

FALL 2017 RAPTOR MIGRATION ANNUAL REPORT: MANZANOS HAWKWATCH, CENTRAL NEW MEXICO



HawkWatch International, Inc.
Salt Lake City, Utah

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INTRODUCTION

The Manzanos HawkWatch in central New Mexico is an ongoing effort to monitor long-term regional population trends of diurnal raptors that migrate through the southern portion of the Rocky Mountain flyway (Hoffman et al. 2002, Hoffman and Smith 2003, Smith et al. 2008a). HawkWatch International (HWI) initiated standardized counts of the autumn raptor migration at the Manzanos in 1985, and began a trapping and banding program in 1990. To date, HWI observers have recorded 18 species of migratory raptors at the site, with counts typically ranging between 4,000 and 7,000 migrants per season. The 2017 season marked the 33rd consecutive count and the 28th consecutive season of trapping and banding efforts. This report summarizes the 2017 fall raptor migration at the Manzanos HawkWatch.

The Manzanos HawkWatch was 1 of 8 long-term, annual fall migration counts and 1 of 4 migration-banding efforts conducted or co-sponsored by HWI in North America during 2017 (Fig. 1). 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 region (Hoffman and Smith 2003; Smith et al. 2001, 2008a, b). Raptors can serve as important biological indicators of ecosystem health (Bildstein 2001) and long-term migration counts are one of the most cost effective and efficient methods for monitoring the 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 knowledge about the biology of migrating raptors. Some of these efforts include: telemetry work to identify species' ranges, migratory routes and connectivity; and blood and feather sampling to track changes in raptor health and populations (e.g., Hoffman et al. 2002, DeLong and Hoffman 2004, McBride et al. 2004, Lott and Smith 2006, Goodrich and Smith 2008,).

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 another important component of the Manzanos HawkWatch and outreach efforts here reach hundreds of people from the Albuquerque area, central New Mexico, and beyond each season.

STUDY SITE

The HawkWatch is located in the Manzano Wilderness Area of the Cibola National Forest (Mountainair Ranger District) near Capilla Peak, approximately 56 km south-southeast of Interstate 40 (34°42.25' N, 106°24.67' W; Fig. 2). The observation point sits at an elevation of 2,805 m (9,195 ft) on a northwest-southeast facing outcrop of a limestone ridge. It is reached by walking up a 1.2 km trail from the main road leading up to Capilla Peak (FS 522). The vegetation on the slopes of the ridge consists of Gambel oak (*Quercus gambelli*), Douglas-fir (*Pseudotsuga menziesii*), White fir (*Abies concolor*), Ponderosa pine (*Pinus ponderosa*), Pinyon pine (*Pinus edulis*), New Mexico locust (*Robinia neomexicana*), and Bigtooth maple (*Acer grandidentatum*).

Two banding stations operate within 0.25–1 km of the observation point (Fig. 1). **North** station, open every year since 1990, is located 100 m east and 50 m north of the observation point at an elevation of 2,790 m. **West** station, open every year since 1991, is located 0.5 km southwest of the observation point at an elevation of 2,684 m.

Many factors make the Manzano Lookout well suited for observing consistent flights of fall migrating raptors. Several mountain ranges to the north serve as leading lines (Bildstein 2006), which cause raptors to funnel into the area. The Manzano Mountains are also a relatively narrow and well-defined north-south range, which creates beneficial updrafts and serves as a distinct flight path for migrating raptors. Capilla Peak provides an excellent source of orographic lift, with two other peaks located 10–15 km north of the observation site also attract southbound migrants that benefit from strong ridge updrafts. The

concentration effect of the Manzano range is further enhanced by the absence of parallel ranges nearby to serve as alternate flight paths.

METHODS

STANDARDIZED COUNTS

Weather permitting; two designated observers conduct standardized daily counts of migrating raptors from late August through late October. Observations typically begin between 0800–0900 hrs and end near 1700 hrs Pacific Standard Time (PST). Visitors occasionally assist with the count.

Data collection follows standardized protocols used at all HWI migration sites (Hoffman and Smith 2003). The 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 tables and figures).
2. Hour of passage for each migrant; e.g., the 1000–1059 hrs 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 are 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 that documents observer distraction by interactions w/ visitors.
7. Daily start and end times for each official observer.

In comparing 2017 counts against means and 95% confidence intervals for previous seasons, we consider a count value falling outside the 95% confidence interval of the historic site means as significantly different. Linear and quadratic regression was used on effort-adjusted annual passage rates (raptors/100hrs) to identify long-term trends in migrating raptors.

TRAPPING AND BANDING

Similar to the counts, trapping and banding efforts begin late August and continue through late October at the two banding stations, generally between 0900–1700 hrs MST. Capture devices include mist nets and remotely triggered bow nets. Trappers lure migrating raptors into the capture stations from camouflaged blinds using live, non-native avian lures attached to lines manipulated from the blinds. Unless already banded, we fit all captured birds a uniquely numbered USGS Biological Resources Division aluminum leg band and release all birds within 45 minutes of capture. Data collection follows standardized protocols used at all HWI migration-banding sites (Hoffman et al. 2002). The crew measure mass, wingchord, tail length on all trapped birds, and when possible, estimate age and sex based on molt patterns and other evidence.

2017 RESULTS AND DISCUSSION

OBSERVATION EFFORT AND WEATHER SUMMARY

The Manzano Mountains HawkWatch standard season runs 27 August—5 November; in 2017 observers counted on 67 of 71 possible days during this period for a total of 570.8 hours (Appendix C).

2017 FLIGHT SUMMARY

Overall Flight:

The crew counted 5,877 migrating raptors representing 16 species in 2017, 12% over the site long-term average (Table 1). Highlights of the flight included the first Variable Hawk documented at the site, a record 23 Broad-winged Hawks, and a record 6 Zone-tailed Hawks.

The flight consisted of 53% accipiters, 26% buteos, 9% falcons, 8% vultures, 2% eagles, 1% harriers and 1% Ospreys. The relative proportions of eagles, falcons, and harriers were low in 2017 compared to historic values; while all other groups occurred in average proportions (Fig. 3). Sharp-shinned Hawks were the most abundant species (28% of the total), followed by Cooper's Hawks (21%), Red-tailed Hawks (16%), Turkey Vultures (8%), Swainson's Hawks (8%), American Kestrels (7%), and Golden Eagles (2%). The remaining species each accounted for 1% or less of the total count (Table 1).

The following sections summarize the 2017 count relative to historic means at the site, and any statistically significant ($p < 0.05$) population trends based on first and second order regression analysis. HWI only depicts significant trends for species with a historic average count rate greater than or equal to 10 individuals per 100 hours. The rationale is that trends for counts below this point likely do not contain biologically useful information on regional populations—species with counts this low likely have a dispersed migration, another primary migration route, or large portions of the population that are resident. We do include count information in the reports, as occurrences of rarer species are of interest to both managers and the public, and could represent the beginning of meaningful long-term changes.

Total Flight (Fig.4):

The Manzano Mountains HawkWatch crew counted 5,877 total birds at a passage rate of 1030 raptors per 100 hours of observation in 2017, both in line with site averages (Table 1). Regression analyses indicate no long-term trend in overall flight (no significant trend).

Vultures, Osprey, and Harriers (Fig. 5a):

In 2017, the crew observed an above average count and average passage rate for Turkey Vultures; above average count and passage rate for Ospreys; and average count and passage rate for Northern Harriers (Table 1). Long-term passage rates for Osprey and Turkey Vulture are stable (no significant trend over time), but declining for Northern Harrier (slope = -0.16, $r^2 = 0.12$, $F=4.37$, $p=0.045$).

Accipiters (Fig. 5b):

We counted above average numbers of all three accipiter species compared to historic averages in 2017 (Table 1). Passage rates were average for Sharp-shinned Hawk and Northern Goshawk, and above average for Cooper's Hawk. Cooper's Hawks are the only accipiter species with a significant trend in passage rates, increasing from 1985 to 1998, but declining in recent years ($F_{2,30} = 6.2$, $r^2 = 0.29$, $p = 0.018$).

Buteoine Hawks (Fig. 5c):

Crewmembers counted a record high 23 Broad-winged Hawks and a record high 6 Zone-tailed Hawks in 2017. We also observed an above average count and passage rate for Red-tailed Hawks. We counted average numbers of Swainson's Hawks and Ferruginous Hawks. We found no long-term trends for any Buteo species with mean passage rates >10 birds/100hrs.

Eagles (Fig. 5d):

We observed an average count and passage rate for Golden Eagles, and below average count and passage rate of Bald Eagles in 2017 compared to historic site averages (Table 1). Regression analysis indicates a near-significant decline in Golden Eagles counted at the Manzano Mountains HawkWatch (slope = -0.24, $r^2 = 0.11$, $p = 0.058$). Similar declines are documented at other HawkWatch International migration sites and elsewhere.

