FALL 2012 RAPTOR MIGRATION STUDIES AT COMMISSARY RIDGE IN SOUTHWESTERN WYOMING

HawkWatch International, Inc.

Salt Lake City, Utah

HAWKWATCH INTERNATIONAL
Conserving Raptors and Our Shared Environment

April 2013

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April 2013

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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 2012 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 (Figs. 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 05 November. The lead observer, Russell Seeley, conducted full season counts the past two seasons at our long-term raptor migration study site in the Manzano Mountains of New Mexico. For the other two observers, Rya Bubenthaler and Donna Wilhelm, this was their first season conducting raptor migration counts (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 2012 follow Farmer et al. (2007). In comparing 2012 annual statistics against means and 95% confidence intervals for previous seasons, we equate significance with a 2012 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 were again withheld.

RESULTS AND DISCUSSION

WEATHER

Inclement weather caused observers to preclude three full days, and one other day to be severly shortened (reduced observation time to ≤ 4 hours, Appendix C). For comparison, weather, on an average seasonal basis (i.e., 2002-2011) has demonstrated to preclude 5.5, and severly hamper 4.0 days of observations in a given season.

Observers, during active observation periods, recorded skies as predominantly clear to partly cloudy, or fair 40% of the time, 34% as transitional (i.e., changed from fair or partly cloudy to mostly cloudy or overcast during the day, or vice versa), and 26% 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 less clear skies and slightly greater than average conditions that were transitional, and mostly cloudy to overcast. In addition, the season's visibility was highly affected by haze and/or fog (87% of the active observational days vs. 29% on average), as well as a slight increase in rain and/or snow (22% vs. 18%, on average). Despite these conditions, however, visibility was rated above average looking towards both the east (89 km vs.69.6 km on average) and west (88 km vs. 73.2 km on average). The season's temperatures were slightly below par compared with the calculated long-term average (13.0˚ C vs. 13.4˚ C on average), partially contributing to a considerably lower than average ranking of good to excellent thermal lift (15% of days vs. 31.6%, on average).

Wind conditions during this past season were again primarily moderate (12-29 kph, occurring on 57% of the active observation days) and strong (≥ 29 kph, occurring 26% of the time), but less so than on average (i.e., 57.4% and 30.9% for average moderate and strong winds, respectively). Light (< 12 kph) winds, which are the least prevalent, were recorded above average (16% vs. 11.7%, on average). Winds blew primarily from the W-NW (34% vs. 47.6%, on average), SW-NW (26% vs. 10.1%), SW-W (18% vs. 21.0%), SW-NW for a major portion of the day then switching to NE-SE for another major portion of the day (10% vs. 7.0%), and Calm/Variable (9% vs. 1.9%). Winds were also recorded blowing from the NE-SE (1% vs. 6.1%, on average), as well as W-NW/Calm/Variable (1% vs. 1.0%). Thus, although still relatively comparable with previous wind speed and directional trends, winds, this past season were less strong and had a broader SW-NW directional component, rather than a tighter SW-W or W-NW directional consistency.

In summary, with the increase SW-NW wind directional variability, coupled with the considerable below average thermal lift and the decrease in wind strength, raptors may have changed their migratory behavior to migrate more broadly and concentrate less on the ridge. Unfortunately, however, this is only speculative as we currently have no understanding of how weather influences the behavior of migratory raptors to concentrate at this site, and thus, influencing the count.

OBSERVATION EFFORT

Counts occurred on 68 of 71 possible days between 27 August and 5 November (Appendix E), which is significantly above the 2001-2011 long-term average (62 ± 95% CI of 4.0 days). Likewise, the number of observation hours (557.83) was also significantly above average (474.91 ± 37.81), and the seasonal average of 2.3 observers per hour was nonsignificantly above the long-term average of 2.17 ± 0.21 observers (Appendix E).

FLIGHT SUMMARY

Flight Volume and Composition

Observers counted 3,693 migrants of 17 raptor species, which results in a 2% decrease compared to the long-term average (Table 1, and see Appendix D for daily count records). The highlight of the season was a record high count of 32 Merlins, and a near record high count of 350 Golden Eagles (Appendix E). In addition to these two species, counts of four other species (i.e., Northern Goshawks, Ferruginous Hawks, Rough-legged Hawks, and Peregrine Falcons) were also significantly above average, and four others (i.e., Northern Harriers, Red-tailed Hawks, Bald Eagles, and Prairie Falcons) were non-significantly above average (Table 1). Two species (Turkey Vultures and Ospreys) were tallied significantly below average, and five others (i.e., Sharp-shinned Hawks, Cooper's Hawks, Broad-winged Hawks, Swainson's Hawks, and American Kestrels) were tallied nonsignificantly below average (Appendix E).

The overall flight consisted of approximately 39% accipiters, 35% buteos, 16% eagles, 8% falcons, 1% vultures, and ≤ 1% Ospreys, harriers, and unidentified raptors. The season featured higher than average proportions of buteos and eagles; below average proportions of accipiters, falcons, vultures, and Ospreys; and equal proportions of harriers that were on par with long-term averages (Figure 3). This past season, counts of Red-tailed Hawks were the most abundant (28% of total count), followed by Sharp-shinned Hawks (25%), Cooper's Hawks (11%), Golden Eagles (9%), Bald Eagles (6%), American Kestrels (6%), and Swainson's Hawks (4%, Appendix E). All other species each comprised ≤ 1% of the total (Appendix E).

Passage Rates and Long-term Trends

Excluding 2001 as an exploratory year, this past season was the eleventh year of full-season counts, so this is the second straight year of conducting statistical analyses for estimating long term population trends (cf. Farmer and Hussell 2008).

Regression analyses of the adjusted passage rates reveal significant ($P \leq 0.10$) linear declines for Turkey Vultures (Fig. 5), Northern Harriers (Fig. 5), and American Kestrels (Fig. 9), as well as a quadratic decline for Peregrine Falcons (Fig. 9). Last year, analyses revealed significant declines for non-adult Golden Eagles, as well as quadratic declines for Northern Goshawks and Red-tailed Hawks (Hawks and Mika 2012). Unfortunately, a formula calculation error truncated the species' passage rate margins too much at 80%, rather than 95%; thus, missing an important percentage of migrants representative of early, but especially later migrant birds. The Broad-winged Hawk is the only species showing a significant increase (Fig. 7). The significant decline for Turkey Vultures is marginally significant (P-value = 0.098), with relatively little information explained by the model ($r^2 = 0.275$). Thus, inferring significance should be done with caution due to the likelihood of a Type I error. For Northern Harriers, although they are commonly observed, less than 40 are typically counted on an annual basis (Appendix E). Nevertheless, a convincingly significant ($r^2 = 0.365$, P-value = 0.049) decline (slope = -0.393, Fig. 5) has emerged as base

line evidence for initial concern and continued monitoring. Evidence for the recent American Kestrel decline continue and have been widespread throughout North America (see Journal of Raptor Research 2009, Vol. 43, No. 4). Investigations involving an extensive cooperative effort are currently underway to help understand potential reasons (cf. The Peregrine Fund's American Kestrel Partnership; http://kestrel.peregrinefund.org/). Like Northern Harriers, the Peregrine Falcon is another species that are counted in low numbers on an annual basis (Appendix E). The quadratic pattern that has emerge may be the result of a beginning autocorrelative cyclic pattern, but more monitoring and further analyses will need to be conducted. Lastly, the significant increase for Broad-winged Hawks that has emerged (Fig. 7) is marginal (P-value = 0.08), with relatively little information explained by the model ($r^2 = 0.290$). Thus, similar to Turkey Vultures, inferring significance should be done with caution due to the likelihood of a Type I error. Whether these emerging patterns continue to demonstrate population declines, increases, or the potential for cyclic patterns is unknown at this point but continued monitoring efforts in future years will try to shed light on population trends of these and other species.

Age Ratios

In four species (i.e., Northern Harriers, Cooper's Hawks, Northern Goshawks, and Golden Eagles), this past season's patterns of immature : adult age ratios deviated compared to the long-term norm (Table 2). With Northern Harriers, usually the counts of adults outnumber those of immatures but this past season's identified immature and adults came through in an equal proportion (Table 2). With Cooper's Hawks, Northern Goshawks, and Golden Eagles, usually more immatures are counted but this past season observers identified a greater proportion of adult Cooper's and Northern Goshawks but nearly equal proportions of adult and non-adult Golden Eagles migrating through (Table 2). Immature : adult age ratios were above average for Ferruginous Hawks but were below average for the rest of the species (Table 2). Accurate age and gender identifications allow us to understand flight volumes, passage dates, and trends in a more detailed context. However, 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). Thus, 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. In addition, whether these changes are the result of observer limitations, low reproductive success, or slight changes in behavior, is unknown but a regression of the long-term time-series can be insightfull to help figure out if it is the adult or the young age class of a species that is in decline, for example.

Daily and Seasonal Migration Patterns

With a few deviations, this past season's daily migration patterns matched similarly with long-term averages (Fig. 4). Normally, migration peaks during the 1000 H, but this past season migration peaked during the 1100 H period. From 1200 H through the 1400 H time periods, this past season's migration count numbers made a slow gradual decline; whereas, normally migration levels off during these time periods (Fig. 4). The season's numbers then made a slight increase during the 1500 H period, followed by a rapid decline during the last two hour time periods, where normally, after the 1400 H time period the decline is more subtle through the 1600 H time period, then drops off tremendously during the last hour (Fig. 4).

For comparisons of migration phenology throughout the whole season, the combined-species median passage date of 03 October was a significant six days later than the long-term average (Table 3). The distribution followed an approximate sinusoidal pattern identifying and separating out approximately four peaks, descending as the season progressed, which shows considerable deviations compared to the norm (Fig. 10).

When comparing the average migration phenology, four species (i.e., Broad-winged Hawks, Swainson's Hawks, American Kestrels, and Prairie Falcons) as a whole, arrived three to nine days early, while the rest of the species arrived one to eleven days later than the norm (Table 3).The age specific median passage dates for most species shifted similarly, except for both age groups of Sharp-shinned Hawks and

immature Cooper's Hawks arriving early, as well as immature Northern Harriers, adult Northern Goshawks, and Golden Eagles arriving on parr compared to the long-term norm (Table 4). Considering the large proportion of birds that were not aged (Table 2), any discrepancy between the overall species-specific and species' age-specific arrival times is unsuprising. Comparing seasonal timing on a year-to-year basis can be insightful to learn how much variation is possible, but it is most insightful to investigate changes in migration phenology over several years to learn if species and/or age-specific migration passage timing has shifted significantly early or later.

