

**FALL 2004 RAPTOR MIGRATION STUDIES  
IN THE GRAND CANYON OF ARIZONA**



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

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*Report prepared by:*

**Jeff P. Smith**

*Counts conducted by:*

**Ken Babcock, Kirsten McDonnell, Chadette Pfaff, and Scott Olmstead**

**Assisted by Brian Gatlin**

*On-site education by:*

**Melanie Keithley and John Terenzini**

*Project coordinated by:*

**HawkWatch International, Inc.**

**Principal Investigator: Dr. Jeff P. Smith**

**1800 South West Temple, Suite 226, Salt Lake City, Utah 84115**

**(801) 484-6808**

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## INTRODUCTION

The Grand Canyon Raptor Migration Project in Arizona is an ongoing effort to monitor long-term trends in populations of raptors using the southern portion of the Intermountain Flyway (Hoffman et al. 2002, Hoffman and Smith 2003). The flight through this region is one of the largest concentrations of migrating raptors known in the western U.S. and Canada. To date, observers have recorded 19 species of migratory raptors at two count sites along the south rim of the canyon, with combined counts ranging from ~8,500–12,300 migrants per season. Chuck LaRue discovered the flyway in 1987 and Christie Van Cleve conducted exploratory counts at points along the south rim in 1989 and 1990. HawkWatch International (HWI) initiated standardized counts of the autumn raptor migration through this region at Lipan Point in 1991, and began standardized monitoring at Yaki Point in 1997. The 2004 season marked the 14<sup>th</sup> consecutive count at Lipan Point and the 8<sup>th</sup> consecutive full-season count at Yaki Point. This report summarizes the 2004 count results for both sites.

The Grand Canyon projects comprised 2 of 14 long-term, annual migration counts conducted or co-sponsored by HWI in North America during 2004. The primary objective of these efforts is to track long-term population trends of diurnal raptors throughout primarily western North America (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), and standardized migration counts represent one of the most efficient means of monitoring populations of multiple species at regional and larger scales (Zalles and Bildstein 2000, Hoffman and Smith 2003).

These migration studies also 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 Grand Canyon field crew has included trained educators dedicated to conducting environmental education programs at the sites and facilitating interactions between visitors and the field biologists. With about 5 million people visiting the park each year and easy accessibility, the Grand Canyon sites offer excellent opportunities for public outreach and education about the ecology and conservation needs of raptors and the Grand Canyon ecosystem.

## STUDY SITES

Lipan Pt. is located in Coconino County, Arizona (36° 01' 59.2" N, 111° 51' 11.5" W) along the south rim of the Grand Canyon (Figure 1) at an elevation of about 2,125 m. The site is an established lookout for visitors to Grand Canyon National Park, which can be accessed by driving 3.2 km southwest on Hwy 64 from the east entrance to the park. The observation point is located about 170 m south of the parking lot at the edge of the canyon rim, directly above an Anasazi granary. The spot provides nearly a 360° view of the surrounding landscape, with excellent visibility along the canyon to the north, south, and west. The predominant vegetation consists of big sagebrush (*Artemisia tridentata*), cliffrose (*Cowania mexicana*), Utah juniper (*Juniperus osteosperma*), and two-needle pinyon (*Pinus edulis*).

Yaki Pt. is located in Coconino County, Arizona (36° 03' 31.0" N, 112° 05' 01.7" W) along the south rim of the Grand Canyon (Figure 1) at an elevation of about 2,025 m. This site also is a popular canyon lookout, which visitors can access from Hwy 64 about 11.2 km northeast of the south entrance to the park. The predominant vegetation is similar to that found at Lipan Pt. The view at Yaki Pt. is superb for sheer grandeur, providing views of the canyon to the west and north; however, thick vegetation obscures the view to the east from the point.

The migration over the Grand Canyon is unique among HWI's western sites because migrating raptors are not guided to the region by mountain ridges and must rely on thermal lift rather than ridge updrafts to carry them over the broad North Kaibab Plateau toward the canyon. The Painted Desert along the eastern boundary of the park (Figure 1) may serve as a barrier to many southbound migrants because most raptors tend to avoid such sparse and inhospitable habitats, although the region produces excellent thermal lift. Conversely, the heavily forested North Kaibab Plateau, which lies immediately west of the desert, provides an accessible pathway toward the canyon. However, because there are no distinct ridges to serve as leading lines for migrating raptors (*sensu* Geyr von Schweppenburg 1963) and provide a concentrated, stable source of lift, the migrants probably approach the canyon along a relatively broad front. Accordingly, monitoring at multiple points will ultimately provide valuable information about variation in daily and seasonal concentrations and a better index to the migration volume through the region. We also believe that Yaki Pt. and Lipan Pt. represent particularly good monitoring locations because they lie immediately across from "peninsulas" of plateau land that jut out into the canyon from the north rim. This arrangement produces especially narrow gaps between the two canyon rims, which we believe the migrants seek out, much as migrating raptors often seek the narrowest passage across large bodies of water (Kerlinger 1989).

## METHODS

Four official or designated observers, assisted occasionally by other local volunteers and frequently by on-site educators Melanie Keithley and John Terenzini, conducted standardized daily counts of migrant raptors from traditional count sites at Yaki and Lipan points. The four official observers rotated between sites and observation partners to minimize potential observer bias. This arrangement ensured that at least two counters were present most of the time at both sites. Official observer and crew leader Ken Babcock had two full and two partial seasons of previous raptor migration counting experience, Kirsten McDonnell four seasons, and Chadette Pfaff one previous season, all in conjunction with HWI or affiliated efforts (see Appendix A for a complete history of observation participation). This was official observer Scott Olmstead's first full season of migration counting; he attended a preseason training session. The on-site educators routinely facilitated interactions with visitors, including coordinating with personnel from Grand Canyon National Park to conduct educational programs with organized groups of park visitors.

Weather permitting, observations typically began by 0900 hrs Mountain Standard Time (MST) and ended by 1700 hrs MST. Data gathering and recording followed standardized protocols used at all HWI migration sites (Hoffman and Smith 2003). The observers routinely recorded the following data:

1. Species, age, sex, and color morph of each migrant raptor, whenever possible and applicable (Appendix B lists common and scientific names for all species, information about the applicability of age, sex, and color morph distinctions, and two-letter codes used to identify species in some tables and figures).
2. Hour of passage for each migrant; e.g., the 1000–1059 hrs MST.
3. Wind speed and direction, air temperature, percent cloud cover, predominant cloud type(s), presence 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 (high, moderate, low, none) for each hour, recorded on the hour.
7. Daily start and end times for each official observer.

Calculation of “adjusted” (to standardize sampling periods and adjust for incompletely identified birds) annual passage rates (migrants counted per 100 hours of observation) and analysis of trends follows Hoffman and Smith (2003). In this report, I compare regression analyses of Lipan Point data alone from 1991–2004 and combined-site data from 1997–2004. In comparing 2004 annual statistics against means and 95% confidence intervals for previous seasons, I equate significance ( $P \leq 0.05$ ) with a 2004 value falling outside the bounds of the confidence interval for the associated mean.

## RESULTS AND DISCUSSION

### WEATHER SUMMARY

In 2004, the numbers of observation days entirely precluded or severely hampered (i.e., reduced to  $\leq 4$  hours observation) by inclement weather were slightly below average at both sites: 3 days affected at both sites compared to 1997–2003 averages of 3.6 days at Lipan Point and 4.0 days at Yaki Point (see Appendixes C and D for daily weather records from the two sites). Otherwise, both sites featured average proportions of active observation days where predominantly fair skies prevailed (53% at Lipan Point and 54% at Yaki Point, compared to 1997–2003 averages of 53% and 52%, respectively), slightly reduced proportions of days where transitional skies (i.e., cloud cover changed during the day from fair skies to mostly cloudy or overcast skies, or vice versa) prevailed (25% vs. average of 30% at Lipan, 22 vs. 28% at Yaki), and slightly higher than average proportions of days where mostly cloudy to overcast skies prevailed (22% vs. 18% at Lipan, 24% vs. 20% at Yaki). Although to a lesser a degree than was true in 2002 and 2003, visibility reducing haze, smoke, and dust were slightly more prevalent than usual, reflecting the influence of dry, dusty conditions resulting from prolonged drought and prevalent wildfires burning on the Kaibab Plateau to the north of the count sites. At Lipan Point, 33% of the active observation days featured appreciable visibility reducing fog and especially haze, compared to the 1997–2003 average of 29%. At Yaki Point, the comparative proportions were 32% and 26%.

The temperature regimes at both sites were close to average in 2004. The average daily temperature (average of daily values, which in turn were averages of hourly readings) recorded at Lipan Point during active observation periods was 18.2°C (1997–2003 average of 18.6°C); at Yaki Point the 2004 value was 17.4°C (long-term average 17.2°C). The daily minimums and maximums also fell well within the usual range of variation.

At Lipan Point there was a slight shift toward stronger winds in 2004, with light winds (<12 kph) prevailing on 75% of the active observation days, moderate winds on 16%, and stronger winds (>29 kph) on 9%, compared to 1997–2003 averages of 82%, 14%, and 4% of days, respectively. A similar shift applied at Yaki Point in terms of the comparative proportions of light (71% vs. average of 76%) and moderate-wind days (25% vs. average of 18%); however, the proportion of strong wind days was actually slightly below average in 2004 (4% vs. average of 5%).

In terms of wind directions, the pattern at Lipan Point was fairly typical for that site, with variable SW-NW winds prevailing throughout most or all of 40% of the active observation days (average 47%), variable NE-SE winds on 26% (average 30%), and calm/variable winds on 16% of the active days (average 17%). Records from Yaki Point indicated greater variability from the average pattern, with

variable SE-SW winds prevailing on 27% of the active days versus an average of 13%). In addition, unlike at Lipan Point, variable NE-SE winds were more prevalent than usual at Yaki Point (29% vs. average of 23%). Otherwise, variable NW-NE winds prevailed on an average 11% of the active days, and calm/variable winds prevailed on an average 15% of the active days.

At both sites, the proportions of active observation days that received a median (of hourly ratings) thermal-lift rating of good to excellent were below average (47% vs. 55% at Lipan, 44% vs. 50% at Yaki).

In summary, compared to the last seven seasons, 2004 featured an average temperature regime; a slightly higher prevalence of mostly cloudy to overcast skies during active observation periods; slightly stronger winds than average at both sites; a fairly typical array of wind directions at Lipan Point but a higher than average proportion of SE-SW winds at Yaki Point; and, reflecting the increase in cloudy skies and stronger winds, below average thermal-lift conditions. Visibility-reducing dust, smoke, and haze were also still more prevalent than average, but to a much lesser degree than during the past two years.

## **OBSERVATION EFFORT**

Counts occurred at both sites on 68 of 71 possible days between 27 August and 5 November 2004 (see Appendices E and F for daily count records for each site). Both the number of observation days and total observation hours (577.4; the total number of hours during which counts occurred at one or both sites) were both within 3% of the respective 1997–2003 averages for the project ( $70 \pm 95\%$  CI of 1.1 days and  $565.5 \pm 21.1$  hours; see Appendices G and H for annual effort and count summaries for each site). The 2004 average of 4.6 observers/hour spread across the two count sites (including official and guest observers; value is mean of daily values, which are in turn means of hourly values) was 15% above the 1997–2003 average of  $4.0 \pm 95\%$  CI of 0.09 observers/hour.

## **MIGRATION SUMMARY**

The observers tallied 8,529 migrant raptors of 15 species at the two count sites in 2004 (Table 1), with 39% recorded at Lipan Point and 61% at Yaki Point. The total count is the lowest combined-site count yet recorded, 23% below the 1997–2003 average. The drop reflected a 44% below average (1997–2003; 49% below 1991–2003 average) count at Lipan Point, but only a 1% below average count at Yaki Point. Before 2002, counts at Lipan Point had always exceeded those at Yaki Point, but a distinct shift in relative abundance at the two sites has occurred since simultaneous counts began in 1997. For the first time in 2004, however, the combined-site count dropped substantially, and ironically following a record-high count in 2003. In contrast to the situation in the Grand Canyon, counts have been well below average for three years in a row farther north in the Intermountain Flyway at the Goshute Mountains, Nevada, undoubtedly reflecting the influence of prolonged and widespread drought throughout the interior West since 1998 (Hoffman and Smith 2003, Smith 2005).

## **Compositional Patterns**

The combined-site flight was composed of 53% accipiters, 24% buteos, 19% falcons, and ~1% each of ospreys, harriers, eagles, and unidentified raptors. The proportion of buteos was significantly above average and the proportion of accipiters was significantly below average. Yaki Point attracted proportionately more accipiters (54% of the site total) and fewer buteos (25%) and falcons (18%) than Lipan Point (41%, 32%, 22%; Figure 2). This pattern of compositional differences between the two count sites is typical, with Yaki Point consistently attracting a higher proportion of accipiters and fewer buteos than Lipan Point. However, in terms of absolute numbers, the pattern has shifted steadily from roughly 60% of the combined-site total accipiter count at Lipan Point in 1997 and 1998 to only 33% of the total at Lipan in 2004. The relative composition differences likely reflect topographic variation



around the two sites, which effect local thermal production and therefore vary the attractiveness of each site for soaring species. However, the shift in the absolute abundance of accipiters at the two sites over the past eight years suggests that other factors are influencing the flight paths of migrating accipiters across the canyon.

One possibility is that habitat change on the Kaibab Plateau caused by extensive wildfires is causing the forest-dwelling accipiters to alter their pathways across this landscape. However, although less true in 2004 than the past few years, there also has been a fairly steady shift over the past eight years at Lipan Point towards increasing prevalence of relatively steady southwest to westerly winds as opposed to more variable southwest to northwest winds. It is unclear how this change in wind conditions might translate to accipiters preferring to cross at Yaki Point rather than Lipan Point, but one possibility is that northwest winds may tend to push birds more towards the east, whereas southwesterly winds may enable easier quartering along the preferred south to southwesterly orientation of the overall regional flyway (see Hoffman et al. 2002). Future detailed analyses of count trends at both sites in relation to weather and other landscape variables should clarify the situation.

