FALL 2006 RAPTOR MIGRATION STUDIES AT COMMISSARY RIDGE IN SOUTHWESTERN WYOMING

HawkWatch International, Inc.
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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 14 long-term, annual migration counts and 1 of 7 migration-banding studies conducted or co-sponsored by HWI in North America during 2006. 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 (Ruelas 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 and 2006. This report summarizes the results of the fall 2006 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.

In 2006, we explored use of two new trapping sites (Figure 2). **Ganths Tooth** station was located ~3.7 km north of the count site at ~2,745 m elevation on a sheltered knoll along the western margin of the ridgetop, featured a full-scale blind and trap array, and was used regularly throughout the season. **South Bowl** station was located ~2.4 km south of the observation point at ~2,600 m elevation within a sheltered "bowl" along the western margin of the ridgetop, involved only a portable blind and limited trap array, and was used only sporadically through the season.

METHODS

STANDARDIZED COUNT

Weather permitting, trained observers conducted daily counts from a single, traditional observation post from 27 August through 31 October. This was the first season of migration counting for both official observers David Janssen and Tiara Westcott, but both received pre-season and on-site field and protocol training (see Appendix A for a complete history of observer participation). Other crewmembers, BLM staff and interns, and visitors also frequently assisted with the counts. In particular, two other multi-purpose crewmembers, Andy Day and James Cedarstrom, each had one season of prior migration counting experience with HWI and assisted with training and support of the new counters. On-site educator John Watterson also assisted with the count a great deal.

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 B lists common and scientific names for all species, information about the applicability of age, sex, and color morph distinctions, and two-letter codes used to identify species in some tables and figures).
2. Hour of passage for each migrant; e.g., the 1000–1059 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, periodically assisted by other crewmembers and volunteers, usually operated a 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 2006). The crew also outfitted one Red-tailed Hawk with a satellite transmitter to enable tracking of its movements for 1.5–2 years. This outwardly healthy adult bird was outfitted with a 32-g battery powered PTT 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 a record high 10 full days of potential observations in 2006 and severely hampered observations (≤4 hrs observation) on five other days (see Appendix D for daily weather records). The reduction in observation time due to weather was similar to 2002 (8 full days and 5 partial days), but 5 times that in 2005 (2 full and 4 partial days). Fifty-four percent of the active observation days featured predominantly fair skies (4% including some fog/haze or scattered rain/snow), 18% transitional skies (i.e., shifted from fair skies to mostly cloudy or overcast skies during the day, or vice versa), and 29% mostly cloudy to overcast/stormy skies (13% including some fog/haze and/or rain/snow). The 2002–2005 averages for the site are 46% fair, 30% transitional, and 24% mostly cloudy to overcast skies.

In 2006, the temperature during active observation periods averaged a record low 11.0°C (average of daily values, which were in turn averages of hourly readings), ranging from -3.5–22.7°C. The range is similar to 2004 but broader on both ends than most other years, and the average is 2.7°C cooler than the long-term average.

In 2006, light winds (<12 kph) predominated on 14% of the active observation days, moderate winds (12–28 kph) on 54%, and strong winds (>28 kph) on 32%. This proportional representation is similar to the 2005 season (8, 56, 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 2006 were similar to 2005 but more consistently moderate than during 2003 and 2004. W–NW winds prevailed on 68% of the active days, which is ~10% higher than the 2002–2005 average of 57.5%, and another 2% of the active days featured primarily W–NW but with significant periods of calm/variable winds. As usual, the second most common wind pattern was SW–W winds, which prevailed on 13% of the active days (average 15.3%). The remaining days featured variable NE–SE winds (5%, avg. 4.4%), combinations of SW–NW and NE–SE winds (7%, avg. 6.9%), calm/variable winds (4%, avg. 2.7%), and variable S–W winds (2%, avg. 4.4%).

Fair-to-poor thermal-lift conditions predominated on a record high 86% of the active observation days in 2006, which is 21% higher than the 2002–2005 average of 64.8%. Visibility averaged ~73 km east and 76 km west in 2006, which is ~10–15 km greater than in 2004 but similar to other years.

In summary, the sky conditions in 2006 were most similar to 2002, but were more unsettled and stormy than in any previous full year of operations. Temperatures averaged cool, with the overall daily average the coolest on record. Wind speeds were more consistently moderate than during many years when a broader range of variation applied, but were similar to 2005. Similar to several previous years, steady W–NW winds predominated with SW–W winds second most common, but the 2006 pattern differed markedly from the 2005 pattern when SW–W winds predominated and W–NW winds prevailed half as often as in most years. Visibility was good in 2006, primarily because of the low occurrence of fog and especially haze. Due to unsettled weather, stronger winds, and cooler temperatures, thermal lift conditions rated poor to fair on a high 86% of the active observation days.

OBSERVATION EFFORT

Counts occurred on 56 of 66 possible days between 27 August and 31 October 2006, averaging 7.9 hours per active day and encompassing 443.58 total hours of observation (see Appendix D for annual data). The numbers of observation days and hours were the lowest yet recorded for the project during years when full-season observations were planned and possible (a 12-day wildfire closure reduced the overall effort in 2002).

FLIGHT VOLUME AND COMPOSITION

The observers tallied only 1,841 migrants of 17 species during the 2006 season, which was 51% below the 2002–2005 average for the site (Table 1, and see Appendix D for daily count records). The flight was composed of 36% buteos, 32% accipiters 16% eagles, 11% falcons, 2% vultures, 1% Northern Harriers, 1% unidentified raptors, and <1% Ospreys (Figure 3). Only the proportion of Northern Harriers was significantly above average, whereas the proportion of accipiters was significantly below average compared to previous years. The most abundant species were the Red-tailed Hawk (32% of the total count), Cooper's Hawk (16%), Sharp-shinned Hawk (12%), Golden Eagle (11%), American Kestrel (8%), Bald Eagle (4%), Swainson's Hawk (3%), and Turkey Vulture (2%). All other species each comprised ≤1% of the total.

The 2006 counts were below average for all species except Prairie Falcons (Table 1), but significantly so only for Turkey Vultures (65% below average), Sharp-shinned Hawks (-78%), American Kestrels (-53%), and Red-tailed (-46%) and Rough-legged Hawks (-35%). New record lows were set for the first three species (see Appendix E for annual count summaries). When translated to passage rates, the 2006 value for Cooper's Hawks also was significantly below average (Table 1).

In the nearby Wellsville Mountains of northern Utah, a similar pattern of very low counts emerged (Smith and Neal 2007a). The total combined-species count of 1,952 migrants was both similar to the total tally at Commissary Ridge and similarly a significant 48% below average, and below-average counts occurred for 15 of 17 species usually seen at the site. In fact, for most species, especially the two smaller accipiters, low counts generally were the rule in 2006 across HWI's network of fall monitoring sites in the interior West. The overall count dropped to 30% below average in the Bridger Mountains of southwestern Montana, 27% in the Goshute Mountains of northeastern Nevada, and 24% in the Grand Canyon of Arizona (Smith and Neal 2007b, c, d; these and other relevant technical reports available at http://www.hawkwatch.org). Reasons for the low 2006 counts are uncertain at present, but may at least partly reflect the lingering and for some areas continuing influence of widespread drought, which began plaguing much of the interior West in 1999 (Smith and Hoffman 2003). In this light, the low 2006 count at Commissary Ridge appears to fit the broader pattern; however, in most cases the 2006 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 remained relatively stable for most species over the past five years (Smith and Neal 2007e). Another factor that may have contributed to the variation in counts at Commissary Ridge is observer dedication and experience. Our 2004/2005 observation teams were generally more experienced and capable than the 2003 and especially 2006 teams, and this easily could have contributed to the elevated counts in the former years.

AGE RATIOS

Among eight sufficiently abundant species for which age-related plumage variation allows for reliable age-specific identification, four species showed immature : adult count ratios that were below the relevant 2002–2005 averages, with the differences significant for Northern Harriers, Cooper's Hawks, and Golden Eagles (Table 2). For each of the four species, counts of immature birds were below average, whereas counts of adults were relatively closer to average. This indicates that the low age ratios were primarily due to proportionately low abundances of immature birds rather than high abundances of adult birds, suggesting that low productivity and juvenile recruitment may have been involved. In contrast, the age ratios for Sharp-shinned Hawks, Red-tailed Hawks, and Peregrine Falcons were substantially above average. Too few Peregrine Falcons were identified to age to render a meaningful comparison. For Sharp-shinned Hawks, the absolute abundances of both immatures and adults were much lower than average, while for Red-tailed Hawks the absolute abundance of immature birds was near average but the number of adult birds was ~50% below average. Thus, the high age ratios for these two species primarily reflect proportional reductions in the abundances of adults rather than high abundances of immatures,

suggesting that high overwinter mortality of adults may have contributed to the high age ratio. Together these data suggest that productivity and juvenile recruitment among central and northern Rocky Mountain source populations was probably low for many species in 2006 compared to the last four years, but also suggest that migrating adults were less abundant than usual in 2006 perhaps due to high overwinter mortality or longer-term declines in regional recruitment.

