FALL 2007 RAPTOR MIGRATION STUDIES IN THE GRAND CANYON OF ARIZONA

HawkWatch International, Inc.
Salt Lake City, Utah

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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, Smith et al. 2008a). 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 ~6,100–12,300 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 2007 season marked the 17th consecutive count at Lipan Point and the 11th consecutive full-season count at Yaki Point. This report summarizes the 2007 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 2007. The primary objective of these efforts is to track long-term population trends of diurnal raptors in western North America and around the Gulf Coast (Hoffman and Smith 2003, Smith et al. 2008a, b). 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, Bildstein 2006, Bildstein et al. 2008).

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 Point is located in Coconino County, Arizona along the south rim of the Grand Canyon at an elevation of 2,243 m (36° 01′ 59.2″ N, 111° 51′ 11.5″ W; Figure 1). 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 Point is located in Coconino County, Arizona along the south rim of the Grand Canyon ~22 km west of Lipan Point at an elevation of 2,213 m (36° 03′ 31.0″ N, 112° 05′ 01.7″ W; Figure 1). 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 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 (Bildstein 2006) 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, Bildstein 2006).

METHODS

Four official or designated observers, assisted occasionally by other local volunteers, 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 two counters were present most of the time at both sites. Lead Observer Jennifer Good had two previous seasons of migration counting experience with HWI in New Mexico (see Appendix A for a complete history of observation participation). Official observer Graeme Davis had one previous season of migration counting experience with HWI in New Mexico. Neither of the other official observers had previously conducted raptor migration counts, but both Tyler Hallman and Jenny Aleman-Zometa attended pre-season training at HWI headquarters and received additional on-site training. All four observers routinely facilitated interactions with visitors, with late assistance provided by Jessie Hallman, 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 H Mountain Standard Time (MST) and ended by 1700 H 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 H 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 updated through 2007 follows Hoffman and Smith (2003). In this report, we compare regression analyses of long-term (1991–2007) Lipan Point data and shorter-term Yaki Point and combined-site data from 1997–2007. In comparing 2007 annual statistics against means and 95% confidence intervals for previous seasons, we equate significance ($P \leq 0.05$) with a 2007 value falling outside the bounds of the confidence interval for the associated mean.

RESULTS AND DISCUSSION

WEATHER SUMMARY

In 2007, inclement weather entirely precluded or severely hampered (i.e., reduced to ≤4 hours observation) no days of observation at either site (see Appendixes C and D for daily weather records from the two sites). The 1997–2006 averages are 1.5 days fully precluded and 1.8 days severely hampered at Lipan Point and 1.6 days fully precluded and 1.7 days severely hampered at Yaki Point. Predominantly fair skies prevailed on an above-average proportion of the active observation days at Lipan Point (61% vs. 1997–2006 average of 53%), but on an average proportion at Yaki Point (51% vs. average of 52%). At Lipan Point, transitional skies (i.e., cloud cover changed during the day from fair skies to mostly cloudy or overcast skies, or vice versa) and mostly cloudy to overcast skies prevailed on below average proportions of the active days (transitional: 25% vs. average of 30%; mostly cloudy to overcast: 14% vs. average of 17%), whereas again the values at Yaki Point were closer to average (transitional: 31% vs. average of 28%; mostly cloudy to overcast: 17% vs. average of 20%). Similar to last year, visibility reducing fog and especially haze, primarily from dust, hampered observations more than usual at both sites. At Lipan Point, 73% of the active observation days featured appreciable fog and/or haze, compared to the 1997–2006 average of 32%. At Yaki Point, the comparative proportions were 69% versus an average of 29%. In contrast, rain and snow showers occurred slightly less often than usual at both sites. At Lipan Point, 13% of the active observation days featured some rain or snow (average 18%); at Yaki Point 14% (average 16%).

The 2007 temperature regimes at both sites were warmer than average. The average daily temperature (average of daily values, which in turn were averages of hourly readings) at Lipan Point during active observation periods was 21.3°C (1997–2006 average of 18.8°C), ranging from 8.3 to 31.2°C. At Yaki Point, the 2007 daily-average was 20.9°C (average 17.6°C), ranging from 10.0 to 30.7°C. At both sites the daily-average minimums and maximums were average to above average.

Similar to last year, at Lipan Point there was a distinct shift toward stronger than usual winds in 2007, with light winds (<12 kph) prevailing on a record-low 68%, moderate winds on a record-high 27%, and stronger winds (>29 kph) on an above-average 6% of the active observation days (1997–2006 averages of 81%, 15%, and 4% of days, respectively). A similar but slightly less substantial shift also occurred at Yaki Point, with light winds prevailing on a below-average 72%, moderate winds on an above average 21%, and strong winds on an above average 7% of the active days (1997–2006 averages of 76%, 20%, and 4%).

In terms of wind directions, at Lipan Point variable S–W winds prevailed on a majority of the active observation days, which is typical; however, such winds prevailed on 51% of the active days in 2007 compared to the 1997–2006 average of only 21%. Curiously, despite a higher than average prevalence of stronger winds, calm/variable winds also prevailed much more often than usual in 2007 (20% vs. average of 7% of the active days). In contrast, windy days where no predominant wind direction could be identified did not occur at all in 2007, compared to the long-term average of 11% of the active days. The only other wind pattern that was noticeably less common than average was variable SW–NW winds (0% vs. average of 12%). The situation at Yaki Point in 2007 was more typical for that site. The only wind pattern that was noticeably more or less common than usual there was days where a combination of NE–SE and calm/variable winds prevailed (18% vs. average of 8% of the active days). Other common patterns at Yaki Point included SW–NW (20% vs. average of 17% of the active days), NE–SE (13% vs. average of 17%), and SE–SW (13% vs. average of 12%). These kinds of differences between the two sites clearly testify to the fact that local wind patterns can be highly variable along the canyon rim.

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 in 2007 (37% vs. average of 59% at Lipan, 44% vs. 53% at Yaki). This is consistent with evidence of stronger than usual winds, which tend to restrict development of strong thermals.

In summary, although the cloud-cover scenarios differed somewhat at the two sites, compared to the last 10 seasons, 2007 generally featured fairer, warmer, windier, and hazier weather than usual, with southwesterly winds prevailing much more often than usual at Lipan Point but a more typical wind-direction pattern prevailing at Yaki Point.

OBSERVATION EFFORT

At both sites, counts occurred on all 71 possible days between 27 August and 5 November 2007 (see Appendices E and F for daily count records for each site). The number of observation days and hours (580.17; the hours during which counts occurred at one or both sites) were both 2% above the 1997–2006 averages (70 ± 95% CI of 0.9 days and 567.88 ± 14.95 hours; see Appendices G and H for annual effort and count summaries for each site). In contrast, the 2007 average of 3.6 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 a significant 12% below average (4.1 ± 0.17 observers/hour). This reflects the fact that the count crew needed to also handle most of the season's public outreach and environmental education efforts, owing to our inability to successfully recruit our usual team of two full-time interpreters to augment the seasonal field crew.

MIGRATION SUMMARY

The observers tallied 8,889 migrant raptors of 15 species at the two count sites in 2007 (Table 1), with 52% recorded at Lipan Point and 48% at Yaki Point. Although an improvement over the last three seasons of very low counts (Appendix G), the total 2007 combined-site count was still a nearly significant 11% below the 1997–2006 average (Table 1). The 2007 Lipan Point count was 10% below the 1997–2006 average and a significant 21% below the 1991–2006 average for that site. The 2007 Yaki Point count also was a significant 14% below the 1997–2006 average for that site. Before 2002, counts at Lipan Point had always exceeded those at Yaki Point, but up until 2007, a distinct, progressive shift in relative abundance at the two sites had occurred, culminating in a significant overall reduction in the combined-site counts in 2004 and especially 2005. This pattern suggested that the east-to-west flight-line shift that had been developing since 1997 finally shifted farther west than either of our two count sites in 2004 and 2005. Reasons for this pattern are uncertain, but may reflect some combination of increased fire prevalence in the past several years on the Kaibab Plateau north of the canyon and shifting dynamics

due to the widespread drought that plagued much of the interior west after 1998. The 2007 season was the first since 2001 that more birds again were seen at Lipan Point than at Yaki Point, and the overall counts also increased again in both 2006 and 2007, suggesting that the east-west shift may have started to reverse again. The counts farther north in the Intermountain Flyway at the Goshute Mountains, Nevada, also dropped markedly for several years following the onset of widespread drought in 1999 (Hoffman and Smith 2003, Smith et al. 2008a), but also finally appear to have begun to rebound in 2006 and 2007 as regional moisture conditions have improved (Smith and Neal 2008).

Compositional Patterns

The combined-site flight was composed of 60% accipiters, 24% buteos, 12% falcons, and ~1% or less each of Ospreys, harriers, eagles, and unidentified raptors. The proportion of accipiters was significantly above average, whereas the proportions of falcons and unidentified raptors were significantly below average (Figure 2). Both sites attracted 50% of the total accipiters (20 more individuals at Lipan Point), Yaki Point attracted more eagles (55% of the combined-site total), and Lipan Point attracted more buteos (55%), falcons (54%), Ospreys (69%), and harriers (61%). The previous 10-year average pattern suggests that passage of accipiters typically is slightly skewed in favor Yaki Point (average 54% of the total); however, the relative abundance of accipiters shifted steadily from roughly 60% of the combined-site total at Lipan Point in 1997/1998 to only 33% in 2004, but then increased again each year after that to reach parity in 2007. The 2007 composition also differed from the average pattern in that eagles typically are more common at Lipan Point (average 61% of the total). The typical compositional differences likely reflect topographic variation around the two sites, which affects local thermal production and therefore varies the attractiveness of each site for soaring species. However, the apparent multi-year shifts in abundance of accipiters between the two sites over the past 11 years suggest that other factors may be influencing their flight paths across the canyon. Possibilities include regional shifts in wind patterns, the effects of widespread drought on regional migration dynamics, and the effects of fire and habitat change on the Kaibab Plateau north of the canyon crossings where the watchsites are situated.

Count and Passage Rate Trends

As usual, Sharp-shinned Hawks, Cooper's Hawks, Red-tailed Hawks, and American Kestrels were by far the most abundant species at both sites (Table 1, Appendices G and H). The combined-site count rose to a new record high for Peregrine Falcons (42), but fell to a new record low for Swainson's Hawks (27) and matched the previous low for Prairie Falcons (8). After falling to new record lows for two years in a row, the count of Ospreys rebounded slightly but still ranked as third lowest since 1997, and the count of American Kestrels rebounded to a much greater degree but also still ranked as second lowest since 1997. Combined-site, adjusted passage rates were significantly above average for 3 species (Northern Goshawk, Bald Eagle, and Peregrine Falcon) and were significantly below average for 5 (Osprey, Swainson's Hawk, Red-tailed Hawk, American Kestrel, and Prairie Falcon) of 15 commonly encountered species (Table 1).

Updated regression analyses of adjusted passage rates at Lipan Point from 1991–2007 (after Hoffman and Smith 2003) indicated significant ($P \leq 0.05$) linear or quadratic (second-order) trends for 8 of 15 commonly encountered species (Figures 3–7). With the addition of two unprecedented high counts in 2006 and 2007, for the first time a significant long-term increase was indicated for Peregrine Falcons (Figure 7). All other significant trends tracked long-term or at least post mid-1990s declines. A recent two-year increase in passage rates of Ferruginous Hawks resulted in a newly significant quadratic trend, however, which suggests passage of this species through the canyon finally may have begun to rebound after at least a 15-year decline (Figure 5). Regression analyses for the period 1997–2007 indicated similar, at least marginally significant, combined-site trends for 6 of the 8 species that showed longer-term trends at Lipan Point alone. Only the longer-term Lipan Point data indicated a significant increase

for Peregrine Falcons (Figure 7) and a significant decrease for Red-tailed Hawks (Figure 5). Conversely, only the shorter-term, combined dataset indicated a significant quadratic trend for Prairie Falcons, tracking a recent, slight upswing (Figure 7).

For most species, the overall patterns and trends indicated in the Yaki and Lipan datasets since 1997 are similar. For a few species, however, the Lipan Point data show declining trends between 1997 and 2005, while the Yaki Point data show comparatively stable or increasing trends over the same period. These species include Ospreys (Figure 3), Sharp-shinned and Cooper's Hawks (Figure 4), Red-tailed Hawks (Figure 5), and, to a lesser degree, Golden Eagles (Figure 6). In other words, for these species a westward shift in activity appeared to occur during this period. The time frame largely corresponds to the period of widespread drought that plagued much of the interior West between 1999 and at least 2005, and which likely resulted in population declines but also may have caused regional shifts in flyway dynamics as surviving migrants sought to avoid the harshest drought environments (Hoffman and Smith 2003, Smith et al. 2008a). At a more localized level, though, the drought also brought major fires and habitat change to the Kaibab Plateau north of the watchsites, which, along with some wind pattern changes discussed above, also may have contributed to localized route shifts among some species. Regardless of the reasons for these shifting dynamics, the notable differences in trend pattern shown for several prominent species clearly advocate in favor of the two-site count combination to afford better coverage of the complex dynamics.

Smith et al. (2008a) present new trend analyses of data collected through 2005 for most of the long-term, on-going, autumn migration studies in western North America. These analyses, which cover many of the same sites, are based on a more sophisticated analytical approach (also see Farmer et al. 2007) than that represented in Hoffman and Smith (2003). Among other refinements, this new approach both fits polynomial trajectories to the complete series of annual count indices and allows for estimating rates of change between various periods, while also allowing for assessments of trend significance and precision. Note, however, that restrictions related to the mathematical assumptions behind the new approach precluded analyzing data for rare species, which for the Grand Canyon included Northern Goshawk; Broad-winged Hawk, Bald Eagle, and Merlin for Lipan Point alone (but 1997–2005 combined-site data analyzed); Ferruginous and Rough-legged Hawks; and Prairie and Peregrine Falcons. Otherwise, the overall patterns of change suggested by the new modeling and the derived trend estimates generally yielded similar inferences as the simpler methodology used in Hoffman and Smith (2003) and herein to provide trend assessments updated through 2007.

