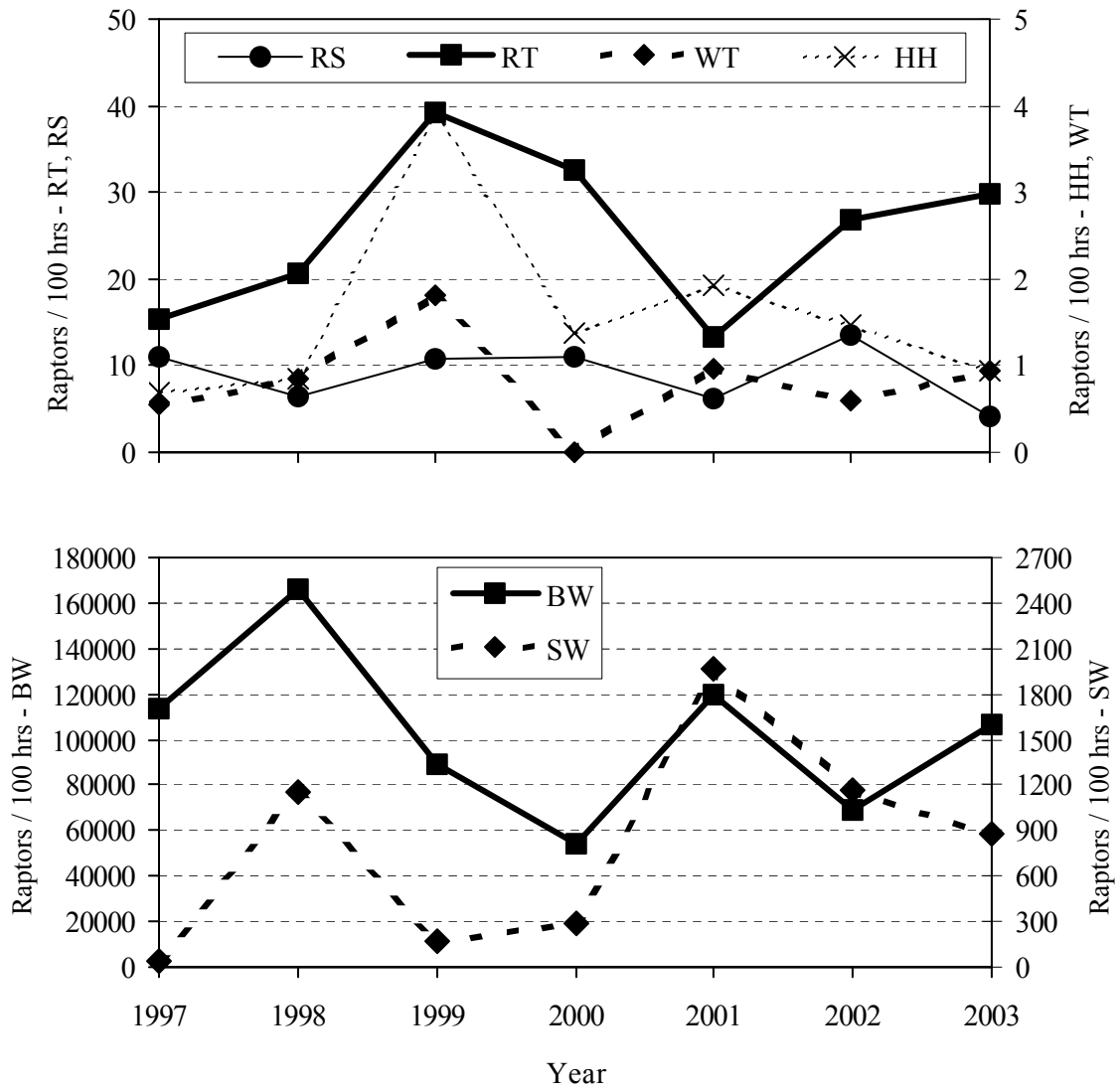


Figure 5. Annual fall-migration passage rates of Red-shouldered, Red-tailed, White-tailed, Broad-winged, and Swainson's Hawks at Hazel Bazemore Park near Corpus Christi, Texas: 1997–2003.

