FALL 2010 RAPTOR MIGRATION STUDIES AT COMMISSARY RIDGE IN SOUTHWESTERN WYOMING

HawkWatch International, Inc.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The Commissary Ridge Raptor Migration Project in southwest Wyoming is an ongoing effort to monitor long-term trends in populations of raptors using the Rocky Mountain Flyway (Hoffman et al. 2002) in southwestern Wyoming. The Commissary Ridge project was 1 of 9 long-term, annual raptor migration studies conducted or co-sponsored by HWI in North America during 2010. The primary objective of these efforts is to track long-term population trends of diurnal raptors in western North America and around the Gulf Coast region (Hoffman et al. 2002, Hoffman and Smith 2003, Smith et al. 2008a, b). Raptors serve as important biological indicators of ecosystem health (Bildstein 2001) and long-term migration counts are one of the most cost effective and efficient methods for monitoring the regional status and trends of multiple raptor species (Zalles and Bildstein 2000, Bildstein et al. 2008).

Before 2002, no long-term raptor migration surveys 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 throughout Wyoming, in 2002 HWI initiated the first full-season, fall-migration count at Commissary Ridge, with annual counts continuing each year since. This report summarizes the results of the fall 2010 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 ridge top 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 ridge top 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 5 November. Robert Baez, the lead observer conducted a full season count in 2008 at our Gulf Coast raptor migration site near Corpus Christi, Texas. Otherwise, this was the first full season of raptor migration counting for the other two observers; John Cannon and Ben Zyla (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.

Smith et al. (2008a) present trend analyses of data collected through 2005 for most of the long-term, on-going, autumn migration studies in western North America (hereafter, called the raptor Population Index or "RPI" analyses; see http://www.repi-project.org). 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 2010 are based on recent methods described in Farmer et al. (2007), as well as those described in Hoffman and Smith (2003), used herein to present analyses updated through 2010. In comparing 2010 annual statistics against means and 95% confidence intervals for previous seasons, we equate significance with a 2010 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 site was withheld during the 2010 migration monitoring efforts.

RESULTS AND DISCUSSION

WEATHER

Inclement weather caused six potential days of observations to be completely cancelled, and another three were severly shortened (reduced observation time to ≤ 4 hours, Appendix C). For comparison, the weather on an average seasonal basis (i.e., 2002-2009) has demonstrated to preclude 5.5, and severly hamper 4.4 days of observations in a given season.

During active observation periods, skies were recorded as predominantly fair 57% of the time, 24% as transitional (i.e., changed from fair or partly cloudy to mostly cloudy or overcast during the day, or vice versa), and 18% as mostly cloudy to overcast. In comparison, the averages for the site are 45% fair, 31% transitional, and 25% as mostly cloudy or overcast, suggesting that even though there were multiple days with overcast and cloudy conditions, the sky condition during the season was overwhelmingly fair. Not surprisingly, snow and/or rain did not affect visibility at all (zero days vs. 18% active observation days on average), but in contrast and in spite of overwhelmingly fair conditions, haze (caused mostly by local controlled burning) and sometimes fog was frequently present (recorded 38% of active days vs. on average 20%). Thus, due to the likely affect of haze, this season's visibility was severely reduced when observers were looking toward the east (56 km in 2010 vs 72.2 km for the average, 2002-2009) as well as the west (less severe at 69 km vs. the mean of 75.6 km). Observers rated the thermal lift as good to excellent on 46% of the active days, which is 29% above the 2002-2009 average.

The strength of winds encountered during the 2010 migration season were moderate (12-29 kph) during 65% of the active observation days (vs 60% on average), strong (≥ 29 kph) 18% of the time (vs 34% on average), and light (< 12 kph) just behind at 17% (vs. 11%). Wind came primarily from the SW-W (38%), SW-NW (34%), W-NW (12%), SW-NW/E-S (9%), and NE-SE (5%). Only 2% of the time, wind conditions were rated as relatively calm and variable. In contrast, the average wind directions in previous years were recorded predominantly from the W-NW (58%), followed by SW-W (16%), SW-NW/NE-SE

(8%), and NE-SE/Calm & Variable (6%). Thus, this past season's wind speeds were lighter and observation records indicated more inconsistent and variable wind directions.

In summary, the level of inclement weather in 2010 was fairly consistent with the average from previous years and did not prevent observers from performing their tasks at the observation platform for most of the season. Lighter winds, predominantly fair skies, and above average thermal lift ranking coupled with the high amount of haze caused by local controlled burns may have caused some high soaring raptors not to be detected. The lighter more variable winds may have been good for bringing larger numbers of Swainson's Hawks over the sight, however the bulk of this species passed through in a superflock on 28 September. A more rigorous analysis on weather patterns in comparison to observation error may be needed to confirm this assumption.

OBSERVATION EFFORT

Counts occurred on 65 of 71 possible days between 27 August and 5 November 2010, which is above the long-term average of 61 ± 95% CI of 4.5 days (see Appendix E). In addition, the seasonal average of 2.7 observers per hour (multi-year average at 2.03 ± 0.08) as well as the number of observation hours for this season of 538.58 (461.54 ± 41.63 hours) was also higher than expected (Appendix E).

FLIGHT SUMMARY

Flight Volume and Composition

Observers counted 5,602 migrant raptors of 17 species, which resulted in the count being significantly (+55%) above the 2002-2009 average (Table 1, and see Appendix D for daily count records). Six species (i.e., Sharp-shinned Hawk, Cooper's Hawk, Broad-winged Hawk, Sainson's Hawk, Merlin, and Peregrine Falcon) were tallied in record numbers (Appendix E). The 2010 counts of Osprey, Northern Harriers, Bald Eagles, and Prairie Falcons were also above average, but in four species (i.e., Northern Goshawk, Red-tailed Hawk, Golden Eagle, and American Kestrel) numbers were below their respective averages (Table 1). The 2010 count of Turkey Vultures did not vary from the mean.

The 2010 flight was composed of 43% accipiters, 40% buteos, 8% eagles, 5% falcons, 2% vultures, 1% Ospreys, 1% harriers, and < 1% of unidentified raptors. The season featured significantly higher than average proportions of buteos, whereas eagles and falcons were significantly below average (Figure 3). On average, the Red-tailed Hawk is typically the most abundant species (see mean values in Appendix E). However, in 2010 the Sharp-shinned Hawk was the most abundant (25% of total count), followed by the Swainson's Hawk (22%), Red-tailed Hawk (16%), Cooper's Hawk (12%), Golden Eagle (5%), Bald Eagle (3%), and American Kestrel (3%, Appendix E). All other species each comprised ≤ 2% of the total (Appendix E). A super-flock of Swainson's Hawks (877 counted) passed by the ridge on 28 September increasing their numbers dramatically.

Count data for nine years is just short of a time frame needed to support robust analyses of population trends. Typically, 10–15 years is considered the minimum necessary for such estimates from raptor migration count data (Farmer and Hussell 2008); and even further, 20–25 years is typically required to yield trend estimates leading to higher precision (Smith et al. 2008a). Therefore, we do not yet present analyses to reflect population trends of any species migrating through Commissary Ridge, Wyoming.

