FALL 2011 RAPTOR MIGRATION STUDIES AT COMMISSARY RIDGE IN SOUTHWESTERN WYOMING

HawkWatch International, Inc.

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HAWKWATCH INTERNATIONAL

Conserving Raptors and Our Shared Environment

FALL 2011 RAPTOR MIGRATION STUDIES AT COMMISSARY RIDGE IN SOUTHWESTERN WYOMING

Report prepared by:

Shawn E. Hawks and Markus Mika

Counts conducted by:

Lainie LaHaye, Mary Raikes, and Emily Underwood

Project coordinated by:

HawkWatch International, Inc.

Principal Investigator: Dr. Markus Mika

2240 South 900 East, Salt Lake City, UT 84106

(801) 484-6808, ext. 109 mmika@hawkwatch.org

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INTRODUCTION

The Commissary Ridge Raptor Migration Project in southwest Wyoming is an ongoing effort to monitor long-term raptor migratory population trends along the Rocky Mountain Flyway (Hoffman et al. 2002). This project was 1 of 8 long-term, annual raptor migration studies conducted or co-sponsored by HWI in North America during this past season. The primary objective of these efforts is to track long-term population trends of diurnal raptors in western North America and around the Texas Gulf Coast region (Hoffman et al. 2002, Hoffman and Smith 2003, Smith et al. 2008a, b). Raptors can serve as important biological indicators of ecosystem health (Bildstein 2001) and long-term migration counts can be a very cost effective and efficient method for monitoring the regional status and trends of multiple raptor species (Zalles and Bildstein 2000, Bildstein et al. 2008).

Before 2002, no long-term raptor migration counts were being conducted in the state of Wyoming, and coverage of the central Rocky Mountains between Montana and New Mexico was generally sparse. Following two years of exploratory surveys to assess the viability of conducting long-term autumn raptor migration studies somewhere in Wyoming, in 2002 HWI initiated standardized counts at Commissary Ridge, and annual counts have been continuing each year since. This report summarizes the results of the fall 2011 efforts.

STUDY SITE

The study site is located atop the southern end of Commissary Ridge on the southwestern tip of South Fork Mountain about 37 km north of Kemmerer, Wyoming, on land managed by the Bureau of Land Management, Kemmerer Field Office (Figures 1 and 2). The site is accessed from Hwy 233 just northeast of Lake Viva Naughton, and is located on the western edge of a broad ridgetop overlooking the Ham's Fork River Valley and Lake Viva Naughton to the west (42°01'29"N 110°35'22"W; T24 R116 S28 SESW; elevation ~2,700 m). The location provides an unobstructed 360° view of the surrounding landscape. The ridgetop features primarily rocky substrates and low growing, desert shrubs and grasses, with scattered stands of mixed-conifer and aspen in sheltered pockets and ravines.

METHODS

STANDARDIZED COUNT

Weather permitting, trained observers conducted daily counts from a single, traditional observation post from 27 August through 31 October. Lainie LaHaye, the lead observer conducted a full season count in 2008 at our Grand Canyon raptor migration studies in Arizona. Otherwise, this was the first full season of raptor migration counting for the other two observers; Mary Raikes and Emily Underwood (see also Appendix A for a complete observer history).

Weather permitting, counts occurred daily and usually from 0900–1700 or 1800 H Mountain Standard Time (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) passage rates (migrants counted per 100 hours of observation) and analysis of trends updated through 2011 follow Farmer et al. (2007). In comparing 2011 annual statistics against means and 95% confidence intervals for previous seasons, we equate significance with a 2011 value falling outside the bounds of the confidence interval for the associated mean.

TRAPPING AND BANDING

Due to budgetary constraints, the trapping and banding efforts at the Commissary Ridge site was again withheld.

RESULTS AND DISCUSSION

WEATHER

This past season, inclement weather forced operations to end five days early (Appendix E). Five additional days were also precluded, and another two were severly shortened (reduced observation time to ≤ 4 hours, Appendix C). For comparison, the weather on an average seasonal basis (i.e., 2002-2010) has demonstrated to preclude 5.6, and severly hamper 4.2 days of observations in a given season.

During active observation periods, skies were recorded as predominantly clear to partly cloudy, fair 49% of the time, 31% as transitional (i.e., changed from fair or partly cloudy to mostly cloudy or overcast during the day, or vice versa), and 20% as mostly cloudy to overcast. In comparison, the averages for the site are 46% fair, 30% transitional, and 24% as mostly cloudy or overcast, suggesting that the sky conditions this past season followed similar trends but with slightly greater than average conditions that were clear to partly cloudy and transitional, but less overcast. In contrast, the season's visibility was highly affected by haze and/or fog (87% of the active observational days vs. 22% on average), as well as an increase in rain and/or snow (34% vs. 16% on average). Thus, visibility towards both the east (56 km vs. 70.5 km on average) and west (57 km vs. 74.9 km on average) were both rated low. In yet another contrast, the season's temperatures were nearly on par with the calculated average from past years (13.3˚ C vs. 13.4˚ C on average) but the season's ranking of thermal lift being good to excellent was slightly above average (39% of days vs. 30.8% on average).

Wind conditions during the 2011 season were primarily moderate (12-29 kph, occurring on 61% of the active observation days vs. 56.5% on average) to strong (≥ 29 kph, occurring 21% of the time vs. 31.8% on average). Light (< 12 kph) winds, which are the least prevalent winds at this site, were recorded slightly more often this past season compared to the average (prevalent 18% vs. 11.7% on average). Average wind directions in the past are typically measured coming from the W-NW (52.7%), SW-W (18.8%), SW-NW (7.6%), SW-NW for a major portion of the day then switching to NE-SE for another major portion of the day (7.1%), and NE-SE (5.9%). This past season winds came primarily from the SW-W (41%), SW-NW (33%), NE-SE (8%), SW-NW for part of the day then switching to NE-SE for another part of the day (7%), and SW-NW far part of the day then switching to E-S for another portion of the day (5%). Thus, although still relatively comparable with previous wind speeds and directional trends, winds recorded this past season were less strong and had a more of a SW directional component.

In summary, inclement weather, a greater frequency of SW winds, and better than average thermal lift rankings could have caused raptors to behave differently, such as wait out storms, use different flight patterns, and migrate at higher altitudes beyond detectibility. Employing relatively inexperienced crewmembers at this site, coupled with rather poor visibility caused by haze, raptors using favorable winds and gaining altitude on thermal lift could have escaped detections and the number of raptors counted could have been underestimated.

OBSERVATION EFFORT

Counts occurred on 61 of 71 possible days between 27 August and 5 November, and ended five days early (Appendix E). Despite the seasonal average of 2.8 observers per hour being slightly lower than average (i.e., 2.10 ± 0.11 observers), the number of observation hours was above average (510.25 hours for the season vs. 470.10 ± 41.63 on average; Appendix E).

FLIGHT SUMMARY

Flight Volume and Composition

Observers counted 2,684 migrants of 17 raptor species, which resulted in the count being significantly below (-31%) the 2002-2010 average (Table 1, and see Appendix D for daily count records). More specifically, all but three species (i.e., Osprey, Sharp-shinned Hawk, and Broad-winged Hawk) were also tallied below average (Appendix E). At the bottom of the scale and far below the expected values, five species were tallied in record lows (i.e., Northern Harrier, Rough-legged Hawk, Golden Eagle, American Kestrel, and Merlin), and the season's counts of Red-tailed Hawks was also a near record low (Appendix E).

The overall flight consisted of approximately 62% accipiters, 20% buteos, 10% eagles, 4% falcons, 2% vultures, 2% ospreys, ≤ 1% harriers, and ≤ 1% of unidentified raptors. The season featured significantly higher than average proportions of accipiters; whereas, buteos and falcons were significantly below average (Figure 3). In 2011, Sharp-shinned Hawks were again the most abundant species for the second straight year (42% of total count), followed by Red-tailed Hawks (14%), Cooper's Hawks (11%), Golden Eagles (5%), Bald Eagles (4%), Swainson's Hawks (3%), and American Kestrels (3%, Appendix E). All other species each comprised ≤ 2% of the total (Appendix E).

Passage Rates and Long-term Trends

Ten to fifteen years is considered the minimum necessary for analyses of raptor migration count data to estimate population trends (Farmer and Hussell 2008). For better precision, Smith et al. (2008a) recommends 20–25 years. Excluding 2001 as an exploratory year, this past season was the tenth year of full-season counts, so for the first time, we can now begin to calculate estimates of species-specific population trends of migrating raptors using Commissary Ridge as a migration corridor.

Regression analyses of the adjusted passage rates reveal significant ($P \leq 0.10$) linear declines for Northern Harriers (Fig. 5), non-adult Golden Eagles (Fig. 8), and American Kestrels (Fig. 9), as well as quadratic declines for Northern Goshawks (Fig. 6) and Red-tailed Hawks (Fig. 7). Otherwise, migration count data from all the other species migrating through Commissary Ridge suggest that the populations using this site as a corridor are remaining relatively stable (Figs. 5-9). Although Northern Harriers are commonly observed migrants, less than 40 are typically counted on an annual basis (Appendix E). Nevertheless, a convincingly significant ($r^2 = 0.470$, P-value = 0.029) decline (slope = -0.566, Fig. 5) has emerged as base line evidence for initial concern and continued monitoring in this species. Recent negative trend data for Golden Eagles and American Kestrels at other monitoring locations have been corroborated as well at Commissary Ridge in 2011, these negative population trends from Commissary Ridge fall in accordance with trends observed elsewhere throughout North America (cf. Farmer et al. (2008) and Katzner et al. (2012) for Golden Eagles, and Farmer et al. (2008) and Farmer and Smith (2009) for American Kestrels, respectively). However, with Golden Eagles, the significant decline is marginal (P-value = 0.089), with

relatively little information explained by the model ($r^2 = 0.319$). Thus, inferring significance should be done with caution due to the likelihood of a Type I error. Additionally, Commissary Ridge counts suggest that the non-adult Golden Eagles are declining (Fig. 8); whereas at other HWI sites the adult age class appears to be in decline (cf. at Chelan Ridge, WA, Bonney Butte, OR, and Goshute Mountains, NV (Hawks and Mika 2011a, b, and HWI unpublished data, respectively). Nevertheless, it is important to be able to contrast whether non-adults, adults, or both age classes are declining to understand what age-specific group may be most affected within and across geographic ranges.

The two species showing quadratic declines, Northern Goshawks and Red-tailed Hawks, both began showing declines four years ago, beginning in 2007 (Figs. 6 and 7, respectively). Whether these emerging patterns continue to demonstrate population declines, or if future counts demonstrate population increases or potential cyclic patterns is unknown at this point. Continued monitoring efforts in future years will try to shed light on future developments in population trends of these two species.

