# FALL 2004 RAPTOR MIGRATION STUDIES AT COMMISSARY RIDGE IN SOUTHWESTERN WYOMING

**HawkWatch International, Inc.**

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## INTRODUCTION

HawkWatch International (HWI) and its organizational precursors have been monitoring raptor migrations in North America since the late 1970s (Hoffman et al. 2002, Hoffman and Smith 2003). During 2004, HWI conducted or co-sponsored 14 long-term, annual migration counts and seven migration banding studies in 10 states and Veracruz, Mexico. The primary objective of these efforts is to track long-term population trends of diurnal raptors throughout primarily western North America (Hoffman and Smith 2003). Raptors feed atop food pyramids, inhabit most ecosystems, occupy large home ranges, and are sensitive to environmental contamination and other human disturbances. Therefore, they serve as important biological indicators of ecosystem health (Bildstein 2001). Moreover, due to the remoteness and widespread distribution of most raptor populations, migration counts represent a particularly cost-effective and efficient method for monitoring the regional status and trends of multiple raptor species (Zalles and Bildstein 2000, Hoffman and Smith 2003).

Intensive counting and banding operations also provide valuable information about breeding and wintering distributions, migratory routes, migratory behavior, mortality factors and longevity, morphometric variation, molt sequences and timing, and health assessments (e.g., Hoffman et al. 2002). This information enables us to better understand the life histories, ecology, status, and conservation needs of raptor populations in North America. In addition, these migration studies offer unique opportunities for the public to learn about raptors and the natural environment, and providing such opportunities is another important component of HWI's mission.

Most of HWI's migration-monitoring projects are located atop mountain ridges in the western United States. Migrating raptors concentrate along north–south aligned mountain ranges for several reasons. Many seek to save energy on their long journeys by taking advantage of wind-driven updrafts that routinely occur along such ranges. Strong updrafts frequently occur along the western flanks of north–south ranges as predominantly westerly winds are deflected upward by the montane topography. Long north–south ranges also serve as navigational aids by forming a "leading line" (*sensu* Geyr von Schweppenburg 1963:192) that raptors can follow en route to their seasonal destination. In many cases, especially in arid landscapes such as the Great Basin, montane ridges may also attract migrants because they provide the only available forested habit. For species such as the accipiter hawks, forest cover may be a necessary requirement to provide suitable stopover and foraging habitat.

To be effective for regional monitoring of broadly distributed species, migration monitoring must involve a network of well-distributed, standardized counts that effectively sample all major flyways and known subpopulations (Smith and Hoffman 2000). Prior to 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 in southwestern Wyoming, with annual counts continuing each year since. During fall 2004, HWI also initiated for the first time at the site an exploratory trapping and banding program. This report summarizes the results of the fall 2004 count and banding 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 (see www.hawkwatch.org for detailed directions). The count site 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. After heavy snowfall prevented further access to the primary project site after 19 October and most of the crew departed, dedicated observer Jennifer Nagy remained and continued to monitor the migration for a further two weeks from a lower point on the southwestern flanks of Commissary Ridge ~1 km SW and ~150 m below the primary count site.

The crew set up a primary trapping station ~1.25 km north of the count site at a similar elevation on the western margin of the ridgetop (Figure 2). The station was situated in a sparsely vegetated area with a mixed conifer backdrop just off the east edge of the ridge ~25 m from the trapping blind. Lead bander Bob Davies also spent a few hours exploring the efficacy of trapping at another site ~600 m south of the count site, just off the eastern edge of the ridgetop and ~75 m lower in elevation, using a portable blind; however, high winds precluded effective use of the portable blind and quickly curtailed that effort.

## METHODS

### STANDARDIZED COUNT

Weather permitting, trained observers conducted daily counts from a single, traditional observation post from late August through the third week of October, and then from a secondary, lower elevation site for another two weeks. Primary observer Mark Vukovich had previously conducted a full-season spring migration count in Pennsylvania, whereas this was primary observer Jennifer Nagy's first experience counting migratory raptors. Both attended a preseason training session, and former Commissary Ridge observer Mike Neal helped orient the new observers to the site at the beginning of the season. Other crewmembers (in particular this year's field coordinator Bob Davies), BLM staff and interns, and visitors also frequently assisted with the counts.

Counts did not occur when heavy fog or other severe weather precluded effective counting or safety issues precluded access to the site. Otherwise, counts occurred daily and usually from 0900–1700 hrs 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 A 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 hrs 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.

The seasonal and daily duration of observation effort can greatly affect count statistics (Hussell 1985, Bednarz and Kerlinger 1989, Bednarz et al. 1990). To generally adjust for variation in sampling effort due to inclement weather and other unforeseeable events, and therefore render data from different years

and sites comparable, common practice calls for converting counts to annual passage rates (total number of migrants counted / total hours of observation * 100 = birds / 100 hrs).

### TRAPPING AND BANDING

Weather permitting, 2–4 trappers and processors operated the primary trapping station each day, generally between 0900 and 1700 hrs MST. Capture devices included mist nets, dho-gaza nets, and remotely triggered bow nets. Trappers lured migrating raptors into the capture stations from camouflaged blinds using live, non-native avian lures attached to lines manipulated from the blinds. Unless already banded, all captured birds were fitted with a uniquely numbered USGS Biological Resources Division aluminum leg band. Data gathering and recording followed standardized protocols used at all HWI migration-banding sites (Hoffman et al. 2002). Two breast feathers were collected from most immature birds that were captured for stable-isotope analysis to determine migrant origins. Two birds were also outfitted with satellite transmitters to enable long-term tracking of their movements. An immature Northern Goshawk was outfitted with a 20-g battery powered PTT and an immature Golden Eagle was outfitted with an 80-g battery powered PTT, in both cases fit using a backpack-style Teflon harness and with the transmitter package weighting ≤3% of the bird's body mass. All birds were released within 45 minutes of capture, usually much quicker, unless outfitted with a satellite transmitter, which takes longer.

## RESULTS AND DISCUSSION

### WEATHER

Inclement weather precluded four full days of potential observations in 2004 and severely hampered observations (≤4 hrs observation) on nine other days (see Appendix B for daily weather records). The reduction in observation time due to weather was similar to 2002 (8 full days and 5 partial days), but almost three times as great as in 2003 (3 full and 2 partial days). Forty-one percent of the active observation days featured predominantly fair skies (3% including some fog or haze), 28% transitional skies (i.e., shifted from fair skies to mostly cloudy or overcast skies during the day, or vice versa; 10% including some fog/haze or rain/snow), and 31% mostly cloudy to overcast/stormy skies (20% including some fog/haze and/or rain/snow). In 2002, mostly cloudy to overcast/stormy skies prevailed on 40% of the active days (32% including some fog/haze and/or rain/snow), whereas in 2003, unsettled weather prevailed on only 21% of the active days (13% including some fog/haze and/or rain/snow).

In 2004, the temperature during active observation periods averaged 12.6°C (average of daily values, which were in turn averages of hourly readings), ranging from -4.4–23.6°C. The average is similar to 2002 but 2.2°C cooler than in 2003, while the minimum is the coldest and the maximum the warmest yet recorded for the project.

In 2004, light winds (<12 kph) predominated on 15% of the active observation days, moderate winds (12–28 kph) on 45%, and strong winds (>28 kph) on 40%. The proportion of days with predominantly light winds was slightly higher than in 2003 (11%) and substantially higher than in 2002 (4%). The proportion of days with predominantly strong winds was less than in 2003 (48%) but higher than in 2002 (36%). In other words, wind speeds averaged slightly lower overall than in 2003, but compared to 2002, 2004 featured both more light and more strong winds—i.e., greater variability across the spectrum.

As usual, W-NW winds were by far the most common winds in 2004, prevailing on 71% of the active observation days. This proportion is slightly less than in 2002 (76%) but substantially greater than in 2003 (52%). The overall wind direction profile in 2004 was similar to 2002, whereas 2003 featured proportionately more southwesterly winds (present at some level on 37% of the days in 2003, but 13–16% in 2002 and 2004). Fair to poor thermal-lift conditions predominated on 78% of the active observation days in 2004, good to excellent conditions on 22%. This is similar to 2002, whereas good to excellent conditions prevailed on 38% of the days in 2003. Visibility averaged ~60–65 km east and west in 2004, which is ~10 km less than in 2002 and ~20 km less than in 2003.

In summary, the weather in 2004 was similar to 2002, but was more unsettled and stormy than in 2003. About two feet of snow fell on the ridge during the last two weeks of October, shut down the trapping operation 12 days earlier than hoped for, and precluded full access to the count site after 25 October. Temperatures averaged moderate but extended across a broader range than during the previous two years. The unsettled weather and frequent low clouds reduced average visibility by ~10–20 km compared to the previous two years. Due to high winds and unsettled weather, thermal lift conditions rated good or better only 22% of the time. Steady W-NW winds predominated as in 2002, whereas southwesterly winds were more common in 2003. Wind speeds averaged slightly lower overall than in 2003 and ranged more broadly than in 2002.

### OBSERVATION EFFORT

Counts occurred on 65 of 69 days between 27 August and 3 November 2004, averaging 7.0 hours per active day and encompassing 452.67 total hours (see Appendix C for annual data). The number of observation days is the highest for the project, but the number of observation hours is 22 less than in 2003. A 12-day wildfire closure reduced the overall effort in 2002.

### FLIGHT VOLUME AND COMPOSITION

The observers tallied 4,149 migrants of 17 species during the 2004 season (Table 1, and see Appendix C for daily count records). The flight was composed of 47% accipiters, 28% buteos, 11% falcons, 6% eagles, 4% vultures, 1% each of Ospreys and Northern Harriers, and 2% unidentified raptors (Figure 3). The proportions of accipiters, vultures, and Ospreys were significantly above average, whereas the proportion of eagles was significantly below average compared to the previous two years. The most abundant species were the Sharp-shinned Hawk (27% of the total count), Red-tailed Hawk (23%), Cooper's Hawk (15%), American Kestrel (10%), Golden Eagle (4%), and Turkey Vulture (4%). All other species each comprised ≤2% of the total.

The 2004 tally included new high counts for 10 species (see Appendix D for annual count summaries). Only the counts of Golden and Bald Eagles were below average compared to 2002–2003. For both eagle species, counts have declined steadily since 2002. The 2004 count of Golden Eagles was less than during even the partial season count in 2001 (Appendix D). Comparing the 2004 seasonal activity distribution for Golden Eagles against the average for the previous two years shows reduced activity around the third week of September when the first big storm hit; then a quick ramping up to peak activity in mid-October; followed by an equally abrupt drop off as heavy snowfall and storminess settled into the region during late October; and finally a conspicuous early November spike just as counts ended (Figure 4). Bald Eagles showed the same late-season pattern, including an early November spike (Figure 4). The latter suggests that some of the eagle migration may have been delayed beyond our monitoring period in 2004. Other species that continued to pass through in good numbers during the final few days of the season included Northern Harriers, Northern Goshawks, Red-tailed Hawks, and Rough-legged Hawks (Appendix C).