TRAPPING AND BANDING SUMMARY

Due to budgetary constraints, the trapping and banding efforts were again withheld, but we hope this next season to resume with part time efforts for strategic banding and physiological blood sampling.

RESIDENT RAPTORS

Again this past season there were quite a few resident raptors identified based on behavior of territorial display, consistent hunting near a general location, and flying in non-migratory directions. For some species (e.g., Red-tailed Hawks, Golden and Bald Eagles), keeping track of a rather large number of individuals was sometimes difficult.

For Red-tailed Hawks, at least six birds perhaps representing two family groups were identified throughout the season; two adult light morphs, one adult dark morph, and three immature light morphs. The last time an immature was observed was on 20 October, adult light and dark morphs were seen on 31 October, but through the last five days only an adult light morph was observed, and that was on the last day, 05 November. Resident Swainson's Hawks were observed on four separate occasions; three light morphs on 27 August, two light morphs and a dark morph on 20 September, four birds on 22 September, and one light morph on 01 October. Most of these sightings occurred quite disparately. Therefore, all these birds may have been distinct and may have only used the site briefly as a short stopover. A single observation of an immature light morph Ferruginous Hawk was also recorded on 09 September, which may have also used the site as a brief stopover as well. Near the end of the season, beginning on 21 October, Rough-legged Hawks began taking up residence. On that day, an adult light morph and two other Rough-legged Hawks of unknown gender, age, and morphology were also observed. Two adult light morphs were observed on 03 November. Otherwise, individual Rough-legged Hawks were observed on eight separate dates from 27 October through the end of the season. For most of these sightings, the birds were recorded as light morphs, and were often adults. However, on 01 and 02 November, the birds were only recorded as Rough-legged Hawks, and their morphology, age, and gender was unknown. Finally, the Rough-legged Hawk that was seen on 27 October was identified as being an adult female light morph, which was the only time the gender was able to be identified, or recorded.

Resident Golden Eagle observations were also common throughout the season. From the beginning and throughout the season, the observers commonly recorded an adult and sub-adult. On 06 September, the observers recorded two adults; two non-adults and one adult on 16 September; three adults on 29 September; two immatures and a sub-adult on 14 October; and an adult, two immatures, and a sub-adult on 31 October. Thus, it is difficult to tell how many total resident Golden Eagles there were throughout the season but at least three adults, two immatures, and a sub-adult were identified. A number of resident Bald Eagles were also observed and recorded starting from 05 September through the end of the season. Adults were recorded on 13 separate dates but on 18 October, three adults were observed and recorded, and on 27 October, two adults were recorded. Sub-adults were recorded on eleven separate dates, where a one-year old bird was identified on 07 and 15 October; three year olds on 05 September, 10 and 15 October, as well as on 03 and 04 November; and four year olds on 12 September, 06 October, as well as on 02 and 04 November. Other sub-adults and immatures were also recorded so it is unknown if some of these birds were residents throughout the season, or if others came in and established temporary residency as the season progressed.

From the beginning of the season up through 26 September, an American Kestrel male and female were seen regularly. That was the last date a female was last seen but a male continued to be recorded up through 06 October. On 08 September, the observers recorded two males and one female, and on 13 September, they recorded one male and two females. Thus, it can be inferred that during the season there were at least two resident American Kestrel males and two females. Resident Peregrine and Prairie Falcons were also observed. Peregrines were observed from 29 August up through 24 September. On 04 September, the observers recorded an adult and immature, possibly indicating a local reproductive effort producing at least one young. Resident Prairie Falcons were recorded beginning 13 September through near the end, 04 November. On two separate dates, 14 and 16 October, the observers recorded seeing two Prairie Falcons as resident birds. It is unknown whether any of the sightings were of young or adults so it is difficult to conclude anything about local reproductive effort.

For accipiters, observers recorded seeing Sharp-shinned Hawks from the beginning up through 05 October. They recorded an adult female on 09 September, two immatures and an adult on 21 September, and an adult male on 05 October. On multiple dates they identified an immature as being a male but the immature they saw on 06 September, they identified it as being a female. This may suggest a local family unit but that is uncertain since they weren't marked. Nine different sightings of resident Cooper's Hawks were recorded throughout the season from 30 August through the last day. On 10 September, the observers recorded seeing an immature; whereas, the rest of the sightings were either that of an adult bird, or a Cooper's Hawk of unknown age. Resident Northern Goshawks were also seen on ten separate dates. Adults were recorded on five dates and immatures on the remainder. Two immatures were recorded on 20 September, one adult and immature on 02 November, and two adults on 05 November. This could have also been a local family unit but none were marked so that is unknown.

Other birds that were recorded were Northern Harriers, Turkey Vultures, and an Osprey. An immature Northern Harrier was recorded multiple times throughout the season from the beginning, 27 August, through 09 October. On 28 September, both an immature and an adult male were seen and recorded as residents. Turkey Vultures were seen from 28 August through 29 September. Initially, three were observed, then on 01 September, the observers identified the birds to be two adults and one immature. Four birds were seen on 15 September but it is unknown what the ages were. Again, whether this was a local family group, is unknown. The last resident bird identified for the season was an Osprey, seen on 10 September.

SITE VISITATION AND PUBLIC OUTREACH

This past season, a total of 21 visitors signed the registration list. Including Wyoming, these folks came from Utah, Iowa, and Oklahoma. As in past years, the crew continued to make good local acquaintenances by visiting with hunters, as well as in nearby Kemmerer.

ACKNOWLEDGMENTS

Funding for the 2012 project was provided by the Bureau of Land Management – Kemmerer Field Office, as well as HWI private donors and members. We also would like to thank the BLM for providing essential logistical support, such as a place to get local water and dump waste.

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Table 1. Annual raptor migration counts and passage rates by species at Commissary Ridge, Wyoming: 2002–2011 versus 2012.

	COUNTS			RAPTORS/100 HOURS		
SPECIES	2002–2011[1]	2012	% CHANGE	2002–2011[1]	2012	% CHANGE
Turkey Vulture	101.9 ± 32.2	50	-51	38.5 ± 12.9	13.5	-65
Osprey	34.5 ± 9.8	25	-28	9.3 ± 2.3	5.7	-39
Northern Harrier	30.2 ± 5.4	32	+6	6.6 ± 1.4	5.6	-16
Sharp-shinned Hawk	979.1 ± 276.3	924	-6	295.9 ± 74.2	227.8	-23
Cooper's Hawk	428.3 ± 85.5	393	-8	146.5 ± 28.8	101.6	-31
Northern Goshawk	36.0 ± 14.5	53	+47	8.8 ± 3.5	9.6	+9
Unknown small accipiter	100.1 ± 52.1	45	-55	–	–	–
Unknown large accipiter	12.1 ± 6.1	4	-67	–	–	–
Unknown accipiter	31.7 ± 21.3	1	-97	–	–	–
TOTAL ACCIPITERS	1,587.3 ± 368.0	1,420	-11	–	–	–
Broad-winged Hawk	17.2 ± 10.1	16	-7	6.4 ± 3.6	5.2	-19
Swainson's Hawk	206.9 ± 226.4	153	-26	91.3 ± 94.4	61.4	-33
Red-tailed Hawk	956.0 ± 199.7	1,043	+9	239.4 ± 50.6	217.7	-9
Ferruginous Hawk	7.4 ± 2.3	11	+49	1.8 ± 0.6	2.4	+37
Rough-legged Hawk	12.7 ± 7.1	24	+89	4.1 ± 2.1	6.3	+52
Unidentified buteo	59.9 ± 21.8	31	-48	–	–	–
TOTAL BUTEOS	1,260.1 ± 314.0	1,278	+1	–	–	–
Golden Eagle	253.3 ± 48.5	350	+38	58.0 ± 15.7	65.9	+14
Bald Eagle	156.0 ± 52.0	207	+33	48.0 ± 17.2	44.7	-7
Unidentified eagle	12.6 ± 6.5	39	+210	–	–	–
TOTAL EAGLES	440.6 ± 103.7	254	-42	–	–	–
American Kestrel	235.7 ± 62.4	209	-11	81.6 ± 23.0	60.1	-26
Merlin	16.8 ± 5.8	32	+90	4.4 ± 1.5	7.1	+61
Prairie Falcon	10.1 ± 3.8	13	+29	2.9 ± 1.0	3.4	+17
Peregrine Falcon	11.4 ± 3.8	17	+49	3.2 ± 1.1	4.4	+37
Unknown small falcon	3.4 ± 1.7	4	+18	–	–	–
Unknown large falcon	2.4 ± 1.5	4	+67	–	–	–
Unknown falcon	2.4 ± 1.6	0	-100	–	–	–
TOTAL FALCONS	282.2 ± 63.3	279	-1	–	–	–
Unidentified raptor	42.7 ± 19.4	13	-70	–	–	–
GRAND TOTAL	3,760.8 ± 732.0	3,693	-2	–	–	–

[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: 2002–2011 versus 2012.

	Total and Age-classified Counts								Immature : Adult	
	2002–2011 Average			2012			% Unknown Age		Ratio	
Species	Total	Imm.	Adult	Total	Imm.	Adult	2002–2011[1]	2012	2002–2011[1]	2012
Northern Harrier	30	8	10	32	11	11	45 ± 12.3	31	0.8 ± 0.3	1.0
Sharp-shinned Hawk	979	252	320	924	246	368	42 ± 6.3	34	0.9 ± 0.3	0.7
Cooper's Hawk	428	123	123	393	79	163	44 ± 9.2	38	1.0 ± 0.3	0.5
Northern Goshawk	36	12	9	53	20	22	29 ± 17.8	21	1.6 ± 1.1	0.9
Broad-winged Hawk	17	2	6	16	2	11	56 ± 17.6	19	0.5 ± 0.3	0.2
Red-tailed Hawk	956	195	507	1043	211	713	28 ± 7.0	11	0.4 ± 0.2	0.3
Ferruginous Hawk	7	2	2	11	6	3	52 ± 20.0	18	1.5 ± 0.7	2.0
Golden Eagle	253	132	85	350	155	156	15 ± 4.3	11	1.6 ± 0.2	1.0
Bald Eagle	156	52	101	207	53	140	2 ± 0.9	7	0.5 ± 0.0	0.4
Peregrine Falcon	11	2	4	17	2	11	53 ± 20.3	24	0.6 ± 0.4	0.2

[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 2012, with comparisons of 2012 and 2002–2011 average median passage dates.