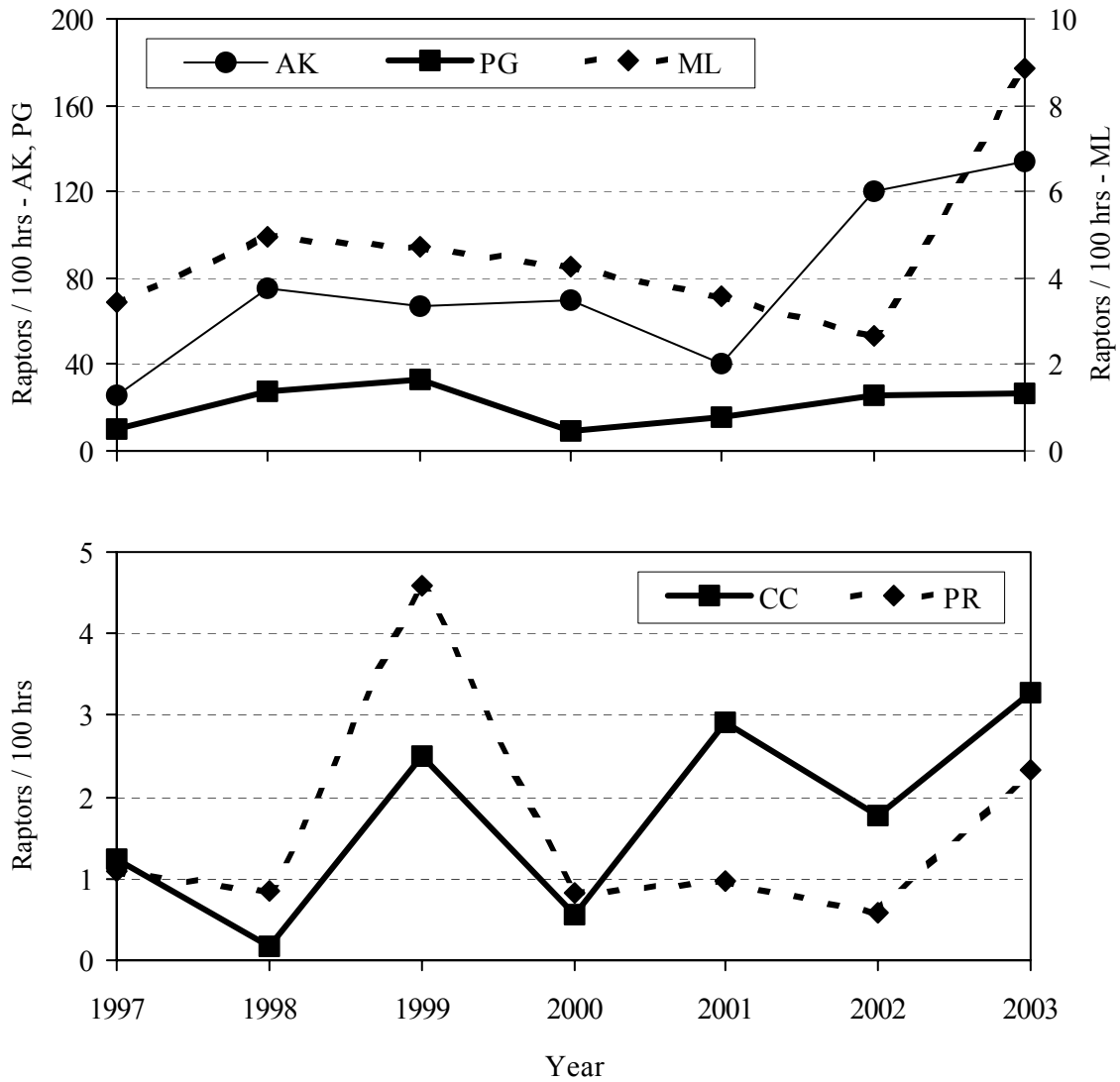


Figure 6. Annual fall-migration passage rates of American Kestrels, Merlins, Peregrine Falcons, Prairie Falcons, and Crested Caracaras at Hazel Bazemore Park near Corpus Christi, Texas: 1997–2003.

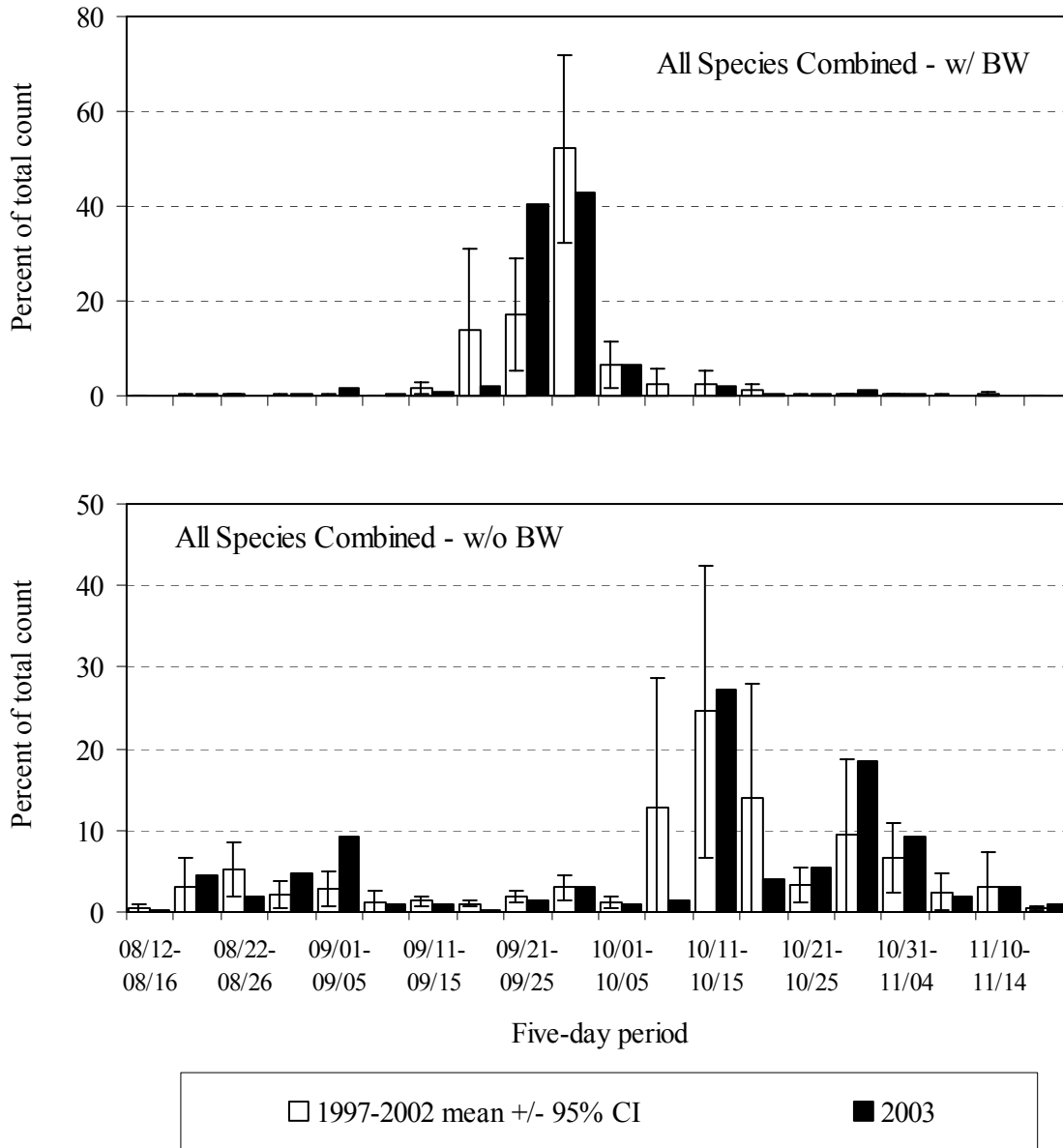


Figure 7. Combined-species flight volume by five-day periods, with and without Broad-wing Hawks, for the fall raptor migration at Hazel Bazemore Park near Corpus Christi, Texas: 1997–2002 versus 2003.

Appendix A. Common and scientific names, species codes, and regularly applied age, sex, and color-morph classifications.