DAILY AND SEASONAL MIGRATION PATTERNS

The diel rhythm of migration at Commissary Ridge in 2006 followed a typical (for the site), slightly bi-modal distribution, with a steep rise in activity between 0900 and 1100 hours, followed by a "noon lull", then a modest secondary peak during the 1300 hour, and finally a gradual tapering off of activity through the 1700 hour (Figure 4). The relative magnitudes of the 1200-hour decline in activity and subsequent rise to the secondary peak during the 1300 hour were more pronounced than shown in the average pattern, but nonetheless the overall pattern was similar to previous years.

The overall, combined-species seasonal activity pattern for 2006 showed a greater degree of within-season variability than usual, with much of the variation in proportional activity due to the influence of inclement weather (Figure 5). The overall combined-species median passage date of 28 September matched the average for the past four seasons (Table 3). At the species level, however, median passage dates were earlier than average for six species (significantly so for Northern Harriers, Northern Goshawks, and Merlins), and later than average for 10 species (significantly so for Cooper's Hawks, Ferruginous Hawks, Golden and Bald Eagles, and American Kestrels; Table 3). Age and sex-specific data revealed additional complexities for some species, but no other clear multi-species patterns (Table 4).

TRAPPING AND BANDING SUMMARY

Trapping occurred on 43 of 64 possible days between 28 August and 30 October 2006, with effort totaling 346.12 hours and averaging 8.0 ± SD of 1.6 hours per day of active trapping (see Appendix F for daily trapping records and Appendix G for annual trapping summaries). Trapping occurred at the Ganths Tooth station on 39 days and at the South Bowl station on 12 days (4 days exclusively).

The crew captured and banded 51 raptors of 7 species in 2006 (Table 5). The most commonly captured species were the Sharp-shinned Hawk (55% of all captures), Cooper's Hawk (24%), Red-tailed Hawk (10%), Northern Goshawk (6%), and American Kestrel (2%). All other species each comprised less than 2% of the total.

Productivity at both of this year's two new trapping locations still suffered occasionally from difficult wind conditions, but both were definitely more sheltered than the main "Camp" blind used the last two years and showed promise in this regard. A small crew and complicated access conditions after early October limited the amount of time spent at the South Bowl station to 32% of that spent at the Ganths Tooth station. The South Bowl station yielded ~20% of the total captures or ~25% of the number captured at Ganths Tooth station, and the overall capture rate at South Bowl was 12.0 captures / 100 station hours, whereas the capture rate at Ganths Tooth was ~30% higher at 15.6 captures / 100 station hours. Given the temporary blind and lesser array of lures and nets used at South Bowl, one would expect lower efficiency there, suggesting that relative trapping efficiency at the two sites was probably similar.

Both the overall capture total and capture rate (14.7 birds / 100 stn. hrs) were ~70% below average compared to the last two years, whereas capture success (2.9% of catchable raptors) was only 28% below the previous two-year average (Table 5). This suggests that poor flight volume (51% below average) was the primary reason for the low trapping totals this year, but below-average capture success also contributed. The latter may reflect variation in crew skill, but also suggests that the new Ganths Tooth station, though more sheltered, did not markedly increase our trapping success as hoped.

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 immature : adult ratios for Sharp-shinned Hawks (1.4 and 4.6, respectively) and Cooper's Hawks (0.5 and 1.4) differed significantly in 2006, 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 Northern Goshawk, both the count and capture data indicated that immature birds were more abundant than adults and similar ratios (count 1.8, banding 2.0) suggested that immature birds were only slightly more susceptible to capture than adults in 2006. Unlike the counts, banding also yields useful data on accipiter sex ratios, or at least sex-related susceptibility to capture. In 2006, female Cooper's Hawks were captured 5.0 times more often than males, which was 14% lower than in 2005 (female : male ratio of 5.8). In contrast, female Sharp-shinned Hawks were 1.8 times more likely to be captured than males in 2006, which was 29% higher than in 2005 (1.4). Female Northern Goshawks were captured only half as often as males in 2006, yielding a sex ratio that was 25% lower than in 2005 (sex ratio 0.7); however, only three goshawks were captured in 2006, precluding a robust comparison for this species. Similarly, only one American Kestrel was caught in 2006, precluding any meaningful insight for this species.

SATELLITE TRACKING

Although similar to 2005 we fell well short of our goal of deploying four satellite transmitters on two species, given the severe wind-related difficulties that our crews faced in both years, we were happy to have succeeded in deploying one additional 32-g transmitter on a probable female Red-tailed Hawk in 2006. Upon release, this after-hatch-year bird headed south-southeast across the southwest corner of Colorado and down through central New Mexico, more or less following the Rio Grande River and I-25 corridor. It continued south through central Chihuahua and Durango, Mexico, and by 13 November had settled for the winter in southern Jalisco, just north of the Colima border. In all, this bird traveled roughly 2,600 km from the project site to its wintering ground. As of early March 2007, it had not yet begun its return spring migration.

During fall 2005, we outfitted one juvenile female and one adult female Northern Goshawk at the site. After release, both birds initially traveled up to ~100 km north but then later backtracked to the south, with the young bird eventually spending the winter ~20 km ENE of Evanston, Wyoming (~60 km south of the project site), and the adult a bit farther south in northeastern Utah near Roosevelt. The immature bird remained on her winter range through early April 2006, then took two days traveling north to reach the La Barge Creek area ~60 km northeast of Commissary Ridge. She then remained in this area, occasionally wandering 20–30 km east or west, through early July when her transmitter battery failed. All sensor data indicated that she was alive and well at this time. Unfortunately, the transmitter battery in the unit on the adult bird only lasted through March, at which time the bird was still on her winter range, again with sensors indicating that she was alive and well a that time. Along with another immature bird that we outfitted at the site in 2004 and which remained alive and transmitted for 8.5 months (all the while remaining on or near Commissary Ridge, except for a brief ~115 km, mid-April jaunt to the northwest into eastern Idaho and back), the survival our three Wyoming goshawks has been much better than for the 20+ other goshawks we have tracked in the Pacific Northwest, Nevada, and New Mexico. Whether this reflects an overall higher probability of survival for Wyoming goshawks or a coincidental correlation with declining regional drought severity (most previous birds were outfitted several years earlier when widespread drought raged across much of the interior West, whereas between 2004 and 2006, regional moisture conditions had begun to improve again in many areas).

These deployments compliment more than 90 others accomplished by HWI 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 2007, we will again attempt to complete our initial deployment objectives for Commissary Ridge by outfitting at least one more Red-tailed Hawk 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 the previous two seasons, the banding crew collected breast and/or tip clippings from secondary feathers from most immature raptors that they captured during the 2006 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 2006). 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 (2006) detail a new GIS-based approach for mapping the origins of raptors based on this technique. 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 2006, 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 two immature Northern Harriers were present on the ridge in 2006. During the morning hours, and later in the day, the locals were often seen hunting on both sides of the ridge, most often between the western ridgeline and main road just north of the observation post. At the beginning of the season, they were seen a few times a day, but less frequently as the season progressed. One immature was last seen on 25 September. 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. Four juvenile Turkey Vultures were most often seen together, kettling on thermals near the quills and around the observation point, or flying to the reservoir. Only a few sightings of an adult occurred, once flying west to east with a juvenile. The last sighting of the Turkey Vultures occurred on 25 September.

Some of the Northern Goshawks captured this season were believed to be local birds because they were not seen by the observation team. Only two sightings of unknown age goshawks, exhibiting resident behavior, were confirmed in 2006. No other accipiters were identified as locals, which is unusual for the site; typically both Sharp-shinned Hawks and Cooper's Hawks are recorded as resident birds.

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 rufous/dark morph adult, which

may have been a resident breeder since at least 2000. Three light-morph adults and four immatures were typically seen along the north ridge, where they often intercepted and escorted migrants. 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 2006, even though one known Swainson's Hawk nest is located near a rural RV park in the valley to the southwest of the ridge. Eight winter-resident Rough-legged Hawks were observed in late October. The group of 7 light and 1 dark morph birds moved in around 27 October, and were seen until the end of the season. One light morph hunted directly in front of the observers, and stooped and called at the owl decoy. Otherwise, the rough legs were only seen moving north, just west of the observation point, usually at the end of the day (likely commuting back to a communal night roost).

At least one family group of Golden Eagles, one adult, one immature bird, and an associated subadult bird, frequented the north ridge in 2006. 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. The immature bird was observed many times, during heavy winds, "playing" with his food, dropping it high in the air and then stooping to catch it. 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 adult Bald Eagle was regularly observed after 1 October and would travel in a circuit, where it either traveled south and then West, or came back North and then continued west. 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, and one S2 subadult (see Appendix B for plumage class descriptions). 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 8 October 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. 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 south of the project camp. 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.

SITE VISITATION AND PUBLIC OUTREACH

Public awareness of HWI's newest migration monitoring project is still developing, but we were pleased to host 30 visitors from seven states (Wyoming, California, Kansas, Wisconsin, Oregon, Colorado, and Utah) at the project site during the 2006 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. Education Department staff facilitated four organized-group visits from the Osher Institute of the University of Utah and our T.A.L.O.N.S. (Teaching And Learning Observation and Natural Science) teacher workshops

(visit http://www.hawkwatch.org/talons for more information). The continued involvement of BLM interns on the project also was a helpful addition.