Differences between results presented in Smith et al (2008a) and those presented herein that clearly relate to addition of two more years of data include: a) addition of two years of moderate counts in 2006 and 2007 eliminated a significant declining trend for Sharp-shinned Hawks at Lipan Point; b) continuation in 2006 and 2007 of a recent declining trend since a high peak occurred in 2003, with the 2007 passage rate dropping to well below average, eliminated a significant long-term increase at Lipan Point for Swainson's Hawks; and c) two years of additional low counts in 2006 and 2007 resulted in a significant decline since 1997 for American Kestrels in the combined-site dataset. No other substantive differences in the two sets of results were evident.

Age Ratios

At the combined-site level, 6 of 10 species with readily distinguishable age classes and for which the 2007 counts were high enough to warrant some attention to age ratios, showed significant variation in immature: adult ratios compared to the 1997–2006 averages (Table 2). The Ferruginous Hawk was the only species to show a significantly above-average age ratio in 2007, but due to a decline in identified adults rather than a decline in identified immature birds. Species that showed significantly below-average age ratios include the Sharp-shinned Hawk, Broad-winged Hawk, Red-tailed Hawk, Bald Eagle, and Peregrine Falcon. For Sharp-shinned and Red-tailed Hawks, the low age ratios reflected the

combination of reduced numbers of immature birds and above-average numbers of identified adults. This suggests that productivity and juvenile survival for these two species may have been a bit low in 2007, but that adult survival and recruitment of last year's juveniles into the adult population were reasonably strong. For Broad-winged Hawks, the numbers of both identified immatures and identified adults were below average, but also note that the proportion of unaged birds was significantly above average, potentially confounding the comparison (Table 2). For Bald Eagles and Peregrine Falcons, the low age ratios were due to elevated numbers of identified adults rather than declines in counts of identified immatures/subadults, suggesting average productivity but high adult survival. Although not a statistically significant difference due to high inter-annual variability, a 37% increase in the age ratio for Northern Goshawks, more than a three-fold increase in the number of indentified immature birds compared to the long-term average, and an 86% higher than average overall count (Table 1) clearly suggest that 2007 was a good productivity year for goshawks in the region.

Seasonal Timing

Based on combined-site data, the overall combined-species median passage date of 1 October 2007 was only one day later than the 1997–2006 average (Table 3). Examination of the seasonal distribution of activity did reveal, however, a few five-day periods during which relative flight volume differed significantly from the average pattern (Figure 8). Most notably, relative passage volume was significantly below average during the 6–10 October period, but then significantly above average the following period. No obvious weather-related reasons for this pattern are apparent, except for the possibility that wind conditions were more favorable for migration during the second period. The first period featured complex mixes of variable easterly, westerly, and calm winds at both sites, whereas the second period featured much more consistent westerly winds (Appendixes C and D).

A more complex picture was apparent at the species level; 12 of 15 species with data sufficient for comparisons showed median passage dates in 2007 that differed significantly from the respective 1997–2006 averages (Table 3). Moreover, 7 species showed significantly late timing (Osprey, Sharp-shinned Hawk, Northern Goshawk, Bald and Golden Eagles, and the two smaller falcons) and 5 species showed significantly early timing (all four buteos suited to comparison, and Peregrine Falcons). In most cases, the significant variations in median dates reflected unusually large spikes in relative activity levels during one or two five-day periods, rather than distinct overall early or late shifts in the seasonal activity patterns. Age-specific median passage dates revealed additional detail, but no notable variations from the species level indicators except for Golden Eagles, for which the age-specific data indicated significantly early passage of immature/subadults while the species-level comparison indicated significantly late timing (Table 4).

RESIDENT RAPTORS

Yaki Point

Turkey Vultures were seen in variable groups until the end of September.

At least one immature Sharp-shinned Hawk was observed regularly through 20 September hunting in the "bowl" west of the observation point, circling the watchsite, and often disappearing to the east. Similarly, at least one Cooper's Hawk (apparently never conclusively aged) was often seen through 21 September acting territorial and hunting in the bowl.

As usual a family of Zone-tailed Hawks, this year including two adults and two juveniles, lived near the count site south of the Kaibab trailhead. Sightings of family members occurred through 17 September. At least two light-morph adult Red-tailed Hawks resided in the area this year and were present throughout the season. Towards the beginning of the season they acted territorial in the vicinity of a small canyon under Cedar Ridge. Apparently no juveniles could be associated with this possible pair.

At least one juvenile Peregrine Falcon was seen frequently through 14 September and one adult male was seen through late September. The male's territorial activity centered on an area west of Mather Point on the south rim. During a two-day period in late August, a female American Kestrel was seen perching above the Kaibab trail.

Lipan Point

At least two Cooper's Hawks, one adult and one immature, were seen frequently through 20 October, with both often seen hunting in the "bowl" west of the watchsite and the adult also to the east. At least two Sharps-shinned Hawks, one immature and one adult, were seen regularly in the bowl and to the east, with the immature bird last seen on 30 September and the adult on 19 October.

Two adult Zone-tailed Hawks but no juveniles resided near the watchsite and were seen through 7 September. Three light-morph Red-Tailed Hawks resided in the area, including two adults and one juvenile. The adult often was seen in the bowl and chasing migrants to east, and was last recorded on 30 October. The immature bird was usually seen to the east, and was last recorded on 20 October. All were often observed kiting along the canyon rim.

Peregrine Falcons (8/27/07- mid October): An apparent pair of adult Peregrine Falcons shared a roost site under Moran Point. They were observed routinely hunting and attacking/escorting migrating raptors. They were last seen together on 29 September, with the female seen again on 12 October. At least one male and one female American Kestrels were observed in the area through mid-September.

These resident assemblages are fairly typical for the sites, except that before 2003 immature Northern Goshawks were often seen around Yaki Point.

VISITOR PARTICIPATION

HWI educators conducted organized education programs most days at both Lipan and Yaki Points in close coordination with personnel of Grand Canyon National Park. These programs reached 1,650 people, with visitors originating in 40 states and Washington, DC, several Canadian provinces, and 25 other foreign countries: Aruba, France, Germany, Spain, United Kingdom, Germany, Israel, Holland, Japan, Poland, Italy, Portugal, South Korea, South Africa, Belgium, Australia, Mexico, Switzerland, Brazil, Switzerland, Sweden, New Zealand, Denmark, South Africa, and Singapore. One organized group visited the sites in 2007 from the White Mountain Audubon Society.

In 2007 at Lipan Point, 567 hourly assessments of visitor disturbance resulted in the following ratings: 97% none, 3% low, <1% moderate, and 0% high. At Yaki Point, 577 hourly assessments of visitor disturbance resulted in the following ratings: 80% none, 16% low, 3% moderate, and 1% high. The low level of visitor-related disturbance of the official observers experienced at Lipan Point in 2007 is typical, whereas the higher level experienced at Yaki Point is not. The primary reason for the difference at Yaki Point in 2007 was our inability to successfully recruit and staff the field crew with dedicated interpreters responsible for "insulating" the counters from visitor interactions. So in this case, the official observers, which included a former site interpreter as the team leader, did double duty conducting the counts and taking time to conduct visitor programs when relevant.

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Marker Marshall for their considerable logistical and educational assistance. We also extend our sincerest appreciation to Park Ranger Brian Gatlin and long-time HWI affiliates Ken Babcock and Melanie Keithley for their efforts to assist with the count.

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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): 1997–2006 versus 2007.

SPECIES	COUNTS			RAPTORS / 100 HOURS		
	1997–2006[1]	2007	% CHANGE	1997–2006[1]	2007	% CHANGE
Osprey	119 ± 21.1	93	-22	27.9 ± 3.15	22.1	-21
Northern Harrier	110 ± 23.4	97	-12	21.9 ± 2.83	19.6	-11
Sharp-shinned Hawk	2,989 ± 317.9	2,818	-6	700.3 ± 36.49	705.1	+1
Cooper's Hawk	1,952 ± 442.8	1,433	-27	535.4 ± 69.38	495.1	-8
Northern Goshawk	11 ± 3.9	21	+86	2.1 ± 0.40	4.5	+119
Unknown small accipiter	223.5 ± 88.1	626	+180	–	–	–
Unknown large accipiter	5.2 ± 3.5	184	+3461	–	–	–
Unknown accipiter	199 ± 100.1	248	+24	–	–	–
TOTAL ACCIPITERS	5,289 ± 668.6	5,330	+1	–	–	–
Red-shouldered Hawk	0.1 ± 0.20	0	-100	–	–	–
Broad-winged Hawk	25 ± 7.8	21	-17	13.8 ± 2.48	11.5	-17
Swainson's Hawk	89 ± 44.2	27	-70	25.0 ± 7.23	6.7	-73
Red-tailed Hawk	2,342 ± 267.0	1,922	-18	490.2 ± 32.91	413.1	-16
Ferruginous Hawk	11 ± 3.0	12	+11	2.3 ± 0.39	2.5	+12
Rough-legged Hawk	0.6 ± 0.60	0	-100	–	–	–
Zone-tailed Hawk	1 ± 0.5	0	-100	–	–	–
Unidentified buteo	55 ± 22.6	163	+198	–	–	–
TOTAL BUTEOS	2,524 ± 281.8	2,145	-15	–	–	–
Golden Eagle	25 ± 10.7	18	-27	4.7 ± 1.21	3.6	-24
Bald Eagle	36 ± 9.1	47	+32	8.4 ± 1.22	11.3	+34
Unidentified eagle	1 ± 1.1	4	+264	–	–	
TOTAL EAGLES	62 ± 19.6	69	+12	–	–	
American Kestrel	1,785 ± 334.5	1,024	-43	463.4 ± 49.65	265.8	-43
Merlin	22 ± 6.1	24	+8	4.5 ± 0.72	4.7	+5
Prairie Falcon	11 ± 1.5	8	-27	2.2 ± 0.25	2.0	-12
Peregrine Falcon	18 ± 4.2	42	+135	3.7 ± 0.62	9.0	+141
Unknown small falcon	7 ± 10.5	7	-5	–	–	–
Unknown large falcon	5 ± 5.2	8	+55	–	–	–
Unknown falcon	6 ± 1.9	3	-52	–	–	–
TOTAL FALCONS	1,850 ± 326.8	1,116	-40	–	–	–
Unidentified Raptor	82 ± 29.5	39	-53	–	–	–
GRAND TOTAL	10,035 ± 1,208.3	8,889	-11	–	–	–

[1] 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): 1997–2006 versus 2007.

	Total and Age-classified Counts								Immature : Adult	
	1997–2006 Average			2007			% Unknown Age		Ratio	
Species	Total	Imm.	Adult	Total	Imm.	Adult	1997–2006[1]	2007	1997–2006[1]	2007
Northern Harrier	110	28	28	97	22	22	51 ± 5.4	55	1.0 ± 0.18	1.0
Sharp-shinned Hawk	2,989	612	1,074	2,818	549	1,262	43 ± 8.8	36	0.6 ± 0.14	0.4
Cooper's Hawk	1,952	445	587	1,433	275	438	47 ± 7.9	50	0.8 ± 0.20	0.6
Northern Goshawk	11	4	3	21	10	4	26 ± 16.1	33	1.9 ± 1.02	2.5
Broad-winged Hawk	25	6	10	21	3	6	31 ± 15.0	57	0.7 ± 0.22	0.5
Red-tailed Hawk	2,342	315	1,432	1,922	219	1,509	25 ± 5.2	10	0.2 ± 0.07	0.1
Ferruginous Hawk	11	3	4	12	3	2	40 ± 10.8	58	0.7 ± 0.29	1.5
Golden Eagle	25	8	9	18	8	3	30 ± 9.0	39	1.7 ± 1.05	2.7
Bald Eagle	36	7	25	47	8	34	8 ± 4.5	11	0.3 ± 0.02	0.2
Peregrine Falcon	18	3	7	42	3	16	44 ± 12.7	55	0.4 ± 0.21	0.2

[1] Mean ± 95% confidence interval. For age ratios, note that the long-term mean immature : adult ratio is an average of annual ratios and may differ from the value obtained by dividing long-term average numbers of 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 2006 and 1997–2006 average median passage dates (Lipan Point and Yaki Point data combined).

	2006				1997–2006
Species	First Observed	Last Observed	Bulk Passage Dates [1]	Median Passage Date [2]	Median Passage Date [3]
Osprey	28-Aug	26-Oct	15-Sep – 4-Oct	21-Sep	19-Sep ± 1.7
Northern Harrier	6-Sep	4-Nov	17-Sep – 27-Oct	8-Oct	7-Oct ± 2.0
Sharp-shinned Hawk	27-Aug	5-Nov	17-Sep – 19-Oct	8-Oct	1-Oct ± 1.1
Cooper's Hawk	27-Aug	4-Nov	17-Sep – 12-Oct	29-Sep	28-Sep ± 2.0
Northern Goshawk	8-Sep	21-Oct	8-Sep – 15-Oct	10-Oct	1-Oct ± 7.6
Broad-winged Hawk	1-Sep	6-Oct	17-Sep – 7-Oct	23-Sep	25-Sep ± 1.2
Swainson's Hawk	28-Aug	2-Oct	16-Sep – 7-Oct	1-Sep	23-Sep ± 4.4
Red-tailed Hawk	27-Aug	5-Nov	21-Sep – 26-Oct	5-Oct	8-Oct ± 1.9
Ferruginous Hawk	27-Aug	19-Oct	26-Sep – 4-Nov	2-Oct	11-Oct ± 5.3
Golden Eagle	4-Sep	5-Nov	28-Sep – 30-Oct	30-Oct	15-Oct ± 5.8
Bald Eagle	4-Sep	5-Nov	13-Oct – 4-Nov	2-Nov	24-Oct ± 2.6
American Kestrel	29-Aug	4-Nov	14-Sep – 11-Oct	26-Sep	23-Sep ± 1.8
Merlin	2-Oct	5-Nov	16-Sep – 7-Oct	19-Oct	3-Oct ± 4.1
Prairie Falcon	9-Sep	25-Oct	2-Sep – 15-Oct	20-Sep	23-Sep ± 5.3
Peregrine Falcon	27-Aug	5-Nov	8-Sep – 7-Oct	18-Sep	24-Sep ± 5.5
All species	27-Aug	5-Nov	17-Sep – 20-Oct	1-Oct	30-Sep ± 1.5

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

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

[3] Mean of annual values ± 95% 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): 1997–2006 versus 2007.

