FALL 2016 RAPTOR MIGRATION REPORT

YAKI POINT HAWKWATCH - GRAND CANYON, ARIZONA

HawkWatch International, Inc.

Salt Lake City, Utah

NATIONAL PARK SERVICE

HAWKWATCH INTERNATIONAL

Conserving Raptors and Our Shared Environment

Grand Canyon Association

April 2017

FALL 2016 RAPTOR MIGRATION REPORT
YAKI POINT HAWKWATCH - GRAND CANYON, ARIZONA

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INTRODUCTION

The Yaki Point HawkWatch in northern Arizona is an ongoing, long-term effort to monitor population trends of migratory raptors that use the southern portion of the Intermountain Flyway (Hoffman et al. 2002, Hoffman and Smith 2003, Smith et al. 2008a). HawkWatch International (HWI) first initiated standardized counts at the Grand Canyon at Lipan Point in 1991, and in 1997 added simultaneous standardized monitoring at Yaki Point. HWI selected these sites based information from the exploratory work of Chuck LaRue in 1987 and Christie Van Cleve during the 1989 and 1990 autumn migration seasons. HWI conducted fall migration counts annually at both sites through the fall of 2008, but budgetary and logistical issues resulted in a pause of these efforts. HWI started counting again annually at Yaki Point in 2013. In 2016, with support from partners at the Park, and the Grand Canyon Association, HWI monitored fall migration at Yaki Point for the 17th season.

The Yaki Point HawkWatch was 1 of 8 long-term, annual migration counts operated or co-sponsored by HWI in North America during 2016. The primary objective of these efforts is to track long-term regional population trends of diurnal raptors in western North America and around the Texas Gulf Coast (Hoffman and Smith 2003; Smith et al. 2001, 2008 a, b). Yaki Point falls within the Southern Rockies/Colorado Plateau and Sierra Madre Occidental bird conservation regions, the Intermountain West Joint Venture, and the Mogollan Rim Partners in Flight region. Raptors can serve as important biological indicators of ecosystem health (Bildstein 2001) and long-term migration counts can be a cost effective and efficient method for monitoring regional status and trends of multiple raptor species (Zalles and Bildstein 2000).

In addition to long-term counting and banding efforts, HWI conducts and supports other studies to further our knowledge about the biology of migrating raptors. Some of these efforts include: telemetry work to identify species' ranges, migratory routes, and connectivity, as well as blood sampling to track changes in raptor health (e.g., Hoffman et al. 2002, Lott and Smith 2006, Goodrich and Smith 2008, DeLong and Hoffman 2004, McBride et al. 2004).

Beyond having scientific and conservation value, each site in HWI's migration network offers unique opportunities for the public to learn about raptors and the natural environment. Providing such opportunities is an important component of the Yaki Point HawkWatch and HWI's overall mission. With about five million people visiting the Grand Canyon National Park each year and easy accessibility, Yaki Point offers excellent opportunities for public outreach and educating visitors about the conservation needs and biology of raptors and the ecosystems of the Grand Canyon National Park in general.

STUDY SITE

The migration over the Grand Canyon is unique among sites in HWI's network because mountain ridges do not guide migrating raptors are not guided to the region; so birds must instead 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 because most raptors tend to avoid sparsely vegetated landscapes, although the region does produce excellent thermal lift. The edge habitat where the forested Kaibab Plateau juxtaposes the desert may provide for a more hospitable migratory pathway southbound as birds migrate towards the canyon. However, because there are no distinct ridges to serve as "leading lines" to provide a stable source of lift to concentrate migrating raptors (Bildstein 2006), migrants probably approach the canyon along a relatively broad front. Yaki Point provides a particularly good monitoring location because it lies immediately across from a "peninsula" of plateau land that juts out into the canyon from the north rim. This peninsula creates a narrow gap between the two canyon rims, and raptors concentrate here, a situation similar to locations where raptors seek narrow passages to cross large bodies of water (Kerlinger 1989, Bildstein 2006).

Yaki Point is a popular canyon lookout located in Coconino County, Arizona along the south rim of the Grand Canyon. Access is from Hwy 64, about 11.2 km northeast of the south entrance of the park. The

observation site elevation is 2,213 m (36° 03′ 31.0″ N, 112° 05′ 01.7″ W; Figure 1), and provides superb views of the canyon to the west and north, but thick vegetation obscures the view towards the east. The predominant vegetation consists of big sagebrush (*Artemisia tridentata*), cliffrose (*Cowania mexicana*), Utah juniper (*Juniperus osteosperma*), and two-needle pinyon (*Pinus edulis*).

METHODS

Two observers conducted standardized daily counts of migrating raptors from a single observation site at Yaki Point in 2014; occasionally other trained staff and volunteers supplemented these efforts.

Weather permitting; observations usually begin at 0800 H and end between 1600 and 1700 H Pacific Standard Time (PST). Data collection follows standardized protocols used at all HWI migration sites (Hoffman and Smith 2003). Observers routinely record 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 PST.
3. Wind speed and direction, air temperature, percent cloud cover, predominant cloud type(s), presence of precipitation, visibility, and an assessment of thermal-lift conditions, recorded for each hour of observation on the half hour.
4. Predominant direction, altitude, and distance from the lookout of the flight during each hour.
5. Total minutes observed and the mean number of observers present during each hour (included designated observers plus volunteers/visitors who actively contributed to the count [active scanning, pointing out birds, recording data, etc.] for more than 10 minutes in a given hour), recorded on the hour.
6. A subjective visitor-disturbance rating for each hour, recorded on the hour.
7. Daily start and end times for each official observer.

In comparing 2016 counts and passage rates against means and 95% confidence intervals for previous seasons, we consider a count value falling outside the 95% confidence interval of the historical site means as significantly different. We used linear and quadratic regression on effort-adjusted annual passage rates (raptors/100hrs) to identify long-term trends in migrating raptors.

2016 RESULTS AND DISCUSSION

Observation effort and weather summary

Yaki Point HawkWatch's standard season runs 27 August – 5 November; in 2016 observers were able to count on 71 of 71 possible days during this period for a total of 590.5 hours—historic averages are 69 days and 543.23 observation hours (Appendix C). Weather varies throughout every season, in 2016 based on hourly recording of conditions during observation it was clear 47% of the time, partly cloudy 21% of the time, mostly cloudy 8% of the time, and overcast 24% of the time; with precipitation 5% of the time.

FLIGHT SUMMARY

2016 Overall Flight

Observers counted a total of 5,788 migrant raptors of 15 species in 2016, making this the third largest flight of migrating raptors documented at the Yaki Point HawkWatch (Table 1). Highlights this season included record high counts for Prairie Falcons (11) and Northern Harriers (68).

