

**FALL 2007 RAPTOR MIGRATION STUDY IN THE  
BRIDGER MOUNTAINS, MONTANA**



**HawkWatch International, Inc.  
Salt Lake City, Utah**

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IN THE BRIDGER MOUNTAINS, MONTANA**

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## TABLE OF CONTENTS

List of Tables .....	iii
List of Figures .....	iii
Introduction.....	1
Study Site.....	1
Methods .....	1
Results and Discussion .....	2
Weather Summary .....	2
Observation Effort.....	3
Flight Summary.....	3
Passage Rates and Long-term Trends.....	3
Age Ratios.....	4
Seasonal Timing .....	5
Resident Raptors .....	5
Visitation .....	6
Acknowledgments.....	6
Literature Cited.....	7
Tables.....	8
Figures .....	11
Appendix A. Common and scientific names, species codes, and regularly applied age, sex, and color-morph classifications for all diurnal raptor species observed during fall migration in the Bridger Mountains, MT.....	19
Appendix B. A history of primary observers for the Bridger Mountains Raptor Migration Project.....	20
Appendix C. Daily observation effort, visitor disturbance ratings, weather records, and flight summaries for the Bridger Mountains Raptor Migration Project: 2007. ....	21
Appendix D. Daily observation effort and fall raptor migration counts by species in the Bridger Mountains, MT: 2007.....	23
Appendix E. Annual observation effort and fall raptor migration counts by species in the Bridger Mountains, MT: 1991–2007. ....	25

## LIST OF TABLES

Table 1.	Annual fall-migration counts and adjusted passage rates (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) by species in the Bridger Mountains, MT: 1992–2005 versus 2007. ....	8
Table 2.	Fall counts by age class and immature : adult ratios for selected species of migrating raptors in the Bridger Mountains, MT: 1992–2006 versus 2007. ....	9
Table 3.	First and last observation, bulk passage, and median passage dates by species for migrating raptors in the Bridger Mountains, MT in 2007, with a comparison of 2007 and 1992–2006 average median passage dates.....	10

## LIST OF FIGURES

Figure 1.	Location of the Bridger Mountains Raptor Migration Project study site.....	11
Figure 2.	Composition of the fall raptor migration in the Bridger Mountains by major species groups: 1992–2006 versus 2007.....	12
Figure 3.	Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Turkey Vultures, Ospreys, and Northern Harriers in the Bridger Mountains, MT: 1992–2007. Dashed lines indicate significant ( $P \leq 0.10$ ) regressions. ....	13
Figure 4.	Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Sharp-shinned Hawks, Cooper’s Hawks, and Northern Goshawks in the Bridger Mountains, MT: 1992–2007. Dashed lines indicate significant ( $P \leq 0.10$ ) regressions. ....	14
Figure 5.	Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Broad-winged, Swainson’s, Red-tailed, Ferruginous, and Rough-legged Hawks in the Bridger Mountains, MT: 1992–2007. Dashed lines indicate significant ( $P \leq 0.10$ ) regressions. ....	15
Figure 6.	Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Golden and Bald Eagles in the Bridger Mountains, MT: 1992–2007. Dashed lines indicate significant ( $P \leq 0.10$ ) regressions.....	16
Figure 7.	Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons in the Bridger Mountains, MT: 1992–2007. Dashed lines indicate significant ( $P \leq 0.10$ ) regressions.....	17
Figure 8.	Passage volume by five-day periods for migrating Golden and Bald Eagles in the Bridger Mountains, MT: 1992–2006 versus 2007. ....	18

## INTRODUCTION

The Bridger Mountains Raptor Migration Project in southwestern Montana is an ongoing effort to monitor long-term population trends of raptors using this northern portion of the Rocky Mountain Flyway (Omland and Hoffman 1996, Hoffman and Smith 2003, Smith et al. 2008a). HawkWatch International (HWI) initiated full-season counts at the site in 1991, with standardized annual monitoring commencing in 1992. This flyway is noted for large concentrations of Golden Eagles (see Appendix A for scientific names of all raptor species observed at the site). To date, 18 species of raptors have been observed migrating along the Bridger Mountains, with annual counts typically ranging between 2,000 and 3,500 migrants. This report summarizes results of the 2007 count, which marked the 17<sup>th</sup> consecutive full-season autumn count of migratory raptors at the site.