Age Ratios

With observational data it can be difficult to correctly identify immature vs. adults in many raptors 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. Here we assessed age ratios between juvenile and adult birds during the current year and compared them to the ratios across all years. In 2010, the immature : adults ratios were above average in three species, the Sharp-shinned Hawk, Cooper's Hawk, and Golden Eagle. They dropped below overall

averages in six species, the Northern Harrier, Northern Goshawk, Broad-winged Hawk, Red-tailed Hawk, Ferruginous Hawk, and Peregrine Falcon. Finally, they stayed within the scope of previously observed averages in Bald Eagles (Table 2). There are various reasons why annual age ratios fluctuate. It may be triggered by observer experience, weather and how it affects migration at a location in relation to phenology, annual reproductive success, short stopping, as well as others. Age and gender ratios mostly make sense in birds that produce consistent numbers at the count location over multiple years. Thus, data from low and inconsistent counts in the Broad-winged Hawk, a raptor more well-known from counts along migration routes in eastern North America (Smith et al. 2008a), and the Ferruginous Hawk, a bird affiliated with grassland and desert habitats (Bechard and Schmutz 1995), should be interpreted with care.

Daily and Seasonal Migration Patterns

The daily rhythm of migration passage at Commissary Ridge in 2010 offered a unique distribution compared to years passed. During morning hours, the initial peak at 1000 H matched previous expectations, however during afternoon observation, passage rates declined steadily until 1500 H before rebounding for a late daily peak (Figure 4; black bars). An unexpected surge appeared at 1600 H, but was mainly caused by a large single kettle of Swainson's Hawks (877 individuals), which passed by the site on 28 September (Appendix D). Late afternoon peaks are not uncommon when buteos and other high soaring birds are more easily detected while descending to lower elevations. According to past observation averages, during the early afternoon hours at Commissary Ridge passage rates maintained a constant level at approximately 13% of the total daily count before dropping in the last two hours of the day (Figure 4; white bars), which contrasted the survey results for 2010.

The 2010 combined-species median passage date of 28 September represented no change from the long-term average (Table 3). In addition, the activity pattern for 2010 followed a bimodal distribution roughly similar to the one represented by the long-term mean, where a major peak occurred mid- to late September, dropped off almost to a short hiatus around the first ten days in October, then rising again to a smaller secondary peak in mid-October (Figure 5). The major difference between the long-term pattern and 2010 occurred during the middle drop-off between the two peaks, where the break this past season took place five days later.

At the species level, the median passage dates in six species (i.e., the Sharp-shinned Hawk, Cooper's Hawk, and all four of the falcons) shifted to an earlier date in 2010 by two to five days (Table 3). Median dates in the Broad-winged Hawk stayed consistent with past estimates, while the rest of the raptor species (except for the Ferruginous Hawk) moved to later median dates by one to nine days (Table 3). Again, since very few Ferruginous Hawks are counted at traditional raptor migration monitoring sites in general, interpreting annual changes in their migratory phenology is difficult, especially since an individual can be observed at any time throughout the season (see also Bechard and Schmutz 1995).

Age specific data in median passage dates revealed much greater complexity (Table 4). In general, Cooper's Hawks stayed consistent with previous findings, immature Sharp-shinned Hawks and Northern Goshawks moved up the dates by three to four days, while the adults of the latter two species shifted to later dates than expected by 7 to 11 days, respectively. Likewise, the median date in non-adult Golden Eagles was shifted to six days earlier than on average, while in adults it moved to a later date by three days. In contrast, immature Red-tailed Hawks and Bald Eagles experienced a slight shift by two days past the expected date, while adults went the other direction by four and two days, respectively. Median passage date shifts in Northern Harriers were substantial. Dates for immatures moved to a later date by 19 days, while the adult median dates moved up by nine days (Table 4).

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

The primary focus of migration monitoring is to track the numbers of migrant raptors moving through during fall migration on an annual basis. Thus, it is important to distinguish between the raptors actively moving or migrating through versus individual birds that have established territories near the site, birds we identify as resident raptors. We must also try to distinguish between local residents (i.e, either year-round residents or local breeders and young fledged in the area prior to migrating outward) as well as those that use the area temporarily as migratory stopover.

From the first day of observations, a resident family of six light morph Red-tailed Hawks (one adult, five young) were often observed hunting along the main ridgeline as well as the ridge to the east. By 06 September, one juvenile had left and the remaining ones slowly started vacating the area when on 10 October, the adult and one juvenile were seen. The last date that any resident Red-tailed Hawk appeared near the observation site was on 17 October. The age of this individual was not detected.

A presumed resident family of American Kestrels was also seen hunting the ridgeline and often attacking the decoy owl starting from 08 August when two birds of unknown gender emerged first during the 2010 season. On 04 September, three Kestrels were observed (2 males and 1 female). It was the only time a female resident Kestrel was observed at the site. The last date that both males were observed was on 13 September. After that, a single male was repeatedly seen throughout September and up to 10 October, when it was last recorded.

Resident Golden Eagles were also present throughout much of the fall. These birds were often seen soaring to the north of the site, not really making any attempts to fly down the ridgeline in a migratory fashion. On 28 August, a single Golden Eagle of unknown age was recorded. Beginning on 04 September, one adult and two juveniles (likely a family unit) were observed repeatedly until 10 October, when they were seen for the last time.

Starting on 13 September, one adult male and one juvenile Northern Harrier were first classified as resident birds. It was the only time the adult male was observed throughout the season. However, the juvenile was recorded many times through the remainder of September until 10 October, when it disappeared for good.

Other resident raptors during the 2010 fall migration at Commissary Ridge were a single adult Bald Eagle on 04 September, a single Peregrine Falcon on the same date, as well as another Peregrine Falcon on 27 September. It is unknown whether the Peregrine Falcons were adult or immature birds.

SITE VISITATION AND PUBLIC OUTREACH

Public awareness of HWI's newest migration-monitoring project is still developing. Although only one individual person visited the hawk watch site during this past season, fortunately this person appeared to be a local resident from Kemmerer. The crew made good local acquaintenances in nearby Kemmerer, who seemed interested in coming out to visit, but unfortunately not many folks showed up.

ACKNOWLEDGMENTS

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Table 1. Annual raptor migration counts and passage rates by species at Commissary Ridge, Wyoming: 2002–2009 versus 2010.

