FALL 2008 RAPTOR MIGRATION STUDIES IN THE GRAND CANYON OF ARIZONA

HawkWatch International, Inc.
Salt Lake City, Utah

HAWKWATCH INTERNATIONAL
Conserving Raptors and Our Shared Environment

April 2009

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April 2009

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INTRODUCTION

The Grand Canyon Raptor Migration Project in northern 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 simultaneous standardized monitoring at Yaki Point in 1997. The 2008 season marked the 18th consecutive count at Lipan Point and the 12th consecutive full-season count at Yaki Point. This report summarizes the 2008 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 2008. 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 interpreters 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 and HWI staff, conducted standardized daily counts of migrating 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 Lyndia Hammer had two previous seasons of exploratory migration counting experience with HWI in Oregon and southern California (see Appendix A for a complete history of observation participation). While official observer Lainie LaHaye had no prior migration counting experience, she and Interpreter Jordan McCormack attended pre-season training at HWI headquarters and received additional on-site training. The remaining crewmembers, including official observers Shannon Longoria and Stephanie Newton, temporary official observer Kris Schuller, and Interpreter Tonya Mammone, all received extensive on-site training from HWI's Southwest Monitoring Coordinator Mike Neal. The interpreters routinely facilitated interactions with visitors, with assistance provided by observers and staff, 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 2008 follow Hoffman and Smith (2003). In this report, we compare regression analyses of long-term (1991–2008) Lipan Point data and shorter-term Yaki Point and combined-site data from 1997–2008. In comparing 2008 annual statistics against means and 95% confidence intervals for previous seasons, we equate significance with a 2008 value falling outside the bounds of the confidence interval for the associated mean.

RESULTS AND DISCUSSION

WEATHER SUMMARY

In 2008, inclement weather did not entirely preclude any days of observation at either site, but severely hampered (i.e., reduced to ≤4 hours observation) two days of observation at Yaki Point (see Appendixes C and D for daily weather records from the two sites). The 1997–2007 averages are 1.6 days fully precluded and 1.4 days severely hampered at Lipan Point, and 1.5 days fully precluded and 1.5 days severely hampered at Yaki Point. Predominantly fair skies prevailed on a significantly above-average proportion of the active observation days at both sites (Lipan Point: 63% vs. 1997–2007 average of 54%; Yaki Point: 68% vs. average of 52%), whereas 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 at both sites (Lipan Point: 21% and 16% vs. averages of 29% and 17%, respectively; Yaki Point: 18% and 14% vs. averages of 29% and 19%, respectively). Unlike the last two years, visibility reducing fog and especially haze (primarily from dust) hampered observations near usual levels at both sites (Lipan Point: 42% vs. average of 36%; Yaki Point 30% vs. average of 33% of the active days). Rain and snow showers also occurred at near-average levels at both sites (Lipan Point: 21% vs. average of 17%; Yaki Point: 17% vs. average of 16%).

The 2008 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 21.6°C (1997–2007 average of 19.0°C), ranging from 7.4 to 33.4°C. At Yaki Point, the 2008 daily-average was 21.1°C (average 17.9°C), ranging from 7.6 to 32.6°C. At both sites the season-average and daily-average maximums were record highs.

Unlike the last two seasons, at Lipan Point the wind speeds were near average but tended toward lighter than usual, with light winds (<12 kph) prevailing on 83% of the active days, moderate winds on 13%, and stronger winds (>29 kph) on 4% of the active observation days (1997–2007 averages of 80%, 16%, and 4% of days, respectively). A more substantial shift toward lighter winds occurred at Yaki Point, with light winds prevailing on a record-high 88%, moderate winds on an below average 11%, and strong winds on a below average 2% of the active days (1997–2007 averages of 76%, 20%, and 4%).

In terms of wind directions, at Lipan Point variable S–W winds were the most common pattern, which is typical, but were twice as common as usual in 2008 (prevailing on 49% of the active days vs. 1997–2007

average of 24%). In contrast, windy days where no predominant wind direction could be identified did not occur at all in 2008, compared to the long-term average of 10% of the active days. The only other wind pattern that was noticeably less common than average was variable NE–SE winds with a calm or variable component (1% vs. average of 9%). The situation at Yaki Point in 2008 was even more atypical for that site. The spread of detected wind directions in 2008 contributed to these records. The most common wind pattern there was SE–SW winds, which prevailed on a record high 26% of the active days (average 12%). The second most common pattern, NE–SE winds, also was slightly more common than usual (20% vs. average of 16% of the active days), as were days with a combination of NW–NE and SE–SW winds (8% vs. average of 2%) and days with variable S–W winds (8% vs. average of 2%). In contrast, the third most common pattern, SW–NW winds, was slightly less common than usual (12% vs. average of 17%) and days of highly variable winds (no predominant pattern) where much less common than usual (2% vs. average of 11%). These kinds of differences between the two sites and among years clearly testify to the fact that local wind patterns can be highly variable along the canyon rim and often are difficult to discern properly.

At both sites, light winds and warm temperatures contributed to record-high proportions of days where the observers rated thermal-lift conditions as good to excellent (Lipan Point: 80% vs. average of 57%; Yaki Point: 83% vs. average of 52%). Visibility also averaged 10–20 km greater than the long-term means at both sites.

In summary, although the wind direction scenarios differed somewhat at the two sites, compared to the last 12 seasons, 2008 generally featured fairer, warmer, calmer, and clearer weather than usual.

OBSERVATION EFFORT

At Lipan Point, counts occurred on 71 of 71 possible days between 27 August and 5 November 2008 (see Appendices E and F for daily count records and Appendices G and H for annual effort and count summaries for each site). At Yaki Point, counts occurred on 66 of 66 possible days between 1 September and 5 November 2008, with the start date five days later than usual due to crew limitations. Both the number of observation days and the total hours of observation (544.90) at Lipan Point were 5% above the 1991–2007 averages for that site (68 ± 95% CI of 1.7 days and 521.19 ± 19.60 hours). In contrast, both the number of days and hours (514.09) of observation at Yaki Point were 5% below the 1991–2007 averages for that site. At the combined-site level, the number of days (71) and hours (556.58) during which counts occurred at one or both sites were, respectively, 1% above and 2% below the relevant 1991–2007 averages (70 ± 95% CI of 0.8 days and 568.99 ± 13.70 hours). In contrast, the 2008 average of 4.9 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 19% above average (4.1 ± 0.18 observers/hour) owing to the greater than usual presence of HWI staff member Mike Neal, which was required to facilitate training and supervision of a mostly inexperienced seasonal field crew.

MIGRATION SUMMARY

The observers tallied 6,688 migrant raptors of 16 species at the two count sites in 2008 (Table 1), with 50% recorded at Lipan Point and 50% at Yaki Point. The 2008 combined-site count was a significant 33% below the 1997–2007 average (Table 1), dropping to the second lowest count after last year's slightly improved count (Appendix G). The 2008 Lipan Point count was a significant 42% below the 1991–2007 average and 34% below the 1997–2007 average for that site, and the Yaki Point count was a significant 32% below the 1997–2007 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 recent years. 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, or changes in prevailing winds. 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 finally appeared to begin rebounding in 2006 and 2007 as regional moisture conditions improved (Smith and Neal 2008). The same cannot be said for the Grand Canyon counts, however, again suggesting that route shifts may be involved.

Compositional Patterns

The combined-site flight was composed of 57% accipiters, 25% buteos, 13% falcons, and ~1% or less each of Ospreys, harriers, eagles, and unidentified raptors. The proportion of accipiters was significantly above average, whereas the proportion of falcons was significantly below average (Figure 2). Yaki Point attracted 54% of the total accipiters (293 more individuals), whereas Lipan Point attracted more eagles (54% of the combined-site total), buteos (58%), Ospreys (63%), and harriers (57%). The previous 11-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 and the mean in 2008. The 2008 composition differed significantly from the average pattern only in that falcons typically are more common at Lipan Point (average 57% of the total), whereas as they were split equally between the two sites in 2008. 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 12 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 watch sites 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 new record highs for Northern Goshawks (28), Zone-tailed Hawks (10), and Prairie Falcons (20), but fell to new record lows for Cooper's Hawks (783) and Broad-winged Hawks (4). After falling to new record lows for two years in a row, the count of Ospreys rebounded slightly in 2007, but then fell again in 2008 to the second lowest since 1997. The 2008 count of American Kestrels also ranked as second lowest since 1997. Combined-site, adjusted passage rates were significantly above average for four species (Northern Goshawk, Merlin, Peregrine Falcon, and Prairie Falcon) and were significantly below average for seven (Osprey, Harrier, Sharp-shinned and Cooper's Hawks, Broad-winged and Red-tailed Hawks, and American Kestrel) of 15 commonly encountered species (Table 1).

Updated regression analyses of adjusted passage rates at Lipan Point from 1991–2008 (after Hoffman and Smith 2003) indicated at least marginally significant ($P \leq 0.10$) linear or quadratic (second-order) trends for 12 of 15 commonly encountered species (Figures 3–7). With the addition of three unprecedented high counts from 2006–2008, for the first time a significant long-term increase was indicated for Peregrine Falcons (Figure 7). A similar quadratic trend was indicated for Prairie Falcons, with a sustained increasing pattern since 2001 and the 2008 passage rate a new record high (Figure 7). For Northern Goshawks and Ferruginous Hawks, significant trough-shaped quadratic regressions tracked declines through the first decade or so of the count but then recent rebounds (Figures 4 and5). All other

significant trends tracked either long-term linear declines (Northern Harrier [Figure 3], Sharp-shinned and Cooper's Hawks [Figure 4], Red-tailed Hawk [Figure 5], and Golden Eagle [Figure 6]) or hill-shaped patterns of increase through the late 1990s followed by recent stabilization or decline (Osprey [Figure 3], Broad-winged Hawk [Figure 5], and Swainson's Hawk [Figure 5]). Regression analyses for the period 1997–2008 indicated similar, at least marginally significant, combined-site trends for most species that showed longer-term trends at Lipan Point alone. Only the longer-term Lipan Point data indicated significant decreases for Sharp-shinned Hawks (Figure 4) and Red-tailed Hawks (Figure 5), and effectively tracked the recent rebound of Ferruginous Hawks with a significant quadratic regression (Figure 5). Conversely, only the shorter-term, combined dataset indicated a significant quadratic trend for Merlins, tracking a decline through about 2002, then a recent 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 trends over the same period. These species include Osprey (Figure 3) and to lesser degrees Sharp-shinned Hawk (Figure 4) and Broad-winged and Red-tailed Hawks (Figure 5). 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 watch sites, 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 complex 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 2008.

Differences between results presented in Smith et al (2008a) and those presented herein that clearly relate to addition of three more years of data include: a) addition of two years of slightly improved counts in 2006 and 2007 rendered the combined-site trend for Cooper's Hawks a simple linear decline rather than a significant quadratic regression suggesting an accelerating decline; b) a record-low combined-site passage rate in 2008 rendered a marginally significant decline for Broad-winged Hawks; c) continuation 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 d) an additional three years of record-low passage rates 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 8 species with readily distinguishable age classes and for which the 2008 counts were high enough to warrant some attention to age ratios, showed significant variation in immature: adult ratios compared to the 1997–2007 averages (Table 2). Only the Peregrine Falcon showed a significantly above-average age ratio in 2008, with the count of identified immature birds slightly higher than average; however, the low number of aged individuals and a much higher than average proportion of unaged birds render this comparison of limited utility. For all five species that showed significantly below average age ratios in 2008, the counts of immature birds were below average, suggesting that low productivity in 2008 may have been a contributing factor. Again, however, note that significant variation in the proportion of unaged birds may confound the comparison for Northern Goshawks. Also note that the numbers of aged, adult Cooper's Hawks and Red-tailed Hawks also were well below average, suggesting that both productivity and adult survival may have been low for these two species in the past year. Conversely, for Sharp-shinned Hawks, the number of identified immatures was significantly below average, but identified adults were above average, suggesting that productivity may have been low in 2008, but adult survival in 2008 and/or recruitment of new adults from the 2007 production year was reasonably strong (Table 2). The average count of Zone-tailed Hawks at these sites is very low and therefore age-specific analyses generally are unwarranted; however, a record-high count of 10 birds in 2008 and the observation of at least two immature birds dispersing on migration, suggests that local productivity and recruitment may have been high for this species in 2008.