The Bridger Mountains project was 1 of 14 long-term, annual migration counts conducted or co-sponsored by HWI in North America during 2007. The primary objective of these efforts is to track long-term population trends of diurnal raptors in western North America and around the Gulf Coast region (Hoffman et al. 2002, Hoffman and Smith 2003, Smith et al. 2008a, b). Raptors serve as important biological indicators of ecosystem health (Bildstein 2001) and long-term migration counts are one of the most cost effective and efficient methods for monitoring the regional status and trends of multiple raptor species (Zalles and Bildstein 2000, Bildstein et al. 2008).

## STUDY SITE

The Bridger Mountains are a relatively small range that runs primarily along a north–south axis. From Sacagawea Peak (2,950 m elevation), the range extends southward for 40 km before meeting the Gallatin Valley 5 km northeast of Bozeman, Montana. Consistent westerly winds collide with the Bridger range and create the lift that attracts southbound migrating raptors each fall. The observation site is a helicopter-landing platform atop the Bridger Bowl Ski Area at an elevation of 2,610 m (45° 49.022' N, 110° 55.778' W; Figure 1). The site lies within the Gallatin National Forest on the east slope of the mountain range, about 25 km north of Bozeman and 3 km north of Saddle Peak. The helicopter pad is a 5 m x 5 m wooden platform located approximately 50 m north of an avalanche cache/ski patrol hut. The site is accessed by following a primitive dirt road for 2.5 km (780 m rise in elevation) to the top of the Bridger chairlift, then continuing a short way along a footpath to the observation site at the top of the ridge.

## METHODS

Weather permitting, two official or designated observers conducted standardized daily counts of migrating raptors from a single, traditional observation site from late August through late October. Observations typically began between 0830–1000 H and ended between 1600–1700 H Mountain Standard Time (MST). This was the first full season of migration counting for both official observers, Jody Vogeler and Brenden McGugin (see Appendix B for a complete observer history). Both received preseason training in Utah and additional on-site training with HWI staff and trained local volunteers. Local volunteers also occasionally assisted with the count at other times. 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 H MST.
3. Wind speed and direction, air temperature, percent cloud cover, predominant cloud type(s), presence or of precipitation, visibility, and an assessment of thermal-lift conditions, recorded for each hour of observation on the half hour.
4. Predominant direction, altitude, and distance from the lookout of the flight during each hour.
5. Total minutes observed and the mean number of observers present during each hour (included designated observers plus volunteers/visitors who actively contributed to the count [active scanning, pointing out birds, recording data, etc.] for more than 10 minutes in a given hour), recorded on the hour.
6. A subjective visitor-disturbance rating (high, moderate, low, none) for each hour, recorded on the hour.
7. Daily start and end times for each official observer.

Calculation of “adjusted” (to standardize sampling periods and adjust for incompletely identified birds) passage rates (migrants counted per 100 hours of observation) and analysis of trends updated through 2007 follows Hoffman and Smith (2003). In comparing 2007 annual statistics against means and 95% confidence intervals for previous seasons, we equate significance with a 2007 value falling outside the bounds of the confidence interval for the associated mean.

## **RESULTS AND DISCUSSION**

### **WEATHER SUMMARY**

Compared to the past 10 seasons (the period for which detailed weather records have been compiled and analyzed), inclement weather and attendant difficult access conditions hampered observations at an average level in 2007, fully precluding 11 days of observation (1997–2006 average of 11.8 days) and reducing observations to  $\leq 4$  hours on six other days (average 5.4 days; see Appendix C for daily weather records). Based on weather data collected on-site during active observation periods, predominantly fair skies prevailed on 24% of the active days, transitional skies (i.e., cloud cover changed from clear or partly cloudy to mostly cloudy or overcast during the day, or vice versa) on 34%, and mostly cloudy or overcast skies on 29%. The 1997–2006 averages for the site are 38% fair, 26% transitional, and 36% mostly cloudy to overcast, indicating that 2007 was somewhat less cloudy than usual. The proportion of active days that included rain and/or snow showers also was well below average (7% vs. average of 15%), whereas the proportion that included some visibility reducing fog and/or haze was only slightly below average (27% vs. average of 31%). Despite the apparent reduction in cloudiness and fog/haze, the observers’ estimates suggested that visibility was below average in 2007 (69–73 km vs. averages of 76–81 km); however, this relatively limited difference may simply reflect the influence of a slight observer bias.