	COUNTS			RAPTORS/100 HOURS		
SPECIES	2002–2009[1]	2010	% CHANGE	2002–2009[1]	2010	% CHANGE
Turkey Vulture	108.1 ± 37.8	108	0	23.8 ± 8.1	20.1	-16
Osprey	31.3 ± 10.9	54	+73	6.6 ± 2.2	10.0	+51
Northern Harrier	32.1 ± 3.5	36	+12	7.1 ± 1.1	6.7	-6
Sharp-shinned Hawk	903.3 ± 322.7	1,425	+58	195.8 ± 66.3	264.6	+35
Cooper's Hawk	414.8 ± 80.4	669	+61	91.9 ± 20.5	124.2	+35
Northern Goshawk	38.9 ± 17.3	35	-10	8.3 ± 3.4	6.5	-22
Unknown small accipiter	62.5 ± 15.4	293	+369	13.9 ± 4.1	54.4	+290
Unknown large accipiter	14.5 ± 6.6	3	-79	3.1 ± 1.4	0.6	-82
Unknown accipiter	39.1 ± 24.0	0	-100	8.3 ± 4.9	0.0	-100
TOTAL ACCIPITERS	1,473.0 ± 402.4	2,425	+65	321.3 ± 84.7	450.3	+40
Broad-winged Hawk	11.6 ± 5.7	58	+399	2.5 ± 1.1	10.8	+333
Swainson's Hawk	97.3 ± 74.1	1,211	+1145	20.9 ± 14.9	224.8	+974
Red-tailed Hawk	1,037.8 ± 194.0	872	-16	225.3 ± 36.8	161.9	-28
Ferruginous Hawk	7.3 ± 2.6	11	+52	1.6 ± 0.6	2.0	+28
Rough-legged Hawk	11.3 ± 6.8	33	+193	2.4 ± 1.3	6.1	+157
Unidentified buteo	61.8 ± 27.3	61	-1	13.0 ± 5.4	11.3	-13
TOTAL BUTEOS	1,226.9 ± 235.8	2,246	+83	265.7 ± 43.1	417.0	+57
Golden Eagle	268.0 ± 52.1	253	-6	60.1 ± 16.5	47.0	-22
Bald Eagle	158.1 ± 63.7	193	+22	35.6 ± 15.7	35.8	+1
Unidentified eagle	11.8 ± 8.1	16	+36	2.6 ± 1.6	3.0	+16
TOTAL EAGLES	437.9 ± 117.5	462	+6	98.2 ± 32.3	85.8	-13
American Kestrel	261.0 ± 63.1	196	-25	58.0 ± 15.5	36.4	-37
Merlin	16.8 ± 5.9	29	+73	3.6 ± 1.1	5.4	+51
Prairie Falcon	9.9 ± 4.6	15	+52	2.1 ± 0.9	2.8	+30
Peregrine Falcon	11.0 ± 3.9	20	+82	2.3 ± 0.7	3.7	+61
Unknown small falcon	3.6 ± 2.0	1	-72	0.8 ± 0.4	0.2	-76
Unknown large falcon	2.9 ± 1.7	1	-65	0.6 ± 0.4	0.2	-69
Unknown falcon	2.4 ± 2.0	2	-16	0.5 ± 0.4	0.4	-30
TOTAL FALCONS	307.5 ± 61.1	264	-14	67.9 ± 14.8	49.0	-28
Unidentified raptor	48.5 ± 22.2	7	-86	10.7 ± 4.8	1.3	-88
GRAND TOTAL	3,665.3 ± 737.6	5,602	+55	801.4 ± 157.8	1040.1	+30

[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: 2002–2009 versus 2010.

	Total and Age-classified Counts								Immature : Adult	
	2002–2009 Average			2010			% Unknown Age		Ratio	
Species	Total	Imm.	Adult	Total	Imm.	Adult	2002–2009[1]	2010	2002–2009[1]	2010
Northern Harrier	32	8	11	36	8	13	40 ± 5.7	42	0.8 ± 0.2	0.6
Sharp-shinned Hawk	903	233	297	1425	566	451	41 ± 3.3	29	0.9 ± 0.2	1.3
Cooper's Hawk	415	114	123	669	289	198	43 ± 4.7	27	1.0 ± 0.2	1.5
Northern Goshawk	39	12	9	35	13	11	32 ± 12.6	31	1.8 ± 0.8	1.2
Broad-winged Hawk	12	2	4	58	4	26	53 ± 11.7	48	0.5 ± 0.2	0.2
Red-tailed Hawk	1038	224	556	872	141	462	24 ± 2.6	31	0.5 ± 0.1	0.3
Ferruginous Hawk	7	2	1	11	2	3	58 ± 12.1	55	1.6 ± 0.5	0.7
Golden Eagle	268	140	91	253	152	73	14 ± 2.6	11	1.6 ± 0.1	2.1
Bald Eagle	158	54	102	193	62	123	1 ± 0.5	4	0.5 ± 0.0	0.5
Peregrine Falcon	11	2	3	20	3	8	48 ± 12.8	45	0.6 ± 0.3	0.4

[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 2010, with comparisons of 2010 and 2002–2009 average median passage dates.

	2010				2002–2009
Species	First Observed	Last Observed	Bulk Passage Dates[1]	Median Passage Date[2]	Median Passage Date[2, 3]
Turkey Vulture	27-Aug	04-Oct	18-Sep – 02-Oct	24-Sep	23-Sep ± 1.9
Osprey	28-Aug	23-Oct	29-Aug – 28-Sep	20-Sep	17-Sep ± 2.8
Northern Harrier	27-Aug	03-Nov	–	02-Oct	27-Sep ± 5.6
Sharp-shinned Hawk	27-Aug	05-Nov	14-Sep – 13-Oct	23-Sep	27-Sep ± 2.1
Cooper's Hawk	27-Aug	22-Oct	12-Sep – 02-Oct	21-Sep	23-Sep ± 2.4
Northern Goshawk	06-Sep	05-Nov	16-Sep – 3-Nov	14-Oct	07-Oct ± 4.5
Broad-winged Hawk	14-Sep	04-Oct	18-Sep – 26-Sep	25-Sep	25-Sep ± 2.3
Swainson's Hawk	29-Aug	30-Sep	26-Sep – 28-Sep	29-Sep	21-Sep ± 4.5
Red-tailed Hawk	20-Aug	05-Nov	14-Sep – 27-Oct	13-Oct	05-Oct ± 5.1
Ferruginous Hawk	04-Sep	27-Oct	5-Sep – 27-Oct	16-Oct	25-Sep ± 6.1
Rough-legged Hawk	24-Sep	05-Nov	14-Oct – 4-Nov	31-Oct	22-Oct ± 2.6
Golden Eagle	27-Aug	05-Nov	14-Sep – 3-Nov	16-Oct	14-Oct ± 4.0
Bald Eagle	02-Sep	05-Nov	2-Oct – 5-Nov	23-Oct	22-Oct ± 3.9
American Kestrel	27-Aug	23-Oct	5-Sep – 28-Sep	20-Sep	22-Sep ± 2.4
Merlin	31-Aug	30-Oct	15-Sep – 17-Oct	30-Sep	05-Oct ± 6.0
Prairie Falcon	07-Sep	17-Oct	10-Sep – 15-Oct	22-Sep	25-Sep ± 2.8
Peregrine Falcon	29-Aug	13-Oct	9-Sep – 30-Sep	21-Sep	25-Sep ± 3.1
Total	27-Aug	5-Nov	14-Sep – 19-Oct	28-Sep	28-Sep ± 1.8

[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: 2002–2009 versus 2010.

	ADULT		IMMATURE / SUBADULT	
SPECIES	2002–2009[1]	2010	2002–2009[1]	2010
Northern Harrier	07-Oct ± 11.0	16-Oct	03-Oct ± 4.6	14-Sep
Sharp-shinned Hawk	04-Oct ± 3.1	27-Sep	23-Sep ± 4.0	19-Sep
Cooper's Hawk	24-Sep ± 2.0	24-Sep	19-Sep ± 3.1	19-Sep
Northern Goshawk	21-Oct ± 7.7	10-Oct	30-Sep ± 9.5	03-Oct
Broad-winged Hawk	24-Sep ± 4.0	26-Sep	26-Sep ± 0.0	–
Red-tailed Hawk	09-Oct ± 4.8	13-Oct	29-Sep ± 4.9	27-Sep
Golden Eagle	18-Oct ± 4.5	15-Oct	10-Oct ± 3.5	16-Oct
Bald Eagle	22-Oct ± 3.8	24-Oct	22-Oct ± 4.1	20-Oct
Peregrine Falcon	20-Sep ± 1.7	27-Sep	7-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.