In July 2006, for the fourth 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. Staff members provided some valuable public outreach about the project and our collaborative efforts with the BLM. 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 2007 with all aspects of this project. We expect the count to proceed much as it has during the past five years, except that if the weather cooperates we may 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 assessing the relative merits of the two new trapping locations we explored in 2006, with hopes of making a final determination about permanent locations after the 2007 season. Lastly, if we do not succeed this spring in deploying satellite transmitters on another adult Red-tailed Hawk and at least two other Golden Eagles near the project site, we will intend to continue our efforts to accomplish this goal in the fall.

ACKNOWLEDGMENTS

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Table 1. Annual raptor migration counts and passage rates by species at Commissary Ridge, Wyoming: 2002–2005 versus 2006.

	Counts			Raptors/100 hours		
Species	2002–2005[1]	2006	% Change	2002–2005[1]	2006	% Change
Turkey Vulture	110 ± 56.7	39	-65	26.0 ± 13.05	8.8	-66
Osprey	34 ± 27.3	11	-68	7.6 ± 5.56	2.5	-67
Northern Harrier	33 ± 7.4	26	-21	7.8 ± 2.68	5.9	-25
Sharp-shinned Hawk	999 ± 353.0	217	-78	229.3 ± 80.90	48.9	-79
Cooper's Hawk	454 ± 166.3	289	-36	107.0 ± 40.76	65.2	-39
Northern Goshawk	28 ± 24.2	26	-7	6.5 ± 5.30	5.9	-10
Unknown small accipiter	71 ± 2.0	39	-45	17.0 ± 5.24	8.8	-48
Unknown large accipiter	16 ± 16.5	6	-63	3.6 ± 3.44	1.4	-62
Unknown accipiter	36 ± 31.7	6	-83	8.2 ± 5.98	1.4	-84
Total Accipiters	1604 ± 572.3	583	-64	371.7 ± 130.44	131.4	-65
Broad-winged Hawk	11 ± 10.3	3	-73	2.6 ± 2.18	0.7	-74
Swainson's Hawk	56 ± 30.9	47	-16	14.0 ± 11.12	10.6	-24
Red-tailed Hawk	1036 ± 125.3	563	-46	240.6 ± 25.92	126.9	-47
Ferruginous Hawk	8 ± 7.1	7	-13	1.9 ± 1.52	1.6	-16
Rough-legged Hawk	8 ± 2.0	5	-35	1.8 ± 0.41	1.1	-36
Unidentified buteo	52 ± 40.3	35	-33	11.6 ± 7.51	7.9	-32
Total Buteos	1171 ± 138.6	660	-44	272.3 ± 28.49	148.8	-45
Golden Eagle	263 ± 113.8	211	-20	64.4 ± 45.13	47.6	-26
Bald Eagle	134 ± 98.3	82	-39	34.1 ± 35.52	18.5	-46
Unidentified eagle	7 ± 2.0	6	-17	1.8 ± 0.92	1.4	-25
Total Eagles	405 ± 209.7	299	-26	100.4 ± 81.16	67.4	-33
American Kestrel	333 ± 83.6	156	-53	77.5 ± 8.17	35.2	-55
Merlin	13 ± 12.2	10	-23	3.0 ± 2.58	2.3	-25
Prairie Falcon	9 ± 0.7	13	49	2.0 ± 0.46	2.9	47
Peregrine Falcon	8 ± 5.2	9	20	1.7 ± 1.09	2.0	21
Unknown small falcon	3 ± 3.4	5	82	0.6 ± 0.75	1.1	90
Unknown large falcon	2 ± 3.3	4	129	0.4 ± 0.72	0.9	137
Unknown falcon	1 ± 1.1	7	833	0.2 ± 0.36	1.6	651
Total Falcons	368 ± 101.9	204	-45	85.4 ± 13.13	46.0	-46
Unidentified raptor	57 ± 36.2	19	-67	13.1 ± 6.36	4.3	-67
Grand Total	3781 ± 671.2	1841	-51	884.3 ± 206.37	415.0	-53

[1] Mean ± 95% confidence interval.

Table 2. Annual raptor migration counts by age classes and immature : adult ratios for selected species at Commissary Ridge, Wyoming: 2002–2005 versus 2006.

	Total and Age-classified Counts								Immature : Adult	
	2002–2005 Average			2006			% Unknown Age		Ratio	
Species	Total	Imm.	Adult	Total	Imm.	Adult	2002–2005[1]	2005	2002–2005[1]	2006
Northern Harrier	33	11	12	26	5	9	32 ± 9.1	46	0.9 ± 0.3	0.6
Sharp-shinned Hawk	999	270	338	217	67	47	40 ± 3.2	47	0.8 ± 0.2	1.4
Cooper's Hawk	454	148	147	289	55	108	36 ± 3.5	44	1.0 ± 0.2	0.5
Northern Goshawk	28	16	9	26	9	5	8 ± 3.4	46	2.3 ± 1.6	1.8
Broad-winged Hawk	11	3	5	3	0	0	30 ± 8.6	100	0.6 ± 0.3	–
Red-tailed Hawk	1036	256	511	563	206	240	26 ± 4.0	21	0.5 ± 0.1	0.9
Ferruginous Hawk	8	3	2	7	0	0	39 ± 11.6	100	1.1 ± 0.6	–
Golden Eagle	263	132	86	211	110	88	17 ± 4.1	6	1.6 ± 0.1	1.3
Bald Eagle	134	45	88	82	28	53	1 ± 0.8	1	0.5 ± 0.0	0.5
Peregrine Falcon	8	2	4	9	1	0	27 ± 4.2	89	0.7 ± 0.5	1.0

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

Table 3. First and last observed, bulk passage, and median passage dates by species for migrating raptors at Commissary Ridge, Wyoming in 2006, with comparisons of 2006 and 2002–2005 average median passage dates.

	2006				2002–2005
Species	First Observed	Last Observed	Bulk Passage Dates[1]	Median Passage Date[2]	Median Passage Date[2, 3]
Turkey Vulture	27-Aug	8-Oct	2-Sep – 28-Sep	24-Sep	22-Sep ± 2.7
Osprey	31-Aug	11-Oct	10-Sep – 10-Oct	17-Sep	16-Sep ± 3.6
Northern Harrier	28-Aug	23-Oct	31-Aug – 10-Oct	15-Sep	01-Oct ± 6.9
Sharp-shinned Hawk	29-Aug	28-Oct	10-Sep – 28-Oct	27-Sep	28-Sep ± 2.2
Cooper's Hawk	27-Aug	29-Oct	–	28-Sep	21-Sep ± 2.9
Northern Goshawk	6-Sep	29-Oct	10-Sep – 28-Oct	24-Sep	09-Oct ± 5.0
Broad-winged Hawk	18-Sep	10-Oct	–	–	25-Sep ± 3.2
Swainson's Hawk	28-Aug	10-Oct	10-Sep – 18-Sep	13-Sep	20-Sep ± 7.2
Red-tailed Hawk	27-Aug	31-Oct	10-Sep – 14-Oct	1-Oct	06-Oct ± 5.5
Ferruginous Hawk	3-Sep	27-Oct	3-Sep – 27-Oct	10-Oct	23-Sep ± 3.0
Rough-legged Hawk	28-Sep	28-Oct	28-Sep – 28-Oct	21-Oct	19-Oct ± 3.1
Golden Eagle	29-Aug	31-Oct	12-Sep – 29-Oct	12-Oct	09-Oct ± 0.9
Bald Eagle	12-Sep	31-Oct	30-Sep – 28-Oct	27-Oct	17-Oct ± 2.3
American Kestrel	27-Aug	14-Oct	–	26-Sep	22-Sep ± 2.9
Merlin	13-Sep	24-Oct	–	26-Sep	05-Oct ± 8.6
Prairie Falcon	7-Sep	29-Oct	10-Sep – 27-Oct	26-Sep	23-Sep ± 4.4
Peregrine Falcon	6-Sep	8-Oct	6-Sep – 8-Oct	26-Sep	25-Sep ± 2.0
Total	27-Aug	31-Oct	10-Sep – 23-Oct	28-Sep	28-Sep ± 1.4

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

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

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

Table 4. Median passage dates by age classes for selected species of migrating raptors at Commissary Ridge, Wyoming: 2002–2005 versus 2006.

	ADULT		IMMATURE / SUBADULT	
SPECIES	2002–2005[1]	2006	2002–2005[1]	2006
Northern Harrier	08-Oct ± 13.8	19-Sep	01-Oct ± 4.2	29-Sep
Sharp-shinned Hawk	05-Oct ± 4.0	30-Sep	22-Sep ± 8.2	24-Sep
Cooper's Hawk	23-Sep ± 1.7	28-Sep	17-Sep ± 4.6	19-Sep
Northern Goshawk[2]	19-Oct ± 13.5	27-Oct	23-Sep ± 11.3	19-Sep
Red-tailed Hawk	10-Oct ± 3.3	8-Oct	29-Sep ± 8.5	28-Sep
Golden Eagle	13-Oct ± 1.7	23-Oct	06-Oct ± 3.8	10-Oct
Bald Eagle	17-Oct ± 1.6	27-Oct	18-Oct ± 3.8	27-Oct

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.