Falcons (Fig. 5e):

The Manzano Mountains HawkWatch crew documented below average counts and passage rates for American Kestrels and Prairie Falcons in 2017, while count and passage rate for Merlins were average, and those for Peregrine Falcon were above average (Table 1). Regional populations of American Kestrel are declining based on fall migration passage rates (slope = -2.89, $r^2 = 0.53$, $F = 35.4$, $p < 0.001$). Other HWI network sites, as well as counts operated by others, have observed similar declines. In response, HWI, along with many other North American researchers and Citizen Scientists are working to understand American Kestrel declines both locally (www.hawkwatch.org/our-work/kestrels) and at the continental scale and have partnered under the umbrella of the American Kestrel Partnership (<http://kestrel.peregrinefund.org/>). Mean passage rates for all other falcons fail to meet the 10 birds/100hrs threshold for reporting trends.

TRAPPING EFFORT

Crews trapped for 59 days (totaling 454 hrs) between 30 August and 31 October, and captured 555 raptors of 11 different species (Table 2). Both the number of hours trapped and capture totals were low compared to historic site averages (Appendix D). Season highlights included the capture of a Broad-winged Hawk, 6 Northern Harriers, 6 Northern Goshawks, and 3 Golden Eagles.

SITE VISITATION

During the season, at least 400 individuals visited the site, primarily from New Mexico. Visitors also traveled from Arizona, California, Florida, Illinois, Massachusetts, Tennessee, Texas, and Vermont. Visitors to the site see raptors in flight and in hand prior to release, learn to identify raptors in flight, and also about raptor migration ecology and what banding and counting efforts can tell us about regional raptor populations and the health of the landscapes they use. They also learn about the ecosystems found around the Manzanos HawkWatch and are introduced to/reminded about leave no trace outdoor ethics.

2017 FALL MIGRATION ACROSS HWI'S NETWORK

HawkWatch International and partners operated 8 fall count sites in 2017 (Fig. 1). During the 4,486 hours of standardized observation, we counted 305,550 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 2017 included (Table 4):

- No sites with above average overall counts in 2017
- Below average Sharp-shinned Hawk numbers at 5 of 8 sites (including 2 sites w/ record low counts).
- Below average count of American Kestrels at 6 of 8 sites (3 with record lows) and no sites with above average counts
- Below average counts for Prairie Falcons at 4 of 8 sites (2 with record lows).
- 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:
 - Broad-winged Hawks at Chelan Ridge and Manzano Mountains
 - Sharp-shinned Hawks and Peregrine Falcons at Corpus Christi
 - Zone-tailed Hawks (6) at Manzano Mountains

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Table 1. Historic fall migration counts (mean±95% CI), counts from fall 2017, and site records at the Manzano Mountains, NM.

Species	1985-2016		All-time Historic Records			
	Mean Count ± 95 % CI	2017	% Change	Season	Year	Daily
Turkey Vulture	377.1 ± 78.7	480	27	1116	1998	256 (2012)
Osprey	30.0 ± 5.6	52	73	86	2003	26 (2003)
Northern Harrier	56.0 ± 8.8	54	-4	133	1998	14 (1998)
Accipiters						
Sharp-shinned Hawk	1445.8 ± 148.4	1658	15	2585	1998	194 (1996)
Cooper's Hawk	933.0 ± 124.5	1244	33	2025	1998	239 (1996)
Northern Goshawk	15.6 ± 3.1	21	34	42	2000	6 (2x)
Unidentified accipiter	109.9 ± 19.2	169	54	266	1993	
TOTAL ACCIPITERS	2504.3 ± 258.4	3092	23	4736	1998	
Buteos						
Zone-tailed Hawk	0.8 ± 0.4	6	700	6	2017	
Broad-winged Hawk	8.5 ± 1.8	23	172	23	2017	8 (2008)
Swainson's Hawk	906.0 ± 559.1	496	-45	7301	1993	5006 (1993)
Red-tailed Hawk	601.8 ± 61.0	930	55	1151	1998	138 (1997)
Ferruginous Hawk	11.3 ± 1.8	11	-3	25	1992	4 (1991)
Rough-legged Hawk	0.4 ± 0.2	0	-100	3	2014	2 (2013)
Unidentified buteo	22.4 ± 7.4	53	137	106	2001	
TOTAL BUTEOS	1550.5 ± 558.4	1519	-2	7916	1993	
Eagles						
Golden Eagle	112.2 ± 11.7	117	4	172	1994	19 (1994)
Bald Eagle	3.3 ± 0.9	1	-70	9	1994	2 (10x)
Unknown eagles	1.2 ± 0.7	1	-18	9	2007	
TOTAL EAGLES	116.7 ± 11.9	119	2	181	1994	
Falcons						
American Kestrel	465.2 ± 65.5	388	-17	905	1996	158 (1993)
Merlin	29.0 ± 5.3	32	10	64	2012.0	8 (2014)
Prairie Falcon	17.7 ± 3.7	13	-26	58	1998.0	5 (1998)
Peregrine Falcon	48.2 ± 10.9	79	64	127	2002.0	14 (2003)
Unidentified falcon	4.4 ± 1.6	14	218	21	2002	
TOTAL FALCONS	564.4 ± 69.2	526	-7	1033	1996	
Unidentified Raptor	34.8 ± 13.3	34	-2	142	1992	
GRAND TOTAL	5234.5 ± 699.9	5877	12	11895	1993	

Table 2. Capture totals and rates for fall migrating raptors at the Manzanos HawkWatch in central New Mexico: 1991–2017.

	Capture Totals			Seasonal Record
	1991-2017 ²		2017	
Northern Harrier	3.7 ± 1.2		6	14 (1998)
Sharp-Shinned Hawk	403.9 ± 75.5		275	987 (1998)
Coopers Hawk	297.3 ± 56.2		237	772 (1998)
Northern Goshawk	4.2 ± 1.3		6	16 (2000)
Broad-winged Hawk	0.3 ± 0.2		1	1(multiple)
Swainson's Hawk	0.3 ± 0.3		1	3 (2002)
Red-tailed Hawk	39.7 ± 8.9		17	112 (1998)
Zone-Tailed Hawk	0.0 ± 0.1		0	1 (1998)
Golden Eagle	3.4 ± 0.8		3	9 (2008)
Bald Eagle	0.0 ± 0.1		0	1 (2014)
American Kestrel	25.2 ± 8.8		2	92 (1996)
Merlin	4.6 ± 1.2		3	12 (2002)
Prairie Falcon	2.9 ± 1.0		0	13 (1998)
Peregrine Falcon	4.9 ± 1.0		4	13 (2002)
All species	790.3 ± 148		555	2005 (1998)

¹Captures / 10 station hours. 10.8 12.2 16.3 (2005)

²Mean of annual values ± 95 % confidence interval.

Table 3. Summary of the 2017 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 2017 HWI monitored fall migration for 4,486 hrs and counted 305,550 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 2017							
Species	430.1	409.1	424.3	530.5	697.75	595.4	570.8	828.3
Black Vulture								409
Turkey Vulture	474	29	*29*	94	264	na	480	87934
Osprey	78	*11*	7	49	88	48	52	138
Northern Harrier	22	74	50	27	157	55	54	351
Crested Caracara								4
Common Black Hawk								0
Harris' Hawk								10
Accipiters								
Sharp-shinned Hawk	*525*	*245*	321	695	2519	1234	1658	*2681*
Cooper's Hawk	347	*110*	191	414	1528	761	1244	1358
Northern Goshawk	26	19	39	36	125	5	21	0
Unidentified accipiter	33	49	45	44	324	133	169	100
TOTAL ACCIPITERS	931	*423*	596	1189	4496	2133	3092	4139
Buteos								
Red-shouldered Hawk	0	0	0	0	0	*1*	0	*15*
Broad-winged Hawk	7	*21*	11	34	95	31	*23*	*160916*
Short-tailed Hawk								1
Swainson's Hawk	2	17	5	112	499	68	496	8891
White-tailed Hawk								16
Zone-tailed Hawk							*6*	16
Red-tailed Hawk	371	*107*	208	846	3884	1291	930	139
Ferruginous Hawk	1	0	5	2	26	4	11	1
Rough-legged Hawk	6	17	64	10	19	0	0	0
Unidentified buteo	18	29	19	31	212	21	53	42
TOTAL BUTEOS	405	*191*	312	1035	4735	1416	1519	*170037*
Eagles								
Golden Eagle	*27*	*11*	1476	289	252	3	117	0
Bald Eagle	86	5	69	155	14	12	1	13
Unknown eagles	2	2	1	1	3	0	1	0
TOTAL EAGLES	115	*18*	1549	445	269	15	119	13
Falcons								
American Kestrel	*7*	11	74	87	*616*	*332*	388	960
Merlin	74	*18*	22	17	60	13	32	113
Prairie Falcon	5	6	13	*2*	31	*2*	13	5
Peregrine Falcon	11	8	13	9	25	10	79	*343*
Aplomado Falcon								1
Unidentified falcon	9	14	6	11	17	7	14	14
TOTAL FALCONS	106	57	128	126	749	*364*	526	1436
Kites								
Hook-billed Kite								0
Swallow-tailed Kite								109
White-tailed Kite								7
Mississippi Kite								11362
Unidentified Kites								0
TOTAL KITES								11478
Unidentified Raptor	10	50	25	15	48	7	34	205
GRAND TOTAL	2141	*853*	2696	2980	10806	4041	5877	*276156*