Common Name	Scientific Name	Species Code	Age ¹	Sex ²	Color Morph ³
Black Vulture	<i>Coragyps atratus</i>	BV	U	U	NA
Turkey Vulture	<i>Cathartes aura</i>	TV	U	U	NA
Osprey	<i>Pandion haliaetus</i>	OS	U	U	NA
Northern Harrier	<i>Circus cyaneus</i>	NH	A I Br U	M F U	NA
Hook-billed Kite	<i>Chondrohierax uncinatus</i>	HK	A I U	AM AF U	D L U
Swallow-tailed Kite	<i>Elanoides forficatus</i>	SK	U	U	NA
White-tailed Kite	<i>Elanus leucurus</i>	WK	U	U	NA
Mississippi Kite	<i>Ictinia mississippiensis</i>	MK	A I U	U	NA
Unknown kite	<i>see above</i>	UK	U	U	NA
Sharp-shinned Hawk	<i>Accipiter striatus</i>	SS	A I U	U	NA
Cooper's Hawk	<i>Accipiter cooperii</i>	CH	A I U	U	NA
Northern Goshawk	<i>Accipiter gentilis</i>	NG	A I U	U	NA
Unknown accipiter	<i>Accipiter spp.</i>	UA	U	U	NA
Harris' Hawk	<i>Parabuteo unicinctus</i>	HH	A I U	U	NA
Red-shouldered Hawk	<i>Buteo lineatus</i>	RS	A I U	U	NA
Broad-winged Hawk	<i>Buteo platypterus</i>	BW	A I U	U	D L U
Short-tailed Hawk	<i>Buteo brachyurus</i>	ST	U	U	D L U
Swainson's Hawk	<i>Buteo swainsoni</i>	SW	U	U	D L U
White-tailed Hawk	<i>Buteo albicaudatus</i>	WT	A I U	U	NA
Zone-tailed Hawk	<i>Buteo albonotatus</i>	ZT	A I U	U	NA
Red-tailed Hawk	<i>Buteo jamaicensis</i>	RT	A I U	U	D L U
Ferruginous Hawk	<i>Buteo regalis</i>	FH	A I U	U	D L U
Rough-legged Hawk	<i>Buteo lagopus</i>	RL	U	U	D L U
Common Black Hawk	<i>Buteogallus anthracinus</i>	CB	A I U	U	NA
Unknown buteo	<i>Buteo spp.</i>	UB	U	U	D L U
Golden Eagle	<i>Aquila chrysaetos</i>	GE	A S I NA U ⁴	U	NA
Bald Eagle	<i>Haliaeetus leucocephalus</i>	BE	A S2 S1 I NA U ⁵	U	NA
Unknown eagle	<i>Aquila or Haliaeetus spp.</i>	UE	U	U	NA
Crested Caracara	<i>Caracara cheriway</i>	CC	U	U	NA
American Kestrel	<i>Falco sparverius</i>	AK	U	M F U	NA
Merlin	<i>Falco columbarius</i>	ML	AM Br	M U	NA
Prairie Falcon	<i>Falco mexicanus</i>	PR	U	U	NA
Peregrine Falcon	<i>Falco peregrinus</i>	PG	A I U	U	NA
Aplomado Falcon	<i>Falco femoralis</i>	AF	A I U	U	NA
Unknown falcon	<i>Falco spp.</i>	UF	U	U	NA
Unknown raptor	Falconiformes	UU	U	U	NA

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

² M = male, F = female, U = unknown.

³ D = dark or rufous, L = light, U = unknown, NA = not applicable.

⁴ Golden Eagle age codes: I = immature, first-year bird, bold white wing patch visible below (small patch may be visible above), bold white in the tail, no molt; S = subadult, white wing patch variable or absent, obvious white in the tail, molt or tawny bar on upper wing visible; NA = not adult, unknown age immature/subadult, obvious white in wing or tail, but rest of plumage not adequately observed; A = adult, no obvious white on wing or tail; U = plumage not adequately observed to make an age determination.

⁵ Bald Eagle age codes: I = immature, first-year bird, dark breast and tawny belly; S1 = young subadult, Basic I and II plumages, light belly or upside-down white triangle on the 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 tip to tail (may be hard to see in field) and adult with pure white head and tail; U = plumage not adequately observed to make an age determination.

Appendix B. History of official observer participation in the Corpus Christi Raptor Migration Project: 1997–2003.

1997: Two observers throughout: Glenn Swartz (6 partial at this site) and Joel Simon (0), regularly assisted by several other dedicated volunteers.

1998: Two observers throughout: Glenn Swartz (1 plus 6 partial at this site) and Joel Simon (1), regularly assisted by several other dedicated volunteers.

1999: Three observers throughout: Joel Simon (2), Fernando Rincon (1), and Ryan Wagner (0), regularly assisted by several other dedicated volunteers.

2000: Rotating team working two at a time except during peak Broad-winged Hawk flight when all three worked together: Scott Rush (2), Beth Hahn (1), and Jo Creglow (several partial at this site), regularly assisted by several other dedicated volunteers.

2001: Rotating team working two at a time except during the peak Broad-winged Hawk flight when all three worked together: Greg Greene (limited experience in Idaho), Devin Taylor (0), and Karen Johnson (0), regularly assisted by several other dedicated volunteers.

2002: Rotating team working two at a time except during the peak Broad-winged Hawk flight when all three worked together: Joel Simon (3), Vicki Simon (regular volunteer on project since 1997), Kirsten McDonnell (2), Paul Sweet (0), regularly assisted by several other dedicated volunteers.

2003: Rotating team working two at a time except during the peak Broad-winged Hawk flight when all three worked together: Joel Simon (4), Ricardo Perez (0, but relevant experience in PA and El Salvador), Taylor Ellis (0, but relevant experience in FL), regularly assisted by several other dedicated volunteers.

¹ Numbers in parentheses indicate the number of previous full-seasons of experience counting migratory raptors.

Appendix C. Daily observation effort, visitor disturbance ratings, and predominant weather conditions during the fall raptor migration at Hazel Bazemore Park near Corpus Christi, TX: 2003.