	2012				2002–2011
Species	First Observed	Last Observed	Bulk Passage Dates[1]	Median Passage Date[2]	Median Passage Date[2, 3]
Turkey Vulture	02-Sep	10-Oct	14-Sep – 07-Oct	26-Sep	23-Sep ± 1.7
Osprey	01-Sep	19-Oct	02-Sep – 14-Oct	17-Sep	16-Sep ± 2.3
Northern Harrier	28-Aug	03-Nov	02-Sep – 01-Nov	28-Sep	27-Sep ± 4.5
Sharp-shinned Hawk	27-Aug	01-Nov	10-Sep – 12-Oct	29-Sep	26-Sep ± 2.0
Cooper's Hawk	28-Aug	04-Nov	11-Sep – 14-Oct	29-Sep	22-Sep ± 2.1
Northern Goshawk	02-Sep	05-Nov	06-Sep – 03-Nov	15-Oct	09-Oct ± 5.6
Broad-winged Hawk	11-Sep	12-Oct	12-Sep – 12-Oct	20-Sep	24-Sep ± 1.8
Swainson's Hawk	27-Aug	29-Sep	10-Sep – 15-Sep	11-Sep	21-Sep ± 4.0
Red-tailed Hawk	30-Aug	05-Nov	11-Sep – 27-Oct	15-Oct	04-Oct ± 4.7
Ferruginous Hawk	08-Sep	21-Oct	14-Sep – 15-Oct	01-Oct	24-Sep ± 8.8
Rough-legged Hawk	19-Sep	05-Nov	14-Oct – 05-Nov	27-Oct	22-Oct ± 3.0
Golden Eagle	27-Aug	05-Nov	28-Sep – 03-Nov	16-Oct	13-Oct ± 3.4
Bald Eagle	02-Sep	05-Nov	12-Oct – 04-Nov	31-Oct	21-Oct ± 3.1
American Kestrel	27-Aug	22-Oct	05-Sep – 02-Oct	17-Sep	21-Sep ± 2.0
Merlin	06-Sep	03-Nov	12-Sep – 30-Oct	10-Oct	04-Oct ± 5.1
Prairie Falcon	28-Aug	14-Oct	04-Sep – 10-Oct	23-Sep	26-Sep ± 5.0
Peregrine Falcon	02-Sep	24-Oct	04-Sep – 03-Oct	24-Sep	22-Sep ± 2.7
Total	27-Aug	05-Nov	10-Sep – 30-Oct	03-Oct	27-Sep ± 1.4

[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: 2002–2011 versus 2012.

	ADULT		IMMATURE / SUBADULT	
SPECIES	2002–2011[1]	2012	2002–2011[1]	2012
Northern Harrier	07-Oct ± 9.9	19-Oct	30-Sep ± 6.1	20-Sep
Sharp-shinned Hawk	04-Oct ± 3.4	03-Oct	22-Sep ± 3.3	16-Sep
Cooper's Hawk	23-Sep ± 2.2	02-Oct	19-Sep ± 2.8	16-Sep
Northern Goshawk	20-Oct ± 6.8	20-Oct	01-Oct ± 8.4	07-Oct
Broad-winged Hawk	23-Sep ± 3.0	20-Sep	25-Sep ± 0.0	–
Red-tailed Hawk	09-Oct ± 4.1	16-Oct	27-Sep ± 4.1	29-Sep
Golden Eagle	18-Oct ± 3.8	18-Oct	11-Oct ± 3.6	15-Oct
Bald Eagle	21-Oct ± 3.1	31-Oct	21-Oct ± 3.3	31-Oct
Peregrine Falcon	21-Sep ± 3.8	24-Sep	06-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.

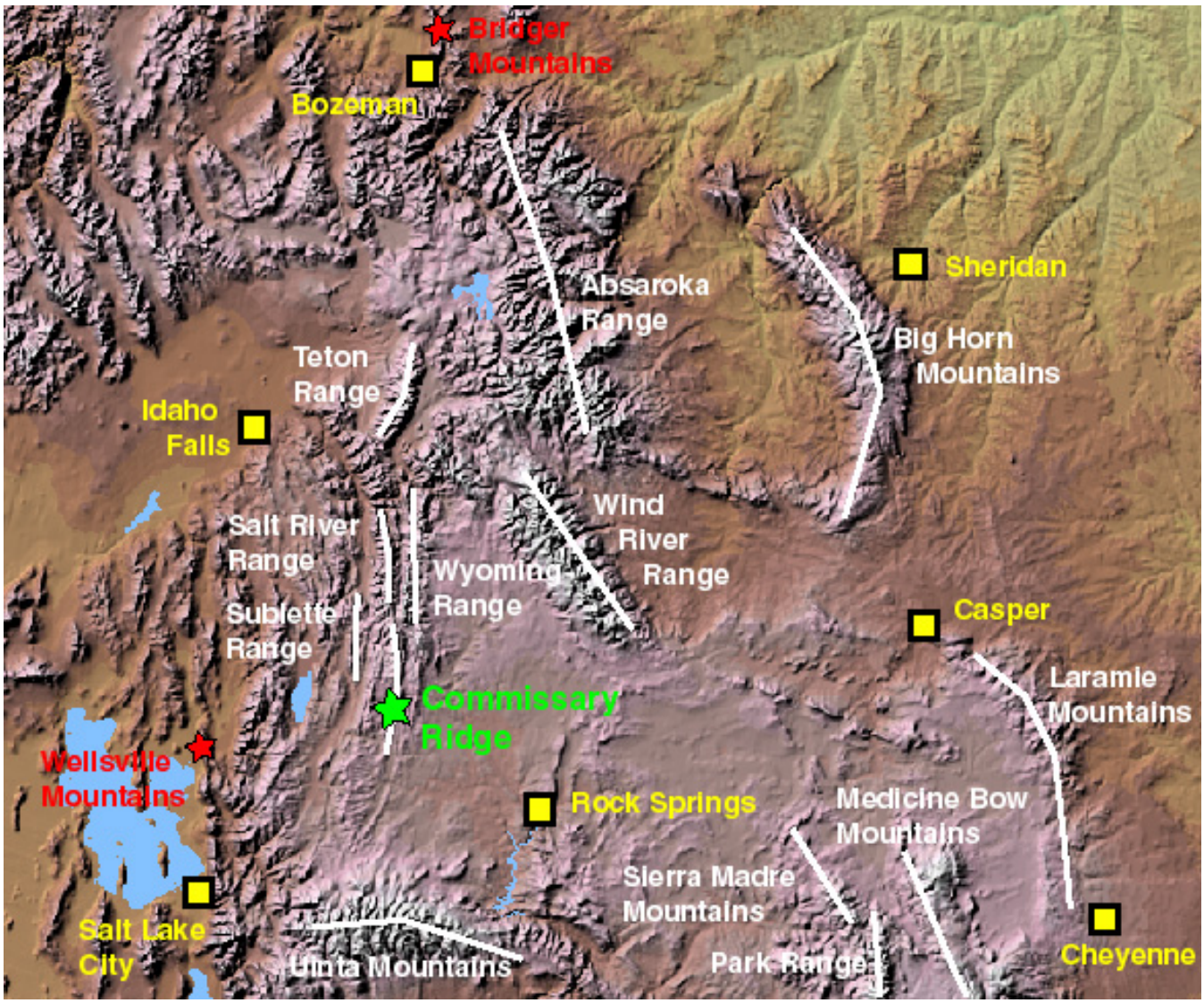

Figure 1. Location of Commissary Ridge Raptor Migration Project site in southwestern Wyoming. Red stars indicate other nearby HWI fall migration monitoring sites in Utah (currently inactive) and Montana.

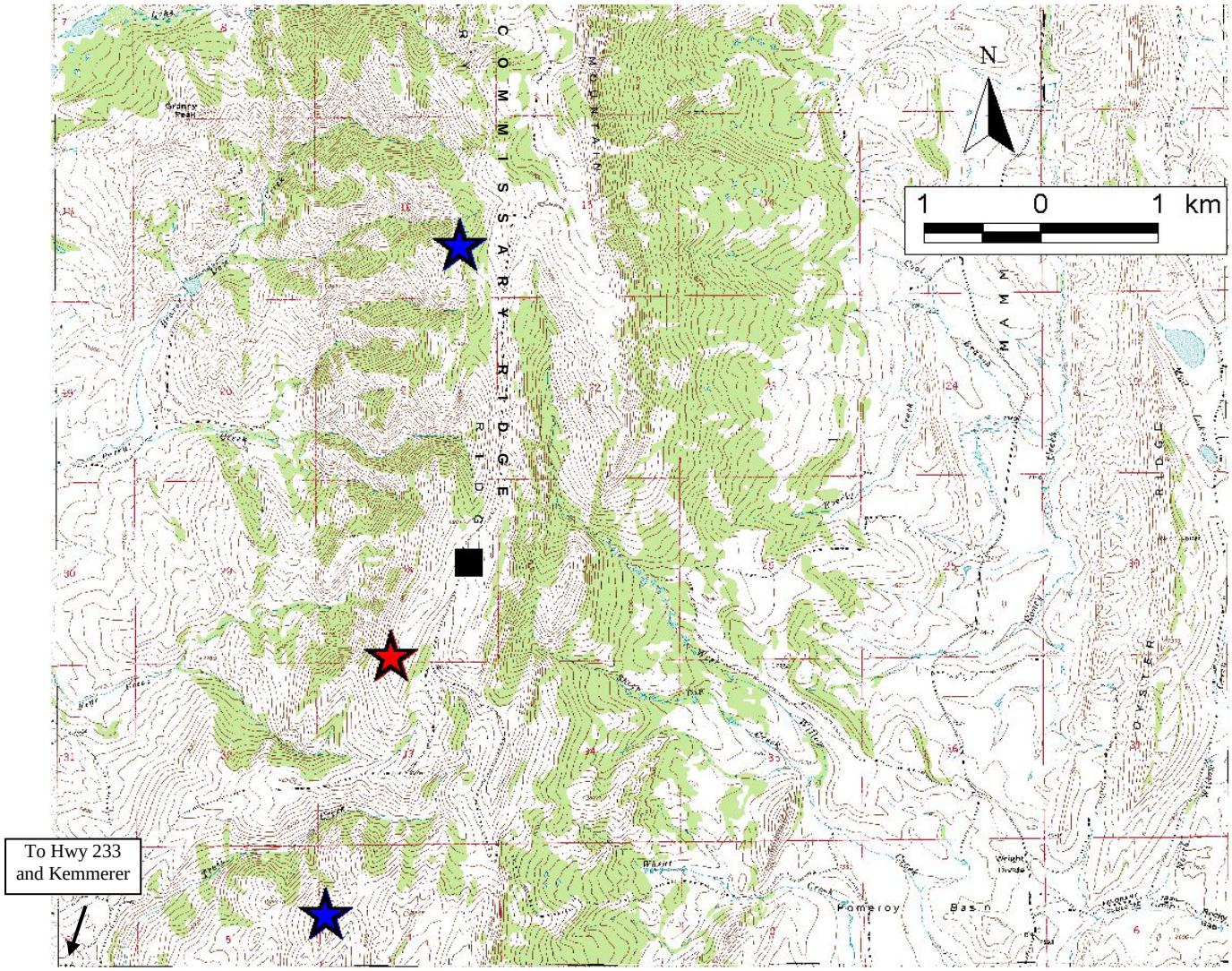

Figure 2. Close-up of Commissary Ridge Raptor Migration Project study site in southwestern Wyoming showing locations of the observation post (red star), the trapping locations (blue stars; both inactive), and base camp (black square).