Seasonal Timing

Based on combined-site data, the overall combined-species median passage date of 3 October 2008 was a significant four days later than the 1997–2007 average (Table 3). Examination of the seasonal distribution of activity also revealed a pattern of distinctly below-average activity during the second half of September, followed by a 10-day period of distinctly above-average activity in late October (Figure 8). No obvious local weather-related reasons for this pattern were 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 a slightly higher percentage of days with westerly winds (Appendixes C and D). Alternatively, it is likely that the presence of a highly trained staff person assisting with the count contributed to the appearance of above-average activity levels in mid-September and late October.

At the species level, 13 of 15 species with data sufficient for comparisons showed median passage dates in 2008 that differed significantly from the respective 1997–2007 averages (Table 3). Moreover, 11 species showed significantly late timing (Osprey, Northern Harrier, all 3 accipiters, Red-tailed Hawk, Ferruginous Hawk, Bald and Golden Eagles, American Kestrel, Merlin, and Peregrine Falcon) and only the Swainson's Hawk showed significantly early timing. Species that clearly followed the pattern of relatively low activity during the latter half of September and comparatively high activity later in October include Osprey, Sharp-shinned Hawk, Cooper's and Ferruginous Hawks to a lesser degree, Red-tailed Hawk, American Kestrel, and Merlin. Northern Harriers also showed the same pattern, except that they also showed a high spike in activity during early September. Age-specific median passage dates revealed additional detail, but no notable variations from the species level indicators except for Sharp-shinned Hawks, for which the age-specific data indicated significantly early passage of immature birds, whereas the adult and species-level comparison indicated significantly late timing (Table 4).

RESIDENT RAPTORS

Yaki Point

At least one adult and one immature Sharp-shinned Hawks were regularly observed displaying territorial behavior and perching in the bowl from 5–18 September. Similar behavior was again observed between 26 September and 6 October.

An immature Cooper's Hawk was seen on 4 and 5 September displaying territorial behavior near Mather Point.

An apparent family of Red-tailed Hawks, including two adults and one immature (all light morphs), were seen regularly between 2–30 September in the "bowl" perching, escorting migrants, and kiting. It appeared that at least one and possibly both adults remained in the area through much of October.

At least one adult and one immature Zone-tailed Hawks were routinely seen in the bowl from 2–20 September, with the last sightings of local birds on 24 and 27 September.

One adult male Peregrine Falcon and one unknown adult often were seen circling and hunting in the bowl from 2 September through 9 October, with another potential sighting of a resident on 17 October.

Lipan Point

One immature and one unknown-age Sharp-shinned Hawks were seen perching and roosting on the "south wall" and displaying territorial behavior in the "bowl" from 14–24 September.

Suspected resident Northern Goshawks were observed four times on 5, 14, and 21 September flying east to west and diving into trees on the canyon rim, and an immature bird perched in the "bowl" on 8 October.

From 27 August through 22 September, at least one adult, light-morph Red-tailed Hawk was consistently seen kiting, escorting migrants, and stealing prey from a Zone tailed Hawk in and around the bowl, over Navajo Point to the east, and along the canyon rim. Another possible resident adult, dark-morph bird was observed twice in early September, and a possible resident immature, light-morph bird was seen during the same period. At least one and possibly two adult, light morphs were seen perching and kiting in and around the bowl and rim from 2–8 October and from 19 October through 4 November.

At least one adult and one immature Zone-tailed Hawks were observed in the bowl and over Navajo Point from 21 August through 11 September, occasionally displaying territorial behavior. On three separate occasions, both immature and adult birds were observed carrying prey items. During one of these observations, an adult Red-tailed Hawk stole the prey item from the Zone-tailed Hawk.

At least one adult Peregrine Falcon was consistently seen from 28 August through 9 October in the bowl, perching on the south wall, hunting, and chasing migrant Sharp-shinned Hawks. Two peregrines were observed together on 14 September, and one possible immature peregrine was seen flying toward the North Rim on 21 September.

Golden Eagles were observed displaying possible but unconfirmed resident behavior in mid-September, with a bird flying north from Navajo Point and a bird being chased to the west by an unidentified buteo.

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

VISITOR PARTICIPATION

Operating in close coordination with personnel of Grand Canyon National Park, HWI interpreters

conducted organized education programs every day from 1 September – 31 October at either Lipan or Yaki Points. These programs reached approximately 1,930 people, with visitors originating in 37 states and Washington, D.C., several Canadian provinces, and 23 other foreign countries: Spain, Switzerland, Wales, South Africa, India, Russia, Venezuela, Scotland, Austria, Ireland, Mexico, Holland, Belgium, Korea, Singapore, Japan, China, Australia, Sweden, Brazil, France, Denmark, and Germany. The average length of a visitor's stay was about 30 minutes. The percentage of repeat visitors was small, perhaps 3%. Other organized groups that visited the site during the season included a group of ornithology students and their professor from Northern Arizona University, a women's birding group led by HWI Board Member Sue Drown, and a boarding school group of about 20 middle-schoolers.

In 2008 at Lipan Point, 548 hourly assessments of visitor disturbance resulted in the following ratings: 84% none, 16% low, <1% moderate, and 0% high. At Yaki Point, 515 hourly assessments of visitor disturbance resulted in the following ratings: 80% none, 17% low, 3% moderate, and <1% high. Given the high levels of visitation at both sites, these modest levels of visitor-related disturbance of the official observers clearly testify to the advantages of staffing the sites with dedicated site-interpreters whose job is to facilitate rich experiences for our guests while minimizing disturbance of the official counters.

ACKNOWLEDGMENTS

Funding for this year's project was provided by the Arthur and Elaine Johnson Foundation, Grand Canyon Association, and HWI private donors and members. The Tusayan Ranger District of the Kaibab National Forest and Grand Canyon National Park provided essential logistical support. Special thanks to park orientation specialists Ron and Pat Brown (both former HWI on-site interpreters in the park) and park interpretative ranger Marker Marshall for their considerable logistical and educational assistance. We also extend our sincerest appreciation to Park Ranger Brian Gatlin and all the other NPS employees who visited the sites and crew in 2008. Special thanks to Kris Schuller in acting as a fill-in observer and Dennis Jennings for committing a week of his time to learn more raptor identification skills.

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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): 1997–2007 versus 2008.

SPECIES	COUNTS			RAPTORS / 100 HOURS		
	1997–2007[1]	2008	% CHANGE	1997–2007[1]	2008	% CHANGE
Osprey	116 ± 19.6	81	-30	26.9 ± 4.92	19.8	-26
Northern Harrier	109 ± 21.3	81	-25	21.7 ± 4.43	15.9	-27
Sharp-shinned Hawk	2,974 ± 289.2	2,506	-16	700.8 ± 56.96	637.8	-9
Cooper's Hawk	1,905 ± 411.1	783	-59	531.7 ± 108.52	246.9	-54
Northern Goshawk	12 ± 3.9	28	+130	2.3 ± 0.76	5.8	+152
Unknown small accipiter	281 ± 135.1	277	-1	–	–	–
Unknown large accipiter	31 ± 50.2	62	+102	–	–	–
Unknown accipiter	204 ± 90.9	139	-32	–	–	–
TOTAL ACCIPITERS	5,293 ± 604.8	3,795	-28	–	–	–
Red-shouldered Hawk	0.1 ± 0.2	0	-100	–	–	–
Broad-winged Hawk	25 ± 7.1	4	-84	13.0 ± 3.74	1.7	-87
Swainson's Hawk	83 ± 41.5	40	-52	23.6 ± 12.04	12.0	-49
Red-tailed Hawk	2,304 ± 252.9	1,503	-35	483.2 ± 53.17	332.1	-31
Ferruginous Hawk	11 ± 2.7	10	-8	2.3 ± 0.61	2.2	-5
Rough-legged Hawk	0.5 ± 0.6	0	-100	–	–	–
Zone-tailed Hawk	0.7 ± 0.5	10	+1275	–	–	–
Unidentified buteo	65 ± 28.1	107	+66	–	–	–
TOTAL BUTEOS	2,489 ± 263.7	1,674	-33	–	–	–
Golden Eagle	24 ± 9.8	26	+8	4.6 ± 1.91	5.0	+9
Bald Eagle	37 ± 8.5	27	-26	8.7 ± 1.96	7.9	-9
Unidentified eagle	1.4 ± 1.2	2	+47	–	–	
TOTAL EAGLES	62 ± 17.8	55	-12	–	–	
American Kestrel	1,716 ± 331.6	766	-55	437.4 ± 83.95	217.1	-50
Merlin	22 ± 5.5	33	+48	4.7 ± 1.18	7.4	+58
Prairie Falcon	11 ± 1.4	20	+86	2.2 ± 0.40	4.6	+108
Peregrine Falcon	20 ± 5.8	23	+14	4.2 ± 1.35	6.8	+62
Unknown small falcon	7 ± 8.9	46	+531	–	–	–
Unknown large falcon	6 ± 4.5	15	+169	–	–	–
Unknown falcon	6 ± 1.8	18	+205	–	–	–
TOTAL FALCONS	1,783 ± 323.2	921	-48	–	–	–
Unidentified Raptor	78 ± 27.8	81	+3	–	–	–
GRAND TOTAL	9,930 ± 1,111.8	6,688	-33	–	–	–

[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): 1997–2007 versus 2008.

	Total and Age-classified Counts								Immature : Adult	
	1997–2007 Average			2008			% Unknown Age		Ratio	
Species	Total	Imm.	Adult	Total	Imm.	Adult	1997–2007[1]	2008	1997–2007[1]	2008
Northern Harrier	109	27	27	81	13	22	51 ± 4.9	57	1.0 ± 0.16	0.6
Sharp-shinned Hawk	2,974	606	1,091	2,506	457	1,187	42 ± 8.1	34	0.6 ± 0.13	0.4
Cooper's Hawk	1,905	429	574	783	196	257	48 ± 7.2	42	0.8 ± 0.19	0.8
Northern Goshawk	12	5	3	28	3	3	26 ± 14.6	79	1.9 ± 0.93	1.0
Broad-winged Hawk	25	6	9	4	1	1	34 ± 14.4	50	0.7 ± 0.20	1.0
Red-tailed Hawk	2,304	306	1,439	1,503	124	1,049	23 ± 5.4	22	0.2 ± 0.06	0.1
Ferruginous Hawk	11	3	4	10	0	1	42 ± 10.3	90	0.8 ± 0.30	0.0
Golden Eagle	24	8	8	26	11	9	31 ± 8.2	23	1.7 ± 0.96	1.2
Bald Eagle	37	7	26	27	3	22	8 ± 4.1	7	0.3 ± 0.02	0.1
Peregrine Falcon	20	3	8	23	4	1	45 ± 11.6	78	0.4 ± 0.20	4.0

[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 2008 and 1997–2007 average median passage dates (Lipan Point and Yaki Point data combined).

	2008				1997–2007
Species	First Observed	Last Observed	Bulk Passage Dates [1]	Median Passage Date [2]	Median Passage Date [3]
Osprey	1-Sep	24-Oct	9-Sep – 10-Oct	26-Sep	19-Sep ± 1.6
Northern Harrier	5-Sep	5-Nov	9-Sep – 28-Oct	15-Oct	7-Oct ± 1.8
Sharp-shinned Hawk	2-Sep	5-Nov	14-Sep – 23-Oct	5-Oct	2-Oct ± 1.6
Cooper's Hawk	2-Sep	5-Nov	15-Sep – 16-Oct	1-Oct	28-Sep ± 1.8
Northern Goshawk	2-Sep	5-Nov	22-Sep – 31-Oct	17-Oct	2-Oct ± 7.0
Broad-winged Hawk	7-Sep	25-Sep	7-Sep – 25-Sep	–	25-Sep ± 1.2
Swainson's Hawk	1-Sep	12-Oct	2-Sep – 10-Oct	12-Sep	21-Sep ± 5.7
Red-tailed Hawk	27-Aug	5-Nov	12-Sep – 26-Oct	12-Oct	8-Oct ± 1.9
Ferruginous Hawk	23-Sep	31-Oct	24-Sep – 31-Oct	21-Oct	10-Oct ± 5.2
Zone-tailed Hawk	27-Aug	25-Sep	2-Sep – 25-Sep	5-Sep	–
Golden Eagle	2-Sep	5-Nov	24-Sep – 1-Nov	18-Oct	17-Oct ± 5.8
Bald Eagle	30-Sep	4-Nov	13-Oct – 4-Nov	28-Oct	25-Oct ± 2.8
American Kestrel	27-Aug	4-Nov	13-Sep – 13-Oct	30-Sep	23-Sep ± 1.6
Merlin	7-Sep	5-Nov	14-Sep – 29-Oct	16-Oct	4-Oct ± 4.6
Prairie Falcon	2-Sep	29-Oct	11-Sep – 18-Oct	19-Sep	23-Sep ± 4.9
Peregrine Falcon	3-Sep	2-Nov	16-Sep – 18-Oct	2-Oct	24-Sep ± 5.1
All species	27-Aug	5-Nov	14-Sep – 23-Oct	3-Oct	30-Sep ± 1.4

[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): 1997–2007 versus 2008.