Table 5. Capture totals, rates, and successes for migrating raptors at Commissary Ridge, Wyoming: 2004–2005 versus 2006.

	Capture Total		Capture Rate[1]		Capture Success (%)[2]	
Species	2004–05 mean[3]	2006	2004–05 mean[3]	2006	2004–05 mean[3]	2006
Northern Harrier	0 ± 0.0	1	0.0 ± 0.23	0.3	0.0 ± 0.0	3.8
Sharp-shinned Hawk	78.5 ± 34.3	28	23.1 ± 12.32	8.1	5.3 ± 0.5	11.9
Cooper's Hawk	56 ± 17.6	12	16.7 ± 10.56	3.5	10.1 ± 6.5	3.8
Northern Goshawk	14.5 ± 4.9	3	4.3 ± 2.76	0.9	34.7 ± 24.5	11.5
Red-tailed Hawk	7 ± 0.0	5	2.1 ± 0.69	1.4	0.6 ± 0.2	0.8
Golden Eagle	0.5 ± 1.0	0	0.2 ± 0.28	0.0	0.3 ± 0.6	0.0
American Kestrel	8 ± 9.8	1	2.2 ± 2.24	0.3	2.4 ± 3.3	0.6
Merlin	3.5 ± 1.0	0	1.0 ± 0.83	0.0	24.0 ± 24.3	0.0
Prairie Falcon	2 ± 0.0	0	0.6 ± 0.50	0.0	17.8 ± 14.2	9.1
Peregrine Falcon	0 ± 0.0	1	0.0 ± 0.23	0.3	0.0 ± 0.0	9.1
All Species	170 ± 66.6	51	50.3 ± 28.71	14.7	4.0 ± 0.9	2.9

[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.

[3.] Mean ± 95% confidence interval in days; unless otherwise indicated, values were calculated only for species with ≥3 years of counts ≥5 birds per year.

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, Wyoming: 2004–2005 versus 2006.

		Female		Male		Female : Male	Imm. : Adult
Species	Years	HY	AHY	HY	AHY	Ratio	Ratio
Sharp-shinned Hawk	Avg. 2004–2005[1]	32	13	23	11	1.4 ± 0.46	2.4 ± 0.38
	2006	13	5	10	0	1.8	4.6
Cooper's Hawk	Avg. 2004–2005[1]	24	24	7	2	5.8 ± 1.98	1.4 ± 1.09
	2006	6	4	1	1	5.0	1.4
Northern Goshawk	Avg. 2004–2005[1]	4	2	7	2	0.7 ± 0.91	3.4 ± 3.12
	2006	1	0	1	1	0.5	2.0
American Kestrel	Avg. 2004–2005[1]	2	0	5	1	0.4 ± 0.20	4.3 ± 2.46
	2006	0	0	1	0	0.0	1.0

[1] Mean ± 95% CI.

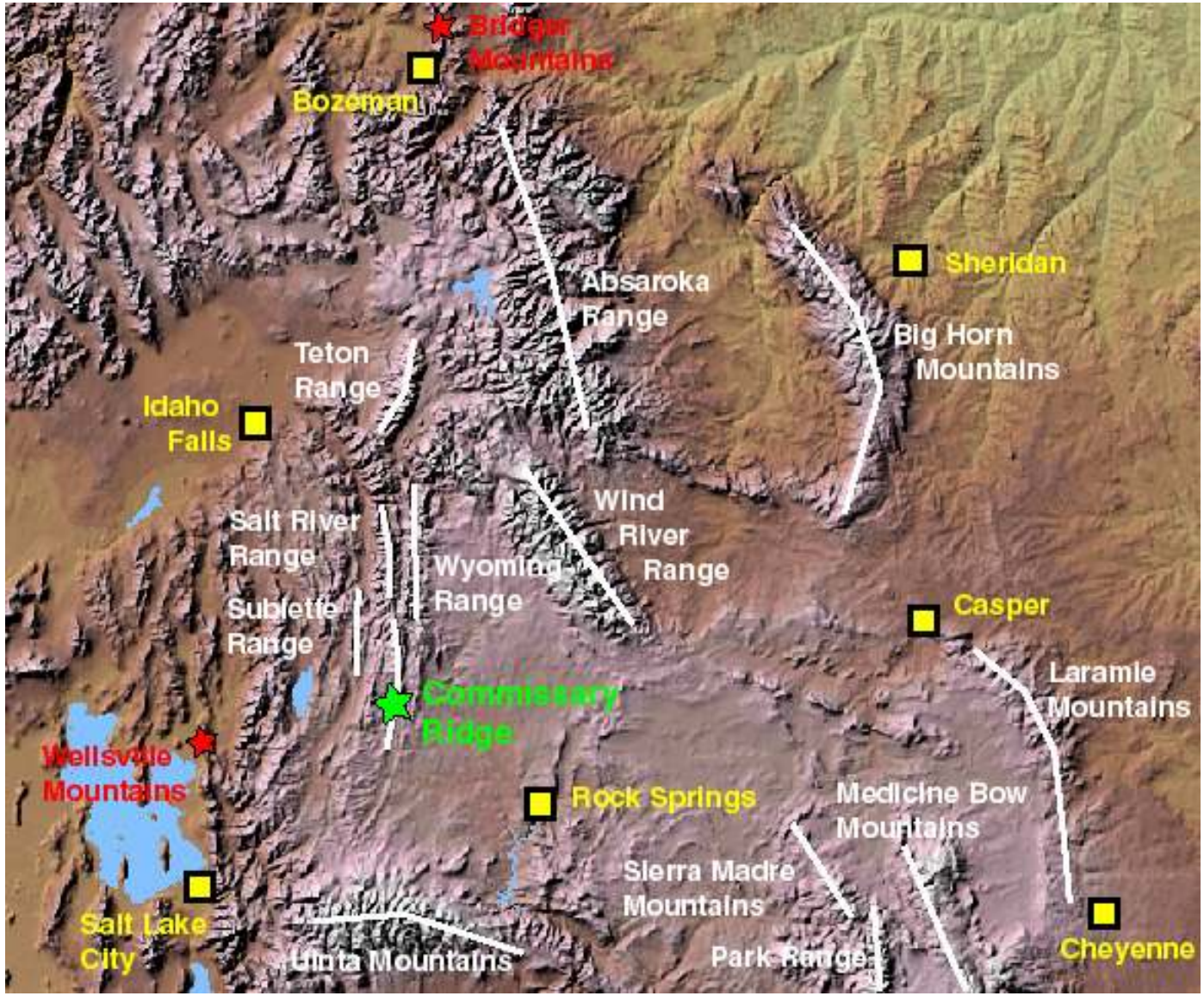

Figure 1. Location of Commissary Ridge Raptor Migration Project site in southwestern Wyoming. Red stars indicate other nearby HWI fall migration monitoring sites in Utah and Montana.

