FALL 2005 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 central Rocky Mountain migratory flyway. The Commissary Ridge project was 1 of 13 long-term, annual migration counts and 1 of 5 migration-banding studies conducted or co-sponsored by HWI in North America during 2005. 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 (Inzunza et al. 2000, Smith and Hoffman 2000, Smith et al. 2001, Hoffman et al. 2002, Hoffman and Smith 2003). 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).

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). 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 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, and continued this effort in 2005. This report summarizes the results of the fall 2005 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), and is located on the western edge of a broad ridgetop overlooking the Ham's Fork River Valley and Lake Viva Naughton to the west (42°01'29"N 110°35'22"W; T24 R116 S28 SESW; elevation ~2,700 m). The location provides an unobstructed 360° view of the surrounding landscape. The ridgetop features primarily rocky substrates and low growing, desert shrubs and grasses, with scattered stands of mixed-conifer and aspen in sheltered pockets and ravines.

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. Bander Wyatt Nimitz also spent time exploring the potential for trapping at six other potential sites during the 2005 season.

METHODS

STANDARDIZED COUNT

Weather permitting, trained observers conducted daily counts from a single, traditional observation post from 27 August through 31 October. Primary observer Rob Spaul had previously conducted a full-season HWI migration count in the nearby Wellsville Mountains of northern Utah. This was primary observer Mary Ann Donovan's first season counting migratory raptors. Other crewmembers, 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, our two primary trappers, periodically assisted by other crewmembers and volunteers, operated the single 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 a camouflaged blind using live, non-native avian lures attached to lines manipulated from the blind. 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). All birds were released within 45 minutes of capture, usually much quicker, unless outfitted with a satellite transmitter, which takes longer.

In addition to collecting standard measurements and health assessment data, the trappers collected two breast feathers from most immature birds for future stable-isotope analyses of migrant origins (e.g., Meehan et al. 2001, Lott et al. 2003, Lott and Smith in press). The crew also outfitted two Northern Goshawks with satellite transmitters to enable tracking of their movements for ~9–11 months. Both outwardly healthy female birds, 1 hatch-year and 1 after-second-year adult, were outfitted with 20-g battery powered PTTs fit using a backpack-style Teflon harness and with the transmitter package weighting ≤3% of the bird's body mass.

RESULTS AND DISCUSSION

WEATHER

Inclement weather precluded two full days of potential observations in 2005 and severely hampered observations (≤4 hrs observation) on four other days (see Appendix B for daily weather records). The reduction in observation time due to weather was similar to 2003 (3 full days and 2 partial days), but half that in 2004 (4 full and 9 partial days). Fifty-four percent of the active observation days featured predominantly fair skies (13% including some fog or haze), 33% transitional skies (i.e., shifted from fair skies to mostly cloudy or overcast skies during the day, or vice versa; 13% including some fog/haze or rain/snow), and 15% mostly cloudy to overcast/stormy skies (4% including some fog/haze and/or rain/snow). In 2004, mostly cloudy to overcast/stormy skies prevailed on 31% of the active days (20% 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 2005, the temperature during active observation periods averaged 14.8°C (average of daily values, which were in turn averages of hourly readings), ranging from 1.1–26.0°C. The average is identical to 2003 but 2.2°C warmer than in 2004, while the minimum is average and the maximum the warmest yet recorded for the project.

In 2005, light winds (<12 kph) predominated on 8% of the active observation days, moderate winds (12–28 kph) on 56%, and strong winds (>28 kph) on 36%. This proportional representation is similar to the 2002 season (4, 60, and 36%), whereas 2003 (11, 41, and 48%) and 2004 (15, 45, and 40%) showed higher proportions of both lighter and stronger winds and fewer days with predominantly moderate winds. In other words, wind speeds in 2005 were more consistently moderate than during the previous two years. For the previous three years, W-NW winds were by far the most common pattern, prevailing on 55–76% of the active days. In 2005, although W-NW still prevailed on 31% of the active days, SW-W winds were the most common wind pattern, prevailing on 48% of the active observation days. SW-W winds also appeared more prevalent during the limited 2001 season.

Fair-to-poor thermal-lift conditions predominated on 41% of the active observation days in 2005, good-to-excellent conditions on 59%. This is a much higher proportion of good-to-excellent conditions than during the previous three years (22–38%), but is identical to the proportion estimated during the limited 2001 season. Visibility averaged ~81 km east and west in 2005, which is ~10-15 km more than in 2004 but similar to other years.

In summary, the weather in 2005 was most similar to 2002, but was less unsettled and stormy than in any previous full year of operations. Temperatures averaged warm, with the maximum daily-average the warmest on record. Wind speeds were more consistently moderate than during the previous two years when a broader range of variation applied, but were similar to 2002. Steady SW-W winds predominated, whereas W-NW winds were much more common during the previous three years. Visibility remained high, primarily because of the low occurrence of fog and especially haze. Due to the lack of unsettled weather, reduction in strong-wind days, and warmer temperatures, thermal lift conditions rated good-to-excellent on a high 59% of the active observation days.

OBSERVATION EFFORT

Counts occurred on 64 of 66 days between 27 August and 31 October 2005, averaging 7.5 hours per active day and encompassing 478.83 total hours of observation (see Appendix C for annual data). The number of observation days is the second highest for the project and the number of observation hours is a few hours higher than the previous high in 2003. A 12-day wildfire closure reduced the overall effort in 2002.

FLIGHT VOLUME AND COMPOSITION

The observers tallied 4,718 migrants of 17 species during the 2005 season (Table 1, and see Appendix C for daily count records). The flight was composed of 48% accipiters, 31% buteos, 10% eagles, 8% falcons, 2% vultures, 1% each of Ospreys and Northern Harriers, and <1% unidentified raptors (Figure 3). Only the proportion of accipiters was significantly above average, whereas the proportions of falcons and harriers were significantly below average compared to previous years. The most abundant species were the Sharp-shinned Hawk (36% of the total count), Red-tailed Hawk (28%), Cooper's Hawk (10%), American Kestrel (7%), Golden Eagle (7%), Bald Eagle (3%), and Turkey Vulture (2%). All other species each comprised ≤1% of the total.

The 2005 tally included new high counts for four species: Sharp-shinned Hawks, Red-tailed Hawks, Peregrine Falcons, and Prairie Falcons (see Appendix D for annual count summaries). Substantial increases in the abundance of Sharp-shinned Hawks (119% above the 2002–2004 average) and Red-tailed Hawks (40% above average) were particularly noteworthy. Only the count of American Kestrels fell below the 2002–2004 average. For both eagle species, counts had been declining steadily since 2002, but the 2005 count rebounded to pre-2003 levels (Appendix D). Species that continued to pass through in good numbers during the final few days of the season included Northern Harriers, Northern Goshawks, Rough-legged Hawks, Golden Eagles, and especially Bald Eagles (Appendix C).

Passage rates of Golden Eagles have been declining for the past 4–5 years in the nearby Wellsville Mountains of northern Utah, the Bridger Mountains of southwest Montana, and the Goshute Mountains of northeastern Nevada (Smith 2005, Smith and Neal 2006a, 2006b). 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 2005; no count occurred at this site in 2005). 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 previous 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. Record high counts for both of these species were recorded at Commissary Ridge in 2005 (Table 1, Appendix D).

The 2005 overall combined-species count dropped 21% in the Bridger Mountains of southwestern Montana compared to the 1991–2004 average for that site (Smith and Neal 2006a); 13% in the Goshute Mountains of northeastern Nevada compared to the 1983–2004 average for that site (Smith and Neal 2006b); and 44% at the Grand Canyon of Arizona compared to the 1997–2004 average for that site (Smith and Neal 2006c). In this light, the high 2005 count at Commissary Ridge does not appear to fit the broader pattern; however, in most cases the 2005 counts at the other sites were more moderate when compared to just the last 3–4 seasons at those sites. Moreover, compared to the above sites, counts in the Manzano Mountains of central New Mexico in the southern Rocky Mountains have remained relatively stable for most species over the past five years (Smith and Neal 2006d). In addition, we were fortunate to have on-board in 2004 and 2005, a dedicated and relatively high caliber observation team, especially compared to 2003. This factor, along with the limited years sampled, undoubtedly contributed to the higher 2004 and 2005 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% lower than

the 2002–2004 averages for seven species (Table 2). Conversely, the only age ratio that was substantially above average was for Broad-winged Hawks, though for this species low total counts preclude attaching much significance to the comparison. For six species with low age ratios (Northern Harrier, Cooper's Hawks, Red-tailed Hawks, Ferruginous Hawks, and Peregrine Falcons), counts of immature birds were similar to averages for the previous three years, whereas counts of adults were generally higher than average. This indicates that the low age ratios were due to high abundances of adult birds rather than low abundances of young birds. For Sharp-shinned Hawks, the absolute abundances of both immatures and adults were much higher than average, so the low age ratio for this species also reflects a relative increase in the abundance of adults rather than a decrease in the abundance of immature birds. Together these data suggest that productivity and juvenile recruitment among central and northern Rocky Mountain source populations was probably moderate for many species in 2005 compared to the last three years, but also suggest that migrating adults were unusually abundant in 2005.