The 2016 flight consisted of 57.2 % accipiters, 29 % buteos, 10 % falcons, 1.2 % Ospreys, 1.2 % harriers, 0.2% eagles, and 1.2 % unidentified raptors. The proportions of accipiters, buteos and Ospreys were above average; harriers were consistent with historic levels, and eagles and falcons were below average (Fig. 2). Sharp-shinned Hawks were the most commonly observed species (28.9 % of the total), followed by Red-tailed Hawks (26.1%), Cooper's Hawks (21.5%), then American Kestrels (8.6%). The remainder of species comprised 2%, or less of the 2016 flight (Table 1).

The following sections summarize the 2016 flight relative to historic means, and any stastistically significant ($\alpha = 0.05$) population trends based on first and second order linear regression analysis of effort adjusted passage rates. HWI only depicts significant trends for species with average historic count rates $\geq$ 10 individuals per 100 hours. The rationale is that trends for counts below this thrshold likely do not contain biologically useful information on regional populations—species with counts this low likely have a very dispersed migration, migrate along a different primary route, or large portions of the population that are resident. We do include count information in the reports, as occurrences of rare species are of interest to managers and the public and could represent the beginning of meaningful long-term changes.

Total Flight (Fig.4):

The record 980 raptors counted per 100 hours of observation at Yaki Point in 2016 is statistically similar to the historic site average; regression results indicate no long-term trend over time in the overall flight (overall flight is stable).

Osprey and Northern Harriers (Fig. 5a):

In 2016 the Yaki Point HawkWatch crew counted above average numbers of both Osprey (71 counted; 12 birds/100 hr) and Northern Harriers (68 counted, 11.5 birds/100hr-both site records) for the second straight year at Yaki Point (Table 1). Average passage rate for both species fall below the 10 birds/100hr threshold for reporting regression results.

Accipiters (Fig. 5b):

The 2016 overall Accipiter flight did not differ from site average, (Table1). This was as driven by the crew counting an average number of Sharp-shinned Hawks (1,675 total, 283.7 birds/100hrs). We did see above average totals of Cooper's Hawks (1,247 total, 211 birds/100hr), and Northern Goshawks (10 total, 1.7 birds/100hr). Regression analyses of the long-term passage rates indicate that Sharp-shinned Hawk counts are stable (no significant trend), and that Cooper's Hawk numbers have been increasing since 2007/2008 ($F_{2,14}=4.57$, $r^2 = 0.24$, $p=0.051$).

Buteoine Hawks (Fig. 5c):

While not record setting like 2015, the crew once again counted above average numbers of Broad-winged Hawks (37 total ; 6.3 birds/100hr) and Red-tailed Hawks (1,511; 260 birds/100hr), and the second highest counts and passage rates for these species at the site. We counted average numbers of Swainson's Hawks (59) and the 10 Ferruginous Hawks counted exceeded the site average (Table 1). Analyses of long-term trends indicate that counts of migrating Red-Tailed Hawks have increased each year since 2008

($F_{2,14}$=4.75, r^2 = 0.4, p=0.047). Average passage rate for other buteo species fall below the 10 birds/100hr threshold for reporting regression results.

Eagles (Fig.5d):

The crew counted 4 Golden Eagles and 8 Bald Eagles at Yaki Point in 2016, a below average and average year , respectively. Despite mean passage rates below the 10 per 100 hr threshold, it is worth noting that Golden Eagle passage rates at Yaki Point are declining (slope= -0.13, r^2 =0.35, F=7.9, p=0.013) because similar trends exist for this species across the HWI network and at other count sites. Research efforts are underway, including some by HWI, to further understand Golden Eagle, ecology, movements and demographics across N. America (Farmer et al. 2008, Katzner et al. 2012).

Falcons (Fig.5e):

We counted above average numbers of Peregrine Falcon, Prairie Falcon, and Merlin in 2016 (Table 1). The 22 Merlins and 11 Prairie Falcons represent all-time high counts for the Yaki Point HawkWatch. Below site average American Kestrel count and passage rate continues a declining trend for this species (slope= -5.6, r^2 = 0.5, F=14.9, p= 0.002). We see similar declines at other HWI network sites and at migration sites operated by others across North America. In response to these declines, HWI, along with many other North American researchers and Citizen Scientists are working to understand Kestrel declines both locally and at the continental scale and currently collaborate under the umbrella of the American Kestrel Partnership (http://kestrel.peregrinefund.org/).

VISITOR PARTICIPATION AND PUBLIC OUTREACH

A total of 2,892 people spent time with HWI crews at Yaki Points to watch hawks together and learn about their migration, natural history, ecology, the Grand Canyon National Park, and some of the threats that raptors face.

2016 FALL MIGRATION ACROSS HWI'S NETWORK

HawkWatch International and partners operated 8 fall count sites in 2016 (Fig. 1). During the 4,451 hours of standardized observation, we counted 713,979 migrating birds of prey. The power and utility of HWI's network of fall count sites, and long-term monitoring in general, lies in that it allows identification of patterns in regional raptor populations, both over time at a single site and also network-wide. Declines in counts or passage rates for a species or group of species at the regional level can highlight the need for more focused research or management attention at local scales, while increases may indicate the success of management and conservation efforts. While each site in HWI's network varied in terms of individual species or group counts, notable network-wide patterns in 2016 included (Table 2):

- Below average Kestrel numbers at 5 of 8 sites (no sites w/ above average counts).
- Below average counts for Prairie Falcons and Osprey at 5 of 8 sites.
- Above average Merlin counts at 5 of 8 sites, only exception was Manzanos with a count below average (this site had second lowest overall (all raptors) count in 32-yr history)
- Above average counts at Bridger, Commissary, and Grand Canyon for second year in a row overall and for most species.

- Below average counts for Red-tailed Hawks at 4 of 8 sites, including a record low at Corpus Christi; above average counts at 3 sites.

- Record highs for:
    - Golden Eagles at Commissary (only network site w above average Golden Eagle count)
    - All falcons except Kestrels and Northern Harriers at the Grand Canyon
    - Bald Eagles at Chelan Ridge
    - Mississippi Kites at Corpus Christi (shattered previous record of 27,285)

ACKNOWLEDGMENTS

The Grand Canyon Association, and HWI private donors and members generously provided funding for this year's migration count and outreach efforts at Yaki Point. Many thanks go to the Grand Canyon National Park rangers, interpreters, biologists, and law enforcement personnel for their encouragement, friendship, and logistical support of this long-term monitoring effort each year. The Park also generously provided lodging for the field crew this season, making life a little easier after a full day of hawkwatching and interpreting.

Finally, enormous thanks and appreciation to the members of our 2016 field crew: Kumara MacLeod, Ben West, and Casey Weissburg. Without your teamwork, skill, dedication, and willingness to brave the elements and crowds over the course of a long field season, these efforts would not be possible.