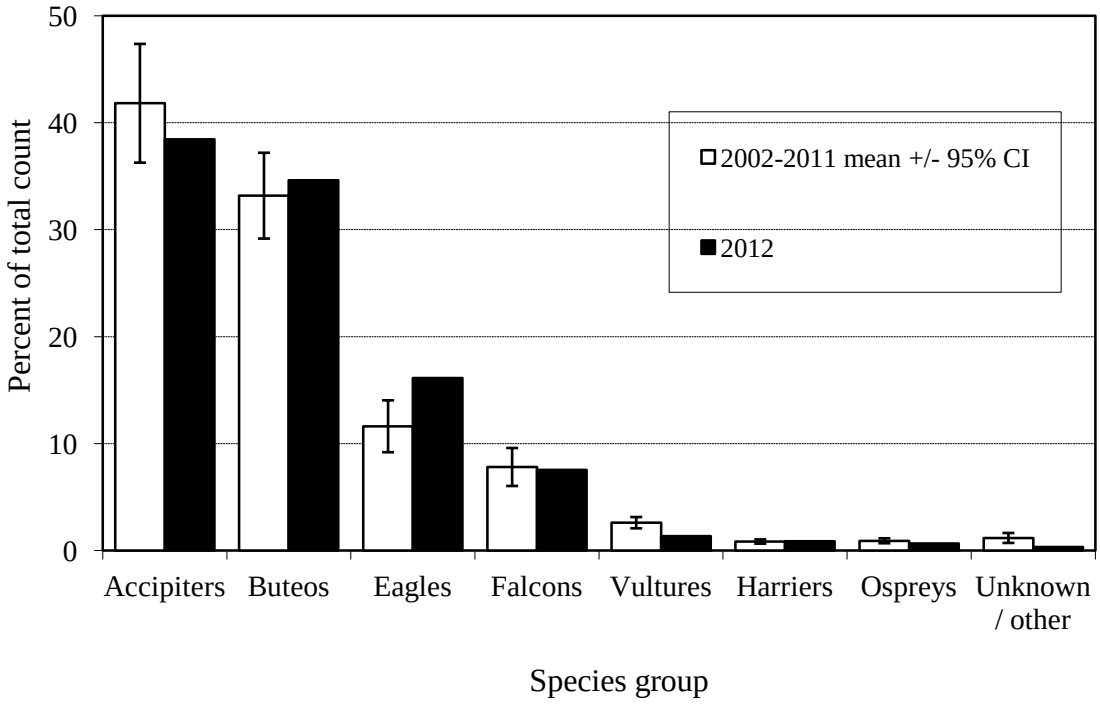

Figure 3. Composition by major species groups of the fall raptor migration at Commissary Ridge, Wyoming: 2002–2011 versus 2012.

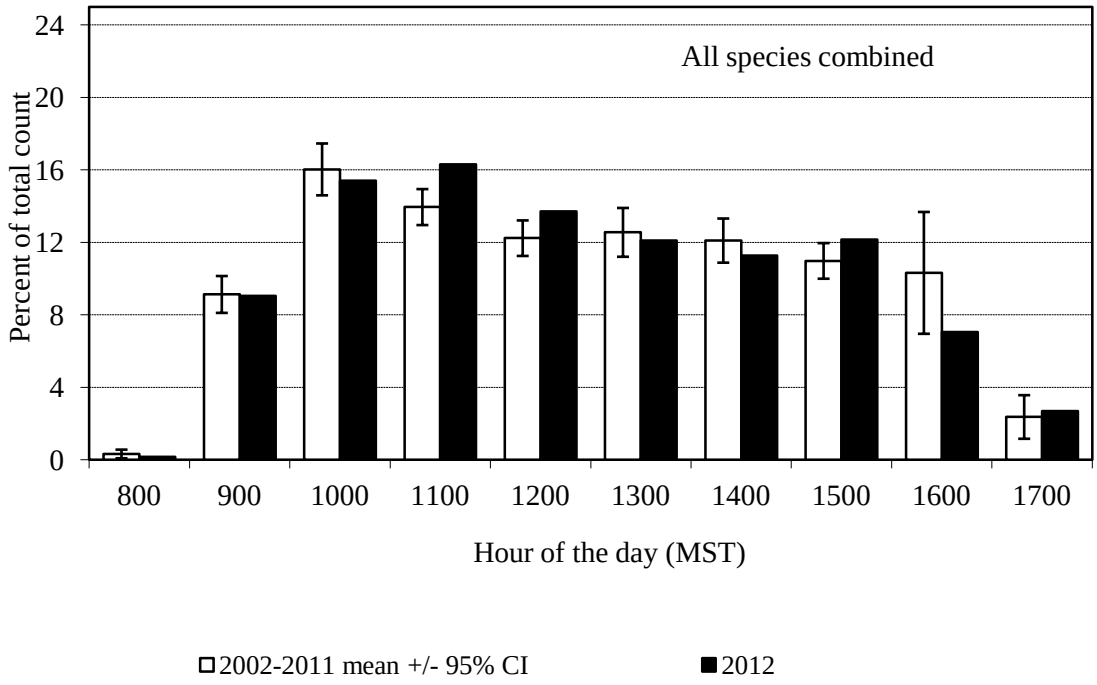

Figure 4. Daily rhythm of the fall raptor migration at Commissary Ridge, Wyoming: 2002–2011 versus 2012.

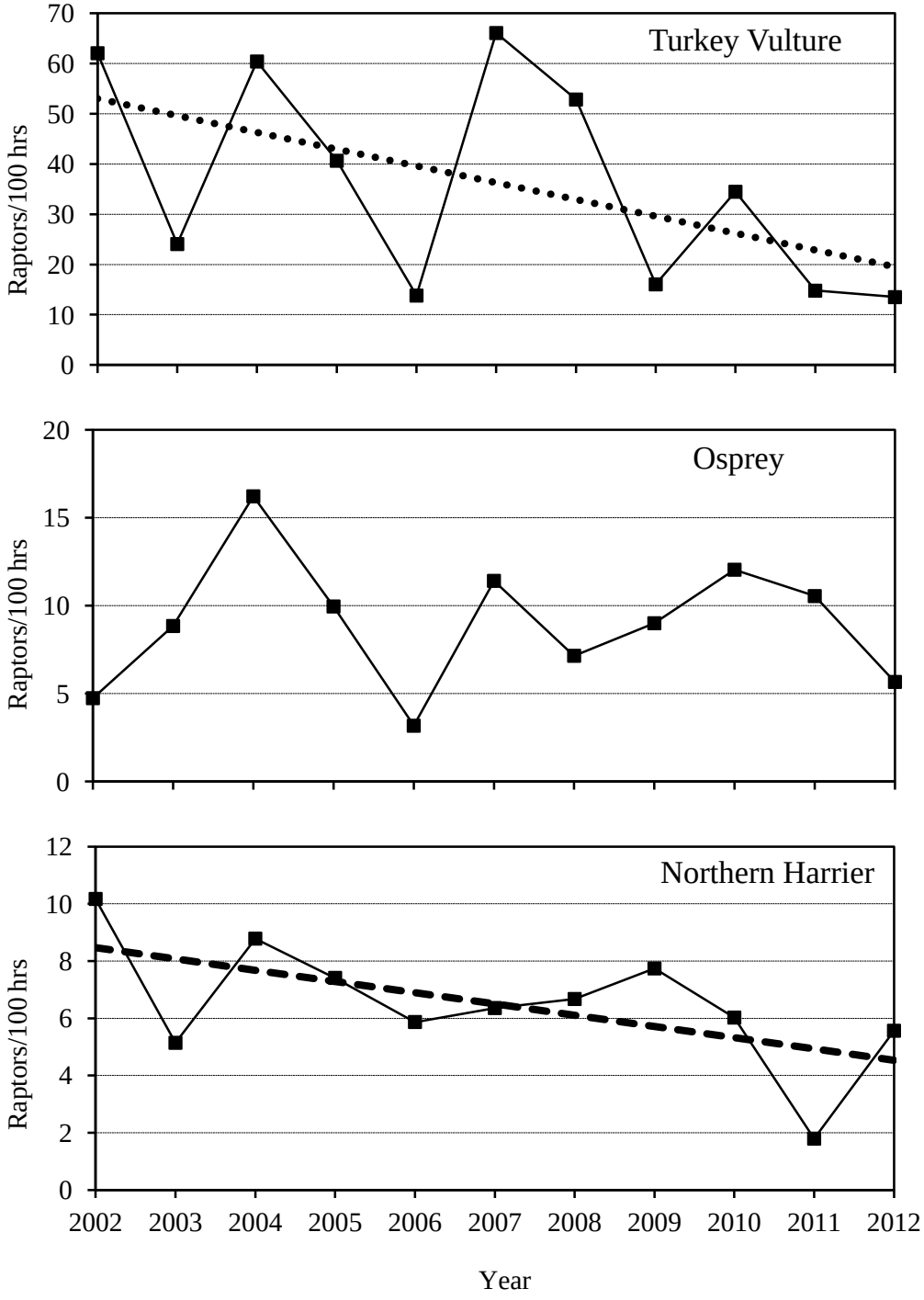

Figure 5. Adjusted fall-migration passage rates at Commissary Ridge, WY for Turkey Vultures, Ospreys, and Northern Harriers: 2002–2012. Dashed lines indicate significant linear or quadratic regressions.