DATE	OBS. HOURS	NUMBER OBSRVRS ¹	VISITOR DISTURB ²	SKY CONDITION ³	WIND SPEED (KPH) ¹	WIND DIRECTION	TEMP. (°C) ¹	BARO. PRESS. (IN HG) ¹	MEDIAN THERMAL LIFT ⁴	VISIB. EAST (KM) ¹	VISIB. WEST (KM) ¹	FLIGHT DIST. ⁵	RAPTORS / HOUR
15-Aug	9.00	3.8	0	mc-ovc, haze	7.8	nnw-ne	33.5	30.03	4	9	9	3	7.2
16-Aug	7.00	3.0	0	ovc-pc	13.9	ne-e	32.5	29.89	4	10	10	2	1.7
17-Aug	7.00	4.8	0	pc-ovc	2.4	calm/var, ne-ene	32.9	29.87	2	10	11	3	219.4
18-Aug	8.00	2.2	0	clr, AM haze	3.8	sse-s, e-ese	32.9	29.87	2	7	8	2	17.0
19-Aug	8.00	3.2	0	clr-pc, AM haze	5.6	AM calm, e-ese	33.9	29.91	2	9	11	2	1.8
20-Aug	8.00	2.5	0	clr-mc, AM haze	3.9	e-s	32.0	29.89	3	10	10	1	19.6
21-Aug	8.00	2.4	0	clr-mc, AM haze	4.0	e-se	32.7	29.88	2	10	11	2	34.0
22-Aug	6.00	2.1	0	clr-ovc, AM haze, PM ts	2.4	var	31.1	29.88	2	7	9	2	2.0
23-Aug	8.00	3.1	0	pc-ovc, AM haze	1.2	calm/var	29.3	29.89	4	6	7	-	0.0
24-Aug	8.00	2.5	0	pc	1.2	calm/ssw, e	31.9	29.91	2	9	10	2	96.5
25-Aug	8.00	2.9	0	clr-pc, AM haze	4.6	AM calm, e-s	32.6	29.90	3	9	9	2	7.5
26-Aug	8.00	2.1	0	clr-pc, AM haze	2.3	calm/e, ese	33.4	29.88	3	10	10	3	3.1
27-Aug	8.00	3.7	0	clr-pc, AM haze	4.9	calm/s, ese	33.1	29.85	3	11	11	2	3.8
28-Aug	8.00	3.3	0	clr-pc, AM haze	5.2	e-se	33.8	29.83	3	10	11	2	17.5
29-Aug	8.00	2.6	0	clr-pc, AM haze	4.4	calm/ese, ne-e	33.7	29.80	3	11	11	2	19.9
30-Aug	8.00	4.6	0	clr-mc, AM haze	4.0	AM calm, ne-ese	31.7	29.78	3	8	9	2	18.8
31-Aug	8.00	3.8	0	pc-mc, AM haze	2.7	nw-n/calm-var	32.3	29.74	3	10	10	3	206.4
01-Sep	6.75	3.8	0	pc-ovc, AM haze, PM ts	3.6	calm/var	30.6	29.85	4	6	7	2	42.8
02-Sep	6.25	2.0	0	clr-ovc, AM fog/haze	2.0	AM calm, var	30.1	29.88	4	4	5	2	3.4
03-Sep	8.00	1.8	0	ovc, AM haze	2.3	AM calm, ne-ese	30.8	29.88	4	8	9	1	1007.9
04-Sep	3.75	1.7	0	mc-ovc, haze, rain	0.0	AM calm, var	29.8	29.89	4	2	4	1	129.1
05-Sep	8.00	4.5	0	ovc-pc, AM haze	2.9	nnw-ne	29.4	29.85	3	6	7	2	214.3
06-Sep	8.50	5.6	0	clr-pc, AM haze	1.9	ne-ene	29.9	29.87	2	7	8	2	54.1
07-Sep	8.00	4.7	0	clr, AM haze	2.6	ne-ene	29.9	29.86	3	7	8	2	41.4
08-Sep	8.50	3.0	0	clr-mc, AM haze	3.4	AM calm, s-ssw, ne-e	30.6	29.81	3	7	7	1	96.6
09-Sep	5.25	3.8	0	clr-ovc, PM ts	3.6	e-s, ne	31.3	29.82	3	8	9	2	4.0
10-Sep	8.00	2.2	0	clr-mc, AM haze	6.4	se-ssw	32.4	29.80	4	8	8	2	0.8
11-Sep	7.50	2.7	0	mc-ovc	5.3	se-ssw	32.9	29.77	4	8	9	2	0.5
12-Sep	0.00			rain									
13-Sep	8.00	3.6	0	clr-mc, AM haze	2.2	s, var	31.1	29.77	3	10	10	2	65.0
14-Sep	8.50	7.2	0	clr-ovc, AM haze	5.7	AM calm, ene-ese	31.0	29.90	3	9	9	2	115.5
15-Sep	8.00	5.1	0	pc-ovc, AM haze, PM rain	4.7	n-e	28.6	29.97	3	9	10	3	708.9
16-Sep	3.25	1.6	0	mc-ovc, AM haze, scat rain	5.0	ne-e	28.0	29.91	4	5	5	2	1.8
17-Sep	7.25	2.5	0	pc-ovc, haze, scat rain	6.6	ene-e	30.1	29.81	4	5	5	2	1.1
18-Sep	0.00			rain									
19-Sep	7.00	5.1	0	ovc, haze, scat rain	8.5	nne-ene	27.3	29.89	4	4	4	2	2284.6
20-Sep	4.50	6.0	0	ovc, AM haze, PM rain	7.8	ne-ene	27.7	29.85	4	4	5	2	14.9
21-Sep	0.00			rain									
22-Sep	9.50	7.0	0	ovc-pc, AM haze	3.9	ne-e	26.8	29.89	3	6	7	2	9226.5
23-Sep	9.50	8.6	0	clr-pc, AM fog, haze	3.6	ne-e	28.4	29.92	2	6	7	2	12575.4
24-Sep	8.00	5.3	0	clr-pc, AM haze/rain	4.7	ne-e	29.4	29.82	2	8	8	2	940.5
25-Sep	9.50	7.5	0	pc-mc, AM haze	5.3	ene-e	30.7	29.79	3	7	7	2	8246.4
26-Sep	9.25	8.8	0	ovc-clr, AM fog/haze	2.6	calm/n-ne	29.7	29.68	2	7	8	2	11637.8
27-Sep	9.50	8.8	0	clr-mc, AM haze	4.7	n-ene	30.1	29.73	2	8	9	2	2089.1
28-Sep	8.50	8.1	0	clr-ovc, haze	8.1	n-ene	29.1	29.88	2	7	8	2	10956.2
29-Sep	8.00	5.3	0	clr	9.2	ne-e	27.3	30.00	2	13	13	3	2570.8
30-Sep	9.00	5.0	0	clr-pc	7.2	ne-e	26.9	29.99	2	12	13	3	7924.6
01-Oct	9.00	4.3	0	clr	9.4	nne-ne	26.9	30.00	2	11	12	3	4308.0
02-Oct	8.00	4.6	0	clr-pc, AM haze	10.9	ne-e	26.6	29.95	3	10	11	3	162.8
03-Oct	7.50	2.3	0	clr-ovc, AM haze	7.2	ne-ene	25.6	29.83	4	7	8	1	556.3
04-Oct	7.50	5.5	0	clr-pc, AM fog/haze	7.3	AM calm/nw, ne-ese	28.4	29.83	3	7	8	1	46.3
05-Oct	7.50	2.4	0	clr-mc, AM fog/haze	5.6	ene-se	29.3	29.82	3	10	10	2	202.4
06-Oct	7.50	2.6	0	pc-ovc, AM fog/haze	4.9	ne-se	30.7	29.78	3	9	10	2	46.4