	ADULT		IMMATURE / SUBADULT	
SPECIES	1997–2007[1]	2008	1997–2007[1]	2008
Northern Harrier	11-Oct ± 2.9	19-Oct	5-Oct ± 3.8	19-Oct
Sharp-shinned Hawk	7-Oct ± 1.1	12-Oct	26-Sep ± 1.6	24-Sep
Cooper's Hawk	1-Oct ± 2.0	5-Oct	25-Sep ± 1.5	26-Sep
Northern Goshawk	13-Oct ± 24.5	–	8-Oct ± 6.0	–
Broad-winged Hawk	24-Sep ± 1.8	–	25-Sep ± 2.8	–
Red-tailed Hawk	8-Oct ± 1.6	12-Oct	2-Oct ± 2.9	7-Oct
Golden Eagle	15-Oct ± 10.4	18-Oct	13-Oct ± 6.5	18-Oct
Bald Eagle	24-Oct ± 2.7	28-Oct	23-Oct ± 3.8	–
Peregrine Falcon	24-Sep ± 6.7	–	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.

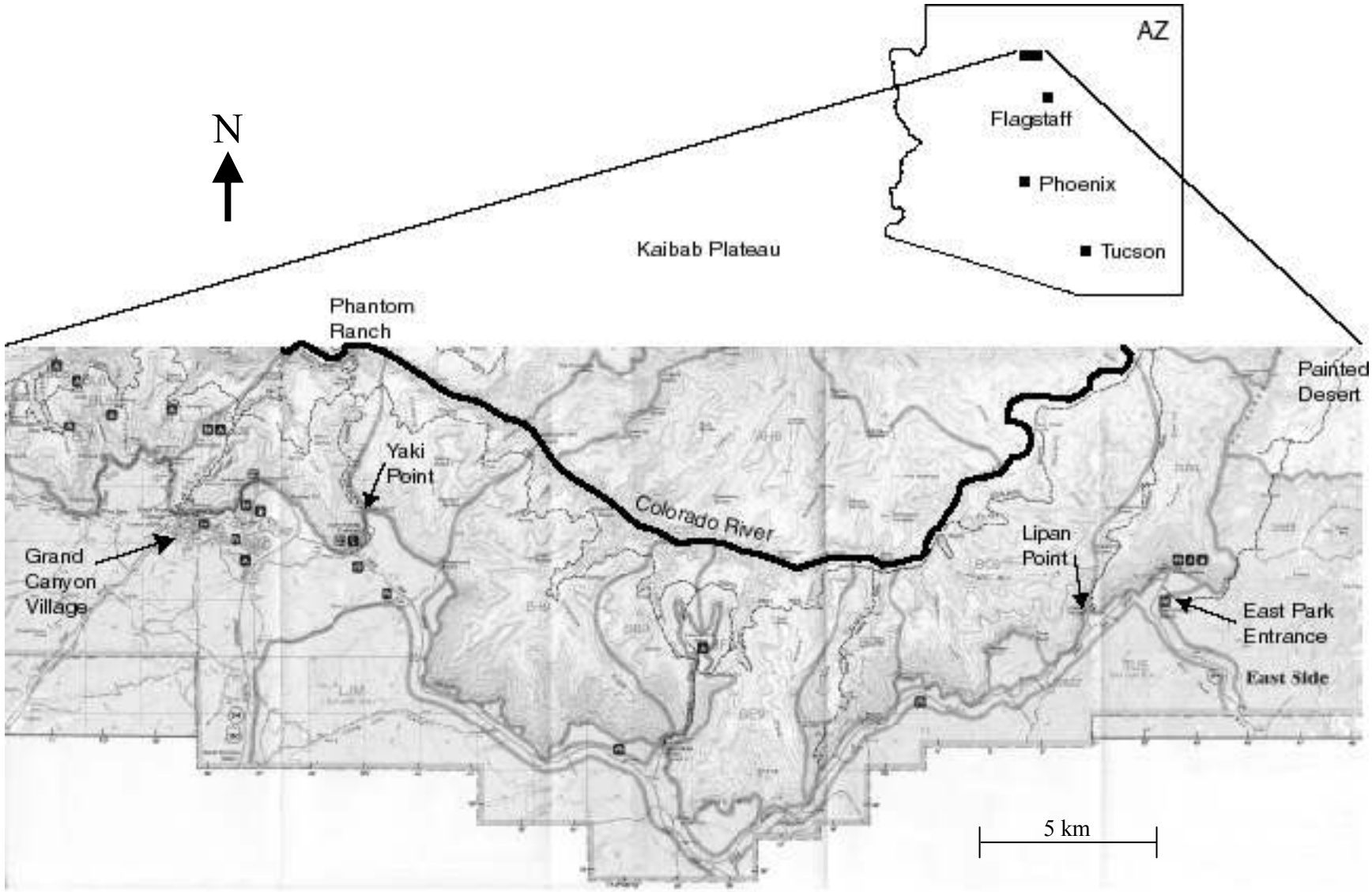

Figure 1. Map showing the Lipan Point and Yaki Point raptor-migration study sites in the Grand Canyon, Arizona.

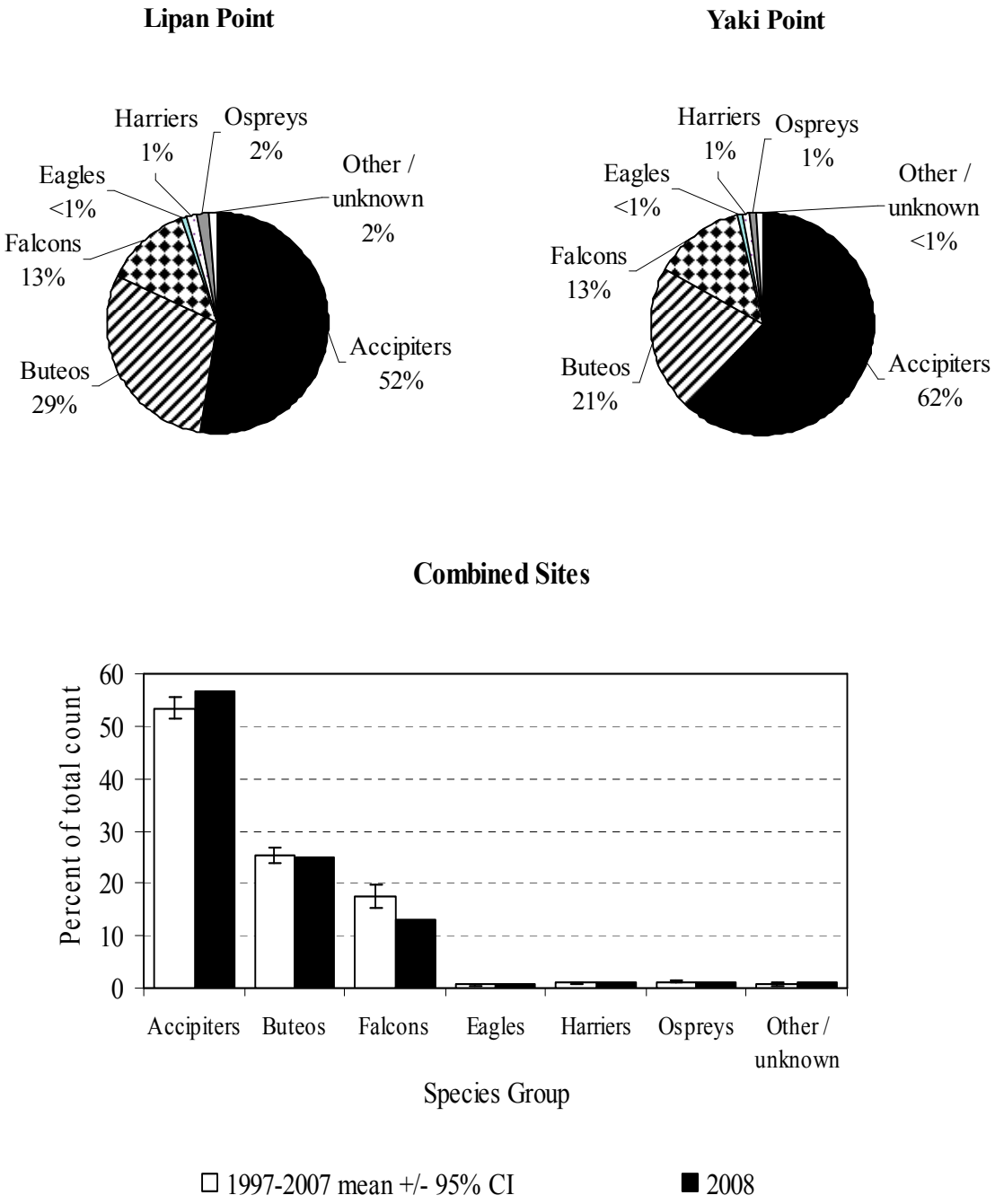

Figure 2. Fall raptor-migration flight composition by major species groups in the Grand Canyon, AZ: 1997–2007 versus 2008.

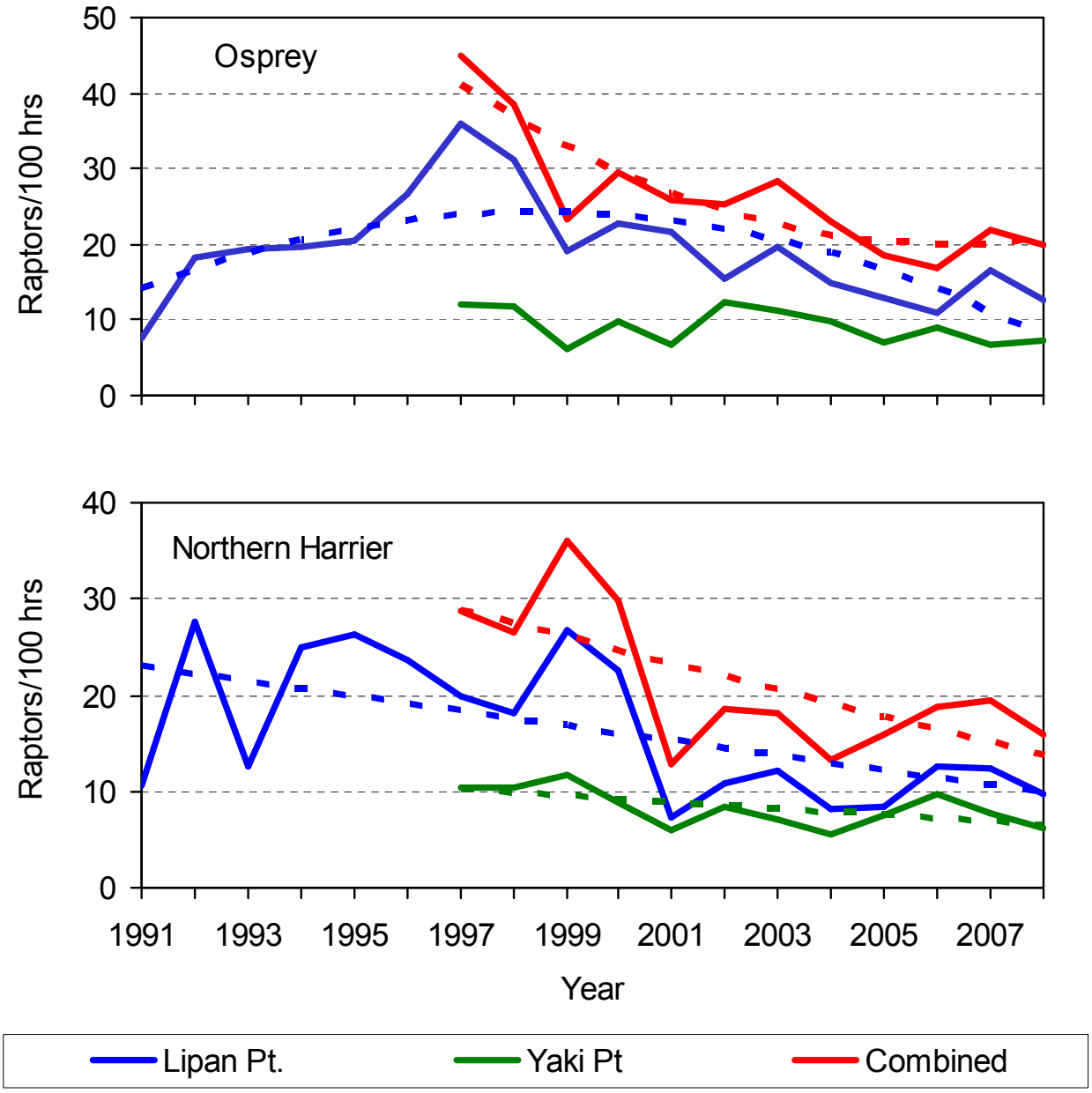

Figure 3. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Ospreys and Northern Harriers in the Grand Canyon, AZ: 1991–2008. Dashed lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