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Table 1. Counts and historic records of fall migrating raptors at the Yaki Point HawkWatch, Grand Canyon, AZ.

Species	1997-2015 Mean Count ± 95 % CI	2016	% Change	All-time Historic Records Season	Year	Daily	Year
				0			
Osprey	44.4 ± 6.6	71	60	75	2015	12	2015
Northern Harrier	41.3 ± 4.0	68	65	68	2016	6	5x
Accipiters							
Sharp-shinned Hawk	1699.2 ± 174.2	1675	-1	2323	2003	232	1999
Cooper's Hawk	987.9 ± 167.4	1247	26	1673	2003	237	2003
Northern Goshawk	6.7 ± 2.4	10	50	18	2008	10	2006
Unidentified accipiter	259.9 ± 98.5	377	45	728	2015		
TOTAL ACCIPITERS	2953.6 ± 357.4	3309	12	4478	2015		
Buteos							
Red-shouldered Hawk	0.1 ± 0.1	0		1		1	
Broad-winged Hawk	14.9 ± 5.4	37	148	47	2015	21	2015
Swainson's Hawk	45.2 ± 21.0	59	31	147	2003	77	2003
Red-tailed Hawk	1044.8 ± 123.7	1511	45	1723	2015	145	2010
Ferruginous Hawk	6.6 ± 1.6	10	52	12	2014	4	2000
Rough-legged Hawk	0.4 ± 0.3	0	-100	2	2002	1	6x
Unidentified buteo	35.5 ± 13.2	60	69	116	2010		
TOTAL BUTEOS	1147.4 ± 149.5	1677	46	1984	2015		
Eagles							
Golden Eagle	6.8 ± 3.5	4	-41	24	1997	3	5x
Bald Eagle	18.1 ± 4.9	8	-56	49	2002	15	2002
Unknown eagles	1.4 ± 0.4	1	-29	3	2007		
TOTAL EAGLES	25.3 ± 7.8	13	-49	73	2000		
Falcons							
American Kestrel	684.0 ± 127.9	496	-27	1035	2000	396	2000
Merlin	11.6 ± 2.5	22	90	22	2001	4	2x
Prairie Falcon	5.6 ± 1.2	11	96	11	2016	2	4x
Peregrine Falcon	10.9 ± 2.5	19	74	19	1998	3	6x
Unidentified falcon	9.2 ± 4.9	33	259	33	2010		
TOTAL FALCONS	721.3 ± 123.3	581	-19	1048	2010		
Unidentified Raptor	24.4 ± 8.6	69	183	71	2002		
GRAND TOTAL	4980.3 ± 535.7	5788	16	7290	2015	715	2000

Table 2. Summary of the 2016 fall flight of migrating raptors across HWI's monitoring network. Values are counts ; green indicates a count significantly higher (outside the 95% confidence interval) than the historic site average, red indicates a count significantly lower than average, and black indicates a count that does not differ from the site average. Asterisks denote a record high or low count. *In 2016 HWI monitored fall migration for 4,451.7 hrs and counted 713,979 birds.*

	Bonney Butte, OR	Chelan Ridge, WA	Bridger Mtn, MT	Commissary Ridge, WY	Goshute Mts, NV	Yaki Pt, AZ	Manzano Mts, NM	Corpus Christi, TX
	Hours Counted in 2016							
Species	**366**	**421**	**381.8**	***573.8***	**698.5**	**600.8**	**553.5**	**856.3**
Black Vulture								140
Turkey Vulture	596	63	14	59	370		214	45293
Osprey	66	*16*	13	22	54	70	22	187
Northern Harrier	12	82	44	52	211	*68*	30	158
Crested Caracara								5
Common Black Hawk								0
Harris' Hawk								5
Accipiters								
Sharp-shinned Hawk	1146	490	616	1487	3204	1667	892	2159
Cooper's Hawk	362	196	198	536	1960	1255	466	824
Northern Goshawk	24	13	62	45	27	10	9	0
Unidentified accipiter	43	74	60	66	656	377	94	64
TOTAL ACCIPITERS	1575	773	936	2134	5847	3309	1461	3047
Buteos								
Red-shouldered Hawk	0	0		0	*3*	0	0	15
Broad-winged Hawk	4	8	31	25	91	37	8	594222
Short-tailed Hawk								0
Swainson's Hawk	0	6	4	96	180	59	149	2255
White-tailed Hawk								22
Zone-tailed Hawk							3	7
Red-tailed Hawk	344	151	212	1183	3128	1510	421	*44*
Ferruginous Hawk	0	0	3	8	9	10	5	2
Rough-legged Hawk	3	28	77	11	20	0	0	0
Unidentified buteo	25	35	16	37	102	60	22	24
TOTAL BUTEOS	376	228	343	1360	3533	1676	608	596591
Eagles								
Golden Eagle	66	87	1434	*476*	139	4	95	0
Bald Eagle	83	*18*	78	230	10	8	2	9
Unknown eagles	*11*	0	1	11	5	1	0	0
TOTAL EAGLES	160	105	1513	*717*	154	13	97	9
Falcons								
American Kestrel	9	26	88	167	893	496	237	810
Merlin	108	34	33	31	42	*22*	17	83
Prairie Falcon	2	6	14	5	11	*11*	13	7
Peregrine Falcon	17	9	30	13	26	*19*	35	224
Aplomado Falcon								0
Unidentified falcon	4	2	4	2	*43*	*33*	9	10
TOTAL FALCONS	140	77	169	218	1015	581	311	1134
Kites								
Hook-billed Kite								0
Swallow-tailed Kite								152
White-tailed Kite								13
Mississippi Kite								*35219*
Unidentified Kites								0
TOTAL KITES								*35384*
Unidentified Raptor	2	30	34	18	185	*71*	6	172
GRAND TOTAL	2927	1374	3066	4580	11369	5788	2749	682126

Figure 1. Locations of fall HawkWatch sites operated by HWI and partners.