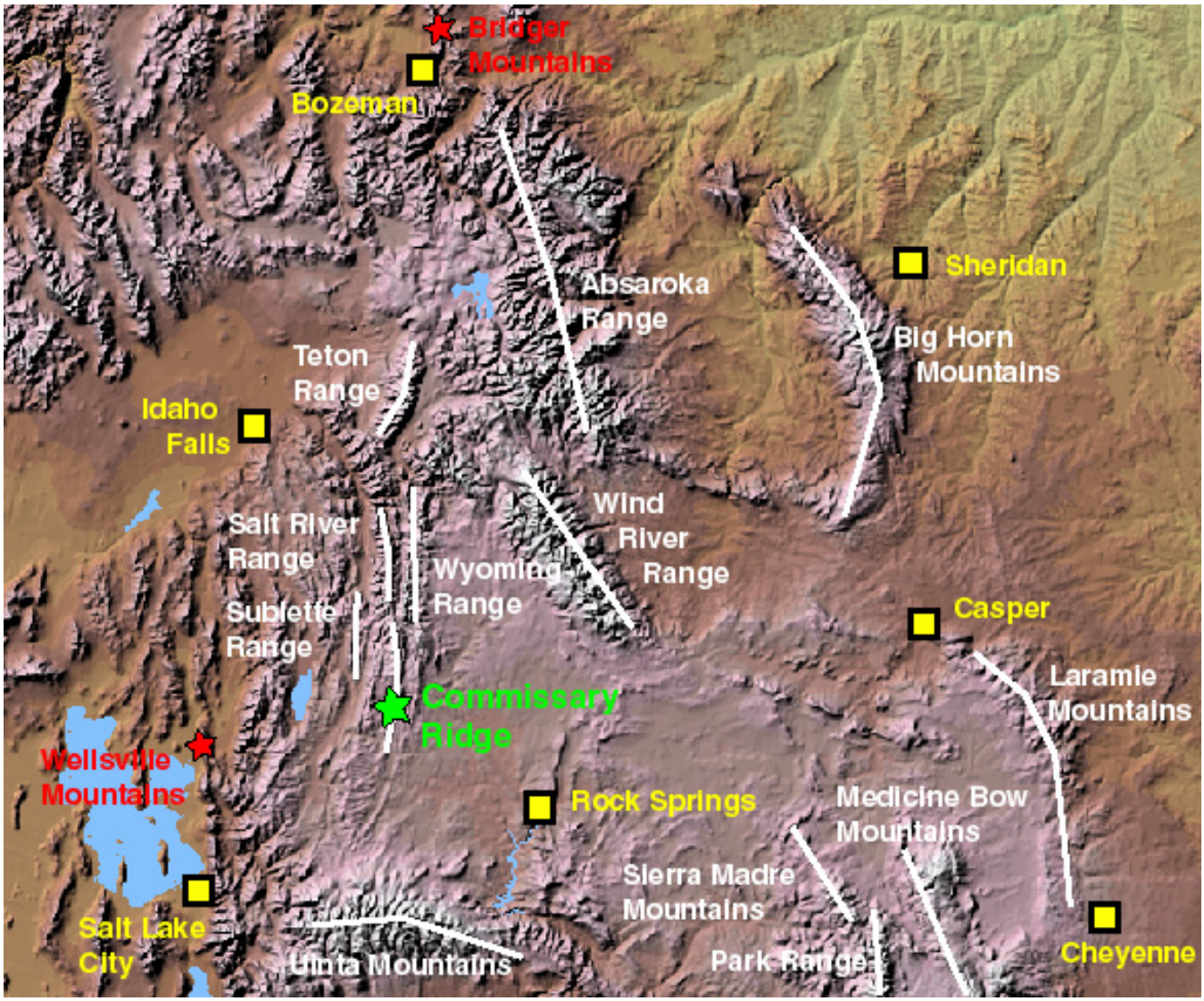

Figure 1. Location of Commissary Ridge Raptor Migration Project site in southwestern Wyoming. Red stars indicate other nearby HWI fall migration monitoring sites in Utah (currently inactive) and Montana.

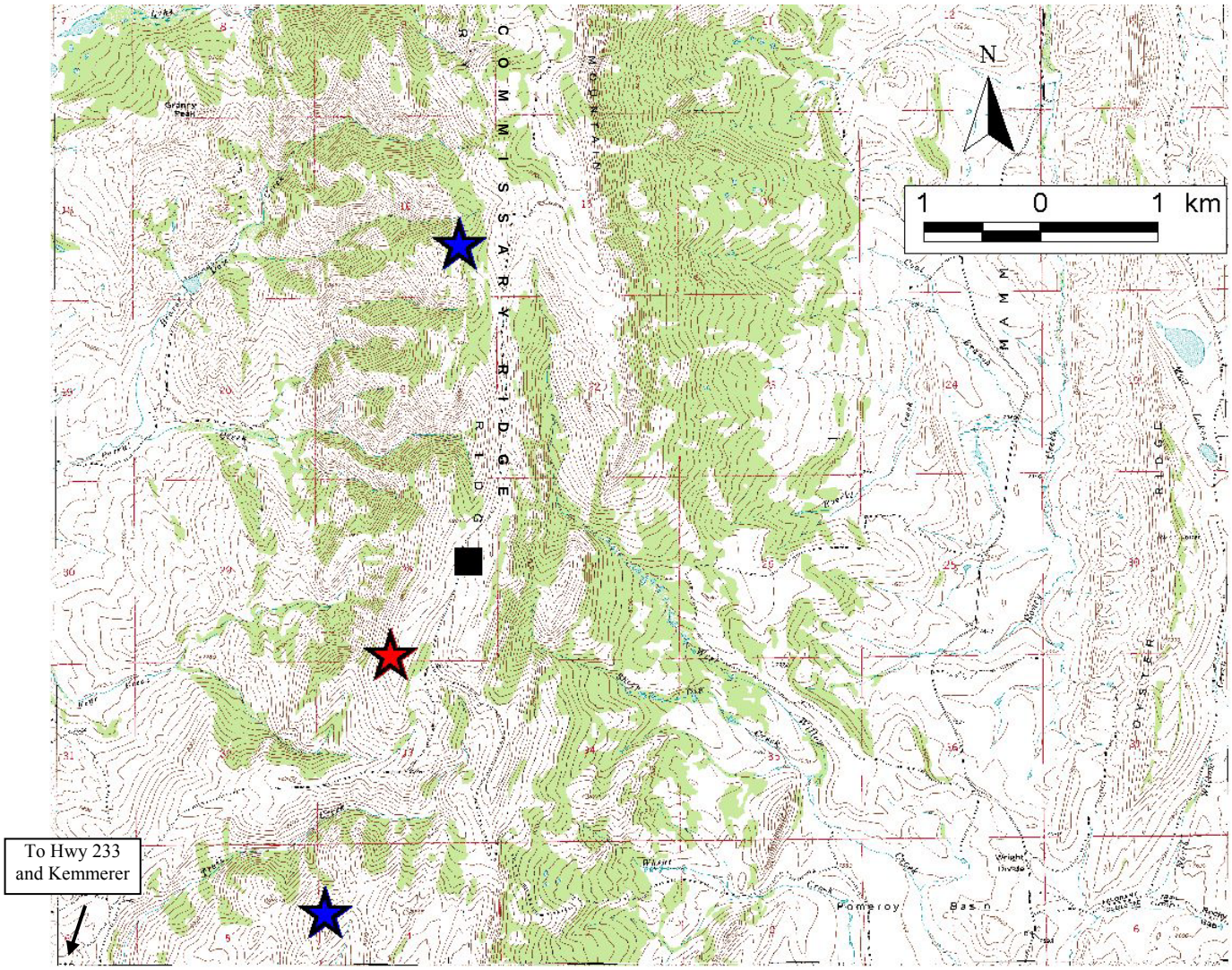

Figure 2. Close-up of Commissary Ridge Raptor Migration Project study site in southwestern Wyoming showing locations of the observation post (red star), the trapping locations (blue stars; both inactive in 2010), and base camp (black square).