### **Count and Passage Rate Trends**

As usual, Sharp-shinned Hawks, Cooper's Hawks, Red-tailed Hawks, and American Kestrels were the four most abundant species at both sites (Table 1, Appendices G and H). Combined-site counts fell to record lows for Cooper's Hawks (1174), Red-tailed Hawks (2120), and Ferruginous Hawks (2), and matched the previous low for Northern Harriers (70). In contrast, the combined site count of Prairie Falcons matched the previous high count (14). This was the second year in a row that no migrating Northern Goshawks were recorded at Lipan Point, but the count of 7 goshawks at Yaki Point was higher than the combined-site average of 6 birds. Combined-site, adjusted passage rates were significantly below average for 12 of 15 commonly encountered species, but were significantly above average for Swainson's Hawks, Merlins, and Prairie Falcons (Table 1).

Eight years is generally too short a period from which to derive robust assessments of long-term trends; however, comparison of trends at the two count sites and comparison of Lipan Point and combined-site counts patterns during the past eight years is instructive. Regression analyses of adjusted passage rates at Lipan Point from 1991–2004 indicated at least marginally significant ( $P \leq 0.10$ ) linear or quadratic trends for 9 of 15 commonly encountered species (Figures 3–7). Regression analyses for the period 1997–2004 indicated similar, at least marginally significant, combined-site trends for five of these species, reflecting declining trends since the late 1990s for Ospreys, Northern Harriers, Cooper's Hawks, and Ferruginous Hawks, but an increasing trend for Swainson's Hawks (Figures 3–5). Until 2002, Golden Eagles had been showing a strong declining trend at Lipan Point, with a similar short-term pattern evident at Yaki Point (Figure 6). A return to moderate counts in 2002 dampened this pattern, but another two-year decline since then at both sites continues to support a significant long-term decline for the species at Lipan Point alone, with the combine-site passage rates following a similar recent pattern.

The lowest passage rate yet for Sharp-shinned Hawks at Lipan Point occurred in 1991, but that was followed by the highest passage rate yet in 1998 (Figure 4). Since 1992, passage rates for this species at Lipan Point have declined fairly steadily, dropping to the second lowest rate in 2004. However, no distinct trend is evident in the combined-site passage rates for Sharp-shinned Hawks since 1997, reflecting the aforementioned distributional shift from Lipan to Yaki Point. Thus, for Sharp-shinned Hawks, counts at multiple sites may be of particular importance for achieving effective monitoring of flights across the canyon. Similar scenarios apply to Red-tailed Hawks (Figure 5) and American Kestrels (Figure 7), which both show long-term (1991–2004) declines at Lipan Point alone, but relatively stable combined-site patterns from 1997–2004. Both Broad-winged Hawks (Figure 5) and Peregrine Falcons (Figure 7) previously had been showing long-term increases at Lipan Point, but since the late 1990s, both the Lipan Point data alone and the combined site data have indicated relatively stable patterns.

Although subtle differences in pattern are evident among the two count datasets for Northern Goshawks (Figure 4), Merlins, and Prairie Falcons (Figure 7), in general all datasets point to the same basic conclusion of no distinct long-term trends for these species.

### **Age Ratios**

At the combined-site level in 2004, 5 of 9 species with readily distinguishable age classes, and for which the 2004 counts were high enough to warrant some attention to age ratios (excludes Ferruginous Hawks), showed significant variation in immature : adult ratios compared to 1997–2003 averages (Table 2). Red-tailed Hawks and Golden Eagles showed significantly above average ratios, whereas Sharp-shinned Hawks, Northern Goshawks, and Broad-winged Hawks showed significantly below average ratios (Table 2). The age ratio for Northern Harriers also was slightly but non-significantly below average, whereas the 2004 age ratios for Cooper's Hawks, Bald Eagles, and Peregrine Falcons exactly matched the 1997–2003 averages for those species. It is also important to note, however, that the actual counts of identified immature/subadult birds in 2004 were below average for all species except Red-tailed Hawks and Peregrine Falcons (Table 2). Overall, except for Red-tailed Hawks, these statistics provide little evidence of good productivity in 2004 among Grand Canyon source populations.

### **Seasonal Timing**

Based on combined-site data, the overall combined-species median passage date in 2004 of 28 September was a marginally significant two days earlier than the 1997–2003 average (Table 3). Examination of the seasonal distribution of activity revealed several five-day periods in which relative flight volume differed significantly from the average pattern; however, no clear overall early or late shift in the activity pattern was apparent (Figure 8). At the species level, significant variation in median passage dates occurred for only 5 of 14 species for which a comparison was possible, with Northern Goshawks and Peregrine Falcons showing earlier than average timing and Northern Harriers, Broad-winged Hawks, and Merlins showing later than average timing (Table 3). Age-specific median passage dates revealed additional detail, but similar to the species-level data indicated no consistent patterns across age classes or species.

## **RESIDENT RAPTORS**

This season a family group of Zone-tailed Hawks, including one immature bird, that are known to have nested in their standard location below Yaki Point were seen regularly around Yaki Point until 6 September. Adult birds were also seen six times from Lipan Point, with the bird carrying prey on four of these occasions (most likely including at least two lizards and one rat).

Otherwise, at Lipan Point several sightings of one or more resident Sharp-shinned Hawks (only immature birds positively identified) were recorded through the end of September. One or more resident immature Cooper's Hawks were seen more frequently around Lipan Point through 9 October, with an apparently local adult seen once on 12 September. A family group of resident, light-morph Red-tailed Hawks, including two adults and two immature birds, were present throughout the season. The status of possible local Golden Eagles around Lipan Point was uncertain this season. Occasional sightings of both immature and adult birds traveling in odd directions suggested the presence of resident birds, and on one occasion an adult was seen displaying in conjunction with possibly escorting a migrant through the area; otherwise, however, no consistent resident activity patterns were observed. Resident Peregrine Falcons, including two adults and one immature bird, were seen regularly through mid-October. Resident American Kestrels, both female and male, were seen occasionally around the point through late September. Local Turkey Vultures were seen in the area regularly through 24 October. California Condors were seen from Lipan Point on only two occasions in 2004, both times in early September.

At Yaki Point, a pair of resident adult Cooper's Hawks and at least one immature bird were seen on many occasions around Yaki Point, with sightings of immature bird(s) most common and continuing through

24 October. The status of resident Sharp-shinned Hawks was uncertain this season, but apparently local immature birds were seen on several occasions. A resident pair of adult, light-morph Red-tailed Hawks and a single immature, light-morph bird frequented the canyon to the west of the observation point through mid-October, and another apparently resident adult, dark-morph bird was seen on three occasions. Only three sightings of apparently local Golden Eagles were recorded this season at Yaki Point, making it difficult to discern any consistent activity patterns. A pair of resident adult Peregrine Falcons and one immature bird were seen regularly around Yaki Point through late October. Late in the season, one of the adult birds appeared to have an injured leg that hung loosely while the bird was in flight. At least one resident female and one male American Kestrels were seen occasionally through September. Condors were a regular presence around Yaki Point, with 17 individuals positively identified at various times throughout the season. At least 30 local Turkey Vultures were seen regularly around Yaki Point, but only through 10 September.

These resident assemblages are fairly typical for the sites, except that before 2003 immature Northern Goshawks were often seen around Yaki Point. At times, the abundance of local Red-tailed Hawks also has been greater.

### **VISITOR PARTICIPATION**

A total of 1,512 park visitors signed the HWI visitor logs during the 2004 season, which is near average for the sites. Roughly two thirds of the visits occurred at Yaki Point. A total of 29 group-education programs coordinated with Grand Canyon National Park occurred at Yaki Point and were attended by 712 guests. A total of 21 group-education programs coordinated with Grand Canyon National Park occurred at Lipan Point and were attended by 298 guests. Visitors originated from many states and a variety of foreign countries, including Germany, England, Scotland, Hungary, Belgium, Switzerland, Spain, Wales, Austria, France, Netherlands, Italy, Denmark, Portugal, Czech Republic, South Africa, Australia, Japan, Mexico, and Canada.

In 2004 at Lipan Point, 583 hourly assessments of visitor disturbance resulted in the following ratings: 90% none, 9% low, 1% moderate, and 0% high. At Yaki Point, 591 hourly assessments of visitor disturbance resulted in the following ratings: 74% none, 21% low, 4% moderate, and 1% high. This low level of visitor-related disturbance of the official observers is solid testimony to the benefits of staffing on-site education specialists to ensure both a high-quality experience for visitors and a high-quality monitoring effort.

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**Table 1. Annual raptor migration counts and adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) annual passage rates by species in the Grand Canyon, AZ (Lipan Point and Yaki Point data combined): 1997–2003 versus 2004.**

SPECIES	COUNTS			RAPTORS / 100 HOURS		
	1997–2003 <sup>1</sup>	2004	% CHANGE	1997–2003 <sup>1</sup>	2004	% CHANGE
Osprey	133 ± 21.5	103	-23	31.4 ± 3.37	23.4	-26
Northern Harrier	122 ± 29.0	70	-42	24.1 ± 3.37	13.1	-46
Sharp-shinned Hawk	3218 ± 249.5	2688	-16	744.5 ± 24.41	645.1	-13
Cooper's Hawk	2333 ± 325.5	1174	-50	635.3 ± 53.80	325.7	-49
Northern Goshawk	12 ± 5.0	7	-40	2.1 ± 0.51	1.3	-40
Unknown small accipiter	222.7 ± 194.8	207	-	–	–	–
Unknown large accipiter	3.7 ± 2.6	1	-	–	–	–
Unknown accipiter	241 ± 130.4	164	-	–	–	–
TOTAL ACCIPITERS	5901 ± 267.2	4241	-28	–	–	–
Red-shouldered Hawk	0.1 ± 0.28	0	-100	–	–	–
Broad-winged Hawk	29 ± 9.6	19	-34	15.9 ± 3.08	11.0	-31
Swainson's Hawk	79 ± 58.0	169	+113	24.2 ± 9.98	45.7	+88
Red-tailed Hawk	2535 ± 185.3	2120	-16	532.5 ± 21.40	438.1	-18
Ferruginous Hawk	13 ± 2.7	2	-85	2.7 ± 0.36	0.4	-84
Rough-legged Hawk	0.7 ± 0.82	0	-100	–	–	–
Zone-tailed Hawk	1 ± 0.5	0	-100	–	–	–
Unidentified buteo	46 ± 16.8	25	-45	–	–	–
TOTAL BUTEOS	2703 ± 241.0	2335	-14	–	–	–
Golden Eagle	31 ± 12.3	13	-59	6.0 ± 1.38	2.5	-59
Bald Eagle	38 ± 12.7	24	-36	8.7 ± 1.66	5.6	-36
Unidentified eagle	2 ± 1.5	0	-100	–	–	–
TOTAL EAGLES	71 ± 25.3	37	-48	–	–	–
American Kestrel	2049 ± 226.5	1619	-21	545.3 ± 31.37	393.2	-28
Merlin	24 ± 7.2	30	+25	5.2 ± 0.95	6.7	+30
Prairie Falcon	10 ± 1.8	14	+36	2.2 ± 0.21	2.8	+28
Peregrine Falcon	17 ± 5.5	13	-24	3.6 ± 0.68	2.6	-28
Unknown small falcon	2 ± 2.3	1	-	–	–	–
Unknown large falcon	3 ± 1.7	0	-	–	–	–
Unknown falcon	6 ± 2.6	5	-	–	–	–
TOTAL FALCONS	2109 ± 223.6	1682	-20	–	–	–
Unidentified Raptor	102 ± 29.9	61	-40	–	–	–
GRAND TOTAL	11140 ± 487.4	8529	-23	–	–	–

<sup>1</sup> Mean of annual values ± 95% confidence interval.

**Table 2. Fall migration counts by age classes and immature : adult ratios for selected raptor species in the Grand Canyon, AZ (Lipan Point and Yaki Point data combined): 1997–2003 versus 2004.**

SPECIES	TOTAL AND AGE-CLASSIFIED COUNTS						IMMATURE : ADULT			
	1997–2003 AVERAGE			2004			% UNKNOWN AGE		RATIO	
	TOTAL	IMM.	ADULT	TOTAL	IMM.	ADULT	1997–2003 <sup>1</sup>	2004	1997–2003 <sup>1</sup>	2004
Northern Harrier	122	32	31	70	17	19	49 ± 3.7	49	1.0 ± 0.13	0.9
Sharp-shinned Hawk	3218	635	1209	2688	352	701	42 ± 4.8	61	0.6 ± 0.07	0.5
Cooper's Hawk	2333	529	722	1174	166	216	47 ± 4.0	67	0.8 ± 0.14	0.8
Northern Goshawk	12	5	3	7	3	2	28 ± 7.5	29	2.0 ± 0.77	1.0
Broad-winged Hawk	29	8	11	19	4	13	28 ± 7.2	11	0.8 ± 0.14	0.3
Red-tailed Hawk	2535	300	1525	2120	472	1133	28 ± 2.9	24	0.2 ± 0.03	0.4
Ferruginous Hawk	13	3	5	2	1	0	39 ± 8.3	50	0.6 ± 0.17	1.0
Golden Eagle	31	9	12	13	5	2	34 ± 4.2	46	0.8 ± 0.19	2.5
Bald Eagle	38	8	25	24	6	18	11 ± 2.5	0	0.3 ± 0.02	0.3
Peregrine Falcon	17	2	7	13	2	7	46 ± 8.2	31	0.3 ± 0.14	0.3

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

**Table 3. First and last dates of observation, bulk passage dates, and median passage dates by species for migrating raptors in the Grand Canyon, AZ, with comparisons of 2004 and 1997–2003 average median passage dates (Lipan Point and Yaki Point data combined).**

SPECIES	2004				1997–2003	
	FIRST OBSERVED	LAST OBSERVED	BULK PASSAGE DATES <sup>1</sup>	MEDIAN PASSAGE DATE <sup>2</sup>	MEDIAN PASSAGE DATE <sup>3</sup>	
Osprey	27-Aug	25-Oct	6-Sep – 5-Oct	20-Sep	19-Sep ± 2.5	
Northern Harrier	30-Aug	3-Nov	5-Sep – 31-Oct	9-Oct	6-Oct ± 2.5	
Sharp-shinned Hawk	27-Aug	5-Nov	15-Sep – 23-Oct	1-Oct	1-Oct ± 1.5	
Cooper's Hawk	28-Aug	5-Nov	15-Sep – 8-Oct	27-Sep	28-Sep ± 2.8	
Northern Goshawk	11-Sep	7-Oct	11-Sep – 7-Oct	24-Sep	7-Oct ± 6.7	
Broad-winged Hawk	21-Sep	3-Oct	25-Sep – 1-Oct	27-Sep	25-Sep ± 1.6	
Swainson's Hawk	27-Aug	16-Oct	8-Sep – 3-Oct	27-Sep	22-Sep ± 6.0	
Red-tailed Hawk	27-Aug	5-Nov	14-Sep – 30-Oct	6-Oct	8-Oct ± 2.6	
Ferruginous Hawk	17-Sep	15-Oct	–	–	11-Oct ± 6.0	
Golden Eagle	4-Oct	31-Oct	7-Oct – 30-Oct	20-Oct	15-Oct ± 8.1	
Bald Eagle	13-Sep	1-Nov	30-Sep – 31-Oct	23-Oct	23-Oct ± 3.5	
American Kestrel	27-Aug	31-Oct	4-Sep – 5-Oct	24-Sep	23-Sep ± 2.1	
Merlin	17-Sep	31-Oct	24-Sep – 31-Oct	9-Oct	5-Oct ± 2.1	
Prairie Falcon	7-Sep	9-Oct	13-Sep – 7-Oct	27-Sep	25-Sep ± 6.6	
Peregrine Falcon	27-Aug	7-Oct	29-Aug – 1-Oct	15-Sep	25-Sep ± 7.0	
All species	27-Aug	5-Nov	10-Sep – 23-Oct	28-Sep	30-Sep ± 2.0	

<sup>1</sup> Dates between which the central 80% of the flight passed.