	ADULT		IMMATURE / SUBADULT	
SPECIES	1997–2006[1]	2007	1997–2006[1]	2007
Northern Harrier	11-Oct ± 3.2	11-Oct	4-Oct ± 4.0	10-Oct
Sharp-shinned Hawk	7-Oct ± 0.8	12-Oct	25-Sep ± 1.4	1-Oct
Cooper's Hawk	1-Oct ± 2.2	2-Oct	25-Sep ± 1.6	29-Sep
Northern Goshawk	13-Oct ± 24.5	–	8-Oct ± 7.7	10-Oct
Broad-winged Hawk	24-Sep ± 2.0	23-Sep	25-Sep ± 2.8	–
Red-tailed Hawk	8-Oct ± 1.6	5-Oct	2-Oct ± 3.2	1-Oct
Golden Eagle	15-Oct ± 10.4	–	15-Oct ± 6.1	28-Sep
Bald Eagle	24-Oct ± 2.7	31-Oct	22-Oct ± 3.4	3-Nov
Peregrine Falcon	25-Sep ± 7.6	23-Sep	30-Sep ± 12.7	–

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.

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

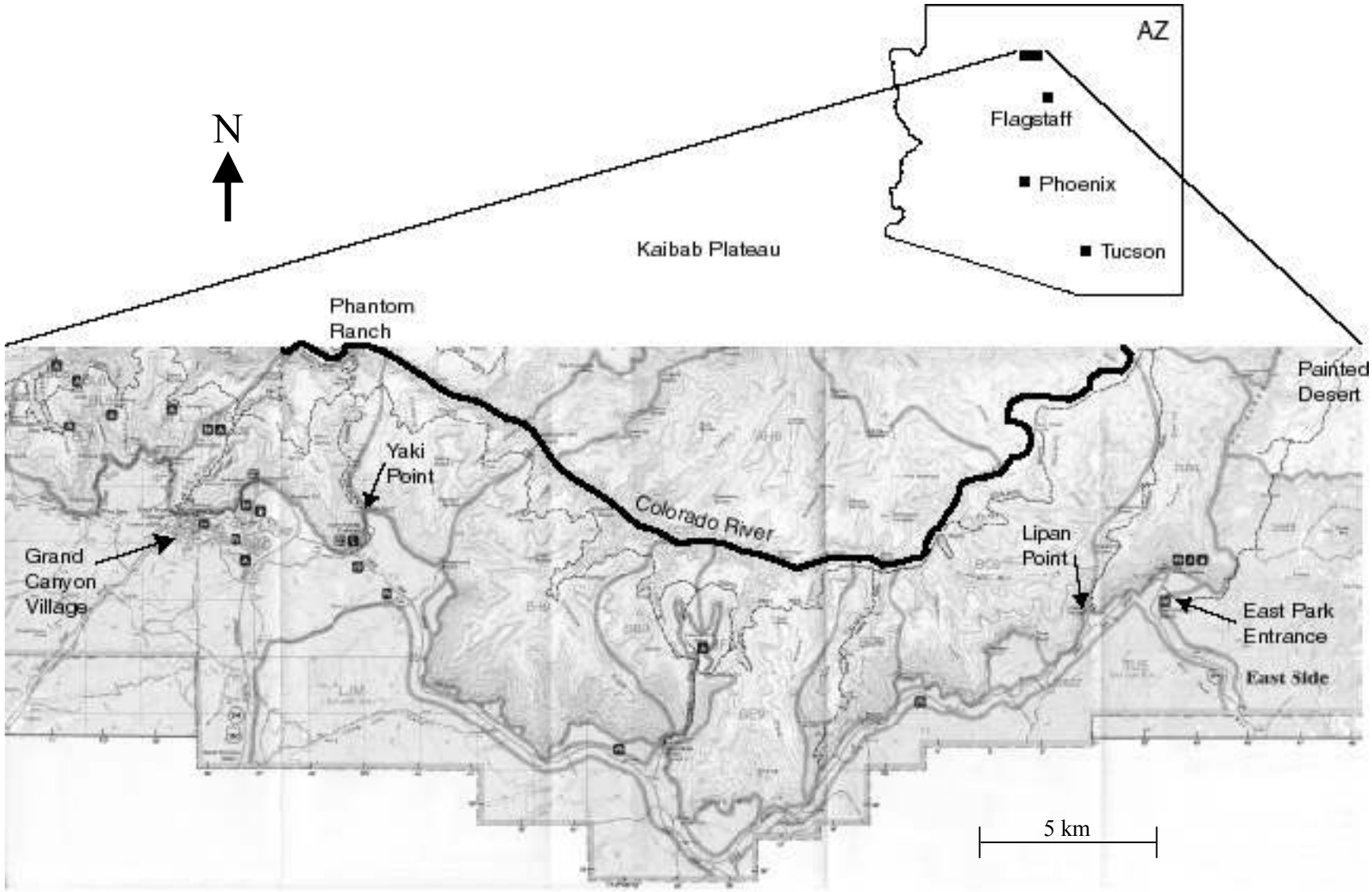

Figure 1. Map showing the Lipan Point and Yaki Point raptor-migration study sites in the Grand Canyon, Arizona.

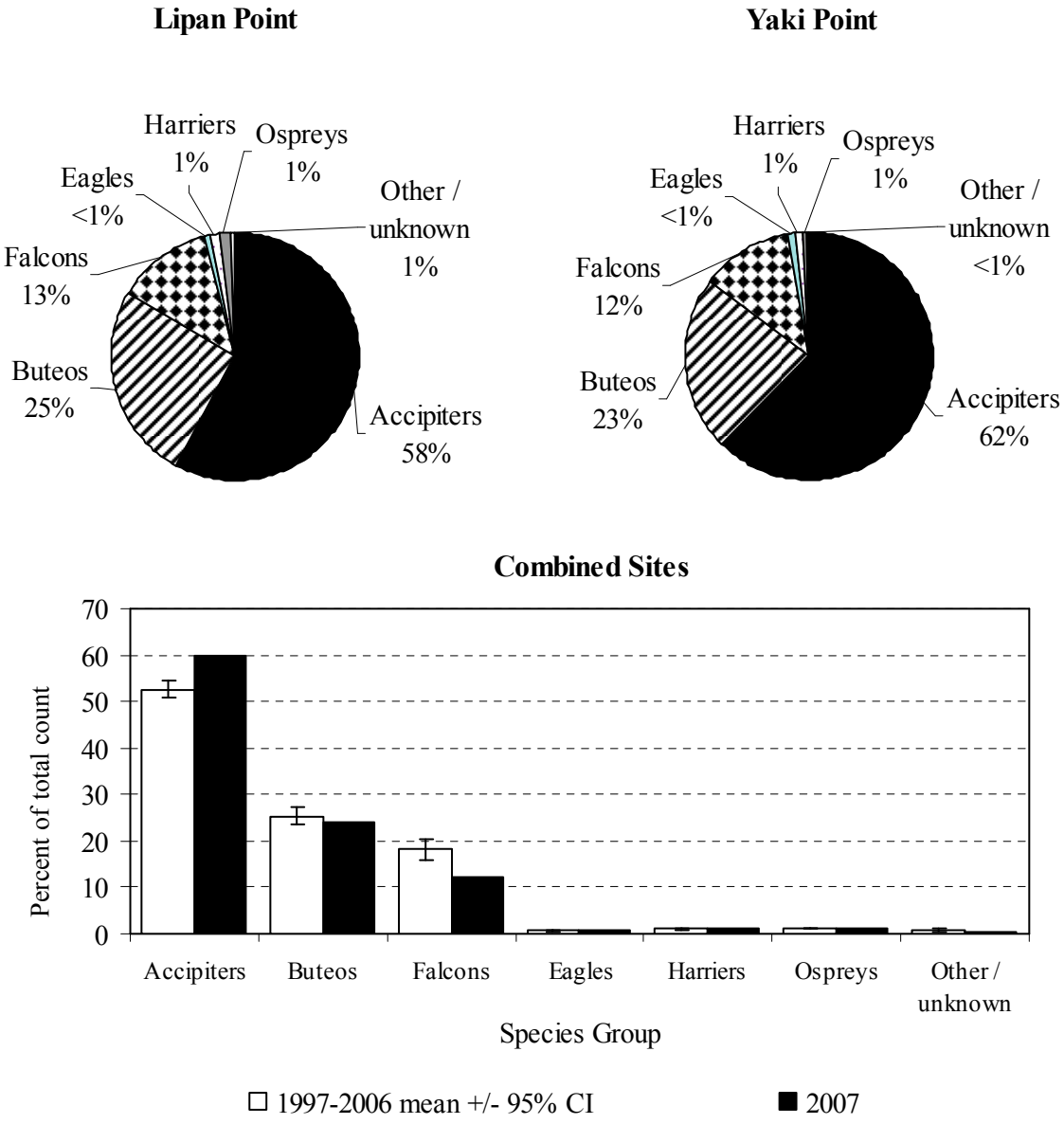

Figure 2. Fall raptor-migration flight composition by major species groups in the Grand Canyon, AZ: 1997–2006 versus 2007.

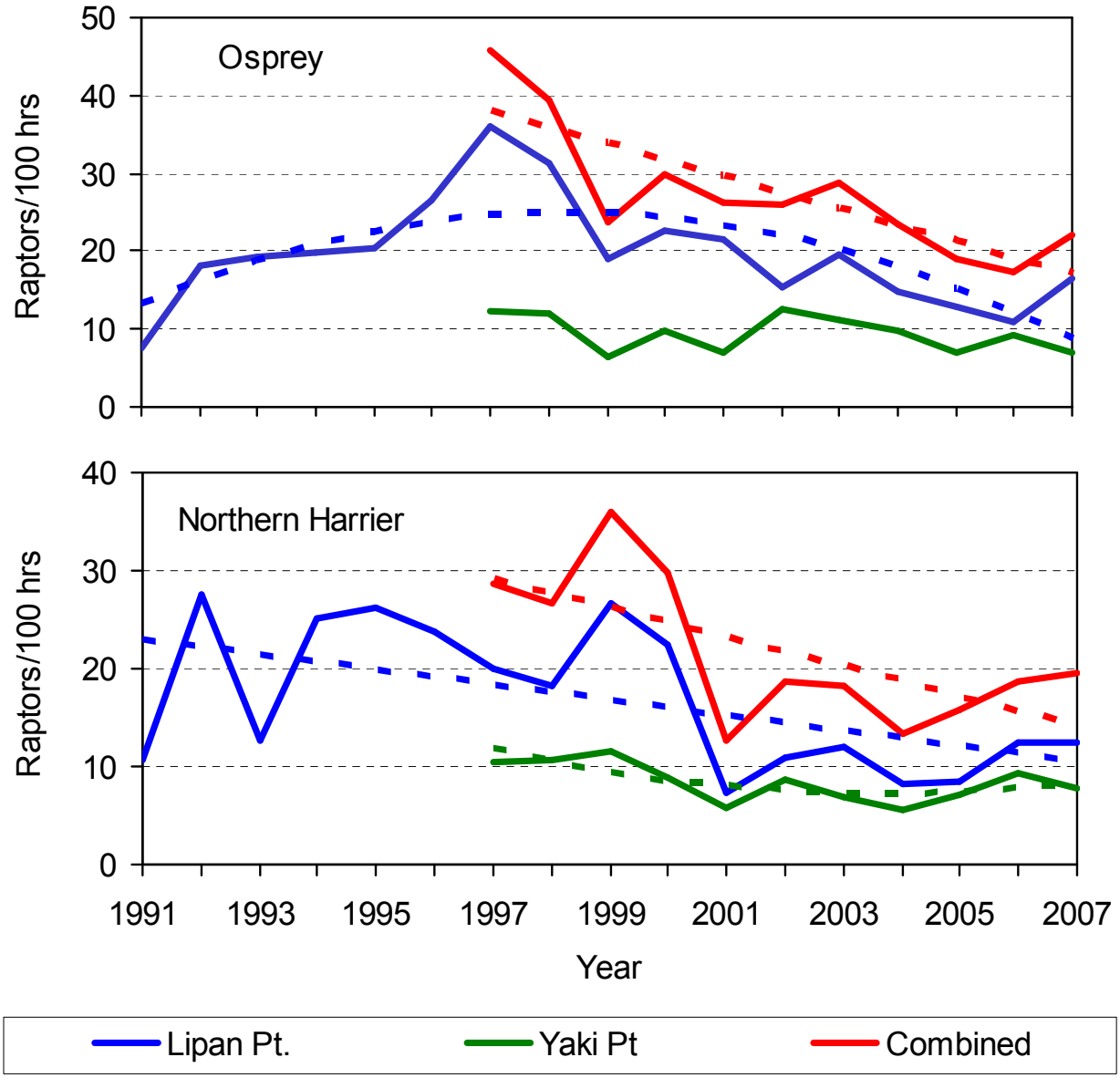

Figure 3. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Ospreys and Northern Harriers in the Grand Canyon, AZ: 1991–2007. Dashed lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