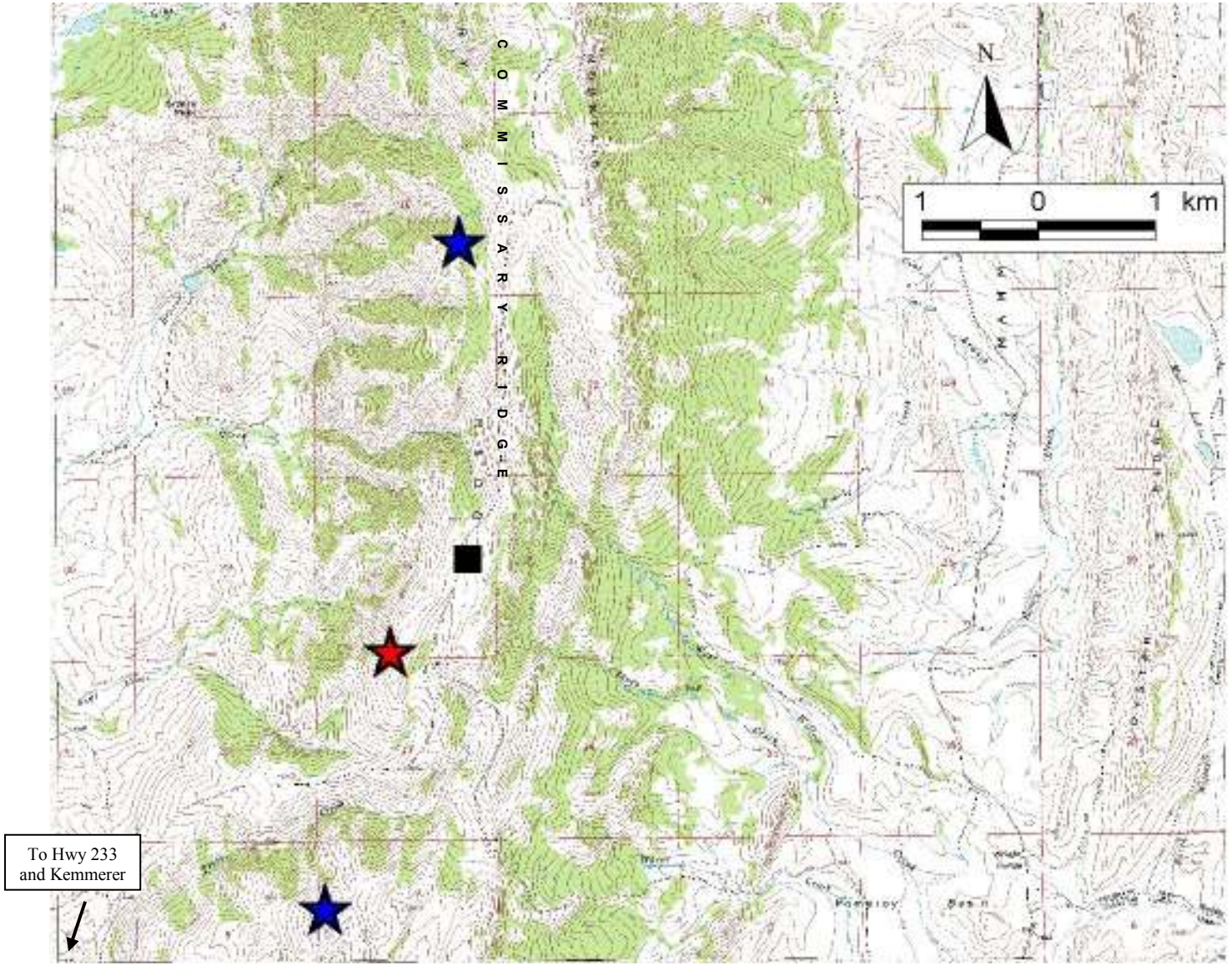

Figure 2. Close-up of Commissary Ridge Raptor Migration Project study site in southwestern Wyoming showing locations of the observation post (red star), the 2006 trapping locations (blue stars), and base camp (black square).

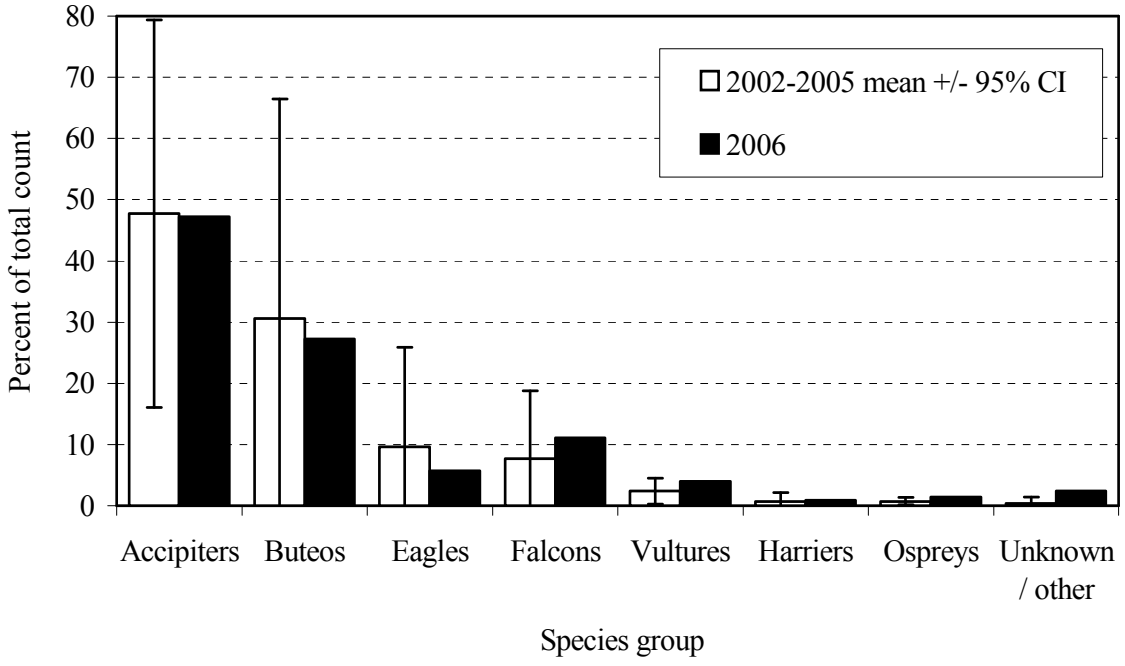

Figure 3. Composition by major species groups of the fall raptor migration at Commissary Ridge, Wyoming: 2002–2005 versus 2006.

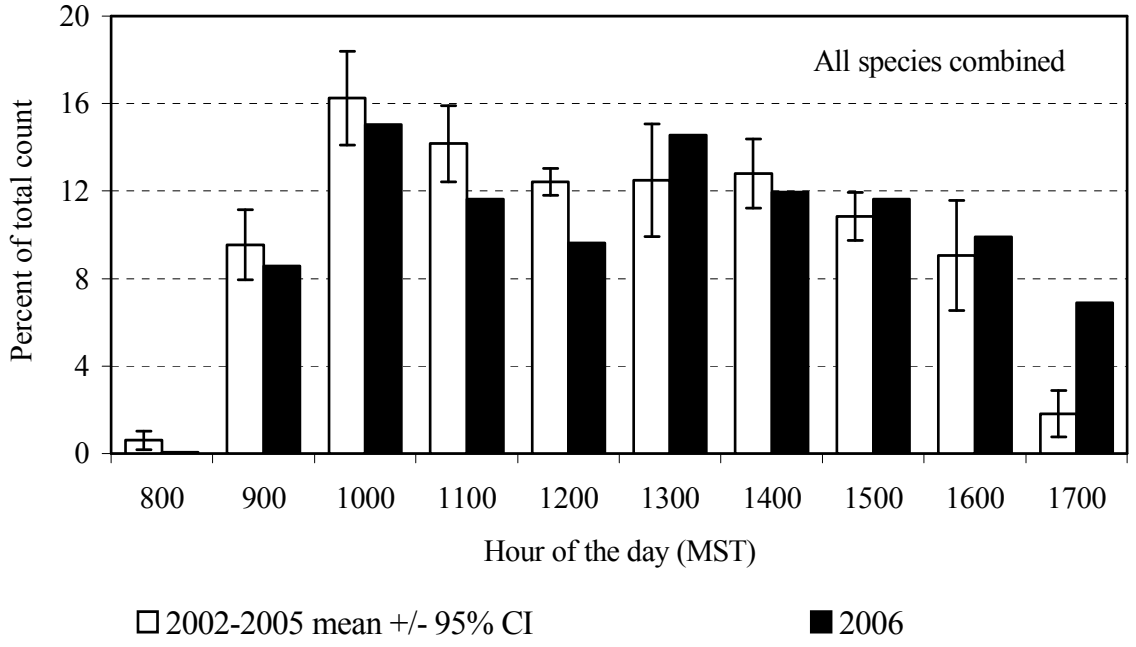

Figure 4. Daily rhythm of the fall raptor migration at Commissary Ridge, Wyoming: 2002–2005 versus 2006.

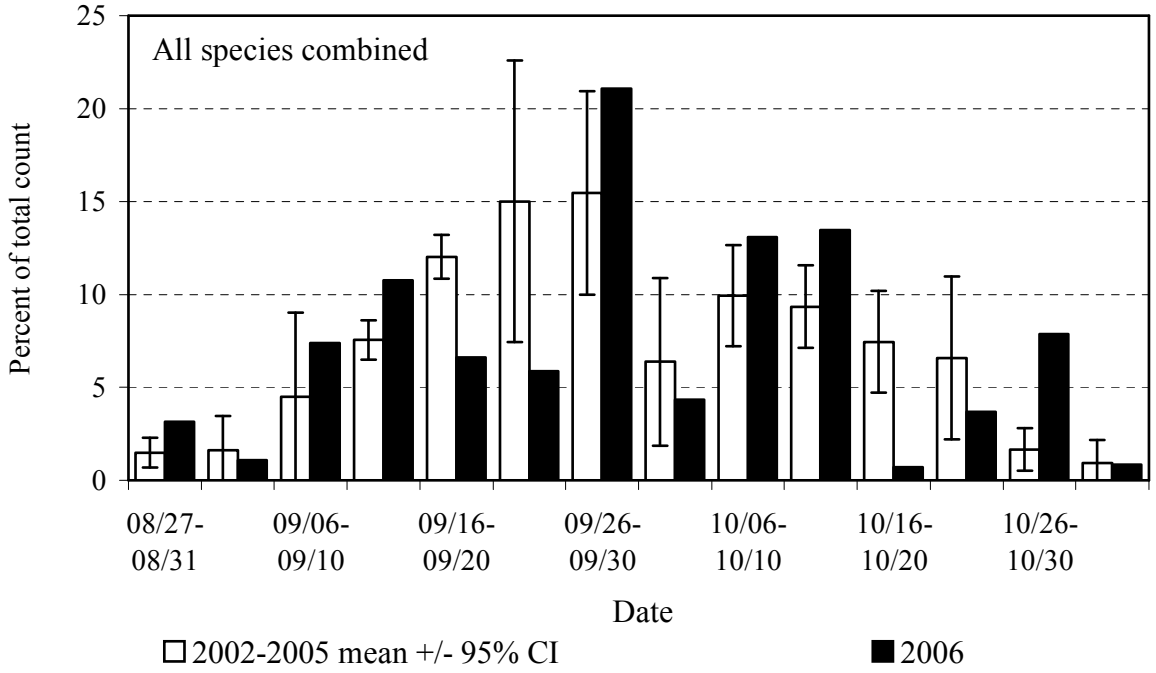

Figure 5. Combined-species seasonal distribution of activity by five-day periods for raptors during fall migration at Commissary Ridge, Wyoming: 2002–2005 versus 2006.