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

<sup>3</sup> Mean of annual values ± 95% confidence interval in days; calculated only for species with annual counts ≥ 5 birds for ≥ 3 years.

**Table 4. Median passage dates by age classes for selected species of migrating raptors in the Grand Canyon, AZ (Lipan Point and Yaki Point data combined): 1997–2003 versus 2004.**

SPECIES	ADULT		IMMATURE / SUBADULT	
	1997–2003 <sup>1</sup>	2004	1997–2003 <sup>1</sup>	2004
Northern Harrier	10-Oct ± 3.3	14-Oct	5-Oct ± 5.2	27-Sep
Sharp-shinned Hawk	8-Oct ± 0.7	6-Oct	25-Sep ± 2.0	26-Sep
Cooper's Hawk	2-Oct ± 2.8	30-Sep	25-Sep ± 2.2	25-Sep
Northern Goshawk	25-Oct ± 11.8	–	8-Oct ± 7.7	–
Broad-winged Hawk	24-Sep ± 2.1	27-Sep	25-Sep ± 2.8	–
Red-tailed Hawk	8-Oct ± 2.1	9-Oct	1-Oct ± 4.2	5-Oct
Ferruginous Hawk	23-Oct ± 9.9	–	25-Sep <sup>2</sup>	–
Golden Eagle	15-Oct ± 10.4	–	15-Oct ± 7.0	24-Oct
Bald Eagle	23-Oct ± 3.6	24-Oct	22-Oct ± 4.8	17-Oct
Peregrine Falcon	26-Sep ± 9.2	13-Sep	24-Sep <sup>3</sup>	–

Note: Median passage dates are dates by which 50% of the flight had passed the lookout; values were calculated based only on counts of ≥5 birds per year.

<sup>1</sup> Mean ± 95% confidence interval in days; unless otherwise indicated, values were calculated only for species with ≥3 years of counts ≥5 birds per year.

<sup>2</sup> Value based on data for 2003 only.

<sup>3</sup> Value is for 1998 only.



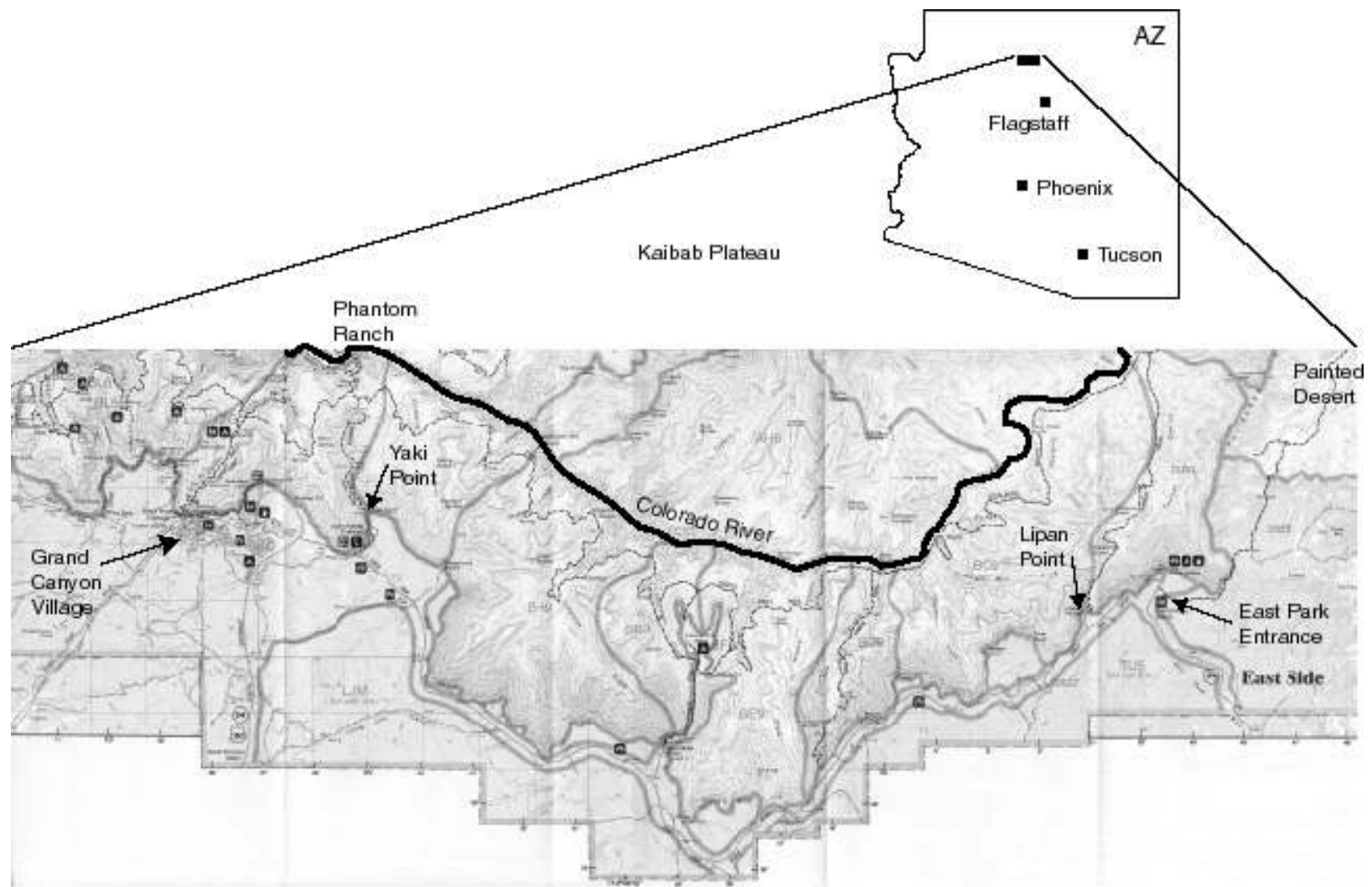
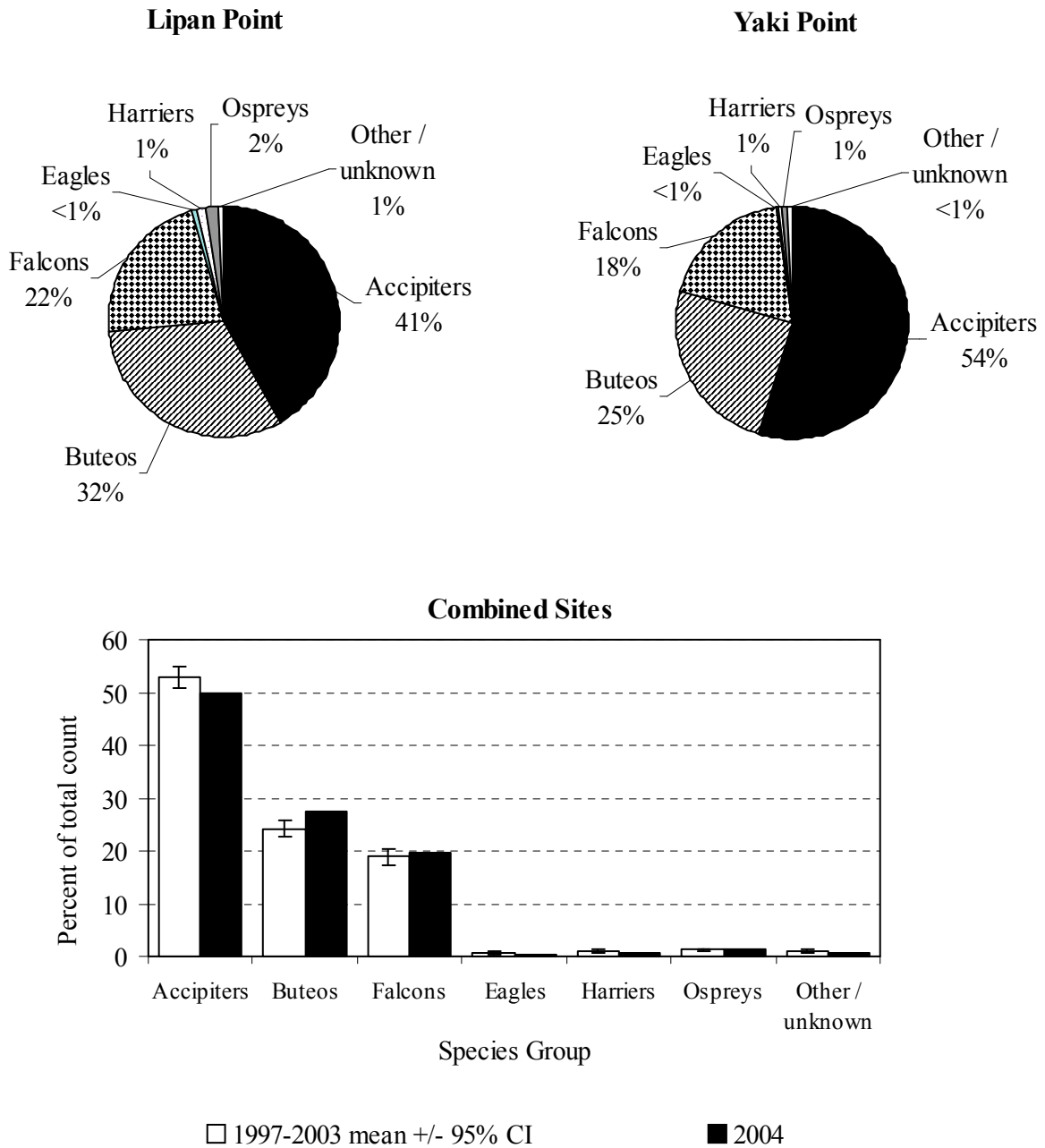
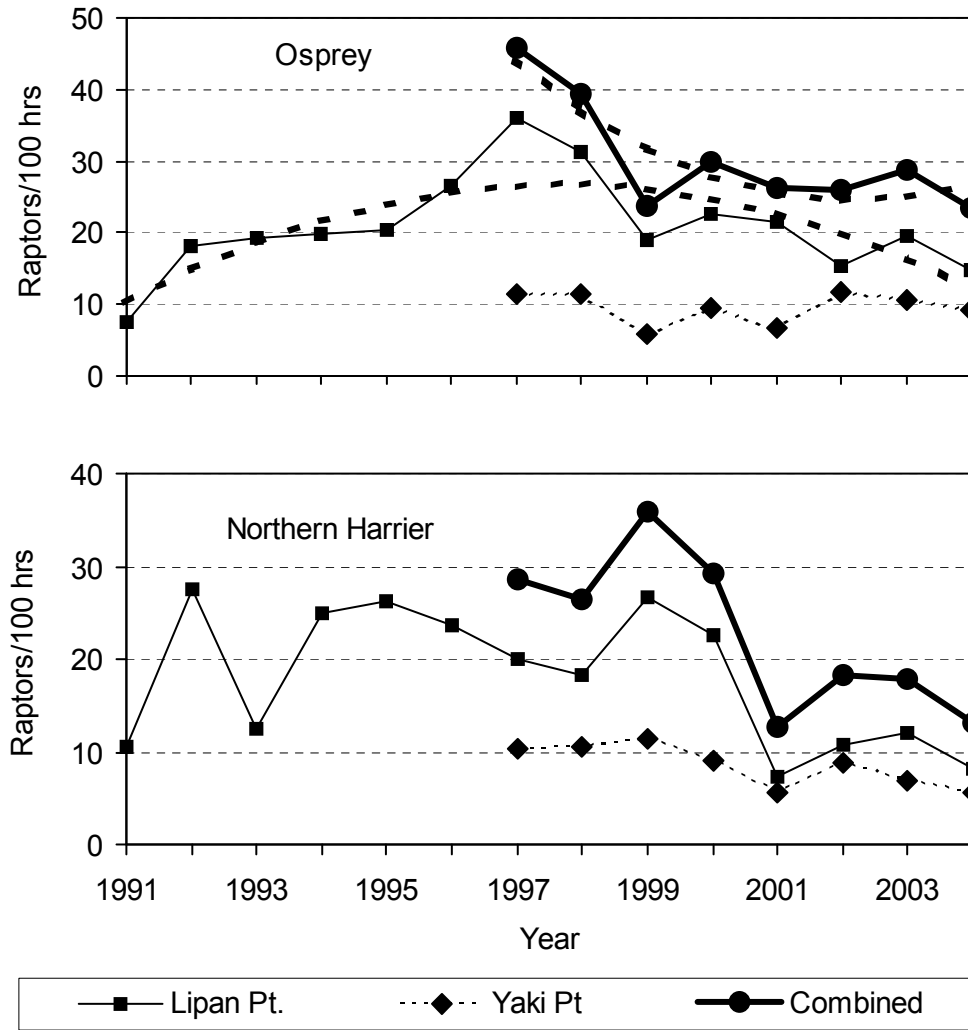


Figure 1. Map showing the Lipan Point and Yaki Point raptor-migration study sites in the Grand Canyon, Arizona.