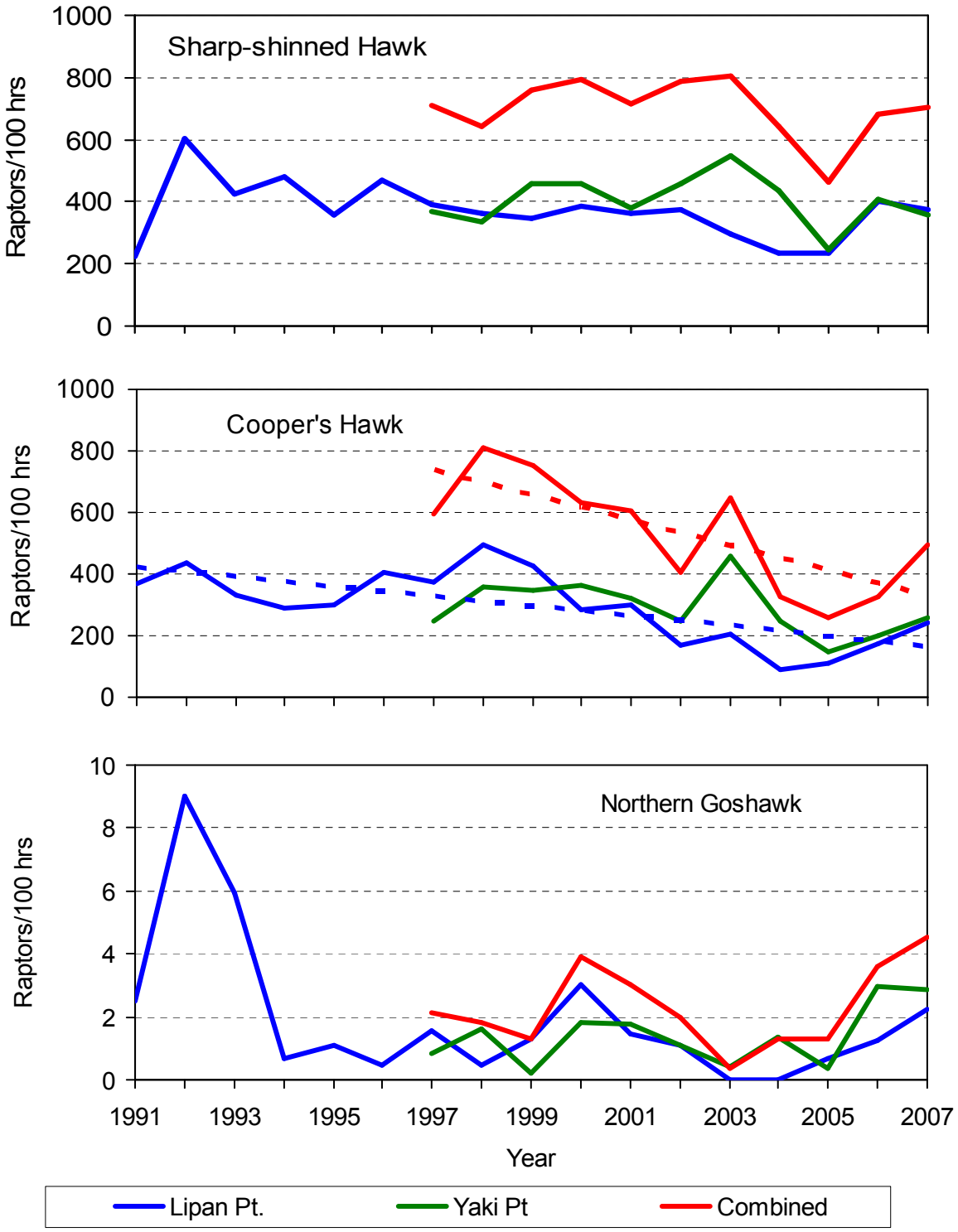

Figure 4. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks in the Grand Canyon, AZ: 1991–2007. Dashed lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

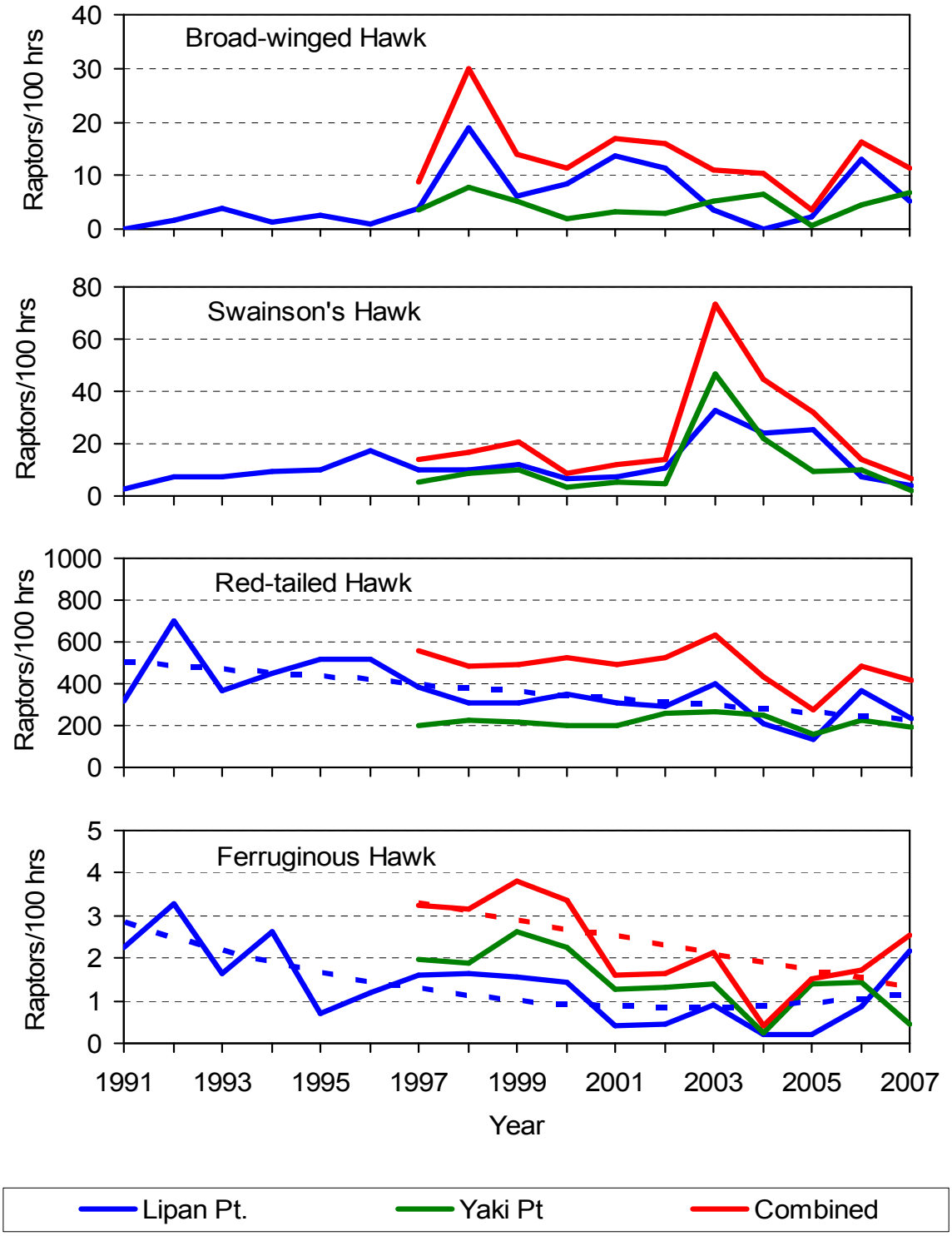

Figure 5. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Broad-winged, Swainson's, Red-tailed, and Ferruginous Hawks in the Grand Canyon, AZ: 1991–2007. Dashed lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

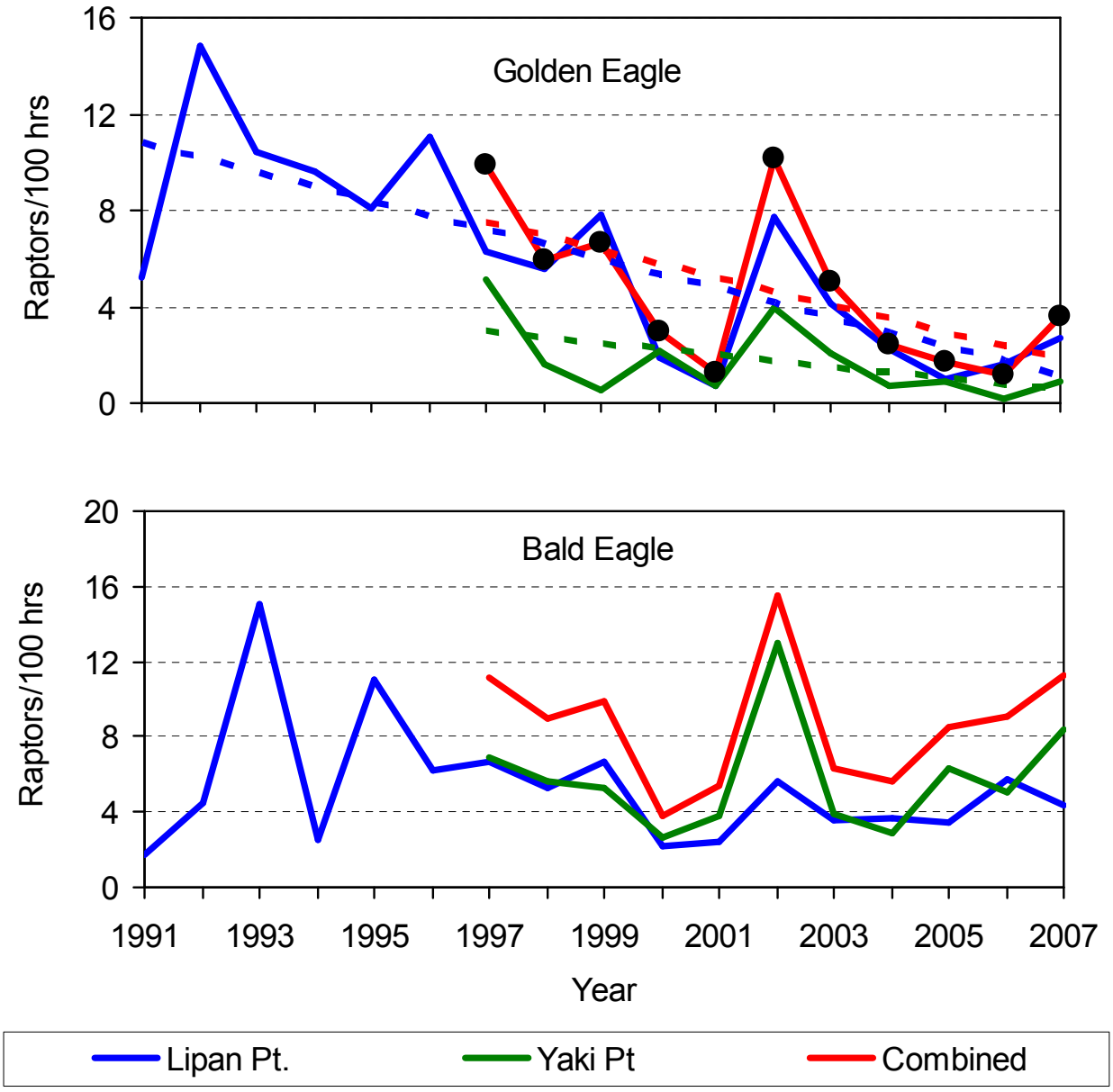

Figure 6. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Golden and Bald Eagles in the Grand Canyon, AZ: 1991–2007. Dashed lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

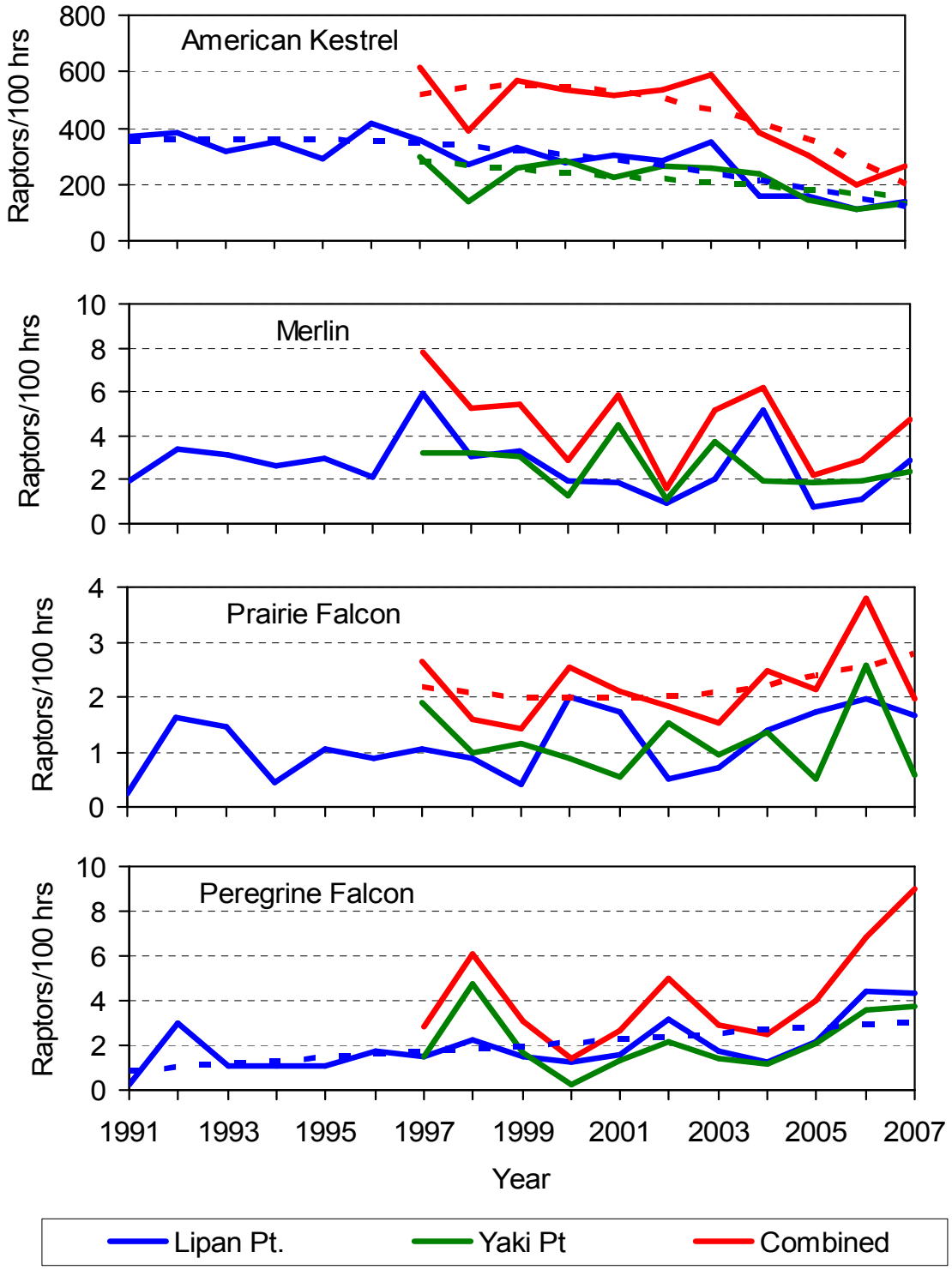

Figure 7. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons in the Grand Canyon, AZ: 1991–2007. Dashed lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