Passage rates of Golden Eagles have also been declining for the past 4–5 years in both the nearby Wellsville Mountains of northern Utah and the Bridger Mountains of southwestern Montana (Smith 2005a, b). This may reflect declines in productivity of northern populations, but it is also possible that the relatively warm winters of the last few years have allowed more northern eagles to remain farther north than usual, thereby reducing migration counts at lower latitudes. The Bald Eagle count in the Wellsville Mountains also has generally been in decline since 1990 (when the highest count to date was recorded there), with a string of particularly low counts between 1998 and 2003 (Smith 2005a). However, the 2004 adjusted passage rate for Bald Eagles in the Wellsvilles was the third highest yet recorded there. Otherwise, 2004 passage rates in the Wellsvilles were well below average compared to the last 13 years for most other species, in most cases extending recent downward trends since the late 1990s when widespread drought began to plague the interior West (Hoffman and Smith 2003). Exceptions include

Prairie and Peregrine Falcons, which have both shown increasing patterns in the Wellsvilles since the late 1980s. For the latter, a high count was also recorded at Commissary Ridge in 2004 (Table 1, Appendix D).

The 2004 overall combined-species count dropped 25% in the Wellsville Mountains compared to the 1991–2003 average for that site (Smith 2005a), 21% in the Bridger Mountains of southwestern Montana compared to the 1991–2003 average for that site (Smith 2005b); 12% in the Goshute Mountains of northeastern Nevada compared to the 1983–2003 average for that site (Smith 2005c); and 15% in the Manzano Mountains of New Mexico compared to the 1985–2003 average for that site (Smith 2005d). In this light, the high 2004 count at Commissary Ridge does not appear to fit the broader pattern; however, in most cases the 2004 counts at the other sites were more moderate when compared to just the last 2–3 seasons at those sites. In addition, we were fortunate to have on-board in 2004 a dedicated and relatively high caliber observation team, especially compared to 2003, and were able to extend our monitoring this year into early November to catch some of the late migrants. This combination undoubtedly contributed to the higher 2004 counts.

### AGE RATIOS

Among 10 species for which age-related plumage variation is sufficient to allow for in-flight differentiation of immature and adult birds, immature : adult count ratios were more than 10% higher than the 2002–2003 averages for eight species (Table 2). For six of these species (Northern Harrier, all three accipiters, Broad-winged Hawk, and Ferruginous Hawk), high counts of immature birds were involved, suggesting that high productivity during 2004 may have contributed to the elevated age ratios and overall counts for these species. In contrast, high age ratios for Golden and Bald Eagles reflected proportionally greater reductions in counts of adults as opposed to immatures/subadults. In contrast, a lower than average age ratio for Peregrine Falcons resulted from an above average count of immature birds and an even higher count of identified adults. For Red-tailed Hawks, a low age ratio resulted from a below average count of immature birds and an above average count of adults, suggesting that red-tail productivity in the northern Rocky Mountains in 2004 may have declined compared to the previous two years.

### DAILY AND SEASONAL MIGRATION PATTERNS

Except for a modest dip during the noon hour, the diel rhythm of migration at Commissary Ridge in 2004 followed a bell-shaped curve with a broad peak in activity beginning during the 1100 hour and extending into the 1400 hour (Figure 5). This pattern differed from the previous two seasons when activity peaked in late morning, declined gradually through mid-afternoon, and then dropped off quickly. The 2004 pattern more closely resembles the typical pattern seen at other western migration sites. Variation in diel rhythms may result from changes in weather patterns, thermal-lift conditions, and wind regimes, because these factors—along with prey resources—influence when and how birds migrate in an energy-efficient manner. The 2004 pattern suggests that, on average, conditions remained favorable for migration along Commissary Ridge for a longer period each day than during previous years. An alternative explanation is that conditions remained favorable for detecting migrants for a longer period each day in 2004. Steady, moderate-to-strong W-NW winds tend to concentrate migrants right along long, north-south ridgelines as the birds seek to take full advantage of the energy-saving lift that the resulting orographic updrafts provide.

The overall, combined-species seasonal activity pattern followed a roughly similar pattern as the previous two years, except that clearly there has been a lot variability in the distribution of activity among five-day periods between mid-September and early October (Figure 6). Again, the general bell-shaped distribution of activity and the late September / early October peak of the 2004 pattern more closely matches the usual pattern seen at other western monitoring sites at similar latitudes. The overall combined-species median passage date of 27 September was one day earlier than the average for the past two seasons (Table 3). At

the species level, median passage dates were significantly earlier than average for three species, significantly later than average for four species, and not significantly different from average for nine species (Table 3). Age and sex-specific data revealed additional complexities in the passage timing for some species, and more so than the species-level data suggested that earlier timing was the most common pattern in 2004 (Table 4).

### TRAPPING AND BANDING SUMMARY

Trapping occurred at the primary station for one or more hours every day (46 days total) between 2 September and 17 October 2004, with effort totaling 280.93 hours and daily effort averaging 6.1 ± SD of 2.13 hours per day (see Appendix F for daily trapping records and Appendix G for annual trapping summaries). Lead bander Bob Davies also spent 6.5 hours over two consecutive days operating his portable blind at the south station, at which point it became clear that high winds would not allow for a productive operation.

In general, high winds on the ridgetop largely precluded effective use of mist nets and dho-gaza nets for trapping, and frequently made it very difficult to effectively manipulate lure birds and for hawks to effectively descend and attack the lure birds. Despite this severe constraint, our dedicated crew was able to successfully secure 136 raptors of eight species, which translates to a total capture rate of 47.3 birds per 100 station hours and total capture success of 3.6% of the catchable raptors (Table 5). The most commonly captured species were the Sharp-shinned Hawk (45% of all captures), Cooper's Hawk (35%), Northern Goshawk (9%), and Red-tailed Hawk (5%). All other species each comprised less than 3% of the total.

By way of comparison, at Bonney Butte, Oregon, the only other site where HWI operated a single trapping station and where the 2004 total count was of a similar magnitude (3,821) as at Commissary Ridge, HWI trappers secured 393 raptors for a total capture rate of 149 captures per 100 station hours and a total capture success of 11.5% (Smith 2005e). Similarly, at the first trapping station migrants encounter in the Goshute Mountains of Nevada, the overall capture rate in 2004 was 178.7 captures per 100 station hours and total capture success for this station was 6%.

Compared to the counts, banding data yield unique and useful sex–age specific data only for the three accipiters and American Kestrels (Table 6). For the three accipiters, both the count and banding data indicated that immature birds were more abundant than adults (immature : adult ratios >1); however, in each case the banding data indicated higher ratios (Sharp-shinned Hawk: 1.1 vs. 2.6; Cooper's Hawk: 1.2 vs. 1.5; Northern Goshawk: 6.5 vs. 9.0), suggesting that immature birds were more susceptible to capture than adults in 2004. Unlike the counts, banding also yields useful data on accipiter sex ratios, and in 2004 indicated that female Sharp-shinned and Cooper's Hawks were captured 1.7 and 6.8 times more often than males, respectively. In contrast, male goshawks were captured five times more often than females. The capture total for kestrels (3) was too low to provide robust estimates of age and sex ratios, but the tally included no adults and twice as many males as females. The count data do not provide age-specific data for kestrels, but indicated that males were ~37% more common than females.

### SATELLITE TRACKING

Although we fell well short of our goal for deploying satellite transmitters at the site in 2004 (9 total on three species), given the severe wind-related difficulties that our crew faced, we were very happy to have succeeded in deploying one transmitter on a hatch-year male Golden Eagle and one on a hatch-year female Northern Goshawk.

After being outfitted on 8 October 2004, the eagle initially spent three days wandering north along Commissary Ridge, then turned to the southeast and traveled ~65 km to the upper Black's Fork River area just west of Grainger, Wyoming. It wandered in this area for about two weeks, then returned to Commissary Ridge briefly before heading south again. Ultimately, it ended up only a few kilometers

southwest of where it had been previously, this time in the vicinity of the Little Muddy Creek and Muddy Creek drainages, just west of an area called the Carter Cedars, where it has remained since. As of late April 2005, sensor data and continued movement confirmed that the bird was still alive and active.

After being outfitted on 1 October 2004, the goshawk remained on Commissary Ridge through 12 April 2005, then between 12 and 15 April it abruptly moved ~110 km northwest up into the Caribou Range of southeastern Idaho. As of 25 April, it had remained for 10 days along Lanes Creek in the Caribou National Forest ~105 km east of Pocatello, with sensor data confirming that it was still alive and active a that time.

These deployments compliment more than 80 others accomplished by HWI field crews since 1999 at migration study sites in Washington, Oregon, Nevada, and New Mexico. The primary goal of this extensive effort is to refine understanding of the movement ecology of Red-tailed Hawks, Golden Eagles, and Northern Goshawks in western North America, and precisely delineate migration routes and connections between specific summer/winter ranges and various migration-monitoring sites. In turn, this information is greatly improving our ability to interpret the population trends we document through migration counts. Complete tracking summaries and maps for all of HWI's satellite-tracked raptors can be found at www.hawkwatch.org

### STABLE ISOTOPE RESEARCH

The banding crew collected breast and/or tip clippings from secondary feathers from 79 immature raptors during the 2004 season. These feathers are being analyzed for hydrogen stable-isotope ratios in an effort to use this cutting-edge technique to determine the approximate natal origins of the sampled migrants (e.g., see Meehan et al. 2001). HWI is currently engaged in a large-scale, multi-site effort to apply this valuable new technique to delineating the source populations of a variety of western migratory raptors. HWI scientists currently have in a review at a respected ornithological journal a manuscript detailing a new GIS-based approach for mapping the origins of raptors based on this technique, and we hope to begin producing several other relevant publications in the next several months. Stable-isotope analysis is not limited to large birds that can safely carry a transmitter, so this line of inquiry provides a valuable compliment to satellite-tracking research by extending to common, smaller species such as Sharp-shinned and Cooper's Hawks.

### RESIDENT RAPTORS

Though not the focus of this study, carefully tracking the occurrence and movements of resident raptors around the site during the migration count both assists the counters in distinguishing resident from migrating birds and provides useful information over time concerning the status and productivity of the local raptor community.

In 2004, the crew observed no resident Ospreys in the Ham's Fork Valley during migration observations; however, they did occasionally observe local birds in the area during drives through the valley. The closest known Osprey nest is ~13 km (8 mi) south of the count site along the Ham's Fork River.

At least one family group of resident Northern Harriers was present on the ridge in 2004. One adult male was seen regularly in September, primarily hunting on the ridge to the north of the observation site. Two immature harriers, one male and one female, were frequently observed hunting alone and sometimes together along the ridge from 26 August to 14 October. Resident harriers frequently flew south low along then west side of the ridge, then rose up and banked back to head north along the east ridge.

Turkey Vultures were active on the ridge from 27 August to 27 September. Groups of 3 and 4 were seen on 12 September and 31 August, respectfully.

At least one pair of Sharp-shinned Hawks resided on Commissary Ridge. An adult female was especially active from 27 August to 10 October, seen regularly hunting near the field camp. Immature birds

displayed resident behavior from 27 August to 10 October. There were at least three immatures, with a male and female seen together on 30 August and two males seen together on 6 August. Only one resident Cooper's Hawk was observed this season; an immature female was seen from 27 August to 8 September. Two resident family groups of Northern Goshawks occurred on Commissary Ridge this season, with various individuals observed throughout the season. Two adults visited the banding station once, and both males were caught. An adult female also attacked the banding station on at least one occasion, but was never secured. One pair of adult goshawks was observed frequently along the western margins of the ridge, while the other pair's territory was probably farther north towards Bridger-Teton National Forest. At least one immature goshawk was seen regularly from 14 September to 10 October, frequently down in the west-side valley area. Subsequent tracking of one immature female goshawk outfitted with a satellite transmitter at the site during the season suggested that she was a local bird.