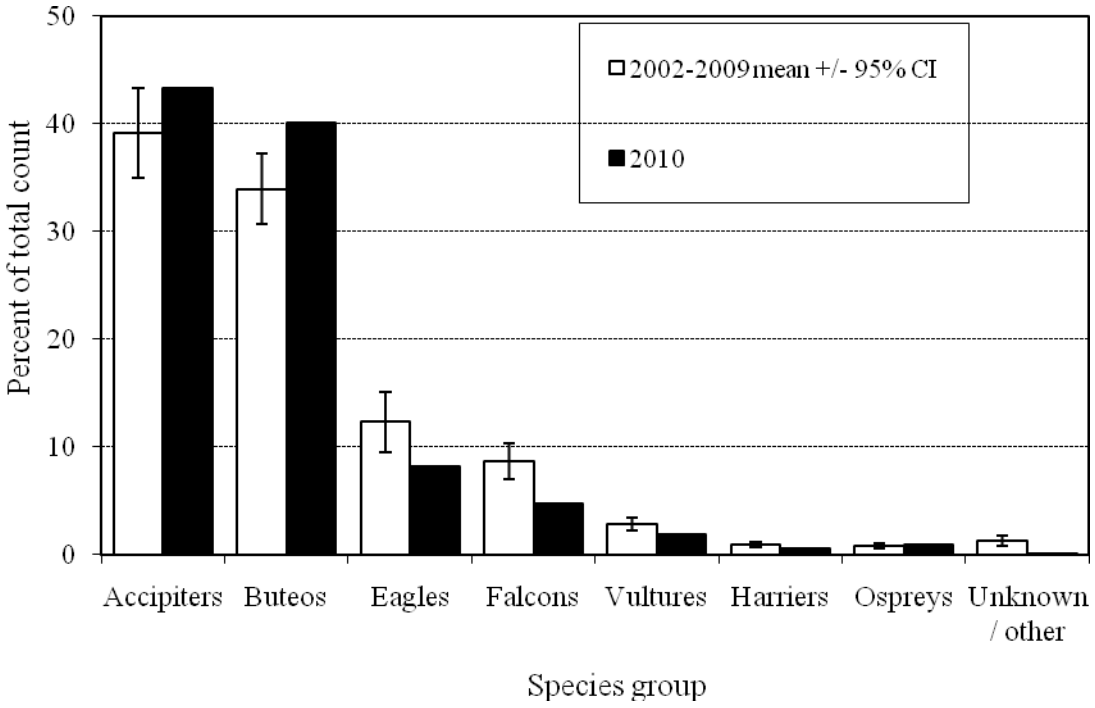

Figure 3. Composition by major species groups of the fall raptor migration at Commissary Ridge, Wyoming: 2002–2009 versus 2010.

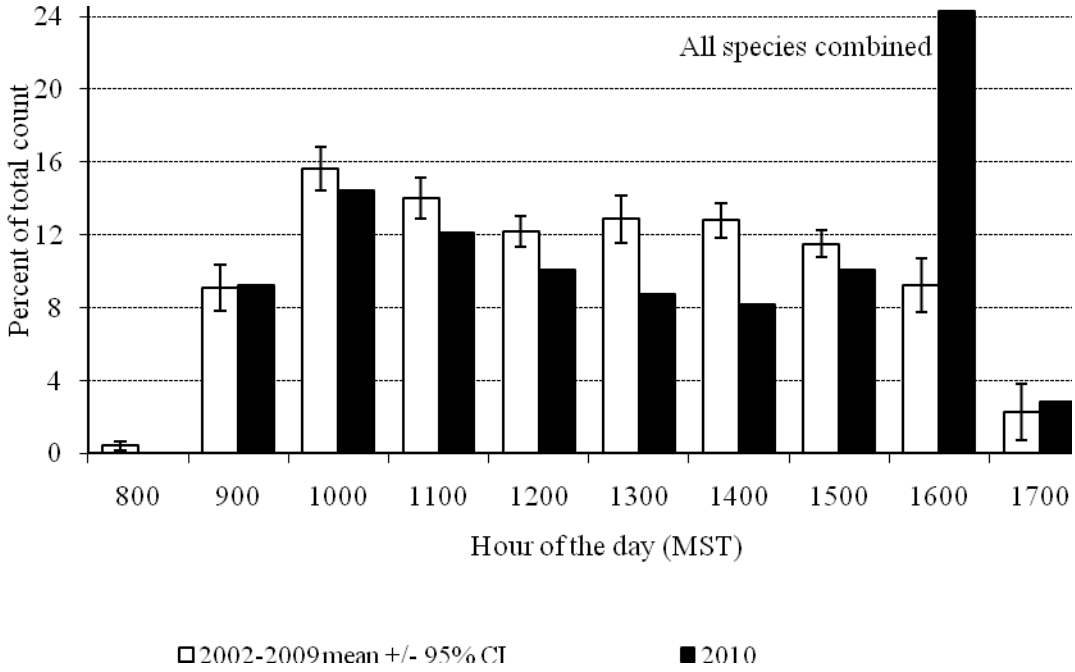

Figure 4. Daily rhythm of the fall raptor migration at Commissary Ridge, Wyoming: 2002–2009 versus 2010.

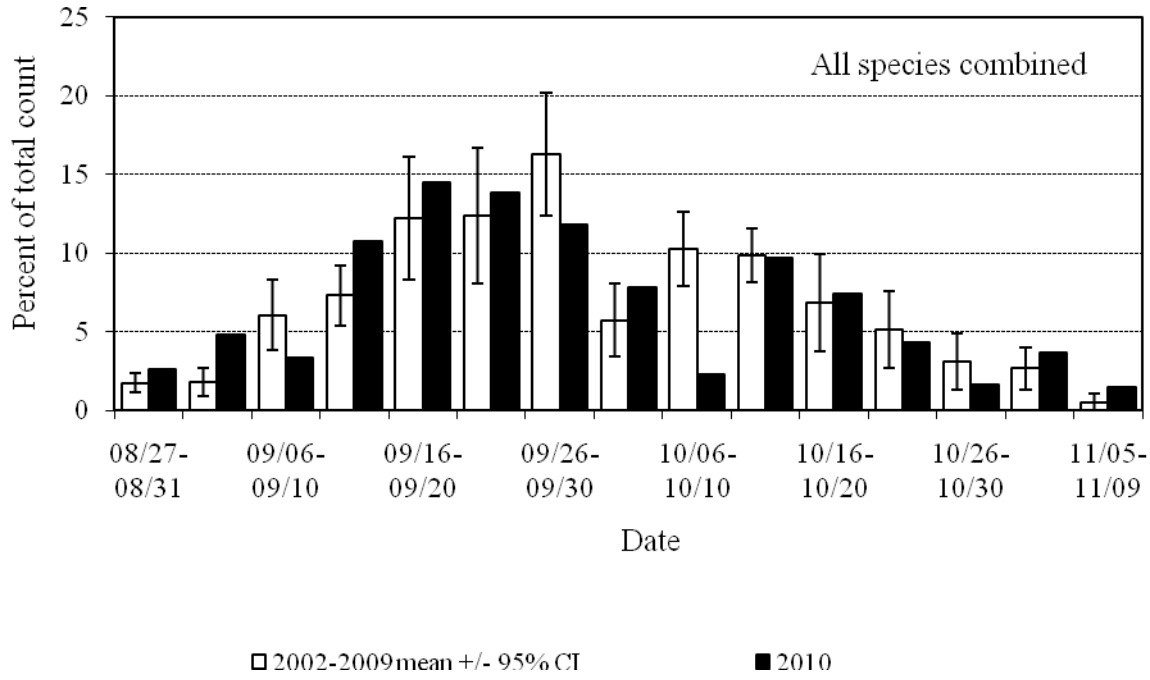

Figure 5. Combined-species seasonal distribution of activity by five-day periods for raptors during fall migration at Commissary Ridge, Wyoming: 2002–2009 versus 2010.