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

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

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

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

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

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

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

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

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

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

Common Name	Scientific Name	Species Code	Age[1]	Sex[2]	Color Morph[3]
Turkey Vulture	*Cathartes aura*	TV	U	U	NA
Osprey	*Pandion haliaetus*	OS	U	U	NA
Northern Harrier	*Circus cyaneus*	NH	A I Br U	M F U	NA
Sharp-shinned Hawk	*Accipiter striatus*	SS	A I U	U	NA
Cooper's Hawk	*Accipiter cooperii*	CH	A I U	U	NA
Northern Goshawk	*Accipiter gentilis*	NG	A I U	U	NA
Unknown small accipiter	*A. striatus* or *cooperii*	SA	U	U	NA
Unknown large accipiter	*A. cooperii* or *gentilis*	LA	U	U	NA
Unknown accipiter	*Accipiter* spp.	UA	U	U	NA
Broad-winged Hawk	*Buteo platypterus*	BW	A I U	U	D L U
Swanson's Hawk	*Buteo swainsoni*	SW	U	U	D L U
Red-tailed Hawk	*Buteo jamaicensis*	RT	A I U	U	D L U
Ferruginous Hawk	*Buteo regalis*	FH	A I U	U	D L U
Rough-legged Hawk	*Buteo lagopus*	RL	U	U	D L U
Unknown buteo	*Buteo* spp.	UB	U	U	D L U
Golden Eagle	*Aquila chrysaetos*	GE	I, S, NA, A, U[4]	U	NA
Bald Eagle	*Haliaeetus leucocephalus*	BE	I, S1, S2, NA, A, U[5]	U	NA
Unknown eagle	*Aquila* or *Haliaeetus spp.*	UE	U	U	NA
American Kestrel	*Falco sparverius*	AK	U	M F U	NA
Merlin	*Falco columbarius*	ML	AM Br	AM U	NA
Prairie Falcon	*Falco mexicanus*	PR	U	U	NA
Peregrine Falcon	*Falco peregrinus*	PG	A I U	U	NA
Unknown small falcon	*F. sparverius* or *columbarius*	SF	U	U	NA
Unknown large falcon	*F. mexicanus* or *peregrinus*	LF	U	U	NA
Unknown falcon	*Falco* spp.	UF	U	U	NA
Unknown raptor	Falconiformes	UU	U	U	NA

[1] Age codes: A = adult, I = immature (HY), Br = brown (adult female or immature), U = unknown age.

[2] Sex codes: M = male, F = female, U = unknown.

[3] Color morph codes: D = dark or rufous, L = light, U – unknown, NA = not applicable.

[4] Golden Eagle age codes: I = Immature: juvenile or first-year bird, bold white wing patch visible below, bold white in tail, no molt; S = Subadult: white wing patch variable or absent, obvious white in tail and molt or tawny bar visible on upper wing; NA = Not adult: unknown age immature/subadult; A = Adult: no white in wings or tail; U = Unknown.

[5] Bald Eagle age codes: I = Immature: juvenile or first-year bird, dark breast and tawny belly; S1 = young Subadult: Basic I and II plumages, light belly, upside-down triangle on back; S2 = older Subadult: Basic III plumage, head mostly white with osprey-like dark eye line and dark band on tail; NA = Not adult: unknown age immature/subadult; A = Adult: includes near adult with dark flecks in head and dark tail tip, and adult with white head and tail; U = Unknown.

Appendix C. Daily observation effort, visitor disturbance ratings, weather records, and flight summaries for the fall raptor migration at Commissary Ridge, Wyoming: 2006.

Date	Obs. Hours	Obsrvr / Hour[1]	Median Visitor Disturb[2]	Predominant Weather[3]	Wind Speed (kph)[1]	Wind Direction	Temp (°C)[1]	Barom. Press. (in Hg)[1]	Median Thermal Lift[4]	Visib. East (km)[1]	Visib. West (km)[1]	Median Flight Distance[5]	Birds / Hour
27-Aug	8.50	3.0	0	clr-mc	17.0	wnw	17.7	30.30	3	73	73	0	0.6
28-Aug	9.00	2.9	0	clr-pc	12.9	var	18.8	30.37	3	88	89	1	0.9
29-Aug	8.50	2.8	0	clr-pc	20.7	w	22.7	30.18	3	71	85	0	1.3
30-Aug	9.00	2.0	0	pc-mc	34.3	wsw	21.4	30.05	2	74	76	0	0.0
31-Aug	9.00	2.0	0	clr-pc	28.8	w	16.0	30.21	3	92	92	3	3.8
1-Sep	9.00	2.0	0	clr	17.6	wsw	17.5	30.35	3	75	82	0	0.3
2-Sep	9.00	2.0	0	clr	14.1	e, sw	17.1	30.34	2	67	67	0	0.2
3-Sep	9.00	2.0	0	clr	9.2	ese, wsw	20.6	30.29	3	75	84	1	0.9
4-Sep	9.00	2.1	0	pc	10.5	e, sw, wnw	22.5	30.38	2	77	81	1	0.6
5-Sep	9.00	2.0	0	pc-ovc	16.2	wnw	21.5	30.44	4	73	81	0	0.2
6-Sep	7.00	2.0	0	pc-mc	16.4	w	21.4	30.36	3	57	61	1	2.7
7-Sep	9.00	2.0	0	ovc, AM rain	8.0	ne, w	14.6	30.19	4	33	31	0	2.3
8-Sep	0.00			weather day, rain									
9-Sep	9.00	3.1	0	clr-mc	25.9	w	16.2	30.06	3	53	53	0	2.4
10-Sep	9.00	3.3	0	clr	24.9	w	16.0	30.23	3	63	63	0	8.2
11-Sep	9.00	1.8	0	clr-pc	24.2	w	18.8	30.46	3	59	59	0	3.9
12-Sep	9.00	2.0	0	clr	14.5	w	20.4	30.38	2	60	68	0	1.3
13-Sep	9.00	2.0	0	clr	29.0	w	20.7	30.11	3	58	58	0	9.0
14-Sep	7.00	1.9	0	mc-ovc	20.6	sw	19.7	29.79	4	50	59	0	1.7
15-Sep	0.00			weather day, rain/snow									
16-Sep	0.00			weather day, fog/snow									
17-Sep	6.00	3.0	0	ovc, snow	44.3	w	2.7	30.04	4	56	56	0	1.8
18-Sep	9.00	3.0	0	clr-pc	22.6	w	7.7	30.16	3	98	98	0	3.4
19-Sep	9.00	2.0	0	pc-mc	10.1	s-sw	13.9	30.05	3	91	93	0	8.4
20-Sep	7.50	3.0	0	ovc	20.3	w	6.1	29.86	4	15	19	0	0.5
21-Sep	0.00			weather day, fog/snow									
22-Sep	0.00			weather day, fog/snow									
23-Sep	9.00	2.1	0	clr-ovc	6.5	calm, wsw	4.9	30.20	4	91	97	2	3.3
24-Sep	9.00	2.6	0	clr	22.2	w	7.5	30.29	3	100	100	0	5.3
25-Sep	9.00	1.8	0	clr	9.4	w	11.9	30.33	2	91	93	2	3.3
26-Sep	9.50	1.9	0	clr-pc	31.8	w	10.9	30.29	3	97	97	1	13.9
27-Sep	9.00	2.0	0	clr	29.1	w	13.7	30.33	3	83	84	0	7.4
28-Sep	9.08	2.0	0	clr	41.9	w	13.3	30.27	3	84	90	0	15.0
29-Sep	9.00	2.1	0	clr	28.5	w	14.1	30.24	3	62	59	0	2.7
30-Sep	9.00	2.0	1	clr, haze	27.8	w	15.4	30.16	3	66	68	0	3.2
1-Oct	9.00	2.0	0	mc-ovc	23.4	w	15.2	30.10	4	79	74	0	6.9
2-Oct	0.00			weather day, fog/rain									
3-Oct	9.00	2.1	1	clr-pc	22.3	w	9.2	30.25	3	68	70	0	0.9
4-Oct	6.50	2.0	0	ovc, AM haze, scat snow	23.9	se	11.7	30.26	4	46	59	0	0.2
5-Oct	6.00	2.0	0	ovc, fog/rain	24.3	e	11.2	30.23	4	45	56	0	0.2
6-Oct	3.50	2.0	0	ovc, fog/rain	12.5	e	10.5	30.10	4	0	9	0	0.3
7-Oct	3.50	1.3	0	ovc, fog/snow	33.0	sw	5.0	30.04	4	27	12	0	0.3
8-Oct	9.00	2.1	0	mc-ovc	8.0	calm, ese, w	6.4	30.21	3	57	64	0	13.3
9-Oct	0.00			weather day, fog/snow									
10-Oct	9.00	2.0	0	clr-pc	19.9	w	4.7	30.04	3	71	77	0	13.2
11-Oct	7.50	1.9	0	pc-ovc	53.6	wsw	5.8	30.00	4	78	71	0	10.4
12-Oct	8.00	2.0	0	clr	30.3	w	6.9	30.02	3	75	93	0	4.1