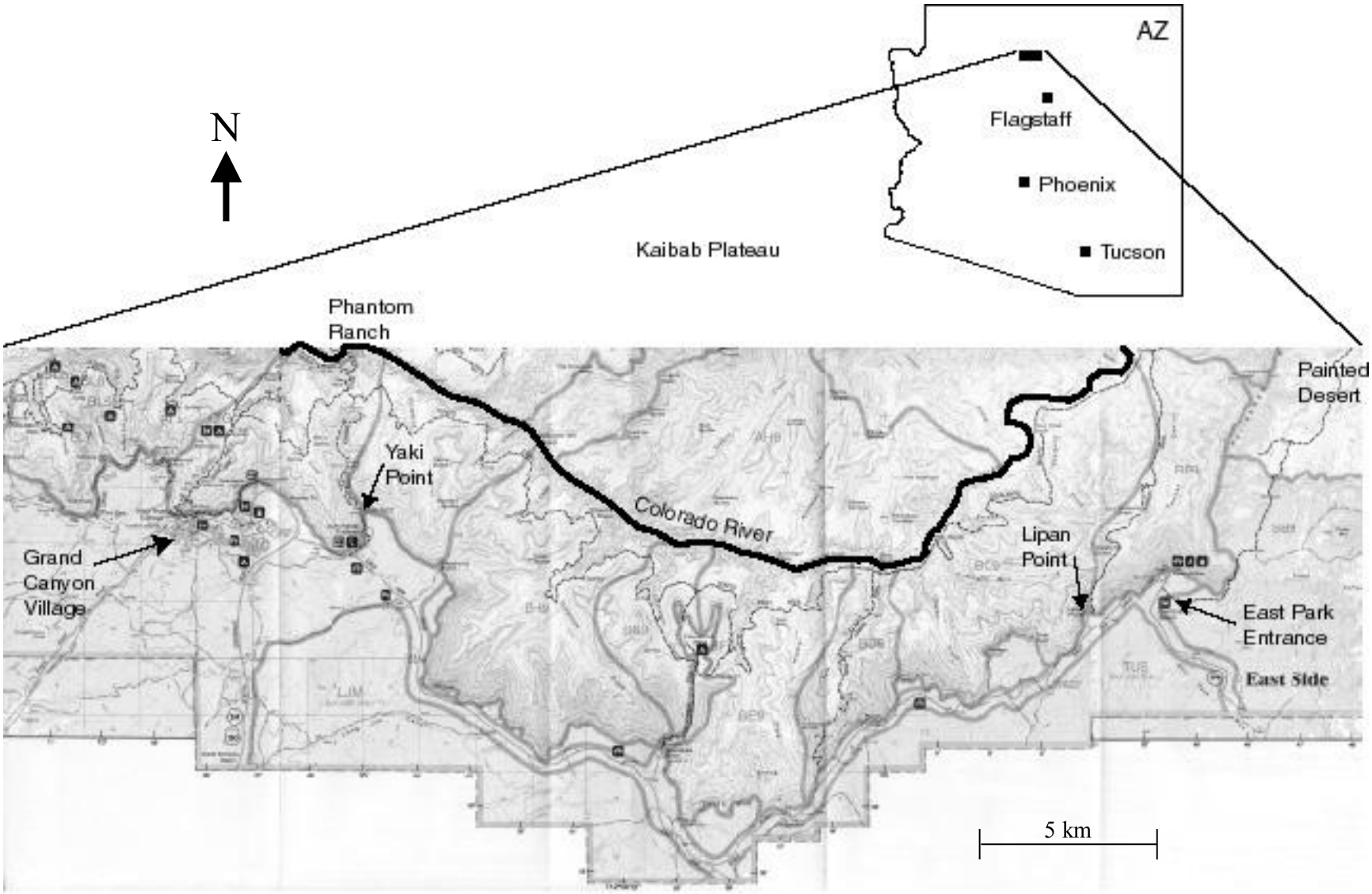

Figure 2. Map showing the Yaki Point and Lipan Point HawkWatches at the Grand Canyon, Arizona.

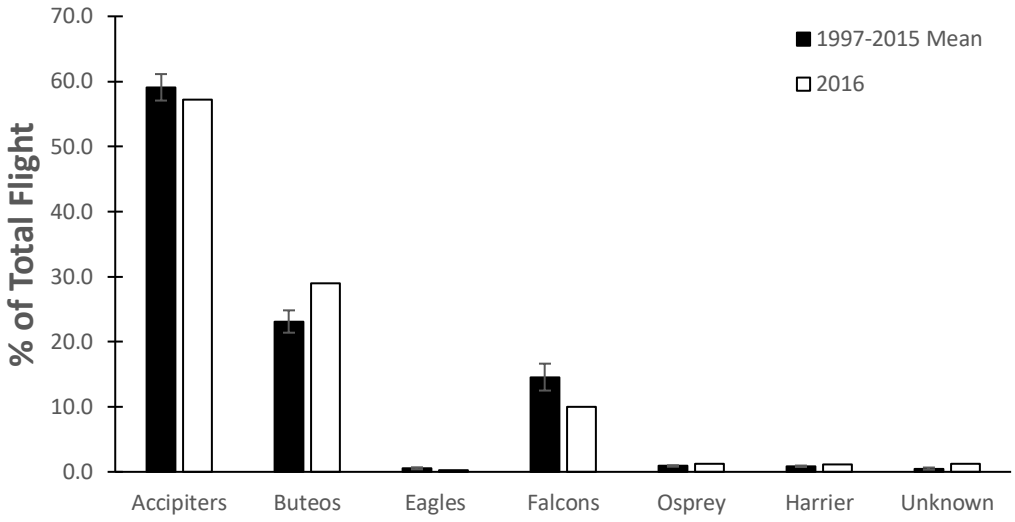

Figure 3. Fall raptor-migration flight composition by major species groups at Yaki Point in the Grand Canyon, AZ: 1997–2014 versus 2015.

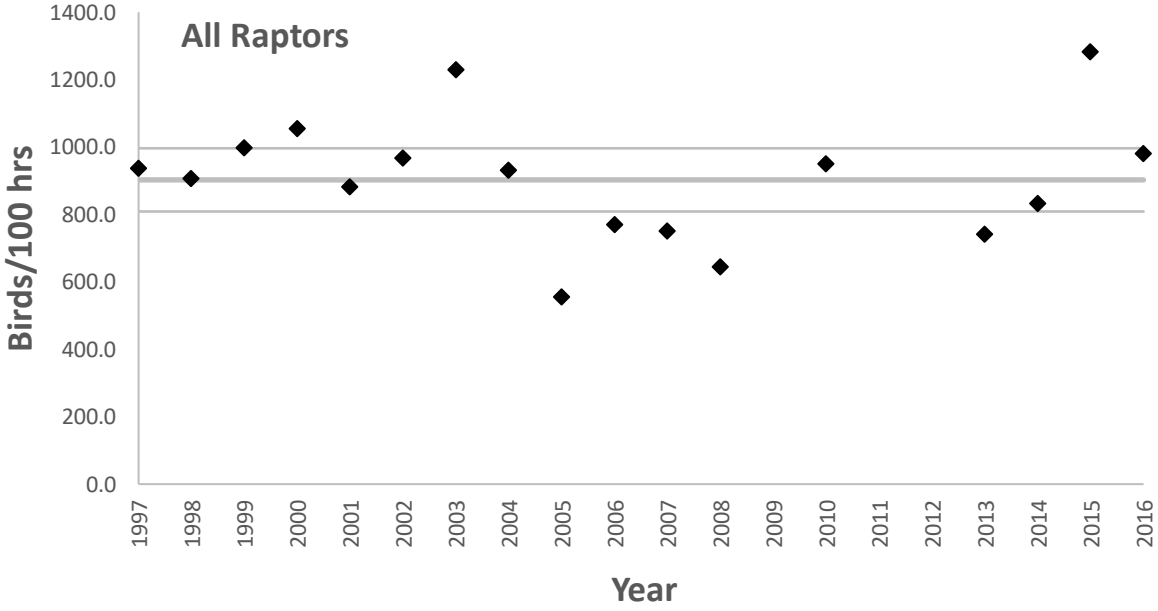

Figure 4. Effort-adjusted fall migration passage rates at Yaki Point forall migrating raptors: 1998-2016. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historical counts (1997-2015) at Yaki Point. (Count did not occur in 2009, 2011, or 2012)