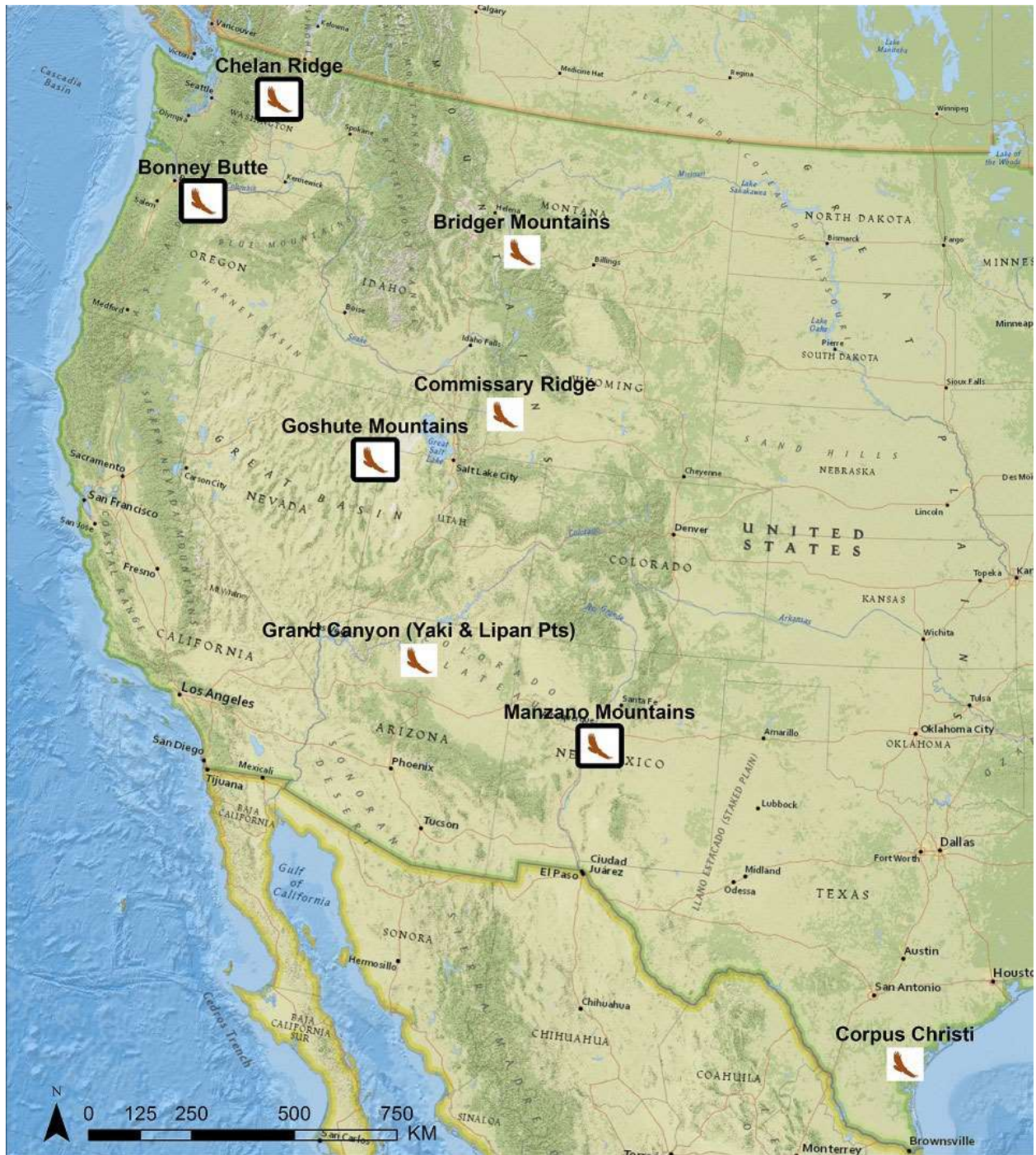


Figure 1. Locations of fall HawkWatch sites operated by HWI and partners (symbols with borders represent banding sites in 2017).

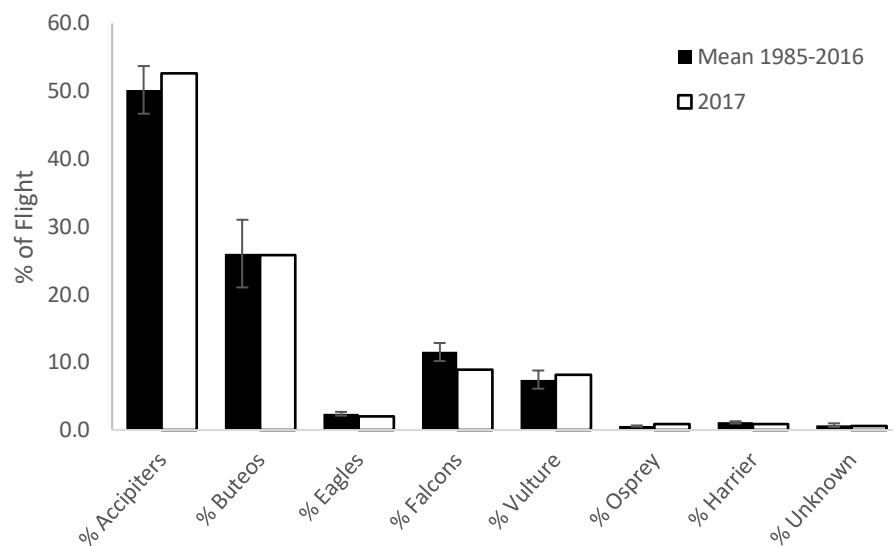


Figure 3. Fall raptor-migration flight composition by major species groups at the Manzanos HawkWatch in central New Mexico: 1985–2015 versus 2017.

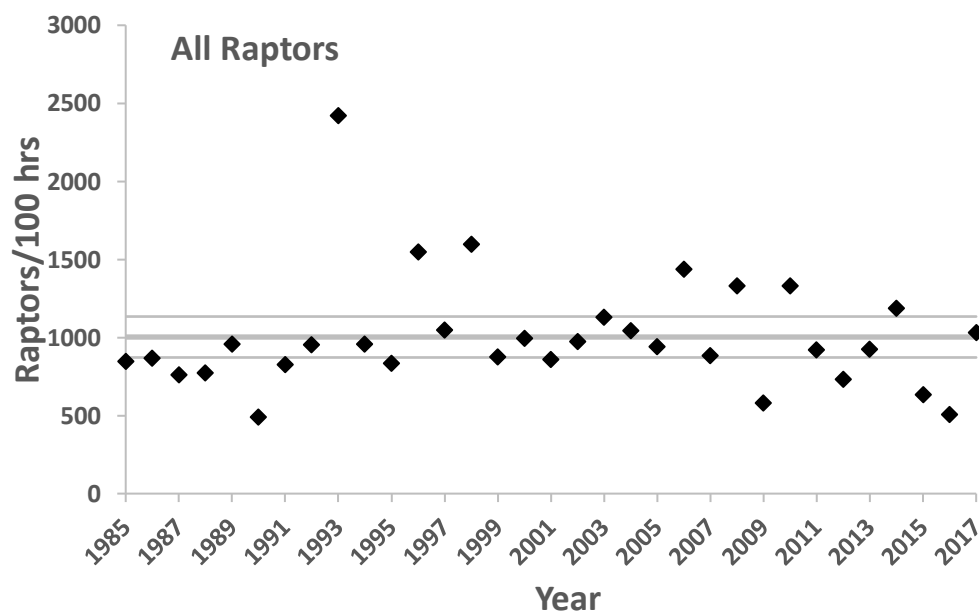


Figure 4. Fall migration passage rates at Manzanos HawkWatch in central New Mexico for all migrating raptors: 1985-2017. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1985-2016) at the Manzanos.