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).

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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: 2010.

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	9.00	3.6	0	clr,pc,mc,haze	34.1	w	17.6	30.34	3	60	72	-	3.2
28-Aug	9.00	3.2	0	pc,mc,ovc	14.4	wsw,wnw	23.5	30.06	3	63	73	2	1.9
29-Aug	9.00	3.0	0	pc,mc	23.2	ese,se,wsw,w	20.7	29.81	1	59	67	2	2.6
30-Aug	0.00			weather day									
31-Aug	9.00	2.9	0	pc	30.1	wsw,w	19.3	29.81	2	74	80	2	1.1
01-Sep	9.00	2.0	0	pc	26.0	w,wnw	14.9	30.17	3	60	71	-	0.4
02-Sep	9.00	5.8	1	pc	42.3	wsw,w	15.0	30.10	2	80	72	2	2.7
03-Sep	9.00	2.7	0	clr	11.1	wsw,w	22.9	30.39	3	74	76	1	1.6
04-Sep	9.00	2.0	0	clr,haze	16.4	ese,wsw	22.4	30.39	2	76	60	2	5.1
05-Sep	9.00	3.0	0	pc,mc,haze	33.0	w	23.3	30.17	2	62	71	3	6.4
06-Sep	9.00	2.9	0	pc,haze	41.1	w	19.2	29.87	3	30	49	2	3.1
07-Sep	9.00	2.8	0	clr,haze	23.8	w	13.0	30.09	3	62	80	2	2.7
08-Sep	9.00	2.9	0	clr,haze	15.3	ese,se,w	18.1	30.09	2	50	71	2	2.2
09-Sep	4.00	2.0	0	pc,mc,ovc	20.1	wsw,w	19.7	29.92	3	60	62	2	1.5
10-Sep	9.00	3.0	0	mc,ovc	42.4	wsw,w	13.1	29.78	4	46	40	2	1.3
11-Sep	9.00	2.0	0	mc,ovc	33.5	w,wnw	9.1	30.12	3	65	58	2	4.6
12-Sep	9.00	3.0	0	clr,haze	24.5	w	16.1	30.26	2	75	74	2	4.9
13-Sep	9.00	2.0	0	clr	20.6	w	22.5	30.33	2	80	80	2	7.4
14-Sep	6.75	2.9	0	pc	19.9	sw,w	22.3	30.25	3	71	74	2	19.9
15-Sep	9.00	3.0	0	pc,mc,ovc	25.0	w	21.4	30.17	2	70	78	2	14.2
16-Sep	8.75	2.5	0	clr,pc,mc,haze	20.3	wsw,w	18.7	30.25	3	62	80	2	19.8
17-Sep	9.00	2.2	0	clr,pc,haze	37.0	wsw,w	20.6	30.22	4	68	70	2	14.9
18-Sep	9.00	5.0	0	clr,pc,haze	24.9	wsw,w	23.3	30.15	2	60	78	2	35.6
19-Sep	9.00	4.2	0	pc,mc	25.3	wsw	21.7	30.19	3	60	76	1	14.2
20-Sep	9.00	3.1	0	clr,pc,haze	28.6	wsw,w	23.5	30.10	4	70	80	2	14.8
21-Sep	9.00	3.4	0	clr,haze	30.5	w	17.1	29.94	3	58	67	2	14.0
22-Sep	6.50	2.9	0	clr,pc,haze	20.5	wsw,w	21.3	29.93	3	50	73	2	13.7
23-Sep	9.00	2.0	0	pc,mc,ovc	15.1	wsw	17.6	29.80	3	57	66	2	20.6
24-Sep	9.00	2.0	0	clr,haze	31.4	w	14.9	30.08	-	48	77	2	26.1
25-Sep	9.00	3.0	0	clr,pc,haze	9.3	wsw	20.6	30.50	1	80	80	2	11.0
26-Sep	9.00	3.8	0	clr,haze	22.0	wsw,w	21.2	30.36	2	64	80	2	41.3
27-Sep	9.00	3.0	0	clr,pc,haze	19.7	w,wnw	23.6	30.41	2	64	75	2	28.4
28-Sep	9.00	2.9	0	clr,haze	28.8	wsw,w	22.3	30.30	2	62	62	2	108.0
29-Sep	9.00	3.0	0	clr,haze	10.1	se,w	23.6	30.27	1	45	63	2	4.4
30-Sep	9.00	2.0	0	clr,haze	13.9	ese,wsw	24.3	30.27	2	28	53	2	9.8
01-Oct	6.50	2.0	0	clr,pc,haze	11.0	sw,nw	24.9	30.41	1	34	49	3	10.0
02-Oct	8.08	4.0	0	pc,haze	10.0	w	22.0	30.37	2	33	46	2	10.1
03-Oct	9.00	2.8	0	pc,haze	8.5	e,ese,sw	22.1	30.24	2	54	62	2	3.4
04-Oct	9.00	2.0	0	pc,mc	17.1	w	14.4	30.11	3	70	70	1	10.6
05-Oct	9.00	2.8	0	mc	7.6	ese,wsw	17.7	30.26	2	61	75	2	3.9
06-Oct	8.75	2.2	0	mc,ovc	30.4	e,ese	14.3	30.28	4	59	71	-	0.8
07-Oct	3.42	2.0	0	mc,ovc	15.8	ese	15.0	30.21	3	11	55	-	0.0
08-Oct	0.00			weather day									
09-Oct	5.33	3.8	0	ovc	26.3	wsw	7.5	30.28	3	38	52	2	4.7
10-Oct	9.00	2.3	0	pc	24.8	w	12.5	12.5	3	60	60	2	4.0
11-Oct	9.00	2.0	0	mc,ovc	28.3	w,wnw	11.4	30.20	4	61	57	2	1.0
12-Oct	8.83	2.7	0	clr,pc	18.2	w	10.0	30.38	2	80	80	2	16.2