Red-tailed Hawks are the most abundant residents at Commissary Ridge. At least four adults and four immatures were frequently observed this season. These included one dark morph adult and one dark morph immature bird; all others were light-morph birds. Two light-morph immatures were typically seen hunting together (probable nest mates) on the west side of the main ridge; the other had unique flight feather damage in its left wing. The dark-morph birds were regularly seen more to the north of the lookout. Resident red-tails were active along the ridge until 15 October. Two known Red-tailed Hawk nests are known in the area, one to the south of the observation post and one down in the valley to the west of the lookout, but there may well be others farther north.

One probable resident adult, light-morph Swainson's Hawk was observed on 25 August high overhead traveling north along the main ridge. One known Swainson's Hawk nest is located near a rural RV park in the valley to the southwest of the ridge.

Winter-resident Rough-legged Hawks were observed in late October. From 15–17 October, one darker plumaged bird was seen traveling back and forth on the west side of the ridge. On 26 October, one light-morph bird was observed hunting to the southwest of the ridge.

At least one family group of Golden Eagles, including at least one adult, a subadult bird, and a first-year bird, frequented the ridge in 2004. This group was regularly seen coursing low to the west of the ridge and atop the ridge to the north of the project area.

One resident adult Bald Eagle was observed on 9 September. After this date, we regularly saw this individual coming out of the valley several kilometers north of the observation post. According to the BLM, one resident Bald Eagle lives on Lake Viva Naughton and along the Ham's Fork River. After 20 September, four younger eagles also were regularly observed. These locals included one first-year bird, two S1 subadults (see Appendix A for plumage class descriptions), and one S2 subadult. The crew believed that these birds were pushed south by the cold front that came through from 19–20 September, and that they were then destined to winter in the area.

At least two pairs of American Kestrels resided on the ridge this season. They were seen from 27 August to 24 September and frequently moved down to lower elevations during inclement weather. This was the first season that resident Peregrine Falcons were recorded on the ridge. An immature bird visited the area on multiple occasions between 28 August and 16 September, typically bombing the plastic owl installed near the count site and then moving off to the north. An apparently resident adult also was seen on 18 September. Resident Prairie Falcons also were observed frequently. At least two adults and one immature were observed from 1 September to 7 October. According to BLM data, a known nest site is located to the northwest of Commissary Ridge. During the peak migration period for Merlins, the crew observed a few birds that displayed resident behavior, possibly reflecting the presence of transient birds that stayed in the area for a few days at a time. On 29 August and 4 October, single Merlins came from the south overhead, continued to the north a ways, and then turned back to the south. The crew also occasionally observed Merlins hunting down near Viva Naughton Reservoir in late August and October on their days off.

### SITE VISITATION AND PUBLIC OUTREACH

Public awareness of HWI's newest migration monitoring project is still developing, but we were pleased to host 58 individual visitors at the project site during the 2004 season. About 15% of the guests were hunters working the area that stopped by to find about the operation. The other 85% came specifically to visit the project; of these, about one third visited the observation post and two thirds visited the trapping blind. Most of the visitors were from the local area, but 19 guests originated in Utah, California, Maine, Idaho, Arizona, Montana, and Washington, and a group of eight Peruvian sheepherders that were working in the local area also stopped by for a visit.

In July 2004 before the season began, HWI staff were pleased to join members of the BLM Kemmerer Field Office at an education booth at the annual Oyster Ridge Music Festival in Kemmerer. Two of HWI's non-releasable education raptors were star attractions at the event and helped us achieve some valuable public outreach about the project and our collaborative efforts with the BLM. We were also very pleased to receive positive attention in the local media in the form of articles in the *Kemmerer Gazette* by reporter Roger Cappellen and in the *Sublette Examiner* by reporter Cat Urbigkit. Our field educators' efforts also included personal visits to and distribution of brochures and other project information at nearly two dozen local businesses and organizations in Kemmerer, and over the past six months HWI education staff have also begun to stimulate interest in the project and potential educational opportunities among local schools.

## PLANS FOR THE FUTURE

With core financial support already secured from the BLM Kemmerer Field Office, HWI fully expects to move ahead strongly with continuing the project in 2006. We expect the count to proceed much as it has during the past three years, except that if the weather cooperates we will strive to continue counting through at least 5 November to cover as much of the late-season eagle migration as possible.

We also expect to continue exploring for more protected sites to locate a productive trapping station. One severe constraint here is having to obtain prior archeological clearance to work at any location on the ridge where ground disturbance may occur. With the substantial cooperation of local BLM archaeologists, however, this summer we expect to seek out and obtain advanced clearance for several potential new locations to give us a variety of options to pursue during the coming season. We will also likely pursue other mobile methods for securing birds such as opportunistically deploying bal-chatri traps along the established roadways that traverse the ridgetop. Due to the prevalence of strong winds along the ridge (which average at least twice as strong as at most of HWI's other western migration sites), it may well turn out that trapping using conventional migration trapping-station methods simply may not be as productive at Commissary Ridge as elsewhere around HWI's western network, and that therefore sustaining a full-time, annual trapping operation may not be feasible in the long run. In the short run, however, HWI will continue exploring the possibilities for at least another season or two, with an important short-term objective of deploying several more satellite transmitters on selected migrants and collecting more feather samples so that we can at least generate a reasonable initial picture of the source populations from which Commissary Ridge migrants derive. Such information is critical for ensuring accurate interpretation of population trends documented by the counts.

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**Table 1. Annual raptor migration counts and passage rates by species at Commissary Ridge, WY: 2002–2003 versus 2004.**

| | COUNTS | | | RAPTORS/100 HOURS | | |
|---|---|---|---|---|---|---|
| SPECIES | 2002–2003[1] | 2004 | % CHANGE | 2002–2003[1] | 2004 | % CHANGE |
| Turkey Vulture | 82 ± 30.4 | 164 | +101 | 22.0 ± 15.84 | 36.2 | +65 |
| Osprey | 21 ± 19.6 | 59 | +181 | 5.0 ± 3.06 | 13.0 | +162 |
| Northern Harrier | 29 ± 6.9 | 38 | +33 | 7.6 ± 4.56 | 8.4 | +11 |
| Sharp-shinned Hawk | 596 ± 155.8 | 1118 | +88 | 158.9 ± 98.52 | 247.0 | +55 |
| Cooper's Hawk | 369 ± 78.4 | 614 | +66 | 98.0 ± 56.32 | 135.6 | +38 |
| Northern Goshawk | 14 ± 13.7 | 49 | +250 | 4.0 ± 4.93 | 10.8 | +171 |
| Unknown small accipiter | 77 ± 2.9 | 75 | -2 | 20.0 ± 8.21 | 16.6 | -17 |
| Unknown large accipiter | 10 ± 6.9 | 34 | +258 | 2.3 ± 0.86 | 7.5 | +227 |
| Unknown accipiter | 37 ± 41.2 | 69 | +86 | 8.6 ± 7.11 | 15.2 | +78 |
| TOTAL ACCIPITERS | 1102 ± 202.9 | 1959 | +78 | 291.8 ± 160.01 | 432.8 | +48 |
| Broad-winged Hawk | 7 ± 2.9 | 22 | +238 | 1.8 ± 1.40 | 4.9 | +175 |
| Swainson's Hawk | 55 ± 52.9 | 62 | +13 | 15.7 ± 19.13 | 13.7 | -13 |
| Red-tailed Hawk | 933 ± 214.6 | 961 | +3 | 237.2 ± 34.91 | 212.3 | -11 |
| Ferruginous Hawk | 5 ± 2.9 | 15 | +233 | 1.2 ± 1.20 | 3.3 | +166 |
| Rough-legged Hawk | 5 ± 0.0 | 8 | +60 | 1.3 ± 0.49 | 1.8 | +36 |
| Unidentified buteo | 52 ± 68.6 | 63 | +21 | 11.8 ± 12.79 | 13.9 | +18 |
| TOTAL BUTEOS | 1056 ± 224.4 | 1131 | +7 | 269.0 ± 44.33 | 249.9 | -7 |
| Golden Eagle | 293 ± 116.6 | 152 | -48 | 79.1 ± 58.82 | 33.6 | -58 |
| Bald Eagle | 162 ± 140.1 | 76 | -53 | 45.6 ± 52.19 | 16.8 | -63 |
| Unidentified eagle | 9 ± 2.9 | 10 | +18 | 2.3 ± 1.59 | 2.2 | -3 |
| TOTAL EAGLES | 463 ± 259.7 | 238 | -49 | 126.9 ± 112.61 | 52.6 | -59 |
| American Kestrel | 307 ± 95.1 | 403 | +31 | 77.4 ± 5.09 | 89.0 | +15 |
| Merlin | 8 ± 2.9 | 26 | +247 | 2.0 ± 1.50 | 5.7 | +183 |
| Prairie Falcon | 6 ± 1.0 | 6 | +9 | 1.5 ± 0.79 | 1.3 | -9 |
| Peregrine Falcon | 3 ± 0.0 | 11 | +267 | 0.8 ± 0.29 | 2.4 | +211 |
| Unknown small falcon | 2 ± 2.9 | 6 | +300 | 0.3 ± 0.62 | 1.3 | +320 |
| Unknown large falcon | 0 ± 0.0 | 5 | – | 0.0 ± 0.00 | 1.1 | – |
| Unknown falcon | 1 ± 2.0 | 1 | 0 | 0.3 ± 0.61 | 0.2 | -29 |
| TOTAL FALCONS | 325 ± 92.1 | 458 | +41 | 82.2 ± 7.66 | 101.2 | +23 |
| Unidentified raptor | 53 ± 29.4 | 102 | +92 | 13.0 ± 2.49 | 22.5 | +73 |
| GRAND TOTAL | 3129 ± 134.3 | 4149 | +3 | 817.6 ± 339.45 | 916.6 | +12 |

[1] Mean ± 95% confidence interval.