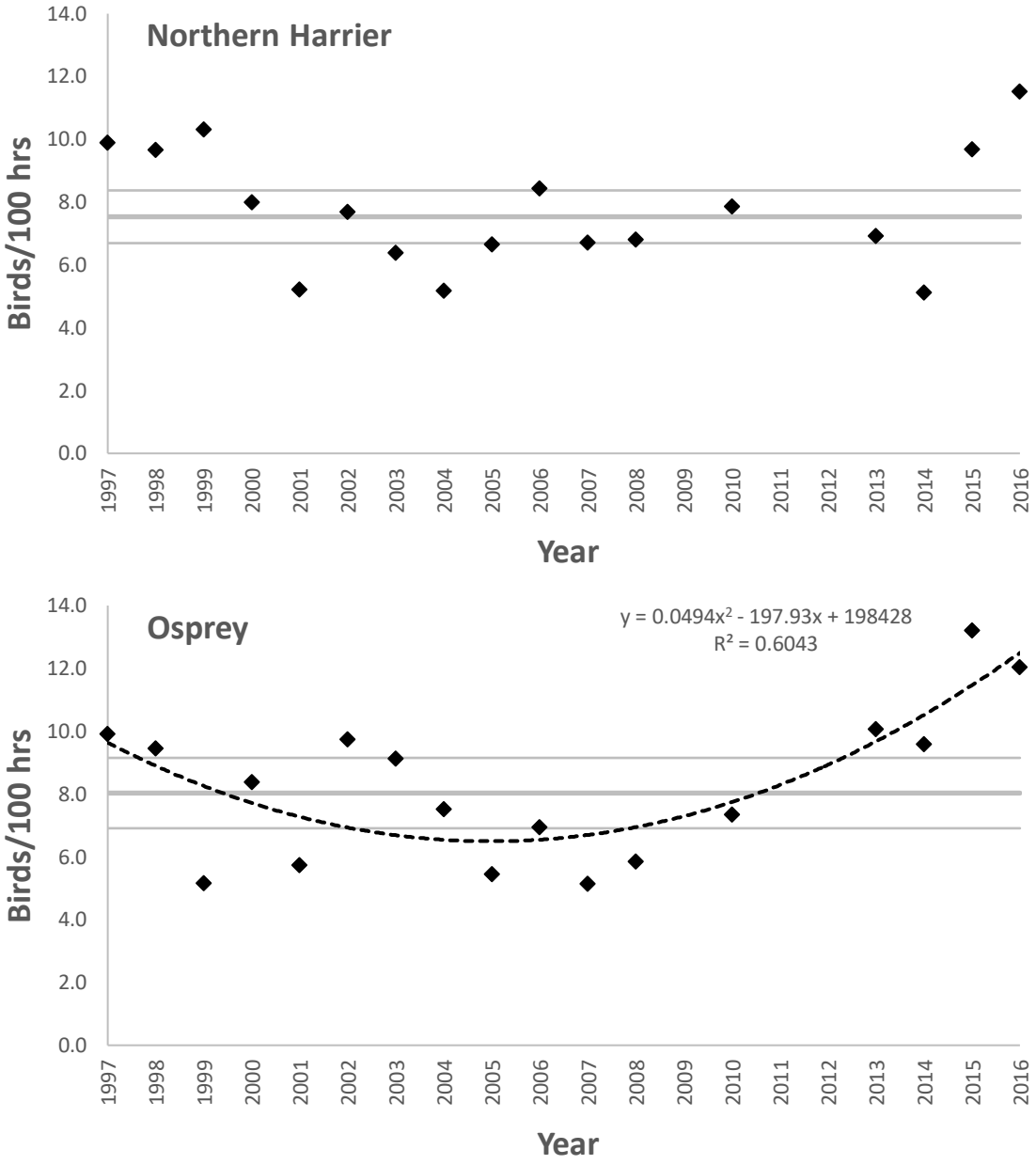

Figure 5a. Fall-migration passage rates for Osprey and Northern Harriers at Yaki Pt. in the Grand Canyon, AZ: 1997–2016. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historical counts (1997-2015) at Yaki Pt. (Count did not occur in 2009, 2011, or 2012)