Appendix C. continued

DATE	OBS. HOURS	NUMBER OBSRVRS ¹	VISITOR DISTURB ²	SKY CONDITION ³	WIND SPEED (KPH) ¹	WIND DIRECTION	TEMP. (°C) ¹	BARO. PRESS. (IN HG) ¹	MEDIAN THERMAL LIFT ⁴	VISIB. EAST (KM) ¹	VISIB. WEST (KM) ¹	FLIGHT DIST. ⁵	RAPTORS / HOUR
07-Oct	7.25	1.9	0	ovc, AM haze, scat rain	7.2	ne-e	27.4	29.78	4	6	6	1	10.5
08-Oct	0.00			rain									
09-Oct	5.00	2.7	0	pc-ovc, AM haze, PM rain	6.7	sse-ssw	30.7	29.68	3	11	11	1	25.0
10-Oct	7.25	2.8	0	ovc, AM fog/haze/rain	4.9	ssw, ne-ene	29.0	29.60	4	7	8	2	18.8
11-Oct	7.50	3.1	0	ovc-pc, AM fog	8.3	ne-e	29.3	29.67	4	8	8	1	33.3
12-Oct	0.00			rain									
13-Oct	0.00			rain									
14-Oct	8.00	5.2	0	clr-ovc, AM haze	9.3	nw-n	28.8	29.82	3	12	12	2	1603.3
15-Oct	8.00	5.6	0	clr-ovc	5.3	n-ese	24.8	29.94	3	14	14	3	149.1
16-Oct	7.75	3.0	0	ovc-pc, AM haze	3.9	nne-ne	29.0	29.88	4	8	9	2	158.3
17-Oct	7.50	3.3	0	ovc-pc	6.1	nnw-n	31.7	29.92	2	13	13	3	137.7
18-Oct	8.00	5.4	0	clr	4.4	nnw-ne	26.7	29.99	2	12	12	3	115.0
19-Oct	8.00	3.6	0	clr, AM haze	1.3	n-nne/calm	28.4	29.97	2	11	11	3	57.5
20-Oct	8.00	2.3	0	clr-pc, AM haze	1.7	n-ese	27.8	30.01	3	8	8	2	23.3
21-Oct	8.00	2.4	0	clr, AM haze	2.1	nw-nne, calm	28.3	30.02	2	9	9	2	22.6
22-Oct	6.50	2.4	0	clr, AM fog/haze	3.6	sw-wsw, nw-nnw	28.1	29.88	3	9	10	2	23.1
23-Oct	8.25	2.3	0	clr	2.2	sw	29.0	29.80	3	12	12	3	151.0
24-Oct	7.50	4.0	0	pc-mc, AM haze	6.0	se-ssw	28.4	29.76	3	11	11	2	39.3
25-Oct	8.00	2.3	0	mc-ovc, AM fog	8.3	s-ssw	30.2	29.79	3	10	10	4	64.1
26-Oct	7.00	4.8	0	ovc	11.3	nw	17.4	30.02	4	11	11	2	10.7
27-Oct	7.75	2.7	0	ovc-pc	6.6	nw	19.4	29.91	4	13	13	3	770.6
28-Oct	7.50	3.8	0	clr	6.9	sw	23.5	29.69	2	15	15	3	102.4
29-Oct	7.50	2.5	0	mc-pc	6.5	sw	26.3	29.69	3	13	13	2	136.4
30-Oct	7.50	1.9	0	ovc, AM haze	6.0	se-sse	29.0	29.71	4	10	10	2	13.7
31-Oct	7.50	1.9	0	ovc, AM haze	9.5	ese-se	30.5	29.85	4	8	8	2	20.1
01-Nov	7.50	2.8	0	pc-ovc, AM fog	8.6	ne-se	28.8	29.91	4	7	7	2	156.4
02-Nov	7.50	3.0	0	mc-ovc, AM haze	8.8	ese-sse	30.6	29.88	3	8	8	2	120.7
03-Nov	7.50	2.7	0	ovc-clr, AM haze	6.4	e-se	30.1	29.81	3	9	9	2	118.5
04-Nov	7.50	2.7	0	pc-ovc, AM haze	6.5	se-s	30.3	29.72	4	10	10	2	116.1
05-Nov	7.00	1.8	0	pc	6.9	se	26.8	29.81	2	13	13	2	64.7
06-Nov	7.00	2.6	0	pc-ovc, AM fog	6.0	ene-ese	27.8	29.93	4	11	11	2	35.4
07-Nov	7.00	2.6	0	ovc, fog/haze	7.0	n-ne	21.9	30.01	4	3	4	2	17.3
08-Nov	1.00	3.0	0	ovc, fog/rain	6.5	nnw	16.0	30.08	4	1	1	-	0.0
09-Nov	0.00			rain									
10-Nov	7.50	3.4	0	clr-mc, AM haze	4.0	ne-e	24.4	30.08	3	5	5	1	47.9
11-Nov	6.00	6.3	0	mc-ovc, AM fog	5.3	se-ssw	28.9	29.94	4	7	7	2	37.0
12-Nov	6.50	2.8	0	mc-pc	4.1	se-s	29.6	29.91	2	13	13	3	27.5
13-Nov	6.50	3.3	0	pc-ovc, PM haze	11.3	n-ne	24.0	30.13	4	7	8	2	2.5
14-Nov	7.00	3.1	0	ovc	5.3	ene-se	23.5	30.01	4	8	9	2	79.1
15-Nov	6.50	3.6	0	pc-ovc, AM fog	3.7	sse-ssw	29.0	29.81	2	12	12	2	61.1

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 fall raptor migration counts by species at Hazel Bazemore Park near Corpus Christi, Texas: 2003.