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
13-Oct	8.83	3.0	0	clr	15.5	wsw,w	12.7	30.47	2	59	71	2	16.5
14-Oct	8.75	2.0	0	clr,haze	15.3	wsw,w	16.2	30.41	3	33	70	2	4.7
15-Oct	8.75	2.0	0	clr,pc,mc	27.6	w,wnw	14.1	30.24	2	62	78	2	14.1
16-Oct	8.67	2.6	0	mc,ovc	20.0	wsw	15.2	30.23	3	36	76	2	9.7
17-Oct	8.75	2.2	0	pc,mc,ovc	24.5	w	12.5	30.12	3	70	80	2	5.7
18-Oct	8.75	2.0	0	clr,pc	15.4	wsw,w	13.5	30.13	2	66	71	3	3.5
19-Oct	8.58	2.0	0	clr	19.8	w	13.3	30.17	3	34	69	2	6.2
20-Oct	8.50	4.0	0	clr	9.5	w	14.1	30.18	1	70	70	2	6.8
21-Oct	8.50	2.0	0	clr,haze	9.0	w	16.5	30.02	2	26	67	2	6.2
22-Oct	8.25	2.0	0	ovc	17.0	w	10.5	29.82	4	28	62	2	6.3
23-Oct	8.08	2.0	0	pc,mc,ovc	30.7	w	6.7	29.85	3	63	59	2	4.1
24-Oct	0.00			weather day									
25-Oct	0.00			weather day									
26-Oct	0.00			weather day									
27-Oct	2.25	3.0	0	mc	22.7	w	-2.3	30.22	4	50	80	2	4.4
28-Oct	7.00	2.7	0	pc,mc	7.1	wsw,w	5.8	30.31	3	45	79	-	0.0
29-Oct	8.00	2.0	0	mc,ovc	16.3	wsw	6.1	30.17	3	40	78	2	4.3
30-Oct	6.50	2.3	0	ovc	12.4	ese,s,wsw	7.7	29.88	4	50	67	-	1.4
31-Oct	0.00			weather day									
01-Nov	7.00	2.0	0	clr,pc	19.4	w,nw	3.3	30.41	4	70	70	1	2.0
02-Nov	8.00	2.0	0	clr	18.6	wsw	7.2	30.56	3	51	80	2	5.5
03-Nov	8.00	3.0	0	clr	13.6	ese	8.6	30.55	3	50	76	2	3.8
04-Nov	7.75	2.0	0	clr,pc	11.8	w	8.8	30.40	3	72	78	1	5.9
05-Nov	7.75	2.0	0	clr,pc,mc	18.5	w	12.0	30.21	3	39	71	2	10.8

[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: 2010.

		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	9.00	3	0	4	1	1	0	0	0	0	0	0	15	0	0	0	1	0	0	4	0	0	0	0	0	0	0	29	3.2
28-Aug	9.00	0	5	0	2	1	0	1	0	0	0	0	4	0	0	0	3	0	0	0	0	0	0	0	0	0	1	17	1.9
29-Aug	9.00	1	8	1	2	2	0	0	0	0	0	2	3	0	0	1	1	0	0	0	0	0	1	0	0	0	1	23	2.6
30-Aug	0.00																												
31-Aug	9.00	0	0	0	0	3	0	0	0	0	0	1	4	0	0	0	1	0	0	0	1	0	0	0	0	0	0	10	1.1
1-Sep	9.00	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	0.4
2-Sep	9.00	0	2	2	2	1	0	0	0	0	0	3	3	0	0	0	2	3	0	6	0	0	0	0	0	0	0	24	2.7
3-Sep	9.00	0	0	0	5	3	0	0	0	0	0	0	1	0	0	0	0	0	0	4	0	0	1	0	0	0	0	14	1.6
4-Sep	9.00	0	3	0	7	12	0	3	0	0	0	2	8	1	0	1	3	1	0	4	0	0	0	0	0	0	1	46	5.1
5-Sep	9.00	0	2	0	13	9	0	6	0	0	0	2	16	1	0	1	4	0	0	4	0	0	0	0	0	0	0	58	6.4
6-Sep	9.00	1	1	1	8	5	1	2	0	0	0	0	6	0	0	0	1	1	0	1	0	0	0	0	0	0	0	28	3.1
7-Sep	9.00	0	0	1	7	3	0	1	0	0	0	2	4	0	0	0	1	0	0	4	0	1	0	0	0	0	0	24	2.7
8-Sep	9.00	0	0	2	8	3	0	0	0	0	0	0	3	0	0	0	3	0	0	1	0	0	0	0	0	0	0	20	2.2
9-Sep	4.00	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	6	1.5
10-Sep	9.00	0	0	0	6	2	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	12	1.3
11-Sep	9.00	0	2	3	9	12	0	4	0	0	0	0	2	0	0	0	2	0	0	4	0	0	1	0	0	0	2	41	4.6
12-Sep	9.00	0	0	0	17	12	1	1	0	0	0	3	3	0	0	0	1	1	0	4	0	1	0	0	0	0	0	44	4.9
13-Sep	9.00	1	0	1	23	20	0	3	0	0	0	2	3	0	0	1	3	0	0	9	0	0	0	1	0	0	0	67	7.4
14-Sep	6.75	0	0	1	47	37	0	6	0	0	1	0	16	0	0	0	10	3	0	12	1	0	0	0	0	0	0	134	19.9
15-Sep	9.00	1	2	0	47	24	1	7	0	0	1	14	14	0	0	2	1	1	0	11	1	1	0	0	0	0	0	128	14.2
16-Sep	8.75	3	2	0	85	49	1	10	0	0	0	3	11	0	0	0	2	0	0	4	3	0	0	0	0	0	0	173	19.8
17-Sep	9.00	0	1	0	80	26	0	6	1	0	0	0	5	0	0	0	3	0	0	10	0	2	0	0	0	0	0	134	14.9
18-Sep	9.00	12	0	0	154	63	0	27	0	0	9	1	31	0	0	3	3	0	0	11	1	1	4	0	0	0	0	320	35.6
19-Sep	9.00	0	1	0	60	33	1	16	0	0	0	2	6	0	0	0	1	1	0	6	0	0	1	0	0	0	0	128	14.2
20-Sep	9.00	14	3	0	55	24	2	5	0	0	1	0	9	0	0	2	2	0	0	13	1	0	2	0	0	0	0	133	14.8
21-Sep	9.00	2	3	0	43	36	0	7	0	0	2	1	11	0	0	0	2	0	0	17	1	1	0	0	0	0	0	126	14.0
22-Sep	6.50	3	4	1	38	26	1	3	0	0	1	0	9	0	0	0	3	0	0	0	0	0	0	0	0	0	0	89	13.7
23-Sep	9.00	25	3	0	86	28	0	11	0	0	0	4	18	0	0	0	1	0	0	5	3	0	0	0	0	1	0	185	20.6
24-Sep	9.00	10	7	0	66	32	0	11	0	0	17	34	32	0	1	1	1	0	0	20	0	0	2	0	1	0	0	235	26.1
25-Sep	9.00	2	0	0	25	10	1	11	0	0	18	2	23	0	0	2	0	0	0	5	0	0	0	0	0	0	0	99	11.0