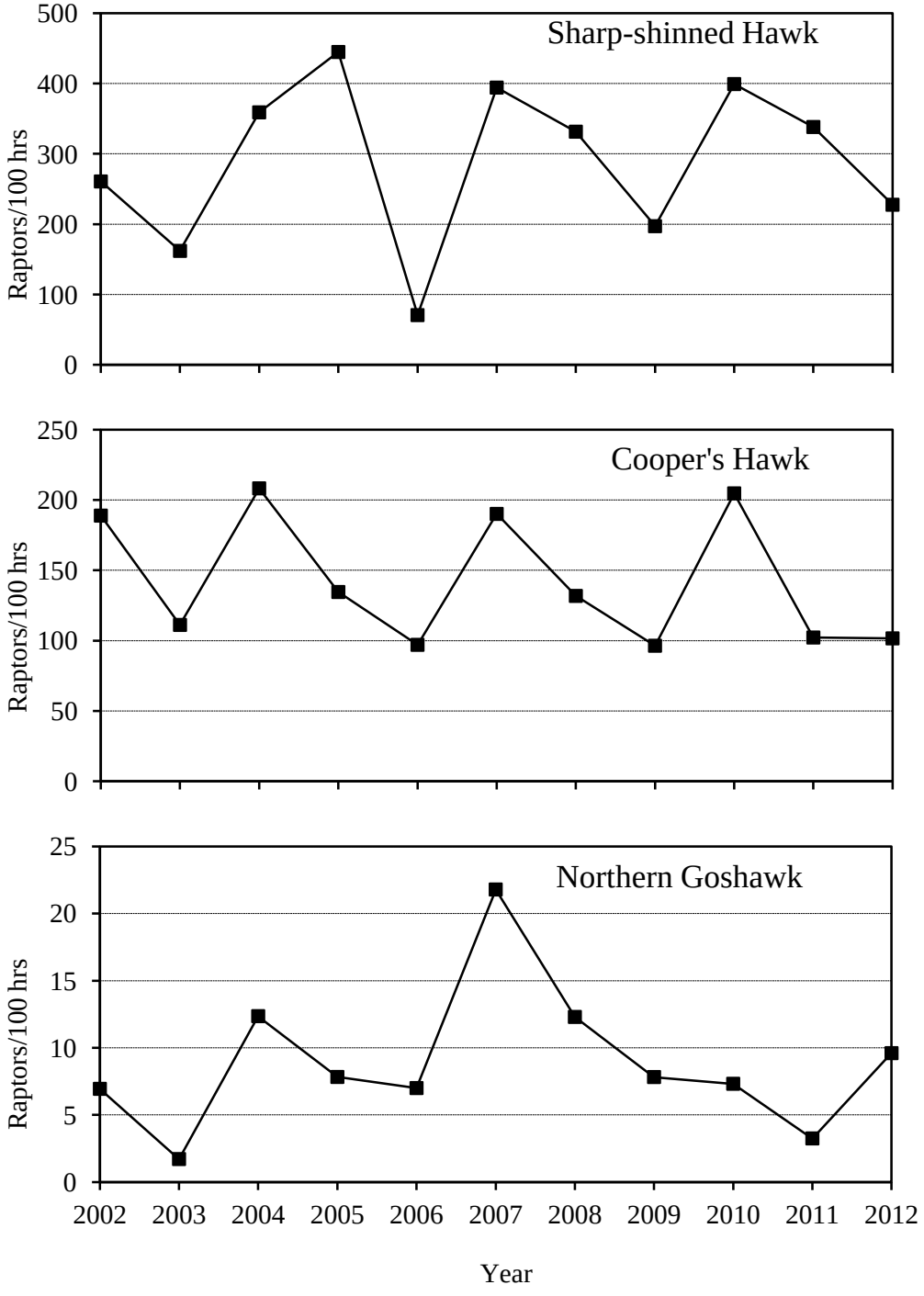

Figure 6. Adjusted fall-migration passage rates at Commissary Ridge, WY for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks: 2002–2012. Dashed lines indicate significant linear or quadratic regressions.

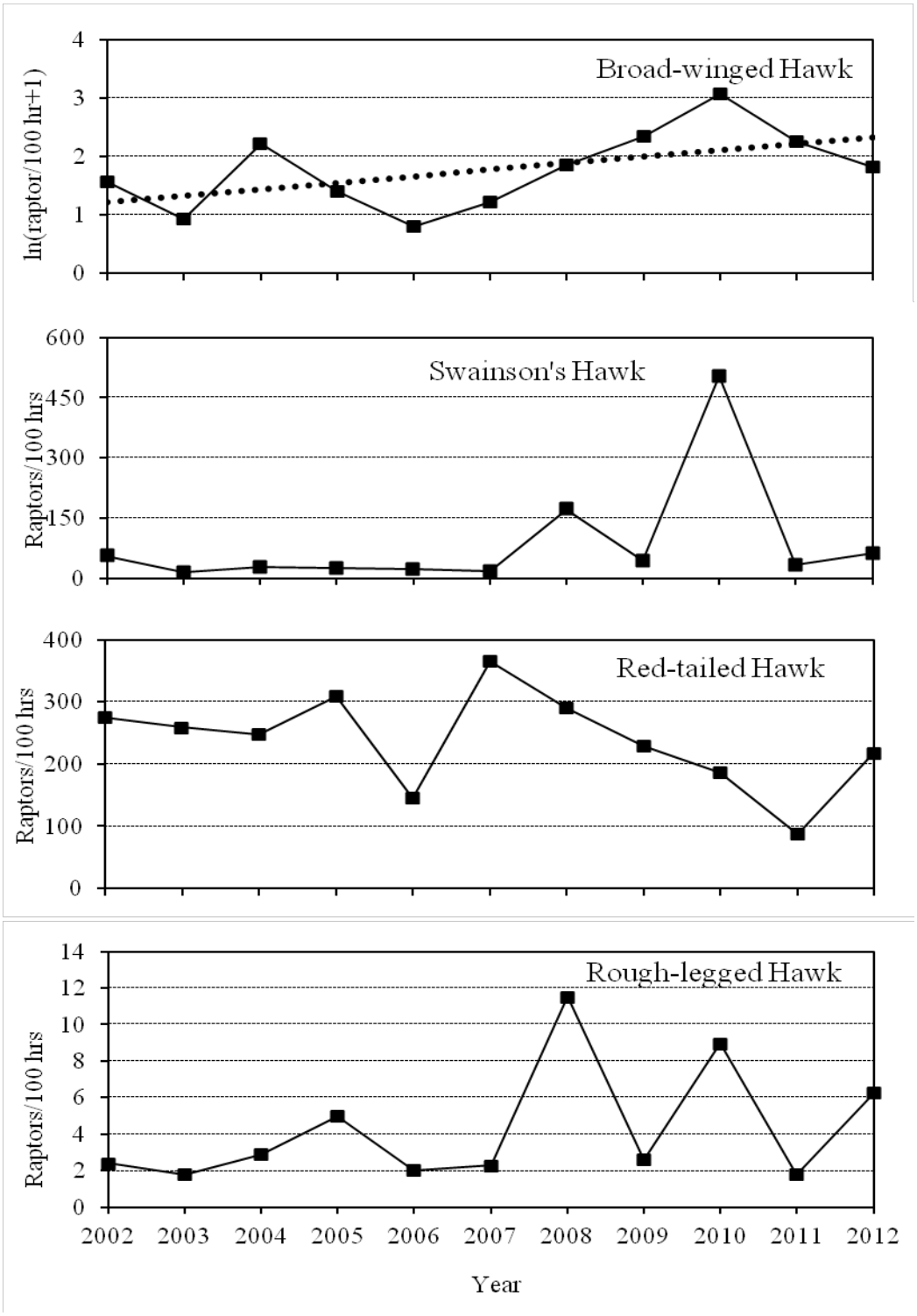

Figure 7. Adjusted fall-migration passage rates at Commissary Ridge, WY for Broad-winged, Swainson's, Red-tailed, and Rough-legged Hawks: 2002–2012. Dashed lines indicate significant linear or quadratic regressions.

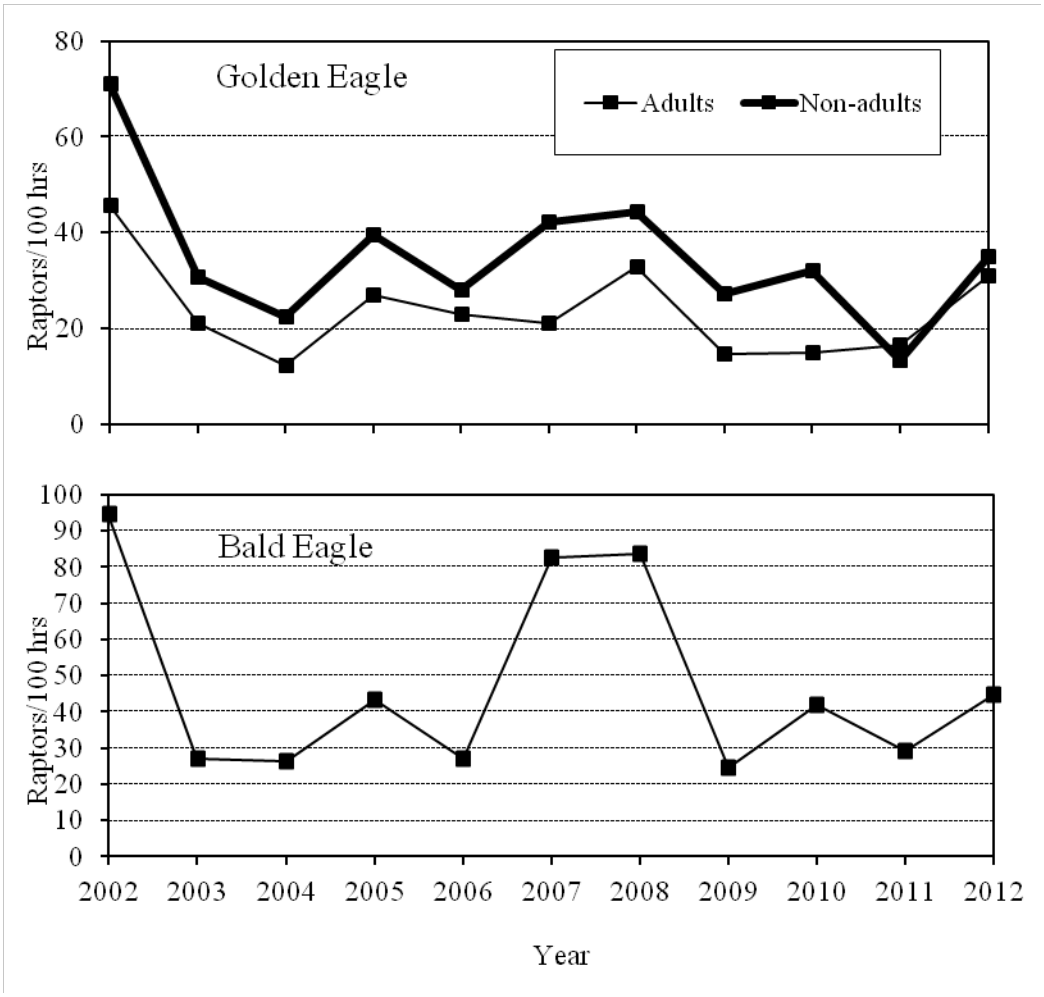

Figure 8. Adjusted fall-migration passage rates at Commissary Ridge, WY for Golden and Bald Eagles: 2002–2012. Dashed lines indicate significant linear or quadratic regressions.