DATE	OBS.		SPECIES ¹																								BIRDS								
	HOURS	BV	TV	OS	NH	HK	SK	WK	MK	SS	CH	UA	HH	RS	BW	SW	WT	ZT	RT	FH	UB	GE	BE	CC	AK	ML	PR	PG	AF	UF	UU	TOTAL	/HOUR		
15-Aug	9.00	0	0	0	0	0	0	0	65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	65	7.2
16-Aug	7.00	0	0	0	0	0	5	0	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	12	1.7
17-Aug	7.00	0	0	0	0	0	4	0	1519	0	0	0	0	4	0	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1536	219.4
18-Aug	8.00	0	0	1	0	0	0	0	135	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	136	17.0	
19-Aug	8.00	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	14	1.8	
20-Aug	8.00	0	0	0	0	0	0	0	15	0	0	0	0	0	134	7	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	157	19.6	
21-Aug	8.00	0	0	0	0	0	1	0	267	0	0	0	0	0	0	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	272	34.0	
22-Aug	6.00	0	0	0	0	0	0	0	7	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	2.0	
23-Aug	8.00	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	0.0
24-Aug	8.00	0	0	1	0	0	0	0	766	0	0	0	0	0	0	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	772	96.5	
25-Aug	8.00	0	0	1	0	0	0	0	38	0	2	0	0	0	6	9	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	60	7.5	
26-Aug	8.00	0	0	1	0	0	0	0	17	0	0	0	0	0	2	3	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	25	3.1	
27-Aug	8.00	0	0	0	1	0	1	0	16	0	0	0	0	0	3	8	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	30	3.8	
28-Aug	8.00	0	0	1	0	0	1	0	100	0	0	0	0	0	34	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	140	17.5	
29-Aug	8.00	0	0	0	0	0	0	0	149	0	0	0	0	0	4	4	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	159	19.9	
30-Aug	8.00	0	0	0	0	0	0	0	140	0	1	0	0	0	1	6	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	150	18.8	
31-Aug	8.00	0	0	1	0	0	0	0	1629	0	0	0	0	0	7	7	0	0	1	0	4	0	0	1	1	0	0	0	0	0	0	0	1651	206.4	
1-Sep	6.75	0	0	0	0	0	0	0	286	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	289	42.8	
2-Sep	6.25	0	0	0	0	0	0	0	12	0	0	0	0	0	3	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	3.4	
3-Sep	8.00	0	0	1	0	0	0	0	1756	0	0	0	0	0	6301	2	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	8063	1007.9	
4-Sep	3.75	0	0	0	0	0	0	0	483	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	484	129.1	
5-Sep	8.00	0	0	5	0	0	6	0	1432	1	1	0	0	1	258	6	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0	0	1714	214.3	
6-Sep	8.50	0	0	6	0	0	0	0	268	0	0	0	0	2	171	5	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	6	460	54.1	
7-Sep	8.00	0	0	3	1	0	0	0	66	0	1	1	0	0	244	9	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	2	331	41.4	
8-Sep	8.50	0	0	4	0	0	1	0	19	0	5	0	1	1	776	4	0	0	2	0	1	0	0	6	0	0	1	0	0	0	0	821	96.6		
9-Sep	5.25	0	0	0	0	0	0	0	0	0	1	0	0	0	16	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	21	4.0	
10-Sep	8.00	0	0	0	0	0	0	0	5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0.8	
11-Sep	7.50	0	0	0	0	0	0	0	1	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0.5	
12-Sep	0.00																																		
13-Sep	8.00	0	0	1	0	0	0	0	35	0	0	0	0	0	468	3	0	0	1	0	1	0	0	2	5	0	1	2	0	0	1	520	65.0		
14-Sep	8.50	0	0	1	1	0	2	0	143	0	0	0	0	0	813	9	0	0	0	0	0	0	0	6	3	0	1	0	1	2	982	115.5			
15-Sep	8.00	0	0	5	1	0	0	0	142	1	1	0	0	0	5489	10	0	0	4	0	2	0	0	11	1	0	4	0	0	0	0	5671	708.9		
16-Sep	3.25	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	6	1.8		
17-Sep	7.25	0	0	2	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	1.1	
18-Sep	0.00																																		
19-Sep	7.00	0	0	3	0	0	0	0	35	0	0	1	0	0	15945	0	0	1	1	0	0	0	0	3	1	0	1	0	0	1	15992	2284.6			
20-Sep	4.50	0	0	1	0	0	0	0	3	0	0	0	0	0	58	0	0	0	0	0	0	0	0	2	0	0	2	0	0	1	67	14.9			
21-Sep	0.00																																		
22-Sep	9.50	0	40	17	2	0	0	0	27	4	9	3	0	1	87429	17	0	0	9	0	0	0	0	42	13	0	29	0	4	6	87652	9226.5			
23-Sep	9.50	0	4	15	0	0	0	0	16	5	20	1	1	1	119302	44	0	0	11	0	0	0	2	24	4	2	11	0	2	1	119466	12575.4			
24-Sep	8.00	0	0	6	0	0	0	0	1	8	5	1	0	0	7482	3	1	2	0	0	0	0	0	10	3	0	2	0	0	0	7524	940.5			