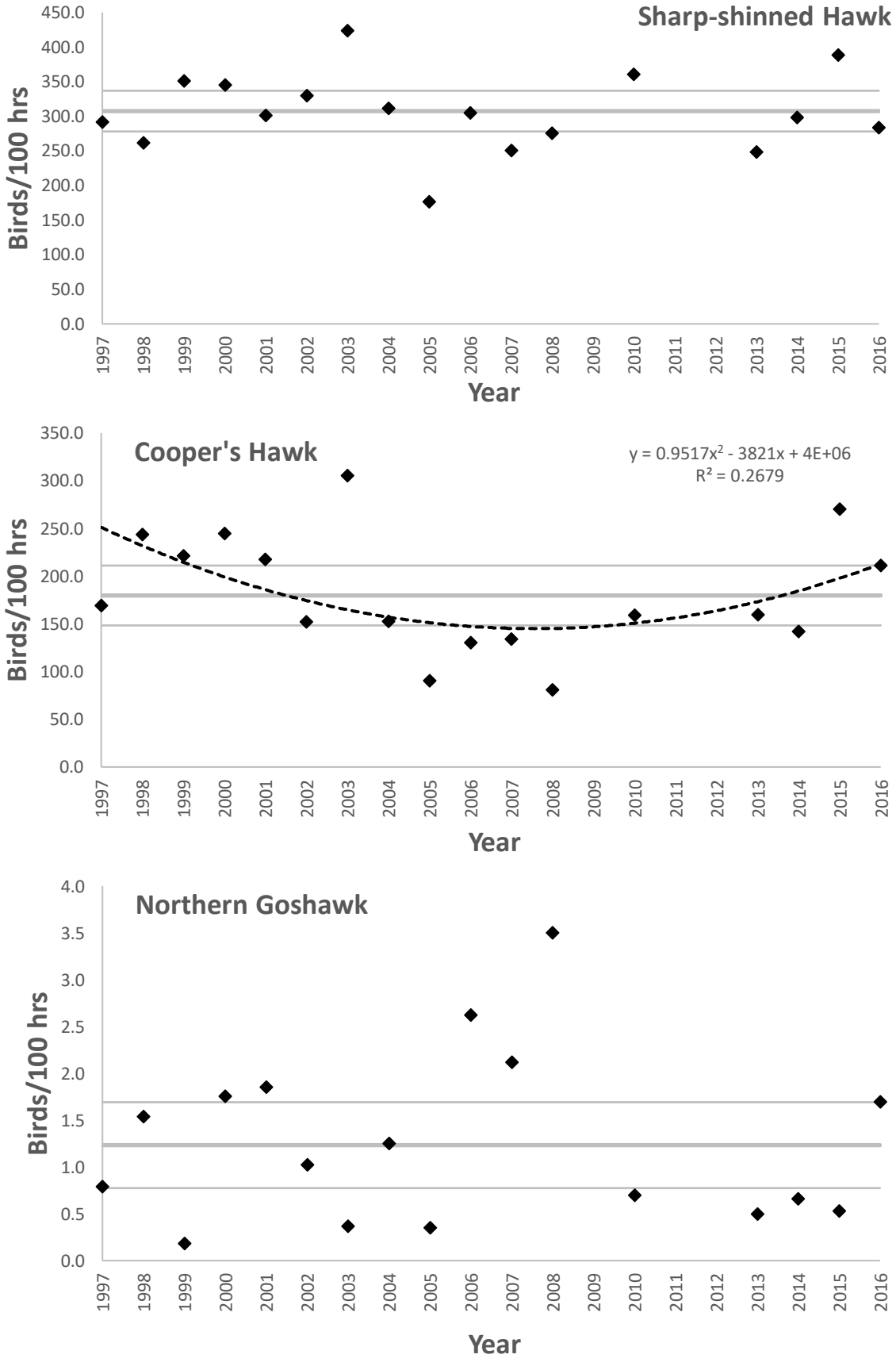

Figure 5b. Fall-migration passage rates for the three North American accipiter species at Yaki Pt. in the Grand Canyon, AZ: 1997–2016. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historical counts (1997-2015). (Count did not occur in 2009, 2011, or 2012)

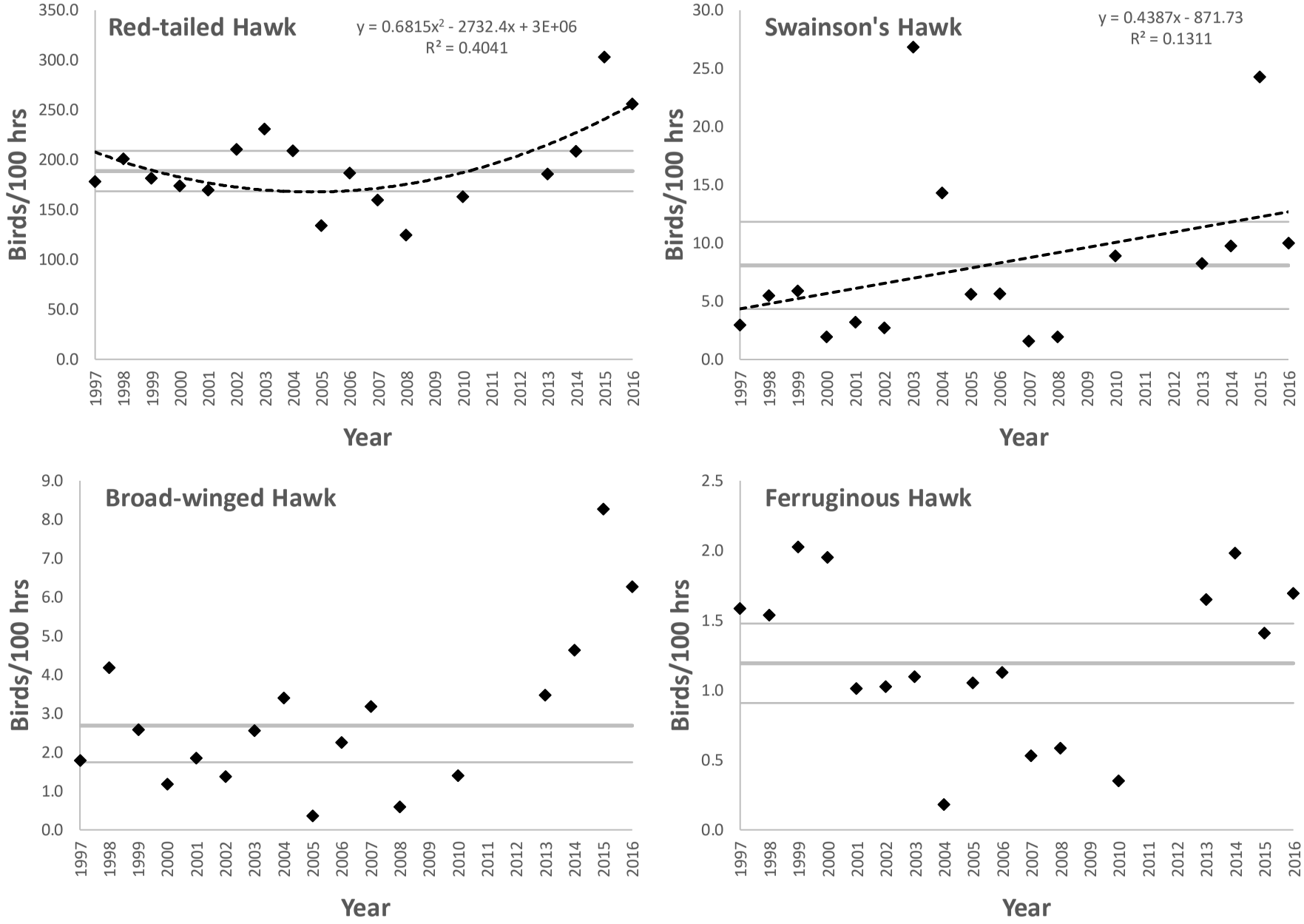

Figure 5c. Fall-migration buteo passage rates at Yaki Pt. in the Grand Canyon, AZ: 1997–2016. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historical counts (1997-2015). (Count did not occur in 2009, 2011, or 2012)