**Figure 2. Fall raptor-migration flight composition by major species groups in the Grand Canyon, AZ: 1997–2003 versus 2004.**



**Figure 3. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Ospreys and Northern Harriers in the Grand Canyon, AZ: 1991–2004. Dashed lines indicate significant ( $P \leq 0.10$ ) linear or quadratic regressions.**

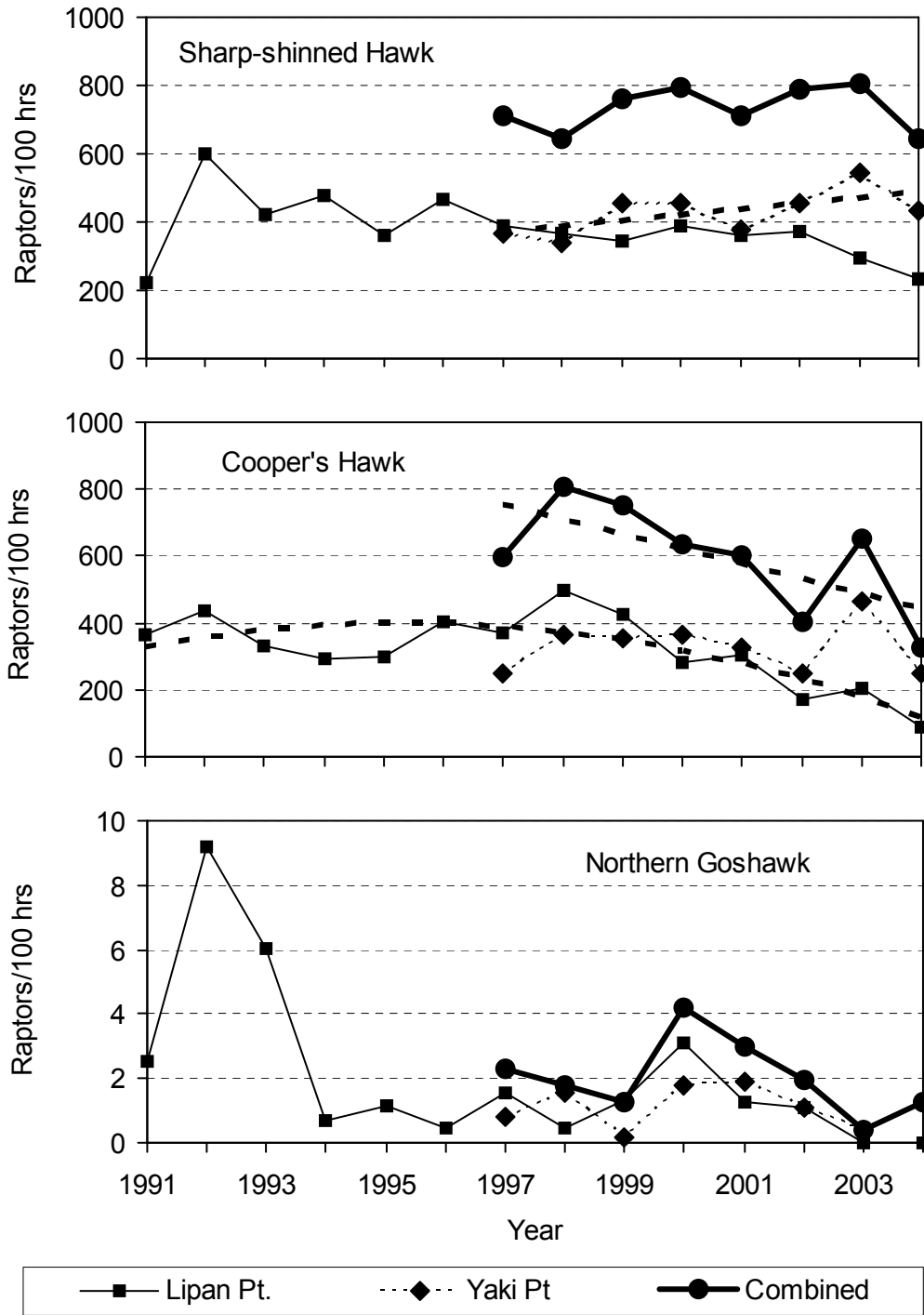


Figure 4. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks in the Grand Canyon, AZ: 1991–2004. Dashed lines indicate significant ( $P \leq 0.10$ ) linear or quadratic regressions.

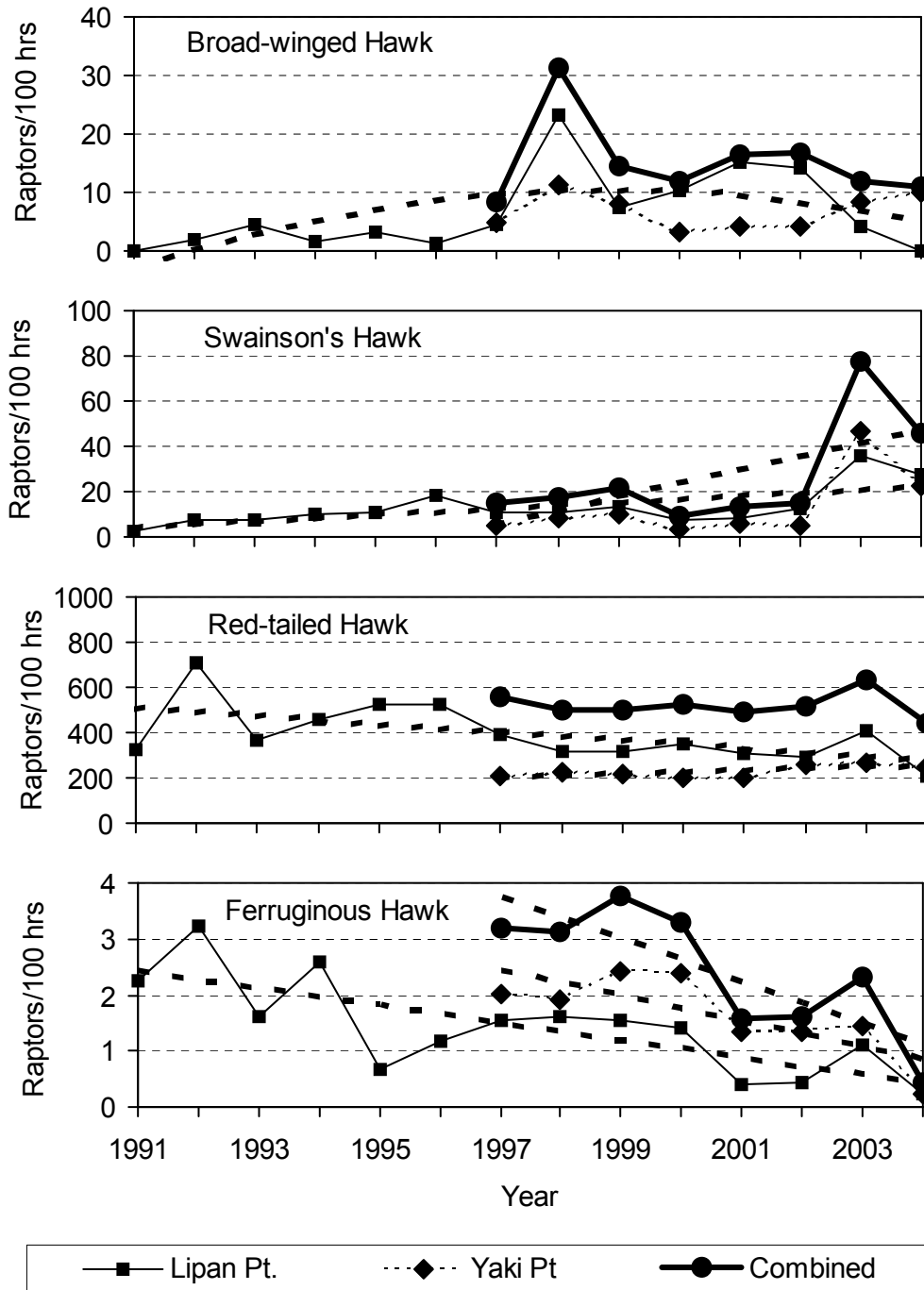
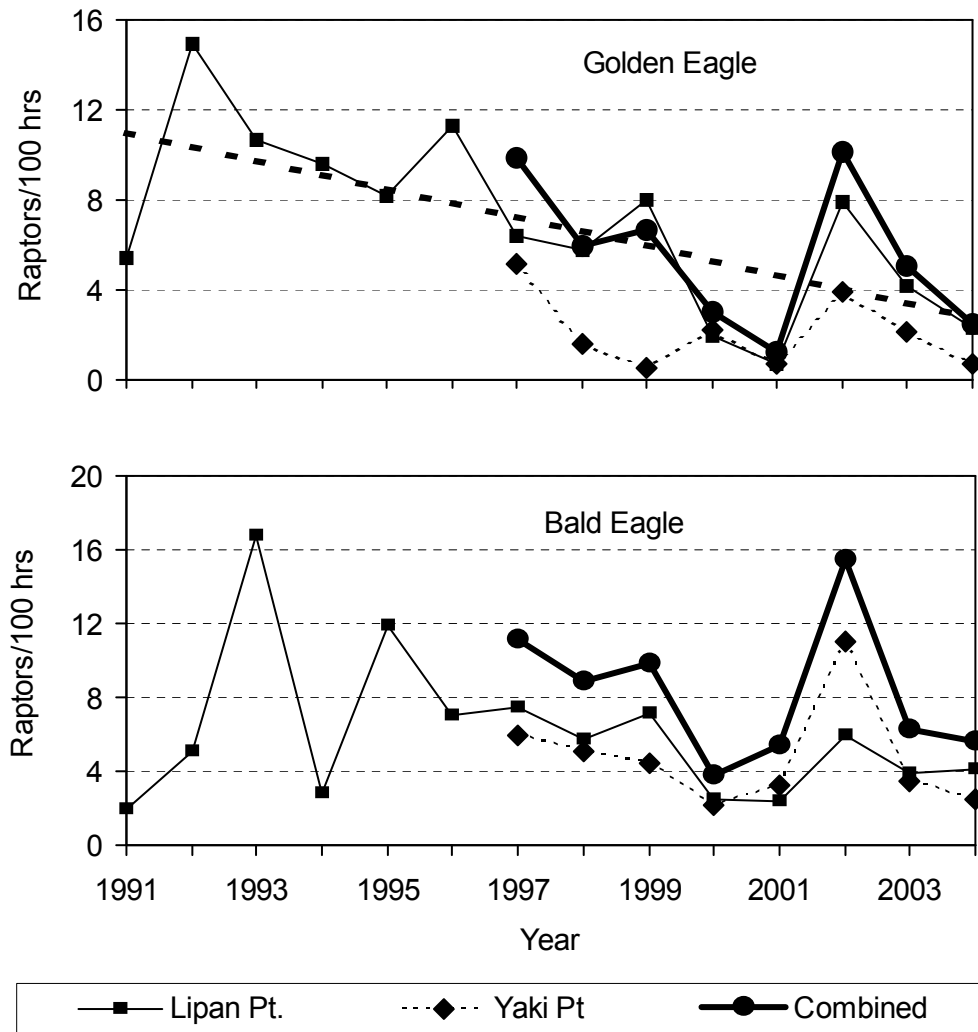


Figure 5. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Broad-winged, Swainson's, Red-tailed, and Ferruginous Hawks in the Grand Canyon, AZ: 1991–2004. Dashed lines indicate significant ( $P \leq 0.10$ ) linear or quadratic regressions.



**Figure 6.** Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Golden and Bald Eagles in the Grand Canyon, AZ: 1991–2004. Dashed lines indicate significant ( $P \leq 0.10$ ) linear or quadratic regressions.