DAILY AND SEASONAL MIGRATION PATTERNS

Except for modest activity during the 0900 hour, the diel rhythm of migration at Commissary Ridge in 2005 followed a pattern similar to a right-tailed lognormal distribution, with a steep rise in activity beginning during the 0900 hour and reaching a peak during the 1000 hour, followed by a gradual tapering off of activity through the 1700 hour (Figure 4). This pattern differed from the 2004 season when activity peaked mid-day and resembled a bell-shaped curve. The 2005 pattern more closely resembles the pre-2004 pattern, but is atypical compared to 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 2005 pattern suggests that, on average, conditions were more favorable for migration along Commissary Ridge early in the day. An alternative explanation is that conditions for detecting migrants progressively declined as the day wore on, whereas unusually poor thermal conditions in 2004 may have kept migrants closer to the ridgeline (observers) throughout the day. Steady, moderate-to-strong SW-W 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 followed a roughly similar pattern as the previous years, except clearly there has been significant variability in the distribution of activity among five-day periods between mid-September and early October (Figure 5). The general bell-shaped distribution of activity and the late September peak of the 2005 pattern are similar to the usual pattern seen at other western monitoring sites at similar latitudes. The overall combined-species median passage date of 27 September was a non-significant 1 day earlier than the average for the past three seasons (Table 3). At the species level, median passage dates were significantly earlier than average for two species (Turkey Vulture and Red-tailed Hawk), significantly later than average for four species (Northern Harrier, Broad-winged Hawk, Merlin, and Peregrine Falcon), and not significantly different from average for 10 species (Table 3). Age and sex-specific data revealed additional complexities for some species, in particular a higher prevalence of significantly early timing than indicated by the species-level data (Table 4).

TRAPPING AND BANDING SUMMARY

Trapping occurred at the primary station 55 of 60 days between 29 August and 27 October 2005, with effort totaling 383.50 hours and daily effort averaging 7.0 ± SD of 1.6 hours per day (see Appendix F for daily trapping records and Appendix G for annual trapping summaries). In addition, Wyatt Nimitz, Ken Etzel, and Rob Spaul conducted 39.5 hours of exploratory observations at nine other sites to locate alternate raptor trapping station(s) for future project years. While the current trapping location has been fruitful, we hope to establish one or two more arenas that are sheltered from high winds and therefore more conducive to migration trapping.

In general, high winds on the ridgetop substantially reduced 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 descend and attack the lure birds. Despite this severe constraint, our dedicated crew was able to successfully secure 204 raptors of seven species, which translates to a total capture rate of 53.2 birds per 100 station hours and total capture success of 4.5% of the catchable raptors (Table 5). The most commonly captured species were the Sharp-shinned Hawk (47% of all captures), Cooper's Hawk (31%), Northern Goshawk (8%), Red-tailed Hawk (6%), and American Kestrel (3%). 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 station hours were similar, HWI trappers secured 521 raptors for a total capture rate of 152 captures per 100 station hours and a total capture success of 19% (Smith and Neal 2006e). Similarly, at the first trapping station migrants encounter in the Goshute Mountains of Nevada, the overall capture rate in 2005 was 177.6 captures per 100 station hours and total capture success for this station was 6% (Smith and Neal 2006b).

Compared to the counts, banding data yield unique and useful sex–age specific data only for the three accipiters and American Kestrels (Table 6). The count and capture age ratios for Sharp-shinned Hawks (0.7 vs. 2.2) and Northern Goshawks (0.8 vs. 2.8) differed significantly in 2005, with the much higher capture age ratios suggesting that immature birds were far more susceptible to capture than adults. This is a fairly typical pattern at HWI's western trapping stations for many species. For the Cooper's Hawk, both the count and capture data indicated that immature birds were less abundant than adults (immature : adult ratios <1) and similar ratios again suggest that immature birds were no more susceptible to capture than adults in 2005. Unlike the counts, banding also yields useful data on accipiter sex ratios, or at least sex-related susceptibility to capture. In 2005, female Cooper's Hawks were captured 4.8 times more often than males, which is similar but slightly lower than in 2004 (6.8 : 1). In contrast, female Sharp-shinned Hawks and Northern Goshawks were captured only slightly more often than males of their species in 2005, with the 2005 capture sex ratio lower than in 2004 for sharp-shins but five times higher than last year for goshawks. For further contrast, male kestrels were captured three times more often than females in 2005, which differs markedly from the count-based sex ratio of 1.61 females to males. This suggests that male kestrels were much more susceptible to capture than females in 2005. Capture age data for kestrels further indicated that immature males were by far the most likely to be captured, and the total of 13 captures included no adult females.

SATELLITE TRACKING

Although like in 2004 we fell well short of our goal of deploying seven satellite transmitters on three species, given the severe wind-related difficulties that our crews faced in both years, we were happy to have succeeded in deploying two additional units on Northern Goshawks in 2005 to complete our site deployment objective for this species. These two new birds, one juvenile female and one adult female, both initially traveled up to ~100 km north after being released but then later tracked back south, with the young bird eventually spending the winter ~20 km ENE of Evanston, Wyoming and the adult a bit farther south in northeastern Utah near Roosevelt. The first immature female goshawk that we outfitted at the site in 2004 ended up remaining near or on Commissary Ridge throughout the 8.5 month period we were able to track her, except for one sudden two week trip she took up and back into the Caribou Range of southeastern Idaho in April. Thus far, the survival rate of our three Wyoming goshawks has been much better than for the more than 20 other goshawks we have tracked in the Pacific Northwest, Nevada, and New Mexico.

We also outfitted one hatch-year, male Golden Eagle at the site in 2004. After a few days following its release, this eagle traveled south ~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, where he remained for the winter. At one point in early spring, he set out to the northwest and ended up along the Bear River on the Utah–Wyoming border, but then abruptly returned to his wintering area. He subsequently made two other brief trips back to Commissary Ridge or nearby, but essentially spent the summer of 2005 in the same area where he wintered. Then in late November 2005, he abruptly set off and traveled ~45 km farther southeast to the Antelope Knoll/Chicken Draw area south of I-80 between Rock Springs and Evanston, Wyoming. He remained in this area through December, but then unfortunately the signals from this bird's transmitter abruptly ceased. Sensor data just before that time indicated that the bird was alive and active, so premature battery failure or damage to the transmitter antenna could be causes.

These deployments compliment more than 85 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. In 2006, we will again attempt to complete our initial deployment objectives for Commissary Ridge by outfitting three Red-tailed Hawks and two more Golden Eagles with transmitters. These Wyoming deployments are designed to provide valuable new tracking data for central and northern Rocky Mountain migrants to augment previous and on-going data collection in the northern Pacific Coast Flyway (OR and WA), the Intermountain Flyway (NV), and southern Rocky Mountain Flyway (NM).

Complete tracking summaries and maps for all of HWI's satellite-tracked raptors can be found at http://www.hawkwatch.org/satelliteprogram.php.

STABLE ISOTOPE RESEARCH

As was the case in 2004, the banding crew collected breast and/or tip clippings from secondary feathers from most immature raptors that they captured during the 2005 season. Such feather collection is designed to support analyses of 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., Meehan et al. 2001, Lott et al. 2003, Lott and Smith in press). 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. Lott and Smith (in press) details a new GIS-based approach for mapping the origins of raptors based on this technique, and we expect to begin producing several other relevant publications in the next year. 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 2005, 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 and another active nest site is located on the north end of Kemmerer, ~ 35 km south of the count site.

At least one family group of resident Northern Harriers was present on the ridge in 2005. One immature bird was seen regularly in September, primarily hunting on the ridge to the north of the observation site.

A pair of adult harriers, one male and one female, were observed hunting alone and sometimes together along the ridge, but were rarely observed with the immature bird. 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. Their territory was thought to be located near the wetland complexes directly east or west of Commissary Ridge.

Turkey Vulture activity was common through the end of September. Groups of 3 and 4 were seen on the north ridge and east slope of South Fork Mountain. The storms in early October seemed to move these birds south.

At least one pair of Sharp-shinned Hawks resided on Commissary Ridge. Immature birds displayed resident behavior through 10 October. At least two immatures were regularly seen foraging in the western forests or on the ridge north of the count site. Cooper's Hawks were observed only sporadically this season. Overall, activity was too sparse to indicate territory use. Two resident family groups of Northern Goshawks occurred on Commissary Ridge this season, with various individuals observed throughout the season. Many of the goshawks captured this season were believed to be local birds because they were not seen by the observation team. One pair of adult goshawks was observed frequently along the southwestern margins of the ridge, while the other pair's territory was probably farther north towards Bridger-Teton National Forest. Goshawks were seen regularly in camp from 14 September to 10 October. Northern Goshawk abundance and behavior seems to indicate that this area may present important foraging and stopover habitat.

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, which may have been a resident breeder since at least 2000. Two light-morph adults and 2-3 immatures were typically seen along the north ridge, where they often intercepted and escorted migrants. The dark-morph adult seemed to be mated with a light-morph adult and produced at least two light-morph offspring. This pair probably nested southwest of the count site and were often observed foraging up to several kilometers north of the count site. Resident red-tails were active along the ridge until early October, but the adults from the north ridge were still present at season's end. Two 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. Commissary Ridge also seems to provide critical stopover habitat for red-tails, as birds often originated from the surrounding forest to migrate in the morning.