Appendix C. continued

Date	Obs. Hours	Obsrvr / Hour[1]	Median Visitor Disturb[2]	Predominant Weather[3]	Wind Speed (kph)[1]	Wind Direction	Temp (°C)[1]	Barom. Press. (in Hg)[1]	Median Thermal Lift[4]	Visib. East (km)[1]	Visib. West (km)[1]	Median Flight Distance[5]	Birds / Hour
13-Oct	8.00	1.9	2.5	clr	24.0	w	11.6	30.01	1	94	94	0	5.8
14-Oct	8.00	3.0	0	mc	10.0	w	12.0	29.89	2	87	97	0	11.4
15-Oct	8.00	2.7	0	mc-ovc	30.6	w	10.9	29.72	4	87	87	0	0.0
16-Oct	6.00	2.0	0	mc-ovc	28.9	wsw	2.9	29.50	4	76	71	0	0.5
17-Oct	0.00			weather day, fog/snow									
18-Oct	4.00	2.0	0	clr	38.8	w	-0.2	29.94	4	91	97	0	2.3
19-Oct	4.00	1.5	0	ovc, fog	49.8	wsw	0.8	29.94	4	38	11	0	0.3
20-Oct	0.00			weather day, fog/snow									
21-Oct	8.00	2.0	0	clr-mc	19.4	w	-0.2	30.08	3	89	92	0	2.5
22-Oct	8.00	2.0	0	clr	27.0	w	0.9	30.18	3	96	100	0	2.4
23-Oct	8.00	1.8	0	clr-pc	19.0	w	7.6	30.18	3	100	100	0	1.5
24-Oct	8.00	2.0	0	clr-pc	22.4	w	8.7	29.90	3	100	100	0	2.1
25-Oct	0.00			weather day, fog/snow									
26-Oct	4.00	2.0	0	pc, snow	39.8	w	-2.8	30.22	4	100	100	0	2.0
27-Oct	8.00	3.5	0	mc	33.6	w	1.6	30.39	4	95	100	0	7.0
28-Oct	8.00	3.3	0	clr	40.0	w	6.8	30.24	4	100	100	0	7.1
29-Oct	8.00	2.2	0	mc	37.3	w	7.0	29.78	4	89	100	0	2.6
30-Oct	8.00	2.0	0	clr-mc	45.2	w	-1.7	29.67	4	100	100	0	0.4
31-Oct	5.50	1.5	0	clr	35.0	w	-3.5	29.95	4	100	100	0	2.9

[1] Average of hourly records.

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

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

[4] Median hourly rating concerning prevalence of lift-generating thermals, based on subjective assessments of solar intensity, wind speeds, and migrant behavior: 1 = excellent, 2 = good, 3 = fair, 4 = poor.

[5] Median hourly rating concerning line-of-sight distance of flight from observation site: 1 = close, detection and identification possible with naked eye; 2 = moderate, detection possible with naked eye, but binoculars needed for identification; 3 = far, binoculars needed for both detection and identification; 4 = distant, birds detected and identified only with excellent binoculars or spotting scope and by experienced observers.

Appendix D. Raptor counts by day and species during fall migration at Commissary Ridge, Wyoming: 2006.

		Species[1]																										Birds	
Date	Hours	TV	OS	NH	SS	CH	NG	SA	LA	UA	BW	SW	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	SF	LF	UF	UU	Total	/Hour
27-Aug	8.50	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	5	0.6
28-Aug	9.00	0	0	2	0	1	0	1	0	0	0	1	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	8	0.9
29-Aug	8.50	0	0	0	1	2	0	1	0	0	0	0	4	0	0	0	2	0	0	1	0	0	0	0	0	0	0	11	1.3
30-Aug	9.00	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
31-Aug	9.00	1	1	1	1	3	0	0	0	0	0	0	18	0	0	2	6	0	0	0	0	0	0	0	0	1	0	34	3.8
1-Sep	9.00	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0.3
2-Sep	9.00	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.2
3-Sep	9.00	0	0	1	1	2	0	0	0	0	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	8	0.9
4-Sep	9.00	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	5	0.6
5-Sep	9.00	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0.2
6-Sep	7.00	0	0	0	5	5	1	0	0	0	0	0	5	0	0	0	2	0	0	0	0	0	1	0	0	0	0	19	2.7
7-Sep	9.00	0	0	2	3	3	1	0	0	0	0	1	7	0	0	0	2	0	0	1	0	1	0	0	0	0	0	21	2.3
8-Sep	0.00																												
9-Sep	9.00	0	0	1	3	2	0	1	0	0	0	1	7	0	0	0	4	0	0	1	0	0	2	0	0	0	0	22	2.4
10-Sep	9.00	4	1	3	13	8	1	3	2	1	0	2	27	0	0	0	1	0	1	5	0	1	0	0	1	0	0	74	8.2
11-Sep	9.00	2	0	0	7	3	1	2	0	0	0	0	12	0	0	0	1	0	0	6	0	1	0	0	0	0	0	35	3.9
12-Sep	9.00	0	0	0	0	3	0	0	0	0	0	0	2	0	0	1	1	1	0	1	0	0	1	0	0	0	2	12	1.3
13-Sep	9.00	1	1	1	6	6	4	2	1	0	0	35	12	0	0	0	4	0	0	7	1	0	0	0	0	0	0	81	9.0
14-Sep	7.00	0	2	0	0	2	0	0	0	0	0	0	4	0	0	0	1	0	1	2	0	0	0	0	0	0	0	12	1.7
15-Sep	0.00																												
16-Sep	0.00																												
17-Sep	6.00	0	1	0	0	1	0	1	0	0	0	2	4	0	0	0	2	0	0	0	0	0	0	0	0	0	0	11	1.8
18-Sep	9.00	1	2	0	2	7	0	0	0	0	1	2	11	0	0	0	3	0	0	1	0	0	0	0	1	0	0	31	3.4
19-Sep	9.00	5	1	1	15	22	3	1	0	0	0	1	14	0	0	1	1	0	0	5	0	0	0	2	0	0	4	76	8.4
20-Sep	7.50	0	0	0	1	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0.5
21-Sep	0.00																												

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	0.00																												
23-Sep	9.00	0	0	1	5	12	0	0	0	0	0	1	5	0	0	2	1	0	0	1	0	1	0	0	0	0	1	30	3.3
24-Sep	9.00	9	0	1	6	7	1	0	0	3	0	0	12	0	0	1	1	0	0	6	1	0	0	0	0	0	0	48	5.3
25-Sep	9.00	1	0	0	4	1	1	0	0	0	0	0	6	0	0	6	1	0	0	6	0	1	0	0	1	0	2	30	3.3
26-Sep	9.50	1	0	0	13	18	0	1	0	1	1	0	31	0	0	3	10	0	0	42	3	2	2	3	0	0	1	132	13.9
27-Sep	9.00	0	0	0	12	13	1	1	0	0	0	0	12	1	0	1	3	0	0	18	1	1	1	0	0	1	1	67	7.4
28-Sep	9.08	8	0	0	15	18	0	1	1	0	0	0	46	1	1	3	10	0	0	30	2	0	0	0	0	0	0	136	15.0
29-Sep	9.00	1	0	2	2	2	0	0	0	0	0	0	5	0	0	0	3	0	0	8	0	0	0	0	0	1	0	24	2.7
30-Sep	9.00	0	0	0	3	5	0	1	0	0	0	0	15	0	0	0	3	1	0	0	0	0	0	0	0	0	1	29	3.2
1-Oct	9.00	1	0	0	12	21	0	1	0	0	0	0	16	0	0	1	5	0	0	2	0	0	1	0	0	1	1	62	6.9
2-Oct	0.00																												
3-Oct	9.00	0	0	0	1	4	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0.9
4-Oct	6.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0.2
5-Oct	6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0.2
6-Oct	3.50	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
7-Oct	3.50	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
8-Oct	9.00	1	0	4	15	22	1	10	0	0	0	0	51	0	0	5	3	0	0	4	0	1	1	0	1	0	1	120	13.3
9-Oct	0.00																												
10-Oct	9.00	0	1	2	18	15	0	3	1	0	1	1	58	1	0	3	14	0	0	1	0	0	0	0	0	0	0	119	13.2
11-Oct	7.50	0	1	0	8	15	1	2	0	0	0	0	38	0	0	0	4	5	1	2	0	0	0	0	0	1	0	78	10.4
12-Oct	8.00	0	0	0	3	10	0	0	0	1	0	0	7	0	0	1	8	1	0	0	0	1	0	0	0	0	1	33	4.1
13-Oct	8.00	0	0	1	4	9	2	0	0	0	0	0	28	0	0	0	1	1	0	0	0	0	0	0	0	0	0	46	5.8
14-Oct	8.00	0	0	0	15	15	0	4	0	0	0	0	28	1	0	2	12	7	1	1	1	0	0	0	0	0	4	91	11.4
15-Oct	8.00	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
16-Oct	6.00	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0.5
17-Oct	0.00																												