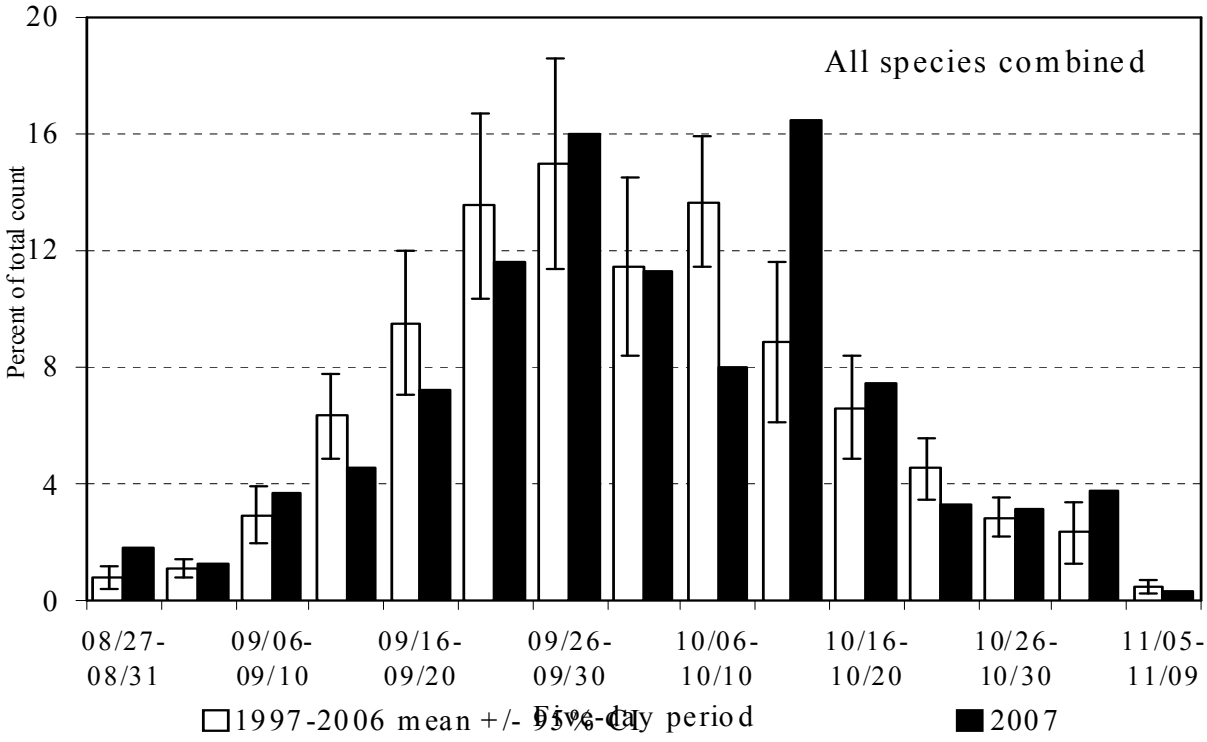

Figure 8. Combined-species, fall-migration passage volume by five-day periods for raptors in the Grand Canyon, AZ: 1997–2006 versus 2007 (Lipan Point and Yaki Point data combined).

Appendix A. History of official observer participation in the Grand Canyon raptor migration studies: 1991–2007.

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), and Don Rosie (0)

1992 Rotating team with at least two observers throughout at Lipan Pt.: Mark Cantrell (2), Daniel Perry (3), and Christie Van Cleve (1)

1993 Rotating team with at least two observers throughout at Lipan Pt.: Daniel Perry (4), Frank LaSorte (1), and 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), and Christie Van Cleve (3)

1995 Rotating team with at least two observers throughout at Lipan Pt.: Amy Adams (1), Elliot Swarthout (0), and Christie Van Cleve (4)

1996 Rotating team with at least two observers throughout at Lipan Pt.: Amy Adams (2), Elliot Swarthout (1), and 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), and 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), and 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), and 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), and 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), and 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 (+), 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), and Scott Olmstead (0).

2005 Rotating team with at least two observers throughout at Lipan Pt. and Yaki Pt.: Surya Bahadur Gurung (1+), Brad Alexander (0), Alyson Webber (0), and Sarah Keller (0).

2006 Rotating team with at least two observers throughout at Lipan Pt. and Yaki Pt.: Sean Wolfe (1), Sumit Gurung (1+), Thuy-Vy Bui (0), and Geni Gellhaus (+).

2007 Rotating team with at least two observers throughout at Lipan Pt. and Yaki Pt.: Jennifer Good (2+), Graeme Davis (1), Tyler Hallman (0), and Jenny Aleman-Zometa (0).

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

Appendix B. Common and scientific names, species codes, and regularly applied age, sex, and color-morph classifications for all diurnal raptor species observed during fall migration in the Grand Canyon, AZ.

Common Name	Scientific Name	Species Code	Age[1]	Sex[2]	Color Morph[3]
Turkey Vulture	*Cathartes aura*	TV	U	U	NA
Osprey	*Pandion haliaetus*	OS	U	U	NA
Northern Harrier	*Circus cyaneus*	NH	A I Br U	M F U	NA
Sharp-shinned Hawk	*Accipiter striatus*	SS	A I U	U	NA
Cooper's Hawk	*Accipiter cooperii*	CH	A I U	U	NA
Northern Goshawk	*Accipiter gentilis*	NG	A I U	U	NA
Unknown small accipiter	*A. striatus* or *cooperii*	SA	U	U	NA
Unknown large accipiter	*A. cooperii* or *gentilis*	LA	U	U	NA
Unknown accipiter	*Accipiter* spp.	UA	U	U	NA
Red-shouldered Hawk	*Buteo lineatus*	RS	A I U	U	NA
Broad-winged Hawk	*Buteo platypterus*	BW	A I U	U	D L U
Swanson's Hawk	*Buteo swainsoni*	SW	U	U	D L U
Red-tailed Hawk	*Buteo jamaicensis*	RT	A I U	U	D L U
Ferruginous Hawk	*Buteo regalis*	FH	A I U	U	D L U
Rough-legged Hawk	*Buteo lagopus*	RL	U	U	D L U
Zone-tailed Hawk	*Buteo albonotus*	ZT	A I U	U	NA
Unknown buteo	*Buteo* spp.	UB	U	U	D L U
Golden Eagle	*Aquila chrysaetos*	GE	I, S, NA, A, U[4]	U	NA
Bald Eagle	*Haliaeetus leucocephalus*	BE	I, S1, S2, NA, A, U[5]	U	NA
Unknown eagle	*Aquila* or *Haliaeetus spp.*	UE	U	U	NA
American Kestrel	*Falco sparverius*	AK	U	M F U	NA
Merlin	*Falco columbarius*	ML	AM Br	AM U	NA
Prairie Falcon	*Falco mexicanus*	PR	U	U	NA
Peregrine Falcon	*Falco peregrinus*	PG	A I U	U	NA
Unknown small falcon	*F. sparverius* or *columbarius*	SF	U	U	NA
Unknown large falcon	*F. mexicanus* or *peregrinus*	LF	U	U	NA
Unknown falcon	*Falco* spp.	UF	U	U	NA
Unknown raptor	Falconiformes	UU	U	U	NA

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

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

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

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

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

Appendix C. Daily observation effort, visitor disturbance ratings, weather records, and raptor-migration flight summaries at Lipan Point, Grand Canyon, AZ: 2007.

Date	Obs. Hours	Obsrvr / Hour[1]	Median Visitor Disturb[2]	Predominant Weather[3]	Wind Speed (kph)[1]	Wind Direction	Temp (°C)[1]	Barom. Press. (in Hg)[1]	Median Thermal Lift[4]	Visib. East (km)[1]	Visib. West (km)[1]	Median Flight Distance[5]	Birds / Hour
27-Aug	7.75	2.0	0	clr-ovc, AM fog/ts, PM haze	6.0	calm/var	20.8	29.77	3	60	56	1	0.5
28-Aug	9.00	2.0	0	clr-pc, haze	0.6	calm/var	26.5	29.85	2	45	75	2	1.4
29-Aug	8.00	2.0	0	clr-pc, PM haze	4.3	calm/var	28.4	29.93	1	100	87	2	1.6
30-Aug	8.00	2.0	0	pc-mc	4.8	calm/var	29.4	29.98	1	58	81	3	5.0
31-Aug	8.00	2.2	0	pc, PM haze	4.4	calm, sw, nw	31.2	29.91	2	92	97	2	2.9
01-Sep	8.00	2.1	0	clr-pc, PM haze	2.9	calm, nw	30.6	29.88	2	89	86	2	1.3
02-Sep	8.00	1.9	0	clr-pc, haze	2.6	calm, ne, nw	29.8	29.89	1	89	74	3	2.0
03-Sep	7.25	1.9	0	mc, haze	5.0	calm, wnw	30.3	29.89	3	89	88	3	3.6
04-Sep	8.00	2.0	0	pc-ovc, haze	5.9	w	29.1	29.73	3	95	81	2	2.6
05-Sep	8.00	2.0	0	clr-mc, haze	13.7	sw, w	27.2	29.64	4	97	63	3	0.8
06-Sep	8.00	1.1	0	pc, haze	7.9	w	29.2	29.76	2	98	74	2	5.0
07-Sep	8.00	2.2	0	clr-pc	1.8	calm, s, sw	28.1	29.85	1	97	86	2	4.0
08-Sep	8.17	2.1	0	clr-mc, haze	4.7	calm, w	29.2	29.81	2	99	84	2	5.5
09-Sep	8.00	2.2	0	clr-ovc, AM haze, PM scat rain	13.7	w	28.6	29.78	2	98	87	2	6.4
10-Sep	7.00	2.0	0	pc-ovc, PM scat rain	2.8	calm/var	28.5	29.92	3	92	83	3	1.9
11-Sep	6.50	2.2	0	clr-mc, PM scat haze/ts/rain	2.4	calm/var	27.3	29.92	2	99	90	3	17.4
12-Sep	8.25	2.0	0	clr-pc, PM haze	8.3	w	28.8	29.85	1	92	94	3	13.5
13-Sep	8.00	1.0	0	clr-pc	19.7	w	28.8	29.81	3	99	76	2	2.5
14-Sep	8.00	2.0	0	pc-ovc, PM haze	27.7	sw, w	26.4	29.82	4	80	76	3	1.1
15-Sep	8.17	2.0	0	pc-mc, PM haze	23.7	sw	27.1	29.86	4	93	77	2	1.1
16-Sep	8.00	2.0	0	pc-mc, haze, AM scat rain	25.4	sw, w	26.1	29.75	4	97	78	2	2.0
17-Sep	8.00	2.0	0	clr-pc	23.4	sw, w	21.8	29.60	3	97	86	2	2.0
18-Sep	8.17	2.0	0	clr	5.0	calm, w	24.3	29.75	1	90	84	3	11.0
19-Sep	8.00	2.0	0	clr	23.3	sw, w	22.0	29.64	4	94	89	2	8.6
20-Sep	8.00	1.2	0	clr	12.0	s, w	24.7	29.65	3	99	92	3	5.6
21-Sep	8.00	2.3	0	pc-mc, PM haze	2.0	calm/var	25.7	29.80	3	97	83	3	18.3
22-Sep	5.67	2.0	0	ovc, rain	12.7	s	19.5	29.68	4	100	61	1	2.1
23-Sep	8.00	2.0	0	mc-ovc	15.1	s, w	15.0	29.55	3	98	76	3	6.3
24-Sep	8.58	2.0	0	clr, PM haze	9.9	w	14.0	29.76	2	100	89	2	25.8
25-Sep	8.00	2.0	0	clr, PM haze	0.6	calm	15.8	29.85	2	99	86	2	16.1
26-Sep	8.00	2.4	0	clr, PM haze	2.2	calm/var	17.6	29.87	3	86	97	2	11.6
27-Sep	8.25	1.0	0	pc-ovc	1.8	calm, ne-se	21.3	29.83	3	99	93	2	9.3
28-Sep	8.00	2.1	0	mc-ovc	19.4	sw	20.4	29.64	4	79	91	3	6.0
29-Sep	8.25	2.4	0	clr, PM haze	38.2	sw-w	18.2	29.51	4	100	79	3	8.1
30-Sep	9.25	2.8	0	clr, haze	2.6	calm/var	17.4	29.95	2	95	77	2	31.0
01-Oct	6.67	2.0	0	ovc, AM rain, PM fog/haze	13.3	sw	15.3	29.85	4	7	4	2	1.5
02-Oct	9.25	2.0	0	clr-pc, haze	6.5	w	20.5	29.89	3	95	75	2	33.6
03-Oct	8.00	1.0	0	clr	18.1	w	23.2	29.74	3	99	96	2	30.5
04-Oct	7.25	1.0	0	mc-ovc, AM ts/rain	38.1	s-sw	19.8	29.54	4	66	56	2	1.8
05-Oct	6.75	2.0	0	mc, PM haze	35.3	sw	17.7	29.42	4	81	74	2	2.2
06-Oct	7.83	2.0	0	clr	17.1	w	11.0	29.57	3	98	93	3	11.1
07-Oct	8.00	1.9	0	clr	1.0	calm, ne, w	12.7	29.79	2	89	86	3	8.1
08-Oct	8.08	2.0	0	clr, PM haze	1.4	calm, ne, w	16.2	29.85	2	93	86	2	6.6
09-Oct	8.00	2.0	0	pc, PM haze	12.2	e, se	20.3	29.83	3	98	88	2	9.3
10-Oct	8.08	1.0	0	clr	20.4	sw, w	21.7	29.74	3	98	94	2	6.9
11-Oct	8.75	1.0	0	clr-pc, PM haze	7.0	w	22.7	29.68	2	89	74	2	38.2
12-Oct	8.00	2.0	0	mc, PM haze	25.1	sw	20.7	29.51	3	87	71	2	14.9
13-Oct	9.00	2.0	0	clr-mc, PM haze	10.4	w	16.9	29.45	3	93	77	3	33.0