Age Ratios

With observational data it can be difficult to correctly identify immature vs. adults in many raptor species, especially at a distance (see Table 2; % of unknown age column). Nevertheless, accurate age and gender identifications allow us to understand flight volumes, passage dates, and trends in a more detailed context. One likely assessment based on observed age classes is to compare the ratio from the most recent seasonal counts in relation to the average ratio over all the years observed (Table 2). Typically, adults are seen in greater numbers than immatures for Northern Harriers, Broad-winged Hawks, Red-tailed Hawks, Bald Eagles, and Peregrine Falcons (Table 2). This past season, Broad-winged Hawks were observed at equal numbers between immatures and adults, but with only two out of the 21 birds being accurately aged and the remainder classified as of unknown age, comparing this past season's ratio is insubstantial. Similarly with Peregrine Falcons, none of the birds observed were aged. Other age comparisions worth highlighting from this past season come from Sharp-shinned Hawks, Cooper's Hawks, and Golden Eagles. Typically, immatures outnumber adults in these three species, but this past season more adults were counted (Table 2). Again, a large percentage of birds were not classified at all, especially for the two accipiters. Thus, whether these changes are the result of observer limitations, low reproductive success, or slight changes in behavior, is unknown. Nevertheless, assessing annual and potential long-term changes in age ratios can be insightful, but to use these data to assess year-to-year reproductive output can be problematic.

Daily and Seasonal Migration Patterns

On average, the daily rhythm of migration passage at Commissary Ridge suggests that migration peaks at 1000 H. Afterwards, activity slowly declines for the next two hours, then it levels off from noon to 1400 H. It then very gradually declines for another two hours before dropping off dramatically during the last hour of observation (Fig. 4). During this past season, migration followed the 1000 H peak, but greatly exceeded it, declined rapidly but remained stable for the rest of the morning, followed by stable decline during the afternoon (Fig. 4).

For at least the last two seasons, the combined-species median passage date of 28 September represented no change from the long-term average (Table 3). In addition, the activity pattern for 2011 followed a crude bimodal distribution roughly similar to the one represented by the long-term mean. It can be characterized by a major peak which occurred mid- to late September, then a dropoff to a low during the second 5-day period in October, another peak again during mid-October, and a final slow decrease towards the end off the season (Fig. 5). Major differences between the long-term pattern and 2011 occurred during mid- to late September, where a 2011 peak occurred a week earlier than usual overlapping an expected (average) small dip in migration numbers followed by a mid-season low approximately one week later than the average (Fig. 5).

At the species level, the median passage dates for seven species moved up by 1 to 23 days (i.e., Northern Harriers, Broad-winged Hawks, Red-tailed Hawks, Swainson's Hawks, Ferruginous Hawks, Bald Eagles, and Peregrine Falcons). For the other nine species median passage dates were pushed back between 1 and 21 days (Table 3). Likewise, the age specific median passage dates for most species shifted similarly, except for adult Red-tailed Hawks, which arrived seven days later than the norm (Table 4). Considering the large proportion of birds that were not aged within the species, a seven day delay isn't very suprising. However, comparing seasonal timing on a year-to-year basis can be insightful to learn how much variation is possible, additional analyses with several years added may provide more insight into species-specific arrival phenology and potential changes as a function of time.

TRAPPING AND BANDING SUMMARY

Again, due to budgetary constraints, the trapping and banding efforts were withheld during 2010, but we hope that we are able to resume our efforts sometime in the future.

RESIDENT RAPTORS

This past season, quite a few resident raptors were identified based on behavior of displaying territoriality, consistent hunting near a general location, and flying in non-migratory directions. Thus, for some species (e.g., Red-tailed Hawks and Golden Eagles), keeping track of a rather large numbers of individuals was sometimes difficult.

From nearly the beginning of observations, a resident of perhaps two family groups of at least six Red-tailed Hawks (two adult light morphs, one adult dark morph, three immature light morps, and one immature dark morph) were often observed hunting along the main ridgeline as well as the ridge to the east. By 25 October, only three were left to finish out the season (one adult light morph, one immature light morph, and the adult dark morph) and the rest had seemingly moved on. Likewise, American Kestrels were also seen nearly throughout the season. Four Kestrels were seen consistently up to 04 September. Thereafter, three Kestrels were observed until 11 September, two (often one male and one female) were consistently seen until 04 October, and after that date, a single kestrel (one male) was documented through 22 October, when no more resident Kestrels were seen again for the rest of the season. Also throughout most of the season, two Northern Harriers (an adult male and one immature), three Golden Eagles (one adult and two non-adults), and one adult Bald Eagle were consistently observed. Later in the season, however, resident Golden and Bald Eagles began to increase in numbers. On 28 September, two adult Golden Eagles were noticed, a total of four were seen between 03 October and 16 October, a phase ending with a group of five resident Golden Eagles. After that date, the resident Golden Eagles seen daily varied from one to five individuals. Likewise, two adult Bald Eagles appeared on 15 October, one immature and one adult were observed on 22 October, and generally three were seen throughout days through the remainder of the season. Whether these birds are year-round residents, or how this site serves as a stopover site, or wintering area for these species, is unknown.

Resident Turkey Vultures were also seen from the first day of observation through 17 October. Two were often seen until 26 September, three appeared on 27 and 29 September, two again on 04 October and the last bird made a final pass on 17 October.

Starting on 04 September, a Sharp-shinned Hawk (likely an immature) was observed and at least one was seen throughout most of the remainder of the season. During most of the month of September, the Sharp-shinned Hawk was identified as an immature, but on 23 September, an adult individual was observed and recorded as a resident. Thereafter, both the adult and immature were seen through the remainder of the season. Simarily, a Cooper's Hawk was also observed beginning on 04 September and throughout the rest of the month. There were at least two Cooper's Hawks, one adult and one immature, based on the observers' account. Towards the end of the season, an adult Northern Goshawk showed up on 24 October and remained in the area for another three days through the end of observation.

On five days between 19 through 29 September, a resident Peregrine Falcon of unknown age was observed. Likewise, a resident Prairie Falcon was seen on four days between 27 September and 04 October. A Swainson's Hawk was observed on five days between 03 Sepember and 01 October. Whether this Swainson's Hawk was always the same individual is unclear, though it appeared that all sightings during the three days were described as light morphs, and the last individual seen was identified as an immature light morph as well. Finally, at least two light morph Rough-legged Hawks were classified as resident birds remaining in the area for a total of seven days beginning 19 October through the end of the season. The reason that two individuals were classified as resident is because the observers identified an immature and an adult concurrently. Again, whether these birds stayed through the winter or the site represents a short stopover location, is unknown.

SITE VISITATION AND PUBLIC OUTREACH

Public awareness at this site is still developing. This past season, only three folks signed the visitor registration list. These folks came from Utah, Oregon, and as far away as the U.K.! The person from Oregon camped and hung out with the crew for a total of four days. Similar to years past, the crew made good local acquaintenances by visiting with hunters, as well as in nearby Kemmerer.

ACKNOWLEDGMENTS

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Table 1. Annual raptor migration counts and passage rates by species at Commissary Ridge, Wyoming: 2002–2010 versus 2011.

	COUNTS			RAPTORS/100 HOURS		
SPECIES	2002–2010[1]	2011	% CHANGE	2002–2010[1]	2011	% CHANGE
Turkey Vulture	108.1 ± 33.4	46	-56	23.3 ± 7.2	9.0	-61
Osprey	33.8 ± 10.8	41	+21	7.0 ± 2.1	8.0	+15
Northern Harrier	32.6 ± 3.2	9	-72	7.0 ± 0.9	1.8	-75
Sharp-shinned Hawk	961.2 ± 306.4	1,140	+19	203.4 ± 60.4	223.4	+10
Cooper's Hawk	443.0 ± 90.0	296	-33	95.5 ± 19.4	58.0	-39
Northern Goshawk	38.4 ± 15.3	14	-64	8.1 ± 3.0	2.7	-66
Unknown small accipiter	88.1 ± 52.0	208	+136	18.4 ± 9.5	40.8	+121
Unknown large accipiter	13.2 ± 6.3	2	-85	2.8 ± 1.3	0.4	-86
Unknown accipiter	34.8 ± 22.8	4	-88	7.4 ± 4.7	0.8	-89
TOTAL ACCIPITERS	1,578.8 ± 411.0	1,664	+5	335.7 ± 79.8	326.1	-3
Broad-winged Hawk	16.8 ± 11.3	21	+25	3.4 ± 2.1	4.1	+21
Swainson's Hawk	221.0 ± 251.2	80	-64	43.6 ± 46.3	15.7	-64
Red-tailed Hawk	1,019.3 ± 174.9	386	-62	218.3 ± 35.3	75.6	-65
Ferruginous Hawk	7.7 ± 2.5	5	-35	1.6 ± 0.5	1.0	-40
Rough-legged Hawk	13.7 ± 7.6	4	-71	2.8 ± 1.4	0.8	-72
Unidentified buteo	61.7 ± 24.1	44	-29	12.8 ± 4.7	8.6	-33
TOTAL BUTEOS	1,340.1 ± 304.2	540	-60	282.5 ± 50.3	105.8	-63
Golden Eagle	266.3 ± 46.1	136	-49	58.6 ± 14.8	26.7	-55
Bald Eagle	162.0 ± 56.7	102	-37	35.6 ± 13.9	20.0	-44
Unidentified eagle	12.2 ± 7.2	16	+31	2.6 ± 1.4	3.1	+20
TOTAL EAGLES	440.6 ± 103.7	254	-42	96.8 ± 28.6	49.8	-49
American Kestrel	253.8 ± 57.4	73	-71	55.6 ± 14.5	14.3	-74
Merlin	18.1 ± 5.8	5	-72	3.8 ± 1.1	1.0	-74
Prairie Falcon	10.4 ± 4.2	7	-33	2.1 ± 0.8	1.4	-38
Peregrine Falcon	12.0 ± 4.0	6	-50	2.5 ± 0.7	1.2	-52
Unknown small falcon	3.3 ± 1.9	4	+20	0.7 ± 0.4	0.8	+12
Unknown large falcon	2.7 ± 1.5	0	-100	0.6 ± 0.3	0.0	-100
Unknown falcon	2.3 ± 1.8	3	+29	0.5 ± 0.4	0.6	+15
TOTAL FALCONS	302.7 ± 54.7	98	-68	65.8 ± 13.7	19.2	-71
Unidentified raptor	43.9 ± 21.6	32	-27	9.6 ± 4.7	6.3	-35
GRAND TOTAL	3,880.4 ± 775.3	2,684	-31	827.9 ± 148.6	526.0	-36

[1] Mean ± 95% confidence interval.

Table 2. Annual raptor migration counts by age classes and immature : adult ratios for selected species at Commissary Ridge, Wyoming: 2002–2010 versus 2011.