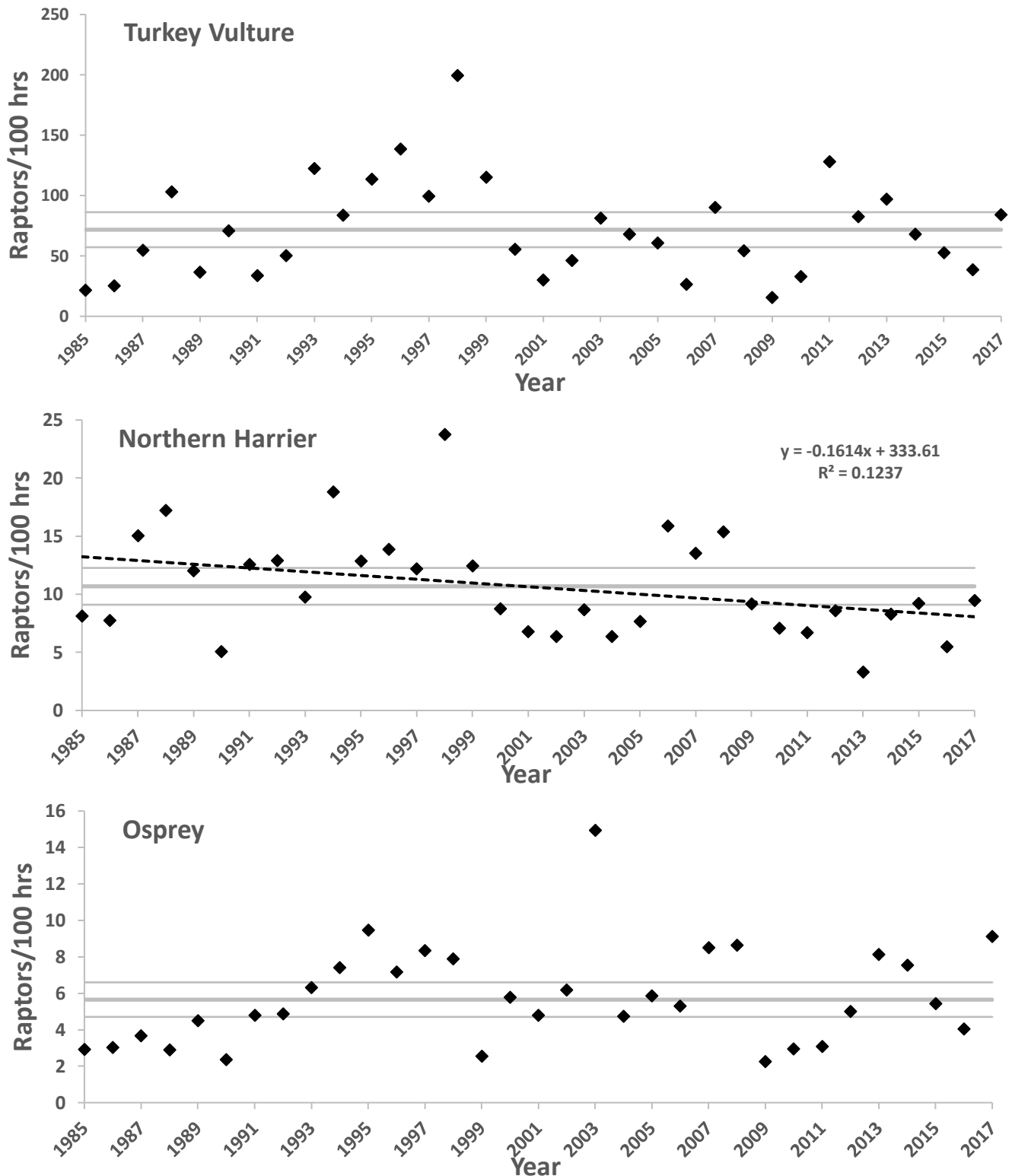


Figure 5a. Effort-adjusted fall-migration passage rates at the Manzanos HawkWatch in central New Mexico for Turkey Vultures, Ospreys, and Northern Harriers: 1985–2017. Dashed lines indicate trend for significant ($p < 0.05$) linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1985–2016) at the Manzano Mountains.

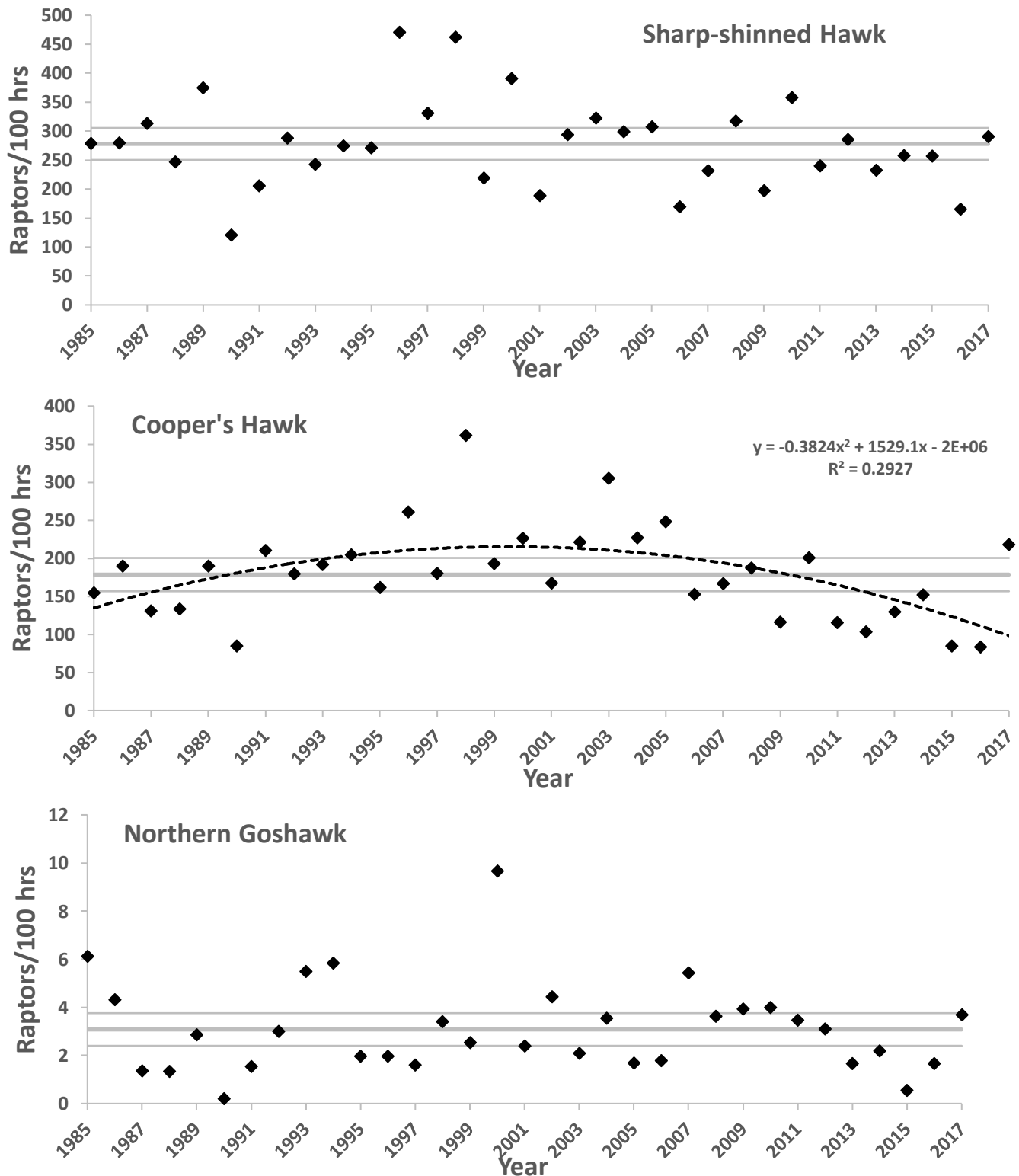


Figure 5b. Effort-adjusted fall-migration passage rates at the Manzanos HawkWatch in central New Mexico for Accipiters: 1985–2017. Dashed lines indicate trend for significant ($p < 0.05$) linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1985–2016).