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
26-Sep	9.00	7	0	1	119	71	0	46	0	0	5	46	51	0	0	1	10	2	0	11	0	0	1	0	0	1	0	372	41.3
27-Sep	9.00	0	0	0	24	10	0	12	0	0	1	182	17	0	0	0	5	1	0	2	1	1	0	0	0	0	0	256	28.4
28-Sep	9.00	6	1	0	40	10	1	7	0	0	0	877	19	0	0	0	0	2	0	5	1	1	2	0	0	0	0	972	108.0
29-Sep	9.00	1	0	0	16	6	0	7	0	0	0	1	4	0	0	0	0	0	0	2	1	0	1	0	0	0	1	40	4.4
30-Sep	9.00	0	0	0	28	11	0	10	0	0	0	27	5	1	0	1	1	0	0	1	1	1	1	0	0	0	0	88	9.8
1-Oct	6.50	0	0	2	20	11	0	9	0	0	0	0	13	0	0	0	7	1	0	0	1	1	0	0	0	0	0	65	10.0
2-Oct	8.08	6	0	0	24	12	1	13	0	0	0	0	14	0	0	0	2	4	0	6	0	0	0	0	0	0	0	82	10.1
3-Oct	9.00	0	1	0	15	2	0	6	1	0	0	0	2	0	0	0	0	2	0	1	1	0	0	0	0	0	0	31	3.4
4-Oct	9.00	10	0	0	24	8	0	1	0	0	2	0	30	0	0	2	2	9	0	4	1	1	1	0	0	0	0	95	10.6
5-Oct	9.00	0	0	0	15	10	0	1	0	0	0	0	4	0	0	2	3	0	0	0	0	0	0	0	0	0	0	35	3.9
6-Oct	8.75	0	0	0	1	1	0	1	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	7	0.8
7-Oct	3.42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
8-Oct	0.00																												
9-Oct	5.33	0	1	1	4	2	2	1	0	0	0	0	9	0	0	0	4	1	0	0	0	0	0	0	0	0	0	25	4.7
10-Oct	9.00	0	0	0	13	3	1	1	0	0	0	0	14	0	1	0	2	1	0	0	0	0	0	0	0	0	0	36	4.0
11-Oct	9.00	0	0	0	4	2	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	9	1.0
12-Oct	8.83	0	0	0	27	6	1	5	0	0	0	0	90	0	0	1	6	4	0	1	2	0	0	0	0	0	0	143	16.2
13-Oct	8.83	0	0	2	33	5	3	12	0	0	0	0	38	2	1	22	11	8	7	0	1	0	1	0	0	0	0	146	16.5
14-Oct	8.75	0	0	0	9	0	2	0	0	0	0	0	14	1	2	0	7	6	0	0	0	0	0	0	0	0	0	41	4.7
15-Oct	8.75	0	0	3	27	7	1	4	0	0	0	0	28	2	1	3	22	19	1	1	3	1	0	0	0	0	0	123	14.1
16-Oct	8.67	0	0	0	25	4	0	2	0	0	0	0	37	0	1	1	8	4	0	1	1	0	0	0	0	0	0	84	9.7
17-Oct	8.75	0	0	0	17	2	3	1	0	0	0	0	17	0	0	0	6	1	0	0	2	1	0	0	0	0	0	50	5.7
18-Oct	8.75	0	1	1	4	2	0	1	0	0	0	0	12	0	0	1	5	3	0	0	0	0	0	0	0	0	1	31	3.5
19-Oct	8.58	0	0	1	0	1	1	0	0	0	0	0	39	0	2	0	6	3	0	0	0	0	0	0	0	0	0	53	6.2
20-Oct	8.50	0	0	0	11	1	0	2	0	0	0	0	24	0	1	4	8	6	1	0	0	0	0	0	0	0	0	58	6.8
21-Oct	8.50	0	0	2	2	1	0	5	0	0	0	0	21	0	0	0	12	9	1	0	0	0	0	0	0	0	0	53	6.2
22-Oct	8.25	0	0	2	9	1	3	1	1	0	0	0	18	1	1	2	8	4	0	1	0	0	0	0	0	0	0	52	6.3
23-Oct	8.08	0	1	1	4	0	0	2	0	0	0	0	4	1	1	0	7	11	0	1	0	0	0	0	0	0	0	33	4.1
24-Oct	0.00																												
25-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
26-Oct	0.00																												
27-Oct	2.25	0	0	0	0	0	0	0	0	0	0	0	8	1	0	0	1	0	0	0	0	0	0	0	0	0	0	10	4.4
28-Oct	7.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
29-Oct	8.00	0	0	1	6	0	1	0	0	0	0	0	17	0	4	1	1	3	0	0	0	0	0	0	0	0	0	34	4.3
30-Oct	6.50	0	0	0	0	0	0	0	0	0	0	0	4	0	2	0	0	2	0	0	1	0	0	0	0	0	0	9	1.4
31-Oct	0.00																												
1-Nov	7.00	0	0	0	0	0	1	0	0	0	0	0	4	0	3	0	3	3	0	0	0	0	0	0	0	0	0	14	2.0
2-Nov	8.00	0	0	0	0	0	0	0	0	0	0	0	11	0	2	0	10	21	0	0	0	0	0	0	0	0	0	44	5.5
3-Nov	8.00	0	0	2	0	0	2	0	0	0	0	0	1	0	1	1	13	9	1	0	0	0	0	0	0	0	0	30	3.8
4-Nov	7.75	0	0	0	2	0	1	0	0	0	0	0	13	0	7	1	11	9	2	0	0	0	0	0	0	0	0	46	5.9
5-Nov	7.75	0	0	0	4	0	2	0	0	0	0	0	25	0	2	2	12	34	3	0	0	0	0	0	0	0	0	84	10.8
Total	538.58	108	54	36	1425	669	35	293	3	0	58	1211	872	11	33	61	253	193	16	196	29	15	20	1	1	2	7	5602	650.0

[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: 2001–2010.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Mean
Start date	3-Sep	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	1-Nov
Observation days	22	45	63	65	64	56	66	66	64	65	61
Observation hours	145.88	322.67	474.85	452.67	478.83	443.58	494.56	493.33	531.82	538.58	461.54
Raptors/100 hrs	1,156	991	644	917	985	415	990	911	559	1040	801
SPECIES	RAPTOR COUNTS										
Turkey Vulture	67	97	66	164	114	39	185	150	50	108	108
Osprey	16	11	31	59	36	11	41	27	34	54	31
Northern Harrier	40	32	25	38	36	26	30	32	38	36	32
Sharp-shinned Hawk	303	675	516	1,118	1,687	217	1,214	1,109	690	1425	903
Cooper's Hawk	256	409	329	614	462	289	535	382	298	669	415
Northern Goshawk	11	21	7	49	35	26	89	52	32	35	39
Unknown small accipiter	11	78	75	75	55	39	61	25	92	293	63
Unknown large accipiter	4	6	13	34	11	6	21	8	17	3	15
Unknown accipiter	29	16	58	69	2	6	98	49	15	0	39
TOTAL ACCIPITERS	614	1,205	998	1,959	2,252	583	2,018	1,625	1,144	2,425	1,473
Broad-winged Hawk	1	8	5	22	9	3	7	13	26	58	12
Swainson's Hawk	18	82	28	62	52	47	36	352	119	1,211	97
Red-tailed Hawk	323	823	1,042	961	1,319	563	1,459	1,148	987	872	1,038
Ferruginous Hawk	7	6	3	15	8	7	3	7	9	11	7
Rough-legged Hawk	20	5	5	8	13	5	13	34	7	33	11
Unidentified buteo	19	17	87	63	42	35	63	144	43	61	62
TOTAL BUTEOS	388	941	1,170	1,131	1,443	660	1,581	1,698	1,191	2,246	1,227
Golden Eagle	279	352	233	152	316	211	324	345	211	253	268
Bald Eagle	72	233	90	76	137	82	299	262	86	193	158
Unidentified eagle	5	10	7	10	2	6	25	34	0	16	12
TOTAL EAGLES	356	595	330	238	455	299	648	641	297	462	438
American Kestrel	166	258	355	403	317	156	229	219	151	196	261
Merlin	7	9	6	26	11	10	24	25	23	29	17
Prairie Falcon	1	6	5	6	18	13	21	6	4	15	10
Peregrine Falcon	5	3	3	11	13	9	18	15	16	20	11
Unknown small falcon	2	0	3	6	2	5	3	9	1	1	4
Unknown large falcon	5	0	0	5	2	4	6	5	1	1	3
Unknown falcon	0	2	0	1	0	7	7	1	1	2	2
TOTAL FALCONS	186	278	372	458	363	204	308	280	197	264	308
Unidentified raptor	19	38	68	102	19	19	83	39	20	7	49
ALL SPECIES	1,686	3,197	3,060	4,149	4,718	1,841	4,894	4,492	2,971	5,602	3,665

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