**Table 2. Annual raptor migration counts by age classes and immature : adult ratios for selected species at Commissary Ridge, WY: 2002–2003 versus 2004.**

| | Total and Age-classified Counts | | | | | | | | Immature : Adult | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2002–2003 Average | | | 2004 | | | % Unknown Age | | Ratio | |
| Species | Total | Imm. | Adult | Total | Imm. | Adult | 2002–2003[1] | 2004 | 2002–2003[1] | 2004 |
| Northern Harrier | 29 | 7 | 10 | 38 | 16 | 10 | 41 ± 24.6 | 32 | 0.8 ± 0.5 | 1.6 |
| Sharp-shinned Hawk | 596 | 149 | 204 | 1118 | 375 | 355 | 41 ± 11.0 | 35 | 0.7 ± 0.6 | 1.1 |
| Cooper's Hawk | 369 | 116 | 111 | 614 | 227 | 196 | 39 ± 11.6 | 31 | 1.1 ± 0.9 | 1.2 |
| Northern Goshawk | 14 | 6 | 7 | 49 | 39 | 6 | 7 ± 14.0 | 8 | 1.1 ± 0.5 | 6.5 |
| Broad-winged Hawk | 7 | 1 | 4 | 22 | 5 | 7 | 26 ± 27.0 | 45 | 0.2 ± 0.4 | 0.7 |
| Red-tailed Hawk | 933 | 299 | 449 | 961 | 180 | 468 | 20 ± 7.8 | 33 | 0.7 ± 0.3 | 0.4 |
| Ferruginous Hawk | 5 | 2 | 2 | 15 | 7 | 3 | 42 ± 49.0 | 33 | 0.8 ± 1.5 | 2.3 |
| Golden Eagle | 293 | 136 | 94 | 152 | 85 | 46 | 23 ± 9.4 | 14 | 1.4 ± 0.1 | 1.8 |
| Bald Eagle | 162 | 52 | 110 | 76 | 29 | 46 | 0 ± 0.0 | 1 | 0.5 ± 0.0 | 0.6 |
| Peregrine Falcon | 3 | 1 | 1 | 11 | 3 | 6 | 33 ± 0.0 | 18 | 1.0 ± 2.0 | 0.5 |

[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, WY in 2004, with comparisons of 2004 and 2002–2003 average median passage dates.**

| | 2004 | | | | 2002–2003 |
|---|---|---|---|---|---|
| Species | First Observed | Last Observed | Bulk Passage Dates[1] | Median Passage Date[2] | Median Passage Date[2, 3] |
| Turkey Vulture | 8-Sep | 6-Oct | 16-Sep – 28-Sep | 24-Sep | 22-Sep ± 2.9 |
| Osprey | 28-Aug | 14-Oct | 3-Sep – 27-Sep | 15-Sep | 16-Sep ± 8.8 |
| Northern Harrier | 6-Sep | 31-Oct | 21-Sep – 24-Oct | 6-Oct | 26-Sep ± 5.9 |
| Sharp-shinned Hawk | 27-Aug | 3-Nov | 9-Sep – 11-Oct | 28-Sep | 28-Sep ± 4.9 |
| Cooper's Hawk | 28-Aug | 11-Oct | 8-Sep – 1-Oct | 17-Sep | 24-Sep ± 0.0 |
| Northern Goshawk | 1-Sep | 3-Nov | 6-Sep – 31-Oct | 3-Oct | 10-Oct ± 8.8 |
| Broad-winged Hawk | 5-Sep | 2-Oct | 8-Sep – 30-Sep | 27-Sep | 23-Sep ± 2.0 |
| Swainson's Hawk | 27-Aug | 1-Oct | 5-Sep – 27-Sep | 16-Sep | 20-Sep ± 15.7 |
| Red-tailed Hawk | 27-Aug | 3-Nov | 9-Sep – 24-Oct | 3-Oct | 10-Oct ± 6.9 |
| Ferruginous Hawk | 1-Sep | 14-Oct | 5-Sep – 13-Oct | 23-Sep | 20-Sep ± 0.0 |
| Rough-legged Hawk | 3-Oct | 3-Nov | 3-Oct – 3-Nov | 14-Oct | 21-Oct ± 0.0 |
| Golden Eagle | 27-Aug | 3-Nov | 9-Sep – 30-Oct | 9-Oct | 09-Oct ± 1.0 |
| Bald Eagle | 12-Sep | 3-Nov | 2-Oct – 31-Oct | 13-Oct | 18-Oct ± 2.0 |
| American Kestrel | 27-Aug | 14-Oct | 9-Sep – 3-Oct | 24-Sep | 22-Sep ± 3.9 |
| Merlin | 7-Sep | 15-Oct | 23-Sep – 11-Oct | 3-Oct | 01-Oct ± 12.7 |
| Prairie Falcon | 9-Sep | 13-Oct | 9-Sep – 13-Oct | 29-Sep | 22-Sep ± 2.9 |
| Peregrine Falcon | 27-Aug | 1-Oct | 16-Sep – 30-Sep | 23-Sep | – |
| Total | 27-Aug | 3-Nov | 8-Sep – 14-Oct | 27-Sep | 28-Sep ± 2.9 |

[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, WY: 2002–2003 versus 2004.**

| | ADULT | | IMMATURE / SUBADULT | |
|---|---|---|---|---|
| SPECIES | 1990–2003[1] | 2004 | 1990–2003[1] | 2004 |
| Northern Harrier | 27-Sep ± 2.0 | 24-Oct | 30-Sep ± 7.8 | 28-Sep |
| Sharp-shinned Hawk | 08-Oct ± 1.0 | 3-Oct | 28-Sep ± 13.7 | 16-Sep |
| Cooper's Hawk | 23-Sep ± 2.9 | 21-Sep | 21-Sep ± 1.0 | 12-Sep |
| Northern Goshawk[2] | 10-Oct [2] | 1-Nov | 23-Sep [2] | 2-Oct |
| Broad-winged Hawk | 24-Sep [2] | 26-Sep | – | 25-Sep |
| Red-tailed Hawk | 12-Oct ± 4.9 | 9-Oct | 03-Oct ± 16.7 | 23-Sep |
| Ferruginous Hawk | – | – | – | 15-Sep |
| Golden Eagle[2] | 12-Oct ± 0.0 | 14-Oct | 09-Oct ± 2.0 | 6-Oct |
| Bald Eagle | 18-Oct ± 2.0 | 14-Oct | 18-Oct ± 4.9 | 13-Oct |
| Peregrine Falcon | – | 17-Sep | – | – |

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.

[2] Values for 2002 only.

**Table 5. Capture totals, rates, and successes for migrating raptors at Commissary Ridge, WY: 2004.**

| SPECIES | CAPTURE TOTAL | CAPTURE RATE[1] | CAPTURE SUCCESS (%)[2] |
|---|---|---|---|
| Sharp-shinned Hawk | 61 | 21.2 | 5.0 |
| Cooper's Hawk | 47 | 16.4 | 6.8 |
| Northern Goshawk | 12 | 4.2 | 22.2 |
| Red-tailed Hawk | 7 | 2.4 | 0.7 |
| Golden Eagle | 1 | 0.3 | 0.6 |
| American Kestrel | 3 | 1.0 | 0.7 |
| Merlin | 3 | 1.0 | 11.5 |
| Prairie Falcon | 2 | 0.7 | 25.0 |
| All Species | 136 | 47.3 | 3.6 |

[1] Captures / 100 station hours.

[2] Number of birds captured / number of birds observed * 100, with birds identified only to the generic group level (i.e., unknown accipiter, buteo, falcon, or eagle) allocated to relevant species in proportion to their occurrence. For calculating the "all species" values, non-trappable species and distant birds not identified at least to the generic group level were excluded.

**Table 6. Capture totals by sex and age (HY = hatching year; AHY = after hatching year), female : male capture ratios, and immature : adult capture ratios for selected species of migrating raptors at Commissary Ridge, WY: 2004.**

| | FEMALE | | MALE | | F : M | HY : AHY |
|---|---|---|---|---|---|---|
| | HY | AHY | HY | AHY | RATIO | RATIO |
| Sharp-shinned Hawk | 27 | 11 | 17 | 6 | 1.65 | 2.59 |
| Cooper's Hawk | 26 | 15 | 5 | 1 | 6.83 | 1.94 |
| Northern Goshawk | 2 | 0 | 8 | 2 | 0.20 | 5.00 |
| American Kestrel | 1 | 0 | 2 | 0 | 0.50 | 3.00 |

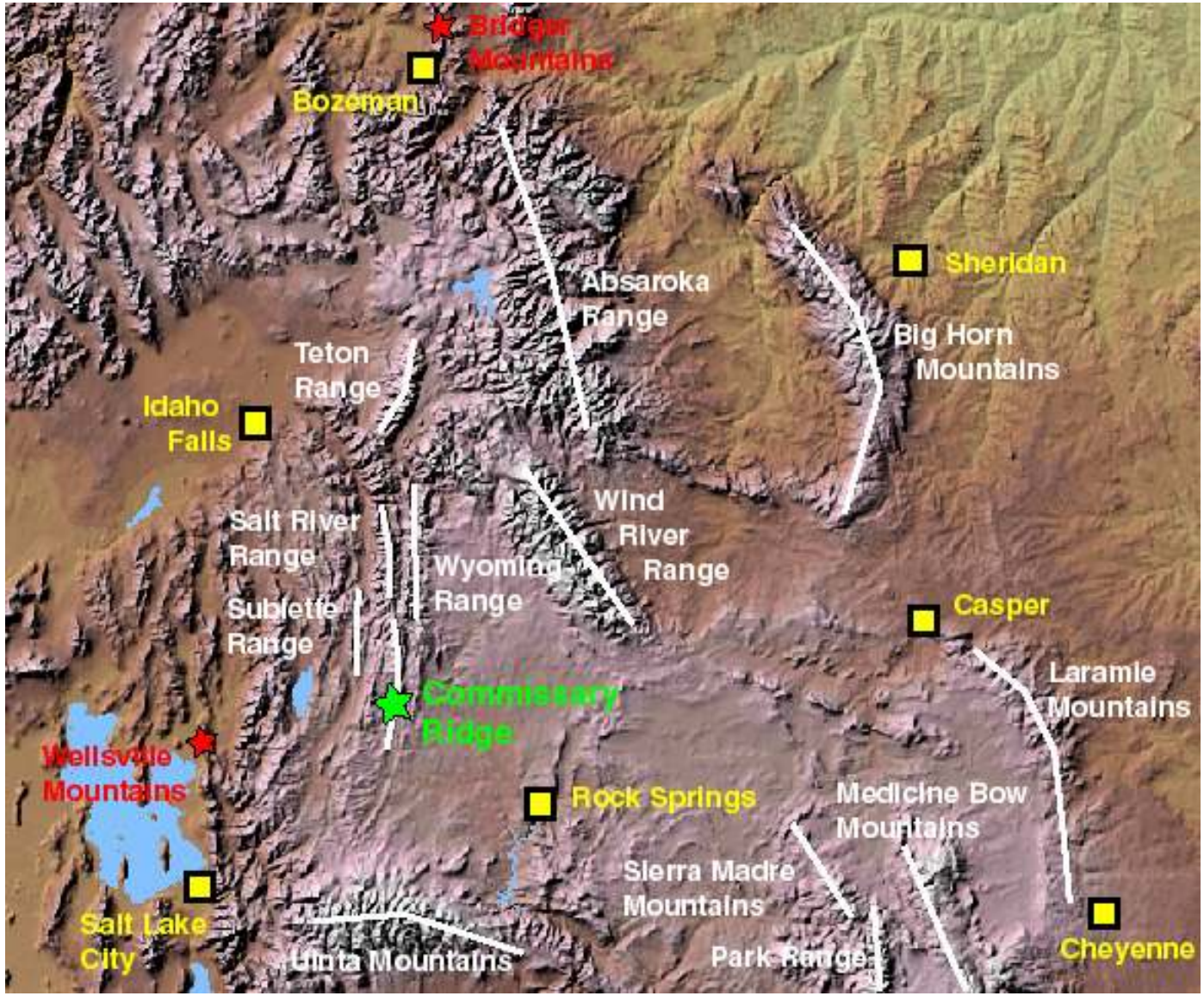


**Figure 1. Location of Commissary Ridge Raptor Migration Project site in southwestern Wyoming. Red stars indicate other nearby HWI fall migration monitoring sites in Utah and Montana.**