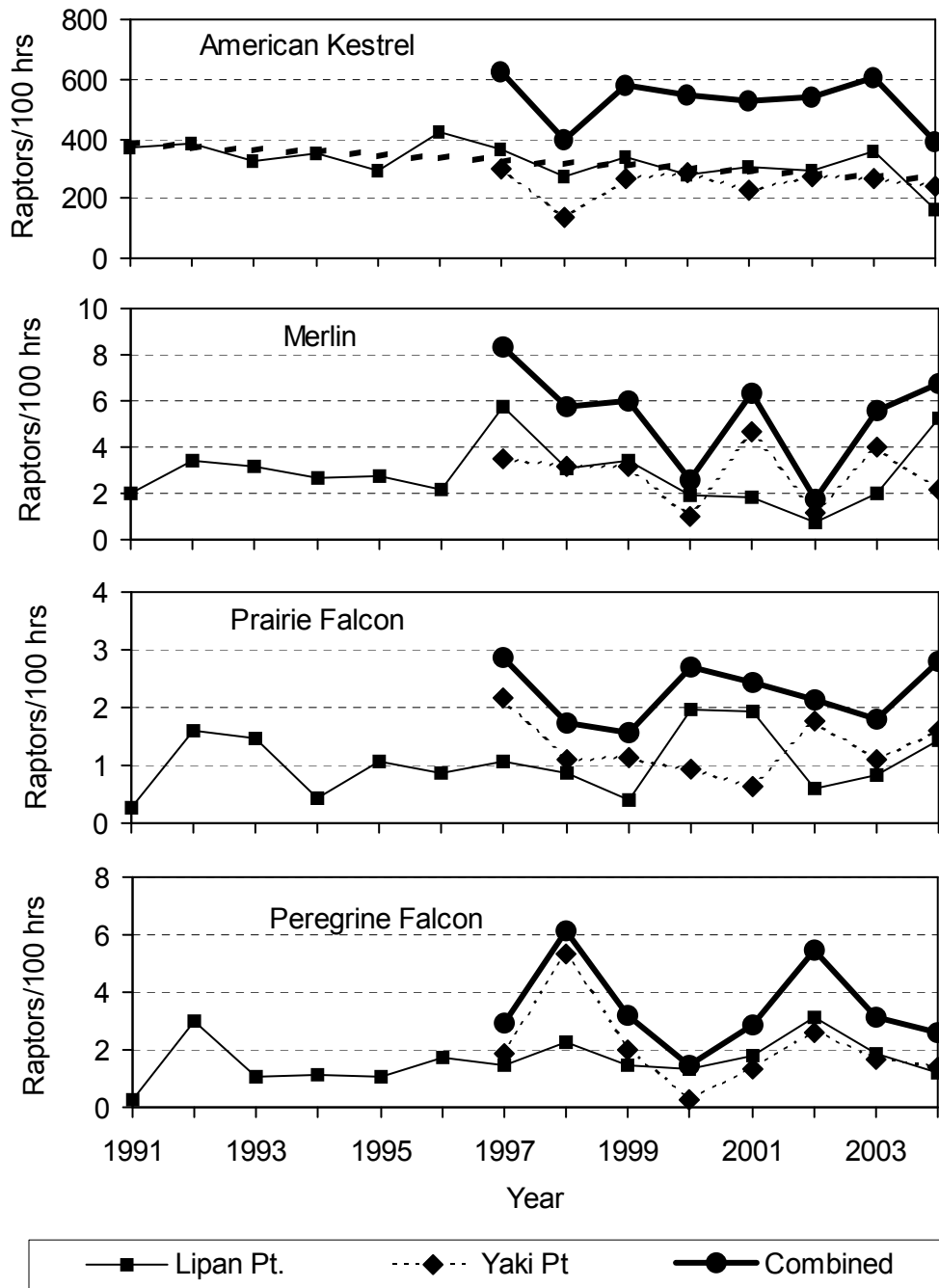
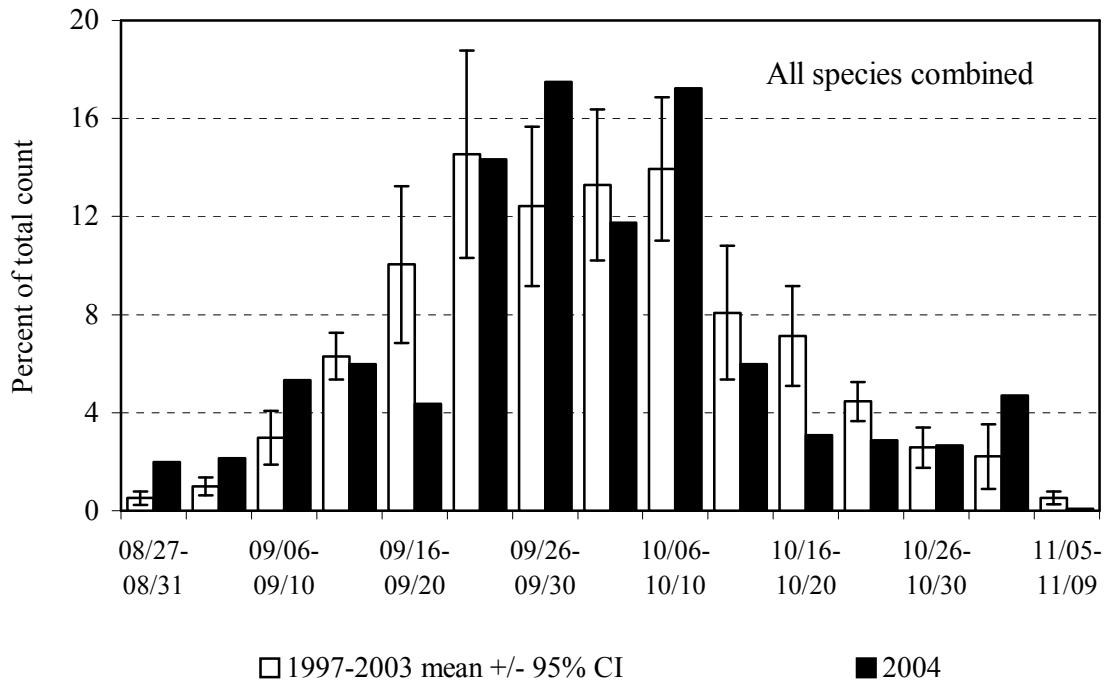


Figure 7. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons in the Grand Canyon, AZ: 1991–2004. Dashed lines indicate significant ( $P \leq 0.10$ ) linear or quadratic regressions.



**Figure 8. Combined-species, fall-migration passage volume by five-day periods for raptors in the Grand Canyon: 1997–2003 versus 2004 (Lipan Point and Yaki Point data combined).**



**Appendix A. History of official observer participation in the Grand Canyon raptor migration studies: 1991–2004.**

- 1991** Rotating team with at least two observers throughout at Lipan Pt.: Mark Cantrell (1), Phil West (0), Vickie O'Brien (0), Christie van Cleve (0), Don Rosie (0)
- 1992** Rotating team with at least two observers throughout at Lipan Pt.: Mark Cantrell (2), Daniel Perry (3), Christie van Cleve (1)
- 1993** Rotating team with at least two observers throughout at Lipan Pt.: Daniel Perry (4), Frank LaSorte (1), Christie van Cleve (2)
- 1994** Rotating team with at least two observers throughout at Lipan Pt. and 1–2 observers at Yaki Pt. for limited season: Daniel Perry (5), Justin Silcox (0), Amy Adams (0), Rod Adams (0), Christie van Cleve (3)
- 1995** Rotating team with at least two observers throughout at Lipan Pt.: Amy Adams (1), Elliot Swarhout (0), Christie van Cleve (4)
- 1996** Rotating team with at least two observers throughout at Lipan Pt.: Amy Adams (2), Elliot Swarhout (1), Christie van Cleve (5)
- 1997** Rotating team with at least two observers throughout at Yaki and Lipan Pts.: Sue Thomas (2), Scott Harris (2), Rusty Namitz (1), Annie Touliatos (0), Christie van Cleve (6)
- 1998** Rotating team with at least two observers throughout at Yaki and Lipan Pts.: Josh Lipton (4), Jackie Speicher (2), Stacy Prosser (1), Karen McDonald (0), Christie van Cleve (7)
- 1999** Rotating team with at least two observers throughout at Lipan Pt. and at least 1 and usually 2 observers throughout at Yaki Pt.: Scott Rush (1), Adam Hutchins (1), Steve Seibel (1), Christie van Cleve (8), Kate James (0).
- 2000** Rotating team with at least two observers throughout at Lipan Pt. and Yaki Pt.: Adam Hutchins (2), Steve Seibel (2), Geoff Evans (0), Jody Bartz (0), Christie van Cleve (9), Kate James (1).
- 2001** Rotating team with at least two observers throughout at Lipan Pt. and Yaki Pt.: Adam Hutchins (3), Jody Bartz (1), Paula Shannon (1), Tom Magarian (0), Christie van Cleve (10).
- 2002** Rotating team with at least two observers throughout at Lipan Pt. and Yaki Pt.: Allison Cebula (2), Corrie Borgman (1), Erin McEldowney (partial), Toni Appleby (0), and Christi Van Cleve (11)
- 2003** Rotating team with at least two observers throughout at Lipan Pt. and Yaki Pt.: Jody Bartz (2), Mark Leavens (1), Ken Babcock (2 partial), and Grant Merrill (0).
- 2004** Rotating team with at least two observers throughout at Lipan Pt. and Yaki Pt.: Ken Babcock (2 + 2 partial), Kirsten McDonnell (4), Chadette Pfaff (1), Scott Olmstead (0).

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<sup>1</sup> 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 diurnal raptor species observed during fall migration in the Grand Canyon, AZ.**

COMMON NAME	SCIENTIFIC NAME	SPECIES CODE	AGE <sup>1</sup>	SEX <sup>2</sup>	COLOR MORPH <sup>3</sup>
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
Sharp-shinned Hawk	<i>Accipiter striatus</i>	SS	A I U	U	NA
Cooper's Hawk	<i>Accipiter cooperii</i>	CH	A I U	U	NA
Northern Goshawk	<i>Accipiter gentilis</i>	NG	A I U	U	NA
Unknown small accipiter	<i>A. striatus</i> or <i>cooperii</i>	SA	U	U	NA
Unknown large accipiter	<i>A. cooperii</i> or <i>gentilis</i>	LA	U	U	NA
Unknown accipiter	<i>Accipiter</i> spp.	UA	U	U	NA
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
Swanson's Hawk	<i>Buteo swainsoni</i>	SW	U	U	D L U
Red-tailed Hawk	<i>Buteo jamaicensis</i>	RT	A I U	U	D L U
Ferruginous Hawk	<i>Buteo regalis</i>	FH	A I U	U	D L U
Rough-legged Hawk	<i>Buteo lagopus</i>	RL	U	U	D L U
Zone-tailed Hawk	<i>Buteo albonotus</i>	ZT	A I U	U	NA
Unknown buteo	<i>Buteo</i> spp.	UB	U	U	D L U
Golden Eagle	<i>Aquila chrysaetos</i>	GE	I, S, NA, A, U <sup>4</sup>	U	NA
Bald Eagle	<i>Haliaeetus leucocephalus</i>	BE	I, S1, S2, NA, A, U <sup>5</sup>	U	NA
Unknown eagle	<i>Aquila</i> or <i>Haliaeetus</i> spp.	UE	U	U	NA
American Kestrel	<i>Falco sparverius</i>	AK	U	M F U	NA
Merlin	<i>Falco columbarius</i>	ML	AM Br	AM U	NA
Prairie Falcon	<i>Falco mexicanus</i>	PR	U	U	NA
Peregrine Falcon	<i>Falco peregrinus</i>	PG	A I U	U	NA
Unknown small falcon	<i>F. sparverius</i> or <i>columbarius</i>	SF	U	U	NA
Unknown large falcon	<i>F. mexicanus</i> or <i>peregrinus</i>	LF	U	U	NA
Unknown falcon	<i>Falco</i> spp.	UF	U	U	NA
Unknown raptor	Falconiformes	UU	U	U	NA

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

<sup>2</sup> Sex codes: M = male, F = female, U = unknown.

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

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

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

**Appendix C. Daily observation effort, visitor disturbance ratings, weather records, and raptor-migration flight summaries at Lipan Point, Grand Canyon, AZ: 2004.**