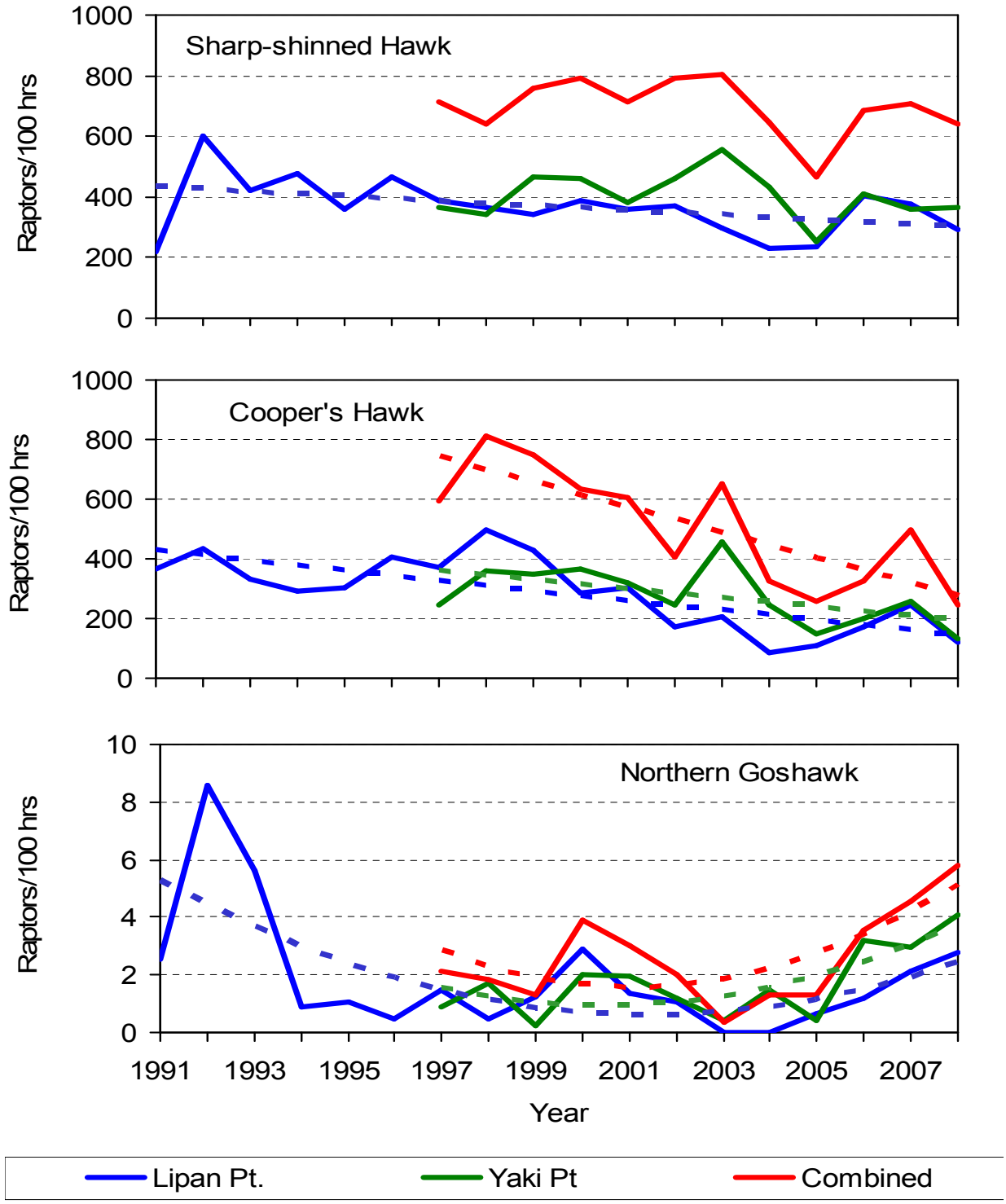

Figure 4. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks in the Grand Canyon, AZ: 1991–2008. Dashed lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

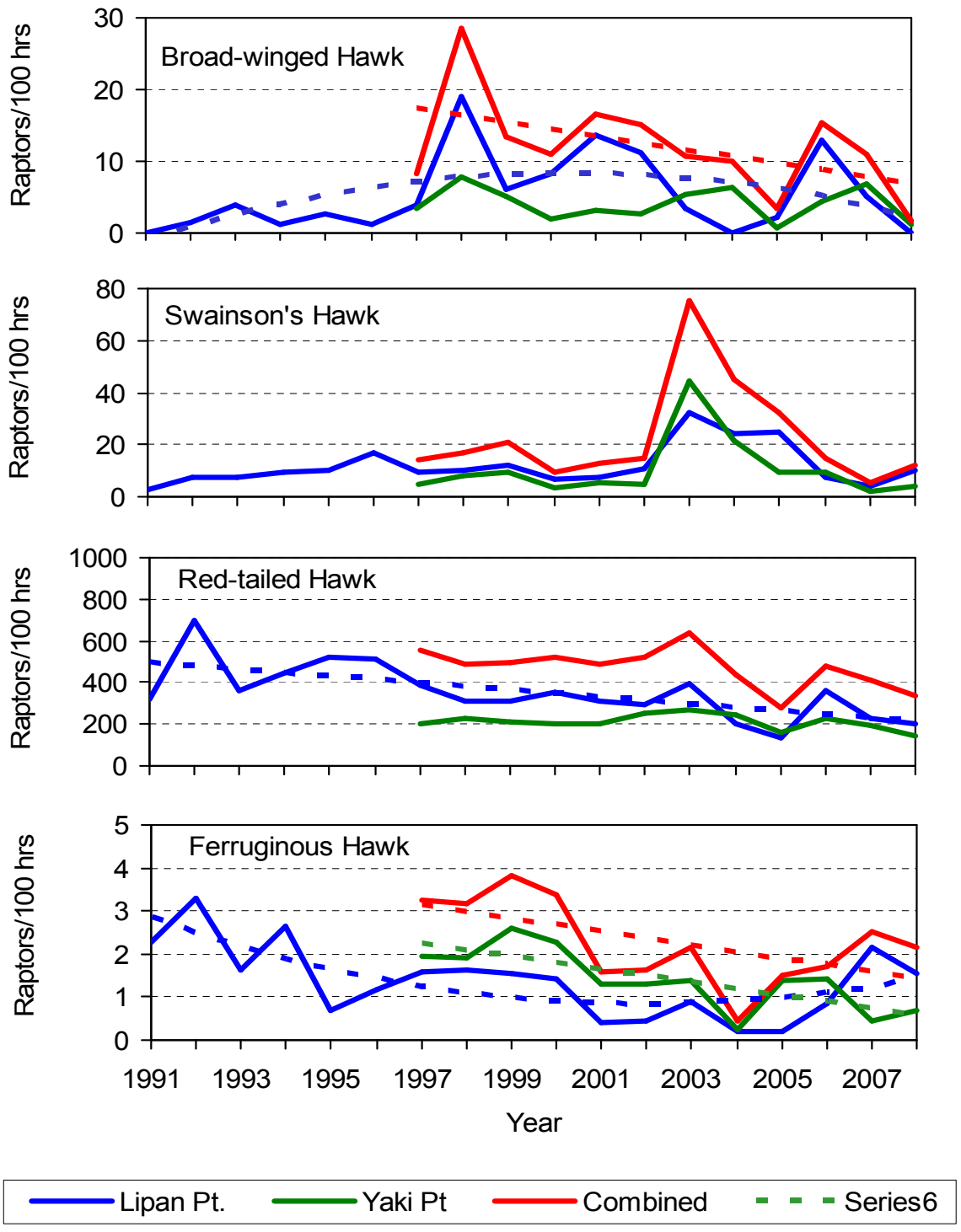

Figure 5. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Broad-winged, Swainson's, Red-tailed, and Ferruginous Hawks in the Grand Canyon, AZ: 1991–2008. Dashed lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

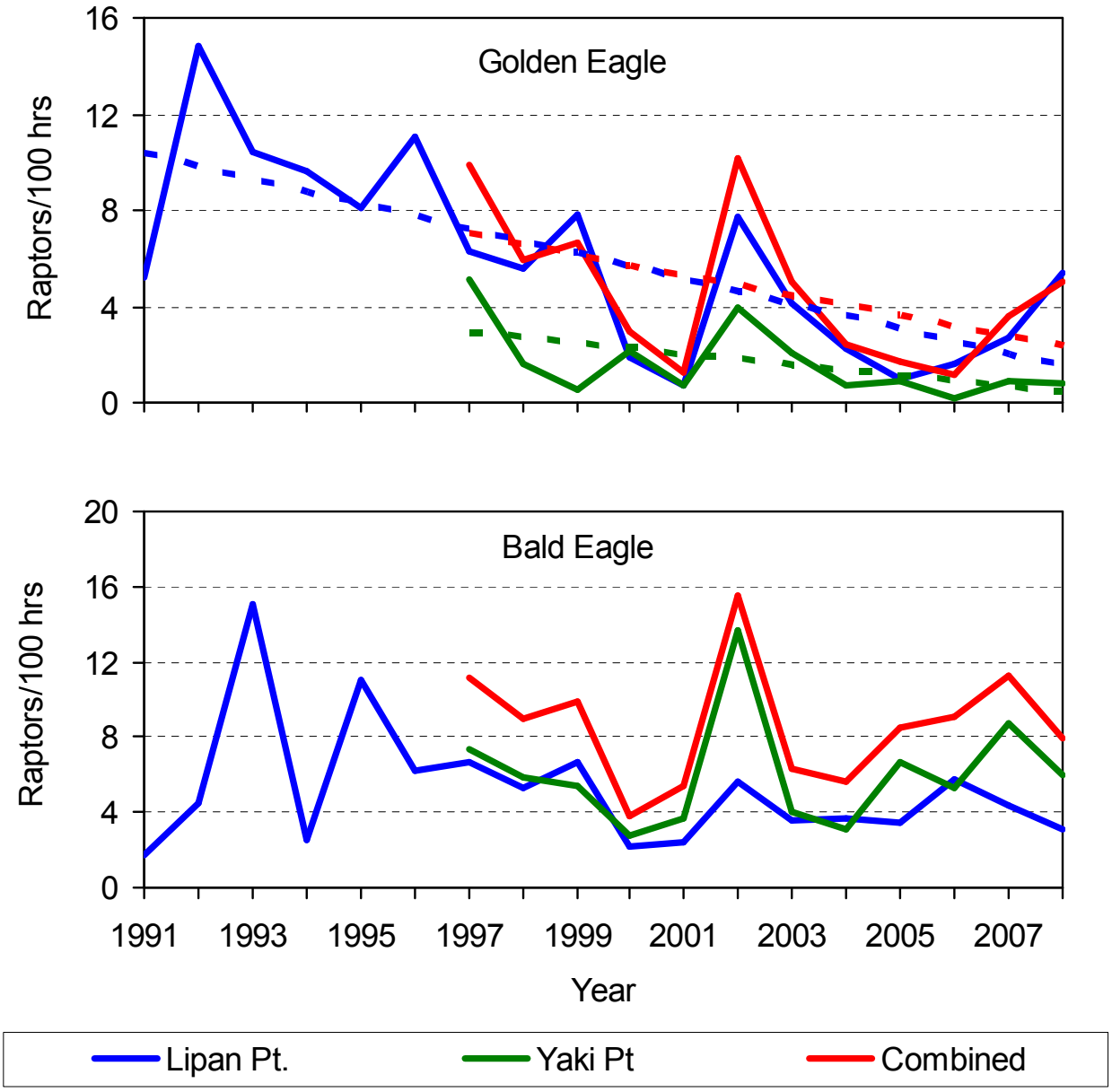

Figure 6. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Golden and Bald Eagles in the Grand Canyon, AZ: 1991–2008. Dashed lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