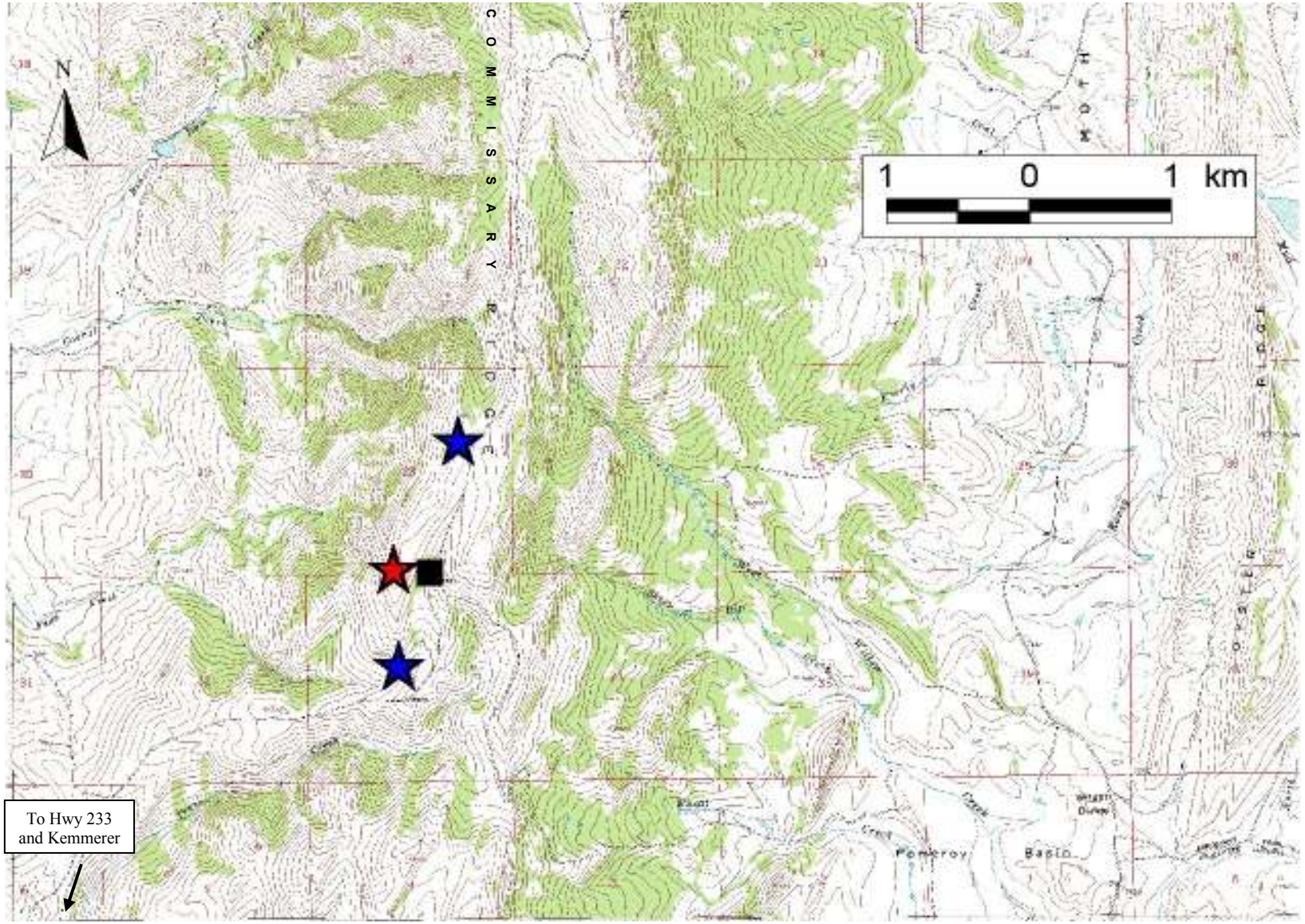


**Figure 2. Close-up of Commissary Ridge Raptor Migration Project study site in southwestern Wyoming showing locations of the observation post (red star), 2004 trapping locations (blue stars), and base camp (black square).**

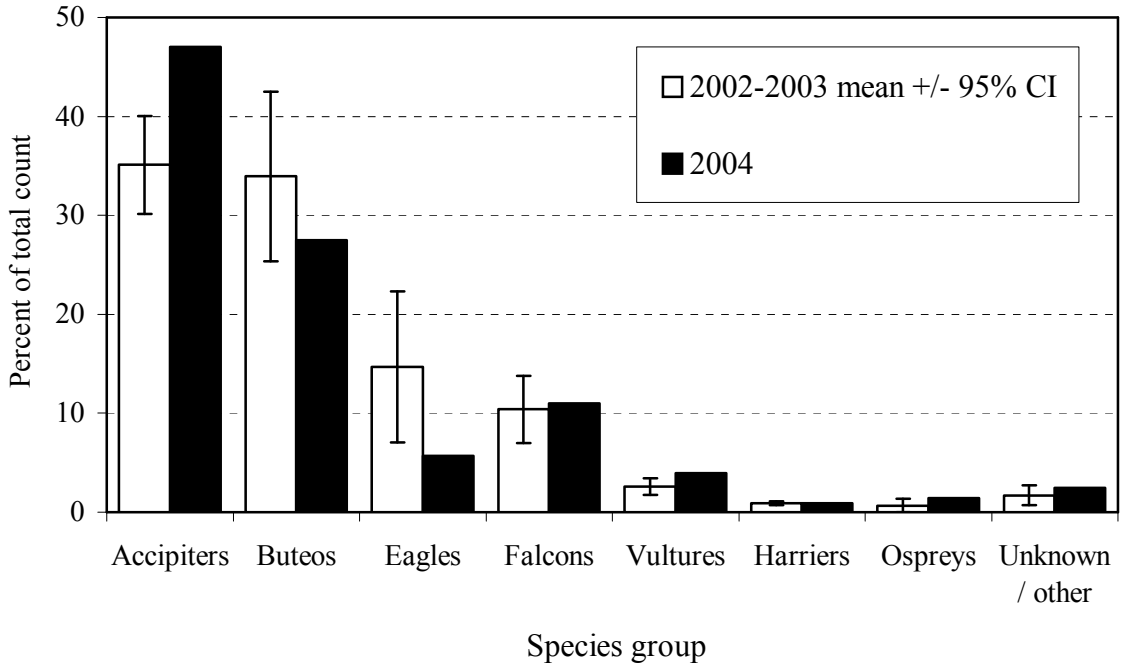


**Figure 3. Composition by major species groups of the fall raptor migration at Commissary Ridge, Wyoming: 2002–2003 versus 2004.**

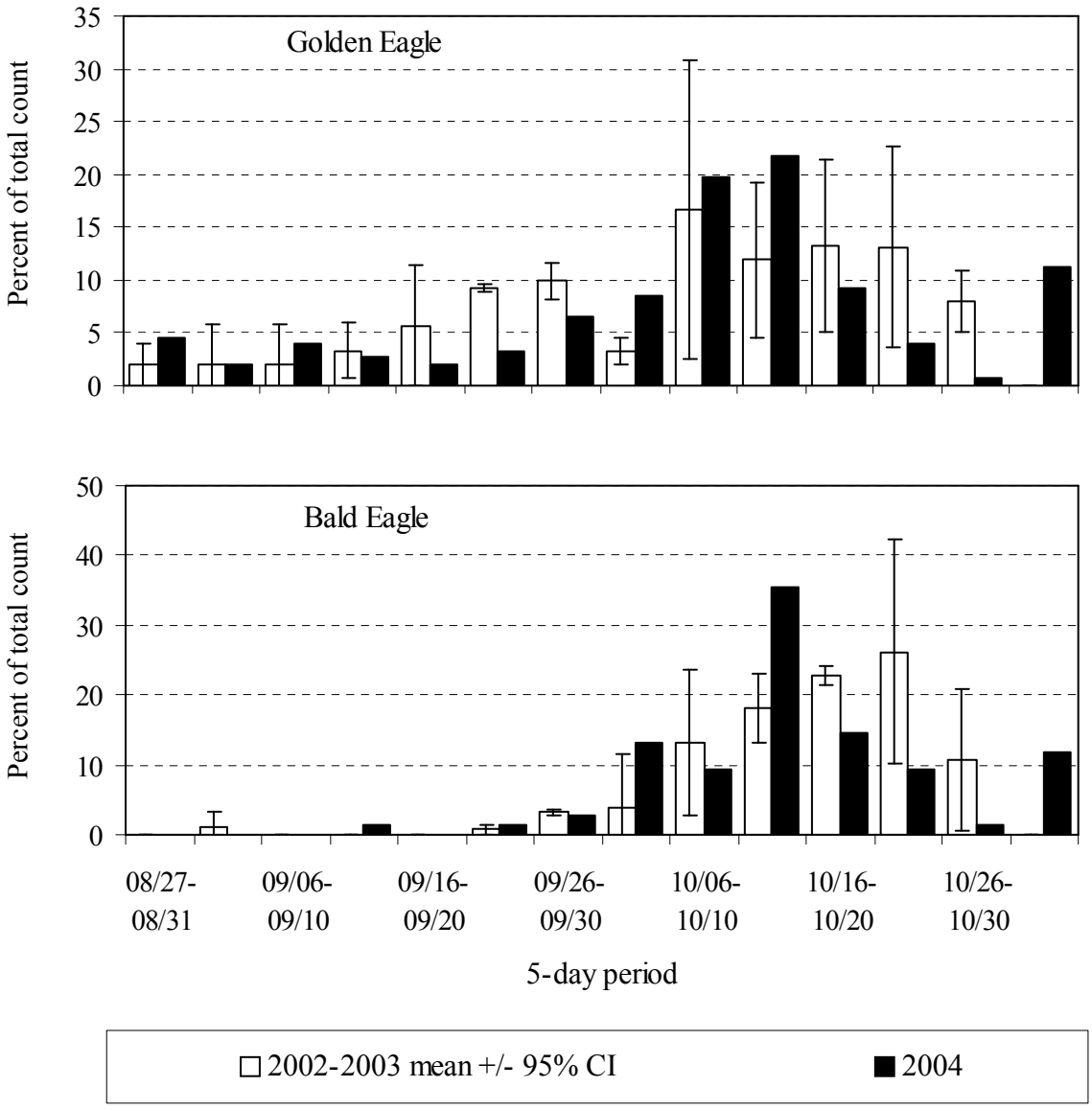


**Figure 4. Seasonal distribution of activity by five-day periods for Golden and Bald Eagles during fall migration at Commissary Ridge, Wyoming: 2002–2003 versus 2004.**