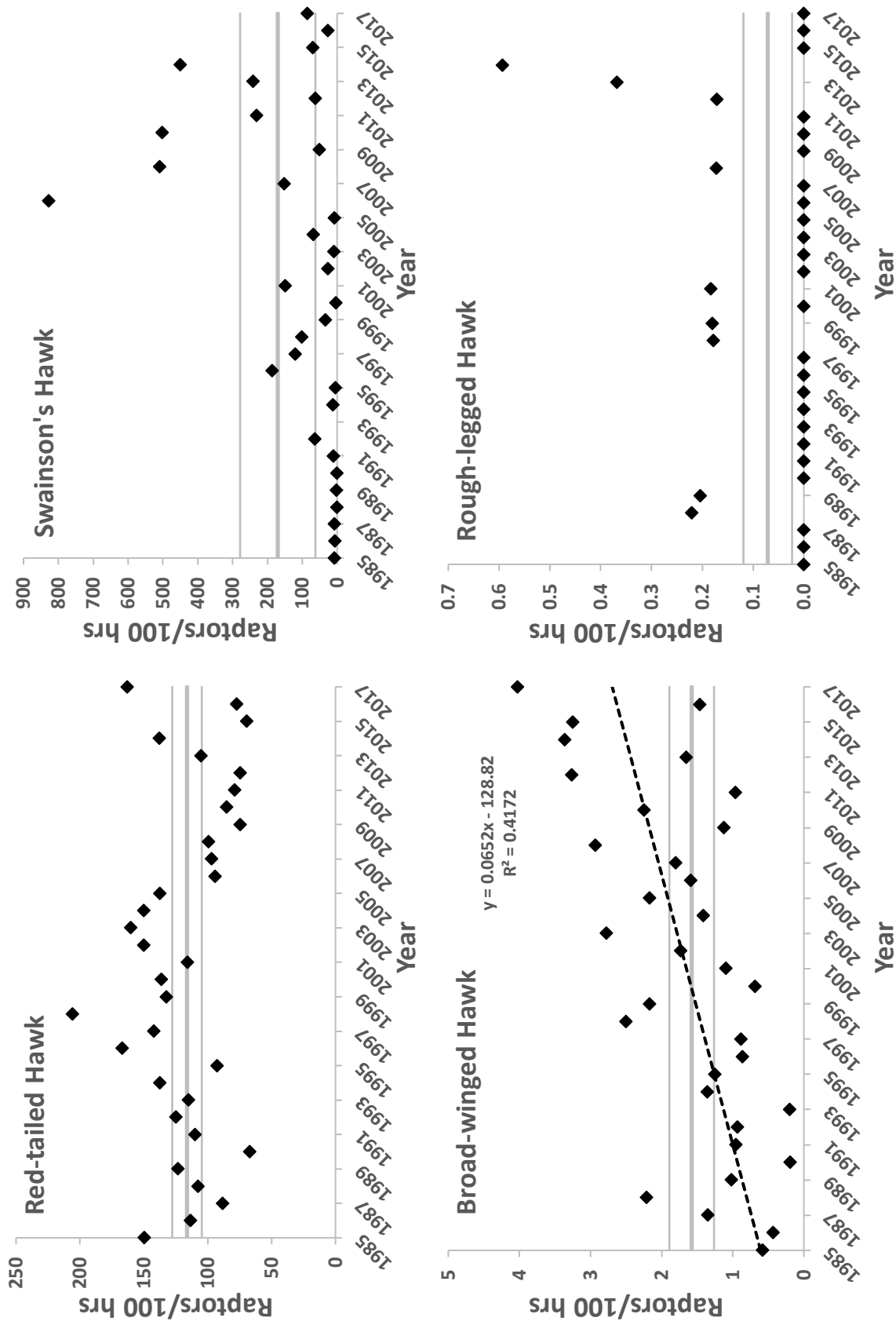


Figure 5c. Effort-adjusted fall-migration passage rates at the Manzanos HawkWatch in central New Mexico for buteoid hawks: 1985–2017. Dashed lines indicate significant ($p < 0.05$) population trends based on linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1985–2016).

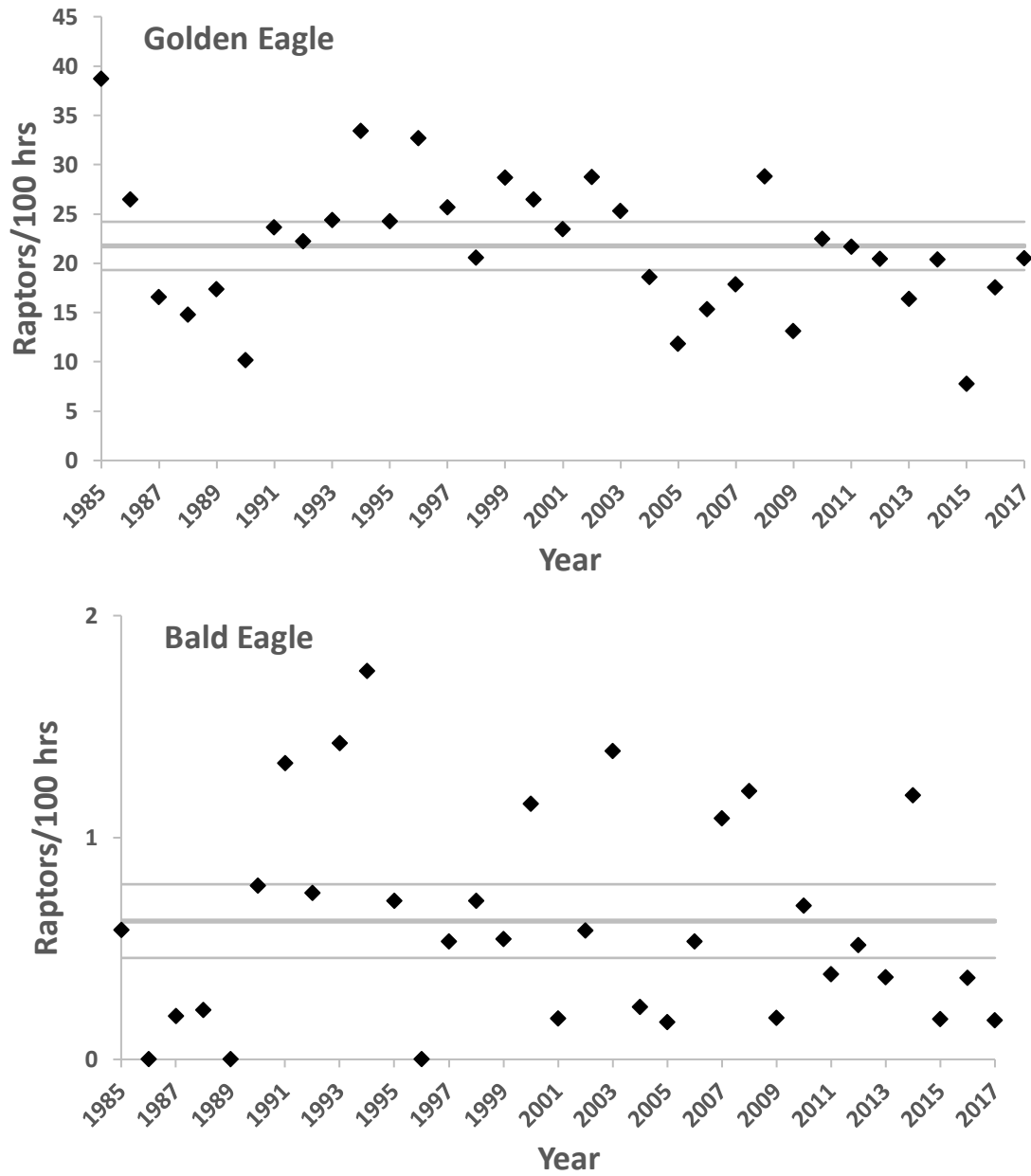


Figure 5d. Effort-adjusted fall-migration passage rates at the Manzanos HawkWatch in central New Mexico for Golden and Bald Eagles: 1985–2017. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1985-2016).