DATE	OBS. HOURS	OBSVRV / HOUR <sup>1</sup>	MEDIAN	PREDOMINANT WEATHER <sup>3</sup>	WIND		TEMP (°C) <sup>1</sup>	BAROM.	MEDIAN	VISIB.	VISIB.	MEDIAN	BIRDS / HOUR
			VISITOR DISTURB <sup>2</sup>		SPEED (KPH) <sup>1</sup>	WIND DIRECTION		PRESS. (IN HG) <sup>1</sup>	THERMAL LIFT <sup>4</sup>	WEST (KM) <sup>1</sup>	EAST (KM) <sup>1</sup>	FLIGHT DISTANCE <sup>5</sup>	
27-Aug	9.00	2.0	0	clr-pc, PM haze	3.5	w			2	90	91	3	3.4
28-Aug	8.00	2.3	0	clr-haze	2.1	var, sw			1	100	96	3	1.6
29-Aug	9.00	1.9	0	clr-haze	1.6	var, nw	27.4		2	85	84	2	4.3
30-Aug	9.00	2.2	0	pc-ovc, haze	3.3	w	28.1		1	70	72	2	1.4
31-Aug	8.50	2.0	0	clr-pc, haze	0.6	calm/ne	27.3		1	65	22	2	4.1
1-Sep	9.00	2.0	0	clr-mc/haze	2.5	w-nw	27.7		3	51	35	2	3.9
2-Sep	8.00	2.0	0	clr-haze	18.5	sw-wnw	25.5		3	64	77	2	0.8
3-Sep	7.33	2.1	0	pc-ovc, AM haze/dust PM ts/rain	27.8	sw-w	20.0	29.44	4	60	60	2	1.1
4-Sep	8.50	2.0	0	clr-pc	14.2	w	20.5	29.63	2	92	87	2	2.8
5-Sep	9.00	2.0	0	clr	1.2	calm/n	22.9	29.86	1	63	42	2	3.4
6-Sep	8.25	3.0	0	clr-mc	6.0	ne, se	25.6	29.91	2	80	89	3	1.0
7-Sep	8.50	2.5	0	clr-haze	2.0	w, sse	27.1	29.85	1	98	85	3	8.4
8-Sep	8.50	2.5	0	pc-mc, PM rain	11.9	w, se-sw	25.9	29.86	3	79	72	2	3.6
9-Sep	7.25	2.5	0	ovc, PM ts/rain	1.4	calm/var	24.4	29.85	4	34	24	2	6.3
10-Sep	9.00	2.3	0	pc-ovc, PM rain	4.5	wsw-wnw	26.2	29.87	3	90	71	2	3.7
11-Sep	7.50	2.7	0	pc-ovc, PM ts/rain	9.4	calm/se	22.9	29.93	3	39	35	2	8.0
12-Sep	9.33	2.8	0	clr-mc, AM haze PM ts	12.0	sw, s	24.0	29.77	2	89	84	2	7.9
13-Sep	8.50	3.0	0	clr, PM haze	12.3	sw, e	26.1	29.63	2	79	84	3	2.4
14-Sep	9.00	2.7	0	clr/haze	8.9	w-wnw	25.1	29.61	3	19	59	2	3.2
15-Sep	9.00	2.0	0	clr-mc, haze	2.5	sw-w	26.0	29.73	1	64	68	2	6.1
16-Sep	9.00	2.4	0	clr/haze	6.6	w-wnw	26.1	29.76	2	81	68	2	7.3
17-Sep	8.50	2.0	0	clr	15.5	sw-nw	26.3	29.76	2	97	85	3	3.3
18-Sep	6.50	2.7	0	pc-ovc, ts/snow PM dust	33.5	ssw	22.0	29.62	4	63	71	2	0.9
19-Sep	4.58	1.9	0	pc-ovc, ts/rain	38.8	sw, wsw	18.7	29.46	4	76	51	2	1.7
20-Sep	9.00	2.0	0	mc-ovc	10.4	wsw-w	14.9	29.57	4	47	36	2	2.0
21-Sep	9.33	2.5	0	clr	1.7	calm, ne, var	14.3	29.74	1	93	89	2	8.6
22-Sep	9.00	1.9	0	clr	1.6	calm/nne	15.2	29.82	2	83	70	3	6.8
23-Sep	9.00	2.8	0	clr	0.8	calm/n-nne	19.7	29.90	2	99	81	2	6.0
24-Sep	8.25	2.0	0	clr-pc	4.8	calm/var	20.3	29.91	2	91	86	3	5.0
25-Sep	9.00	2.7	0	clr	0.1	calm/ne	23.7	29.87	2	99	82	2	3.6
26-Sep	9.00	2.9	0	clr, PM haze	5.8	e, calm	20.5	29.86	2	79	62	2	10.8
27-Sep	9.00	2.8	0	clr-pc, PM haze	1.4	calm/var	21.9	29.86	2	52	51	2	23.4
28-Sep	6.67	2.3	0	ovc, ts/rain	9.5	calm/var	20.1	29.81	4	46	44	2	5.2
29-Sep	5.42	2.0	0	ovc, AM fog PM ts/rain	10.9	e, calm	14.9	29.64	4	22	11	2	2.8
30-Sep	8.75	2.7	1	mc-ovc	7.4	w	15.9	29.58	3	45	35	3	12.6
1-Oct	8.50	2.0	0	clr-ovc	3.9	calm/ene	17.0	29.79	3	53	41	2	9.6
2-Oct	9.00	2.5	0	clr-pc	7.7	e, calm/var	18.0	29.92	2	56	53	2	11.4
3-Oct	8.83	2.7	0	pc-ovc	2.5	var	19.7	29.91	3	68	56	3	6.2
4-Oct	9.00	2.3	0	clr-pc	3.7	calm, ne-se	18.2	29.83	1	60	54	2	13.1
5-Oct	8.83	2.0	0	clr-mc	0.7	calm/nne	17.5	29.76	2	67	59	2	20.2
6-Oct	9.00	3.3	0	clr/haze	0.0	calm/var	18.2	29.80	1	67	57	3	23.7
7-Oct	9.00	2.0	0	clr/haze	0.4	calm	20.4	29.89	2	67	58	2	11.8
8-Oct	8.50	2.0	0	clr/haze	3.9	e	21.3	29.94	2	41	71	2	1.8
9-Oct	9.00	2.8	0	pc-ovc	19.3	sw	20.9	29.72	4	58	51	2	8.3
10-Oct	7.00	2.0	0	ovc, ts/rain	6.9	e	13.2	29.60	4	13	9	2	0.4
11-Oct	7.83	3.0	0	ovc, PM ts	2.9	calm/e	14.2	29.71	3	50	65	3	2.3
12-Oct	9.00	2.5	0	clr-pc, PM haze	1.9	nw-ne	16.3	29.81	3	67	61	2	6.7
13-Oct	8.00	2.4	1	clr-pc	5.4	var	15.9	29.82	2	76	59	2	5.1

Appendix C. continued

DATE	OBS. HOURS	OBSRVR / HOUR <sup>1</sup>	MEDIAN	PREDOMINANT WEATHER <sup>3</sup>	WIND	WIND DIRECTION	TEMP (°C) <sup>1</sup>	BAROM.	MEDIAN	VISIB.	VISIB.	MEDIAN	BIRDS / HOUR
			VISITOR DISTURB <sup>2</sup>		SPEED (KPH) <sup>1</sup>			PRESS. (IN HG) <sup>1</sup>	THERMAL LIFT <sup>4</sup>	WEST (KM) <sup>1</sup>	EAST (KM) <sup>1</sup>	FLIGHT DISTANCE <sup>5</sup>	
14-Oct	8.33	2.8	0	clr-pc	0.6	calm/var	18.1	29.81	2	66	69	3	3.8
15-Oct	8.50	2.0	0	clr-pc, haze	8.2	sw	20.3	29.68	3	59	58	2	8.0
16-Oct	8.50	2.8	0	ovc	14.2	sw	16.7	29.63	4	58	61	2	4.6
17-Oct	8.00	3.9	0	mc-ovc	34.7	s-sw	13.5	29.45	4	61	48	2	2.1
18-Oct	7.83	3.5	0	ovc/rain	36.6	w	8.6	29.46	4	31	33	2	0.5
19-Oct	7.17	2.9	0	ovc	33.9	sw	10.6	29.51	4	16	19	2	0.6
20-Oct	8.00	1.9	0	ovc, AM rain	27.3	s-w	14.0	29.47	4	60	29	2	0.3
21-Oct	0.00			weather day									
22-Oct	0.00			weather day									
23-Oct	8.50	2.7	0	clr, AM haze	7.9	calm/sw	10.5	29.61	3	38	57	2	10.7
24-Oct	8.50	1.9	0	clr-pc	6.8	w	12.4	29.54	3	73	70	2	5.4
25-Oct	8.00	2.0	0	mc	14.3	sw-w	11.9	29.47	4	65	54	2	5.8
26-Oct	8.00	2.6	0	mc-ovc	21.3	sw	12.8	29.47	4	49	44	2	3.4
27-Oct	7.17	1.9	0	ovc	36.1	se, s	10.4	29.40	4	29	48	2	0.4
28-Oct	0.00			weather day									
29-Oct	7.50	2.0	0	pc-mc	2.3	w, calm	7.0	29.72	4	79	56	2	10.8
30-Oct	7.83	2.0	0	clr	0.4	e, calm	7.9	29.65	1	68	64	2	19.9
31-Oct	7.75	2.0	0	clr-pc	6.5	w	8.0	29.51	3	66	64	2	9.7
1-Nov	7.50	2.0	0	clr	10.9	wnw-nne	2.1	29.76	3	60	63	3	0.4
2-Nov	7.50	2.7	0	clr	3.6	nw	7.3	29.95	4	82	70	3	2.8
3-Nov	5.17	1.8	0	clr	1.8	wsw-w	11.9		2	83	56	2	0.4
4-Nov	7.75	2.0	0	clr-mc	11.1	se	9.9	29.41	3	66	57	2	0.3
5-Nov	4.83	1.9	0	clr	2.4	e-se	11.3	29.96	4	70	84	-	0.6

<sup>1</sup> Average of hourly records.

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

<sup>3</sup> 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.

<sup>4</sup> 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.

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

**Appendix D. Daily observation effort, visitor disturbance ratings, weather records, and raptor-migration flight summaries at Yaki Point, Grand Canyon, AZ: 2004.**

DATE	OBS. HOURS	OBSRVR / HOUR <sup>1</sup>	MEDIAN	PREDOMINANT WEATHER <sup>3</sup>	WIND	TEMP (°C) <sup>1</sup>	BAROM.	MEDIAN	VISIB.	MEDIAN	BIRDS / HOUR	
			VISITOR DISTURB <sup>2</sup>		SPEED (KPH) <sup>1</sup>		WIND DIRECTION	PRESS. (IN HG) <sup>1</sup>	THERMAL LIFT <sup>4</sup>	EAST (KM) <sup>1</sup>		FLIGHT DISTANCE <sup>5</sup>
27-Aug	8.83	3.0	0	clr-pc	7.2	var		1	0	90	2	
28-Aug	9.00	2.0	0	clr, AM haze	12.3	ene, wnw-nw		1	0	88	2	
29-Aug	8.08	3.3	0	clr/haze	1.2	calm, nnw		1	0	95	2	
30-Aug	8.83	4.9	0	clr/haze	1.4	w-nw		1	0	89	2	
31-Aug	10.00	2.2	0	pc-ovc, haze	1.8	ne	28.7	2	0	8	2	
1-Sep	9.50	2.2	0	clr-pc, haze	1.0	wnw		1	0	48	2	
2-Sep	8.50	2.3	0	clr-pc	29.2	s-sw	24.2	3	0	87	2	
3-Sep	5.33	1.8	0	pc-ovc, PM ts/rain	41.6	s	20.6	4	0	52	-	
4-Sep	8.83	3.7	0	clr-mc	10.9	s-sse, n	19.7	29.37	3	0	74	2
5-Sep	9.50	3.9	1	clr/haze	1.5	s, n	22.5	29.57	2	0	80	2
6-Sep	8.92	3.2	0	clr-mc	4.2	e, ne	24.5	29.62	1	0	79	2
7-Sep	9.25	2.5	0	clr	2.1	e, calm, e	25.5	29.59	1	0	68	2
8-Sep	9.00	1.8	0	pc-ovc, PM rain	8.4	calm, se-sw	25.7	29.59	2	0	73	3
9-Sep	5.00	2.0	0	ovc, AM haze PM ts/rain	3.8	calm/var	22.7	29.59	3	0	80	3
10-Sep	9.00	2.9	0	pc-ovc, PM ts/rain	5.9	sw-w	23.7	29.64	3	0	90	2
11-Sep	9.00	2.3	1	pc-ovc, ts	6.4	calm/var	25.7	29.68	3	0	75	2
12-Sep	8.75	2.7	0	pc-ovc	20.9	sw-wnw	25.2	29.46	3	0	75	2
13-Sep	9.75	2.4	1.5	clr	14.2	s, var, s	24.5	29.39	1	0	47	2
14-Sep	9.17	2.3	1	clr/haze	17.0	sw, n	24.1	29.31	3	0	71	2
15-Sep	9.25	2.6	1	clr-pc, haze	6.8	calm/nw-n, sw	26.0	29.46	2	0	73	3
16-Sep	8.83	2.5	0	clr, AM haze	6.9	wnw	24.4	29.51	2	0	73	2
17-Sep	9.00	2.8	0	clr, PM dust	17.6	s-sw	24.7	29.51	2	0	60	2
18-Sep	6.50	2.1	0	ovc, PM ts	31.1	s	22.8	29.38	4	0	56	2
19-Sep	5.00	2.6	1	mc-ovc	34.7	s-sw	17.3	29.10	4	0	51	2
20-Sep	9.33	2.7	0	ovc-clr	18.0	sw-w	13.4	29.34	4	0	62	2
21-Sep	9.75	3.7	0	clr-pc	3.1	calm, nnw-n	13.6	29.50	1	0	65	2
22-Sep	9.33	3.0	1	clr	4.1	ne-e, calm, nw-n	16.1	29.50	2	0	82	2
23-Sep	9.17	3.8	0	clr-mc	5.2	e, calm	16.7	29.64	3	0	69	3
24-Sep	8.67	4.3	0	clr	6.0	e	19.7	29.65	1	0	72	3
25-Sep	9.00	4.0	0	clr-pc	3.1	e, calm	21.4	29.61	2	0	61	3
26-Sep	9.25	3.3	1	clr-pc	3.3	calm/e	21.7	29.58	1	0	72	2
27-Sep	9.17	3.1	0	clr/haze	0.0	calm/w	22.7	29.61	1	0	75	2
28-Sep	7.17	3.1	0	mc-ovc, PM ts	17.4	var, s-sw	20.9	29.49	3	0	67	3
29-Sep	7.17	2.4	0	ovc, AM fog PM ts/rain	7.1	calm/e-se	14.9	29.35	4	0	11	3
30-Sep	8.83	1.8	1	mc-ovc, AM rain	5.1	var	15.9	29.34	4	0	67	2
1-Oct	9.00	3.9	0	mc-ovc	7.5	e-se	15.3	29.53	3	0	62	3
2-Oct	9.00	2.9	0	clr	4.5	e-se	18.7	29.67	2	0	62	2
3-Oct	9.00	2.5	0	pc	7.8	e	16.5	29.65	2	0	70	3
4-Oct	9.00	2.7	1	clr-pc	8.1	e, ne	19.8	29.55	3	0	71	3
5-Oct	8.83	2.8	0	clr-pc	1.5	calm/n	18.5	29.51	2	0	58	3
6-Oct	9.00	3.1	0	clr-pc	0.8	nw-n	18.4	29.54	1	0	70	3
7-Oct	9.00	3.5	0	clr/haze	0.9	calm/n	19.9	29.63	2	0	48	2
8-Oct	8.83	3.1	2	clr/haze	6.5	var	20.5	29.69	3	0	81	2
9-Oct	8.50	2.4	0	clr/haze	13.6	s	19.3	29.49	4	0	66	2
10-Oct	5.58	2.3	1	ovc, PM rain	11.4	ene	14.0	29.32	4	0	45	3
11-Oct	8.50	2.6	0	pc-mc	6.1	ne-se	15.3	29.44	2	0	55	2
12-Oct	9.00	2.8	0	clr/haze	5.1	n-e	16.1	29.55	3	0	61	2
13-Oct	8.33	4.0	0	clr-pc, AM haze	6.8	var	17.3	29.57	2	0	72	3
14-Oct	9.00	2.9	0	clr-pc, haze	5.0	var	18.9	29.56	3	0	75	3