No resident Swainson's Hawk activity was observed in 2005, even though 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. One light-morph bird was thought to stopover for 1-2 days.

At least one family group of Golden Eagles, two adults, two immature birds, and an associated subadult bird, frequented the north ridge in 2005. This group was regularly seen coursing low to the west of the ridge and atop the ridge a few kilometers north of the project area. Additionally, another subadult and adult seemed to hold a territory southwest of the count site. These birds were often seen foraging around the Ham's Fork River and often rose to meet migrating eagles. Resident Golden Eagles were often observed coursing along the east-slope of South Fork Mountain, but it is unclear with which territory they may have been associated. Suitable nesting cliffs are found in this area, and the presence of birds may be indicative of a third territory.

At least one family group of Bald Eagles was regularly observed early in the season. According to the BLM, one resident Bald Eagle lives on Lake Viva Naughton and along the Ham's Fork River. After mid September, two adults and three younger eagles also were regularly observed. The young included one first-year bird, one S1 subadult (see Appendix A for plumage class descriptions), and one S2 subadult. These birds would often play in the updrafts and intercept migrating eagles that were adding to the burgeoning winter population.

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. The proximate pair held a territory on the northwest slope of Commissary Ridge and often foraged just north of the project area. The young included at least two females and one male. Foraging behavior and low flights from south to north by adult Peregrine Falcons were recorded twice on the ridge, but no activity could be tied directly to territory use. Resident Prairie Falcons also were observed frequently in the sagebrush flats southwest of the project site. According to BLM data, a nest site is located to the northwest of Commissary Ridge, but activity in this area was only observed until mid-September. 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. One adult male Taiga Merlin was observed multiple times and observers believed a pair held a territory in the western forest patch.

SITE VISITATION AND PUBLIC OUTREACH

Public awareness of HWI's newest migration monitoring project is still developing, but we were pleased to host nine visitors at the project site during the 2005 season. All the visitors 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 two guests originated in Montana and Oregon, including HawkWatch International's Founder – Steve Hoffman. The continued involvement of BLM interns on the project also has been a welcome addition.

In July 2005, for the second year in a row, 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 *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, we expect to move ahead strongly again in 2006 with all aspects of this project. We expect the count to proceed much as it has during the past four 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 hope to identify final locations for one or two trapping stations that afford good protection from the wind, reasonable trapping success, and productive situations for exposing the public to our banding operations. Following our extensive exploration of several other potential sites in 2005, we have identified two locations that we expect to afford great promise in this regard, one a bit farther north than the station used in 2004 and 2005, and one to the south of the count site.

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Table 1. Annual raptor migration counts and passage rates by species at Commissary Ridge, WY: 2002–2004 versus 2005.

	Counts			Raptors/100 hours		
Species	2002–2004[1]	2005	% Change	2002–2004[1]	2005	% Change
Turkey Vulture	109 ± 56.7	114	5	26.7 ± 13.05	23.8	-11
Osprey	34 ± 27.3	36	7	7.7 ± 5.56	7.5	-2
Northern Harrier	32 ± 7.4	36	14	7.9 ± 2.68	7.5	-4
Sharp-shinned Hawk	770 ± 353.0	1687	119	188.3 ± 80.90	352.3	87
Cooper's Hawk	451 ± 166.3	462	3	110.6 ± 40.76	96.5	-13
Northern Goshawk	26 ± 24.2	35	36	6.3 ± 5.30	7.3	17
Unknown small accipiter	76 ± 2.0	55	-28	18.8 ± 5.24	11.5	-39
Unknown large accipiter	18 ± 16.5	11	-38	4.0 ± 3.44	2.3	-43
Unknown accipiter	48 ± 31.7	2	-96	10.8 ± 5.98	0.4	-96
Total Accipiters	1387 ± 572.3	2252	62	338.8 ± 130.44	470.3	39
Broad-winged Hawk	12 ± 10.3	9	-23	2.8 ± 2.18	1.9	-33
Swainson's Hawk	57 ± 30.9	52	-9	15.0 ± 11.12	10.9	-28
Red-tailed Hawk	942 ± 125.3	1319	40	228.9 ± 25.92	275.5	20
Ferruginous Hawk	8 ± 7.1	8	0	1.9 ± 1.52	1.7	-14
Rough-legged Hawk	6 ± 2.0	13	117	1.5 ± 0.41	2.7	86
Unidentified buteo	56 ± 40.3	42	-25	12.5 ± 7.51	8.8	-30
Total Buteos	1081 ± 138.6	1443	34	262.6 ± 28.49	301.4	15
Golden Eagle	246 ± 113.8	316	29	63.9 ± 45.13	66.0	3
Bald Eagle	133 ± 98.3	137	3	36.0 ± 35.52	28.6	-20
Unidentified eagle	9 ± 2.0	2	-78	2.3 ± 0.92	0.4	-82
Total Eagles	388 ± 209.7	455	17	102.2 ± 81.16	95.0	-7
American Kestrel	339 ± 83.6	317	-6	81.2 ± 8.17	66.2	-19
Merlin	14 ± 12.2	11	-20	3.3 ± 2.58	2.3	-30
Prairie Falcon	6 ± 0.7	18	218	1.4 ± 0.46	3.8	166
Peregrine Falcon	6 ± 5.2	13	129	1.3 ± 1.09	2.7	104
Unknown small falcon	3 ± 3.4	2	-33	0.7 ± 0.75	0.4	-36
Unknown large falcon	2 ± 3.3	2	20	0.4 ± 0.72	0.4	13
Unknown falcon	1 ± 1.1	0	-100	0.3 ± 0.36	0.0	-100
Total Falcons	369 ± 101.9	363	-2	88.6 ± 13.13	75.8	-14
Unidentified raptor	69 ± 36.2	19	-73	16.2 ± 6.36	4.0	-76
Grand Total	3469 ± 671.2	4718	36	850.6 ± 206.37	985.3	16

[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: 2002–2004 versus 2005.

	Total and Age-classified Counts								Immature : Adult	
	2002–2004 Average			2005			% Unknown Age		Ratio	
Species	Total	Imm.	Adult	Total	Imm.	Adult	2002–2004[1]	2005	2002–2004[1]	2005
Northern Harrier	32	10	10	36	12	19	38 ± 8.7	14	1.0 ± 0.4	0.6
Sharp-shinned Hawk	770	224	254	1687	406	589	39 ± 4.4	41	0.8 ± 0.2	0.7
Cooper's Hawk	451	153	139	462	132	169	37 ± 4.8	35	1.1 ± 0.3	0.8
Northern Goshawk	26	17	6	35	13	18	7 ± 4.6	11	2.9 ± 2.0	0.7
Broad-winged Hawk	12	2	5	9	4	3	33 ± 11.3	22	0.4 ± 0.2	1.3
Red-tailed Hawk	942	259	455	1319	248	678	24 ± 5.2	30	0.6 ± 0.1	0.4
Ferruginous Hawk	8	3	2	8	2	3	39 ± 16.3	38	1.3 ± 0.8	0.7
Golden Eagle	246	119	78	316	173	110	20 ± 4.5	10	1.6 ± 0.2	1.6
Bald Eagle	133	44	89	137	46	87	0 ± 0.5	3	0.5 ± 0.1	0.5
Peregrine Falcon	6	2	3	13	2	8	28 ± 5.6	23	0.8 ± 0.7	0.3

[1] Mean ± 95% confidence interval. For age ratios, note that long-term mean immature : adult ratios are averages of annual ratios and may differ from values obtained by dividing average numbers of immatures and adults. Discrepancies in the two values reflect high annual variability in the observed age ratio.

Table 3. First and last observed, bulk passage, and median passage dates by species for migrating raptors at Commissary Ridge, WY in 2005, with comparisons of 2005 and 2002–2004 average median passage dates.

	2005				2002–2004
Species	First Observed	Last Observed	Bulk Passage Dates[1]	Median Passage Date[2]	Median Passage Date[2, 3]
Turkey Vulture	29-Aug	8-Oct	5-Sep – 28-Sep	19-Sep	23-Sep ± 2.4
Osprey	29-Aug	7-Oct	2-Sep – 29-Sep	16-Sep	16-Sep ± 5.1
Northern Harrier	27-Aug	31-Oct	8-Sep – 26-Oct	8-Oct	29-Sep ± 7.9
Sharp-shinned Hawk	27-Aug	31-Oct	10-Sep – 16-Oct	27-Sep	28-Sep ± 2.8
Cooper's Hawk	27-Aug	20-Oct	5-Sep – 2-Oct	20-Sep	22-Sep ± 3.9
Northern Goshawk	30-Aug	31-Oct	4-Sep – 26-Oct	12-Oct	08-Oct ± 6.6
Broad-winged Hawk	22-Sep	24-Oct	22-Sep – 24-Oct	29-Sep	24-Sep ± 3.5
Swainson's Hawk	7-Sep	7-Oct	19-Sep – 30-Sep	25-Sep	19-Sep ± 9.3
Red-tailed Hawk	27-Aug	31-Oct	13-Sep – 22-Oct	1-Oct	08-Oct ± 5.8
Ferruginous Hawk	28-Aug	20-Oct	28-Aug – 20-Oct	25-Sep	22-Sep ± 3.9
Rough-legged Hawk	10-Oct	31-Oct	13-Oct – 26-Oct	22-Oct	19-Oct ± 3.9
Golden Eagle	27-Aug	31-Oct	5-Sep – 25-Oct	8-Oct	09-Oct ± 0.7
Bald Eagle	4-Sep	31-Oct	7-Oct – 31-Oct	19-Oct	16-Oct ± 2.8
American Kestrel	27-Aug	20-Oct	5-Sep – 1-Oct	19-Sep	23-Sep ± 3.0
Merlin	6-Sep	25-Oct	13-Sep – 23-Oct	16-Oct	02-Oct ± 7.5
Prairie Falcon	2-Sep	21-Oct	6-Sep – 16-Oct	20-Sep	25-Sep ± 5.2
Peregrine Falcon	8-Sep	13-Oct	16-Sep – 13-Oct	26-Sep	24-Sep ± 0.0
Total	27-Aug	31-Oct	8-Sep – 20-Oct	27-Sep	28-Sep ± 1.7

[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: 2002–2004 versus 2005.