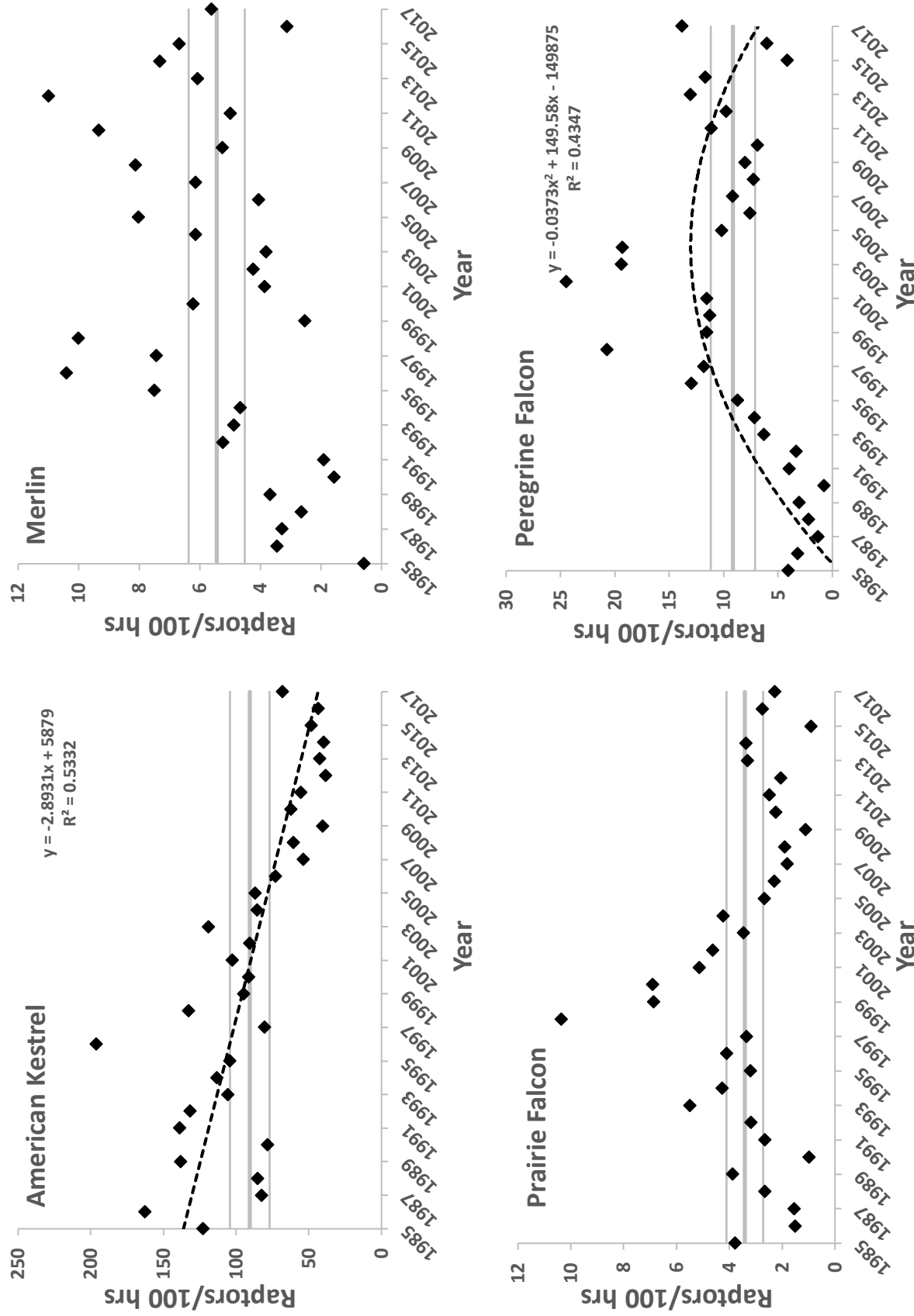


Figure 5e. Effort-adjusted fall-migration passage rates at the Manzanos HawkWatch in central New Mexico for falcons: 1985–2017. Dashed lines indicate significant ($p < 0.05$) population trends based on linear. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1985–2016).

Appendix A. History of official observer participation at the Manzanos HawkWatch: 1985–2014.

1985	Single observer throughout, shared duty: Gary Cress (0) ¹ , Jim Daly (1), Allen Hale (1)
1986	Single observer throughout: Jim Daly (2)
1987	Single observer throughout: Jim Daly (3)
1988	Single observer throughout: Gordon Vickrey (1)
1989	Two observers during peak 3/4 of the season, one observer otherwise: Brett Ewald (2), Tim Menard (0)
1990	Two observers during peak 3/4 of the season, one observer otherwise: David Curson (0), Gary Cress (1)
1991	Two observers throughout: Eric Meyer (1), Tylan Dean (0)
1992	Two observers throughout: Eric Meyer (3), Jessie Jewell (0)
1993	Two observers throughout: Jessie Jewell (2), John Haskell (0)
1994	Two observers throughout: Jessie Jewell (4), Jeff Ogburn (1)
1995	Two observers throughout: Jessie Jewell (6), Jeff Ogburn (2)
1996	Two observers throughout: Jessie Jewell (8), Sean O'Connor (3)
1997	Two observers throughout: Jeff Ogburn (4), Sean O'Connor (4)
1998	Two observers throughout: Dan Rossman (1), Lawry Sager (0)
1999	Two observers throughout: Jason Beason (4), Lawry Sager (1)
2000	Two observers throughout: Jorge Canaca (1), Laura Lutz (1)
2001	Two observers throughout: Tim Meehan (1), Carrie Hisaoka (0)
2002	Two observers throughout: Carrie Hisaoka (1), Richard Sim (0)
2003	Two observers throughout: Carrie Hisaoka (2), Tim Hanks (1)
2004	Two observers throughout: Paula Shannon (3), Frank Mayer (2)
2005	Two observers throughout: Tim Hanks (2), Geoff Gould (0)
2006	Two observers throughout: Tim Hanks (3), Greg Levandoski (3)
2007	Two observers throughout: Tim Hanks (4), Aldo Raul Coutreras Reyes (4)
2008	Two observers throughout: Tim Hanks (5), Aldo Raul Coutreras Reyes (5), Roger Grimshaw (1)
2009	Two observers throughout: Kimberly Cullen (1), Amber Wingert (1), Roger Grimshaw (2)
2010	Two observers throughout: Tim Hanks (6+), Russell Seeley (0), Roger Grimshaw (3+)
2011	Two observers throughout: Tim Hanks (7+), Russell Seeley (1), Roger Grimshaw (4+)
2012	Two observers throughout: Robert Baez (3), Ian Dolly (+), Dan D. Tempest (0), Roger Grimshaw (5+), Steve deLaPena (+)
2013	Two observers throughout: Robert Baez (4), Sarah Dudek (0), Ian Dolly (1+), Roger Grimshaw (6+), Steve deLaPena (+)
2014	Two observers throughout: Robert Baez (5), Olivia DeRugna (1), Stephen Brenner (+), Roger Grimshaw (7+), Steve deLaPena (+)
2015	Two observers throughout: Olivia DeRugna(3), Phil Kavouriaris (1), Keelan Dann (1), Istvan Balasz (0), Roger Grimshaw (7+), Steve deLaPena (+)
2016	Two observers throughout: Phil Kavouriaris (2), Keelan Dann (2), Stephanie Szarmach (1), Marie Soderberg (0), Brian Long (0), Roger Grimshaw (8+), Steve deLaPena (+)
2017	Two observers throughout: Jessica Taylor (4), Tucker Davidson (2), Steve Seibel (12+), Sara Hecocks (1), Danny Erickson (0), Roger Grimshaw (9+), Steve deLaPena (+)

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 at the Manzanos HawkWatch in central New Mexico.

COMMON NAME	SCIENTIFIC NAME	SPECIES CODE	AGE ¹	SEX ²	COLOR MORPH ³
Turkey Vulture	<i>Cathartes aura</i>	TV	U	U	NA
Osprey	<i>Pandion haliaetus</i>	OS	U	U	NA
Northern Harrier	<i>Circus cyaneus</i>	NH	A I Br U	M F U	NA
Sharp-shinned Hawk	<i>Accipiter striatus</i>	SS	A I U	U	NA
Cooper's Hawk	<i>Accipiter cooperii</i>	CH	A I U	U	NA
Northern Goshawk	<i>Accipiter gentilis</i>	NG	A I U	U	NA
Unknown accipiter	<i>Accipiter</i> spp.	UA	U	U	NA
Broad-winged Hawk	<i>Buteo platypterus</i>	BW	A I U	U	D L U
Swainson's Hawk	<i>Buteo swainsoni</i>	SW	U	U	D L U
Red-tailed Hawk	<i>Buteo jamaicensis</i>	RT	A I U	U	D L U
Ferruginous Hawk	<i>Buteo regalis</i>	FH	A I U	U	D L U
Rough-legged Hawk	<i>Buteo lagopus</i>	RL	U	U	D L U
Zone-tailed Hawk	<i>Buteo albonotus</i>	ZT	A I U	U	NA
Unknown buteo	<i>Buteo</i> spp.	UB	U	U	D L U
Golden Eagle	<i>Aquila chrysaetos</i>	GE	I, S, NA, A, U ⁴	U	NA
Bald Eagle	<i>Haliaeetus leucocephalus</i>	BE	I, S1, S2, NA, A, U ⁵	U	NA
Unknown eagle	<i>Aquila</i> or <i>Haliaeetus</i> spp.	UE	U	U	NA
American Kestrel	<i>Falco sparverius</i>	AK	U	M F U	NA
Merlin	<i>Falco columbarius</i>	ML	AM Br	AM U	NA
Prairie Falcon	<i>Falco mexicanus</i>	PR	U	U	NA
Peregrine Falcon	<i>Falco peregrinus</i>	PG	A I U	U	NA
Unknown falcon	<i>Falco</i> 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 the Manzanos HawkWatch in central NM: 1985–2015.