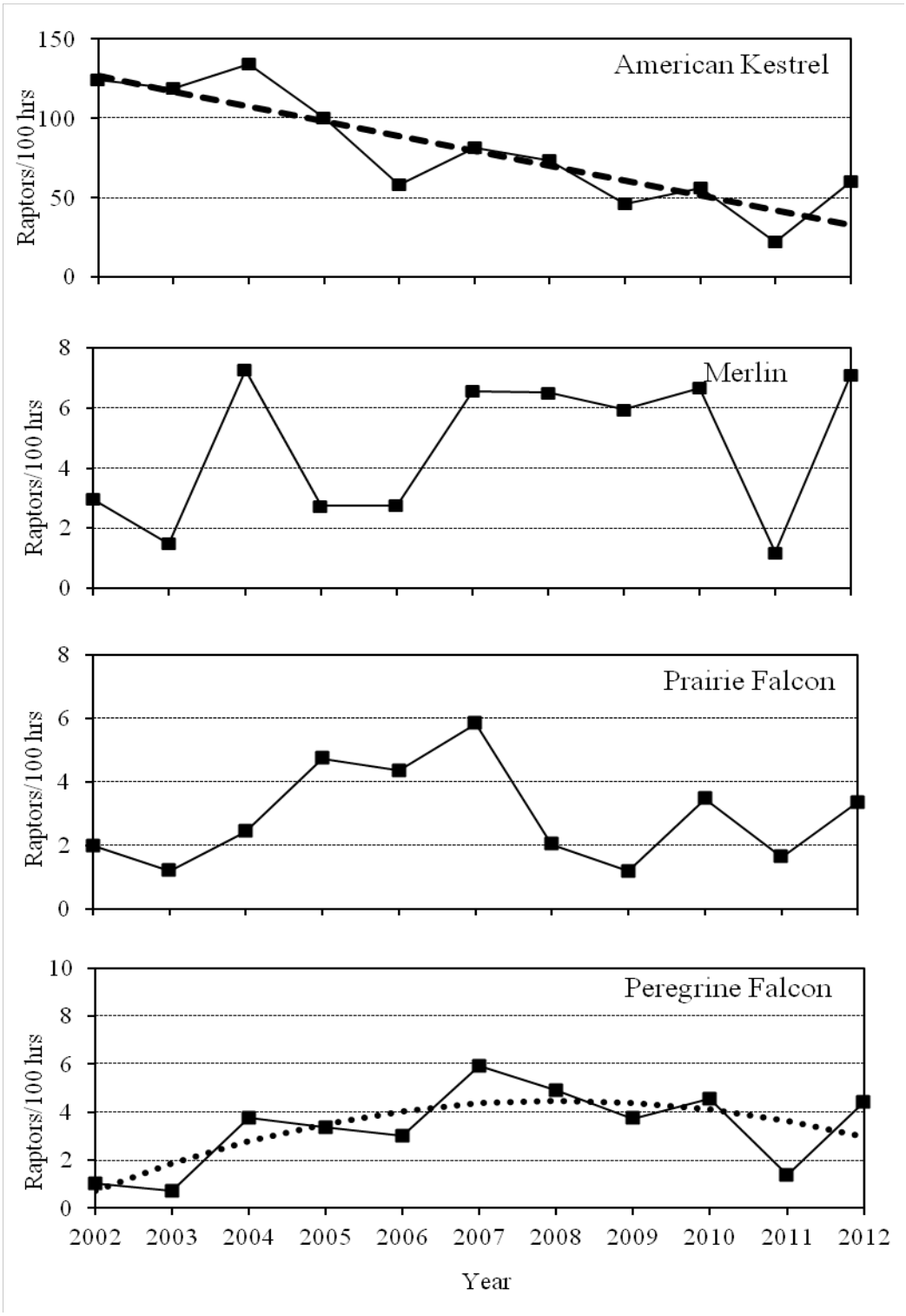

Figure 9. Adjusted fall-migration passage rates at Commissary Ridge, WY for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons: 2002–2012. Dashed lines indicate significant linear or quadratic regressions.

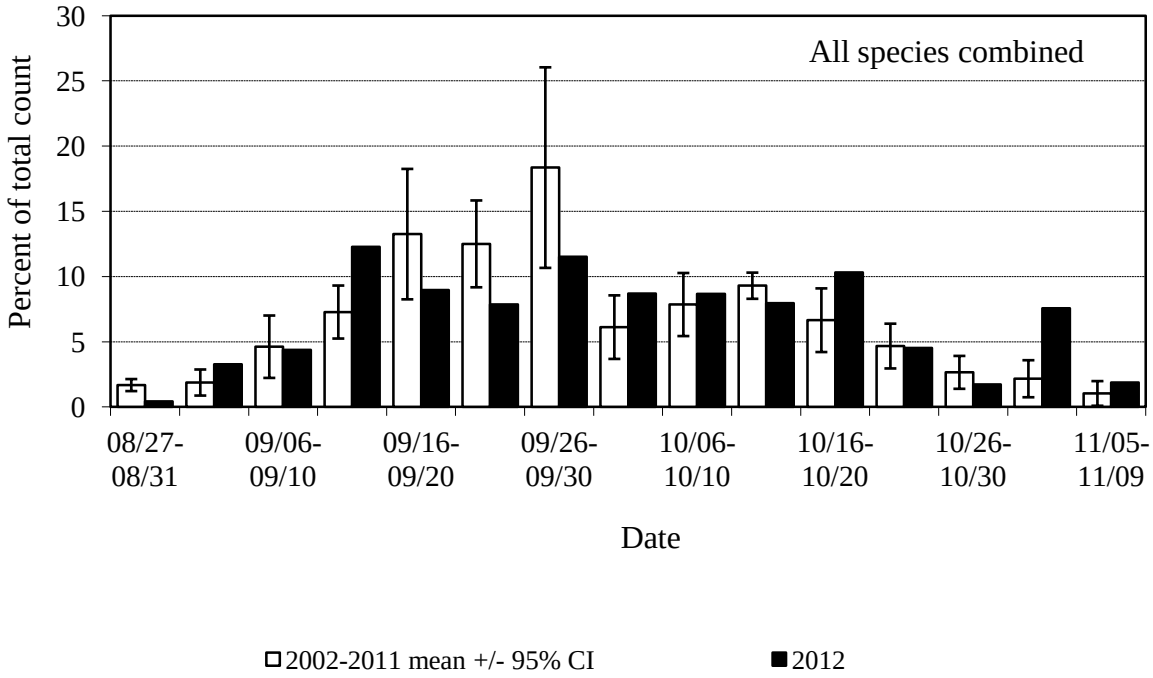

Figure 10. Combined-species seasonal distribution of activity by five-day periods for raptors during fall migration at Commissary Ridge, Wyoming: 2002–2011 versus 2012.

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).

2012: Two observers throughout: Russell Seeley (2), Rya Rubenthaler (0), Donna Wilhelm (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: 2012.