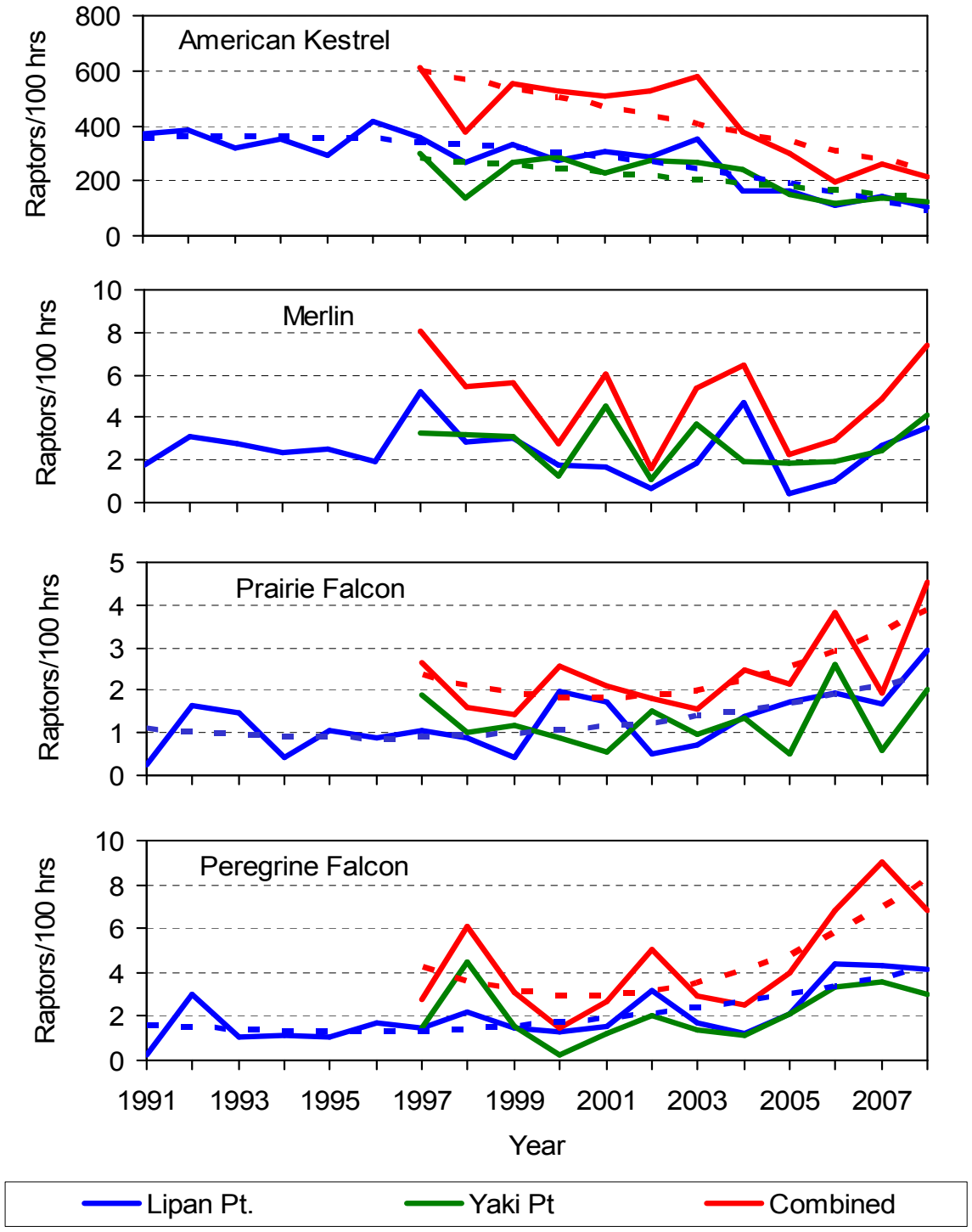

Figure 7. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons in the Grand Canyon, AZ: 1991–2008. Dashed lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

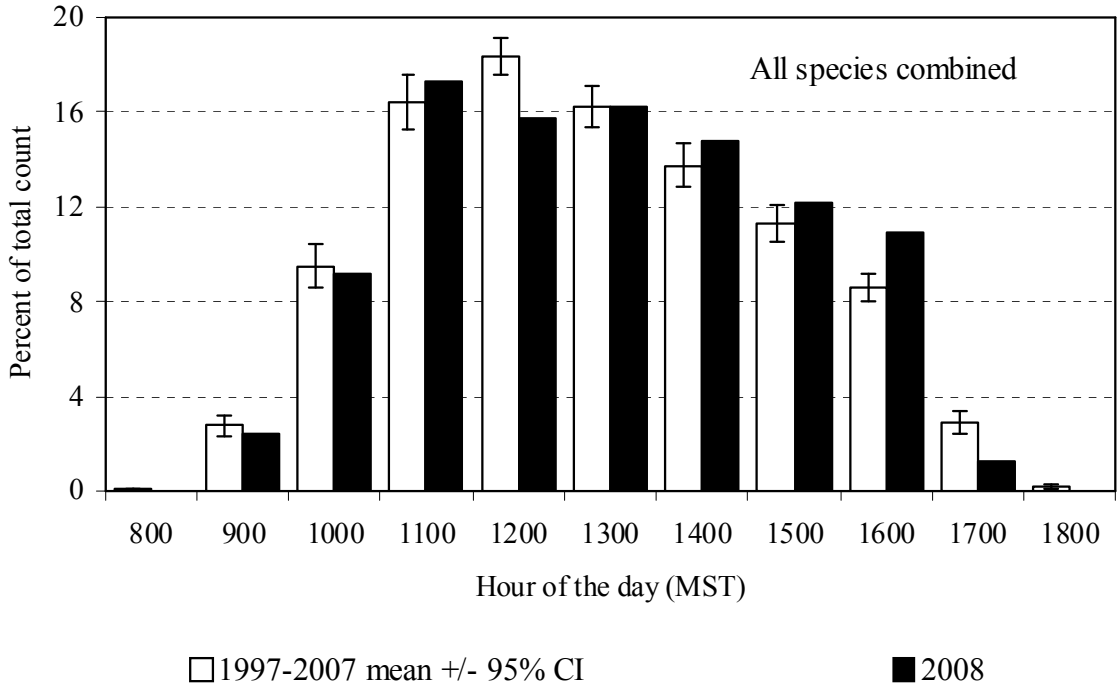

Figure 8. Combined-species, fall-migration passage volume by five-day periods for raptors in the Grand Canyon, AZ: 1997–2007 versus 2008 (Lipan Point and Yaki Point data combined).

Appendix A. History of official observer participation in the Grand Canyon raptor migration studies: 1991–2008.

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).

2008 Rotating team with at least two observers throughout at Lipan Pt. and Yaki Pt.: Lyndia Hammer (2+), Lainie LaHaye (0), Shannon Longoria (0), Stephanie Newton (0), Kris Schuller (0), Mike Neal (10+).

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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: 2008.

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	8.00	1.2	0	clr-mc, haze	2.2	calm/var	31.5	29.75	2	50	47	2	0.6
28-Aug	8.00	1.0	0	clr, haze	3.0	calm/var	33.4	29.75	1	50	50	2	0.4
29-Aug	7.83	1.2	0	pc-ovc, haze	2.4	se, w	33.3	29.75	2	46	50	3	0.5
30-Aug	3.50	1.0	0	ovc, haze, ts/rain	3.0	sw, w	25.5	29.69	4	40	30	-	0.0
31-Aug	3.00	1.0	0	ovc, haze, AM rain	11.2	w	22.0	29.56	4	32	38	-	0.0
01-Sep	8.00	2.0	0	pc-ovc, haze, scat rain	12.5	sw	23.6	29.64	4	48	39	1	1.1
02-Sep	8.25	1.8	0	clr, haze	1.3	calm, sw-w	25.3	30.27	1	83	78	3	3.9
03-Sep	8.00	2.0	0	clr	6.4	w	27.3	30.24	2	100	86	1	1.5
04-Sep	8.00	3.4	1.5	clr, haze	5.6	sw-w	30.5	30.20	2	61	55	2	1.4
05-Sep	8.00	2.0	0	clr, haze	10.2	w	30.1	30.19	2	51	51	3	0.9
06-Sep	8.00	1.9	0	clr	11.0	w	29.5	30.23	2	98	75	2	2.3
07-Sep	7.75	2.3	0	clr-pc	7.4	w	28.9	30.18	1	96	91	1	5.0
08-Sep	5.50	3.0	0	clr-ovc, PM ts	13.4	se-s, w	26.1	30.19	2	86	81	1	1.6
09-Sep	7.83	1.8	0	mc, haze	10.6	sw-w	25.8	30.12	3	80	77	2	0.8
10-Sep	5.50	2.0	0	mc-ovc, rain	16.5	w	20.8	30.07	4	88	76	3	2.0
11-Sep	8.00	3.3	0	clr-ovc, PM rain	4.7	sw	24.7	30.14	2	80	76	3	4.3
12-Sep	8.00	2.9	0	clr	6.4	w	25.4	30.12	1	86	83	2	15.8
13-Sep	8.00	3.2	0	clr, PM haze	1.8	sw	25.1	30.17	1	87	81	2	5.6
14-Sep	8.00	2.0	0	clr, PM haze	3.5	se, sw-w	25.9	30.32	2	97	83	2	5.4
15-Sep	8.00	3.2	0	clr, PM haze	3.5	ne-se, sw-w	25.7	30.38	1	90	87	2	3.5
16-Sep	8.00	1.9	0	pc-mc	7.2	calm/var	22.6	30.38	1	87	86	4	3.0
17-Sep	8.00	2.8	0	pc-ovc, AM rain, PM ts	7.1	se, sw-w	24.3	30.34	3	85	80	2	3.5
18-Sep	8.00	3.6	1	pc-ovc, ts	6.1	sw-w	25.3	30.29	2	100	91	3	5.8
19-Sep	7.75	2.1	0	pc-ovc, rain	4.4	calm, w	21.2	30.27	3	95	91	2	6.3
20-Sep	8.00	3.8	0	mc-ovc	13.4	sw	23.6	30.21	3	88	84	2	2.6
21-Sep	8.00	2.3	0	pc	23.6	sw-w	23.5	30.15	1	100	100	2	3.1
22-Sep	8.00	2.0	0	pc	12.3	w	22.9	30.17	1	95	95	2	2.1
23-Sep	8.25	3.3	0	clr	2.6	sw-w	25.9	30.32	1	93	90	2	16.7
24-Sep	8.25	2.0	0	clr-pc	7.6	w	25.4	30.37	1	99	99	3	14.8
25-Sep	8.00	3.2	0	clr-pc, scat rain	3.4	calm, sw-w	25.0	30.35	2	95	89	3	14.0
26-Sep	8.00	2.0	0	clr-pc, scat ts/rain, PM haze	0.9	calm, w	26.1	30.32	1	89	89	2	5.4
27-Sep	8.00	3.0	0	mc, ts/rain	3.9	calm/var	25.1	30.31	2	83	81	2	11.4
28-Sep	8.00	2.8	0	pc, PM haze	1.9	e, sw	24.8	30.35	1	89	81	2	3.4
29-Sep	8.00	2.0	0	clr	1.6	se-s	24.9	30.38	1	89	86	2	5.8
30-Sep	8.00	2.8	0	clr, AM haze	3.6	sw	22.1	30.45	1	81	81	2	6.5
01-Oct	8.00	3.0	0	clr-pc	0.9	calm, ne	25.5	30.36	1	89	86	2	12.0
02-Oct	8.50	3.6	0	pc-ovc, PM haze	5.9	sw-w	23.2	30.17	2	75	84	3	32.6
03-Oct	7.83	2.1	1.5	mc-ovc	11.8	sw-w	21.0	30.08	3	83	81	2	6.4
04-Oct	3.25	2.7	0	ovc, AM rain	20.2	sw-w	11.6	29.88	4	80	64	-	0.0
05-Oct	7.83	3.1	0	pc	6.0	w	17.9	29.97	2	89	91	2	20.7
06-Oct	8.00	2.0	0	clr	1.6	sw-w	18.1	30.26	1	89	85	3	2.5
07-Oct	8.00	4.1	0	clr	1.6	ese-se	18.4	30.40	2	87	86	2	6.1
08-Oct	8.00	2.1	0	clr, PM haze	5.0	e-se, w	23.4	30.24	2	89	86	2	23.4
09-Oct	8.00	2.8	0	clr	25.9	sw-w	20.8	29.94	3	95	89	3	4.1
10-Oct	5.50	1.8	0	clr, PM blow dust	44.9	sw	17.5	29.72	4	88	86	2	2.0
11-Oct	8.00	2.6	0	clr	28.4	w-nw	9.9	29.64	3	89	79	2	2.1
12-Oct	7.75	3.3	1	clr, PM haze	1.8	w	8.9	29.99	2	88	79	2	8.9
13-Oct	8.00	2.0	0	clr	1.3	nw	9.1	30.28	2	90	91	2	1.5