Appendix D. continued

DATE	OBS. HOURS	OBSRVR / HOUR <sup>1</sup>	MEDIAN	PREDOMINANT WEATHER <sup>3</sup>	WIND	WIND DIRECTION	TEMP (°C) <sup>1</sup>	BAROM.	MEDIAN	VISIB.	MEDIAN	BIRDS / HOUR
			VISITOR DISTURB <sup>2</sup>		SPEED (KPH) <sup>1</sup>			PRESS. (IN HG) <sup>1</sup>	THERMAL LIFT <sup>4</sup>	EAST (KM) <sup>1</sup>	FLIGHT DISTANCE <sup>5</sup>	
15-Oct	9.00	4.0	0	clr, AM haze	9.3	ese-sse, ne	20.7	29.43	2	0	61	1
16-Oct	8.25	2.5	0	mc-ovc	17.7	se-s	17.0	29.42	4	0	43	1
17-Oct	7.67	2.9	0	mc-ovc	17.8	ssw-wsw			4	0	59	2
18-Oct	6.75	1.7	1.5	ovc/rain	24.8	s, sw	9.0	29.22	4	0	9	2
19-Oct	6.50	2.5	0	ovc, PM rain	22.1	s-ssw	8.8	29.29	4	0	9	2
20-Oct	5.67	2.0	0	ovc, AM ts	22.3	sse-ssw	12.0	29.23	4	0	36	2
21-Oct	0.00			Weather Day								
22-Oct	0.00			Weather Day								
23-Oct	8.25	2.4	0	clr-pc, AM haze	16.3	sw	9.6	29.37	4	0	65	2
24-Oct	8.50	3.8	0	clr-pc	6.2	s	11.6	29.29	3	0	64	1
25-Oct	8.00	2.1	1	ovc	25.5	ws-w	10.7	29.22	4	0	44	2
26-Oct	8.00	2.0	1	ovc	10.7	s-ssw	11.6	29.24	4	0	63	2
27-Oct	6.00	2.1	0	ovc, PM rain	22.3	sse-s	11.0	29.19	4	0	16	1
28-Oct	0.00			Weather Day								
29-Oct	7.25	2.4	0	pc-mc/AM fog, clr-pc	3.0	calm/sse	6.4	29.48	1	0	69	2
30-Oct	7.75	3.3	0	clr	2.4	e, calm	7.9	29.40	3	0	66	1
31-Oct	8.00	1.4	0	pc-mc	8.9	ne	5.9	29.26	3	0	67	2
1-Nov	7.00	1.6	0	clr	1.9	calm/var	5.1	29.53	3	0	64	2
2-Nov	7.50	1.0	0	clr	3.8	e, calm, e	4.5	29.70	4	0	72	2
3-Nov	6.25	1.0	0	clr	0.4	calm	11.5		2	0	63	2
4-Nov	8.00	1.0	0	pc-ovc	10.8	ene-e	10.4	29.93	4	0	66	3
5-Nov	4.83	2.2	0	clr-mc	16.1	e	9.7	29.69	3	0	82	3

<sup>1</sup> Average of hourly records.

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

<sup>3</sup> 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.

<sup>4</sup> 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.

<sup>5</sup> 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 E. Daily raptor migration counts by species at Lipan Point, Grand Canyon, AZ: 2004.**

DATE	OBSERV		SPECIES <sup>1</sup>																								BIRDS			
	HOURS	OS	NH	SS	CH	NG	SA	LA	UA	RS	BW	SW	RT	FH	RL	ZT	UB	GE	BE	UE	AK	ML	PR	PG	SF	LF	UF	UU	TOTAL	/ HOUR
27-Aug	9.00	1	0	1	0	0	1	0	1	0	0	2	5	0	0	0	0	0	0	0	19	0	0	1	0	0	0	0	31	3.4
28-Aug	8.00	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	13	1.6
29-Aug	9.00	0	0	6	2	0	0	0	1	0	0	2	14	0	0	0	0	0	0	14	0	0	0	0	0	0	0	39	4.3	
30-Aug	9.00	1	1	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	5	0	0	1	0	0	0	2	13	1.4	
31-Aug	8.50	1	0	3	1	0	3	0	0	0	0	0	5	0	0	0	0	0	0	22	0	0	0	0	0	0	0	35	4.1	
01-Sep	9.00	0	1	3	7	0	1	0	0	0	0	0	4	0	0	0	0	0	0	19	0	0	0	0	0	0	0	35	3.9	
02-Sep	8.00	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	1	0	0	0	0	6	0.8	
03-Sep	7.33	3	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	8	1.1	
04-Sep	8.50	1	1	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	24	2.8	
05-Sep	9.00	0	0	2	2	0	1	0	2	0	0	1	9	0	0	0	1	0	0	13	0	0	0	0	0	0	0	31	3.4	
06-Sep	8.25	1	0	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	8	1.0	
07-Sep	8.50	7	0	13	4	0	1	0	6	0	0	0	14	0	0	0	1	0	0	24	0	0	0	0	0	0	1	71	8.4	
08-Sep	8.50	2	0	6	2	0	1	0	0	0	0	1	1	0	0	0	0	0	0	18	0	0	0	0	0	0	0	31	3.6	
09-Sep	7.25	7	0	9	1	0	3	0	2	0	0	2	5	0	0	0	0	0	0	17	0	0	0	0	0	0	0	46	6.3	
10-Sep	9.00	2	0	18	2	0	0	0	0	0	0	1	3	0	0	0	0	0	0	7	0	0	0	0	0	0	0	33	3.7	
11-Sep	7.50	3	2	0	1	0	0	0	1	0	0	1	12	0	0	0	1	0	0	38	0	0	0	0	0	0	1	60	8.0	
12-Sep	9.33	0	0	7	7	0	2	0	3	0	0	1	19	0	0	0	0	0	0	34	0	0	0	0	0	0	1	74	7.9	
13-Sep	8.50	1	0	7	3	0	0	0	0	0	0	0	2	0	0	0	0	1	0	6	0	0	0	0	0	0	0	20	2.4	
14-Sep	9.00	1	1	6	1	0	1	0	2	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	29	3.2	
15-Sep	9.00	0	0	19	4	0	0	0	1	0	0	0	10	0	0	0	1	0	0	18	0	0	1	0	0	1	0	55	6.1	
16-Sep	9.00	2	0	29	15	0	4	0	0	0	0	0	13	0	0	0	0	0	0	3	0	0	0	0	0	0	0	66	7.3	
17-Sep	8.50	0	0	8	7	0	0	0	1	0	0	0	4	1	0	0	0	0	0	6	1	0	0	0	0	0	0	28	3.3	
18-Sep	6.50	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	6	0.9	
19-Sep	4.58	3	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	8	1.7	
20-Sep	9.00	1	0	0	4	0	0	0	0	0	0	1	3	0	0	0	0	0	0	9	0	0	0	0	0	0	0	18	2.0	
21-Sep	9.33	2	0	22	13	0	4	0	0	0	0	0	24	0	0	0	0	0	0	14	0	0	0	1	0	0	0	80	8.6	
22-Sep	9.00	3	1	10	8	0	0	0	0	0	0	1	19	0	0	0	2	0	0	13	1	0	0	0	0	0	3	61	6.8	
23-Sep	9.00	1	0	15	11	0	2	0	0	0	0	3	10	0	0	0	0	0	0	11	0	1	0	0	0	0	0	54	6.0	
24-Sep	8.25	0	1	10	6	0	3	0	2	0	0	1	8	0	0	0	0	0	0	9	0	0	0	0	0	0	1	41	5.0	
25-Sep	9.00	2	2	4	2	0	0	0	1	0	0	0	6	0	0	0	0	0	0	15	0	0	0	0	0	0	0	32	3.6	
26-Sep	9.00	0	1	15	5	0	1	0	0	0	0	3	22	0	0	0	0	0	0	48	0	1	1	0	0	0	0	97	10.8	
27-Sep	9.00	1	0	44	26	0	9	0	3	0	0	9	47	0	0	0	0	0	0	65	1	1	1	0	0	0	4	211	23.4	
28-Sep	6.67	0	0	8	2	0	0	0	0	0	0	1	2	0	0	0	0	0	0	22	0	0	0	0	0	0	0	35	5.2	
29-Sep	5.42	0	0	1	2	0	0	0	0	0	0	0	4	0	0	0	0	0	0	8	0	0	0	0	0	0	0	15	2.8	
30-Sep	8.75	4	0	25	13	0	1	0	0	0	0	37	14	0	0	0	0	0	0	13	1	0	0	0	0	0	2	110	12.6	
01-Oct	8.50	1	0	26	9	0	2	0	2	0	0	2	17	0	0	0	0	0	0	23	0	0	0	0	0	0	0	82	9.6	
02-Oct	9.00	1	2	33	22	0	8	0	3	0	0	6	7	0	0	0	0	0	0	19	0	0	0	0	0	0	2	103	11.4	
03-Oct	8.83	2	0	15	6	0	4	0	0	0	0	0	11	0	0	0	0	1	0	14	0	0	0	0	0	0	2	55	6.2	

## Appendix E. continued

DATE	OBSERV			SPECIES <sup>1</sup>																								BIRDS			
	HOURS	OS	NH	SS	CH	NG	SA	LA	UA	RS	BW	SW	RT	FH	RL	ZT	UB	GE	BE	UE	AK	ML	PR	PG	SF	LF	UF	UU	TOTAL	/HOUR	
04-Oct	9.00	1	0	33	26	0	2	0	1	0	0	8	21	0	0	0	0	1	0	0	21	1	2	0	0	0	0	1	118	13.1	
05-Oct	8.83	0	2	66	22	0	8	0	4	0	0	1	58	0	0	0	0	0	0	0	15	2	0	0	0	0	0	0	178	20.2	
06-Oct	9.00	1	1	83	31	0	16	0	2	0	0	0	55	0	0	0	1	0	0	0	18	2	1	0	0	0	0	2	213	23.7	
07-Oct	9.00	1	0	53	14	0	1	0	0	0	0	0	31	0	0	0	0	0	0	0	5	0	0	1	0	0	0	0	106	11.8	
08-Oct	8.50	0	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	15	1.8	
09-Oct	9.00	1	0	12	6	0	0	0	0	0	0	2	43	0	0	0	1	0	0	0	8	0	1	0	0	0	0	1	75	8.3	
10-Oct	7.00	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0.4	
11-Oct	7.83	2	0	7	4	0	0	0	0	0	0	0	3	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	18	2.3	
12-Oct	9.00	0	3	31	7	0	1	0	1	0	0	0	12	0	0	0	0	1	0	0	4	0	0	0	0	0	0	0	60	6.7	
13-Oct	8.00	0	1	21	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	3	2	0	0	0	0	0	1	41	5.1	
14-Oct	8.33	0	2	15	3	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	32	3.8	
15-Oct	8.50	0	1	23	2	0	1	0	0	0	0	0	39	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	68	8.0	
16-Oct	8.50	0	0	5	0	0	1	0	0	0	0	0	32	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	39	4.6	
17-Oct	8.00	0	0	4	1	0	0	0	0	0	0	0	11	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	17	2.1	
18-Oct	7.83	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0.5	
19-Oct	7.17	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	4	0.6	
20-Oct	8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0.3	
21-Oct	0.00																														
22-Oct	0.00																														
23-Oct	8.50	0	2	47	0	0	0	0	0	0	0	0	37	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	91	10.7	
24-Oct	8.50	0	1	31	0	0	0	0	0	0	0	0	7	0	0	0	0	2	2	0	0	2	0	0	0	0	0	1	46	5.4	
25-Oct	8.00	1	0	26	2	0	1	0	0	0	0	0	15	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	46	5.8	
26-Oct	8.00	0	1	12	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	27	3.4	
27-Oct	7.17	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0.4	
28-Oct	0.00																														
29-Oct	7.50	0	0	36	2	0	1	0	0	0	0	0	40	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	81	10.8	
30-Oct	7.83	0	5	27	6	0	0	0	0	0	0	0	113	0	0	0	0	1	3	0	1	0	0	0	0	0	0	0	156	19.9	
31-Oct	7.75	0	4	18	1	0	0	0	0	0	0	0	45	0	0	0	0	0	3	0	0	4	0	0	0	0	0	0	75	9.7	
01-Nov	7.50	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0.4	
02-Nov	7.50	0	0	1	1	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	2.8	
03-Nov	5.17	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.4	
04-Nov	7.75	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.3	
05-Nov	4.83	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0.6	
Total	554.98	61	41	945	319	0	85	0	39	0	0	89	951	1	0	0	8	9	14	0	689	21	7	7	1	0	1	25	3313	6.0	

<sup>1</sup> See Appendix B for explanation of species codes.