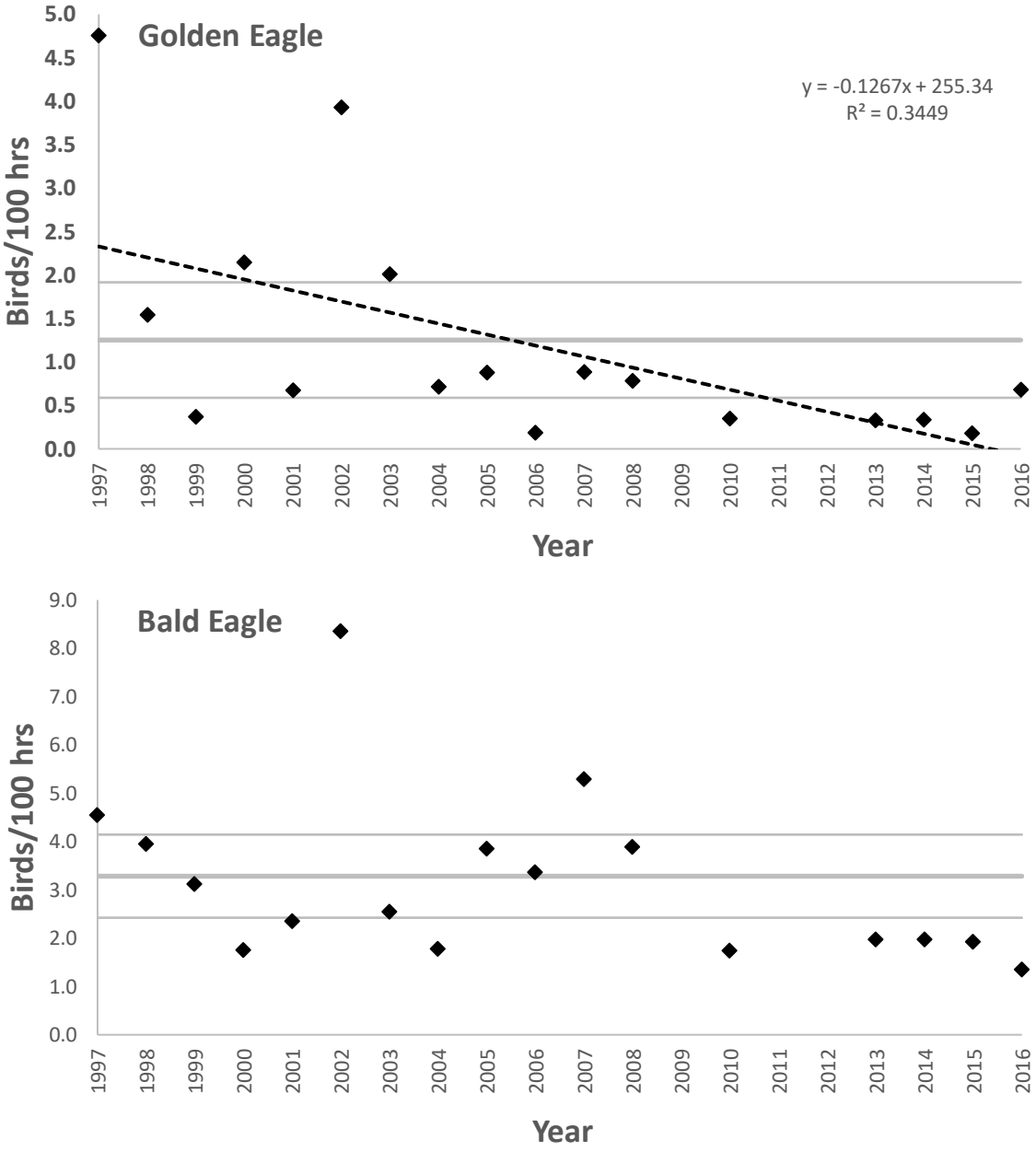

Figure 5d. Eagle fall-migration passage rates at Yaki Pt. in the Grand Canyon, AZ: 1997–2016. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historical counts (1997-2015). (Count did not occur in 2009, 2011, or 2012)