	ADULT		IMMATURE / SUBADULT	
SPECIES	2002-2004[1]	2005	2002–2004[1]	2005
Northern Harrier	06-Oct ± 18.3	16-Oct	29-Sep ± 4.6	5-Oct
Sharp-shinned Hawk	07-Oct ± 3.0	30-Sep	24-Sep ± 10.7	18-Sep
Cooper's Hawk	23-Sep ± 2.0	25-Sep	18-Sep ± 5.6	14-Sep
Northern Goshawk[2]	21-Oct ± 22.5	16-Oct	28-Sep ± 9.8	13-Sep
Red-tailed Hawk	11-Oct ± 3.3	7-Oct	30-Sep ± 11.4	25-Sep
Golden Eagle	13-Oct ± 2.0	15-Oct	08-Oct ± 1.7	1-Oct
Bald Eagle	17-Oct ± 2.3	17-Oct	17-Oct ± 4.1	22-Oct
Peregrine Falcon	18-Sep [3]	21-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] 2002–2004 values based on data for 2002 and 2004 only.

[3] Value is for 2004 only.

Table 5. Capture totals, rates, and successes for migrating raptors at Commissary Ridge, WY: 2004–2005.

	Capture Total		Capture Rate[1]		Capture Success (%)[2]	
Species	2004	2005	2004	2005	2004	2005
Sharp-shinned Hawk	61	96	21.2	25.0	5.0	5.5
Cooper's Hawk	47	65	16.4	16.9	6.8	13.4
Northern Goshawk	12	17	4.2	4.4	22.2	47.2
Red-tailed Hawk	7	7	2.4	1.8	0.7	0.5
Golden Eagle	1	0	0.3	0.0	0.6	0.0
American Kestrel	3	13	1.0	3.4	0.7	4.1
Merlin	3	4	1.0	1.0	11.5	36.4
Prairie Falcon	2	2	0.7	0.5	25.0	10.5
All Species	136	204	47.3	53.2	3.6	4.5

[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: 2004–2005.

		Female		Male					
Species	Year	HY	AHY	HY	AHY	F:M Ratio	% change	I:A Ratio	% change
Sharp-shinned Hawk	2004	27	11	17	6	1.7		2.6	
	2005	37	15	29	15	1.2	-28	0.8	-68
Cooper's Hawk	2004	26	15	5	1	6.8		1.9	
	2005	21	32	8	3	4.8	-29	1.8	-5
Northern Goshawk	2004	2	0	8	2	0.2		5.0	
	2005	5	4	6	2	1.1	463	5.5	10
American Kestrel	2004	1	0	2	0	0.5		3.0	
	2005	3	0	8	2	0.3	-40	0.0	-100

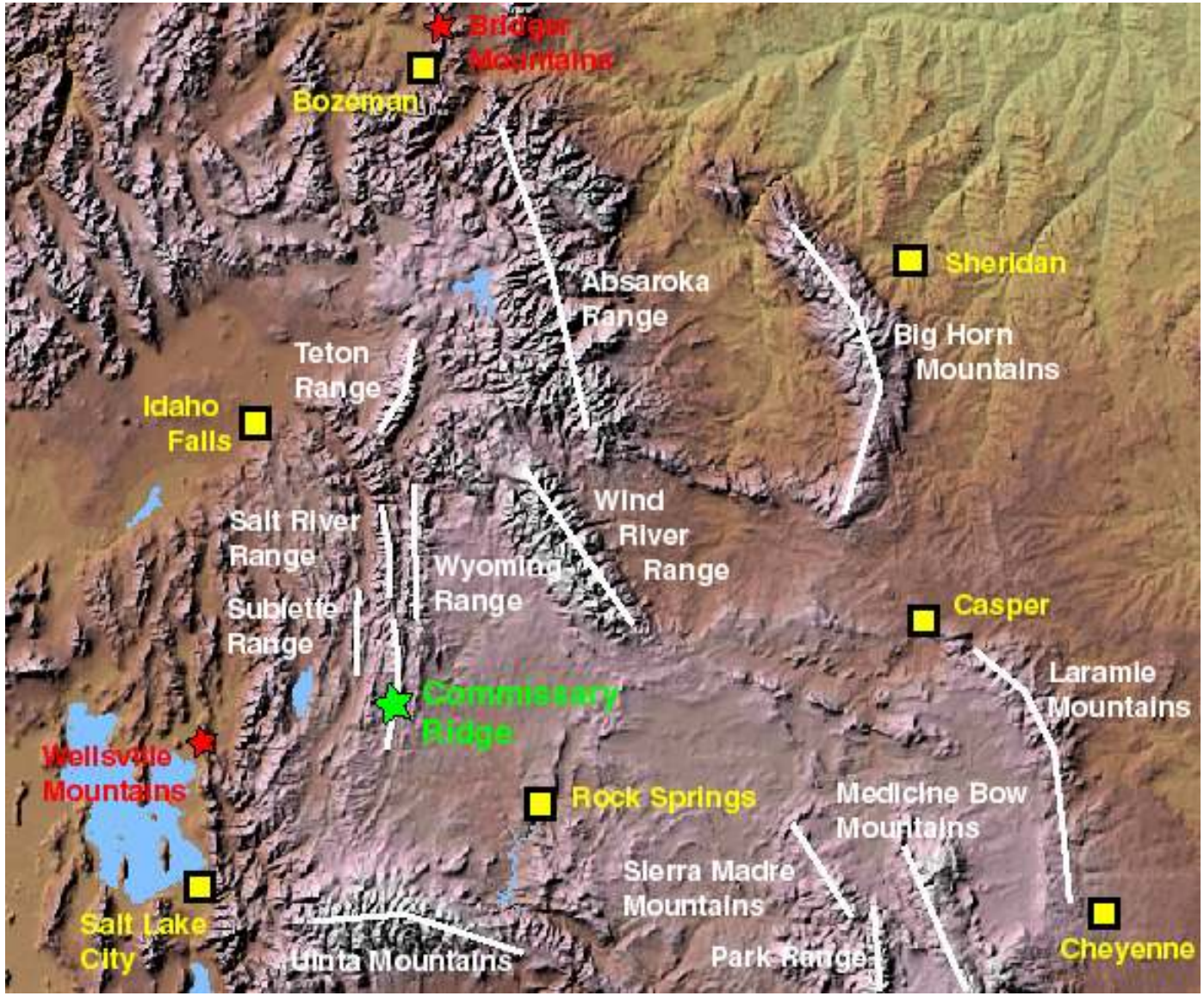

Figure 1. Location of Commissary Ridge Raptor Migration Project site in southwestern Wyoming. Red stars indicate other nearby HWI fall migration monitoring sites in Utah and Montana.