Appendix D. continued

		Species[1]																										Birds	
Date	Hours	TV	OS	NH	SS	CH	NG	SA	LA	UA	BW	SW	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	SF	LF	UF	UU	Total	/Hour
18-Oct	4.00	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	2.3
19-Oct	4.00	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.3
20-Oct	0.00																												
21-Oct	8.00	0	0	0	0	3	0	0	0	0	0	0	9	1	2	0	3	1	0	0	0	0	0	0	0	1	0	20	2.5
22-Oct	8.00	0	0	0	2	2	0	0	0	0	0	0	6	0	1	0	2	5	1	0	0	0	0	0	0	0	0	19	2.4
23-Oct	8.00	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	6	3	0	0	0	0	0	0	0	0	0	12	1.5
24-Oct	8.00	0	0	0	0	2	0	0	0	0	0	0	4	0	0	1	7	2	0	0	1	0	0	0	0	0	0	17	2.1
25-Oct	0.00																												
26-Oct	4.00	0	0	0	0	0	1	0	0	0	0	0	4	0	0	0	2	1	0	0	0	0	0	0	0	0	0	8	2.0
27-Oct	8.00	0	0	0	1	0	3	0	0	0	0	0	8	1	0	0	19	23	0	0	0	1	0	0	0	0	0	56	7.0
28-Oct	8.00	0	0	0	4	1	2	1	0	0	0	0	5	0	1	1	25	16	0	0	0	0	0	0	0	1	0	57	7.1
29-Oct	8.00	0	0	0	0	1	1	0	0	0	0	0	3	0	0	0	11	4	0	0	0	1	0	0	0	0	0	21	2.6
30-Oct	8.00	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	0.4
31-Oct	5.50	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	12	3	0	0	0	0	0	0	0	0	0	16	2.9
Total	443.58	39	11	24	207	271	25	37	5	6	3	47	549	7	5	34	202	75	6	156	10	12	9	5	4	7	19	1775	4.0

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

Appendix E. Annual summaries of fall-migration observation effort and raptor counts by species at Commissary Ridge, Wyoming: 2001–2006 versus mean.

	YEAR						
	2001	2002	2003	2004	2005	2006	MEAN
Start date	3-Sep	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	26-Aug
End date	23-Oct	29-Oct	29-Oct	3-Nov	31-Oct	31-Oct	30-Oct
Observation days	22	45	63	65	64	56	59
Observation hours	145.88	322.67	474.85	452.67	478.83	443.58	434.52
Raptors/100 hrs	1155.7	990.8	644.4	916.6	985.3	415.0	790.4
SPECIES	RAPTOR COUNTS						
Osprey	16	11	31	59	36	11	30
Northern Harrier	40	32	25	38	36	26	31
Sharp-shinned Hawk	303	675	516	1,118	1,687	217	843
Cooper's Hawk	256	409	329	614	462	289	421
Northern Goshawk	11	21	7	49	35	26	28
Unknown small accipiter	11	78	75	75	55	39	64
Unknown large accipiter	4	6	13	34	11	6	14
Unknown accipiter	29	16	58	69	2	6	30
TOTAL ACCIPITERS	614	1,205	998	1,959	2,252	583	1,399
Broad-winged Hawk	1	8	5	22	9	3	9
Swainson's Hawk	18	82	28	62	52	47	54
Red-tailed Hawk	323	823	1,042	961	1,319	563	942
Ferruginous Hawk	7	6	3	15	8	7	8
Rough-legged Hawk	20	5	5	8	13	5	7
Unidentified buteo	19	17	87	63	42	35	49
TOTAL BUTEOS	388	941	1,170	1,131	1,443	660	1,069
Golden Eagle	279	352	233	152	316	211	253
Bald Eagle	72	233	90	76	137	82	124
Unidentified eagle	5	10	7	10	2	6	7
TOTAL EAGLES	356	595	330	238	455	299	383
American Kestrel	166	258	355	403	317	156	298
Merlin	7	9	6	26	11	10	12
Prairie Falcon	1	6	5	6	18	13	10
Peregrine Falcon	5	3	3	11	13	9	8
Unknown small falcon	2	0	3	6	2	5	3
Unknown large falcon	5	0	0	5	2	4	2
Unknown falcon	0	2	0	1	0	7	2
TOTAL FALCONS	186	278	372	458	363	204	335
Unidentified raptor	19	38	68	102	19	19	49
ALL SPECIES	1,686	3,197	3,060	4,149	4,718	1,841	3,393

Appendix F. Raptor capture totals by day and species during fall migration at Commissary Ridge, Wyoming: 2006.

	STN.	SPECIES[1]											CAPTURES /
DATE	HOURS	NH	SS	CH	NG	RT	GE	AK	ML	PR	PG	TOTAL	HOUR
28-Aug	1.50	0	0	0	0	0	0	0	0	0	0	0	0.0
29-Aug	7.50	0	1	1	0	0	0	0	0	0	0	2	0.3
30-Aug	9.25	0	0	0	0	0	0	0	0	0	1	1	0.1
31-Aug	0.00												
1-Sep	9.00	0	0	0	0	0	0	0	0	0	0	0	0.0
2-Sep	9.00	0	0	0	0	0	0	0	0	0	0	0	0.0
3-Sep	9.25	0	5	1	0	0	0	0	0	0	0	6	0.6
4-Sep	8.00	0	0	1	0	0	0	1	0	0	0	2	0.3
5-Sep	9.25	0	5	1	0	0	0	0	0	0	0	6	0.6
6-Sep	7.25	0	0	0	0	0	0	0	0	0	0	0	0.0
7-Sep	0.00												
8-Sep	0.00												
9-Sep	9.00	0	1	0	0	0	0	0	0	0	0	1	0.1
10-Sep	9.00	0	2	1	0	0	0	0	0	0	0	3	0.3
11-Sep	8.75	0	2	0	0	0	0	0	0	0	0	2	0.2
12-Sep	7.50	0	1	2	0	0	0	0	0	0	0	3	0.4
13-Sep	0.00												
14-Sep	7.75	0	0	0	0	0	0	0	0	0	0	0	0.0
15-Sep	0.00												
16-Sep	0.00												
17-Sep	0.00												
18-Sep	8.75	0	0	1	0	0	0	0	0	0	0	1	0.1
19-Sep	9.00	0	0	2	0	0	0	0	0	0	0	2	0.2
20-Sep	13.25	0	0	0	0	0	0	0	0	0	0	0	0.0
21-Sep	0.00												
22-Sep	0.00												
23-Sep	14.75	0	0	1	1	0	0	0	0	0	0	2	0.1
24-Sep	9.50	1	0	0	0	2	0	0	0	0	0	3	0.3
25-Sep	9.50	0	0	0	0	0	0	0	0	0	0	0	0.0
26-Sep	10.00	0	3	1	0	0	0	0	0	0	0	4	0.4
27-Sep	7.75	0	0	0	1	0	0	0	0	0	0	1	0.1
28-Sep	7.75	0	0	0	0	0	0	0	0	0	0	0	0.0
29-Sep	13.00	0	1	0	0	0	0	0	0	0	0	1	0.1
30-Sep	6.16	0	0	0	0	0	0	0	0	0	0	0	0.0
1-Oct	14.92	0	2	0	0	0	0	0	0	0	0	2	0.1
2-Oct	0.00												
3-Oct	14.85	0	0	0	0	0	0	0	0	0	0	0	0.0
4-Oct	11.50	0	0	0	0	1	0	0	0	0	0	1	0.1
5-Oct	8.00	0	0	0	0	0	0	0	0	0	0	0	0.0

Appendix F. continued

	STN.	SPECIES[1]											CAPTURES /
DATE	HOURS	NH	SS	CH	NG	RT	GE	AK	ML	PR	PG	TOTAL	HOUR
6-Oct	3.50	0	0	0	0	0	0	0	0	0	0	0	0.0
7-Oct	0.00												
8-Oct	13.41	0	5	0	1	0	0	0	0	0	0	6	0.4
9-Oct	0.00												
10-Oct	0.00												
11-Oct	6.50	0	0	0	0	0	0	0	0	0	0	0	0.0
12-Oct	5.58	0	0	0	0	1	0	0	0	0	0	1	0.2
13-Oct	6.00	0	0	0	0	0	0	0	0	0	0	0	0.0
14-Oct	0.00												
15-Oct	6.80	0	0	0	0	1	0	0	0	0	0	1	0.1
16-Oct	2.00	0	0	0	0	0	0	0	0	0	0	0	0.0
17-Oct	0.00												
18-Oct	0.00												
19-Oct	0.00												
20-Oct	0.00												
21-Oct	2.25	0	0	0	0	0	0	0	0	0	0	0	0.0
22-Oct	6.75	0	0	0	0	0	0	0	0	0	0	0	0.0
23-Oct	5.25	0	0	0	0	0	0	0	0	0	0	0	0.0
24-Oct	5.90	0	0	0	0	0	0	0	0	0	0	0	0.0
25-Oct	0.00												
26-Oct	0.00												
27-Oct	0.00												
28-Oct	5.00	0	0	0	0	0	0	0	0	0	0	0	0.0
29-Oct	4.50	0	0	0	0	0	0	0	0	0	0	0	0.0
30-Oct	2.00	0	0	0	0	0	0	0	0	0	0	0	0.0
Total	346.12	1	28	12	3	5	0	1	0	0	1	51	0.1

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