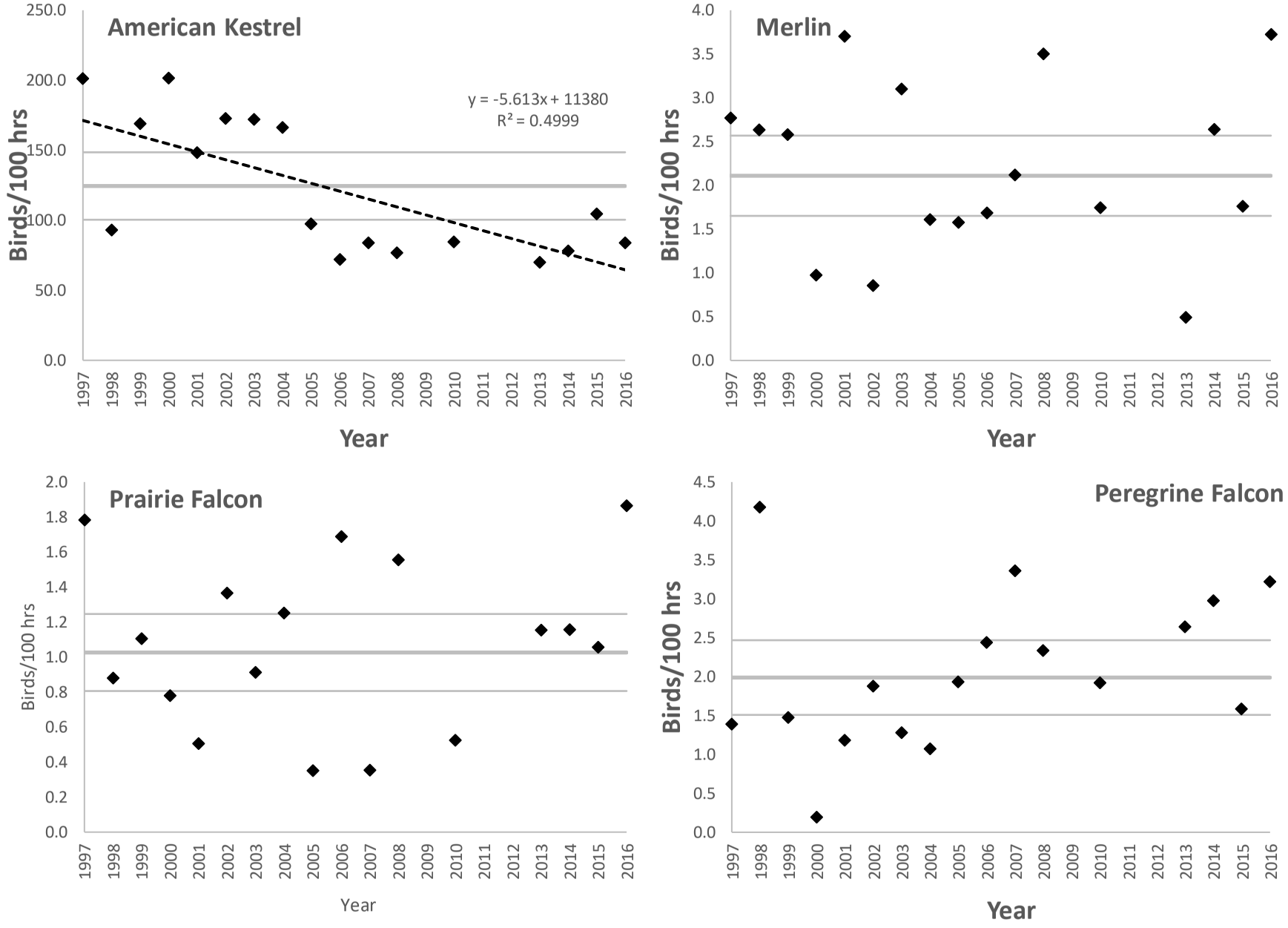

Figure 5e. Falcon fall-migration passage rates at Yaki Pt. in the Grand Canyon, AZ: 1997–2016. Dashed lines indicate significant ($p < 0.05$) population trends based on linear regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1997-2015). (Count did not occur in 2009, 2011, or 2012)

Appendix A. History of official observer participation in the Grand Canyon raptor migration studies: 1991–2014.

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+).

2009 No counts

2010 Two observers throughout at Yaki Pt. only: Kimberly Cullen (2), Christine Duffy (0), Felipe Guerrero (0)

2011 - 2012 No counts

2013 Two observers thoughout at Yaki Pt. only: Amy Zimmerman (0), David Millican (+), Timothy Alvey (0), Sanders Li Ho (+)

2014 Two observers thoughout at Yaki Pt. only: Amy Zimmerman (1), Frank Mayer (5), Steve Seibel (8+), Jeremy Halka (1), Anna Butler (0), Melissa Murillo (0)

2015 Two observers throughout: Steve Seibel (9+), Kumara MacLeod (0), and Emilee Sparks (0)

2016 Two observers throughout: Kumara MacLeod (1), Casey Weissburg (0), and Ben West (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 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 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. Annual observation effort and fall raptor migration counts by species at Yaki Point, Grand Canyon, AZ: 1997–2015.

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2010
Start date	27-Aug	28-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	1-Sep	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	5-Nov
Days of observation	71	66	71	66	71	71	70	68	70	70	71	66	71
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	514.09	572.42
Raptors / 100 hours	938	908	998	1054	881	968	1229	932	556	771	750	645	951
SPECIES	RAPTOR COUNTS												
Osprey	50	43	28	43	34	57	50	42	31	37	29	30	42
Northern Harrier	50	44	56	41	31	45	35	29	38	45	38	35	45
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	1,417	2,065
Cooper's Hawk	856	1,109	1,204	1,256	1,293	891	1,673	855	516	695	761	417	911
Northern Goshawk	4	7	1	9	11	6	2	7	2	14	12	18	4
Unknown accipiter	94	140	109	236	72	239	156	248	127	136	465	192	688
TOTAL ACCIPITERS	2,428	2,446	3,220	3,273	3,168	3,068	4,154	2,853	1,653	2,472	2,655	2,044	3,668
Red-shouldered Hawk	1	0	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	3	8
Swainson's Hawk	15	25	32	10	19	16	147	80	32	30	9	10	51
Red-tailed Hawk	899	916	985	892	1,008	1,234	1,264	1,169	765	995	903	641	934
Ferruginous Hawk	8	7	11	10	6	6	6	1	6	6	3	3	2
Rough-legged Hawk	0	0	0	1	1	2	0	0	0	1	0	0	0
Zone-tailed Hawk	0	0	1	0	1	1	0	0	0	0	0	5	0
Unidentified buteo	20	20	13	8	8	43	42	17	24	48	36	34	116
TOTAL BUTEOS	952	987	1,056	927	1,054	1,310	1,473	1,286	829	1,092	969	696	1,111
Golden Eagle	24	7	2	11	4	23	11	4	5	1	5	4	2
Bald Eagle	23	18	17	9	14	49	14	10	22	18	30	20	10
Unidentified eagle	1	0	1	0	0	1	0	0	0	0	3	0	1
TOTAL EAGLES	48	25	20	20	18	73	25	14	27	19	38	24	13
American Kestrel	1,016	423	918	1,035	881	1,011	943	930	555	384	475	395	485
Merlin	14	12	14	5	22	5	17	9	9	9	12	18	10
Prairie Falcon	9	4	6	4	3	8	5	7	2	9	2	8	3
Peregrine Falcon	7	19	8	1	7	11	7	6	11	13	19	12	11
Unknown falcon	0	4	2	3	2	8	1	4	6	27	4	25	31
TOTAL FALCONS	1,046	462	948	1,048	915	1,043	973	956	583	442	512	458	540
Unidentified raptor	20	38	16	10	25	71	23	36	12	6	8	31	23
GRAND TOTAL	4,594	4,045	5,344	5,362	5,245	5,667	6,733	5,216	3,173				

Appendix C. continued

YEAR	2013	2014	2015	2016	MEAN
Start date	27-Aug	27-Aug	27-Aug	27-Aug	27Aug
End date	5-Nov	5-Nov	6-Nov	5-Nov	4-Nov
Days of observation	71	71	68	71	69
Hours of observation	606.33	605.65	568.3	590.5	552.5
Raptors / 100 hours	741.0	833.0	1282.8	980.2	902.6
SPECIES					
Osprey	61	58	75	71	44
Northern Harrier	42	31	55	68	41
Sharp-shinned Hawk	1,506	1806	2209	1,675	1,699
Cooper's Hawk	969	862	1538	1,247	988
Northern Goshawk	3	4	3	10	7
Unknown accipiter	186	342	728	377	260
TOTAL ACCIPITERS	2,664	3,014	4478	3,309	2,954
Red-shouldered Hawk	0	0	0	0	0
Broad-winged Hawk	21	28	47	37	15
Swainson's Hawk	50	59	138	59	45
Red-tailed Hawk	1,126	1,262	1723	1,511	1045
Ferruginous Hawk	10	12	8	10	7
Rough-legged Hawk	1	0	0	0	0
Zone-tailed Hawk	0	0		0	1
Unidentified buteo	42	28	68	60	36
TOTAL BUTEOS	1,250	1,389	1984	1,677	1,147
Golden Eagle	2	2	1	4	7
Bald Eagle	12	12	11	8	18
Unidentified eagle	0	0	0	1	1
TOTAL EAGLES	14	14	12	13	25
American Kestrel	424	474	595	496	684
Merlin	3	16	10	22	12
Prairie Falcon	7	7	6	11	6
Peregrine Falcon	16	18	9	19	11
Unknown falcon	8	5	17	33	9
TOTAL FALCONS	458	520	637	581	721
Unidentified raptor	4	19	49	69	24
GRAND TOTAL	4,493	5,045	7290	5,788	4,980