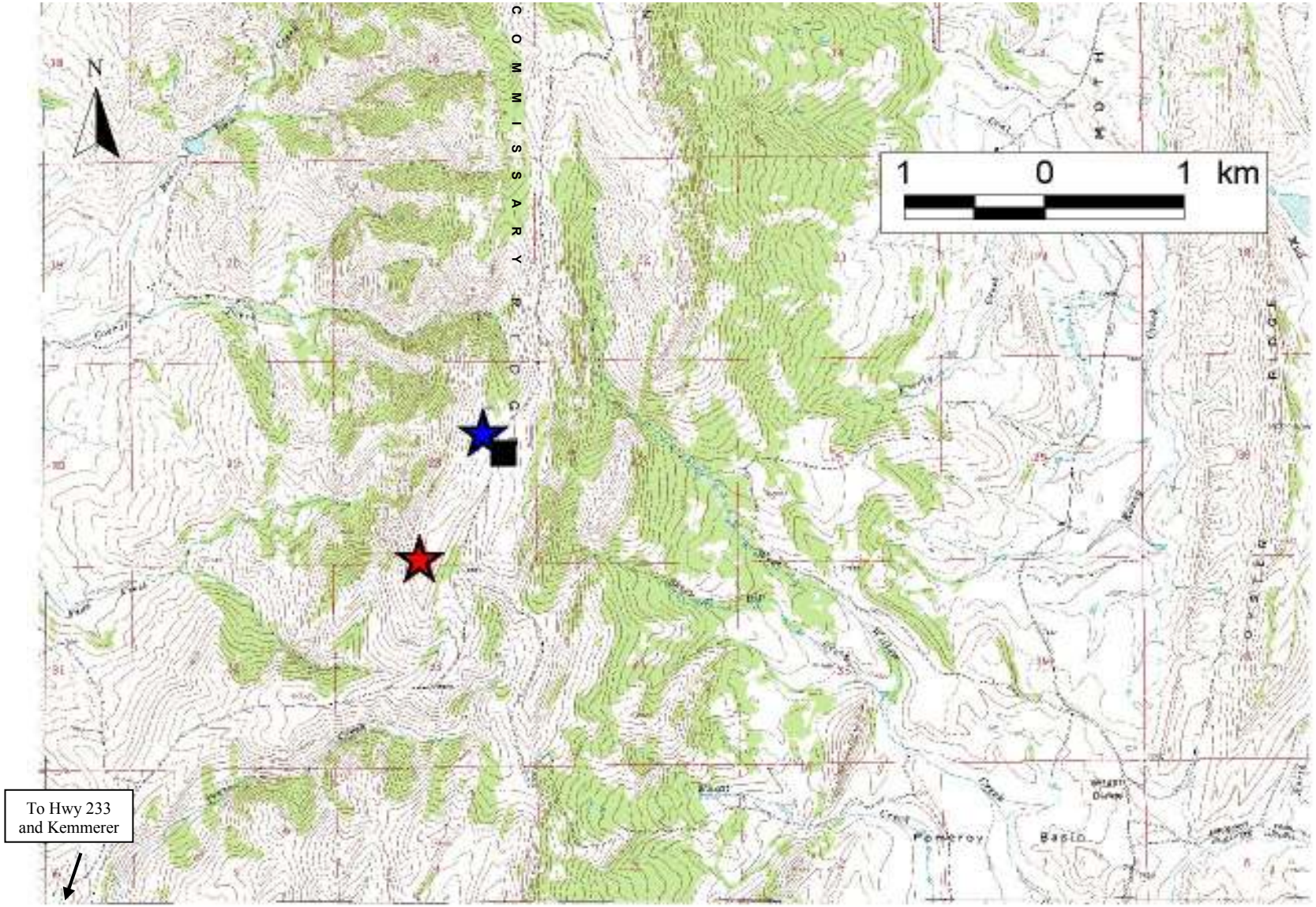

Figure 2. Close-up of Commissary Ridge Raptor Migration Project study site in southwestern Wyoming showing locations of the observation post (red star), the 2005 trapping location (blue star), and base camp (black square).

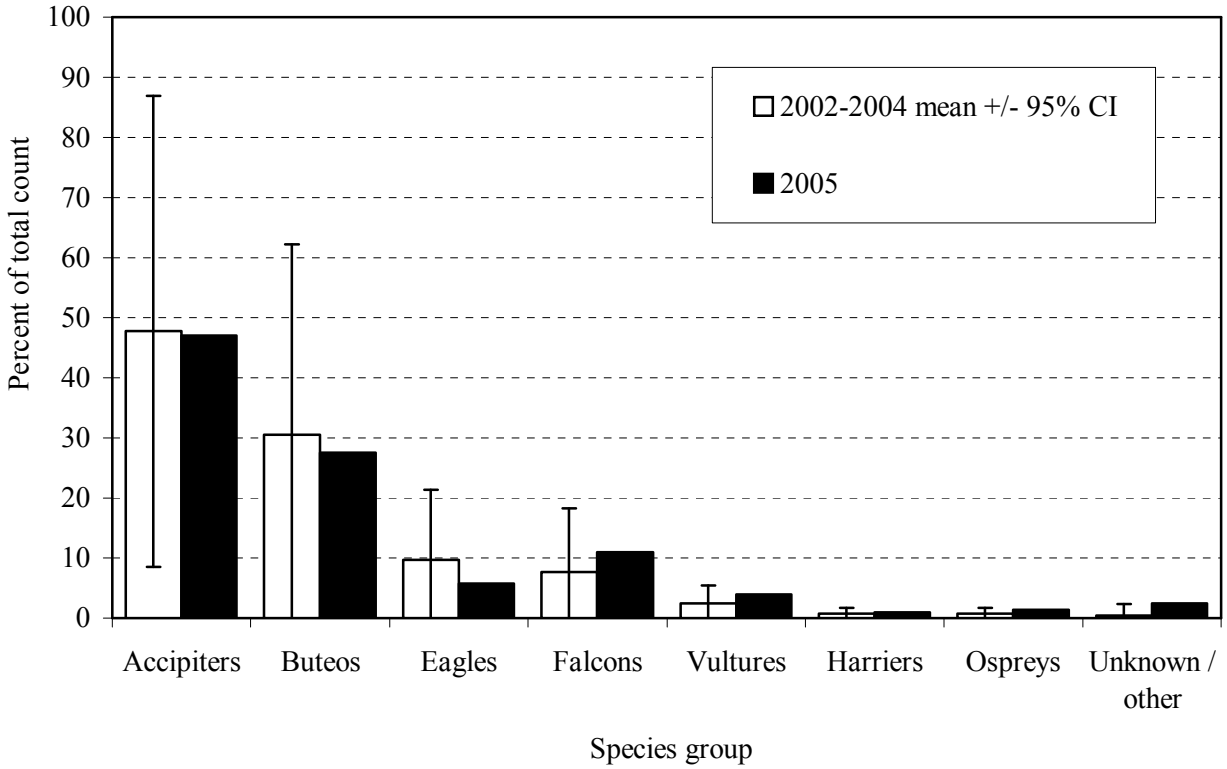

Figure 3. Composition by major species groups of the fall raptor migration at Commissary Ridge, Wyoming: 2002–2004 versus 2005.

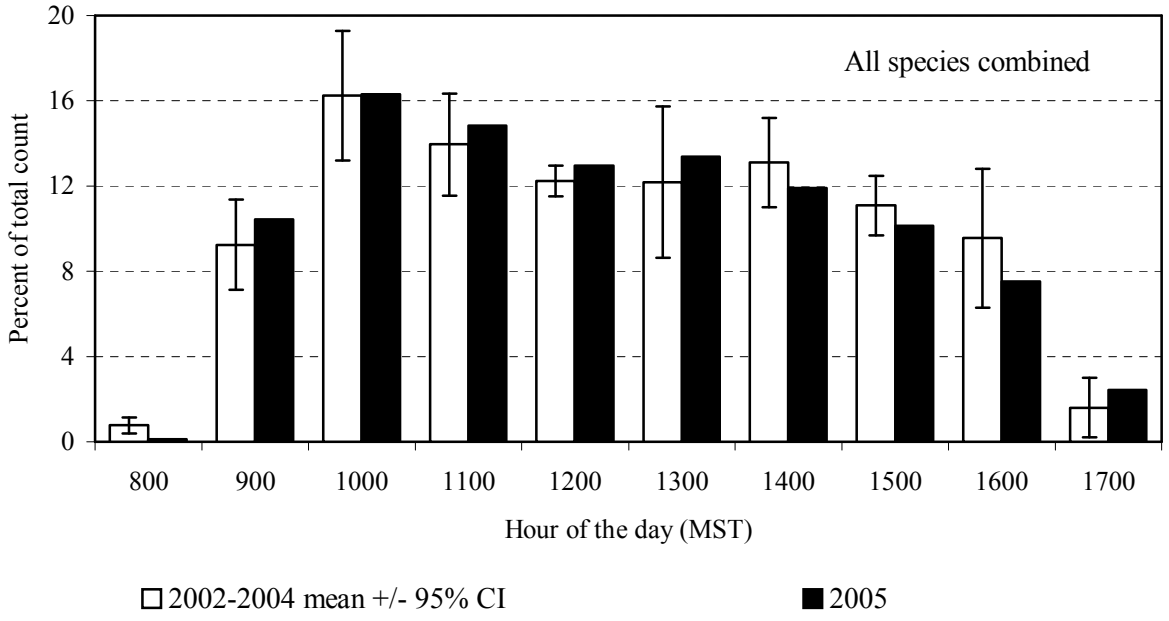

Figure 4. Daily rhythm of the fall raptor migration at Commissary Ridge, Wyoming: 2002–2004 versus 2005.