Appendix C. continued

Date	Obs. Hours	Obsrvr / Hour[1]	Median Visitor Disturb[2]	Predominant Weather[3]	Wind Speed (kph)[1]	Wind Direction	Temp (°C)[1]	Barom. Press. (in Hg)[1]	Median Thermal Lift[4]	Visib. East (km)[1]	Visib. West (km)[1]	Median Flight Distance[5]	Birds / Hour
14-Oct	8.00	2.9	0	clr, PM haze	3.8	w-nw	12.0	30.26	2	85	86	2	5.3
15-Oct	8.00	2.0	0	clr	3.3	se	15.4	30.34	1	90	83	2	1.6
16-Oct	8.00	2.9	1	clr-pc	1.8	nw	18.4	30.40	2	82	79	2	19.3
17-Oct	8.00	2.5	0	clr, PM haze	3.0	se	20.3	30.47	1	90	82	2	7.8
18-Oct	8.75	4.5	0	clr-pc	6.9	w	21.0	30.32	2	90	86	2	14.7
19-Oct	8.83	2.9	0	pc-ovc	5.6	sw, nw	20.4	30.28	1	95	88	2	18.6
20-Oct	8.00	4.1	1	clr-pc, PM haze	10.8	sw	19.4	30.25	1	87	79	2	13.8
21-Oct	7.83	3.2	0	clr	11.3	w	20.0	30.25	1	89	84	2	9.5
22-Oct	8.00	2.0	0	clr-mc	3.9	ne	11.5	30.43	2	90	87	2	1.6
23-Oct	8.00	3.8	0	clr, haze	1.9	ne	14.4	30.29	1	89	84	2	13.4
24-Oct	8.00	2.9	0	clr, haze	4.5	nw	17.1	30.27	1	92	84	2	4.0
25-Oct	8.00	4.7	0	clr, PM haze	4.5	w-nw	20.0	30.34	1	90	87	2	3.1
26-Oct	8.00	2.9	0	pc, PM haze	2.0	ne	20.4	30.46	1	89	89	2	1.5
27-Oct	8.00	2.0	0	clr, PM haze	1.9	calm, ene, w	19.9	30.58	1	89	83	2	1.4
28-Oct	8.00	2.8	0	clr, PM haze	2.3	ne-ese	21.1	30.51	1	88	80	2	1.3
29-Oct	7.92	3.0	0	clr, PM haze	6.0	sw-w	22.9	30.36	1	84	79	2	3.5
30-Oct	8.00	2.9	0	clr-ovc	2.8	sse-sw	20.0	30.39	1	88	83	2	4.9
31-Oct	8.00	2.1	0	mc-ovc, PM rain	5.1	se-sw	18.7	30.53	2	87	80	2	3.3
01-Nov	8.00	2.1	0	pc-ovc	8.9	sw-w	21.0	30.39	2	91	86	2	2.5
02-Nov	8.00	3.5	0	ovc, PM scat rain	25.4	sw-w	15.5	30.09	3	94	88	2	0.9
03-Nov	7.75	2.2	0	clr-mc	12.6	se-sw	15.9	30.03	2	90	90	2	2.7
04-Nov	6.75	2.0	0	mc-ovc	32.0	w	11.5	29.81	4	90	86	2	0.4
05-Nov	7.00	2.0	0	clr	5.4	sw, nw	7.4	30.05	1	95	91	2	0.3

[1] Average of hourly records.

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

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

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

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

Appendix D. Daily observation effort, visitor disturbance ratings, weather records, and raptor-migration flight summaries at Yaki Point, Grand Canyon, AZ: 2008.

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
1-Sep	6.50	2.0	0	mc-ovc	8.8	s	20.5	30.13	4	79	82	1	0.8
2-Sep	8.25	2.0	0	clr, haze	1.2	calm, se-s	24.3	30.29	1	87	90	2	0.4
3-Sep	8.00	1.7	0	clr, haze	1.4	var	26.0	30.27	2	80	78	2	2.1
4-Sep	8.00	2.1	1.5	clr	7.5	w	26.5	30.24	2	95	88	1	1.3
5-Sep	7.50	3.1	1	clr, AM haze	9.6	w	27.5	30.22	2	86	75	1	2.3
6-Sep	8.00	2.0	1	clr, haze	6.5	calm, nw	32.6	30.25	2	50	50	2	1.8
7-Sep	8.00	1.8	0	clr-pc, haze	5.7	se, nw	29.2	30.27	2	43	51	2	1.3
8-Sep	3.50	2.8	0	pc	0.8	calm, se	28.6	30.23	3	76	80	4	3.4
9-Sep	8.00	2.7	0	clr-ovc, PM scat ts/rain	7.1	s-w	23.3	30.16	3	89	84	3	1.6
10-Sep	8.00	3.0	0	ovc, PM scat ts	9.3	s-w	22.0	30.15	3	85	84	2	1.8
11-Sep	8.00	2.0	1.5	pc-ovc, PM scat rain	5.5	w	23.8	30.12	2	98	93	1	5.9
12-Sep	8.00	3.0	1.5	clr	4.9	w-nw	25.2	30.15	2	90	90	2	10.1
13-Sep	8.00	3.0	0	clr, PM haze	2.9	wnw	25.6	30.28	1	86	90	2	5.0
14-Sep	9.00	2.8	0	clr, haze	2.0	calm, e, nw	27.3	30.34	1	81	56	2	11.8
15-Sep	8.00	2.7	1.5	clr	4.0	ene-ese	27.2	30.40	1	91	80	3	18.1
16-Sep	8.00	3.9	0	clr-pc, rain	4.8	e-se	25.3	30.40	1	89	87	2	4.0
17-Sep	7.17	2.0	0	pc-ovc, PM ts/rain	0.7	calm/var	22.8	30.36	2	83	80	1	3.6
18-Sep	8.00	3.0	0	mc-ovc, PM rain	3.1	calm/var	24.1	30.32	2	82	89	2	4.0
19-Sep	8.00	3.4	0	mc-ovc, PM rain	5.3	sw-w	24.7	30.29	3	85	80	2	7.1
20-Sep	8.00	3.0	0	mc-ovc, blowing dust, PM haze	12.7	s-sw	23.2	30.25	3	85	80	2	1.1
21-Sep	8.00	3.1	0	clr	14.0	s-sw	23.5	30.20	3	95	84	2	3.0
22-Sep	9.25	2.8	0	clr, blowing dust	14.4	s-w	22.2	30.21	3	90	90	2	8.1
23-Sep	8.25	2.8	1	clr-pc, PM haze	2.1	calm, nnw	24.8	30.37	1	90	90	2	15.2
24-Sep	8.00	3.3	1.5	clr-pc	8.6	s-w	26.5	30.40	1	89	86	2	13.8
25-Sep	8.00	2.0	0	clr-ovc, PM rain	5.4	s-w	25.4	30.38	2	84	87	2	9.3
26-Sep	8.25	2.9	0	pc-mc, PM rain	3.6	se, w-nw	25.4	30.34	1	83	84	2	8.4
27-Sep	7.00	3.0	0	pc-ovc, AM rain	4.1	se, w	23.9	30.34	2	84	71	2	5.0
28-Sep	8.00	3.0	0	pc-mc	1.4	se	26.3	30.37	1	91	94	2	7.1
29-Sep	8.00	3.8	0	clr	3.8	se	26.4	30.40	2	92	92	2	5.6
30-Sep	8.00	3.9	0	clr, PM haze	2.8	se, n	23.8	30.47	1	84	83	2	12.4
1-Oct	8.00	2.8	0	clr-pc	2.3	se, nw	25.5	30.39	1	86	88	2	26.9
2-Oct	8.00	2.0	0	clr-ovc, haze	5.4	se-sw	24.5	30.23	2	77	77	2	3.1
3-Oct	8.00	2.9	0	mc-ovc	5.7	s	21.3	30.10	2	80	84	2	2.9
4-Oct	1.67	2.0	0	pc-ovc	22.7	s, nw-n	12.7	29.92	4	77	70	2	1.8
5-Oct	8.25	2.9	1.5	pc	4.0	nw-n	15.8	30.01	2	91	93	2	20.2
6-Oct	8.00	2.9	0	clr	1.3	se	18.0	30.31	1	90	95	2	9.6
7-Oct	8.00	2.5	0	clr	5.3	se	19.9	30.44	1	95	93	2	18.9
8-Oct	8.00	3.7	0	clr	1.1	calm, se, n	23.9	30.28	1	93	91	2	11.4
9-Oct	8.00	2.0	0	clr, PM blowing dust	21.0	sw	21.1	29.99	2	90	89	2	5.5
10-Oct	6.50	2.8	0	clr, PM blowing dust	33.1	s-sw	16.3	29.81	2	88	79	2	13.7
11-Oct	8.00	2.0	0	pc, PM rain	14.5	s-sw	8.6	29.70	2	90	84	2	8.8
12-Oct	8.00	3.3	0	clr	2.1	nnw	9.8	30.04	2	83	94	2	11.9
13-Oct	8.00	2.9	1.5	clr	3.4	n	10.6	30.33	2	88	84	2	6.9
14-Oct	8.00	2.0	0	clr	3.1	nw-n	12.6	30.30	1	91	90	2	5.3
15-Oct	8.00	4.3	0	clr, PM haze	6.5	e	16.3	30.36	2	89	76	2	4.9
16-Oct	8.00	4.0	1	pc, PM haze	3.3	ne, w	19.3	30.44	2	90	84	2	6.9
17-Oct	8.00	3.3	0	clr	5.4	ne-e	20.6	30.51	1	90	91	2	8.6
18-Oct	8.00	2.0	0	clr	4.6	calm/var	21.5	30.37	1	96	94	2	4.4

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
19-Oct	8.25	3.4	0	pc-mc	9.2	sw-w	20.3	30.31	2	89	90	2	5.1
20-Oct	8.00	2.7	0	clr	5.4	s-sw	19.9	30.29	1	88	88	2	2.9
21-Oct	8.00	2.0	0	clr, PM haze	10.3	se-sw	18.6	30.31	2	88	93	2	3.9
22-Oct	8.00	2.9	0	clr-pc	7.8	ne-e	10.5	30.44	2	88	87	2	4.0
23-Oct	8.00	2.4	0	clr	1.8	se, s	16.9	30.32	2	88	88	2	14.3
24-Oct	8.25	2.5	0	pc-mc	4.3	w-nw	18.1	30.31	1	90	88	2	12.5
25-Oct	8.00	3.0	0	clr	1.0	sw	19.8	30.38	1	89	88	2	4.0
26-Oct	8.00	2.9	0	clr-pc	7.0	e-se	20.4	30.50	2	88	88	2	3.0
27-Oct	8.00	2.8	0	clr, PM haze	3.4	ne, se	21.1	30.61	1	89	88	2	1.9
28-Oct	8.00	2.3	1	clr	5.5	se	20.6	30.55	1	90	86	2	3.3
29-Oct	7.75	3.2	0	clr, PM haze	2.0	nw	21.6	30.40	1	90	83	2	2.3
30-Oct	8.00	3.1	0	clr-pc	5.1	s-sw	20.4	30.43	1	89	83	2	3.6
31-Oct	7.50	3.0	0	mc-ovc	3.6	s, sw, n	20.3	30.56	2	88	86	2	4.4
1-Nov	8.00	2.3	0	pc	10.3	se-s	19.8	30.44	1	94	93	2	1.0
2-Nov	8.00	2.0	0	ovc, blowing dust	26.3	sw	15.4	30.14	4	90	84	2	0.6
3-Nov	8.00	1.9	0	clr-ovc	4.3	sse	15.6	30.09	1	95	91	2	1.5
4-Nov	8.00	1.9	0	mc-ovc	11.3	s-sw	10.9	29.90	3	88	84	2	0.5
5-Nov	7.25	1.7	0	clr	9.8	ne	7.6	30.10	3	100	98	2	2.6

[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: 2008.