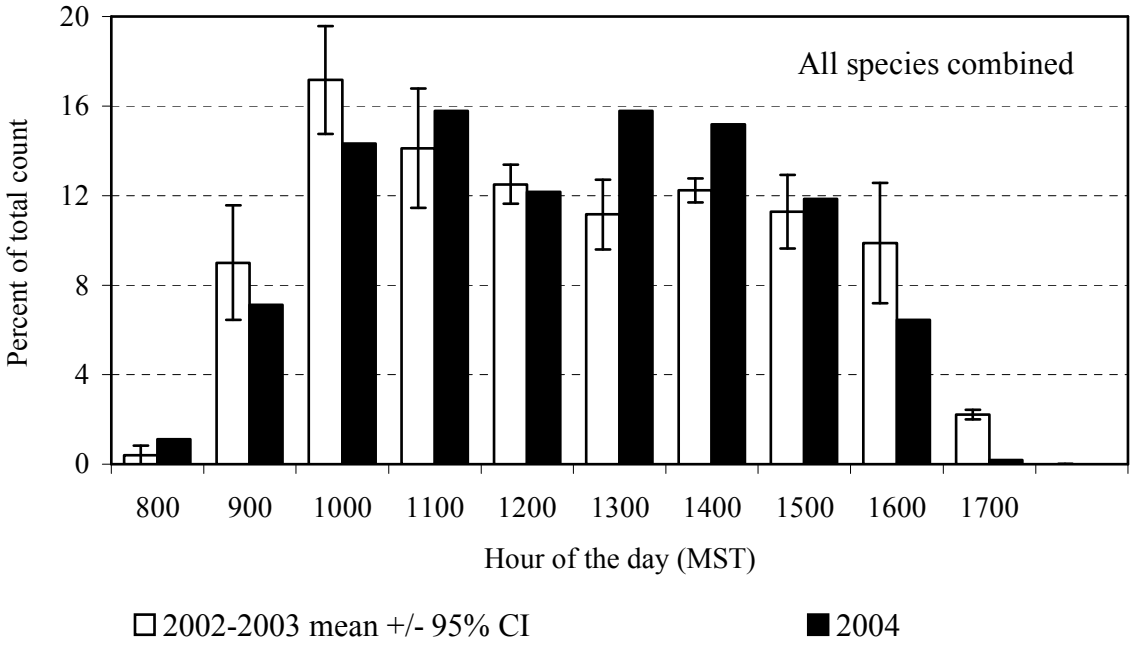


**Figure 5. Daily rhythm of the fall raptor migration at Commissary Ridge, Wyoming: 2002–2003 versus 2004.**

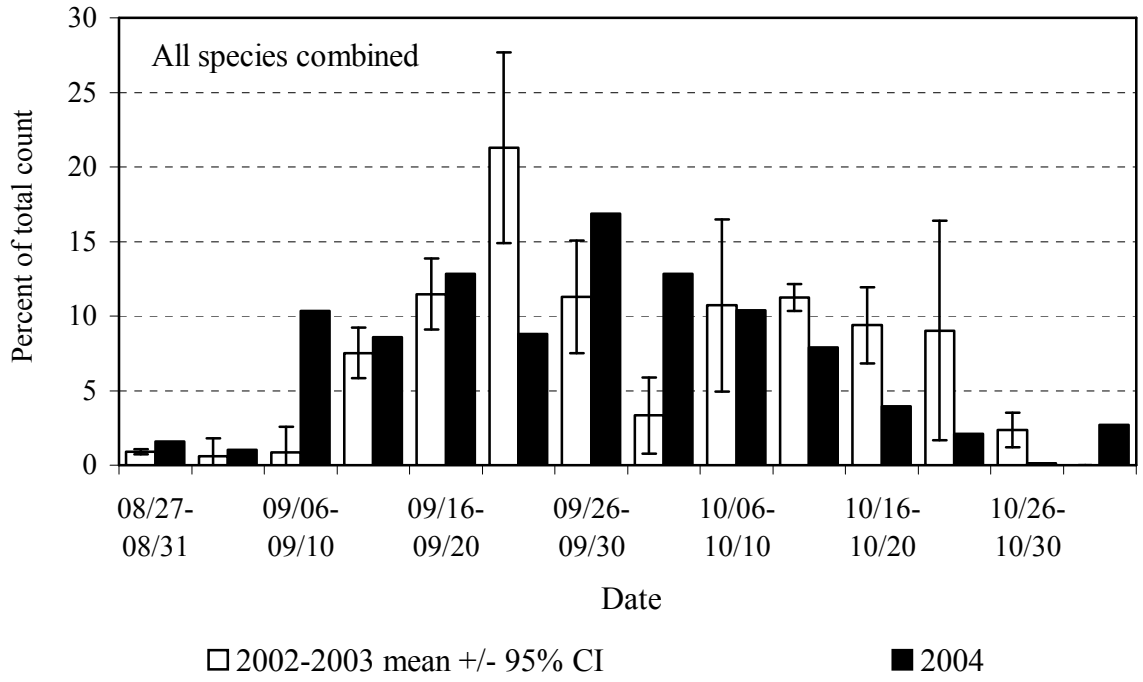


**Figure 6. Combined-species seasonal distribution of activity by five-day periods for raptors during fall migration at Commissary Ridge, Wyoming: 2002–2003 versus 2004.**

**Appendix A. 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 B. Daily observation effort, visitor disturbance ratings, weather records, and flight summaries for the fall raptor migration at Commissary Ridge, Wyoming: 2004.**

| 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 | 2.1 | 0 | clr-mc | 10.8 | w | 18.7 | 30.71 | 1 | - | - | 2 | 1.7 |
| 28-Aug | 10.00 | 3.0 | 0 | clr | 14.5 | w | 18.5 | 30.69 | 1 | - | - | 3 | 2.6 |
| 29-Aug | 8.00 | 2.1 | 0 | clr | 24.2 | w | 20.7 | 30.72 | 1 | - | - | 2 | 1.9 |
| 30-Aug | 8.00 | 2.1 | 0 | clr-pc | 20.9 | w | 19.7 | 30.78 | 1 | - | - | 3 | 1.1 |
| 31-Aug | 8.00 | 2.0 | 0 | clr | 12.1 | w | 21.2 | 30.86 | 1 | - | - | 3 | 0.5 |
| 1-Sep | 8.00 | 2.4 | 0 | pc-ovc, dust | 32.1 | sw-w | 23.6 | 30.74 | 2 | - | - | 3 | 2.3 |
| 2-Sep | 8.00 | 2.0 | 0 | ovc | 38.3 | w | 17.3 | 30.42 | 4 | - | - | 2 | 0.8 |
| 3-Sep | 6.25 | 1.7 | 0 | mc-ovc | 21.5 | w | 11.9 | 30.32 | 4 | - | - | 2 | 1.8 |
| 4-Sep | 3.75 | 1.8 | 0 | mc-ovc | 18.3 | w | 13.0 | 30.54 | 4 | - | - | 3 | 1.1 |
| 5-Sep | 8.00 | 2.2 | 0 | pc | 39.1 | w | 13.6 | 30.58 | 3 | - | - | - | 9.3 |
| 6-Sep | 8.00 | 2.0 | 0 | clr | 28.6 | w | 18.0 | 30.73 | 2 | - | - | 2 | 7.4 |
| 7-Sep | 8.00 | 2.1 | 0 | clr-pc | 25.9 | w | 19.4 | 30.72 | 2 | - | - | - | 9.0 |
| 8-Sep | 8.00 | 3.2 | 0 | pc | 26.7 | w | 22.0 | 30.68 | 1 | - | - | 3 | 14.0 |
| 9-Sep | 8.00 | 2.0 | 0 | clr-pc | 29.6 | w | 22.2 | 30.65 | 2 | - | - | - | 14.0 |
| 10-Sep | 7.00 | 1.9 | 0 | pc | 36.9 | w | 20.8 | 30.66 | 3 | - | - | 2 | 10.7 |
| 11-Sep | 8.00 | 2.0 | 0 | clr | 30.4 | w | 23.2 | 30.75 | 3 | - | - | 2 | 9.1 |
| 12-Sep | 8.00 | 2.0 | 0 | pc-ovc | 38.4 | sw | 21.1 | 30.44 | 4 | - | - | 2 | 12.3 |
| 13-Sep | 8.00 | 2.2 | 0 | pc-mc | 43.4 | w | 12.9 | 30.35 | 4 | - | - | 4 | 9.5 |
| 14-Sep | 8.00 | 2.2 | 0 | pc-ovc | 46.1 | w | 8.4 | 30.32 | 4 | 100 | 100 | 2 | 4.3 |
| 15-Sep | 8.00 | 2.3 | 0 | clr-pc | 29.2 | w | 12.0 | 30.52 | 3 | 100 | 100 | 3 | 11.5 |
| 16-Sep | 8.50 | 2.9 | 0 | clr-pc, dust | 43.8 | w | 15.6 | 30.48 | 3 | 100 | 100 | 3 | 23.2 |
| 17-Sep | 8.50 | 2.0 | 0 | clr-pc | 30.3 | w | 20.7 | 30.51 | 2 | 100 | 100 | 2 | 14.0 |
| 18-Sep | 8.50 | 2.2 | 0 | pc | 38.9 | ssw-sw | 19.7 | 30.36 | 3 | 93 | 98 | 2 | 13.3 |
| 19-Sep | 7.33 | 2.4 | 0 | pc-ovc, rain | 30.3 | e-ese, ssw-sw | 10.7 | 30.06 | 4 | 100 | 93 | 2 | 1.5 |
| 20-Sep | 1.75 | 1.0 | 0 | ovc, fog/snow | 30.0 | w | 5.3 | 30.29 | 4 | 21 | 14 | 2 | 1.7 |
| 21-Sep | 7.50 | 2.2 | 0 | ovc | 17.8 | w-wnw | 9.4 | 30.58 | 4 | 100 | 100 | 3 | 14.8 |
| 22-Sep | 4.50 | 1.9 | 0 | mc, scat snow | 38.6 | w | 5.6 | 30.54 | 4 | 89 | 75 | 2 | 5.3 |
| 23-Sep | 8.50 | 3.7 | 0 | pc-ovc | 44.1 | w | 10.1 | 30.66 | 4 | 100 | 100 | 2 | 17.5 |
| 24-Sep | 9.00 | 2.0 | 0 | pc | 27.6 | w | 14.8 | 30.77 | 3 | 100 | 100 | 3 | 8.7 |
| 25-Sep | 8.83 | 2.0 | 0 | clr | 14.0 | w | 18.4 | 30.74 | 1 | 100 | 100 | 3 | 12.9 |
| 26-Sep | 8.75 | 2.0 | 0 | clr-pc | 19.5 | w | 18.2 | 30.70 | 2 | 100 | 100 | 2 | 16.6 |
| 27-Sep | 8.67 | 2.0 | 0 | pc-ovc | 20.3 | e, w | 17.1 | 30.74 | 4 | 100 | 100 | 2 | 25.0 |
| 28-Sep | 8.50 | 2.6 | 0 | pc-ovc | 20.1 | var | 17.8 | 30.63 | 3 | 100 | 100 | 3 | 20.1 |
| 29-Sep | 6.00 | 2.0 | 0 | ovc, PM rain | 19.0 | e | 11.3 | 30.42 | 4 | 100 | 91 | 3 | 8.7 |
| 30-Sep | 7.00 | 1.9 | 0 | ovc, AM fog PM rain | 23.6 | w-wnw | 11.6 | 30.31 | 4 | 87 | 67 | 2 | 16.3 |
| 1-Oct | 4.00 | 1.0 | 0 | pc-mc, AM fog | 13.2 | w | 11.0 | 30.62 | 3 | 79 | 93 | - | 16.8 |
| 2-Oct | 8.50 | 2.8 | 0 | pc | 28.0 | w | 14.0 | 30.74 | 3 | 100 | 100 | 2 | 24.2 |
| 3-Oct | 8.50 | 2.8 | 0 | pc-mc | 9.3 | calm/var | 13.9 | 30.79 | 3 | 100 | 100 | 3 | 11.3 |
| 4-Oct | 8.00 | 3.3 | 0 | clr-ovc, scat rain | 9.2 | calm/var | 14.4 | 30.71 | 4 | 100 | 100 | 2 | 6.1 |
| 5-Oct | 5.00 | 1.7 | 0 | pc-ovc, scat snow | 10.2 | s-w | 12.1 | 30.62 | 4 | 100 | 97 | 2 | 6.4 |
| 6-Oct | 8.25 | 2.0 | 0 | clr | 22.6 | w | 13.7 | 30.59 | 2 | 100 | 100 | 3 | 14.8 |
| 7-Oct | 8.00 | 2.3 | 0 | pc-mc | 38.7 | w | 12.4 | 30.66 | 3 | 100 | 100 | 3 | 12.5 |
| 8-Oct | 5.50 | 2.0 | 0 | clr | 16.4 | s-sw, w | 16.6 | 30.81 | 3 | 100 | 100 | 3 | 11.6 |
| 9-Oct | 8.00 | 2.4 | 0 | pc | 28.7 | ssw-sw, w | 17.2 | 30.60 | 3 | 100 | 100 | 3 | 14.1 |
| 10-Oct | 7.50 | 2.0 | 0 | ovc, blowing snow | 29.2 | e | 12.9 | 30.46 | 4 | 96 | 98 | 2 | 4.1 |
| 11-Oct | 8.00 | 3.0 | 0 | pc | 24.2 | e | 10.2 | 30.64 | 3 | 100 | 100 | 2 | 3.3 |
| 12-Oct | 8.25 | 2.0 | 0 | mc-ovc | 37.9 | w | 12.0 | 30.62 | 4 | 100 | 100 | 2 | 13.2 |
| 13-Oct | 9.00 | 1.8 | 0 | pc-ovc, fog | 19.0 | w | 8.7 | 30.76 | 3 | 90 | 85 | 2 | 6.3 |
| 14-Oct | 8.50 | 2.7 | 0 | pc | 53.7 | w | 11.3 | 30.55 | 3 | 100 | 100 | 2 | 12.4 |
| 15-Oct | 8.00 | 2.8 | 0 | pc-mc | 56.2 | w | 11.0 | 30.33 | 4 | 100 | 100 | 2 | 9.3 |
| 16-Oct | 8.00 | 2.0 | 0 | clr-pc, dust | 64.1 | w | 12.0 | 30.14 | 3 | 100 | 100 | 2 | 9.4 |