Appendix D. continued

DATE	OBS.		SPECIES ¹																								BIRDS								
	HOURS		BV	TV	OS	NH	HK	SK	WK	MK	SS	CH	UA	HH	RS	BW	SW	WT	ZT	RT	FH	UB	GE	BE	CC	AK	ML	PR	PG	AF	UF	UU	TOTAL	/ HOUR	
25-Sep	9.50	0	61	14	2	0	0	0	21	11	27	5	0	2	78151	17	0	0	2	0	0	0	0	0	12	4	0	9	0	3	0	78341	8246.4		
26-Sep	9.25	0	7	13	5	1	1	0	35	37	70	6	1	0	107379	28	0	1	8	0	1	0	1	0	37	5	0	11	0	0	3	107650	11637.8		
27-Sep	9.50	3	8	13	1	0	0	0	3	45	41	10	0	1	19626	9	0	1	8	0	0	0	0	58	2	0	12	0	3	2	19846	2089.1			
28-Sep	8.50	0	1	14	9	0	0	0	32	133	103	7	0	2	92637	10	0	0	18	0	0	0	2	136	3	0	13	0	3	5	93128	10956.2			
29-Sep	8.00	0	2	9	6	0	0	0	3	40	51	25	0	2	20353	5	0	0	4	1	0	0	0	43	2	2	7	0	2	9	20566	2570.8			
30-Sep	9.00	4	15	5	2	0	0	0	2	21	47	17	0	0	71161	3	0	0	4	0	1	0	0	28	0	4	5	0	0	2	71321	7924.6			
1-Oct	9.00	0	9	5	2	0	0	0	4	28	48	8	0	0	38607	8	0	1	12	0	0	0	0	18	4	2	9	0	4	3	38772	4308.0			
2-Oct	8.00	0	5	1	0	0	0	0	15	14	10	5	0	0	1236	7	0	0	0	0	0	0	0	2	2	0	0	0	2	3	1302	162.8			
3-Oct	7.50	0	4	3	1	0	0	0	7	19	17	0	0	0	4100	5	0	0	1	0	0	0	0	1	8	1	0	5	0	0	0	4172	556.3		
4-Oct	7.50	0	20	2	4	0	0	0	2	9	17	3	0	0	268	3	0	0	0	0	0	0	0	7	0	0	9	0	1	2	347	46.3			
5-Oct	7.50	2	11	2	2	0	0	0	2	5	9	1	0	0	1445	12	0	0	1	0	1	0	0	21	1	0	3	0	0	0	1518	202.4			
6-Oct	7.50	0	105	1	1	0	0	0	0	8	5	0	0	1	8	214	0	0	0	0	0	0	0	0	0	0	4	0	1	0	348	46.4			
7-Oct	7.25	1	9	0	2	0	0	0	2	15	9	5	0	0	12	2	0	0	0	0	1	0	0	1	17	0	0	0	0	0	76	10.5			
8-Oct	0.00																																		
9-Oct	5.00	0	61	1	0	0	0	0	0	7	4	0	0	0	39	10	0	0	0	0	0	0	0	1	0	0	1	0	0	1	125	25.0			
10-Oct	7.25	0	10	1	0	0	0	0	0	30	10	4	0	0	58	5	0	0	0	0	0	0	0	15	1	0	0	0	1	1	136	18.8			
11-Oct	7.50	0	49	9	0	0	0	0	1	75	21	5	0	0	28	26	0	0	0	0	0	2	0	0	24	0	0	4	0	0	6	250	33.3		
12-Oct																																			
13-Oct																																			
14-Oct	8.00	6	5164	7	4	0	0	0	9	221	162	79	0	5	2021	4900	2	0	23	0	5	0	0	184	0	3	8	0	5	18	12826	1603.3			
15-Oct	8.00	2	224	1	4	0	0	1	1	131	136	35	0	1	521	36	0	1	8	0	20	1	0	47	3	1	3	0	2	14	1193	149.1			
16-Oct	7.75	0	75	4	2	0	0	0	0	27	43	10	0	0	1025	23	0	0	1	0	0	1	0	11	3	0	1	0	1	0	1	1227	158.3		
17-Oct	7.50	0	531	2	2	0	0	0	0	22	20	4	0	0	404	27	0	0	0	0	3	0	0	10	0	0	2	0	2	4	1033	137.7			
18-Oct	8.00	0	304	3	3	0	0	0	0	38	39	15	0	0	467	10	0	0	6	0	5	0	0	18	0	0	2	0	3	7	920	115.0			
19-Oct	8.00	0	201	0	0	0	0	0	0	13	10	4	0	1	215	1	0	0	2	0	4	0	0	7	0	0	0	0	1	1	460	57.5			
20-Oct	8.00	0	123	0	0	0	0	0	0	11	12	4	0	0	22	5	0	0	7	0	0	0	0	0	0	0	0	0	0	0	2	186	23.3		
21-Oct	8.00	0	118	0	1	0	0	0	0	7	6	3	1	0	34	8	0	0	1	0	0	0	2	0	0	0	0	0	0	0	181	22.6			
22-Oct	6.50	0	138	0	0	0	0	0	0	4	0	0	0	0	4	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	150	23.1			
23-Oct	8.25	0	1194	0	0	0	0	0	0	12	9	5	0	0	9	3	0	0	0	0	2	0	0	7	0	0	4	0	1	0	1246	151.0			
24-Oct	7.50	7	261	1	0	0	0	0	0	3	3	6	0	0	2	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	295	39.3			
25-Oct	8.00	0	498	3	0	0	0	0	0	0	2	0	1	0	0	8	0	0	0	0	0	0	0	0	0	0	1	0	0	0	513	64.1			
26-Oct	7.00	0	0	0	14	0	0	0	0	30	11	12	0	0	0	0	0	0	1	0	2	0	0	1	0	0	0	0	0	4	75	10.7			
27-Oct	7.75	1	5859	1	9	0	0	0	0	39	18	12	1	0	0	11	0	0	8	0	2	0	0	7	0	0	0	0	1	3	5972	770.6			
28-Oct	7.50	0	650	0	5	0	0	0	0	40	18	22	0	0	3	3	0	0	8	0	1	0	2	5	0	0	1	0	3	7	768	102.4			
29-Oct	7.50	0	983	0	2	0	0	0	0	15	3	3	0	0	3	8	0	0	1	0	1	0	0	0	0	0	0	0	0	4	1023	136.4			
30-Oct	7.50	0	98	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	103	13.7			
31-Oct	7.50	0	147	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0	151	20.1			
1-Nov	7.50	11	1132	2	1	0	0	0	0	8	5	4	0	1	0	0	1	0	2	0	0	0	3	1	0	0	0	0	1	1	1173	156.4			
2-Nov	7.50	3	885	0	0	0	0	0	0	2	0	1	0	0	0	10	0	0	2	0	0	0	0	0	0	0	0	0	0	2	905	120.7			
3-Nov	7.50	3	872	2	1	0	0	0	0	2	1	0	0	0	0	5	0	0	3	0	0	0	0	0	0	0	0	0	0	0	889	118.5			
4-Nov	7.50	128	702	0	3	0	0	0	0	11	6	5	0	0	2	4	0	0	6	0	1	0	0	2	0	0	1	0	0	0	871	116.1			