Date	Obs. Hours	Obsrvr / Hour[1]	Median Visitor Disturb[2]	Predominant Weather[3]	Wind Speed (kph)[1]	Wind Direction	Temp (°C)[1]	Barom. Press. (in Hg)[1]	Median Thermal Lift[4]	Visib. East (km)[1]	Visib. West (km)[1]	Median Flight Distance[5]	Birds / Hour
27-Aug	8.83	2.0	0	pc AM, mc, ovc PM	11.5	sw, wsw	24.3	30.03	3	95	100	0	0.5
28-Aug	8.50	2.0	0	clr, pc, fog, haze	17.2	wsw, w	25.8	30.01	3	90	100	0	0.7
29-Aug	8.50	2.0	0	clr, haze	39.0	w, wsw	23.6	29.86	4	95	99	0	0.4
30-Aug	8.58	2.0	0	ovc rain AM, mc PM	11.9	w, sw	20.5	29.89	3	90	91	0	0.3
31-Aug	8.50	2.0	0	ovc, haze AM, rain	10.0	wsw, sw, se	18.9	29.87	4	95	94	0	0.1
1-Sep	7.33	2.0	0	mc, ovc rain PM	16.3	wsw, w	17.3	29.86	3	87	91	0	0.1
2-Sep	8.75	2.9	0	clr-pc, haze AM	19.4	nw, wsw, w	17.8	29.92	3	97	99	2	4.2
3-Sep	9.00	3.0	0	clr haze AM, pc PM	26.8	w, wsw	19.1	29.94	3	99	100	1	4.1
4-Sep	8.75	1.7	0	clr, pc, haze PM	34.2	w	19.0	29.89	3	95	98	1	5.1
5-Sep	8.50	2.6	0	clr, haze	30.4	wsw, w	18.3	29.89	3	87	98	1	2.6
6-Sep	8.75	2.7	0	ovc, haze AM, rain PM	19.5	w, wsw	19.8	29.82	3	93	93	1	5.0
7-Sep	9.25	2.6	0	clr, haze, pc late PM	14.1	wnw, sw, w	18.3	30.02	2	86	91	1	1.1
8-Sep	9.08	2.0	0	clr, haze	10.2	e, ene, w	19.3	30.07	2	85	88	1	1.2
9-Sep	9.33	2.9	0	pc, haze AM	21.3	w	19.8	29.89	3	94	98	2	8.0
10-Sep	9.00	2.7	0	pc AM, mc-ovc, haze, rain	27.5	w, wsw	18.1	29.79	4	95	90	1	17.2
11-Sep	9.00	1.7	0	mc, haze early AM	27.7	w, wnw	16.5	29.75	3	99	100	2	13.1
12-Sep	9.33	2.5	0	clr, haze PM	26.8	w, wnw	14.7	29.93	3	92	93	1	4.7
13-Sep	9.17	2.1	0	clr, haze	5.9	ese, w, wnw	17.7	30.17	1	85	82	1	3.3
14-Sep	9.25	2.7	0	clr AM, pc PM, haze	14.1	wsw, wnw, w	20.5	30.11	2	97	94	2	11.5
15-Sep	9.50	3.9	0	mc	23.1	w, wnw	19.3	30.00	3	100	100	2	15.9
16-Sep	8.50	2.2	0	pc, ovc PM, haze, rain early PM	24.8	wnw, w	18.3	29.89	3	96	98	2	9.2
17-Sep	8.50	2.0	0	clr, haze	22.7	w, wnw	15.8	29.87	3	80	68	1	2.1
18-Sep	5.00	2.0	0	clr, haze	23.1	wnw, w	16.1	29.97	3	61	54	1	0.6
19-Sep	9.50	2.7	0	mc early AM, pc, haze	22.3	wnw, w	18.6	29.97	3	80	80	2	8.5
20-Sep	8.50	2.4	0	clr, haze	19.8	wsw, w	19.0	29.96	2	56	49	1	4.4
21-Sep	7.67	2.6	0	clr, haze	9.1	ese, sw	21.4	29.97	2	59	51	1	2.3
22-Sep	9.00	2.0	0	clr AM, pc, mc mid-day, haze	17.1	e, w, wsw, wnw	20.5	29.95	3	74	68	2	10.7
23-Sep	8.75	2.3	0	ovc, pc late AM, haze	18.7	sw, wsw, wnw	19.1	29.90	2	89	93	1	10.2
24-Sep	8.50	1.9	0	ovc, rain PM	15.2	e, wsw	15.9	29.77	4	95	91	1	5.9
25-Sep	8.50	2.7	0	mc early AM, ovc, rain PM	9.6	ese, ne, nw	13.9	29.71	3	93	88	1	3.3
26-Sep	8.33	2.5	0	mc AM, ovc, rain PM	4.8	wnw, ese, e	13.2	29.80	3	92	90	1	1.6
27-Sep	6.92	2.0	0	pc AM, mc, ovc, haze, t-storms, rain	8.5	wnw	11.5	29.90	3	92	87	1	3.8
28-Sep	9.00	2.9	0	clr, pc, haze	12.9	wsw, wnw	15.2	29.87	2	90	90	2	20.6
29-Sep	9.00	2.6	0	ovc, mc mid-day, pc PM, haze	30.0	wnw, w	14.3	29.88	3	90	88	1	19.2
30-Sep	8.75	3.3	0	clr, haze	24.7	w, wnw	15.1	29.96	3	87	84	1	6.7
1-Oct	9.00	2.8	0	clr, haze	21.7	sw, w	16.0	29.99	3	90	95	2	7.4
2-Oct	9.25	2.7	0	clr, haze	34.9	w, wnw, wsw	15.0	29.73	3	92	92	0	6.5
3-Oct	8.50	2.2	0	clr, haze	44.0	w, wnw	10.1	29.65	4	85	84	2	6.4
4-Oct	8.50	2.4	0	clr, ovc late PM, haze	19.6	e, wnw, nw	7.1	29.72	3	90	88	2	9.5
5-Oct	8.50	2.0	0	mc AM, clr, haze	28.2	wnw, w	5.9	29.72	4	87	86	1	6.7
6-Oct	7.25	2.4	0	pc AM, clr, haze	15.1	e, w, wnw	4.1	29.73	4	89	78	1	5.8
7-Oct	8.75	2.6	0	clr, haze PM	21.8	w	5.9	29.71	4	96	93	2	8.1

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	9.00	2.1	0	pc, clr PM, haze	30.9	w	8.9	29.61	4	84	85	1	7.8
9-Oct	8.83	2.0	0	clr AM, mc, haze	28.5	w, wnw	9.9	29.67	3	71	68	1	9.1
10-Oct	8.50	2.8	0	pc AM, mc PM, haze	25.8	wnw, wsw, w	12.9	29.72	2	86	82	1	6.5
11-Oct	9.00	2.4	0	pc, mc PM, haze rain late PM	12.1	w, wsw, wnw	14.7	29.73	2	94	95	1	3.7
12-Oct	8.00	2.0	0	ovc, haze, rain late PM	11.3	e, ene, ese	12.3	29.60	4	83	86	2	5.1
13-Oct	1.50	2.0	0	ovc, fog, rain	22.7	w	5.3	29.75	4	60	52	1	1.3
14-Oct	9.00	2.9	0	ovc-mc fog AM, clr PM, haze	24.3	w, wnw	7.9	–	3	90	90	2	18.1
15-Oct	9.17	2.8	0	ovc AM, mc-pc haze PM	40.9	wsw, w	9.4	–	3	98	99	1	11.8
16-Oct	6.00	2.4	0	ovc, haze rain mid-day	59.3	w	7.1	–	4	68	59	0	0.7
17-Oct	8.50	2.6	0	clr, haze	50.9	w, wnw	0.0	–	3	94	96	1	9.3
18-Oct	8.75	2.3	0	clr, pc lat PM, haze	31.7	w	5.0	–	3	93	97	1	8.8
19-Oct	8.50	2.0	0	pc AM, ovc, mc haze	37.3	wnw, w	8.7	–	3	95	99	1	13.3
20-Oct	8.50	2.1	0	mc, pc noon, clr late PM, haze	45.0	w	11.4	–	3	95	97	1	4.2
21-Oct	8.25	2.3	0	ovc, haze	21.8	ese, wsw, w	8.3	–	4	93	94	0	3.0
22-Oct	8.00	1.9	0	ovc, fog AM, rain, t-storms late PM	20.5	se, sw, wsw	7.6	–	4	82	75	0	1.9
23-Oct	0.00			Weather Day									
24-Oct	5.00	2.0	0	ovc, fog	17.0	w, wnw	-3.4	–	3	82	75	1	18.2
25-Oct	0.00			Weather Day									
26-Oct	4.50	2.0	0	mc, pc, ovc, fog	19.8	w, wnw	-4.0	–	3	96	85	1	2.2
27-Oct	6.75	2.4	0	ovc, mc PM, fog	40.3	wnw, w	0.9	–	4	90	95	1	6.8
28-Oct	0.00			Weather Day									
29-Oct	7.50	2.0	0	ovc early AM, pc	30.0	wsw, w, wnw	7.4	–	3	100	100	1	1.1
30-Oct	8.50	2.0	0	pc AM, ovc-clr PM, haze AM	22.1	w	8.3	–	3	98	100	1	7.9
31-Oct	8.50	2.0	0	clr AM, mc, pc, haze	7.9	wnw, w	10.6	–	3	99	99	1	3.4
1-Nov	7.50	2.0	0	ovc, haze	34.8	wnw, w	8.8	–	4	99	100	1	6.7
2-Nov	8.00	2.0	0	clr, pc early PM, haze	23.6	wnw, w	4.7	–	3	99	99	1	7.3
3-Nov	7.50	2.0	0	pc, mc late AM, haze	22.4	w, wnw	5.8	–	3	97	99	1	10.0
4-Nov	7.00	2.0	0	mc haze AM, ovc noon, pc PM	33.0	w, wnw	6.4	–	3	98	100	1	6.3
5-Nov	6.50	2.0	0	ovc	29.4	w, wnw	8.3	–	3	100	100	1	3.8

[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: 2012.

		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	8.83	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	4	0.5
28-Aug	8.50	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	6	0.7
29-Aug	8.50	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3	0.4
30-Aug	8.58	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0.3
31-Aug	8.50	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1
1-Sep	7.33	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1
2-Sep	8.75	3	2	3	6	1	1	0	0	0	0	1	8	0	0	1	2	1	0	7	0	0	1	0	0	0	0	37	4.2
3-Sep	9.00	0	2	1	3	1	1	0	0	0	0	2	16	0	0	1	0	0	0	10	0	0	0	0	0	0	0	37	4.1
4-Sep	8.75	1	0	1	9	3	3	0	0	0	0	0	22	0	0	0	1	1	0	1	0	1	2	0	0	0	0	45	5.1
5-Sep	8.50	0	0	0	7	3	0	0	0	0	0	0	6	0	0	0	0	0	0	5	0	1	0	0	0	0	0	22	2.6
6-Sep	8.75	0	0	0	17	8	2	0	0	0	0	4	10	0	0	0	1	0	0	1	1	0	0	0	0	0	0	44	5.0
7-Sep	9.25	0	0	0	4	1	0	0	0	0	0	0	1	0	0	0	2	0	0	2	0	0	0	0	0	0	0	10	1.1
8-Sep	9.08	0	0	0	4	1	0	0	0	0	0	1	0	1	0	0	0	0	0	4	0	0	0	0	0	0	0	11	1.2
9-Sep	9.33	0	2	0	36	18	1	0	0	0	0	1	6	0	0	0	1	0	0	9	0	0	1	0	0	0	0	75	8.0
10-Sep	9.00	0	2	0	13	1	0	0	0	0	0	108	19	0	0	0	5	0	0	5	1	0	1	0	0	0	0	155	17.2
11-Sep	9.00	1	1	0	36	16	1	2	0	0	1	3	35	0	0	0	1	1	0	17	1	0	2	0	0	0	0	118	13.1
12-Sep	9.33	0	0	0	18	5	0	0	0	0	1	0	9	0	0	1	4	0	0	5	1	0	0	0	0	0	0	44	4.7
13-Sep	9.17	0	0	0	17	2	0	0	0	0	0	0	4	0	0	0	0	0	0	5	0	1	1	0	0	0	0	30	3.3
14-Sep	9.25	5	0	0	39	19	2	1	1	0	0	0	30	1	0	1	2	1	0	4	0	0	0	0	0	0	0	106	11.5
15-Sep	9.50	1	1	2	34	25	2	1	1	1	0	21	46	0	0	1	2	0	0	11	0	1	0	0	1	0	0	151	15.9
16-Sep	8.50	0	2	1	20	7	0	1	0	0	0	5	16	0	0	0	0	0	0	23	0	1	0	2	0	0	0	78	9.2
17-Sep	8.50	0	0	0	10	3	0	0	0	0	0	1	1	0	0	0	0	0	0	2	1	0	0	0	0	0	0	18	2.1
18-Sep	5.00	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0.6
19-Sep	9.50	0	0	4	15	20	0	0	0	0	7	2	23	1	1	0	2	1	0	3	1	0	1	0	0	0	0	81	8.5
20-Sep	8.50	0	0	0	15	4	0	0	0	0	0	0	2	1	0	0	6	0	0	9	0	0	0	0	0	0	0	37	4.4
21-Sep	7.67	0	0	1	9	2	0	0	0	0	0	0	1	0	0	0	0	0	0	5	0	0	0	0	0	0	0	18	2.3
22-Sep	9.00	6	0	1	37	17	1	4	0	0	0	0	18	0	0	1	3	0	0	7	0	1	0	0	0	0	0	96	10.7
23-Sep	8.75	7	0	0	39	17	0	0	0	0	2	0	13	0	0	0	2	0	0	4	1	0	4	0	0	0	0	89	10.2
24-Sep	8.50	1	3	1	21	8	0	0	0	0	0	2	11	0	0	0	0	0	0	1	0	0	2	0	0	0	0	50	5.9