	Total and Age-classified Counts								Immature : Adult	
	2002–2010 Average			2011			% Unknown Age		Ratio	
Species	Total	Imm.	Adult	Total	Imm.	Adult	2002–2010[1]	2011	2002–2010[1]	2011
Northern Harrier	33	8	11	9	8	13	40 ± 5.0	89	0.8 ± 0.1	0.6
Sharp-shinned Hawk	961	270	314	1140	93	375	40 ± 3.3	59	1.0 ± 0.2	0.2
Cooper's Hawk	443	133	131	296	33	53	41 ± 4.8	71	1.1 ± 0.2	0.6
Northern Goshawk	38	12	9	14	7	6	32 ± 11.1	7	1.7 ± 0.7	1.2
Broad-winged Hawk	17	2	6	21	1	1	52 ± 10.3	90	0.5 ± 0.2	1.0
Red-tailed Hawk	1019	215	546	386	19	155	25 ± 2.4	55	0.4 ± 0.1	0.1
Ferruginous Hawk	8	2	2	5	3	2	58 ± 10.7	0	1.5 ± 0.5	1.5
Golden Eagle	266	141	89	136	47	54	14 ± 2.4	26	1.6 ± 0.1	0.9
Bald Eagle	162	55	104	102	28	73	2 ± 0.6	1	0.5 ± 0.0	0.4
Peregrine Falcon	12	2	4	6	0	0	48 ± 11.3	100	0.6 ± 0.3	–

[1] Mean ± 95% confidence interval. For age ratios, note that long-term mean immature : adult ratios are averages of annual ratios and may differ from values obtained by dividing 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 observed, bulk passage, and median passage dates by species for migrating raptors at Commissary Ridge, Wyoming in 2011, with comparisons of 2011 and 2002–2010 average median passage dates.

	2011				2002–2010
Species	First Observed	Last Observed	Bulk Passage Dates[1]	Median Passage Date[2]	Median Passage Date[2, 3]
Turkey Vulture	01-Sep	10-Oct	18-Sep – 28-Sep	27-Sep	23-Sep ± 1.7
Osprey	29-Aug	17-Oct	30-Aug – 12-Oct	18-Sep	17-Sep ± 2.6
Northern Harrier	19-Sep	25-Oct	19-Sep – 25-Oct	26-Sep	28-Sep ± 5.1
Sharp-shinned Hawk	02-Sep	31-Oct	15-Sep – 19-Oct	01-Oct	27-Sep ± 2.0
Cooper's Hawk	31-Aug	23-Oct	12-Sep – 12-Oct	26-Sep	22-Sep ± 2.2
Northern Goshawk	19-Sep	30-Oct	27-Sep – 29-Oct	28-Oct	07-Oct ± 4.3
Broad-winged Hawk	27-Aug	12-Oct	–	24-Sep	25-Sep ± 2.0
Swainson's Hawk	27-Aug	01-Oct	05-Sep – 24-Sep	18-Sep	22-Sep ± 4.4
Red-tailed Hawk	27-Aug	31-Oct	04-Sep – 24-Oct	26-Sep	06-Oct ± 4.8
Ferruginous Hawk	29-Aug	17-Sep	29-Aug – 17-Sep	05-Sep	28-Sep ± 7.7
Rough-legged Hawk	12-Oct	28-Oct	–	–	23-Oct ± 3.0
Golden Eagle	27-Aug	31-Oct	04-Sep – 28-Oct	20-Oct	14-Oct ± 3.6
Bald Eagle	29-Aug	31-Oct	01-Oct – 27-Oct	21-Oct	22-Oct ± 3.4
American Kestrel	02-Sep	30-Oct	12-Sep – 18-Oct	24-Sep	22-Sep ± 2.2
Merlin	15-Sep	15-Oct	15-Sep – 15-Oct	13-Oct	04-Oct ± 5.4
Prairie Falcon	15-Sep	17-Oct	15-Sep – 17-Oct	15-Oct	24-Sep ± 2.5
Peregrine Falcon	15-Sep	28-Sep	15-Sep – 28-Sep	19-Sep	24-Sep ± 2.8
Total	27-Aug	31-Oct	12-Sep – 22-Oct	28-Sep	28-Sep ± 1.6

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

[2] Date by which 50% of the flight had passed the lookout.

[3] Mean ± 95% confidence interval in days; calculated using only data for years with counts ≥5 birds.

Table 4. Median passage dates by age classes for selected species of migrating raptors at Commissary Ridge, Wyoming: 2002–2010 versus 2011.

	ADULT		IMMATURE / SUBADULT	
SPECIES	2002–2010[1]	2011	2002–2010[1]	2011
Northern Harrier	08-Oct ± 9.9	–	01-Oct ± 6.1	–
Sharp-shinned Hawk	04-Oct ± 3.2	13-Oct	22-Sep ± 3.6	25-Sep
Cooper's Hawk	24-Sep ± 1.8	01-Oct	19-Sep ± 2.7	26-Sep
Northern Goshawk	20-Oct ± 7.2	30-Oct	30-Sep ± 8.3	19-Oct
Broad-winged Hawk	24-Sep ± 3.0	–	26-Sep ± 0.0	–
Red-tailed Hawk	09-Oct ± 4.3	16-Oct	29-Sep ± 4.3	22-Sep
Golden Eagle	18-Oct ± 4.1	23-Oct	11-Oct ± 3.4	21-Oct
Bald Eagle	22-Oct ± 3.4	21-Oct	22-Oct ± 3.7	21-Oct
Peregrine Falcon	22-Sep ± 3.8	–	07-Sep ± 0.0	–

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.

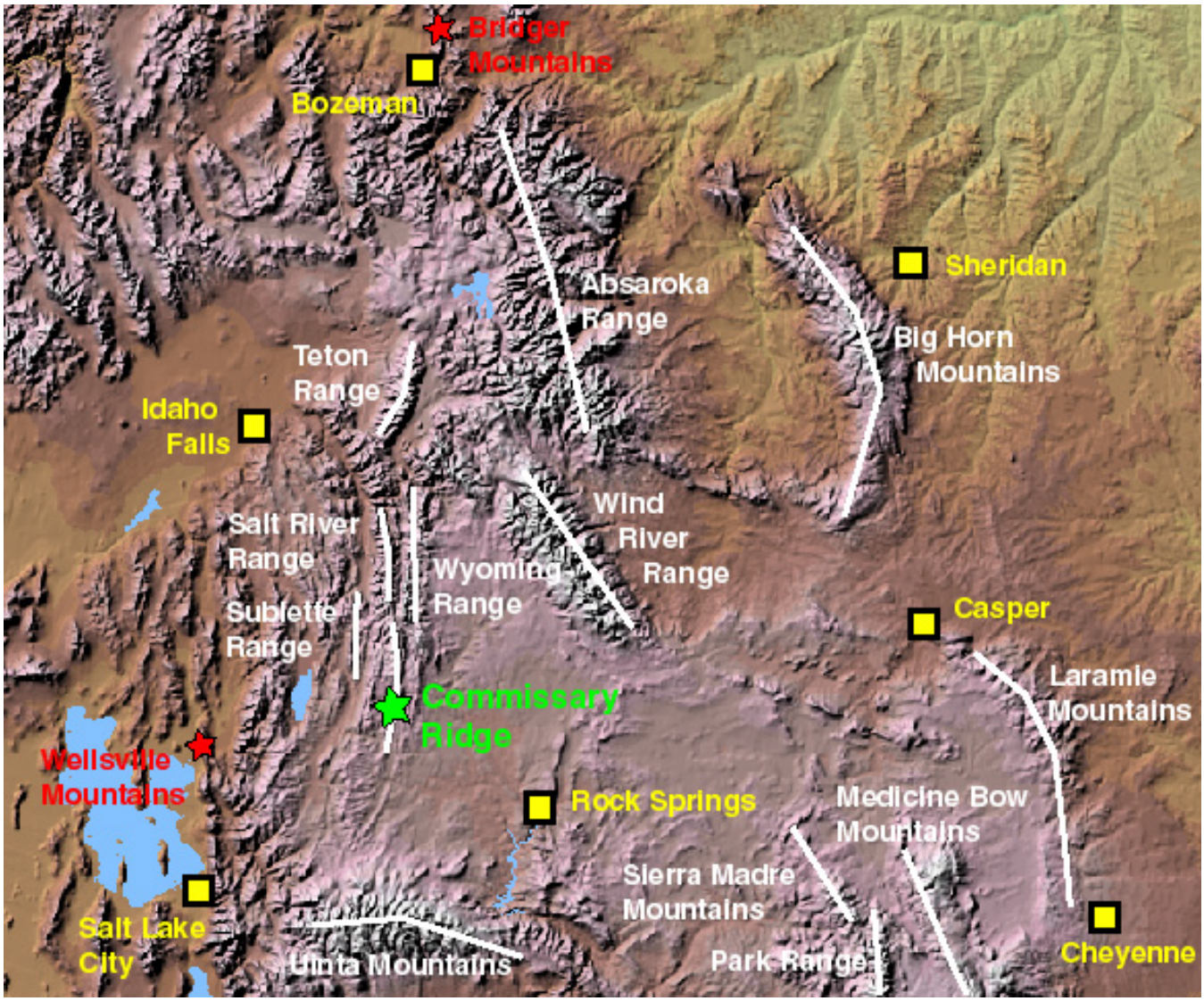

Figure 1. Location of Commissary Ridge Raptor Migration Project site in southwestern Wyoming. Red stars indicate other nearby HWI fall migration monitoring sites in Utah (currently inactive) and Montana.