**Appendix F. Daily raptor migration counts by species at Yaki Point, Grand Canyon, AZ: 2004.**

DATE	OBSERV		SPECIES <sup>1</sup>																								BIRDS				
	HOURS	OS	NH	SS	CH	NG	SA	LA	UA	RS	BW	SW	RT	FH	RL	ZT	UB	GE	BE	UE	AK	ML	PR	PG	SF	LF	UF	UU	TOTAL	/ HOUR	
27-Aug	8.83	0	0	4	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	11	1.2
28-Aug	9.00	0	0	1	2	0	1	0	0	0	0	1	4	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	10	1.1
29-Aug	8.08	0	0	1	2	0	0	0	0	0	0	2	11	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	19	2.4
30-Aug	8.83	0	1	8	1	0	0	0	0	0	0	3	7	0	0	0	0	0	0	0	12	0	0	0	0	0	0	1	33	3.7	
31-Aug	10.00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	25	2.5	
01-Sep	9.50	0	1	7	1	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	23	2.4	
02-Sep	8.50	0	0	2	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	7	0.8	
03-Sep	5.33	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	0	0	0	0.0	
04-Sep	8.83	0	2	1	1	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	8	0	0	1	0	0	0	1	20	2.3	
05-Sep	9.50	0	1	19	7	0	0	0	2	0	0	1	4	0	0	0	0	0	0	0	17	0	0	0	0	0	0	1	52	5.5	
06-Sep	8.92	2	0	13	10	0	1	0	0	0	0	0	6	0	0	0	0	0	0	0	78	0	0	0	0	0	0	0	110	12.3	
07-Sep	9.25	1	0	31	5	0	10	0	0	0	0	0	8	0	0	0	0	0	0	0	16	0	1	0	0	0	0	0	72	7.8	
08-Sep	9.00	0	0	10	6	0	1	0	1	0	0	0	4	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	24	2.7	
09-Sep	5.00	1	0	2	3	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	1.8		
10-Sep	9.00	1	0	3	6	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	19	2.1	
11-Sep	9.00	3	0	11	5	1	0	0	2	0	0	5	15	0	0	0	0	0	0	0	23	0	0	0	0	0	0	1	66	7.3	
12-Sep	8.75	2	0	19	10	0	1	0	1	0	0	0	11	0	0	0	0	0	0	0	19	0	0	0	0	0	0	2	65	7.4	
13-Sep	9.75	1	0	13	5	1	2	0	2	0	0	3	13	0	0	0	0	0	0	0	50	0	1	1	0	0	1	1	94	9.6	
14-Sep	9.17	1	0	10	9	0	1	0	1	0	0	0	4	0	0	0	1	0	0	0	23	0	0	0	0	0	0	0	50	5.5	
15-Sep	9.25	0	0	42	29	0	2	0	9	0	0	1	12	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	100	10.8	
16-Sep	8.83	0	0	17	12	0	0	0	0	0	0	1	12	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	47	5.3	
17-Sep	9.00	1	0	18	7	0	0	0	2	0	0	0	4	0	0	0	0	0	0	0	8	0	1	0	0	0	0	0	41	4.6	
18-Sep	6.50	0	0	3	5	0	0	0	1	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	2.0	
19-Sep	5.00	1	0	2	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	7	1.4	
20-Sep	9.33	1	1	8	3	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	23	2.5	
21-Sep	9.75	6	1	73	59	1	10	0	4	0	1	6	29	0	0	0	1	0	0	0	48	0	1	0	0	0	0	2	242	24.8	
22-Sep	9.33	0	1	49	30	0	2	0	6	0	0	2	31	0	0	0	0	0	0	0	19	1	0	0	0	0	0	2	143	15.3	
23-Sep	9.17	1	0	102	40	0	2	0	6	0	0	4	54	0	0	0	0	0	0	0	46	0	0	0	0	0	0	1	256	27.9	
24-Sep	8.67	4	0	93	44	1	0	0	17	0	0	5	35	0	0	0	0	0	0	0	96	1	0	2	0	0	0	7	305	35.2	
25-Sep	9.00	0	3	81	45	0	13	0	10	0	1	1	12	0	0	0	3	0	0	0	91	0	0	0	0	0	0	1	261	29.0	
26-Sep	9.25	0	3	129	59	0	18	0	5	0	4	2	33	0	0	0	3	0	0	0	58	2	0	0	0	0	0	1	317	34.3	
27-Sep	9.17	2	2	141	83	0	4	0	7	0	10	13	89	0	0	0	0	0	1	0	32	0	0	0	0	0	0	1	385	42.0	
28-Sep	7.17	2	0	51	14	0	0	0	4	0	1	5	11	0	0	0	0	0	0	0	18	0	0	0	0	0	0	1	107	14.9	
29-Sep	7.17	3	0	12	5	0	3	0	0	0	0	0	5	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	33	4.6	
30-Sep	8.83	1	0	12	7	0	0	0	0	0	0	0	3	0	0	0	0	0	1	0	3	0	0	0	0	0	0	0	27	3.1	
01-Oct	9.00	0	0	31	29	0	2	1	3	0	1	12	11	0	0	0	2	0	0	0	29	0	0	1	0	0	1	0	123	13.7	
02-Oct	9.00	1	0	30	13	2	5	0	0	0	0	3	5	0	0	0	1	0	0	0	25	0	0	0	0	0	0	1	86	9.6	
03-Oct	9.00	0	0	35	25	0	2	0	3	0	1	1	39	0	0	0	1	0	0	0	26	1	0	0	0	0	1	1	136	15.1	

Appendix F. continued

DATE	OBSERV		SPECIES <sup>1</sup>																								BIRDS				
	HOURS	OS	NH	SS	CH	NG	SA	LA	UA	RS	BW	SW	RT	FH	RL	ZT	UB	GE	BE	UE	AK	ML	PR	PG	SF	LF	UF	UU	TOTAL	/ HOUR	
04-Oct	9.00	1	0	67	29	0	2	0	7	0	0	1	32	0	0	0	0	0	0	0	21	0	0	0	0	0	0	0	2	162	18.0
05-Oct	8.83	1	0	67	47	0	16	0	10	0	0	2	34	0	0	0	3	0	0	0	16	0	1	0	0	0	1	3	201	22.8	
06-Oct	9.00	1	0	118	52	0	9	0	15	0	0	0	44	0	0	0	0	0	0	13	0	0	0	0	0	0	0	5	257	28.6	
07-Oct	9.00	0	0	105	61	1	7	0	0	0	0	1	73	0	0	0	1	1	2	0	17	0	2	0	0	0	0	0	271	30.1	
08-Oct	8.83	2	0	60	11	0	1	0	2	0	0	0	21	0	0	0	0	0	0	27	0	0	0	0	0	0	0	0	124	14.0	
09-Oct	8.50	0	1	11	3	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	30	3.5	
10-Oct	5.58	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0.5	
11-Oct	8.50	0	1	10	4	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	19	2.2	
12-Oct	9.00	0	1	60	19	0	2	0	2	0	0	0	63	0	0	0	0	0	1	0	11	0	0	0	0	0	0	0	159	17.7	
13-Oct	8.33	0	0	12	4	0	2	0	2	0	0	0	12	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	35	4.2	
14-Oct	9.00	0	2	46	18	0	0	0	0	0	0	0	71	0	0	0	0	0	1	0	3	0	0	0	0	0	0	0	141	15.7	
15-Oct	9.00	1	2	16	6	0	1	0	0	0	0	0	49	1	0	0	0	1	1	0	1	0	0	0	0	0	0	0	79	8.8	
16-Oct	8.25	0	0	4	0	0	0	0	0	0	0	1	28	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	35	4.2	
17-Oct	7.67	0	0	4	1	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	1.7	
18-Oct	6.75	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.3	
19-Oct	6.50	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.3	
20-Oct	5.67	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.4	
21-Oct	0.00																														
22-Oct	0.00																														
23-Oct	8.25	0	1	9	4	0	0	0	1	0	0	0	5	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	22	2.7	
24-Oct	8.50	0	0	24	2	0	0	0	0	0	0	0	56	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	83	9.8	
25-Oct	8.00	0	0	4	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	1.5	
26-Oct	8.00	0	0	2	1	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	6	0.8	
27-Oct	6.00	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.2	
28-Oct	0.00																														
29-Oct	7.25	0	0	7	2	0	0	0	0	0	0	0	42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	51	7.0	
30-Oct	7.75	0	1	17	5	0	1	0	0	0	0	0	26	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	51	6.6	
31-Oct	8.00	0	4	10	2	0	1	0	0	0	0	0	62	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	82	10.3	
01-Nov	7.00	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	
02-Nov	7.50	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0.7	
03-Nov	6.25	0	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0.6	
04-Nov	8.00	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	
05-Nov	4.83	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.2	
Total	559.40	42	29	1743	855	7	122	1	125	0	19	80	1169	1	0	0	17	4	10	0	930	9	7	6	0	0	4	36	5216	9.3	

<sup>1</sup> See Appendix B for explanation of species codes.

**Appendix G. Annual observation effort and fall raptor migration counts by species at Lipan Point, Grand Canyon, AZ: 1991–2004**

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	MEAN
Start date	8-Sep	1-Sep	31-Aug	1-Sep	1-Sep	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	28-Aug
End date	5-Nov	5-Nov	5-Nov	5-Nov	5-Nov	5-Nov	5-Nov	5-Nov	5-Nov	5-Nov	5-Nov	5-Nov	5-Nov	5-Nov	4-Nov
Days of observation	57	65	66	64	65	69	70	68	71	67	71	69	70	68	67
Hours of observation	399.66	513.50	504.50	482.92	492.54	508.84	522.19	505.18	546.70	511.54	575.08	557.72	535.58	554.98	515.06
Raptors / 100 hours	1231	1957	1249	1372	1369	1574	1331	1283	1152	1107	1008	901	1036	597	1226
SPECIES	RAPTOR COUNTS														
Osprey	26	72	73	73	77	99	135	115	72	88	83	58	75	61	79
Northern Harrier	43	131	64	111	121	111	93	81	130	99	39	51	56	41	84
Sharp-shinned Hawk	698	2472	1643	1802	1441	1680	1566	1366	1427	1449	1609	1455	1263	945	1487
Cooper's Hawk	1077	1673	1243	974	1052	1322	1332	1715	1515	968	1158	599	765	319	1122
Northern Goshawk	10	42	26	4	5	3	8	2	6	13	7	5	0	0	9
Unknown small accipiter <sup>1</sup>	-	-	-	-	-	-	-	-	-	-	98	197	31	85	103
Unknown large accipiter <sup>1</sup>	-	-	-	-	-	-	-	-	-	-	1	2	4	0	2
Unknown accipiter	360	337	199	200	243	423	213	243	185	252	0	46	47	39	199
TOTAL ACCIPITERS	2145	4524	3111	2980	2741	3428	3119	3326	3133	2682	2873	2304	2110	1388	2847
Red-shouldered Hawk	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
Broad-winged Hawk	0	3	7	2	7	2	7	35	11	15	25	20	6	0	10
Swainson's Hawk	6	24	25	33	34	57	32	31	40	22	26	33	108	89	40
Red-tailed Hawk	1194	3229	1613	1898	2299	2275	1704	1390	1401	1498	1458	1302	1791	951	1715
Ferruginous Hawk	8	15	7	11	3	6	7	6	7	6	3	2	6	1	6
Rough-legged Hawk	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Zone-tailed Hawk	0	0	0	0	0	0	1	1	0	0	0	1	2	0	0
Unidentified buteo	55	19	2	8	11	16	33	40	17	15	8	33	20	8	20
TOTAL BUTEOS	1263	3291	1654	1952	2354	2357	1784	1503	1476	1556	1520	1392	1933	1049	1792
Golden Eagle	18	62	37	36	32	47	26	22	29	9	3	32	17	9	27
Bald Eagle	5	20	49	8	38	23	25	18	24	11	9	20	12	14	20
Unidentified eagle	0	0	3	0	0	0	0	1	4	0	0	3	0	0	1
TOTAL EAGLES	23	82	89	44	70	70	51	41	57	20	12	55	29	23	48
American Kestrel	1156	1508	1209	1273	1096	1631	1340	978	1218	1045	1180	1057	1300	689	1191
Merlin	7	14	12	10	12	8	24	12	13	9	8	4	9	21	12
Prairie Falcon	1	8	8	2	5	4	5	5	2	9	8	1	3	7	5
Peregrine Falcon	2	14	5	5	5	8	8	10	8	6	6	14	8	7	8
Unknown small falcon <sup>1</sup>	-	-	-	-	-	-	-	-	-	-	2	1	0	1	1
Unknown large falcon <sup>1</sup>	-	-	-	-	-	-	-	-	-	-	3	3	1	0	2
Unknown falcon	0	4	4	1	1	0	6	8	6	5	3	0	0	1	3
TOTAL FALCONS	1166	1548	1238	1291	1119	1651	1383	1013	1247	1074	1210	1080	1321	726	1219
Unknown raptor	106	124	24	66	48	60	97	96	107	48	60	83	23	25	69
GRAND TOTAL	4920	10048	6301	6625	6745	8008	6952	6479	6297	5664	5797	5023	5547	3313	6266

<sup>1</sup> New designations used regularly beginning in 2001 (see Appendix B).

**Appendix H. Annual observation effort and fall raptor migration counts by species at Yaki Point, Grand Canyon, AZ: 1997–2004.**

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	MEAN
Start date	27-Aug	28-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug
End date	5-Nov	5-Nov	5-Nov	5-Nov	5-Nov	5-Nov	5-Nov	5-Nov	5-Nov
Days of observation	71	66	71	66	71	71	70	68	69
Hours of observation	504.97	455.41	543.20	513.10	595.59	585.70	547.90	559.40	538.15
Raptors / 100 hours	938.3	907.5	997.8	1054.2	880.6	967.6	1228.9	932.4	979.6
SPECIES	RAPTOR COUNTS								
Osprey	50	43	28	43	34	57	50	42	43
Northern Harrier	50	44	56	41	31	45	35	29	41
Sharp-shinned Hawk	1474	1190	1906	1772	1792	1932	2323	1743	1767
Cooper's Hawk	856	1109	1204	1256	1293	891	1673	855	1142
Northern Goshawk	4	7	1	9	11	6	2	7	6
Unknown small accipiter <sup>1</sup>	–	–	–	–	72	218	52	122	116
Unknown large accipiter <sup>1</sup>	–	–	–	–	0	3	1	1	1
Unknown accipiter	94	140	109	236	0	18	103	125	103
TOTAL ACCIPITERS	2428	2446	3220	3273	3168	3068	4154	2853	3076
Red-shouldered Hawk	1	0	0	0	0	0	0	0	0
Broad-winged Hawk	9	19	14	6	11	8	14	19	13
Swainson's Hawk	15	25	32	10	19	16	147	80	43
Red-tailed Hawk	899	916	985	892	1008	1234	1264	1169	1046
Ferruginous Hawk	8	7	11	10	6	6	6	1	7
Rough-legged Hawk	0	0	0	1	1	2	0	0	1
Zone-tailed Hawk	0	0	1	0	1	1	0	0	0
Unidentified buteo	20	20	13	8	8	43	42	17	22
TOTAL BUTEOS	952	987	1056	927	1054	1310	1473	1286	1131
Golden Eagle	24	7	2	11	4	23	11	4	11
Bald Eagle	23	18	17	9	14	49	14	10	19
Unidentified eagle	1	0	1	0	0	1	0	0	0
TOTAL EAGLES	48	25	20	20	18	73	25	14	32
American Kestrel	1016	423	918	1035	881	1011	943	930	895
Merlin	14	12	14	5	22	5	17	9	12
Prairie Falcon	9	4	6	4	3	8	5	7	6
Peregrine Falcon	7	19	8	1	7	11	7	6	8
Unknown small falcon <sup>1</sup>	–	–	–	–	0	3	0	0	1
Unknown large falcon <sup>1</sup>	–	–	–	–	0	1	0	0	0
Unknown falcon	0	4	2	3	2	4	1	4	3
TOTAL FALCONS	1046	462	948	1048	915	1043	973	956	924
Unidentified raptor	20	38	16	10	25	71	23	36	30
GRAND TOTAL	4594	4045	5344	5362	5245	5667	6733	5216	5276

<sup>1</sup> New designations used regularly beginning in 2001 (see Appendix B).