	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	8.00	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	5	0.6
28-Aug	8.00	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	3	0.4
29-Aug	7.83	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	4	0.5
30-Aug	3.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
31-Aug	3.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
1-Sep	8.00	2	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	9	1.1
2-Sep	8.25	0	0	3	5	1	0	0	0	0	0	2	13	0	0	2	2	1	0	0	1	0	1	0	0	0	0	1	32	3.9
3-Sep	8.00	0	0	2	1	0	0	0	0	0	0	1	4	0	0	1	2	0	0	0	1	0	0	0	0	0	0	0	12	1.5
4-Sep	8.00	1	0	2	2	0	0	0	0	0	0	1	1	0	0	0	2	0	0	0	1	0	0	0	0	0	1	0	11	1.4
5-Sep	8.00	0	0	0	1	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	1	0	0	2	7	0.9
6-Sep	8.00	0	0	1	1	0	0	0	0	0	0	2	11	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	18	2.3
7-Sep	7.75	1	2	18	0	0	2	0	0	0	1	0	5	0	0	0	0	0	0	0	9	1	0	0	0	0	0	0	39	5.0
8-Sep	5.50	0	1	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	9	1.6
9-Sep	7.83	1	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	6	0.8
10-Sep	5.50	1	2	1	0	0	0	1	0	0	0	0	4	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	11	2.0
11-Sep	8.00	1	1	10	2	0	0	3	0	0	0	4	5	0	0	0	0	0	0	0	2	0	0	0	1	1	2	2	34	4.3
12-Sep	8.00	0	3	53	5	0	4	0	0	0	0	5	36	0	0	0	5	0	0	0	14	1	0	0	0	0	0	0	126	15.8
13-Sep	8.00	0	1	22	4	0	0	0	0	0	0	1	5	0	0	0	0	0	0	0	8	0	1	0	0	0	2	1	45	5.6
14-Sep	8.00	1	0	7	2	0	2	1	1	0	0	2	7	0	0	0	3	0	0	0	12	0	1	0	4	0	0	0	43	5.4
15-Sep	8.00	1	0	6	4	0	0	0	3	0	0	1	7	0	0	0	1	0	0	0	3	0	0	0	0	0	2	0	28	3.5
16-Sep	8.00	2	0	3	7	0	0	1	0	0	0	0	4	0	0	0	3	0	0	0	2	0	0	0	0	1	0	1	24	3.0
17-Sep	8.00	2	0	5	2	0	0	0	0	0	0	0	6	0	0	0	1	0	0	0	8	0	0	1	1	1	0	1	28	3.5
18-Sep	8.00	1	1	16	15	0	2	0	0	0	0	0	3	0	0	0	1	0	0	0	7	0	0	0	0	0	0	0	46	5.8
19-Sep	7.75	0	0	24	7	0	4	0	0	0	0	0	1	0	0	0	2	0	0	0	9	0	2	0	0	0	0	0	49	6.3
20-Sep	8.00	0	0	7	0	0	0	2	2	0	0	0	6	0	0	0	1	0	0	0	2	0	1	0	0	0	0	0	21	2.6
21-Sep	8.00	0	1	12	3	0	0	1	0	0	0	0	3	0	0	0	1	0	0	0	1	0	1	0	1	1	0	0	25	3.1
22-Sep	8.00	0	0	5	0	0	3	0	0	0	0	0	2	0	0	0	0	0	0	0	5	0	0	0	2	0	0	0	17	2.1
23-Sep	8.25	1	0	43	17	1	10	5	4	0	0	0	11	0	0	0	1	1	0	0	35	1	3	0	2	0	0	3	138	16.7
24-Sep	8.25	5	0	27	27	0	5	4	3	0	0	0	18	0	0	0	3	2	0	0	10	0	0	3	4	4	3	4	122	14.8
25-Sep	8.00	8	0	22	24	0	12	1	12	0	0	0	11	0	0	0	8	1	0	0	9	0	0	1	2	1	0	0	112	14.0
26-Sep	8.00	2	1	10	11	0	2	3	3	0	0	0	6	0	0	0	1	0	0	0	3	0	0	0	0	0	0	1	43	5.4
27-Sep	8.00	2	0	23	9	0	10	1	7	0	0	3	17	0	0	0	2	0	0	0	14	0	0	0	1	1	0	1	91	11.4
28-Sep	8.00	2	0	10	5	0	2	0	1	0	0	0	6	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	27	3.4
29-Sep	8.00	0	0	17	6	1	1	0	0	0	0	0	14	0	0	0	1	0	0	0	6	0	0	0	0	0	0	0	46	5.8
30-Sep	8.00	2	0	4	3	2	1	4	1	0	0	0	10	0	0	0	3	0	1	0	16	0	0	0	3	0	0	2	52	6.5
1-Oct	8.00	0	0	25	16	0	12	0	4	0	0	0	14	0	0	0	2	0	0	0	15	0	0	1	2	1	0	4	96	12.0
2-Oct	8.50	1	0	132	50	0	9	0	8	0	0	1	45	1	0	0	2	1	0	0	23	0	0	1	1	0	0	2	277	32.6
3-Oct	7.83	2	0	17	5	0	1	0	1	0	0	0	18	0	0	0	1	0	0	1	2	0	0	0	0	0	0	2	50	6.4

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	3.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
5-Oct	7.83	2	1	61	24	0	20	1	17	0	0	1	15	0	0	0	6	0	0	0	6	0	0	1	2	0	0	5	162	20.7
6-Oct	8.00	1	0	5	3	0	1	0	0	0	0	0	8	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	20	2.5
7-Oct	8.00	0	2	13	5	0	0	0	3	0	0	1	5	0	0	0	2	0	0	0	15	0	0	0	0	0	0	3	49	6.1
8-Oct	8.00	2	1	56	12	1	6	1	6	0	0	0	50	0	0	0	1	1	0	0	42	0	0	1	2	0	1	4	187	23.4
9-Oct	8.00	1	0	5	3	0	2	0	0	0	0	0	13	0	0	0	1	0	0	0	6	0	0	0	0	0	0	2	33	4.1
10-Oct	5.50	1	1	1	2	0	1	0	0	0	0	0	4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	11	2.0
11-Oct	8.00	0	0	1	2	0	1	0	0	0	0	1	5	0	0	0	2	0	0	0	3	0	0	0	0	0	1	1	17	2.1
12-Oct	7.75	0	0	34	11	0	2	0	0	0	0	1	15	0	0	0	1	0	0	0	5	0	0	0	0	0	0	0	69	8.9
13-Oct	8.00	0	0	6	3	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	12	1.5
14-Oct	8.00	0	0	8	2	0	2	0	1	0	0	0	19	0	0	0	1	0	0	0	8	0	0	0	0	0	0	1	42	5.3
15-Oct	8.00	0	1	5	1	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	13	1.6
16-Oct	8.00	0	0	43	13	0	6	0	0	0	0	0	73	0	0	0	0	2	0	0	15	2	0	0	0	0	0	0	154	19.3
17-Oct	8.00	1	0	28	5	0	0	0	0	0	0	0	20	1	0	0	0	1	0	0	6	0	0	0	0	0	0	0	62	7.8
18-Oct	8.75	0	4	60	8	0	5	0	0	0	0	0	34	0	0	0	2	4	0	0	9	1	1	1	0	0	0	0	129	14.7
19-Oct	8.83	2	7	51	8	0	9	0	4	0	0	0	70	0	0	0	2	1	0	0	7	2	0	1	0	0	0	0	164	18.6
20-Oct	8.00	0	2	43	1	1	12	1	2	0	0	0	44	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3	110	13.8
21-Oct	7.83	0	1	28	12	0	0	1	1	0	0	0	23	1	0	0	0	2	0	0	3	2	0	0	0	0	0	0	74	9.5
22-Oct	8.00	0	2	5	1	0	0	0	0	0	0	0	4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	13	1.6
23-Oct	8.00	1	4	38	9	0	3	1	1	0	0	0	47	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	107	13.4
24-Oct	8.00	1	0	11	0	0	2	0	0	0	0	0	16	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	32	4.0
25-Oct	8.00	0	1	9	1	0	5	0	0	0	0	0	7	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	25	3.1
26-Oct	8.00	0	1	4	1	0	1	0	0	0	0	0	3	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	12	1.5
27-Oct	8.00	0	2	1	2	1	0	0	0	0	0	0	4	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	11	1.4
28-Oct	8.00	0	0	4	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	10	1.3
29-Oct	7.92	0	1	10	0	1	0	0	0	0	0	0	11	1	0	0	0	1	0	0	0	2	0	0	1	0	0	0	28	3.5
30-Oct	8.00	0	2	8	0	0	0	1	1	0	0	0	23	1	0	0	1	0	0	0	0	1	0	0	0	0	0	1	39	4.9
31-Oct	8.00	0	0	9	0	1	0	0	0	0	0	0	11	0	0	0	1	0	1	0	3	0	0	0	0	0	0	0	26	3.3
1-Nov	8.00	0	0	4	2	0	0	0	0	0	0	0	12	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	20	2.5
2-Nov	8.00	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	7	0.9
3-Nov	7.75	0	0	7	0	0	1	0	1	0	0	0	10	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	21	2.7
4-Nov	6.75	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	3	0.4
5-Nov	7.00	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
Total	544.9	51	46	1089	366	10	165	33	88	0	1	30	862	7	0	5	73	22	7	2	371	15	12	11	30	11	13	50	3370	6.2

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

Appendix F. Daily raptor migration counts by species at Yaki Point, Grand Canyon, AZ: 2008.