Appendix C. continued

Date	Obs. Hours	Obsrvr / Hour[1]	Median Visitor Disturb[2]	Predominant Weather[3]	Wind Speed (kph)[1]	Wind Direction	Temp (°C)[1]	Barom. Press. (in Hg)[1]	Median Thermal Lift[4]	Visib. East (km)[1]	Visib. West (km)[1]	Median Flight Distance[5]	Birds / Hour
14-Oct	8.00	2.0	0	clr	1.7	wnw	16.4	29.64	2	96	84	2	7.3
15-Oct	7.50	1.0	0	clr, PM haze	8.3	wnw	20.3	29.61	3	98	88	2	21.9
16-Oct	8.00	2.0	0	pc-ovc, haze, PM rain	21.3	sw-w	14.3	29.35	4	92	69	1	3.3
17-Oct	8.00	3.0	0	clr, haze	21.8	w	14.1	29.36	3	95	70	2	7.0
18-Oct	8.00	2.2	0	clr, PM haze	5.6	w	14.6	29.71	2	99	82	2	12.3
19-Oct	8.00	2.2	0	clr	11.1	w	21.8	29.76	3	94	89	2	13.3
20-Oct	8.00	2.0	0	pc-ovc, dust/haze	37.2	w	19.3	29.49	4	85	78	2	2.6
21-Oct	8.00	2.0	0	clr, PM haze	4.7	se, sw	8.3	29.86	2	99	83	2	2.8
22-Oct	8.00	2.0	0	clr, PM haze	2.9	s, w	10.7	30.13	3	100	77	2	0.6
23-Oct	8.00	2.0	0	clr, haze	3.4	calm/var	16.4	30.13	3	100	78	2	1.1
24-Oct	8.00	2.0	0	clr, haze	1.3	calm, ne, e	19.7	30.08	3	96	88	2	5.8
25-Oct	8.00	2.0	0	clr, PM haze	4.9	s-sw	21.4	29.82	3	100	77	2	7.3
26-Oct	8.00	2.0	0	clr, haze	7.2	w	22.0	29.78	3	100	70	2	5.3
27-Oct	8.00	2.0	0	mc-ovc, haze	0.0	calm	20.9	29.99	3	45	44	2	2.0
28-Oct	8.00	2.0	0	clr-pc, haze	7.1	calm, e-se	20.7	30.07	3	93	70	2	4.0
29-Oct	8.00	2.0	0	mc, haze	11.7	e, se	20.6	29.96	3	100	68	2	1.6
30-Oct	8.00	2.0	0	clr-pc, blow dust	21.6	sw-w	18.2	29.71	3	97	86	3	1.8
31-Oct	8.00	2.3	0	clr, haze	3.0	calm/var	17.7	29.86	2	95	74	2	6.0
01-Nov	8.00	2.0	0	clr, haze	1.3	calm, n-ne	17.6	29.76	2	94	81	2	8.6
02-Nov	8.00	2.2	0	clr-pc, haze	1.0	calm/var	16.8	29.83	3	99	75	2	2.1
03-Nov	8.00	2.0	0	clr, haze	1.9	calm, ne, e	16.1	29.98	3	86	98	2	2.1
04-Nov	8.00	2.0	0	clr-mc, haze	1.9	calm, ne, w	19.3	29.93	2	97	84	2	3.9
05-Nov	7.00	2.0	0	clr-mc, haze	5.8	calm, se	19.4	29.87	3	86	71	2	1.9

[1] Average of hourly records.

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

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

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

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

Appendix D. Daily observation effort, visitor disturbance ratings, weather records, and raptor-migration flight summaries at Yaki Point, Grand Canyon, AZ: 2007.

Date	Obs. Hours	Obsrvr / Hour[1]	Median Visitor Disturb[2]	Predominant Weather[3]	Wind Speed (kph)[1]	Wind Direction	Temp (°C)[1]	Barom. Press. (in Hg)[1]	Median Thermal Lift[4]	Visib. East (km)[1]	Visib. West (km)[1]	Median Flight Distance[5]	Birds / Hour
27-Aug	8.25	2.0	0	pc-ovc, scat ts/rain	0.0	calm, se	22.0	29.56	2	50	44	2	1.1
28-Aug	9.00	1.2	0	clr-pc, haze	0.6	calm, n, se	26.6	29.60	2	100	88	1	1.4
29-Aug	8.00	1.0	0	clr-mc, scat ts/rain	5.2	se, s	28.1	30.31	2	93	83	2	0.8
30-Aug	6.75	1.0	0	clr-mc, haze	3.6	calm, s	28.3	29.72	2	100	87	2	0.6
31-Aug	8.00	1.2	1.5	clr-pc	2.0	calm/var	29.6	29.67	1	99	86	3	4.6
01-Sep	8.00	2.1	0	clr-mc, AM haze	2.3	calm, nne, sse	30.7	29.63	1	100	80	2	1.5
02-Sep	8.00	2.0	0	pc-mc	0.4	calm/var	30.3	29.63	1	100	85	2	1.6
03-Sep	6.75	1.0	0	clr-ovc, haze, ts	2.8	calm, nw	29.1	29.63	2	99	70	3	0.6
04-Sep	8.00	2.0	1	pc-mc, PM haze	7.7	var	27.9	29.49	3	88	82	2	0.1
05-Sep	8.00	1.0	1	pc-mc, haze	15.4	s	26.1	29.39	3	79	58	2	0.5
06-Sep	8.00	2.4	0	pc-mc, PM haze	3.2	nne, nnw	28.4	29.50	1	90	81	2	3.5
07-Sep	8.00	1.0	0	clr, haze	2.9	calm, nne, s	28.7	29.60	1	96	81	2	4.8
08-Sep	8.00	1.8	1.5	clr-mc, haze	3.4	calm, w, nw	29.1	29.56	2	88	71	3	5.8
09-Sep	8.00	2.0	0	clr-mc	4.8	calm, se, nw	27.7	29.54	2	91	90	3	2.1
10-Sep	7.00	1.0	0	mc-ovc, ts/rain	3.1	calm, ese	26.2	29.67	3	100	83	2	3.0
11-Sep	8.00	1.8	0	clr-mc	1.8	calm/var	27.6	29.65	2	98	99	3	6.1
12-Sep	8.25	1.1	1	clr-pc, haze	4.7	calm, nne	27.7	29.60	2	95	85	3	5.3
13-Sep	8.00	1.8	0	clr-mc	10.4	sse, nw	28.0	29.57	2	89	91	3	3.1
14-Sep	8.00	1.0	0	mc-ovc, haze, blow dust	26.3	s	25.6	29.56	3	79	50	1	0.9
15-Sep	8.00	1.8	0	mc-ovc	20.4	s	25.2	29.62	4	82	72	2	1.9
16-Sep	8.00	2.0	0	mc-ovc, haze/rain	14.2	w-nw	24.2	29.51	3	96	77	2	1.3
17-Sep	9.50	1.2	0	clr, haze	13.7	sw, w, nw	21.8	29.38	4	100	72	3	8.1
18-Sep	8.75	1.8	0	clr-pc, haze	7.0	calm, sw, w	23.1	29.50	2	100	82	2	19.3
19-Sep	8.00	1.0	1	clr, PM dust	30.3	s, sw	21.4	29.41	3	96	80	2	4.5
20-Sep	8.50	2.0	0	clr	6.4	s, sw	24.1	29.42	1	97	78	2	13.1
21-Sep	8.00	1.2	1.5	pc-mc, AM haze	4.6	calm/var	23.8	29.55	2	89	78	3	7.9
22-Sep	5.00	1.8	0	ovc, ts/rain, PM haze	17.8	calm, se	17.5	29.47	4	38	32	3	0.2
23-Sep	8.00	2.0	0	mc-ovc, scat haze	16.2	var	14.0	29.33	3	66	57	2	5.3
24-Sep	9.25	1.5	0	clr	10.8	wnw	16.7	29.52	3	100	96	2	20.4
25-Sep	8.25	2.3	0	clr	3.1	calm, e-se	18.9	29.60	3	100	94	2	22.1
26-Sep	9.00	1.0	2	clr, haze	3.6	calm, se	21.6	29.62	2	94	74	2	31.2
27-Sep	8.00	2.0	1.5	mc	5.9	se	22.6	29.58	2	100	90	2	18.3
28-Sep	8.00	1.1	1	mc-ovc	29.4	s, w	20.2	29.38	4	83	82	2	3.8
29-Sep	9.25	2.3	0	clr-pc, PM haze	29.1	sw-w	17.9	29.30	4	100	85	2	12.8
30-Sep	8.25	5.6	0	clr, haze	1.8	se, w	17.9	29.68	2	100	91	2	33.3
01-Oct	4.17	1.0	0	pc-ovc	14.8	sw	15.7	29.65	4	100	48	2	1.4
02-Oct	8.00	3.9	0	clr-pc, PM haze	4.6	var	20.6	29.66	2	93	72	2	30.5
03-Oct	8.25	2.2	1	clr, haze	19.7	sw, wnw	19.9	29.51	3	100	83	2	15.4
04-Oct	6.92	1.9	0	ovc, AM ts/rain, PM haze	26.9	sw-w	19.5	29.32	4	100	84	2	2.7
05-Oct	8.00	1.1	0	pc-ovc, PM rain	41.1	s	17.2	29.19	4	85	66	2	1.8
06-Oct	8.00	1.8	0	clr-pc, PM haze	11.8	w-nw	10.0	29.36	3	100	84	2	6.9
07-Oct	8.25	1.8	0	clr, PM haze	2.4	calm, nne, nw	12.8	29.55	1	100	82	3	15.9
08-Oct	8.00	1.1	0	clr-pc	11.6	ne, e	14.0	29.59	3	100	97	2	5.3
09-Oct	8.25	1.7	0	clr-pc, haze	8.6	se	20.3	29.58	2	99	80	2	4.1
10-Oct	8.25	2.0	0	clr, scat haze	17.3	s, sw, w	21.1	29.50	2	100	81	2	14.1
11-Oct	8.25	1.8	0	clr, haze	7.9	sw-w	22.0	29.44	3	100	92	2	14.5
12-Oct	8.00	1.3	0	mc-ovc	27.1	sw-w	18.9	29.26	3	88	63	2	6.6
13-Oct	8.50	1.8	0	clr-mc, AM haze, PM scat ts/rain	7.0	w-nw	16.0	29.21	3	100	86	2	18.7

Appendix D. continued

Date	Obs. Hours	Obsrvr / Hour[1]	Median Visitor Disturb[2]	Predominant Weather[3]	Wind Speed (kph)[1]	Wind Direction	Temp (°C)[1]	Barom. Press. (in Hg)[1]	Median Thermal Lift[4]	Visib. East (km)[1]	Visib. West (km)[1]	Median Flight Distance[5]	Birds / Hour
14-Oct	8.67	1.7	0	clr, scat haze	0.1	nw	16.8	29.40	2	100	84	2	11.8
15-Oct	8.00	2.5	0	clr, PM haze	9.4	w	17.9	29.39	3	100	90	2	7.1
16-Oct	7.25	2.3	0	ovc, PM rain	17.4	w-nw	14.6	29.12	4	96	86	2	4.0
17-Oct	7.75	1.0	0	clr-pc, haze	24.9	nw	13.3	29.15	2	91	64	2	9.2
18-Oct	8.00	2.0	1	clr	6.0	w-nw	14.8	29.48	3	100	87	2	17.4
19-Oct	8.50	2.0	0	clr, PM haze	2.0	calm/var	20.6	29.52	2	100	84	2	12.1
20-Oct	8.00	1.8	0	pc-ovc, haze	30.3	sw	18.8	29.22	4	52	77	2	1.8
21-Oct	8.00	2.7	0	clr, PM haze	2.7	sw, nw	10.2	29.62	3	100	91	2	2.6
22-Oct	8.00	1.9	0	clr	5.6	calm/var	11.3	29.89	3	100	92	2	2.1
23-Oct	8.00	2.5	0	clr, PM haze	7.2	ne, e, se	16.7	29.87	3	100	86	2	4.3
24-Oct	8.00	2.0	1	clr, haze	4.2	se	18.7	29.83	3	100	75	2	5.8
25-Oct	8.00	1.7	1.5	clr, haze	2.3	calm, ne	21.8	29.58	3	100	68	2	4.6
26-Oct	8.00	2.0	0	clr, haze	5.0	calm, sw, nw	20.4	29.54	3	98	61	2	4.1
27-Oct	7.75	1.9	0	ovc	2.9	calm, ne, w	21.0	29.73	3	98	53	2	4.4
28-Oct	8.00	2.6	0	clr-pc, haze	6.8	ne	20.4	29.83	2	100	62	2	5.3
29-Oct	8.00	2.0	0	ovc, haze	2.1	calm, ne	21.1	29.72	3	100	74	2	3.0
30-Oct	8.00	2.6	0	pc-mc, haze	10.2	var	18.2	29.48	3	100	77	2	3.8
31-Oct	8.25	2.0	0	clr, haze	1.8	calm, se	17.3	29.62	2	100	74	2	4.5
01-Nov	8.00	2.0	0	clr, haze	4.1	calm, ne, se	17.3	29.52	2	99	77	2	7.5
02-Nov	8.00	2.4	0	pc-mc, haze	5.8	ne	15.6	29.58	3	96	81	3	2.1
03-Nov	8.00	2.0	0	clr, haze	5.6	ne, se	14.6	29.72	3	100	83	3	1.6
04-Nov	8.00	2.0	0	clr-ovc, haze	4.2	calm, se	18.1	29.69	3	98	73	2	3.6
05-Nov	8.00	2.0	0	pc-ovc, haze	10.7	ne, se	18.6	29.62	3	100	77	3	2.1

[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 E. Daily raptor migration counts by species at Lipan Point, Grand Canyon, AZ: 2007.