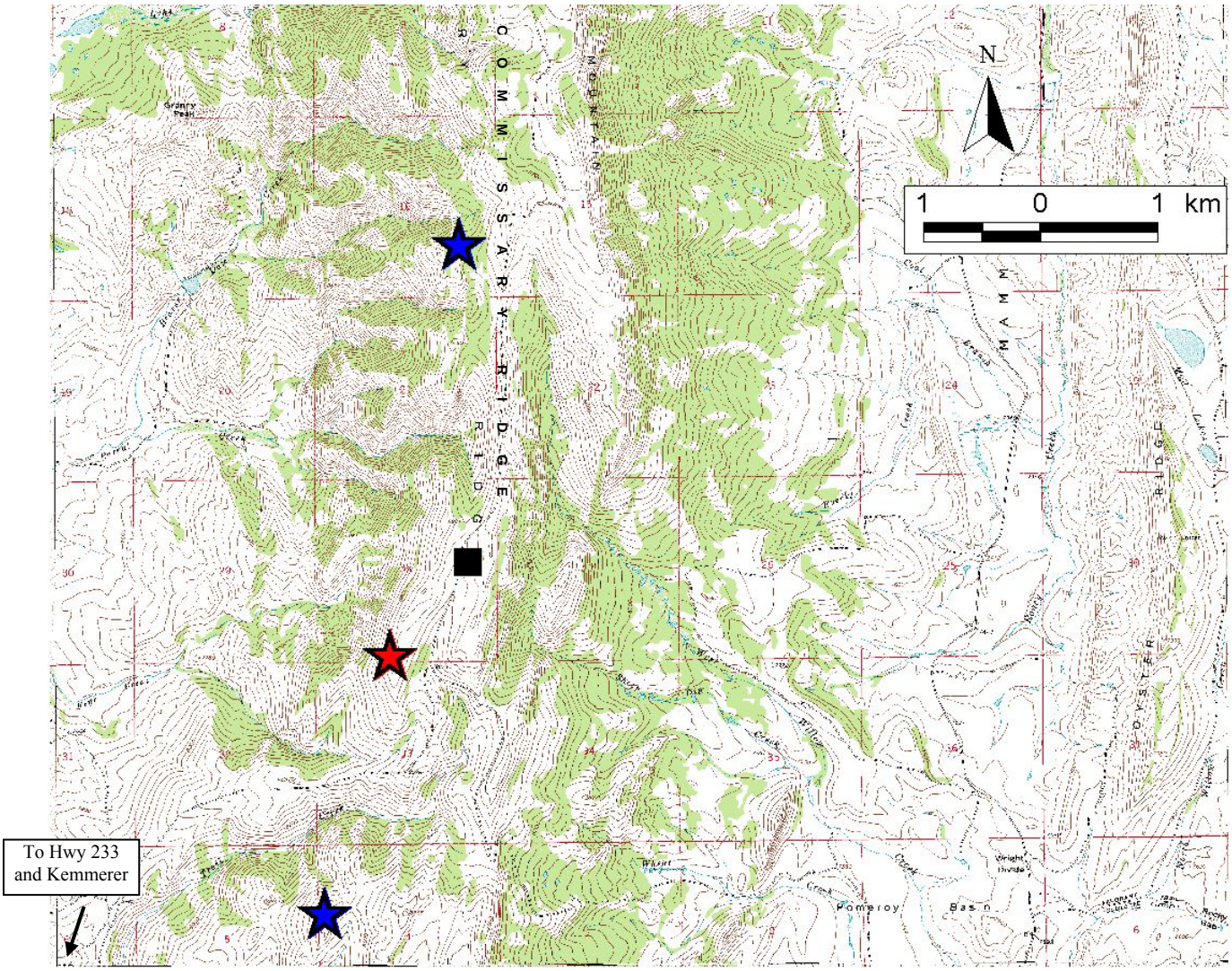

Figure 2. Close-up of Commissary Ridge Raptor Migration Project study site in southwestern Wyoming showing locations of the observation post (red star), the trapping locations (blue stars; both inactive), and base camp (black square).

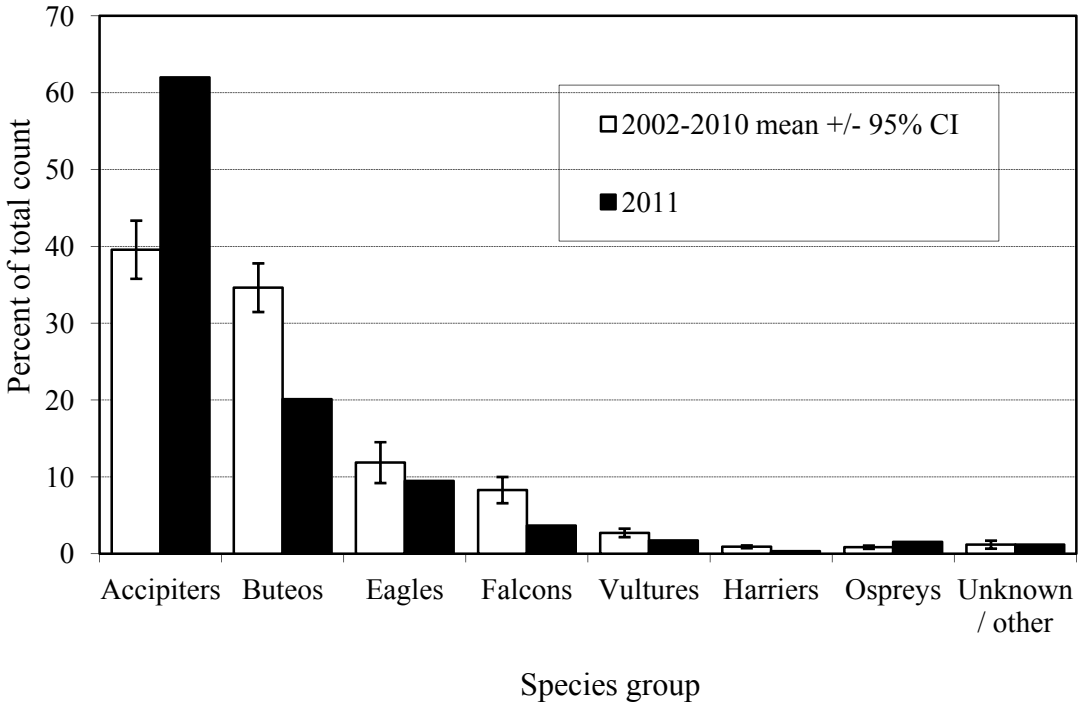

Figure 3. Composition by major species groups of the fall raptor migration at Commissary Ridge, Wyoming: 2002–2010 versus 2011.

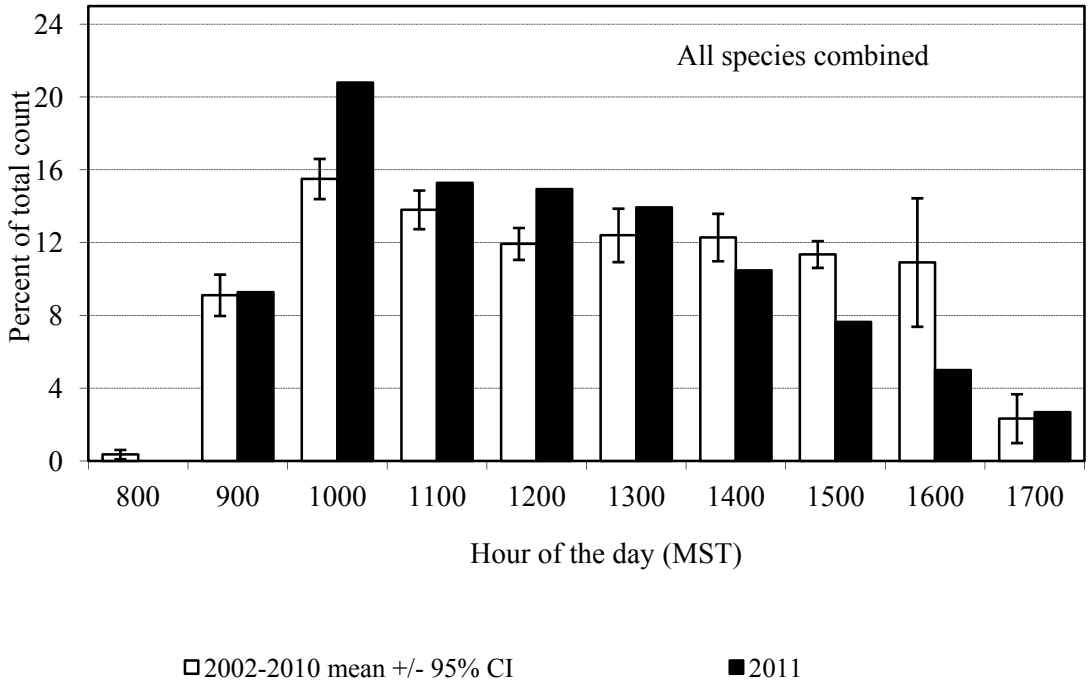

Figure 4. Daily rhythm of the fall raptor migration at Commissary Ridge, Wyoming: 2002–2010 versus 2011.

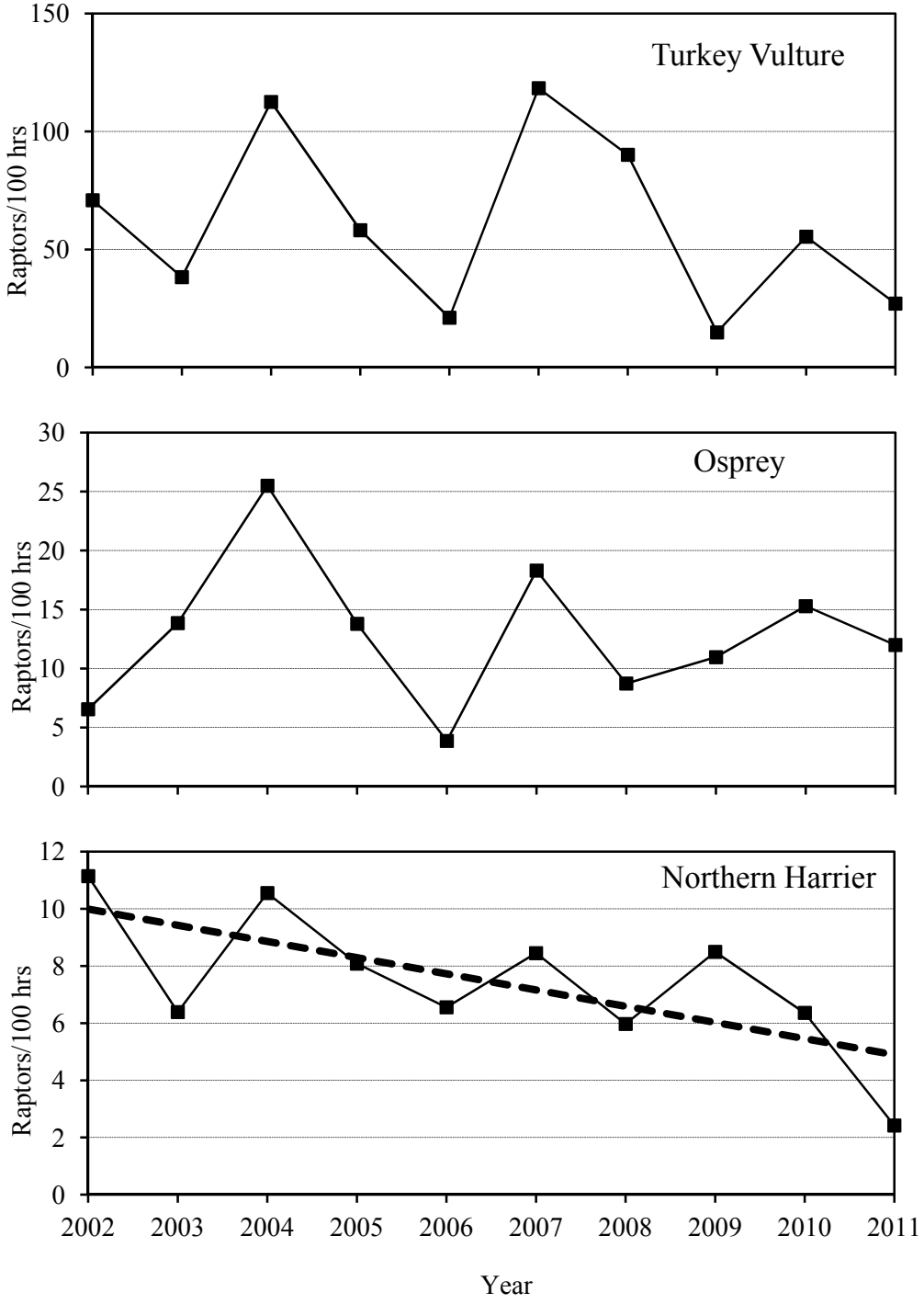

Figure 5. Adjusted fall-migration passage rates at Commissary Ridge, WY for Turkey Vultures, Ospreys, and Northern Harriers: 2002–2011. Dashed lines indicate significant linear or quadratic regressions.