Appendix B. 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17-Oct | 3.17 | 2.0 | 0 | ovc, ts/snow | 36.0 | w | 9.8 | 30.10 | 4 | 94 | 100 | 2 | 4.7 |
| 18-Oct | 0.25 | 2.0 | 0 | ovc, snow | 56.0 | wnw | 3.0 | 29.95 | 4 | 70 | 100 | - | 0.0 |
| 19-Oct | 0.00 | | | snow | | | | | | | | | |
| 20-Oct | 0.17 | 2.0 | 0 | ovc, snow | 30.0 | ne | 3.0 | 30.12 | 4 | 0 | 0 | - | 0.0 |
| 21-Oct | 0.00 | | | snow | | | | | | | | | |
| 22-Oct | 4.00 | 1.3 | 0 | ovc, blowing snow | 24.2 | var | 2.4 | 30.66 | 4 | 50 | 100 | 2 | 7.8 |
| 23-Oct | 3.33 | 1.0 | 0 | ovc, snow | 15.0 | w | 6.4 | 30.72 | 4 | 50 | 86 | 2 | 2.1 |
| 24-Oct | 7.50 | 1.8 | 0 | pc-mc | 10.6 | w | 1.1 | 30.78 | 4 | 50 | 100 | 2 | 6.7 |
| 25-Oct | 0.00 | | | snow | | | | | | | | | |
| 26-Oct | 6.25 | 1.0 | 0 | mc-ovc | 9.6 | sw, e-se | 7.9 | 30.79 | 4 | 36 | 81 | 1 | 0.5 |
| 27-Oct | 6.00 | 1.0 | 0 | ovc | 15.6 | e | 7.1 | 30.54 | 4 | 63 | 83 | 2 | 0.3 |
| 28-Oct | 2.00 | 1.0 | 0 | ovc, snow | 8.0 | s | 5.8 | 30.67 | 4 | 35 | 30 | - | 0.0 |
| 29-Oct | 0.00 | | | snow | | | | | | | | | |
| 30-Oct | 5.00 | 1.0 | 0 | ovc, fog/snow | 18.1 | w | 1.4 | 30.87 | 4 | 21 | 37 | 2 | 0.6 |
| 31-Oct | 6.17 | 1.0 | 0 | mc-ovc, snow | 19.1 | w | -1.7 | 30.77 | 4 | 17 | 21 | 2 | 11.5 |
| 01-Nov | 6.00 | 1.0 | 0 | clr | 9.1 | w | -4.4 | 31.24 | 4 | 50 | 100 | 2 | 2.3 |
| 02-Nov | 7.00 | 1.0 | 0 | clr | 4.9 | w | 4.6 | 31.34 | 4 | 50 | 100 | 2 | 1.0 |
| 03-Nov | 7.00 | 1.0 | 0 | clr-ovc | 5.9 | w | 4.9 | 31.08 | 4 | 50 | 100 | 2 | 2.4 |

[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 C. Raptor counts by day and species during fall migration at Commissary Ridge, Wyoming: 2004.**

| | | 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 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 0 | 0 | 0 | 2 | 0 | 2 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 15 | 1.7 |
| 28-Aug | 10.00 | 0 | 1 | 0 | 6 | 4 | 0 | 1 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 3 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26 | 2.6 |
| 29-Aug | 8.00 | 0 | 1 | 0 | 2 | 3 | 0 | 1 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 15 | 1.9 |
| 30-Aug | 8.00 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 2 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 1.1 |
| 31-Aug | 8.00 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0.5 |
| 01-Sep | 8.00 | 0 | 2 | 0 | 5 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 4 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 18 | 2.3 |
| 02-Sep | 8.00 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0.8 |
| 03-Sep | 6.25 | 0 | 4 | 0 | 2 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 1.8 |
| 04-Sep | 3.75 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1.1 |
| 05-Sep | 8.00 | 0 | 1 | 0 | 8 | 16 | 0 | 0 | 2 | 6 | 2 | 14 | 17 | 1 | 0 | 3 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 74 | 9.3 |
| 06-Sep | 8.00 | 0 | 3 | 1 | 12 | 11 | 2 | 3 | 1 | 5 | 0 | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 59 | 7.4 |
| 07-Sep | 8.00 | 0 | 0 | 0 | 25 | 15 | 0 | 1 | 1 | 4 | 0 | 0 | 7 | 0 | 0 | 2 | 4 | 0 | 0 | 10 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 72 | 9.0 |
| 08-Sep | 8.00 | 1 | 4 | 0 | 23 | 21 | 1 | 2 | 2 | 3 | 2 | 1 | 40 | 0 | 0 | 2 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 112 | 14.0 |
| 09-Sep | 8.00 | 2 | 0 | 0 | 22 | 19 | 1 | 9 | 1 | 4 | 0 | 0 | 15 | 0 | 0 | 3 | 1 | 0 | 0 | 29 | 0 | 1 | 0 | 1 | 0 | 0 | 4 | 112 | 14.0 |
| 10-Sep | 7.00 | 0 | 2 | 0 | 17 | 21 | 0 | 5 | 1 | 1 | 0 | 1 | 8 | 1 | 0 | 2 | 1 | 0 | 1 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 75 | 10.7 |
| 11-Sep | 8.00 | 0 | 0 | 0 | 25 | 20 | 1 | 1 | 0 | 3 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 73 | 9.1 |
| 12-Sep | 8.00 | 0 | 2 | 1 | 35 | 37 | 0 | 1 | 0 | 1 | 0 | 1 | 7 | 0 | 0 | 1 | 2 | 1 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 98 | 12.3 |
| 13-Sep | 8.00 | 0 | 4 | 0 | 17 | 29 | 2 | 1 | 6 | 0 | 0 | 2 | 8 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 76 | 9.5 |
| 14-Sep | 8.00 | 0 | 3 | 1 | 3 | 17 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 34 | 4.3 |
| 15-Sep | 8.00 | 11 | 5 | 0 | 28 | 27 | 1 | 2 | 1 | 2 | 0 | 1 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 92 | 11.5 |
| 16-Sep | 8.50 | 17 | 3 | 0 | 49 | 55 | 2 | 9 | 6 | 4 | 0 | 4 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 1 | 0 | 0 | 0 | 4 | 197 | 23.2 |
| 17-Sep | 8.50 | 3 | 3 | 0 | 46 | 36 | 0 | 0 | 0 | 1 | 0 | 4 | 11 | 0 | 0 | 0 | 1 | 0 | 0 | 12 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 119 | 14.0 |
| 18-Sep | 8.50 | 17 | 3 | 0 | 41 | 23 | 0 | 1 | 3 | 1 | 0 | 0 | 10 | 0 | 0 | 0 | 1 | 0 | 0 | 12 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 113 | 13.3 |
| 19-Sep | 7.33 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 1.5 |
| 20-Sep | 1.75 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1.7 |
| 21-Sep | 7.50 | 4 | 5 | 1 | 18 | 40 | 0 | 0 | 2 | 0 | 0 | 4 | 26 | 0 | 0 | 2 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | 111 | 14.8 |
| 22-Sep | 4.50 | 0 | 0 | 0 | 7 | 10 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 5.3 |
| 23-Sep | 8.50 | 24 | 2 | 0 | 22 | 33 | 0 | 1 | 1 | 3 | 0 | 6 | 28 | 3 | 0 | 1 | 1 | 0 | 1 | 18 | 1 | 0 | 3 | 0 | 0 | 0 | 1 | 149 | 17.5 |
| 24-Sep | 9.00 | 4 | 0 | 1 | 18 | 10 | 2 | 0 | 1 | 3 | 1 | 0 | 17 | 0 | 0 | 2 | 1 | 0 | 0 | 13 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | 78 | 8.7 |
| 25-Sep | 8.83 | 1 | 3 | 3 | 27 | 13 | 0 | 3 | 0 | 3 | 2 | 0 | 24 | 0 | 0 | 2 | 0 | 0 | 0 | 26 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 114 | 12.9 |
| 26-Sep | 8.75 | 13 | 0 | 1 | 47 | 16 | 1 | 1 | 0 | 0 | 3 | 0 | 21 | 0 | 0 | 2 | 1 | 2 | 0 | 33 | 2 | 0 | 0 | 1 | 0 | 0 | 1 | 145 | 16.6 |
| 27-Sep | 8.67 | 44 | 1 | 2 | 41 | 11 | 0 | 6 | 1 | 1 | 7 | 5 | 48 | 2 | 0 | 13 | 2 | 0 | 0 | 23 | 0 | 0 | 1 | 0 | 0 | 0 | 9 | 217 | 25.0 |
| 28-Sep | 8.50 | 16 | 2 | 1 | 45 | 25 | 1 | 3 | 0 | 1 | 0 | 0 | 32 | 1 | 0 | 0 | 7 | 0 | 0 | 33 | 2 | 0 | 1 | 0 | 0 | 0 | 1 | 171 | 20.1 |
| 29-Sep | 6.00 | 0 | 0 | 0 | 25 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 5 | 0 | 0 | 3 | 0 | 0 | 0 | 7 | 1 | 1 | 0 | 0 | 0 | 1 | 6 | 52 | 8.7 |
| 30-Sep | 7.00 | 1 | 0 | 0 | 31 | 28 | 2 | 4 | 1 | 4 | 3 | 1 | 13 | 0 | 0 | 4 | 3 | 0 | 0 | 9 | 1 | 0 | 1 | 0 | 1 | 0 | 7 | 114 | 16.3 |