	Observ.	Species[1]																											Birds
Date	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	7.75	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	4	0.5
28-Aug	9.00	1	0	1	1	0	0	0	0	0	0	0	3	0	0	0	2	0	0	0	0	0	0	1	0	0	1	3	13	1.4
29-Aug	8.00	0	0	1	0	0	1	0	1	0	0	3	5	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	13	1.6
30-Aug	8.00	0	0	1	2	0	4	0	0	0	0	4	18	0	0	0	1	0	0	0	9	0	0	0	0	0	0	1	40	5.0
31-Aug	8.00	0	0	2	3	0	2	0	2	0	0	1	9	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0	23	2.9
1-Sep	8.00	0	0	2	0	0	2	0	0	0	0	1	1	0	0	0	1	0	0	0	2	0	0	0	0	0	1	0	10	1.3
2-Sep	8.00	0	0	4	0	0	5	1	1	0	0	1	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	16	2.0
3-Sep	7.25	1	0	0	2	0	1	0	1	0	0	0	13	0	0	0	1	0	0	0	7	0	0	0	0	0	0	0	26	3.6
4-Sep	8.00	0	0	7	0	0	0	0	1	0	0	1	4	0	0	0	2	1	1	0	3	0	0	1	0	0	0	0	21	2.6
5-Sep	8.00	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	6	0.8
6-Sep	8.00	2	2	15	3	0	3	1	2	0	0	1	2	0	0	0	1	0	0	0	7	0	0	0	1	0	0	0	40	5.0
7-Sep	8.00	0	0	4	1	0	4	0	1	0	0	0	5	0	0	0	4	1	0	0	9	0	0	0	0	0	0	3	32	4.0
8-Sep	8.17	5	0	6	5	0	5	0	4	0	0	2	8	1	0	0	2	0	0	0	6	0	0	0	1	0	0	0	45	5.5
9-Sep	8.00	0	0	11	6	0	11	1	3	0	0	0	11	0	0	0	1	0	0	0	5	0	1	0	0	0	0	1	51	6.4
10-Sep	7.00	3	0	1	0	0	1	1	0	0	0	0	2	1	0	0	3	0	0	1	0	0	0	0	0	0	0	0	13	1.9
11-Sep	6.50	3	4	17	13	0	11	2	5	0	0	0	45	0	0	0	2	0	0	0	9	0	0	1	0	1	0	0	113	17.4
12-Sep	8.25	2	1	29	13	0	20	0	4	0	0	0	13	0	0	0	5	0	0	0	20	0	0	0	0	1	0	3	111	13.5
13-Sep	8.00	1	0	4	4	0	2	0	3	0	0	0	4	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	20	2.5
14-Sep	8.00	1	0	1	1	0	1	1	1	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	9	1.1
15-Sep	8.17	3	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	9	1.1
16-Sep	8.00	4	0	2	2	0	4	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	16	2.0
17-Sep	8.00	1	0	5	2	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	4	0	0	1	0	0	0	1	16	2.0
18-Sep	8.17	3	3	16	13	1	5	1	0	0	0	0	20	0	0	0	0	0	0	0	25	0	2	0	0	0	0	1	90	11.0
19-Sep	8.00	1	0	14	21	0	5	6	3	0	0	1	4	0	0	0	5	0	0	0	7	0	0	1	0	0	0	1	69	8.6
20-Sep	8.00	1	1	3	10	0	0	2	2	0	1	0	2	0	0	0	18	0	0	0	5	0	0	0	0	0	0	0	45	5.6
21-Sep	8.00	0	2	21	31	0	19	1	4	0	1	0	39	0	0	0	4	0	0	0	22	0	1	1	0	0	0	0	146	18.3
22-Sep	5.67	6	1	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	12	2.1
23-Sep	8.00	0	0	11	14	0	7	4	3	0	0	0	5	0	0	0	2	0	0	0	3	0	0	1	0	0	0	0	50	6.3
24-Sep	8.58	3	0	57	52	1	28	12	6	0	0	0	15	0	0	0	2	0	0	0	43	0	0	1	0	1	0	0	221	25.8
25-Sep	8.00	1	2	29	24	0	15	7	3	0	0	0	24	0	0	0	13	0	0	0	9	0	0	1	0	0	0	1	129	16.1
26-Sep	8.00	1	3	17	6	1	8	1	4	0	0	0	19	0	0	0	0	0	0	0	30	0	1	0	0	1	0	1	93	11.6
27-Sep	8.25	3	0	18	19	0	1	2	4	0	0	0	16	0	0	0	2	0	1	0	11	0	0	0	0	0	0	0	77	9.3
28-Sep	8.00	0	1	7	2	0	8	4	5	0	0	0	16	0	0	0	3	0	0	0	2	0	0	0	0	0	0	0	48	6.0
29-Sep	8.25	1	0	9	8	0	8	5	5	0	0	0	12	0	0	0	2	1	0	0	15	0	0	0	0	0	0	1	67	8.1
30-Sep	9.25	1	1	97	38	0	10	2	13	0	1	1	43	0	0	0	6	1	0	0	71	0	0	0	0	0	0	2	287	31.0
1-Oct	6.67	0	0	6	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	10	1.5
2-Oct	9.25	1	2	88	48	0	16	9	19	0	0	2	62	1	0	0	14	0	0	0	47	1	0	0	0	1	0	0	311	33.6
3-Oct	8.00	0	3	78	61	0	3	6	7	0	0	0	64	1	0	0	2	0	1	0	18	0	0	0	0	0	0	0	244	30.5

Appendix E. continued

Date	Observ. Hours	Species[1]																											Total	Birds / Hour
		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		
4-Oct	7.25	0	2	3	3	0	1	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	1.8
5-Oct	6.75	0	0	7	3	0	0	0	1	0	0	0	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	15	2.2
6-Oct	7.83	2	1	30	15	1	5	3	6	0	0	0	13	0	0	0	2	0	0	0	5	0	0	1	0	0	0	3	87	11.1
7-Oct	8.00	0	3	20	16	0	3	3	4	0	0	0	12	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	65	8.1
8-Oct	8.08	0	0	14	5	0	6	1	0	0	0	0	21	0	0	0	2	0	0	0	4	0	0	0	0	0	0	0	53	6.6
9-Oct	8.00	1	1	28	7	0	1	0	1	0	0	0	13	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	74	9.3
10-Oct	8.08	0	0	10	11	0	0	1	0	0	0	0	16	1	0	0	5	1	0	0	10	0	0	0	0	0	0	1	56	6.9
11-Oct	8.75	3	3	123	40	3	26	5	4	0	0	0	88	1	0	0	0	0	0	0	38	0	0	0	0	0	0	0	334	38.2
12-Oct	8.00	0	0	29	10	0	15	2	4	0	0	0	39	0	0	0	4	0	0	0	13	2	0	1	0	0	0	0	119	14.9
13-Oct	9.00	0	3	124	59	0	21	13	8	0	0	0	58	0	0	0	0	0	0	0	6	2	1	1	1	0	0	0	297	33.0
14-Oct	8.00	1	2	20	13	2	6	1	3	0	0	0	7	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	58	7.3
15-Oct	7.50	2	0	58	32	0	5	2	5	0	0	0	38	0	0	0	2	0	1	0	17	1	0	0	0	0	0	1	164	21.9
16-Oct	8.00	0	0	15	1	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	26	3.3
17-Oct	8.00	0	2	20	5	0	1	1	0	0	0	0	25	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	56	7.0
18-Oct	8.00	2	0	46	12	0	4	1	9	0	0	0	15	1	0	0	4	0	0	0	3	0	0	0	1	0	0	0	98	12.3
19-Oct	8.00	0	3	45	11	0	3	1	3	0	0	0	33	1	0	0	0	0	0	0	3	0	0	0	1	0	0	2	106	13.3
20-Oct	8.00	1	0	4	3	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	21	2.6
21-Oct	8.00	0	0	7	3	0	2	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	2.8
22-Oct	8.00	0	0	1	1	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0.6
23-Oct	8.00	0	0	4	0	0	0	0	0	0	0	0	4	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	9	1.1
24-Oct	8.00	0	3	32	1	0	1	1	0	0	0	0	5	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	46	5.8
25-Oct	8.00	1	0	35	3	0	1	1	2	0	0	0	11	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	58	7.3
26-Oct	8.00	1	0	17	0	0	1	0	0	0	0	0	16	0	0	0	0	0	1	0	2	3	0	1	0	0	0	0	42	5.3
27-Oct	8.00	0	0	7	0	0	1	0	0	0	0	0	5	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	16	2.0
28-Oct	8.00	0	4	19	3	0	1	0	0	0	0	0	3	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	32	4.0
29-Oct	8.00	0	0	9	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	13	1.6
30-Oct	8.00	0	0	3	1	0	1	0	0	0	0	0	6	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	14	1.8
31-Oct	8.00	0	0	26	0	0	1	0	0	0	0	0	15	0	0	0	1	1	0	0	2	0	0	0	1	0	0	1	48	6.0
1-Nov	8.00	0	4	26	6	0	5	0	0	0	0	0	24	0	0	0	0	0	1	0	2	0	0	0	0	0	0	1	69	8.6
2-Nov	8.00	0	1	6	0	0	1	0	1	0	0	0	6	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	17	2.1
3-Nov	8.00	0	0	6	1	0	1	0	0	0	0	0	6	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	17	2.1
4-Nov	8.00	0	1	13	0	0	2	0	0	0	0	0	8	0	0	0	0	3	4	0	0	0	0	0	0	0	0	0	31	3.9
5-Nov	7.00	0	0	6	0	0	1	0	0	0	0	0	3	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	13	1.9
Total	564.42	64	59	1401	672	9	328	105	160	0	3	18	1,019	9	0	0	127	13	17	1	549	12	6	23	6	6	2	31	4,640	8.2

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

Appendix F. Daily raptor migration counts by species at Yaki Point, Grand Canyon, AZ: 2007.

Date	Observ. Hours	Species[1]																											Total	Birds / Hour
		OS	NH	SS	CH	NG	SA	LA	UA	RS	BW	SAW	RT	FH	RL	ZT	UB	GE	BE	UE	AK	ML	PR	PG	SF	LF	UF	UU		
27-Aug	8.25	0	0	3	1	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	9	1.1
28-Aug	9.00	0	0	3	3	0	1	0	0	0	0	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	1.4
29-Aug	8.00	0	0	1	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0.8
30-Aug	6.75	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	4	0.6
31-Aug	8.00	0	0	10	4	0	3	0	2	0	0	1	13	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	37	4.6
1-Sep	8.00	0	0	4	0	0	1	1	1	0	1	0	1	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	12	1.5
2-Sep	8.00	0	0	1	4	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	5	0	0	2	0	0	0	0	13	1.6
3-Sep	6.75	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	0.6
4-Sep	8.00	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
5-Sep	8.00	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	4	0.5
6-Sep	8.00	1	0	5	3	0	3	0	1	0	0	0	5	0	0	0	0	0	0	0	7	0	0	1	0	0	0	2	28	3.5
7-Sep	8.00	0	0	10	6	0	3	1	1	0	1	0	10	0	0	0	1	0	0	0	5	0	0	0	0	0	0	0	38	4.8
8-Sep	8.00	1	0	9	3	1	8	1	2	0	0	1	8	0	0	0	3	0	0	0	8	0	0	0	0	0	0	1	46	5.8
9-Sep	8.00	1	0	4	0	0	3	0	0	0	0	0	5	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	17	2.1
10-Sep	7.00	0	0	4	2	0	3	2	4	0	0	0	3	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	21	3.0
11-Sep	8.00	0	0	12	15	0	4	1	0	0	0	0	12	0	0	0	2	0	0	0	3	0	0	0	0	0	0	0	49	6.1
12-Sep	8.25	0	0	6	13	0	5	0	0	0	0	0	12	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	44	5.3
13-Sep	8.00	1	0	4	9	0	2	0	1	0	0	0	7	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	25	3.1
14-Sep	8.00	0	0	1	3	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	7	0.9
15-Sep	8.00	1	0	3	2	0	3	0	0	0	0	0	2	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0	15	1.9
16-Sep	8.00	1	1	4	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	10	1.3
17-Sep	9.50	1	0	11	13	1	5	0	3	0	0	1	13	0	0	0	1	0	0	0	27	0	0	0	0	0	0	1	77	8.1
18-Sep	8.75	1	3	23	33	0	12	10	6	0	2	0	17	0	0	0	5	0	0	0	57	0	0	0	0	0	0	0	169	19.3
19-Sep	8.00	1	1	11	11	0	2	1	0	0	0	0	7	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	36	4.5
20-Sep	8.50	1	1	43	24	0	11	3	3	0	1	0	12	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	111	13.1
21-Sep	8.00	3	0	11	17	0	17	0	1	0	0	0	10	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	63	7.9
22-Sep	5.00	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.2
23-Sep	8.00	1	0	16	8	0	4	2	0	0	0	0	6	0	0	0	2	0	0	0	2	0	0	1	0	0	0	0	42	5.3
24-Sep	9.25	5	0	42	71	1	8	4	4	0	4	2	29	1	0	0	0	0	1	1	15	0	0	1	0	0	0	0	189	20.4
25-Sep	8.25	1	0	38	42	0	17	12	9	0	0	1	14	0	0	0	4	0	0	0	44	0	0	0	0	0	0	0	182	22.1
26-Sep	9.00	1	1	69	66	1	21	5	1	0	1	0	72	0	0	0	0	0	0	0	43	0	0	0	0	0	0	0	281	31.2
27-Sep	8.00	0	1	26	29	0	20	2	2	0	5	0	26	0	0	0	0	0	0	0	35	0	0	0	0	0	0	0	146	18.3
28-Sep	8.00	0	0	6	8	0	4	0	0	0	0	0	7	0	0	0	1	0	0	0	4	0	0	0	0	0	0	0	30	3.8
29-Sep	9.25	1	1	28	27	1	3	1	1	0	0	0	15	0	0	0	0	1	0	0	37	0	0	2	0	0	0	0	118	12.8
30-Sep	8.25	1	0	125	54	0	16	4	9	0	1	0	40	0	0	0	1	0	1	0	23	0	0	0	0	0	0	0	275	33.3
1-Oct	4.17	0	0	4	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	6	1.4
2-Oct	8.00	1	1	71	65	0	32	7	4	0	0	0	45	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	244	30.5
3-Oct	8.25	0	2	36	21	0	8	2	7	0	0	0	36	0	0	0	1	0	0	0	13	0	0	1	0	0	0	0	127	15.4