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Start date	6-Sep	23-Aug	25-Aug	30-Aug	28-Aug	27-Aug	27-Aug	25-Aug	25-Aug	25-Aug
End date	2-Nov	31-Oct	4-Nov	31-Oct	31-Oct	31-Oct	5-Nov	5-Nov	5-Nov	2-Nov
Days of observation	50	63	65	60	63	62	67	70	68	66
Hours of observation	343.33	464.5	517.92	453.08	489.75	510.75	524.58	537.25	489.67	508.75
Raptors / 100 hours	843.2	863.9	758.6	772.3	955.4	494.6	825.6	946.3	2429.2	966.5
SPECIES	RAPTOR COUNTS									
Turkey Vulture	74	118	283	466	178	295	176	268	601	430
Osprey	10	14	19	13	22	12	24	26	31	38
Northern Harrier	28	36	78	78	59	27	66	69	48	97
Mississippi Kite	0	0	0	0	0	0	0	0	0	0
Sharp-shinned Hawk	956	1300	1622	1118	1834	688	1080	1540	1193	1415
Cooper's Hawk	531	881	679	604	929	471	1105	961	944	1054
Northern Goshawk	21	20	7	6	14	3	8	16	27	30
Unknown accipiter	78	104	119	111	121	133	156	117	266	118
TOTAL ACCIPITERS	1586	2305	2427	1839	2898	1186	2349	2634	2430	2617
Broad-winged Hawk	2	2	7	10	5	2	5	5	1	7
Swainson's Hawk	27	33	44	3	16	9	58	344	7301	67
Red-tailed Hawk	513	527	457	486	604	329	577	667	566	707
Ferruginous Hawk	14	15	17	20	16	13	19	25	17	13
Rough-legged Hawk	0	0	0	1	1	0	0	0	0	0
Zone-tailed Hawk	0	0	0	0	0	0	0	2	0	1
Unknown buteo	21	12	11	16	4	19	30	11	31	22
TOTAL BUTEOS	577	589	536	536	646	372	689	1054	7916	817
Golden Eagle	133	123	86	67	85	52	124	119	120	172
Bald Eagle	2	0	1	1	3	4	7	4	7	9
Unknown Eagle	0	0	0	4	0	4	0	0	0	0
TOTAL EAGLES	135	123	87	72	88	60	131	123	127	181
American Kestrel	421	755	426	385	677	409	728	704	520	582
Merlin	2	16	17	12	18	9	10	28	24	24
Prairie Falcon	13	7	8	12	19	9	14	17	27	22
Peregrine Falcon	14	15	7	10	15	5	21	18	31	37
Unknown falcon	4	0	1	0	3	7	3	1	0	1
TOTAL FALCONS	454	793	459	419	732	437	776	768	602	666
Unknown raptor	31	35	40	76	56	41	120	142	140	71
TOTAL	2895	4013	3929	3499	4679	2526	4331	5084	11895	4917

Appendix C. Continued

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Start date	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	28-Aug
End date	08-Nov	05-Nov	5-Nov	5-Nov	5-Nov	2-Nov	4-Nov	3-Nov	5-Nov	30-Oct
Days of observation	70	59	68	65	70	57	68	65	69	57
Hours of observation	560.00	461.67	565.08	559.58	553.77	434.33	545.47	518.50	577.25	424.08
Raptors / 100 hours	832.9	1545.9	1044.8	1594.2	873.1	991.6	855.8	972.0	1126.4	1039.9
SPECIES	RAPTOR COUNTS									
Turkey Vulture	636	640	563	1116	637	241	164	239	468	289
Osprey	53	33	47	44	14	25	26	32	86	20
Northern Harrier	72	64	69	133	69	38	37	33	50	27
Mississippi Kite	0	0	0	0	0	0	0	0	0	0
Sharp-shinned Hawk	1519	2174	1872	2585	1212	1698	1032	1524	1861	1268
Cooper's Hawk	907	1205	1018	2025	1069	984	913	1149	1758	964
Northern Goshawk	11	9	9	19	14	42	13	23	12	15
Unknown accipiter	44	147	76	107	51	29	86	202	215	201
TOTAL ACCIPITERS	2481	3535	2975	4736	2346	2753	2044	2898	3846	2448
Broad-winged Hawk	7	4	5	14	12	3	6	9	16	6
Swainson's Hawk	32	867	679	572	194	19	815	139	53	291
Red-tailed Hawk	519	771	803	1151	733	591	632	778	924	636
Ferruginous Hawk	13	4	13	10	8	3	10	14	7	8
Rough-legged Hawk	0	0	0	1	1	0	1	0	0	0
Zone-tailed Hawk	1	0	1	2	0	3	1	1	0	0
Unknown buteo	9	11	3	28	5	2	106	32	30	69
TOTAL BUTEOS	581	1657	1504	1778	953	621	1571	973	1030	1010
Golden Eagle	136	151	145	115	159	115	128	149	146	79
Bald Eagle	4	0	3	4	3	5	1	3	8	1
Unknown Eagle	0	0	0	0	0	1	0	0	1	0
TOTAL EAGLES	140	151	148	119	162	121	129	152	155	80
American Kestrel	584	905	455	742	525	397	560	470	686	362
Merlin	42	48	42	56	14	27	21	22	22	26
Prairie Falcon	18	19	19	58	38	30	28	24	20	18
Peregrine Falcon	49	60	67	116	64	49	63	127	112	82
Unknown falcon	0	1	0	12	2	1	5	21	6	7
TOTAL FALCONS	693	1033	583	984	643	504	677	664	846	495
Unknown raptor	8	24	15	11	11	4	20	49	21	41
TOTAL	4664	7137	5904	8921	4835	4307	4668	5040	6502	4410

Appendix C. Continued

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Start date	27- Aug	27- Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug
End date	5-Nov	5-Nov	5-Nov	5-Nov	5-Nov	4-Nov	4-Nov	5-Nov	4-Nov	03-Nov
Days of observation	69	68	63	69	68	70	68	70	67	65
Hours of observation	599.58	566.41	553.58	579.00	535.68	578.00	521.00	582.42	542.92	506.13
Raptors / 100 hours	937.8	1433.4	883.2	1327.5	577.0	1327.7	919.4	729.4	923.7	1184.1
SPECIES	RAPTOR COUNTS									
Turkey Vulture	363	150	499	315	82	189	668	481	527	343
Osprey	35	30	47	50	12	17	16	29	44	38
Northern Harrier	46	90	75	89	49	41	35	50	18	42
Mississippi Kite	0	0	0	0	0	0	1	0	0	0
Sharp-shinned Hawk	1842	958	1283	1836	1051	2067	1252	1665	1263	1304
Cooper's Hawk	1486	865	922	1084	620	1162	602	603	703	770
Northern Goshawk	10	10	30	21	21	23	18	18	9	11
Unknown accipiter	135	127	91	83	118	114	36	73	74	51
TOTAL ACCIPITERS	3473	1960	2326	3024	1810	3366	1908	2359	2049	2136
Broad-winged Hawk	13	9	10	17	6	13	5	19	9	17
Swainson's Hawk	52	4695	841	2952	274	2906	1204	371	1317	2279
Red-tailed Hawk	823	534	537	575	398	491	410	435	570	696
Ferruginous Hawk	13	9	8	10	8	9	14	8	11	7
Rough-legged Hawk	0	0	0	1	0	0	0	1	2	3
Zone-tailed Hawk	1	0	0	0	0	1	4	0	1	1
Unknown buteo	33	23	19	11	57	22	10	9	13	7
TOTAL BUTEOS	935	5270	1415	3566	743	3442	1647	843	1923	3010
Golden Eagle	71	87	99	167	70	130	113	119	89	103
Bald Eagle	1	3	6	7	1	4	2	3	2	6
Unknown Eagle	4	1	9	2	4	4	5	0	0	0
TOTAL EAGLES	76	91	114	176	75	138	120	122	91	109
American Kestrel	520	412	298	350	216	359	288	224	230	200
Merlin	48	23	34	47	28	54	26	64	33	37
Prairie Falcon	16	13	10	11	6	13	13	12	18	17
Peregrine Falcon	61	43	51	42	43	40	58	57	71	59
Unknown falcon	13	5	3	4	9	7	5	3	3	2
TOTAL FALCONS	658	496	396	454	302	473	390	360	355	315
Unknown raptor	37	32	17	12	18	8	5	4	8	0
TOTAL	5623	8119	4889	7686	3091	7674	4790	4248	5015	5993