Appendix D. continued

DATE	OBS.		SPECIES ¹																								BIRDS							
	HOURS	BV	TV	OS	NH	HK	SK	WK	MK	SS	CH	UA	HH	RS	BW	SW	WT	ZT	RT	FH	UB	GE	BE	CC	AK	ML	PR	PG	AF	UF	UU	TOTAL	/ HOUR	
5-Nov	7.00	29	418	0	0	0	0	0	0	2	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	453	64.7
6-Nov	7.00	6	180	2	3	0	0	0	0	22	10	3	0	0	13	0	0	0	2	0	2	0	0	0	2	0	0	0	0	0	0	3	248	35.4
7-Nov	7.00	2	87	0	1	0	0	0	0	2	16	1	0	0	4	0	0	0	4	0	0	0	0	0	2	0	0	0	0	0	2	121	17.3	
8-Nov	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
9-Nov																																		
10-Nov	7.50	0	333	0	1	0	0	0	0	4	11	4	0	0	0	0	0	0	5	0	0	0	0	0	1	0	0	0	0	0	0	359	47.9	
11-Nov	6.00	11	207	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	222	37.0	
12-Nov	6.50	22	144	0	0	0	0	0	0	3	3	2	0	0	1	0	0	0	3	0	0	0	0	0	1	0	0	0	0	0	0	179	27.5	
13-Nov	6.50	0	7	1	0	0	0	0	0	1	3	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	16	2.5	
14-Nov	7.00	0	552	0	1	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	554	79.1	
15-Nov	6.50	0	392	1	0	0	0	0	0	2	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	397	61.1	
Total	643.00	241	22900	199	100	1	22	1	9753	1193	1083	344	6	26	684815	5633	6	7	192	1	71	2	1	21	860	57	15	169	1	47	133	727900	1132.0	

¹ See Appendix A for explanation of species codes.

Appendix E. Annual observation effort and fall raptor migration counts by species at Hazel Bazemore Park near Corpus Christi, Texas: 1997–2003.

	1997	1998	1999	2000	2001	2002	2003	MEAN
Start date	15-Aug	15-Aug	14-Aug	15-Aug	15-Aug	15-Aug	15-Aug	15-Aug
End date	15-Nov	15-Nov	15-Nov	15-Nov	15-Nov	15-Nov	15-Nov	15-Nov
Observation days	89	83	90	91	93	89	86	89
Observation hours	725.00	585.50	719.75	728.58	723.50	676.50	643.00	685.98
SPECIES	RAPTOR COUNTS							
Black Vulture	431	138	1,398	491	222	470	241	484
Turkey Vulture	11,221	5,011	30,027	36,690	4,870	42,536	22,900	21,894
Total vultures	11,652	5,149	31,425	37,181	5,092	43,006	23,141	22,378
Osprey	81	179	181	88	114	146	199	141
Northern Harrier	93	180	331	153	162	109	100	161
Hook-billed Kite	0	0	0	0	0	0	1	0
Swallow-tailed Kite	7	6	31	0	37	57	22	23
White-tailed Kite	4	6	6	2	2	2	1	3
Mississippi Kite	2,974	3,584	5,513	4,569	10,155	8,394	9,753	6,420
TOTAL KITES	2,985	3,596	5,550	4,571	10,194	8,453	9,776	6,446
Sharp-shinned Hawk	936	1,208	1,348	929	698	1,869	1,193	1,169
Cooper's Hawk	418	260	1,092	555	473	645	1,083	647
Northern Goshawk	0	0	1	0	0	1	0	0
Unknown accipiter	308	316	310	379	298	108	344	295
TOTAL ACCIPITERS	1,662	1,784	2,751	1,863	1,767	2,649	2,620	2,157
Harris' Hawk	5	5	28	10	14	10	6	11
Red-shouldered Hawk	79	38	77	81	45	92	26	63
Broad-winged Hawk	823,602	970,025	640,258	396,774	864,355	464,772	684,815	692,086
Short-tailed Hawk	0	0	2	0	0	0	0	0
Swainson's Hawk	300	6,790	1,246	2,085	14,260	7,912	5,633	5,461
White-tailed Hawk	4	5	13	0	7	4	6	6
Zone-tailed Hawk	2	0	6	0	1	2	7	3
Red-tailed Hawk	112	121	282	237	96	182	192	175
Ferruginous Hawk	1	0	14	1	1	2	1	3
Rough-legged Hawk	1	0	4	0	0	0	0	1
Common Black Hawk	0	0	0	0	0	1	0	0
Unidentified buteo	18	25	62	215	368	80	71	120
TOTAL BUTEOS	824,124	977,009	641,992	399,403	879,147	473,057	690,757	697,927
Golden Eagle	1	0	4	1	1	1	2	1
Bald Eagle	0	2	4	0	2	1	1	1
Unknown eagle	0	0	1	0	0	0	0	0
TOTAL EAGLES	1	2	9	1	3	2	3	3
Crested Caracara	9	1	18	4	21	12	21	12
American Kestrel	189	438	483	509	292	811	860	512
Merlin	25	29	34	31	26	18	57	31
Prairie Falcon	8	5	33	6	7	4	15	11
Peregrine Falcon	76	163	241	65	114	176	169	143
Aplomado Falcon	0	0	1	0	0	0	1	0
Unknown falcon	14	39	92	103	41	25	47	52
TOTAL FALCONS	312	674	884	714	480	1,043	1,163	753
Unidentified raptor	220	4,376	3,874	506	837	98	133	1,435
GRAND TOTAL	841,139	992,950	687,015	444,484	897,519	528,540	727,900	731,364