Appendix F. continued

Date	Observ. Hours	Species[1]																										Total	Birds / Hour
		OS	NH	SS	CH	NG	SA	LA	UA	RS	BW	SAW	RT	FH	RL	ZT	UB	GE	BE	UE	AK	ML	PR	PG	SF	LF	UF	UU		
4-Oct	6.92	1	0	3	5	0	0	0	2	0	0	0	5	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	19	2.7
5-Oct	8.00	0	0	2	4	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	14	1.8
6-Oct	8.00	0	2	16	7	0	2	0	1	0	1	0	20	0	0	0	0	0	0	0	5	0	0	1	0	0	0	0	55	6.9
7-Oct	8.25	1	1	41	30	0	14	4	0	0	0	0	26	0	0	0	1	0	0	0	13	0	0	0	0	0	0	0	131	15.9
8-Oct	8.00	0	1	16	3	0	0	0	1	0	0	0	12	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	42	5.3
9-Oct	8.25	1	1	17	5	0	1	0	0	0	0	0	7	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	34	4.1
10-Oct	8.25	0	1	54	21	1	4	2	1	0	0	0	19	0	0	0	0	0	0	0	10	0	0	0	1	0	0	2	116	14.1
11-Oct	8.25	0	1	40	25	0	1	1	5	0	0	0	34	0	0	0	1	0	0	0	10	2	0	0	0	0	0	0	120	14.5
12-Oct	8.00	0	2	19	6	0	2	1	0	0	0	0	18	0	0	0	0	0	0	0	4	0	1	0	0	0	0	0	53	6.6
13-Oct	8.50	1	1	74	24	2	0	3	2	0	0	0	41	0	0	0	1	0	0	0	9	1	0	0	0	0	0	0	159	18.7
14-Oct	8.67	0	0	38	6	0	28	2	5	0	0	0	13	0	0	0	3	0	0	0	5	1	0	0	0	0	1	0	102	11.8
15-Oct	8.00	0	2	18	5	0	3	1	2	0	0	0	23	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	57	7.1
16-Oct	7.25	0	0	11	3	1	0	1	0	0	0	0	10	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	29	4.0
17-Oct	7.75	0	2	24	7	0	2	0	0	0	0	0	32	0	0	0	0	1	0	0	3	0	0	0	0	0	0	0	71	9.2
18-Oct	8.00	0	3	92	10	2	0	0	0	0	0	0	28	0	0	0	0	0	1	0	2	0	0	1	0	0	0	0	139	17.4
19-Oct	8.50	0	0	60	6	0	4	0	1	0	0	0	29	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	103	12.1
20-Oct	8.00	0	0	2	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	1.8
21-Oct	8.00	0	2	8	1	1	2	3	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	2.6
22-Oct	8.00	0	0	9	3	0	0	1	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	2.1
23-Oct	8.00	0	0	27	4	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	34	4.3
24-Oct	8.00	0	0	22	2	0	0	0	1	0	0	0	19	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	46	5.8
25-Oct	8.00	0	1	21	9	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	37	4.6
26-Oct	8.00	0	0	18	2	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	4.1
27-Oct	7.75	0	1	14	3	0	3	0	0	0	0	0	11	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	34	4.4
28-Oct	8.00	0	2	30	2	0	1	0	0	0	0	0	4	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	42	5.3
29-Oct	8.00	0	1	6	3	0	2	0	1	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	3.0
30-Oct	8.00	0	0	15	0	0	1	0	0	0	0	0	10	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	30	3.8
31-Oct	8.25	0	2	26	1	0	3	0	0	0	0	0	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	37	4.5
1-Nov	8.00	0	0	34	1	0	1	0	0	0	0	0	18	0	0	0	0	0	3	0	1	2	0	0	0	0	0	0	60	7.5
2-Nov	8.00	0	0	5	0	0	0	0	0	0	0	0	11	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	17	2.1
3-Nov	8.00	0	0	1	1	0	1	0	0	0	0	0	6	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	13	1.6
4-Nov	8.00	0	0	7	3	0	0	0	0	0	0	0	4	0	0	0	0	2	12	0	1	0	0	0	0	0	0	0	29	3.6
5-Nov	8.00	0	0	2	0	0	1	0	0	0	0	0	2	0	0	0	1	1	6	2	0	1	0	0	0	0	0	1	17	2.1
Total	566.76	29	38	1417	761	12	298	79	88	0	18	9	903	3	0	0	36	5	30	3	475	12	2	19	1	2	1	8	4,249	7.5

[1] 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: 1991–2007.

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Start date	8-Sep	1-Sep	31-Aug	1-Sep	1-Sep	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	5-Nov
Days of observation	57	65	66	64	65	69	70	68	71	67
Hours of observation	399.66	513.50	504.50	482.92	492.54	508.84	522.19	505.18	546.70	511.54
Raptors / 100 hours	1,231	1,957	1,249	1,372	1,369	1,574	1,331	1,283	1,152	1,107
SPECIES	RAPTOR COUNTS									
Osprey	26	72	73	73	77	99	135	115	72	88
Northern Harrier	43	131	64	111	121	111	93	81	130	99
Sharp-shinned Hawk	698	2,472	1,643	1,802	1,441	1,680	1,566	1,366	1,427	1,449
Cooper's Hawk	1,077	1,673	1,243	974	1,052	1,322	1,332	1,715	1,515	968
Northern Goshawk	10	42	26	4	5	3	8	2	6	13
Unknown small accipiter[1]	-	-	-	-	-	-	-	-	-	-
Unknown large accipiter[1]	-	-	-	-	-	-	-	-	-	-
Unknown accipiter	360	337	199	200	243	423	213	243	185	252
TOTAL ACCIPITERS	2,145	4,524	3,111	2,980	2,741	3,428	3,119	3,326	3,133	2,682
Red-shouldered Hawk	0	1	0	0	0	1	0	0	0	0
Broad-winged Hawk	0	3	7	2	7	2	7	35	11	15
Swainson's Hawk	6	24	25	33	34	57	32	31	40	22
Red-tailed Hawk	1,194	3,229	1,613	1,898	2,299	2,275	1,704	1,390	1,401	1,498
Ferruginous Hawk	8	15	7	11	3	6	7	6	7	6
Rough-legged Hawk	0	0	0	0	0	0	0	0	0	0
Zone-tailed Hawk	0	0	0	0	0	0	1	1	0	0
Unidentified buteo	55	19	2	8	11	16	33	40	17	15
TOTAL BUTEOS	1,263	3,291	1,654	1,952	2,354	2,357	1,784	1,503	1,476	1,556
Golden Eagle	18	62	37	36	32	47	26	22	29	9
Bald Eagle	5	20	49	8	38	23	25	18	24	11
Unidentified eagle	0	0	3	0	0	0	0	1	4	0
TOTAL EAGLES	23	82	89	44	70	70	51	41	57	20
American Kestrel	1,156	1,508	1,209	1,273	1,096	1,631	1,340	978	1,218	1,045
Merlin	7	14	12	10	12	8	24	12	13	9
Prairie Falcon	1	8	8	2	5	4	5	5	2	9
Peregrine Falcon	2	14	5	5	5	8	8	10	8	6
Unknown small falcon[1]	-	-	-	-	-	-	-	-	-	-
Unknown large falcon[1]	-	-	-	-	-	-	-	-	-	-
Unknown falcon	0	4	4	1	1	0	6	8	6	5
TOTAL FALCONS	1,166	1,548	1,238	1,291	1,119	1,651	1,383	1,013	1,247	1,074
Unknown raptor	106	124	24	66	48	60	97	96	107	48
GRAND TOTAL	4,920	10,048	6,301	6,625	6,745	8,008	6,952	6,479	6,297	5,664

[1] New designations used regularly beginning in 2001 (see Appendix B).

Appendix G. continued

YEAR	2001	2002	2003	2004	2005	2006	2007	MEAN
Start date	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	4-Nov
Days of observation	71	69	70	68	70	70	71	68
Hours of observation	575.08	557.72	535.58	554.98	554.38	530.53	564.42	521.19
Raptors / 100 hours	1,008	901	1036	597	528	683	822	1129
SPECIES								
Osprey	83	58	75	61	52	33	64	74
Northern Harrier	39	51	56	41	44	49	59	78
Sharp-shinned Hawk	1,609	1,455	1,263	945	891	1,155	1,401	1,427
Cooper's Hawk	1,158	599	765	319	377	426	672	1,011
Northern Goshawk	7	5	0	0	5	4	9	9
Unknown small accipiter[1]	98	197	31	85	104	136	328	140
Unknown large accipiter[1]	1	2	4	0	2	9	105	18
Unknown accipiter	0	46	47	39	28	84	160	180
TOTAL ACCIPITERS	2,873	2,304	2,110	1,388	1407	1814	2,675	2,692
Red-shouldered Hawk	0	0	0	0	0	0	0	0
Broad-winged Hawk	25	20	6	0	6	15	3	10
Swainson's Hawk	26	33	108	89	80	22	18	40
Red-tailed Hawk	1,458	1,302	1,791	951	594	1,207	1,019	1,578
Ferruginous Hawk	3	2	6	1	1	2	9	6
Rough-legged Hawk	0	1	0	0	0	0	0	0
Zone-tailed Hawk	0	1	2	0	0	0	0	0
Unidentified buteo	8	33	20	8	36	93	127	32
TOTAL BUTEOS	1,520	1,392	1,933	1,049	717	1,339	1,176	1,666
Golden Eagle	3	32	17	9	4	5	13	24
Bald Eagle	9	20	12	14	14	15	17	19
Unidentified eagle	0	3	0	0	0	0	1	1
TOTAL EAGLES	12	55	29	23	18	20	31	43
American Kestrel	1,180	1,057	1,300	689	639	308	549	1,069
Merlin	8	4	9	21	4	2	12	11
Prairie Falcon	8	1	3	7	9	4	6	5
Peregrine Falcon	6	14	8	7	10	12	23	9
Unknown small falcon[1]	2	1	0	1	2	19	6	4
Unknown large falcon[1]	3	3	1	0	3	8	6	3
Unknown falcon	3	0	0	1	1	7	2	3
TOTAL FALCONS	1,210	1,080	1,321	726	668	360	604	1,100
Unknown raptor	60	83	23	25	20	7	31	60
GRAND TOTAL	5,797	5,023	5,547	3,313	2,926	3,622	4,640	5,818

[1] 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: 1997–2007.

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	MEAN
Start date	27-Aug	28-Aug	27-Aug	27-Aug	27-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	4-Nov	5-Nov	5-Nov
Days of observation	71	66	71	66	71	71	70	68	70	70	71	69
Hours of observation	504.97	455.41	543.20	513.10	595.59	585.70	547.90	559.40	570.48	533.33	566.76	543.23
Raptors / 100 hours	938	908	998	1054	881	968	1229	932	556	771	749.7	901.3
SPECIES	RAPTOR COUNTS											
Osprey	50	43	28	43	34	57	50	42	31	37	29	40
Northern Harrier	50	44	56	41	31	45	35	29	38	45	38	41
Sharp-shinned Hawk	1,474	1,190	1,906	1,772	1,792	1,932	2,323	1,743	1,008	1,627	1,417	1,653
Cooper's Hawk	856	1,109	1,204	1,256	1,293	891	1,673	855	516	695	761	1,010
Northern Goshawk	4	7	1	9	11	6	2	7	2	14	12	7
Unknown small accipiter[1]	–	–	–	–	72	218	52	122	108	118	298	141
Unknown large accipiter[1]	–	–	–	–	0	3	1	1	4	4	79	13
Unknown accipiter	94	140	109	236	0	18	103	125	15	14	88	86
TOTAL ACCIPITERS	2,428	2,446	3,220	3,273	3,168	3,068	4,154	2,853	1,653	2,472	2,655	2,854
Red-shouldered Hawk	1	0	0	0	0	0	0	0	0	0	0	0
Broad-winged Hawk	9	19	14	6	11	8	14	19	2	12	18	12
Swainson's Hawk	15	25	32	10	19	16	147	80	32	30	9	38
Red-tailed Hawk	899	916	985	892	1,008	1,234	1,264	1,169	765	995	903	1003
Ferruginous Hawk	8	7	11	10	6	6	6	1	6	6	3	6
Rough-legged Hawk	0	0	0	1	1	2	0	0	0	1	0	0
Zone-tailed Hawk	0	0	1	0	1	1	0	0	0	0	0	0
Unidentified buteo	20	20	13	8	8	43	42	17	24	48	36	25
TOTAL BUTEOS	952	987	1,056	927	1,054	1,310	1,473	1,286	829	1,092	969	1085
Golden Eagle	24	7	2	11	4	23	11	4	5	1	5	9
Bald Eagle	23	18	17	9	14	49	14	10	22	18	30	20
Unidentified eagle	1	0	1	0	0	1	0	0	0	0	3	1
TOTAL EAGLES	48	25	20	20	18	73	25	14	27	19	38	31
American Kestrel	1,016	423	918	1,035	881	1,011	943	930	555	384	475	779
Merlin	14	12	14	5	22	5	17	9	9	9	12	12
Prairie Falcon	9	4	6	4	3	8	5	7	2	9	2	5
Peregrine Falcon	7	19	8	1	7	11	7	6	11	13	19	10
Unknown small falcon[1]	–	–	–	–	0	3	0	0	1	15	1	3
Unknown large falcon[1]	–	–	–	–	0	1	0	0	2	10	2	2
Unknown falcon	0	4	2	3	2	4	1	4	3	2	1	2
TOTAL FALCONS	1,046	462	948	1,048	915	1,043	973	956	583	442	512	812
Unidentified raptor	20	38	16	10	25	71	23	36	12	6	8	24
GRAND TOTAL	4,594	4,045	5,344	5,362	5,245	5,667	6,733	5,216	3,173	4,113	4,249	4,886

[1] New designations used regularly beginning in 2001 (see Appendix B).