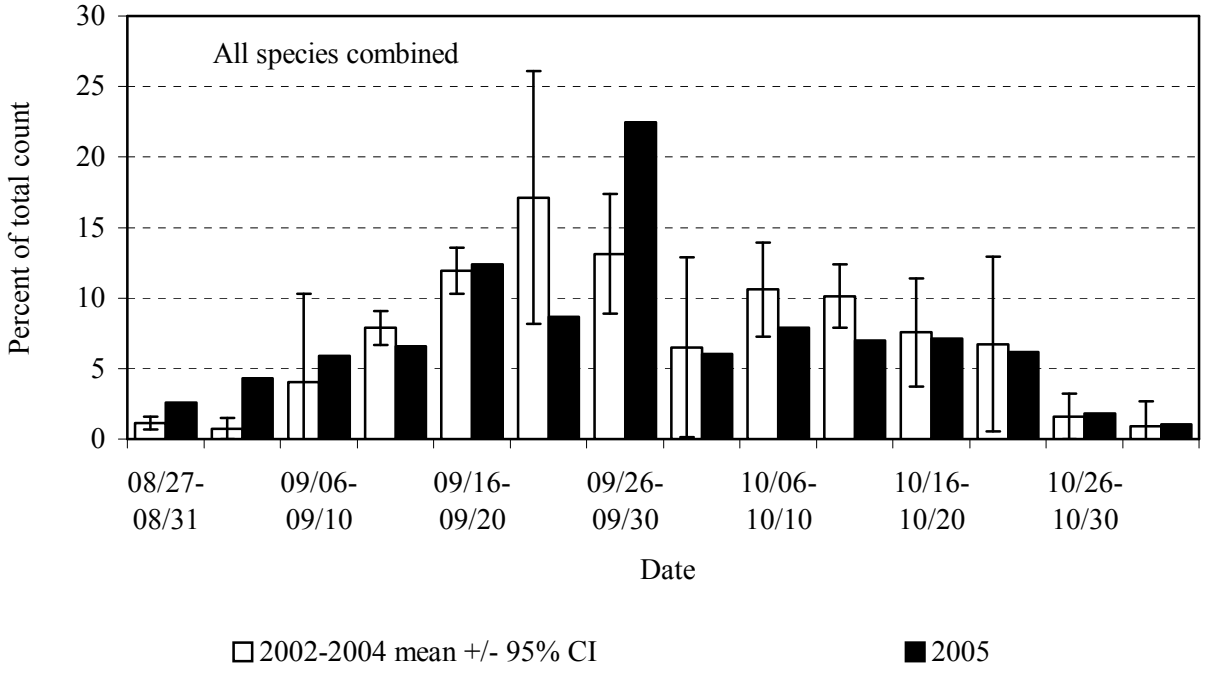

Figure 5. Combined-species seasonal distribution of activity by five-day periods for raptors during fall migration at Commissary Ridge, Wyoming: 2002–2004 versus 2005.

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: 2005.

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	6.50	3.0	0	ovc-pc, AM rain	22.8	wsw-wnw	23.0	30.30	2	93	86	0	1.7
28-Aug	7.50	2.0	0	clr	22.0	w	25.4	30.31	2	90	98	0	2.0
29-Aug	7.75	2.1	0	clr	29.4	ssw-sw	26.0	30.16	3	88	98	0	2.8
30-Aug	7.75	3.3	0	clr/haze	54.1	w	15.8	30.07	4	66	81	1	6.6
31-Aug	8.33	2.6	0	clr/haze	15.3	calm, w	18.8	30.27	1	53	53	2	2.9
1-Sep	8.00	1.0	0	clr/haze	24.6	w-wnw	22.5	30.28	2	72	84	0	3.0
2-Sep	8.00	2.5	0	pc-mc, AM haze	20.3	e, sw-w	23.2	30.32	2	82	90	1	4.3
3-Sep	8.00	1.0	0	pc-mc, scat ts/rain/haze	26.1	wsw-w	23.1	30.31	3	84	95	0	4.1
4-Sep	8.00	1.0	0	clr-pc, haze	33.9	sw	22.5	30.25	1	94	85	1	6.4
5-Sep	8.00	1.1	0	clr-pc, haze	30.3	w	21.3	30.28	2	88	78	0	7.8
6-Sep	8.50	1.7	0	clr	28.5	se, w	22.4	30.33	2	91	96	2	10.0
7-Sep	8.00	1.8	0	pc-mc	12.4	w	24.4	30.37	1	94	79	2	6.4
8-Sep	8.25	1.0	0	pc-mc, scat rain	22.8	w	24.6	30.24	2	87	73	2	7.9
9-Sep	4.25	1.0	0	pc-ovc, PM ts/rain	24.6	sw	19.8	29.89	4	60	77	1	8.0
10-Sep	8.08	2.0	0	pc, fog	34.0	sw-w	15.3	29.89	3	56	54	0	5.4
11-Sep	8.75	2.1	1	mc-pc	28.0	sw-w	14.3	30.03	2	96	84	2	4.7
12-Sep	2.25	2.1	0	pc	49.0	w	7.0	29.97	3	100	85	0	1.3
13-Sep	8.67	1.9	0	pc-mc	18.2	sw-w	13.3	30.10	2	96	93	6	6.8
14-Sep	9.00	2.6	0	pc	29.2	sw-w	12.4	30.09	2	98	95	1	12.8
15-Sep	8.67	3.0	0	clr	21.6	w	16.0	30.18	2	89	89	2	10.6
16-Sep	9.08	3.0	0	pc	30.3	ssw-w	17.1	30.06	2	89	91	0	15.9
17-Sep	8.33	1.8	0	pc-mc	34.4	w	13.4	30.02	3	72	67	0	10.1
18-Sep	8.67	2.8	0	pc	27.4	wsw	15.2	30.24	2	91	89	0	12.8
19-Sep	8.58	1.9	0	clr	25.7	sw-w	15.7	30.39	2	92	93	0	16.4
20-Sep	8.25	2.0	0	clr-pc	27.0	sw-w	21.6	30.52	2	88	94	0	12.6
21-Sep	4.42	1.7	0	ovc	14.8	sw	18.4	30.22	3	51	70	2	10.2
22-Sep	9.00	2.0	0	clr-pc	19.7	w	16.2	30.13	1	87	86	4	11.6
23-Sep	8.67	2.9	0	mc-ovc	16.6	sw	17.0	29.96	2	79	77	0	11.5
24-Sep	7.50	1.6	1	pc-ovc	22.1	sw-w	15.0	29.88	3	70	59	2	5.9
25-Sep	8.08	3.2	0	clr-pc	38.1	wsw-w	8.6	30.14	3	74	74	0	14.4
26-Sep	8.67	2.0	0	clr	15.4	wsw-w	14.4	30.31	1	86	89	0	21.6
27-Sep	5.67	2.7	0	mc-ovc	32.0	wsw	16.2	30.13	3	72	70	0	54.4
28-Sep	7.42	1.8	0	clr	14.9	sw-w	12.5	30.38	2	76	84	0	25.6
29-Sep	8.75	1.4	0	clr	33.1	w	15.1	30.19	2	87	89	0	28.0
30-Sep	8.67	2.0	0	clr	30.9	w	15.8	31.55	3	87	95	2	15.0
1-Oct	8.67	2.0	0	clr	32.2	wsw	17.8	31.38	2	87	82	1	20.8
2-Oct	8.17	2.6	0	mc-ovc	33.4	w	13.0	31.29	3	78	71	0	11.5
3-Oct	1.00	0.5	0	ovc, scat fog/rain/snow	37.0	w	12.0	31.32	4	26	27	0	1.0
4-Oct	0.00			weather day									
5-Oct	7.58	1.9	0	pc-ovc	5.8	calm/var	7.8	31.70	3	96	84	0	1.3
6-Oct	8.00	1.9	0	clr	15.8	sw-w	11.3	30.29	2	91	89	2	7.5
7-Oct	8.58	3.1	0	clr	30.6	sw-w	11.9	29.99	3	86	94	0	13.7
8-Oct	7.33	2.1	0	mc-ovc	31.3	sw-w	12.8	29.74	4	89	81	3	17.3
9-Oct	5.08	2.0	0	mc	26.8	sw-w	7.2	29.86	3	69	79	0	4.7
10-Oct	8.25	2.0	0	pc-mc	12.8	ne-se, sw-w	7.9	30.12	2	80	80	1	5.2
11-Oct	8.00	1.8	0	clr-pc	28.9	sw-w	7.3	29.95	3	88	98	2	6.8
12-Oct	8.25	1.7	0	ovc-pc	19.9	sw-w	9.8	30.21	3	88	89	6	8.5

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
13-Oct	8.25	2.0	0	clr-pc	28.0	sw-w	9.6	30.24	3	88	89	0	8.1
14-Oct	8.33	2.4	0	clr	9.8	w	14.8	30.34	1	91	88	0	8.3
15-Oct	8.17	2.0	0	clr-pc	17.6	s-wsw	15.6	30.00	2	84	90	0	8.4
16-Oct	8.00	2.6	0	clr-mc	40.6	w	12.3	30.18	3	83	86	1	15.1
17-Oct	8.00	1.8	0	pc	32.5	wsw	11.5	30.24	3	88	84	1	5.1
18-Oct	8.00	2.0	0	pc-ovc	8.5	wsw	15.3	30.09	2	80	84	2	5.0
19-Oct	6.25	1.6	0	mc-pc	25.3	wnw	14.4	30.02	2	84	74	0	13.6
20-Oct	7.25	2.0	0	ovc-pc	36.4	wsw	11.1	30.14	4	68	63	0	6.8
21-Oct	8.00	2.0	0	clr	20.0	w	8.9	30.27	2	75	93	0	7.6
22-Oct	8.00	2.7	0	clr	15.3	w-nw	12.0	30.12	1	88	89	0	10.6
23-Oct	8.00	1.6	0	clr, AM haze	12.8	e, wsw	13.1	30.16	2	85	94	1	7.4
24-Oct	7.83	2.0	0	clr/haze	9.0	sw-wnw	16.4	30.31	1	89	93	0	7.3
25-Oct	8.00	2.0	0	mc-pc	13.8	wsw-w	15.4	30.15	2	88	93	1	3.6
26-Oct	8.00	1.9	0	clr-mc, AM haze	12.8	wsw-nw	12.5	30.07	2	84	84	1	5.4
27-Oct	7.42	1.4	0	mc-ovc, scat ts	21.1	sw	13.3	29.95	4	85	83	1	4.7
28-Oct	0.00			rain/snow		s							
29-Oct	3.00	2.0	0	clr-ovc, fog/snow	8.6	s-sw	7.8	30.03	4	29	18	0	0.3
30-Oct	2.33	1.5	0	mc-ovc	38.8	wsw	3.3	30.15	4	78	65	0	3.0
31-Oct	5.08	2.0	0	pc-ovc, AM fog, PM rain/snow	48.0	w	1.1	30.29	4	71	68	1	9.8

[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 C. Raptor counts by day and species during fall migration at Commissary Ridge, Wyoming: 2005.