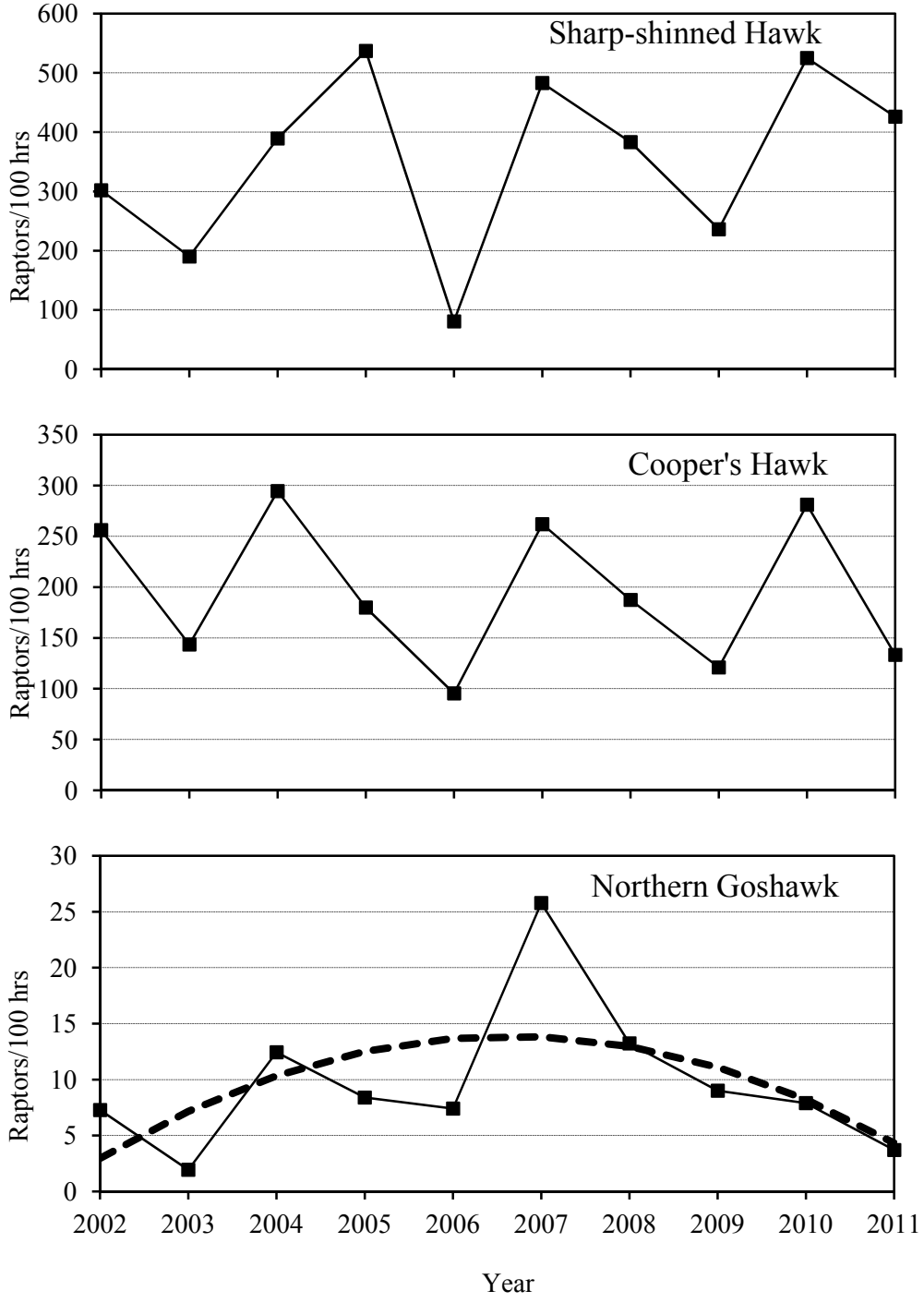

Figure 6. Adjusted fall-migration passage rates at Commissary Ridge, WY for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks: 2002–2011. Dashed lines indicate significant linear or quadratic regressions.

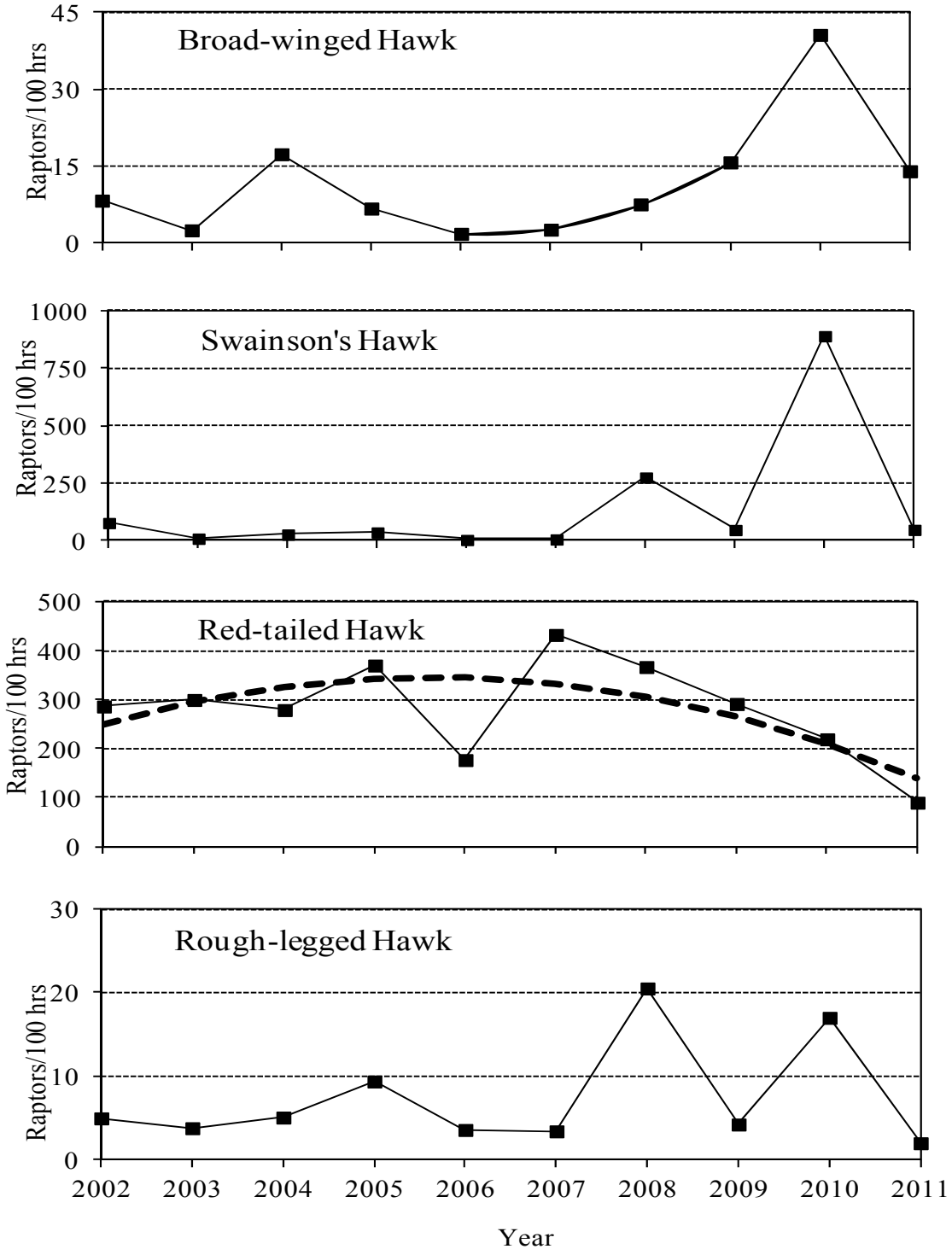

Figure 7. Adjusted fall-migration passage rates at Commissary Ridge, WY for Broad-winged, Swainson's, Red-tailed, and Rough-legged Hawks: 2002–2011. Dashed lines indicate significant linear or quadratic regressions.

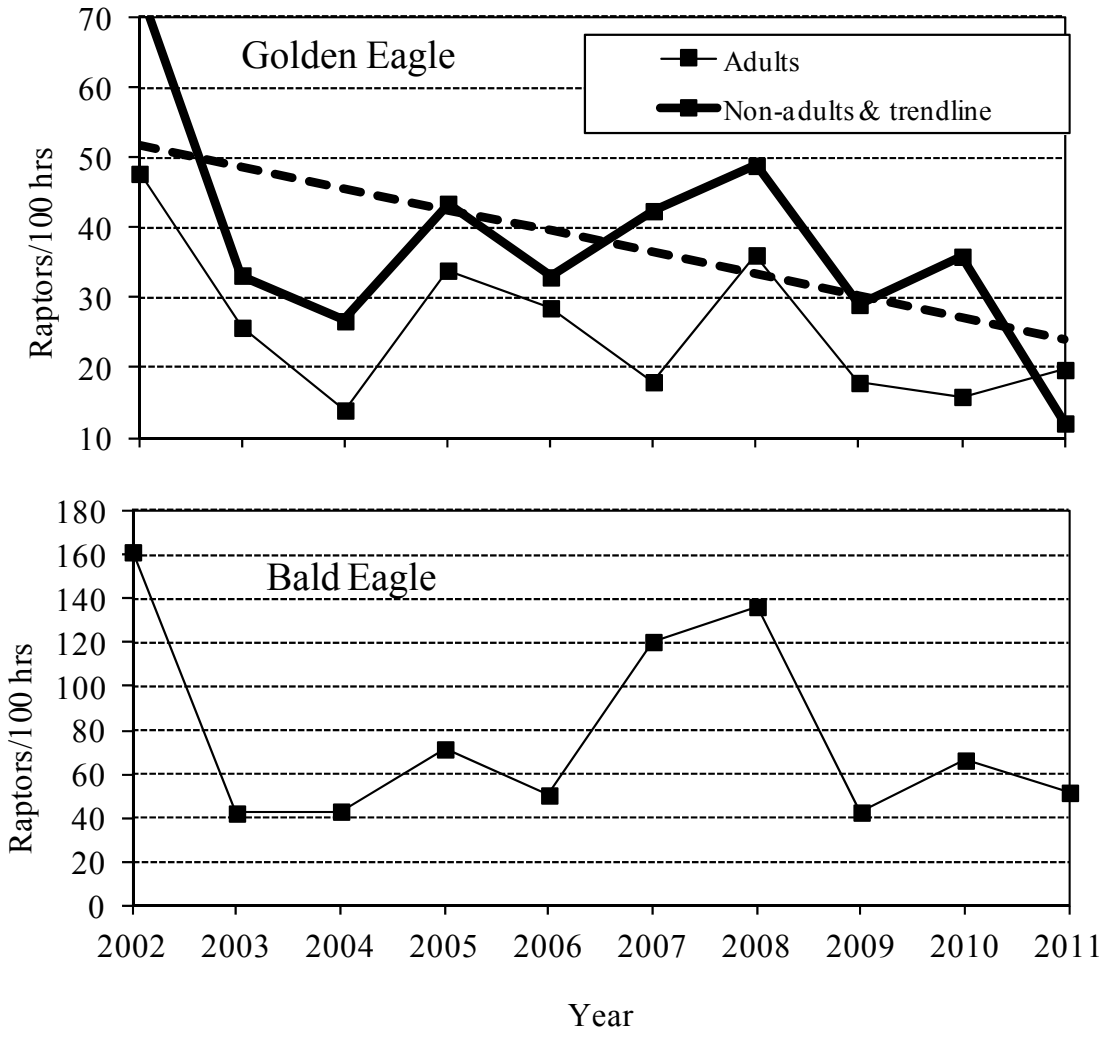

Figure 8. Adjusted fall-migration passage rates at Commissary Ridge, WY for Golden and Bald Eagles: 2002–2011. Dashed lines indicate significant linear or quadratic regressions.