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	8.50	1	0	0	12	5	0	3	0	0	0	0	1	0	0	0	1	1	1	3	0	0	0	0	0	0	0	28	3.3
26-Sep	8.33	0	0	0	5	5	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	13	1.6
27-Sep	6.92	3	1	1	7	3	0	0	0	0	1	0	5	1	0	0	0	0	0	2	1	0	0	0	0	0	1	26	3.8
28-Sep	9.00	5	1	0	71	37	5	8	1	0	0	0	36	0	0	1	9	1	2	7	0	0	0	0	0	0	1	185	20.6
29-Sep	9.00	6	2	0	75	19	1	4	1	0	0	1	32	0	0	0	5	0	0	21	3	1	0	1	0	0	1	173	19.2
30-Sep	8.75	1	0	1	21	4	0	0	0	0	1	0	16	1	0	1	7	0	1	4	1	0	0	0	0	0	0	59	6.7
1-Oct	9.00	0	0	0	28	6	0	3	0	0	0	0	12	2	0	4	3	0	0	5	0	0	0	0	0	0	4	67	7.4
2-Oct	9.25	0	0	0	33	3	1	0	0	0	0	0	8	0	0	1	6	0	0	6	1	1	0	0	0	0	0	60	6.5
3-Oct	8.50	1	0	0	21	3	0	0	0	0	0	0	25	0	0	0	0	0	0	2	0	0	1	0	1	0	0	54	6.4
4-Oct	8.50	0	0	0	22	18	0	5	0	0	0	0	13	1	1	5	10	0	2	3	0	0	0	0	1	0	0	81	9.5
5-Oct	8.50	0	0	0	30	5	1	0	0	0	0	0	12	0	0	1	6	0	0	1	0	0	0	0	1	0	0	57	6.7
6-Oct	7.25	2	0	0	5	7	1	1	0	0	1	0	7	0	0	1	12	1	3	0	0	1	0	0	0	0	0	42	5.8
7-Oct	8.75	2	0	0	19	8	1	3	0	0	0	0	20	0	0	2	5	6	0	2	1	0	0	0	0	0	2	71	8.1
8-Oct	9.00	1	0	0	18	9	1	0	0	0	0	0	18	0	0	0	15	2	1	4	1	0	0	0	0	0	0	70	7.8
9-Oct	8.83	0	0	1	13	6	1	0	0	0	0	0	34	0	0	0	14	3	0	3	3	1	0	0	0	0	1	80	9.1
10-Oct	8.50	3	0	0	22	6	0	0	0	0	0	0	9	0	0	0	10	3	0	0	1	1	0	0	0	0	0	55	6.5
11-Oct	9.00	0	0	0	16	4	0	3	0	0	0	0	1	0	1	0	5	1	1	1	0	0	0	0	0	0	0	33	3.7
12-Oct	8.00	0	1	0	6	3	1	3	0	0	2	0	7	0	0	1	14	1	2	0	0	0	0	0	0	0	0	41	5.1
13-Oct	1.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	1.3
14-Oct	9.00	0	2	1	16	21	6	2	0	0	0	0	71	0	1	2	18	12	7	0	2	1	0	1	0	0	0	163	18.1
15-Oct	9.17	0	1	1	16	6	1	0	0	0	0	0	48	1	0	2	21	6	0	1	4	0	0	0	0	0	0	108	11.8
16-Oct	6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	1	0	0	0	0	0	0	4	0.7
17-Oct	8.50	0	0	1	10	2	1	0	0	0	0	0	51	0	1	0	11	2	0	0	0	0	0	0	0	0	0	79	9.3
18-Oct	8.75	0	0	1	6	1	1	1	0	0	0	0	46	0	1	1	9	2	4	0	1	0	0	0	0	0	3	77	8.8
19-Oct	8.50	0	1	1	13	10	2	0	0	0	0	0	61	0	0	1	14	7	3	0	0	0	0	0	0	0	0	113	13.3
20-Oct	8.50	0	0	0	1	1	1	0	0	0	0	0	14	0	0	1	4	11	2	0	1	0	0	0	0	0	0	36	4.2
21-Oct	8.25	0	0	2	7	0	0	0	0	0	0	0	6	1	3	0	4	0	2	0	0	0	0	0	0	0	0	25	3.0
22-Oct	8.00	0	0	0	3	0	0	0	0	0	0	0	6	0	0	0	2	3	0	1	0	0	0	0	0	0	0	15	1.9
23-Oct	0.00																												

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	5.00	0	0	2	2	1	0	0	0	0	0	0	73	0	3	0	2	7	0	0	0	0	1	0	0	0	0	91	18.2
25-Oct	0.00																												
26-Oct	4.50	0	0	0	0	0	0	0	0	0	0	0	9	0	1	0	0	0	0	0	0	0	0	0	0	0	0	10	2.2
27-Oct	6.75	0	0	0	0	0	0	0	0	0	0	0	9	0	3	0	16	16	2	0	0	0	0	0	0	0	0	46	6.8
28-Oct	0.00																												
29-Oct	7.50	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	8	1.1
30-Oct	8.50	0	0	0	2	1	3	0	0	0	0	0	31	0	1	0	12	16	0	0	1	0	0	0	0	0	0	67	7.9
31-Oct	8.50	0	0	0	2	3	1	0	0	0	0	0	5	0	1	0	8	8	1	0	0	0	0	0	0	0	0	29	3.4
1-Nov	7.50	0	0	1	5	5	2	0	0	0	0	0	16	0	2	0	11	7	0	0	1	0	0	0	0	0	0	50	6.7
2-Nov	8.00	0	0	1	0	2	2	0	0	0	0	0	12	0	0	0	13	28	0	0	0	0	0	0	0	0	0	58	7.3
3-Nov	7.50	0	0	1	0	0	5	0	0	0	0	0	21	0	0	1	15	27	4	0	1	0	0	0	0	0	0	75	10.0
4-Nov	7.00	0	0	0	0	3	0	0	0	0	0	0	7	0	1	0	16	17	0	0	0	0	0	0	0	0	0	44	6.3
5-Nov	6.50	0	0	0	0	0	1	0	0	0	0	0	2	0	3	0	7	12	0	0	0	0	0	0	0	0	0	25	3.8
Total	557.83	50	25	32	924	393	53	45	4	1	16	153	1043	11	24	31	350	207	39	209	32	13	17	4	4	0	13	3693	6.6

[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: 2001–2012.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	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	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	5-Nov	1-Nov
Observation days	22	45	63	65	64	56	66	66	64	65	61	68	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	557.83	474.91
Raptors/100 hrs	1,156	991	644	917	985	415	990	911	559	1040	526	662	797
SPECIES								RAPTOR COUNTS					
Turkey Vulture	67	97	66	164	114	39	185	150	50	108	46	50	102
Osprey	16	11	31	59	36	11	41	27	34	54	41	25	35
Northern Harrier	40	32	25	38	36	26	30	32	38	36	9	32	30
Sharp-shinned Hawk	303	675	516	1,118	1,687	217	1,214	1,109	690	1425	1,140	924	979
Cooper's Hawk	256	409	329	614	462	289	535	382	298	669	296	393	428
Northern Goshawk	11	21	7	49	35	26	89	52	32	35	14	53	36
Unknown small accipiter	11	78	75	75	55	39	61	25	92	293	208	45	100
Unknown large accipiter	4	6	13	34	11	6	21	8	17	3	2	4	12
Unknown accipiter	29	16	58	69	2	6	98	49	15	0	4	1	32
TOTAL ACCIPITERS	614	1,205	998	1,959	2,252	583	2,018	1,625	1,144	2,425	1,664	1,420	1,587
Broad-winged Hawk	1	8	5	22	9	3	7	13	26	58	21	16	17
Swainson's Hawk	18	82	28	62	52	47	36	352	119	1,211	80	153	207
Red-tailed Hawk	323	823	1,042	961	1,319	563	1,459	1,148	987	872	386	1,043	956
Ferruginous Hawk	7	6	3	15	8	7	3	7	9	11	5	11	7
Rough-legged Hawk	20	5	5	8	13	5	13	34	7	33	4	24	13
Unidentified buteo	19	17	87	63	42	35	63	144	43	61	44	31	60
TOTAL BUTEOS	388	941	1,170	1,131	1,443	660	1,581	1,698	1,191	2,246	540	1,278	1,260
Golden Eagle	279	352	233	152	316	211	324	345	211	253	136	350	253
Bald Eagle	72	233	90	76	137	82	299	262	86	193	102	207	156
Unidentified eagle	5	10	7	10	2	6	25	34	0	16	16	39	13
TOTAL EAGLES	356	595	330	238	455	299	648	641	297	462	254	596	422
American Kestrel	166	258	355	403	317	156	229	219	151	196	73	209	236
Merlin	7	9	6	26	11	10	24	25	23	29	5	32	17
Prairie Falcon	1	6	5	6	18	13	21	6	4	15	7	13	10
Peregrine Falcon	5	3	3	11	13	9	18	15	16	20	6	17	11
Unknown small falcon	2	0	3	6	2	5	3	9	1	1	4	4	3
Unknown large falcon	5	0	0	5	2	4	6	5	1	1	0	4	2
Unknown falcon	0	2	0	1	0	7	7	1	1	2	3	0	2
TOTAL FALCONS	186	278	372	458	363	204	308	280	197	264	98	279	282
Unidentified raptor	19	38	68	102	19	19	83	39	20	7	32	13	43
ALL SPECIES	1,686	3,197	3,060	4,149	4,718	1,841	4,894	4,492	2,971	5,602	2,684	3,693	3,761

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