		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	6.50	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	2	0	0	4	0	0	0	0	0	0	1	11	1.7
28-Aug	7.50	0	0	0	2	1	0	0	0	0	0	0	0	1	0	0	5	0	0	6	0	0	0	0	0	0	0	15	2.0
29-Aug	7.75	3	1	1	2	4	0	0	0	0	0	0	7	0	0	0	2	0	0	2	0	0	0	0	0	0	0	22	2.8
30-Aug	7.75	3	2	0	3	15	1	1	0	0	0	0	15	0	0	0	10	0	0	0	0	0	0	1	0	0	0	51	6.6
31-Aug	8.33	0	0	0	9	4	0	1	0	0	0	0	7	0	0	0	1	0	0	2	0	0	0	0	0	0	0	24	2.9
1-Sep	8.00	1	0	0	10	3	0	1	0	0	0	0	2	0	0	0	3	0	0	3	0	0	0	0	0	0	1	24	3.0
2-Sep	8.00	3	1	0	8	4	0	0	0	0	0	0	13	1	0	0	2	0	0	0	0	1	0	1	0	0	0	34	4.3
3-Sep	8.00	0	0	0	12	4	0	0	0	0	0	0	10	0	0	0	4	0	0	2	0	0	0	0	0	0	1	33	4.1
4-Sep	8.00	0	0	0	13	10	3	1	1	0	0	0	11	0	0	0	2	1	0	9	0	0	0	0	0	0	0	51	6.4
5-Sep	8.00	3	1	1	27	6	0	2	0	0	0	0	9	0	0	0	4	0	0	9	0	0	0	0	0	0	0	62	7.8
6-Sep	8.50	0	3	0	27	8	0	1	1	0	0	0	10	0	0	0	2	0	0	28	1	1	0	0	0	0	3	85	10.0
7-Sep	8.00	6	0	0	17	8	0	1	1	0	0	1	10	0	0	0	0	0	0	6	0	0	0	0	0	0	1	51	6.4
8-Sep	8.25	1	0	2	22	13	1	1	0	0	0	0	11	0	0	1	2	0	0	10	0	0	1	0	0	0	0	65	7.9
9-Sep	4.25	1	2	1	5	11	0	3	0	0	0	0	6	0	0	1	2	0	0	2	0	0	0	0	0	0	0	34	8.0
10-Sep	8.08	0	1	0	21	10	1	0	0	0	0	1	6	0	0	0	2	0	0	1	0	1	0	0	0	0	0	44	5.4
11-Sep	8.75	0	4	0	13	9	0	3	0	0	0	0	3	0	0	0	2	0	0	6	0	0	0	0	0	0	1	41	4.7
12-Sep	2.25	0	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	3	1.3
13-Sep	8.67	2	0	0	28	7	2	0	0	0	0	0	10	1	0	1	4	0	0	2	1	1	0	0	0	0	0	59	6.8
14-Sep	9.00	4	0	1	41	14	1	1	0	0	0	0	25	0	0	2	3	0	0	23	0	0	0	0	0	0	0	115	12.8
15-Sep	8.67	6	0	0	37	15	0	2	0	0	0	0	16	0	0	0	4	0	0	12	0	0	0	0	0	0	0	92	10.6
16-Sep	9.08	2	3	0	64	23	1	1	0	0	0	0	29	0	0	0	3	0	0	13	0	3	2	0	0	0	0	144	15.9
17-Sep	8.33	0	1	0	52	12	1	0	1	0	0	1	9	0	0	0	2	2	0	3	0	0	0	0	0	0	0	84	10.1
18-Sep	8.67	6	2	0	40	23	0	2	0	0	0	1	17	0	0	0	4	0	0	14	0	0	1	0	0	0	1	111	12.8
19-Sep	8.58	20	1	0	55	10	1	2	0	0	0	4	27	0	0	0	4	0	0	17	0	0	0	0	0	0	0	141	16.4
20-Sep	8.25	0	1	1	35	22	0	0	1	0	0	2	22	0	0	0	6	2	1	8	0	2	0	0	0	0	1	104	12.6
21-Sep	4.42	0	0	0	10	8	0	1	1	0	0	9	10	0	0	0	2	0	0	2	0	1	1	0	0	0	0	45	10.2

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
22-Sep	9.00	6	4	0	47	11	0	1	0	0	2	4	16	0	0	0	1	1	0	9	1	0	1	0	0	0	0	104	11.6
23-Sep	8.67	0	0	1	52	9	0	5	0	1	0	1	18	0	0	3	7	0	0	3	0	0	0	0	0	0	0	100	11.5
24-Sep	7.50	0	0	0	20	6	0	0	0	0	0	0	10	0	0	1	2	1	1	3	0	0	0	0	0	0	0	44	5.9
25-Sep	8.08	5	0	2	40	8	0	0	0	0	0	2	45	1	0	0	2	1	0	9	1	0	0	0	0	0	0	116	14.4
26-Sep	8.67	6	3	1	87	21	0	5	0	0	1	2	40	0	0	1	5	1	0	13	0	0	1	0	0	0	0	187	21.6
27-Sep	5.67	18	0	1	131	42	0	0	0	0	1	3	64	1	0	3	7	1	0	34	0	0	1	0	0	0	1	308	54.4
28-Sep	7.42	9	2	0	69	23	1	7	0	1	0	2	53	0	0	5	4	0	0	12	0	0	0	0	0	0	2	190	25.6
29-Sep	8.75	0	1	2	107	22	1	2	1	0	4	1	86	0	0	1	4	3	0	10	0	0	0	0	0	0	0	245	28.0
30-Sep	8.67	1	0	0	55	6	0	2	0	0	0	13	28	0	0	3	12	0	0	7	0	2	0	0	1	0	0	130	15.0
1-Oct	8.67	6	0	0	70	15	0	2	0	0	0	1	57	0	0	3	12	0	0	10	0	0	1	0	0	0	3	180	20.8
2-Oct	8.17	0	0	0	46	19	1	1	0	0	0	2	15	0	0	0	7	0	0	3	0	0	0	0	0	0	0	94	11.5
3-Oct	1.00	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1.0
4-Oct	0.00																												
5-Oct	7.58	0	1	1	2	2	0	0	0	0	0	1	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	10	1.3
6-Oct	8.00	0	0	0	17	1	0	0	0	0	0	0	36	0	0	1	3	0	0	1	0	0	0	0	1	0	0	60	7.5
7-Oct	8.58	0	2	0	42	7	0	2	1	0	0	1	42	0	0	2	7	3	0	8	0	1	0	0	0	0	0	118	13.7
8-Oct	7.33	2	0	2	42	6	1	0	0	0	0	0	53	0	0	1	7	4	0	7	0	0	1	0	0	0	1	127	17.3
9-Oct	5.08	0	0	0	5	1	0	0	0	0	0	0	14	0	0	0	4	0	0	0	0	0	0	0	0	0	0	24	4.7
10-Oct	8.25	0	0	1	5	1	1	0	0	0	0	0	22	0	1	1	7	1	0	2	0	0	1	0	0	0	0	43	5.2
11-Oct	8.00	0	0	1	11	4	0	2	0	0	0	0	24	0	0	2	5	5	0	0	0	0	0	0	0	0	0	54	6.8
12-Oct	8.25	0	0	0	26	2	1	0	0	0	0	0	24	0	0	1	7	6	0	0	1	1	0	0	0	0	1	70	8.5
13-Oct	8.25	0	0	0	23	3	0	1	0	0	0	0	21	0	1	1	13	2	0	0	0	0	2	0	0	0	0	67	8.1
14-Oct	8.33	0	0	0	31	0	0	0	1	0	0	0	16	0	0	0	9	10	0	0	0	2	0	0	0	0	0	69	8.3
15-Oct	8.17	0	0	1	26	0	0	1	0	0	0	0	12	0	1	2	15	11	0	0	0	0	0	0	0	0	0	69	8.4
16-Oct	8.00	0	0	1	33	0	2	0	0	0	0	0	61	1	1	0	13	7	0	0	1	1	0	0	0	0	0	121	15.1
17-Oct	8.00	0	0	3	5	0	1	0	0	0	0	0	21	0	1	0	5	3	0	0	2	0	0	0	0	0	0	41	5.1