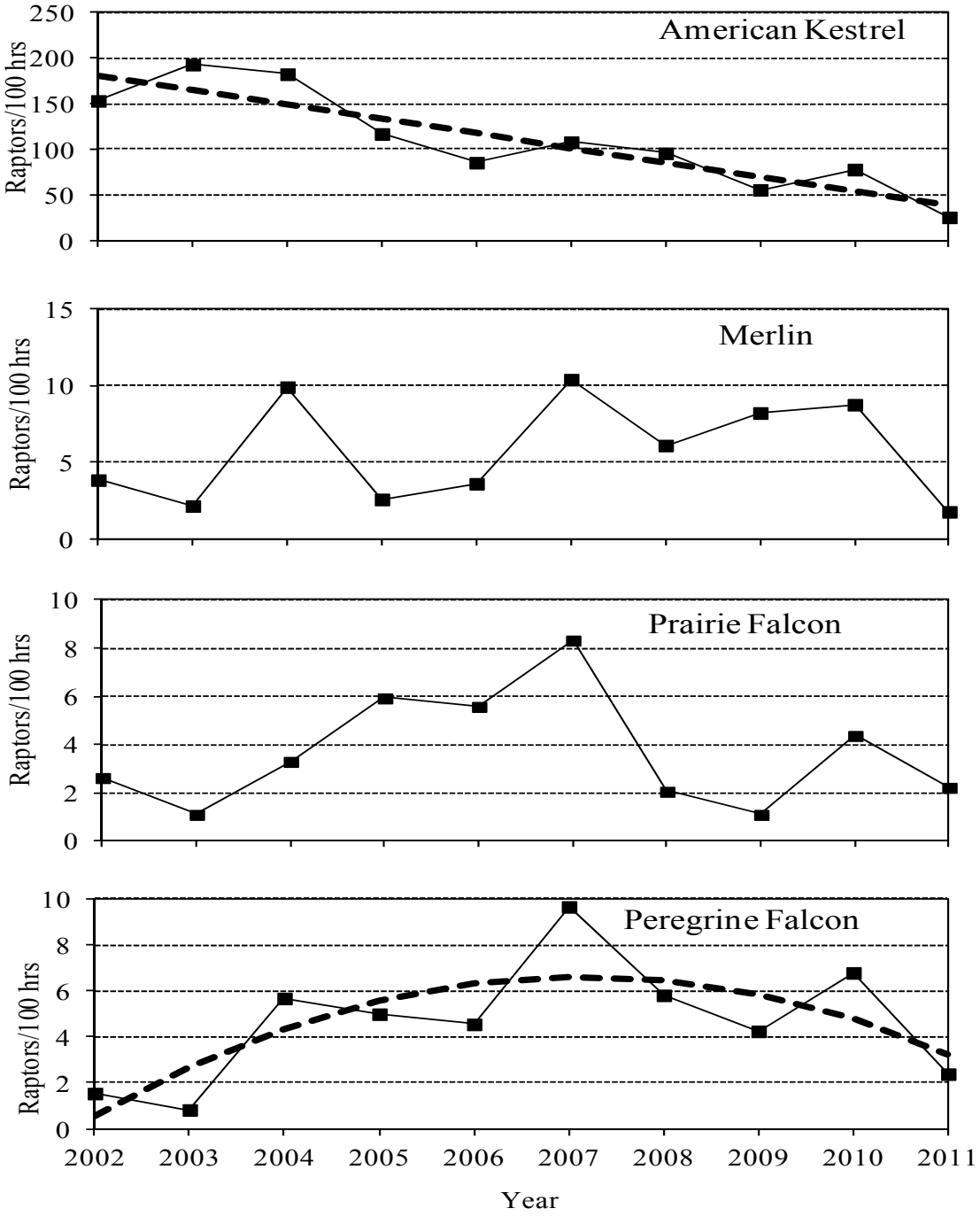

Figure 9. Adjusted fall-migration passage rates at Commissary Ridge, WY for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons: 2002–2011. Dashed lines indicate significant linear or quadratic regressions.

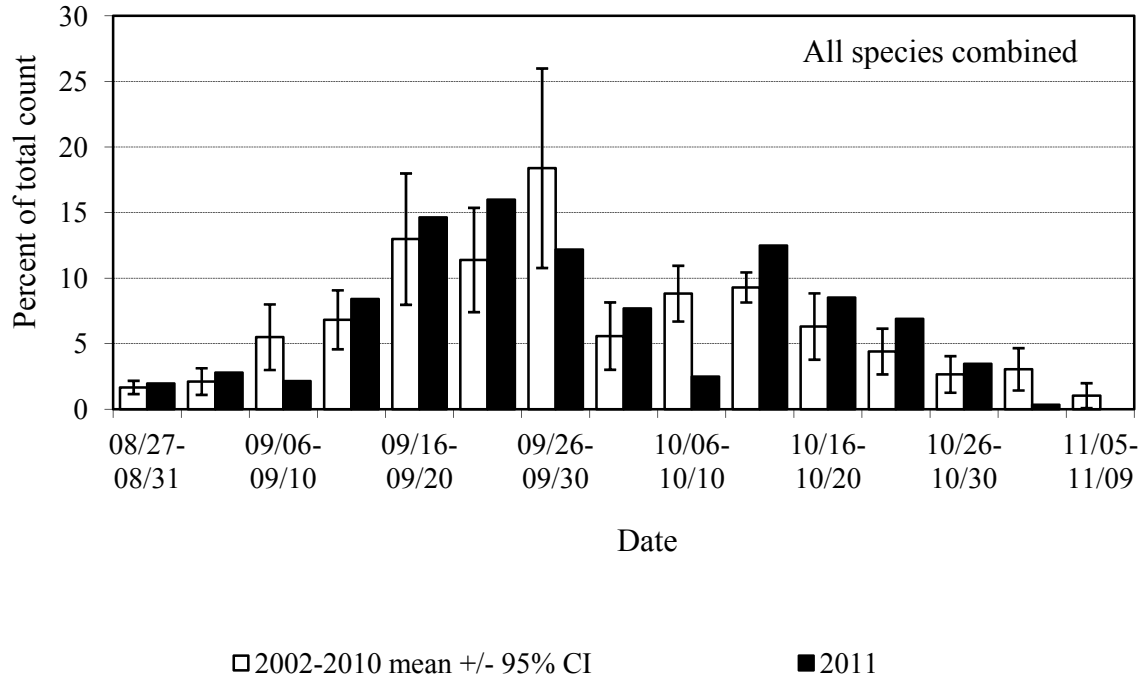

Figure 10. Combined-species seasonal distribution of activity by five-day periods for raptors during fall migration at Commissary Ridge, Wyoming: 2002–2010 versus 2011.

Appendix A. History of official observer participation at the Commissary Ridge Raptor Migration Project.

2000: Exploratory count, single observer throughout, rotating observers: Mike Neal (3)[1] and Margarite Lomow (0).

2001: Exploratory count, single observer throughout: Mike Neal (4)

2002: Single observer throughout, two observers for peak: Mike Neal (5), Nick Meyer (1), assisted by other trained crew members and staff.

2003: Two observers throughout: Chadette Pfaff (+), Don Higgins (0), Jason Farrell (0), assisted by Mike Neal (6).

2004: Two observers throughout: Mark Vukovich (1), Jennifer Nagy (0), assisted by other trained crew members and staff.

2005: Two observers throughout: Rob Spaul (1), Mary Ann Donnovan (0), assisted by other trained crew members and staff.

2006: Two observers throughout: David Jansen (0), Tiara Westcott (0), assisted by other trained crew members and staff.

2007: Two observers throughout: Tiffany Russell (0), Patty Brundage (0), assisted by other trained crew members and staff.

2008: Two observers throughout: Sue Bruner (4), Sedona Maniak (0), Chase Cammarota (0); assisted by other trained crew members and staff.

2009: Two observers throughout: Andrew Eberly (1), Julia Fromfeld (0), Andrew Grant (+).

2010: Two observers throughout: Robert Baez (1), John Cannon (0), Ben Zyla (0).

2011: Two observers throughout: Lainie LaHaye (1), Mary Raikes (0), Emily Underwood (0).

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[1] Numbers in parentheses indicate the number of seasons of previous experience conducting season-long migratory raptor counts.

Appendix B. Common and scientific names, species codes, and regularly applied age, sex, and color-morph classifications for all raptors observed on migration at Commissary Ridge, Wyoming.

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
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
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 flight summaries for the fall raptor migration at Commissary Ridge, Wyoming: 2011.