Appendix C. continued

	2015	2016	2017	Mean
Start date	27-Aug	27-Aug	27-Aug	27-Aug
End date	4-Nov	3-Nov	5 Nov	3-Nov
Days of observation	66	68	69	65.29
Hours of observation	553.4	545.9	570.8	521.21
Raptors / 100 hours	632.5	503.3	1029.6	1004.3
RAPTOR SPECIES				
Turkey Vulture	292	210	480	378.2
Osprey	30	22	52	30.6
Northern Harrier	51	30	54	56.0
Mississippi Kite	0		0	0.00
Sharp-shinned Hawk	1420	903	1658	1454.3
Cooper's Hawk	469	456	1244	943.5
Northern Goshawk	3	9	21	15.8
Unknown accipiter	39	94	169	111.7
TOTAL ACCIPITERS	1931	1462	3092	2522.1
Broad-winged Hawk	18	8	23	8.9
Swainson's Hawk	388	149	496	893.5
Red-tailed Hawk	384	421	930	611.4
Ferruginous Hawk	2	5	11	11.3
Rough-legged Hawk	0	0	0	0.4
Zone-tailed Hawk	1		6	0.8
Unknown buteo	16	22	53	23.2
TOTAL BUTEOS	809	608	1519	1549.7
Golden Eagle	43	96	117	112.4
Bald Eagle	1	2	1	3.3
Unknown Eagle	1	0	1	1.2
TOTAL EAGLES	45	98	119	116.9
American Kestrel	267	237	388	463.1
Merlin	37	17	32	29.1
Prairie Falcon	5	15	13	17.6
Peregrine Falcon	23	33	79	49.2
Unknown falcon	3	9	14	4.7
TOTAL FALCONS	335	311	526	563.6
Unknown raptor	7	6	34	34.7
TOTAL	3500	2747	5877	5254.8

Appendix D. Annual trapping and banding effort and capture totals of migrating raptors by species at the Manzanos HawkWatch in central NM: 1990–2017.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Start Date	28-Aug	5-Sep	31-Aug	3-Sep	1-Sep	4-Sep	2-Sep	31-Aug	29-Aug	31-Aug
End Date	27-Oct	29-Oct	30-Oct	24-Oct	25-Oct	31-Oct	19-Oct	28-Oct	29-Oct	16-Oct
Blinds in operation	1	3	3	3	3	4	4	4	3	3
Trapping days	47	54	57	50	48	53	45	54	58	46
Station days	47	95	131	120	121	136	132	151	114	86
Station hours	511.0	693.0	967.0	889.0	926.0	1041.0	1030.0	1211.0	1352.6	663.8
Captures / 100 hours	47.7	72.4	108.2	100.8	110.7	85.6	137.0	94.9	148.2	115.6
Species	Raptor Captures									
Northern Harrier	1	2	2	3	9	2	1	8	14	0
Sharp-shinned Hawk	124	262	589	430	502	493	778	611	987	320
Cooper's Hawk	95	195	335	374	353	309	460	427	772	323
Northern Goshawk	1	7	6	6	7	1	5	3	6	6
Broad-winged Hawk	0	0	0	0	0	0	0	0	1	0
Swainson's Hawk	0	0	0	0	0	0	0	0	0	0
Red-tailed Hawk	8	18	61	55	83	50	50	46	112	56
Zone-tailed Hawk	0	0	0	0	0	0	0	0	1	0
Golden Eagle	1	3	4	4	4	4	6	4	5	2
Bald Eagle	0	0	0	0	0	0	0	0	0	0
American Kestrel	10	13	42	14	59	28	92	32	75	44
Merlin	1	0	2	4	1	1	11	6	7	2
Prairie Falcon	1	1	3	5	3	1	3	5	13	6
Peregrine Falcon	2	1	2	1	4	2	5	7	12	8
All Species	244	502	1046	896	1025	891	1411	1149	2005	767
Recaptures ¹	0	0	1	1	2	2	1	2	4	4
Foreign Recaptures ²	2	1	1	1	2	0	5	1	2	2

¹ Recaptures at the Manzanos of birds originally banded in the Manzanos.

² Recaptures at the Manzanos of birds originally banded elsewhere (includes birds initially captured at other HWI sites).

Appendix D. Annual trapping and banding effort and capture totals of migrating raptors by species at the Manzanos HawkWatch in central NM: 1990–2017.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Start Date	2-Sep	1-Sep	3-Sep	7-Sep	5-Sep	4-Sep	4-Sep	2-Sep	3-Sep	3-Sep
End Date	27-Oct	25-Oct	25-Oct	24-Oct	28-Oct	28-Oct	24-Oct	27-Oct	30-Oct	27-Oct
Blinds in operation	3	3	3	3	3	2	2	2	2	2
Trapping days	49	55	50	45	47	51	48	46	56	48
Station days	91	145	131	84	105	99	94	65	80	61
Station hours	791.4	1036.7	956.9	632.5	756.2	707.8	677.7	453.0	586.0	390.3
Captures / 100 hours	121.7	85.9	135.4	152.7	136.0	163.0	96.5	83.2	104.3	138.4
Species										
Northern Harrier	5	7	6	3	0	3	6	3	4	2
Sharp-shinned Hawk	495	426	636	458	566	562	299	196	313	273
Cooper's Hawk	330	337	510	400	378	495	280	142	246	200
Northern Goshawk	16	1	10	1	2	3	3	3	3	8
Broad-winged Hawk	0	0	1	1	1	0	1	1	0	0
Swainson's Hawk	0	1	3	0	0	0	1	0	0	0
Red-tailed Hawk	76	39	56	38	43	35	35	9	20	34
Zone-tailed Hawk	0	0	0	0	0	0	0	0	0	0
Golden Eagle	4	5	7	8	2	2	1	1	9	0
Bald Eagle	0	0	0	0	0	0	0	0	0	0
American Kestrel	25	56	37	43	18	37	10	9	4	18
Merlin	8	2	12	3	10	3	2	5	8	2
Prairie Falcon	3	7	5	4	3	4	4	2	1	1
Peregrine Falcon	1	10	13	7	5	10	12	6	3	2
All Species	963	891	1296	966	1028	1154	654	377	611	540
Recaptures ¹	3	2	3	2	2	3	2	0	1	1
Foreign Recaptures ²	0	0	3	2	0	0	1	0	0	1

¹ Recaptures at the Manzanos of birds originally banded in the Manzanos.

² Recaptures at the Manzanos of birds originally banded elsewhere (includes birds initially captured at other HWI sites).

Appendix D. Annual trapping and banding effort and capture totals of migrating raptors by species at the Manzanos HawkWatch in central NM: 1990–2017.

	2010	2011	2012	2013	2014	2015	2016	2017	Mean	Total
Start Date	2-Sep	1-Sep	31-Aug	29-Aug	28-Aug	28-Aug	2-Sep	30 Aug	1-Sep	---
End Date	27-Oct	28-Oct	28-Oct	30-Oct	29-Oct	31-Oct	1-Nov	31 Oct	26-Oct	---
Blinds in operation	2	2	2	2	2	2	2	2	2.6	---
Trapping days	52	46	56	60	55	59	60	59	51.7	1395
Station days	61	58	76	79	73	68	78	59	95.6	2581
Station hours	408.7	397.0	495.3	527.8	500.5	440.8	506.7	454	724.1	19549.4
Captures / 100 hours	93.2	80.6	121.6	134.0	76.5	90.1	69.3	122	109.0	---
Species										
Northern Harrier	2	2	2	2	0	3	5	6	3.5	97
Sharp-shinned Hawk	183	171	362	387	218	227	160	275	418.0	11028
Cooper's Hawk	160	105	171	257	140	139	147	237	305.1	8080
Northern Goshawk	2	1	2	3	1	0	4	6	4.1	111
Broad-winged Hawk	0	0	1	0	0	0	1	1	0.3	8
Swainson's Hawk	0	0	0	2	1	0	0	1	0.3	8
Red-tailed Hawk	22	27	41	31	13	14	23	17	41.2	1095
Zone-tailed Hawk	0	0	0	0	0	0	0	0	0.0	1
Golden Eagle	1	1	4	3	1	1	3	3	3.3	90
Bald Eagle	0	0	0	0	1	0	0	0	0.0	1
American Kestrel	5	8	9	10	2	2	2	2	27.0	704
Merlin	2	3	8	5	3	5	4	3	4.5	120
Prairie Falcon	3	0	0	1	0	0	1	0	3.0	80
Peregrine Falcon	1	2	2	6	3	6	1	4	5.1	134
All Species	381	320	602	707	383	397	351	555	815.6	21557
Recaptures ¹	2	1	1	1	1	0	0		1.6	42
Foreign Recaptures ²	0	0	0	0	1	0	0		0.9	25

¹ Recaptures at the Manzanos of birds originally banded in the Manzanos.

² Recaptures at the Manzanos of birds originally banded elsewhere (includes birds initially captured at other HWI sites).