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
18-Oct	8.00	0	0	1	14	4	0	0	1	0	0	0	14	0	0	1	3	1	0	0	1	0	0	0	0	0	0	40	5.0
19-Oct	6.25	0	0	2	36	1	0	0	0	0	0	0	30	0	0	4	5	7	0	0	0	0	0	0	0	0	0	85	13.6
20-Oct	7.25	0	0	1	17	1	1	0	0	0	0	0	22	2	0	0	3	0	0	2	0	0	0	0	0	0	0	49	6.8
21-Oct	8.00	0	0	0	11	0	3	0	0	0	0	0	30	0	0	0	9	7	0	0	0	1	0	0	0	0	0	61	7.6
22-Oct	8.00	0	0	1	13	0	2	0	0	0	0	0	42	0	2	0	15	10	0	0	0	0	0	0	0	0	0	85	10.6
23-Oct	8.00	0	0	1	8	0	1	0	0	0	0	0	39	0	1	0	4	4	0	0	1	0	0	0	0	0	0	59	7.4
24-Oct	7.83	0	0	1	13	0	1	0	0	0	1	0	29	0	0	0	7	5	0	0	0	0	0	0	0	0	0	57	7.3
25-Oct	8.00	0	0	0	7	0	0	0	0	0	0	0	12	0	1	1	5	1	0	0	1	0	0	0	0	0	1	29	3.6
26-Oct	8.00	0	0	2	7	0	3	0	0	0	0	0	14	0	3	0	8	6	0	0	0	0	0	0	0	0	0	43	5.4
27-Oct	7.42	0	0	1	9	0	2	0	0	0	0	0	13	0	0	0	6	4	0	0	0	0	0	0	0	0	0	35	4.7
28-Oct	0.00																												
29-Oct	3.00	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.3
30-Oct	2.33	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	3	2	0	0	0	0	0	0	0	0	0	7	3.0
31-Oct	5.08	0	0	1	4	0	1	0	0	0	0	0	7	0	1	0	11	25	0	0	0	0	0	0	0	0	0	50	9.8
Total	478.83	114	36	36	1687	462	35	55	11	2	9	52	1319	8	13	42	316	137	2	317	11	18	13	2	2	0	19	4718	9.9

[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: 2001–2005.

	YEAR					
	2001	2002	2003	2004	2005	MEAN
Start date	3-Sep	27-Aug	27-Aug	27-Aug	27-Aug	26-Aug
End date	23-Oct	29-Oct	29-Oct	3-Nov	31-Oct	30-Oct
Observation days	22	45	63	65	64	58
Observation hours	145.88	322.67	474.85	452.67	478.83	416.73
Raptors/100 hrs	1155.7	990.8	644.4	916.6	985.3	850.6
SPECIES	RAPTOR COUNTS					
Osprey	16	11	31	59	36	34
Northern Harrier	40	32	25	38	36	32
Sharp-shinned Hawk	303	675	516	1,118	1687	770
Cooper's Hawk	256	409	329	614	462	451
Northern Goshawk	11	21	7	49	35	26
Unknown small accipiter	11	78	75	75	55	76
Unknown large accipiter	4	6	13	34	11	18
Unknown accipiter	29	16	58	69	2	48
TOTAL ACCIPITERS	614	1,205	998	1,959	2252	1,387
Broad-winged Hawk	1	8	5	22	9	12
Swainson’s Hawk	18	82	28	62	52	57
Red-tailed Hawk	323	823	1,042	961	1319	942
Ferruginous Hawk	7	6	3	15	8	8
Rough-legged Hawk	20	5	5	8	13	6
Unidentified buteo	19	17	87	63	42	56
TOTAL BUTEOS	388	941	1170	1131	1443	1,081
Golden Eagle	279	352	233	152	316	246
Bald Eagle	72	233	90	76	137	133
Unidentified eagle	5	10	7	10	2	9
TOTAL EAGLES	356	595	330	238	455	388
American Kestrel	166	258	355	403	317	339
Merlin	7	9	6	26	11	14
Prairie Falcon	1	6	5	6	18	6
Peregrine Falcon	5	3	3	11	13	6
Unknown small falcon	2	0	3	6	2	3
Unknown large falcon	5	0	0	5	2	2
Unknown falcon	0	2	0	1	0	1
TOTAL FALCONS	186	278	372	458	363	369
Unidentified raptor	19	38	68	102	19	69
ALL SPECIES	1,686	3,197	3,060	4,149	4718	3,469

Appendix E. Raptor capture totals by day and species during fall migration at Commissary Ridge, WY: 2005.

		Species[1]									Captures /
Date	Hours	SS	CH	NG	RT	GE	AK	ML	PR	Total	Hour
29-Aug	4.21	0	1	0	0	0	0	0	0	1	0.2
31-Aug	8.00	3	2	0	1	0	1	0	0	7	0.9
1-Sep	6.66	1	1	0	0	0	0	0	1	3	0.5
2-Sep	8.00	2	0	0	0	0	0	0	0	2	0.3
3-Sep	8.00	3	1	0	0	0	3	0	0	7	0.9
4-Sep	8.00	2	5	1	0	0	0	0	0	8	1.0
5-Sep	8.00	2	2	0	0	0	2	0	0	6	0.8
6-Sep	8.00	2	4	1	0	0	1	0	0	8	1.0
7-Sep	8.00	6	4	0	0	0	1	0	0	11	1.4
8-Sep	8.12	7	1	0	1	0	1	0	0	10	1.2
9-Sep	4.30	0	5	0	0	0	0	0	0	5	1.2
10-Sep	7.00	1	2	0	0	0	0	0	0	3	0.4
11-Sep	7.00	2	2	0	0	0	0	0	0	4	0.6
13-Sep	8.00	5	3	2	0	0	0	0	0	10	1.3
14-Sep	8.00	1	1	0	1	0	0	0	0	3	0.4
15-Sep	8.00	5	4	0	0	0	1	0	0	10	1.3
16-Sep	8.00	0	5	0	1	0	0	0	0	6	0.8
17-Sep	8.00	1	1	0	0	0	0	0	0	2	0.3
18-Sep	8.00	1	1	1	0	0	1	0	0	4	0.5
19-Sep	7.60	4	2	0	2	0	0	0	0	8	1.1
20-Sep	7.75	5	1	0	0	0	0	0	0	6	0.8
21-Sep	4.00	0	0	0	0	0	0	0	0	0	0.0
22-Sep	7.00	1	1	0	0	0	0	0	0	2	0.3
23-Sep	8.00	5	4	0	0	0	0	0	0	9	1.1
24-Sep	7.00	3	0	1	0	0	0	0	0	4	0.6
26-Sep	8.50	4	3	0	1	0	0	0	0	8	0.9
27-Sep	1.45	1	0	0	0	0	0	0	0	1	0.7
28-Sep	6.25	0	1	0	0	0	0	0	0	1	0.2
29-Sep	8.00	1	2	1	0	0	0	0	0	4	0.5
30-Sep	4.33	0	0	0	0	0	0	0	0	0	0.0
1-Oct	5.00	0	0	0	0	0	0	0	0	0	0.0
2-Oct	7.50	1	2	0	0	0	0	0	0	3	0.4
5-Oct	5.00	0	0	0	0	0	0	0	0	0	0.0
6-Oct	6.50	0	0	0	0	0	0	0	0	0	0.0
7-Oct	8.50	3	2	0	0	0	0	0	1	6	0.7
8-Oct	7.33	7	1	0	0	0	1	0	0	9	1.2

Appendix E. continued

		Species[1]									Captures /
Date	Hours	SS	CH	NG	RT	GE	AK	ML	PR	Total	Hour
9-Oct	5.00	0	0	0	0	0	0	0	0	0	0.0
10-Oct	7.25	0	0	0	0	0	0	1	0	1	0.1
11-Oct	6.00	0	0	2	0	0	0	0	0	2	0.3
12-Oct	7.00	1	0	2	0	0	0	0	0	3	0.4
13-Oct	8.00	0	0	0	0	0	0	0	0	0	0.0
14-Oct	8.25	4	0	0	0	0	0	0	0	4	0.5
15-Oct	8.25	5	1	1	0	0	1	2	0	10	1.2
16-Oct	5.00	1	0	0	0	0	0	0	0	1	0.2
17-Oct	3.00	0	0	0	0	0	0	0	0	0	0.0
18-Oct	8.25	3	0	0	0	0	0	1	0	4	0.5
19-Oct	6.00	0	0	0	0	0	0	0	0	0	0.0
20-Oct	5.50	0	0	1	0	0	0	0	0	1	0.2
21-Oct	8.00	0	0	0	0	0	0	0	0	0	0.0
22-Oct	8.00	1	0	0	0	0	0	0	0	1	0.1
23-Oct	7.50	0	0	1	0	0	0	0	0	1	0.1
24-Oct	8.00	1	0	1	0	0	0	0	0	2	0.3
25-Oct	8.00	1	0	0	0	0	0	0	0	1	0.1
26-Oct	8.00	0	0	1	0	0	0	0	0	1	0.1
27-Oct	7.50	0	0	1	0	0	0	0	0	1	0.1
Total	383.50	96	65	17	7	0	13	4	2	204	0.5

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