Date	Obs. Hours	Obsrvr / Hour[1]	Median Visitor Disturb[2]	Predominant Weather[3]	Wind Speed (kph)[1]	Wind Direction	Temp (°C)[1]	Barom. Press. (in Hg)[1]	Median Thermal Lift[4]	Visib. East (km)[1]	Visib. West (km)[1]	Median Flight Distance[5]	Birds / Hour
27-Aug	7.83	4.4	0	pc, haze/rain	12.8	s-w	28.6	30.36	3	65	29	2	1.4
28-Aug	8.75	4.9	0	ovc-mc-pc, haze/rain	10.2	w-nw / calm/variable	21.8	30.36	3	56	27	0	0.6
29-Aug	9.00	3.9	0	clr-pc, haze	26.7	sw-nw	20.3	30.20	3	65	30	3	1.7
30-Aug	8.17	3.7	0	clr-pc	21.8	sw-w	21.0	30.15	3	61	30	3	2.1
31-Aug	9.00	3.4	0	clr-pc, haze-blowing snow/dust	37.1	sw-w	21.8	30.01	3	57	30	3	1.2
1-Sep	9.00	2.0	0	clr, haze	26.9	sw-w	18.2	30.13	3	40	20	0	0.6
2-Sep	9.00	2.3	0	clr, haze	28.5	sw-nw	16.6	30.19	3	48	24	2	1.0
3-Sep	9.00	3.2	0	clr, haze	15.5	sw-nw, ne-se	17.8	30.29	3	52	30	2	1.8
4-Sep	9.00	3.8	0	clr, haze	12.8	sw-nw, ne-se	19.4	30.32	2	60	35	2	3.2
5-Sep	9.00	3.0	0	clr-ovc, haze/rain	11.1	sw-nw, ne-se	20.6	30.26	3	72	57	2	1.7
6-Sep	3.50	3.0	0	ovc	10.0	w-nw	11.8	30.33	3	17	17	1	1.7
7-Sep	9.00	3.0	0	pc-mc, haze/rain	23.4	ne-se	14.5	30.50	3	56	41	0	1.0
8-Sep	9.00	2.0	0	clr-pc-mc, haze	28.3	ne-se	16.9	30.42	2	58	48	2	1.9
9-Sep	9.00	2.0	0	clr-pc, haze	29.9	ne-se	16.8	30.32	3	66	66	3	1.0
10-Sep	9.00	2.8	0	clr-pc, haze	27.1	ne-se	17.5	30.32	3	56	56	3	2.1
11-Sep	8.25	3.7	0	ovc, fog, rain, t-storms	17.2	sw-w	17.2	30.31	3	64	68	2	7.0
12-Sep	7.33	3.0	0	ovc-mc-ovc, haze-t-storms	15.6	sw-w	18.3	30.37	3	58	53	3	7.0
13-Sep	5.00	3.0	0	clr-pc-mc, haze/t-storms	22.4	sw-nw	15.9	30.35	2	70	57	2	10.2
14-Sep	2.83	3.0	0	pc, haze/t-storms	18.0	ne-se	15.2	30.21	2	47	54	3	4.6
15-Sep	9.00	2.0	0	clr-pc-mc, fog/haze/rain/t-storms	13.7	sw-w	13.4	30.09	2	63	56	2	6.4
16-Sep	9.00	2.0	0	clr-pc-ovc-pc, haze/rain/t-storms	29.2	sw-w	16.0	29.95	4	57	59	2	3.9
17-Sep	8.50	2.0	0	ovc-mc, rain	31.9	sw-w	8.3	30.11	4	58	36	2	9.8
18-Sep	9.00	3.0	0	clr-pc, haze	30.6	sw-w	11.5	30.34	2	64	70	2	9.9
19-Sep	9.00	3.0	0	clr-pc	38.3	sw-nw	14.4	30.22	3	79	79	2	12.2
20-Sep	9.00	3.0	0	clr-pc, haze	24.7	sw-nw	13.8	30.22	1	69	70	2	8.0
21-Sep	9.00	3.0	0	clr, haze	21.1	sw-nw	14.7	30.26	2	64	65	2	10.2
22-Sep	9.00	2.0	0	clr-pc, haze	22.0	sw-nw	17.5	30.38	2	65	74	2	8.0
23-Sep	9.00	2.0	0	clr, haze	17.7	sw-nw	17.6	30.43	2	63	70	2	11.9
24-Sep	9.00	2.9	0	clr, haze	9.9	ne-se / calm/variable	21.3	30.30	1	64	64	3	3.4
25-Sep	9.00	3.8	0	clr	23.1	sw-nw	19.1	30.15	2	80	80	2	14.1
26-Sep	9.00	3.0	0	clr-mc, haze/rain	14.2	sw-nw	17.7	30.27	1	69	75	2	7.4
27-Sep	9.00	3.0	0	clr, haze	20.7	sw-nw	18.0	30.34	2	68	68	2	8.2
28-Sep	9.00	3.0	0	clr, haze	26.0	sw-nw	17.8	30.34	1	65	75	2	9.3
29-Sep	9.00	2.0	0	clr, haze	14.8	sw-nw, ne-se	16.3	30.41	1	72	67	3	1.8
30-Sep	9.00	2.0	0	clr, haze	12.7	sw-w	19.2	30.34	1	68	70	2	9.2
1-Oct	8.50	2.0	0	clr-ovc, haze/rain	12.3	sw-nw, e-s	17.9	30.29	4	63	60	2	5.2
2-Oct	9.00	3.8	0	pc-mc-ovc-mc, haze/rain	15.4	sw-w	16.5	30.27	3	62	68	2	8.9
3-Oct	9.00	3.0	0	clr-pc-ovc-pc	11.6	sw-nw, e-s	16.8	30.23	3	63	61	0	3.1
4-Oct	9.00	3.0	0	ovc-mc-ovc, haze/rain	12.7	sw-w	13.3	29.99	4	58	50	1	5.4
5-Oct	4.58	2.4	0	ovc, haze/rain	12.0	sw-nw, e-s	9.6	29.65	4	44	36	2	1.5
6-Oct	0.00												
7-Oct	0.00												

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
8-Oct	0.00												
9-Oct	8.00	2.9	0	ovc, haze	10.4	sw-w	2.8	30.06	4	56	51	0	1.5
10-Oct	9.00	3.0	0	mc-ovc, blowing snow/dust, haze	24.2	sw-nw	2.9	29.91	3	63	61	2	6.0
11-Oct	0.00												
12-Oct	8.83	3.0	0	clr, haze	29.0	sw-nw	4.7	30.17	3	60	60	2	8.3
13-Oct	8.83	2.0	0	mc-pc-mc, haze	34.4	sw-nw	8.0	30.09	4	62	64	2	6.1
14-Oct	8.75	2.6	0	clr-pc-mc, haze, blowing snow/dust	29.3	sw-nw	10.7	30.13	3	68	69	2	8.8
15-Oct	8.75	2.0	0	pc	27.9	sw-nw	13.5	30.11	3	80	80	2	14.6
16-Oct	8.75	3.0	0	mc-ovc, haze, rain	30.6	sw-nw	10.5	30.08	4	59	61	2	5.0
17-Oct	8.67	2.0	0	clr-pc-clr, haze	29.6	sw-w	2.1	30.27	3	69	74	2	1.2
18-Oct	8.67	3.0	0	clr, haze	7.0	sw-w	5.5	30.36	2	75	80	2	2.5
19-Oct	8.67	3.0	0	clr, haze	12.3	sw-w	10.0	30.06	2	64	65	2	7.3
20-Oct	8.58	2.0	0	pc, haze	23.6	sw-w	8.0	30.13	2	63	70	2	10.3
21-Oct	8.58	2.0	0	clr-pc-mc, haze	24.9	sw-w	8.9	30.22	3	69	72	2	2.4
22-Oct	8.58	2.0	0	pc-clr, haze	30.0	sw-w	6.7	30.25	3	62	62	2	6.3
23-Oct	8.50	3.0	0	clr, haze	27.3	sw-w	8.0	30.24	2	69	70	2	4.7
24-Oct	8.50	2.2	0	pc-mc	33.1	sw-nw	10.0	29.97	3	73	76	2	5.5
25-Oct	8.25	2.9	0	ovc-mc, haze	15.9	sw-w	2.0	29.97	4	59	54	1	2.7
26-Oct	0.00												
27-Oct	8.42	2.0	0	clr, haze	26.1	sw-nw	-0.2	30.02	2	70	75	2	6.7
28-Oct	8.42	2.0	0	clr-mc-pc, haze	17.2	sw-w	2.3	30.20	3	54	54	2	1.8
29-Oct	4.50	2.0	0	ovc-mc, blowing snow/dust, rain-haze	57.7	sw-w	3.5	29.99	4	48	38	2	1.6
30-Oct	8.42	3.0	0	clr, haze	25.1	sw-w	5.5	30.23	2	70	70	2	1.7
31-Oct	8.33	2.7	0	pc-ovc	28.5	sw-w	5.6	30.02	4	58	75	0	1.1

[1] Average of hourly records.

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

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

[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. Raptor counts by day and species during fall migration at Commissary Ridge, Wyoming: 2011.

		SPECIES[1]																									BIRDS
DATE	HOURS	TV	OS	NH	SS	CH	NG	SA	LA	UA	BW	SW	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	SF	LF	UF	UU	TOTAL	/HOUR
27-Aug	7.83	0	0	0	0	0	0	0	0	0	2	1	6	0	0	1	1	0	0	0	0	0	0	0	0	0	0	11	1.4
28-Aug	8.75	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	3	0	0	0	0	0	0	0	0	0	0	5	0.6
29-Aug	9.00	0	3	0	0	0	0	0	0	1	0	0	4	1	0	1	2	1	0	0	0	0	0	0	0	0	2	15	1.7
30-Aug	8.17	0	3	0	0	0	0	1	0	1	0	2	3	0	0	0	2	0	1	0	0	0	0	0	0	0	4	17	2.1
31-Aug	9.00	0	1	0	0	2	0	0	0	0	0	2	3	0	0	0	2	0	0	0	0	0	0	0	0	0	1	11	1.2
1-Sep	9.00	1	0	0	0	0	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	5	0.6
2-Sep	9.00	0	1	0	2	1	0	0	0	0	0	0	2	0	0	0	2	0	0	1	0	0	0	0	0	0	0	9	1.0
3-Sep	9.00	2	0	0	2	1	0	0	0	0	0	0	6	0	0	0	3	0	0	2	0	0	0	0	0	0	0	16	1.8
4-Sep	9.00	0	1	0	5	0	0	1	0	0	0	0	14	2	0	1	4	1	0	0	0	0	0	0	0	0	0	29	3.2
5-Sep	9.00	0	1	0	4	0	0	0	0	0	0	3	5	0	0	0	1	1	0	0	0	0	0	0	0	0	0	15	1.7
6-Sep	3.50	0	1	0	2	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	1.7
7-Sep	9.00	0	1	0	1	1	0	0	0	0	0	0	3	0	0	0	2	0	0	0	0	0	0	0	0	0	1	9	1.0
8-Sep	9.00	0	0	0	4	1	0	0	0	0	0	0	8	0	0	0	4	0	0	0	0	0	0	0	0	0	0	17	1.9
9-Sep	9.00	0	0	0	1	0	0	1	0	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	9	1.0
10-Sep	9.00	0	1	0	5	4	0	0	0	0	0	0	0	0	0	4	3	0	0	1	0	0	0	0	0	0	1	19	2.1
11-Sep	8.25	0	1	0	14	11	0	6	0	0	0	5	11	0	0	3	2	0	0	1	0	0	0	0	0	1	3	58	7.0
12-Sep	7.33	1	2	0	10	10	0	7	0	0	0	0	12	0	0	0	2	1	0	4	0	0	0	0	0	0	2	51	7.0
13-Sep	5.00	0	0	0	21	7	0	10	0	0	0	0	7	0	0	1	1	0	0	3	0	0	0	0	0	0	1	51	10.2
14-Sep	2.83	0	0	0	3	0	0	1	0	0	0	1	2	0	0	0	6	0	0	0	0	0	0	0	0	0	0	13	4.6
15-Sep	9.00	0	0	0	15	8	0	9	1	0	0	0	5	0	0	2	3	0	1	7	1	2	1	1	0	0	2	58	6.4
16-Sep	9.00	0	1	0	12	7	0	5	0	0	0	0	5	0	0	1	2	0	0	1	0	0	0	0	0	1	0	35	3.9
17-Sep	8.50	0	8	0	7	4	0	8	0	0	0	36	8	1	0	2	1	2	0	5	0	0	1	0	0	0	0	83	9.8
18-Sep	9.00	1	2	0	35	14	0	6	0	0	0	7	16	0	0	2	0	2	0	1	0	0	1	2	0	0	0	89	9.9
19-Sep	9.00	6	3	1	41	19	1	14	0	0	1	6	14	0	0	1	0	0	0	3	0	0	0	0	0	0	0	110	12.2
20-Sep	9.00	1	2	0	30	7	0	15	0	0	0	3	8	0	0	3	0	0	0	1	0	0	1	0	0	0	1	72	8.0
21-Sep	9.00	1	1	1	45	10	0	11	0	0	4	2	12	0	0	0	0	0	0	5	0	0	0	0	0	0	0	92	10.2
22-Sep	9.00	9	0	1	32	7	0	8	0	0	1	0	10	0	0	0	0	1	0	0	0	1	0	0	0	0	2	72	8.0
23-Sep	9.00	0	0	0	60	9	0	9	0	0	8	1	9	0	0	5	1	0	0	2	0	0	0	0	0	0	3	107	11.9
24-Sep	9.00	0	0	0	16	2	0	6	0	0	4	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	31	3.4