Appendix C. 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 |
| 01-Oct | 4.00 | 4 | 0 | 0 | 11 | 8 | 1 | 0 | 0 | 1 | 1 | 3 | 25 | 0 | 0 | 0 | 0 | 2 | 0 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 6 | 67 | 16.8 |
| 02-Oct | 8.50 | 1 | 2 | 3 | 76 | 30 | 2 | 6 | 0 | 5 | 1 | 0 | 46 | 0 | 0 | 2 | 2 | 4 | 0 | 22 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 206 | 24.2 |
| 03-Oct | 8.50 | 0 | 0 | 2 | 29 | 10 | 3 | 1 | 1 | 1 | 0 | 0 | 27 | 0 | 1 | 0 | 6 | 4 | 0 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | 96 | 11.3 |
| 04-Oct | 8.00 | 0 | 0 | 0 | 14 | 6 | 0 | 1 | 1 | 0 | 0 | 0 | 17 | 0 | 0 | 2 | 2 | 0 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 49 | 6.1 |
| 05-Oct | 5.00 | 0 | 0 | 1 | 9 | 2 | 4 | 0 | 1 | 1 | 0 | 0 | 8 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 32 | 6.4 |
| 06-Oct | 8.25 | 1 | 0 | 1 | 51 | 4 | 0 | 1 | 0 | 2 | 0 | 0 | 29 | 0 | 1 | 0 | 11 | 1 | 0 | 10 | 5 | 0 | 0 | 0 | 0 | 0 | 5 | 122 | 14.8 |
| 07-Oct | 8.00 | 0 | 0 | 2 | 45 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 28 | 0 | 0 | 0 | 7 | 3 | 0 | 10 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 100 | 12.5 |
| 08-Oct | 5.50 | 0 | 0 | 1 | 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 1 | 4 | 1 | 0 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 64 | 11.6 |
| 09-Oct | 8.00 | 0 | 0 | 3 | 57 | 4 | 2 | 5 | 0 | 1 | 0 | 0 | 21 | 0 | 0 | 1 | 6 | 2 | 0 | 7 | 2 | 0 | 0 | 1 | 0 | 0 | 1 | 113 | 14.1 |
| 10-Oct | 7.50 | 0 | 0 | 0 | 15 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 2 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 31 | 4.1 |
| 11-Oct | 8.00 | 0 | 0 | 0 | 12 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 26 | 3.3 |
| 12-Oct | 8.25 | 0 | 0 | 1 | 22 | 0 | 0 | 3 | 0 | 2 | 0 | 0 | 55 | 0 | 0 | 4 | 3 | 12 | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 109 | 13.2 |
| 13-Oct | 9.00 | 0 | 0 | 0 | 22 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 9 | 1 | 0 | 0 | 10 | 9 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 57 | 6.3 |
| 14-Oct | 8.50 | 0 | 1 | 3 | 16 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 58 | 1 | 2 | 0 | 15 | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 105 | 12.4 |
| 15-Oct | 8.00 | 0 | 0 | 2 | 14 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 39 | 0 | 1 | 2 | 7 | 6 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 74 | 9.3 |
| 16-Oct | 8.00 | 0 | 0 | 0 | 12 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 52 | 0 | 0 | 1 | 3 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 75 | 9.4 |
| 17-Oct | 3.17 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 4.7 |
| 18-Oct | 0.25 | 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 |
| 19-Oct | 0.00 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20-Oct | 0.17 | 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 |
| 21-Oct | 0.00 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 22-Oct | 4.00 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 31 | 7.8 |
| 23-Oct | 3.33 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 2.1 |
| 24-Oct | 7.50 | 0 | 0 | 4 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 35 | 0 | 0 | 0 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 6.7 |
| 25-Oct | 0.00 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 26-Oct | 6.25 | 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 | 0.5 |
| 27-Oct | 6.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0.3 |
| 28-Oct | 2.00 | 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 | 0.00 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 30-Oct | 5.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0.6 |
| 31-Oct | 6.17 | 0 | 0 | 3 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 51 | 0 | 1 | 1 | 6 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 71 | 11.5 |
| 01-Nov | 6.00 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 1 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 2.3 |
| 02-Nov | 7.00 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 1.0 |
| 03-Nov | 7.00 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 1 | 0 | 4 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17 | 2.4 |
| Total | 452.67 | 164 | 59 | 38 | 1118 | 614 | 49 | 75 | 34 | 69 | 22 | 62 | 961 | 15 | 8 | 63 | 152 | 76 | 10 | 403 | 26 | 6 | 11 | 6 | 5 | 1 | 102 | 4149 | 9.2 |

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

**Appendix D. Annual summaries of fall-migration observation effort and raptor counts by species at Commissary Ridge, WY: 2001–2004.**

| | YEAR | | | | |
|---|---|---|---|---|---|
| | 2001 | 2002 | 2003 | 2004 | MEAN |
| Start date | 3-Sep | 27-Aug | 27-Aug | 27-Aug | 26-Aug |
| End date | 23-Oct | 29-Oct | 29-Oct | 3-Nov | 30-Oct |
| Observation days | 22 | 45 | 63 | 65 | 58 |
| Observation hours | 145.88 | 322.67 | 474.85 | 452.67 | 416.73 |
| Raptors/100 hrs | 1155.7 | 990.8 | 644.4 | 916.6 | 850.6 |
| SPECIES | RAPTOR COUNTS | | | | |
| Turkey Vulture | 67 | 97 | 66 | 164 | 109 |
| Osprey | 16 | 11 | 31 | 59 | 34 |
| Northern Harrier | 40 | 32 | 25 | 38 | 32 |
| Sharp-shinned Hawk | 303 | 675 | 516 | 1,118 | 770 |
| Cooper's Hawk | 256 | 409 | 329 | 614 | 451 |
| Northern Goshawk | 11 | 21 | 7 | 49 | 26 |
| Unknown small accipiter | 11 | 78 | 75 | 75 | 76 |
| Unknown large accipiter | 4 | 6 | 13 | 34 | 18 |
| Unknown accipiter | 29 | 16 | 58 | 69 | 48 |
| TOTAL ACCIPITERS | 614 | 1,205 | 998 | 1,959 | 1,387 |
| Broad-winged Hawk | 1 | 8 | 5 | 22 | 12 |
| Swainson’s Hawk | 18 | 82 | 28 | 62 | 57 |
| Red-tailed Hawk | 323 | 823 | 1,042 | 961 | 942 |
| Ferruginous Hawk | 7 | 6 | 3 | 15 | 8 |
| Rough-legged Hawk | 20 | 5 | 5 | 8 | 6 |
| Unidentified buteo | 19 | 17 | 87 | 63 | 56 |
| TOTAL BUTEOS | 388 | 941 | 1170 | 1131 | 1,081 |
| Golden Eagle | 279 | 352 | 233 | 152 | 246 |
| Bald Eagle | 72 | 233 | 90 | 76 | 133 |
| Unidentified eagle | 5 | 10 | 7 | 10 | 9 |
| TOTAL EAGLES | 356 | 595 | 330 | 238 | 388 |
| American Kestrel | 166 | 258 | 355 | 403 | 339 |
| Merlin | 7 | 9 | 6 | 26 | 14 |
| Prairie Falcon | 1 | 6 | 5 | 6 | 6 |
| Peregrine Falcon | 5 | 3 | 3 | 11 | 6 |
| Unknown small falcon | 2 | 0 | 3 | 6 | 3 |
| Unknown large falcon | 5 | 0 | 0 | 5 | 2 |
| Unknown falcon | 0 | 2 | 0 | 1 | 1 |
| TOTAL FALCONS | 186 | 278 | 372 | 458 | 369 |
| Unidentified raptor | 19 | 38 | 68 | 102 | 69 |
| ALL SPECIES | 1,686 | 3,197 | 3,060 | 4,149 | 3,469 |

**Appendix E. Raptor capture totals by day and species during fall migration at Commissary Ridge, WY: 2004.**

| Date | Stn. Hours | Species[1] | | | | | | | | Total | Captures / Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SS | CH | NG | RT | GE | AK | ML | PR | | |
| 02-Sep | 5.50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 03-Sep | 2.50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 04-Sep | 2.75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 05-Sep | 5.60 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0.2 |
| 06-Sep | 6.50 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0.5 |
| 07-Sep | 8.00 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0.1 |
| 08-Sep | 7.50 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0.5 |
| 09-Sep | 7.00 | 2 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0.9 |
| 10-Sep | 5.00 | 0 | 2 | 1 | 0 | 0 | 2 | 0 | 0 | 5 | 1.0 |
| 11-Sep | 8.50 | 0 | 5 | 0 | 1 | 0 | 0 | 0 | 0 | 6 | 0.7 |
| 12-Sep | 5.00 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 1.0 |
| 13-Sep | 4.50 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.2 |
| 14-Sep | 3.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 15-Sep | 8.00 | 1 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 5 | 0.6 |
| 16-Sep | 3.25 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0.6 |
| 17-Sep | 12.00 | 4 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0.8 |
| 18-Sep | 5.50 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0.5 |
| 19-Sep | 8.50 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0.4 |
| 20-Sep | 1.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 21-Sep | 6.00 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.2 |
| 22-Sep | 2.25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 23-Sep | 4.00 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.3 |
| 24-Sep | 7.50 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.1 |
| 25-Sep | 8.50 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 7 | 0.8 |
| 26-Sep | 7.75 | 5 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 10 | 1.3 |
| 27-Sep | 8.00 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0.3 |
| 28-Sep | 7.00 | 3 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 8 | 1.1 |
| 29-Sep | 8.00 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0.4 |
| 30-Sep | 5.58 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0.7 |
| 01-Oct | 3.75 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0.3 |
| 02-Oct | 8.00 | 7 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 9 | 1.1 |
| 03-Oct | 7.00 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.1 |
| 04-Oct | 8.50 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5 | 0.6 |
| 05-Oct | 9.00 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | 0.4 |
| 06-Oct | 8.50 | 3 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 6 | 0.7 |
| 07-Oct | 4.50 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0.4 |
| 08-Oct | 7.75 | 2 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 4 | 0.5 |
| 09-Oct | 8.00 | 2 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 5 | 0.6 |
| 10-Oct | 7.00 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0.3 |
| 11-Oct | 8.00 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0.3 |
| 12-Oct | 7.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 13-Oct | 7.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0.1 |
| 14-Oct | 3.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 15-Oct | 4.50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 16-Oct | 6.00 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 3 | 0.5 |
| 17-Oct | 5.75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| Total | 287.43 | 61 | 47 | 12 | 7 | 1 | 3 | 3 | 2 | 136 | 0.5 |

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