	Observ.	Species[1]																											Birds
Date	Hours	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	Total	/ Hour
27-Aug	0.00																													
28-Aug	0.00																													
29-Aug	0.00																													
30-Aug	0.00																													
31-Aug	0.00																													
1-Sep	6.50	3	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	5	0.8
2-Sep	8.25	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	3	0.4
3-Sep	8.00	0	0	1	1	0	2	0	1	0	0	0	9	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	17	2.1
4-Sep	8.00	0	0	2	2	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	10	1.3
5-Sep	7.50	0	1	2	5	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	5	0	0	0	0	0	0	0	17	2.3
6-Sep	8.00	0	1	4	2	0	1	0	1	0	0	0	3	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	14	1.8
7-Sep	8.00	0	0	3	1	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	10	1.3
8-Sep	3.50	0	0	2	0	0	0	0	1	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	12	3.4
9-Sep	8.00	3	4	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	13	1.6
10-Sep	8.00	2	0	6	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	14	1.8
11-Sep	8.00	0	1	12	11	0	1	0	0	0	0	1	13	0	0	0	1	0	0	0	5	1	1	0	0	0	0	0	47	5.9
12-Sep	8.00	0	3	40	5	0	0	1	3	0	0	0	20	0	0	1	1	0	0	0	6	0	0	0	0	0	0	1	81	10.1
13-Sep	8.00	0	1	20	5	0	0	1	2	0	0	0	4	0	0	0	0	0	0	0	4	0	1	0	0	0	0	2	40	5.0
14-Sep	9.00	0	0	58	17	0	1	0	0	0	0	0	9	0	0	0	0	0	0	0	20	1	0	0	0	0	0	0	106	11.8
15-Sep	8.00	1	0	63	23	0	3	0	1	0	0	0	7	0	0	0	1	0	0	0	36	2	1	0	6	0	0	1	145	18.1
16-Sep	8.00	0	1	10	4	0	0	2	2	0	0	0	1	0	0	0	0	0	0	0	9	0	1	1	0	0	0	1	32	4.0
17-Sep	7.17	1	0	8	10	0	0	0	0	0	1	2	1	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	26	3.6
18-Sep	8.00	0	0	14	8	0	0	1	0	0	0	0	2	0	0	1	0	0	0	0	2	0	0	0	1	1	1	1	32	4.0
19-Sep	8.00	1	0	22	2	0	0	4	1	0	0	0	10	0	0	0	1	0	0	0	12	0	1	1	0	0	1	1	57	7.1
20-Sep	8.00	0	0	5	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	9	1.1
21-Sep	8.00	0	0	10	5	0	0	0	1	0	0	0	5	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	24	3.0
22-Sep	9.25	1	0	24	11	3	1	2	1	0	0	0	8	0	0	0	2	0	0	0	18	0	0	0	2	1	1	0	75	8.1
23-Sep	8.25	0	0	54	17	2	14	2	2	0	1	0	13	1	0	2	0	0	0	0	16	0	0	0	0	0	0	1	125	15.2
24-Sep	8.00	0	0	52	23	1	3	4	7	0	0	0	6	1	0	0	3	0	0	0	10	0	0	0	0	0	0	0	110	13.8
25-Sep	8.00	0	0	37	16	0	1	0	1	0	1	0	12	0	0	1	0	0	0	0	2	1	0	0	0	0	1	1	74	9.3
26-Sep	8.25	1	0	35	9	0	2	1	1	0	0	1	8	0	0	0	1	0	0	0	10	0	0	0	0	0	0	0	69	8.4
27-Sep	7.00	0	0	14	3	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	5	0	0	0	2	1	0	2	35	5.0
28-Sep	8.00	0	0	24	6	0	7	0	0	0	0	0	6	0	0	0	2	0	0	0	11	0	0	0	1	0	0	0	57	7.1
29-Sep	8.00	0	0	19	5	0	0	0	1	0	0	1	10	0	0	0	1	0	0	0	8	0	0	0	0	0	0	0	45	5.6
30-Sep	8.00	2	3	19	12	0	8	1	4	0	0	1	5	0	0	0	8	0	0	0	35	0	0	0	1	0	0	0	99	12.4
1-Oct	8.00	1	1	107	44	0	15	4	8	0	0	0	9	0	0	0	1	0	0	0	23	0	0	0	0	0	0	2	215	26.9
2-Oct	8.00	0	0	13	5	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	25	3.1
3-Oct	8.00	0	0	13	5	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	23	2.9

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	1.67	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1.8
5-Oct	8.25	0	0	92	36	1	8	2	2	0	0	0	16	0	0	0	0	0	0	0	9	0	0	1	0	0	0	0	167	20.2
6-Oct	8.00	1	0	33	18	0	2	0	3	0	0	0	7	0	0	0	1	0	0	0	12	0	0	0	0	0	0	0	77	9.6
7-Oct	8.00	0	0	71	9	0	2	0	3	0	0	1	18	0	0	0	0	1	1	0	45	0	0	0	0	0	0	0	151	18.9
8-Oct	8.00	0	0	30	28	0	5	0	1	0	0	0	18	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	91	11.4
9-Oct	8.00	1	1	12	4	0	6	0	0	0	0	0	8	0	0	0	0	0	0	0	9	1	0	1	0	0	1	0	44	5.5
10-Oct	6.50	10	1	3	2	0	0	0	2	0	0	2	35	0	0	0	0	0	0	0	29	1	0	0	0	0	0	4	89	13.7
11-Oct	8.00	1	2	15	4	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	6	1	0	0	0	0	0	1	70	8.8
12-Oct	8.00	0	0	56	11	0	0	0	0	0	0	0	20	0	0	0	1	0	0	0	2	1	1	1	0	0	0	2	95	11.9
13-Oct	8.00	0	1	29	6	0	5	0	0	0	0	0	10	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	55	6.9
14-Oct	8.00	0	1	20	3	0	2	0	0	0	0	0	11	0	0	0	0	0	0	0	2	2	0	0	0	0	0	1	42	5.3
15-Oct	8.00	0	1	15	6	0	3	0	0	0	0	0	13	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	39	4.9
16-Oct	8.00	0	1	32	3	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	55	6.9
17-Oct	8.00	0	0	37	5	1	2	0	0	0	0	0	18	0	0	0	1	0	2	0	3	0	0	0	0	0	0	0	69	8.6
18-Oct	8.00	0	0	13	3	1	1	1	0	0	0	0	10	0	0	0	0	1	0	0	0	1	1	3	0	0	0	0	35	4.4
19-Oct	8.25	0	0	27	2	0	1	0	0	0	0	0	11	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	42	5.1
20-Oct	8.00	0	1	12	0	1	0	0	0	0	0	0	8	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	23	2.9
21-Oct	8.00	0	1	18	1	1	1	0	0	0	0	0	5	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0	31	3.9
22-Oct	8.00	0	0	30	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	32	4.0
23-Oct	8.00	1	0	46	3	0	0	0	2	0	0	0	59	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	114	14.3
24-Oct	8.25	0	2	44	8	1	5	1	0	0	0	0	39	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	103	12.5
25-Oct	8.00	0	0	17	0	2	1	0	0	0	0	0	11	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	32	4.0
26-Oct	8.00	0	0	7	3	0	2	0	0	0	0	0	8	0	0	0	0	0	1	0	3	0	0	0	0	0	0	0	24	3.0
27-Oct	8.00	0	1	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	15	1.9
28-Oct	8.00	0	1	15	1	2	0	0	0	0	0	0	6	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	26	3.3
29-Oct	7.75	0	0	5	1	0	1	0	0	0	0	0	7	0	0	0	0	0	1	0	0	2	1	0	0	0	0	0	18	2.3
30-Oct	8.00	0	0	6	0	0	3	0	0	0	0	0	17	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	29	3.6
31-Oct	7.50	0	0	7	0	0	0	0	0	0	0	0	21	1	0	0	2	0	1	0	0	0	0	0	0	0	0	1	33	4.4
1-Nov	8.00	0	0	2	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	8	1.0
2-Nov	8.00	0	0	2	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	5	0.6
3-Nov	8.00	0	0	5	0	0	0	0	0	0	0	0	6	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	12	1.5
4-Nov	8.00	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	4	0.5
5-Nov	7.25	0	5	6	1	2	1	0	0	0	0	0	2	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	19	2.6
Total	514.09	30	35	1417	417	18	112	29	51	0	3	10	641	3	0	5	34	4	20	0	395	18	8	12	16	4	5	31	3318	6.5

[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: 1991–2008.

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	2008	MEAN
Start date	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	4-Nov
Days of observation	71	69	70	68	70	70	71	71	68
Hours of observation	575.08	557.72	535.58	554.98	554.38	530.53	564.42	544.90	522.50
Raptors / 100 hours	1,008	901	1036	597	528	683	822	618	1,101
SPECIES									
Osprey	83	58	75	61	52	33	64	51	73
Northern Harrier	39	51	56	41	44	49	59	46	76
Sharp-shinned Hawk	1,609	1,455	1,263	945	891	1,155	1,401	1,089	1,408
Cooper's Hawk	1,158	599	765	319	377	426	672	366	975
Northern Goshawk	7	5	0	0	5	4	9	10	9
Unknown small accipiter[1]	98	197	31	85	104	136	328	165	143
Unknown large accipiter[1]	1	2	4	0	2	9	105	33	20
Unknown accipiter	0	46	47	39	28	84	160	88	175
TOTAL ACCIPITERS	2,873	2,304	2,110	1,388	1407	1814	2,675	1,751	2,640
Red-shouldered Hawk	0	0	0	0	0	0	0	0	0
Broad-winged Hawk	25	20	6	0	6	15	3	1	9
Swainson's Hawk	26	33	108	89	80	22	18	30	39
Red-tailed Hawk	1,458	1,302	1,791	951	594	1,207	1,019	862	1,538
Ferruginous Hawk	3	2	6	1	1	2	9	7	6
Rough-legged Hawk	0	1	0	0	0	0	0	0	0
Zone-tailed Hawk	0	1	2	0	0	0	0	5	1
Unidentified buteo	8	33	20	8	36	93	127	73	34
TOTAL BUTEOS	1,520	1,392	1,933	1,049	717	1,339	1,176	978	1,627
Golden Eagle	3	32	17	9	4	5	13	22	24
Bald Eagle	9	20	12	14	14	15	17	7	18
Unidentified eagle	0	3	0	0	0	0	1	2	1
TOTAL EAGLES	12	55	29	23	18	20	31	31	43
American Kestrel	1,180	1,057	1,300	689	639	308	549	371	1,030
Merlin	8	4	9	21	4	2	12	15	11
Prairie Falcon	8	1	3	7	9	4	6	12	6
Peregrine Falcon	6	14	8	7	10	12	23	11	9
Unknown small falcon[1]	2	1	0	1	2	19	6	30	8
Unknown large falcon[1]	3	3	1	0	3	8	6	11	4
Unknown falcon	3	0	0	1	1	7	2	13	3
TOTAL FALCONS	1,210	1,080	1,321	726	668	360	604	463	1,065
Unknown raptor	60	83	23	25	20	7	31	50	60
GRAND TOTAL	5,797	5,023	5,547	3,313	2,926	3,622	4,640	3,370	5,682

[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: 1997–2008.

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

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

Appendix H. continued

YEAR	2006	2007	2008	MEAN
Start date	27-Aug	27-Aug	1-Sep	27-Aug
End date	4-Nov	5-Nov	5-Nov	5-Nov
Days of observation	70	71	66	69
Hours of observation	533.33	566.76	514.09	540.80
Raptors / 100 hours	771	750	645	880
SPECIES	RAPTOR COUNTS			
Osprey	37	29	30	40
Northern Harrier	45	38	35	41
Sharp-shinned Hawk	1,627	1,417	1,417	1,633
Cooper's Hawk	695	761	417	961
Northern Goshawk	14	12	18	8
Unknown small accipiter[1]	118	298	112	138
Unknown large accipiter[1]	4	79	29	15
Unknown accipiter	14	88	51	83
TOTAL ACCIPITERS	2,472	2,655	2,044	2,786
Red-shouldered Hawk	0	0	0	0
Broad-winged Hawk	12	18	3	11
Swainson's Hawk	30	9	10	35
Red-tailed Hawk	995	903	641	973
Ferruginous Hawk	6	3	3	6
Rough-legged Hawk	1	0	0	0
Zone-tailed Hawk	0	0	5	1
Unidentified buteo	48	36	34	26
TOTAL BUTEOS	1,092	969	696	1,053
Golden Eagle	1	5	4	8
Bald Eagle	18	30	20	20
Unidentified eagle	0	3	0	1
TOTAL EAGLES	19	38	24	30
American Kestrel	384	475	395	747
Merlin	9	12	18	12
Prairie Falcon	9	2	8	6
Peregrine Falcon	13	19	12	10
Unknown small falcon[1]	15	1	16	5
Unknown large falcon[1]	10	2	4	2
Unknown falcon	2	1	5	3
TOTAL FALCONS	442	512	458	782
Unidentified raptor	6	8	31	25
GRAND TOTAL	4,113	4,249	3,318	4,755

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