Appendix D. continued

		SPECIES[1]																									BIRDS
DATE	HOURS	TV	OS	NH	SS	CH	NG	SA	LA	UA	BW	SW	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	SF	LF	UF	UU	TOTAL	/HOUR
25-Sep	9.00	0	1	2	65	33	0	11	0	0	0	1	10	0	0	1	0	1	0	2	0	0	0	0	0	0	0	127	14.1
26-Sep	9.00	1	0	0	39	15	0	7	0	0	0	1	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	67	7.4
27-Sep	9.00	9	0	0	36	6	1	8	0	1	0	2	8	0	0	2	0	0	0	1	0	0	0	0	0	0	0	74	8.2
28-Sep	9.00	10	1	0	47	11	0	6	0	0	0	1	4	0	0	0	0	0	0	2	0	0	2	0	0	0	0	84	9.3
29-Sep	9.00	1	0	0	2	1	0	2	0	0	0	1	7	0	0	1	0	0	0	0	0	0	0	0	0	0	1	16	1.8
30-Sep	9.00	2	0	0	42	19	0	10	0	0	0	0	4	0	0	1	0	0	0	5	0	0	0	0	0	0	0	83	9.2
1-Oct	8.50	0	0	0	19	12	1	5	1	0	0	1	1	0	0	0	0	2	0	2	0	0	0	0	0	0	0	44	5.2
2-Oct	9.00	0	0	0	41	14	0	7	0	0	0	0	4	0	0	0	1	0	13	0	0	0	0	0	0	0	0	80	8.9
3-Oct	9.00	0	0	0	7	3	0	13	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4	28	3.1
4-Oct	9.00	0	0	0	35	10	0	1	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	49	5.4
5-Oct	4.58	0	0	0	3	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	1.5
6-Oct	0.00																												
7-Oct	0.00																												
8-Oct	0.00																												
9-Oct	8.00	0	0	0	4	2	0	0	0	0	0	0	0	0	0	5	0	0	0	1	0	0	0	0	0	0	0	12	1.5
10-Oct	9.00	1	0	0	36	6	1	4	0	0	0	0	4	0	0	1	0	0	0	1	0	0	0	0	0	0	0	54	6.0
11-Oct	0.00																												
12-Oct	8.83	0	2	1	46	6	0	1	0	1	1	0	3	0	1	0	0	0	0	8	2	0	0	1	0	0	0	73	8.3
13-Oct	8.83	0	0	0	30	4	0	0	0	0	0	0	8	0	0	1	5	5	0	1	0	0	0	0	0	0	0	54	6.1
14-Oct	8.75	0	0	0	51	5	0	7	0	0	0	0	8	0	0	1	0	0	1	2	0	1	0	0	0	0	1	77	8.8
15-Oct	8.75	0	2	0	86	10	0	3	0	0	0	0	14	0	0	1	5	4	0	0	1	2	0	0	0	0	0	128	14.6
16-Oct	8.75	0	1	1	26	3	0	0	0	0	0	0	5	0	0	0	5	1	0	1	0	0	0	0	0	0	1	44	5.0
17-Oct	8.67	0	1	0	6	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	10	1.2
18-Oct	8.67	0	0	0	13	1	1	0	0	0	0	0	5	0	0	0	0	1	0	1	0	0	0	0	0	0	0	22	2.5
19-Oct	8.67	0	0	0	29	3	0	2	0	0	0	0	13	0	0	0	3	10	0	2	0	0	0	0	0	1	0	63	7.3
20-Oct	8.58	0	0	1	20	1	0	0	0	0	0	0	29	0	0	0	14	21	0	2	0	0	0	0	0	0	0	88	10.3
21-Oct	8.58	0	0	0	9	0	0	1	0	0	0	0	7	0	0	0	3	1	0	0	0	0	0	0	0	0	0	21	2.4
22-Oct	8.58	0	0	0	24	0	1	1	0	0	0	0	7	0	0	0	14	7	0	0	0	0	0	0	0	0	0	54	6.3
23-Oct	8.50	0	0	0	19	1	0	0	0	0	0	0	12	0	0	0	5	2	0	1	0	0	0	0	0	0	0	40	4.7

Appendix D. continued

		SPECIES[1]																									BIRDS
DATE	HOURS	TV	OS	NH	SS	CH	NG	SA	LA	UA	BW	SW	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	SF	LF	UF	UU	TOTAL	/HOUR
24-Oct	8.50	0	0	0	17	0	0	0	0	0	0	0	22	0	0	0	3	3	0	1	0	0	0	0	0	0	1	47	5.5
25-Oct	8.25	0	0	1	5	0	0	0	0	0	0	0	10	0	1	0	5	0	0	0	0	0	0	0	0	0	0	22	2.7
26-Oct	0.00																												
27-Oct	8.42	0	0	0	7	0	2	0	0	0	0	0	4	0	1	0	13	29	0	0	0	0	0	0	0	0	0	56	6.7
28-Oct	8.42	0	0	0	1	0	0	0	0	0	0	0	4	0	1	1	5	3	0	0	0	0	0	0	0	0	0	15	1.8
29-Oct	4.50	0	0	0	1	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	7	1.6
30-Oct	8.42	0	0	0	4	0	1	0	0	0	0	0	2	0	0	0	4	2	0	1	0	0	0	0	0	0	0	14	1.7
31-Oct	8.33	0	0	0	3	0	0	0	0	0	0	0	3	0	0	1	1	1	0	0	0	0	0	0	0	0	0	9	1.1
Total	510.25	46	41	9	1140	296	14	208	2	4	21	80	386	5	4	44	136	102	16	73	5	7	6	4	0	3	32	2684	315.6

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

Appendix E. Annual observation effort and raptor counts by species during fall migration at Commissary Ridge, Wyoming: 2001–2011.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Mean
Start date	3-Sep	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	26-Aug
End date	23-Oct	29-Oct	29-Oct	3-Nov	31-Oct	31-Oct	5-Nov	5-Nov	5-Nov	5-Nov	31-Oct	1-Nov
Observation days	22	45	63	65	64	56	66	66	64	65	61	62
Observation hours	145.88	322.67	474.85	452.67	478.83	443.58	494.56	493.33	531.82	538.58	510.25	470.10
Raptors/100 hrs	1,156	991	644	917	985	415	990	911	559	1040	526	828
SPECIES	RAPTOR COUNTS											
Turkey Vulture	67	97	66	164	114	39	185	150	50	108	46	108
Osprey	16	11	31	59	36	11	41	27	34	54	41	34
Northern Harrier	40	32	25	38	36	26	30	32	38	36	9	33
Sharp-shinned Hawk	303	675	516	1,118	1,687	217	1,214	1,109	690	1425	1,140	961
Cooper's Hawk	256	409	329	614	462	289	535	382	298	669	296	443
Northern Goshawk	11	21	7	49	35	26	89	52	32	35	14	38
Unknown small accipiter	11	78	75	75	55	39	61	25	92	293	208	88
Unknown large accipiter	4	6	13	34	11	6	21	8	17	3	2	13
Unknown accipiter	29	16	58	69	2	6	98	49	15	0	4	35
TOTAL ACCIPITERS	614	1,205	998	1,959	2,252	583	2,018	1,625	1,144	2,425	1,664	1,579
Broad-winged Hawk	1	8	5	22	9	3	7	13	26	58	21	17
Swainson's Hawk	18	82	28	62	52	47	36	352	119	1,211	80	221
Red-tailed Hawk	323	823	1,042	961	1,319	563	1,459	1,148	987	872	386	1,019
Ferruginous Hawk	7	6	3	15	8	7	3	7	9	11	5	8
Rough-legged Hawk	20	5	5	8	13	5	13	34	7	33	4	14
Unidentified buteo	19	17	87	63	42	35	63	144	43	61	44	62
TOTAL BUTEOS	388	941	1,170	1,131	1,443	660	1,581	1,698	1,191	2,246	540	1,340
Golden Eagle	279	352	233	152	316	211	324	345	211	253	136	266
Bald Eagle	72	233	90	76	137	82	299	262	86	193	102	162
Unidentified eagle	5	10	7	10	2	6	25	34	0	16	16	12
TOTAL EAGLES	356	595	330	238	455	299	648	641	297	462	254	441
American Kestrel	166	258	355	403	317	156	229	219	151	196	73	254
Merlin	7	9	6	26	11	10	24	25	23	29	5	18
Prairie Falcon	1	6	5	6	18	13	21	6	4	15	7	10
Peregrine Falcon	5	3	3	11	13	9	18	15	16	20	6	12
Unknown small falcon	2	0	3	6	2	5	3	9	1	1	4	3
Unknown large falcon	5	0	0	5	2	4	6	5	1	1	0	3
Unknown falcon	0	2	0	1	0	7	7	1	1	2	3	2
TOTAL FALCONS	186	278	372	458	363	204	308	280	197	264	98	303
Unidentified raptor	19	38	68	102	19	19	83	39	20	7	32	44
ALL SPECIES	1,686	3,197	3,060	4,149	4,718	1,841	4,894	4,492	2,971	5,602	2,684	3,880

[1] Designations used for the first time in 2001.