Data collected in 2007 during active observations indicated wind-speed conditions that were more similar to those seen in the late 1990s as opposed to most of the past six seasons; i.e., a relatively high prevalence of moderate as opposed to light winds. Light winds ( $< 12$  kph) prevailed on 71% of the active observation days, moderate winds (12–29 kph) on 29%, and strong winds on 0%, compared to 1997–2006 averages of 80%, 18%, and 2%, respectively. In terms of wind directions, SW–W, W, W–NW, and NE–SE winds average most common at this site, in that order of prevalence. This was only partly true in 2007. Steady W winds, relatively variable NE–SE winds, and days where the wind conditions completely shifted at some point during the day from the E–S quadrant to the SW–NW quadrant, or vice

versa, were much more common than usual (W: 58% vs. average of 24%; NE–SE: 15% vs. average of 7%; E–S, SW–NW: 9% vs. average of 3%). In contrast, SW–W and W–NW winds were substantially less common than usual (SW–W: 13% vs. average of 30%; W–NW: 0% vs. average of 13%). The only previous season since 1997 when steady W winds were similarly common (i.e., at least twice as common as any other season) was 2005, when W winds prevailed on 65% of the active days.

The temperature during active observation periods averaged 11.6°C (the average of daily values, which in turn were averages of hourly readings), ranging from -0.8–27.8°C. The daily average nearly matched the long-term average of 11.9°C, and all other temperature metrics fell well within the normal ranges of variability for the site. The on-site barometric pressure during active observation periods averaged 30.65 in Hg (the average of daily values, which in turn were averages of hourly readings), ranging from 30.16–31.14 in Hg. All of these values are among the highest recorded since 2000 when we began recording barometric pressure data at the site. The observers subjectively rated 42% of the active days as featuring predominantly good to excellent thermal lift conditions, which nearly matches the 1997–2006 average of 40%.

In summary, inclement weather and difficult access conditions hampered observations at an average level in 2007; however, active observation periods were less cloudy and included fewer rain and snow showers and, to a lesser degree, visibility reducing fog/haze than usual. The winds during active observation periods also averaged stronger than usual and relatively steady west winds were much more common than usual. Otherwise, the temperature regime and observers' subjective assessments of thermal-lift conditions during the season ranked as average.

## **OBSERVATION EFFORT**

Observations occurred on 56 of 66 days between 27 August and 31 October in 2007, with heavy snowfall shutting down the count two days earlier than the standard ending date of 31 October. The number of observation days was a significant 11% higher than the 1992–2006 average of  $51 \pm 95\%$  CI of 4.1 days, and the number of observation hours (384.59) was a significant 16% higher than the long-term average of  $332.60 \pm 29.56$  hours. The 2007 average of 1.8 observers per hour (including official and guest observers; value is mean of daily values, which are in turn means of hourly values) matched the long-term average of  $1.8 \pm 95\%$  CI of 0.11 observers per hour.

## **FLIGHT SUMMARY**

The observers tallied 2,117 migrating raptors of 17 species during the 2007 season (Table 1; see Appendix D for daily count records). The total count was a significant 15% below average, but was higher than most years since counts peaked over 3,000 for four years in the late 1990s (see Appendix E for annual summaries). In particular, the count of 1,247 Golden Eagles stands in marked contrast to the record-low count of 859 in 2006, and reverses what had been a strong four-year decline for this species (Appendix E). No record low or high species-specific counts or unusual sightings occurred in 2007.

The flight was composed of 63% eagles, 23% accipiters, 8% buteos, 4% falcons, 1% harriers, and <1% each of Ospreys, vultures, and unidentified raptors (Figure 2). The proportion of buteos was significantly above average, primarily reflecting a 21% higher than average count of Red-tailed Hawks. The most numerous species were the Golden Eagle (59% of the total count), Sharp-shinned Hawk (13%), Cooper's Hawk (7%), Red-tailed Hawk (6%), Bald Eagle (4%), American Kestrel (2%), and Northern Harrier (1%). All other species each comprised <1% the total.

## **Passage Rates and Long-term Trends**

In 2007, adjusted passage rates were significantly above average only for the uncommon Ferruginous Hawk, whereas passage rates were significantly below average for all three accipiters, Broad-winged

Hawks, Rough-legged Hawks, Golden Eagles, and American Kestrels (Table 1, Figures 3–7). Regression analyses updated through 2007 (after Hoffman and Smith 2003) revealed a highly significant ( $P \leq 0.01$ ) linear decreasing trend for Golden Eagles (Figure 6), reflecting a marginally significant ( $P \leq 0.10$ ) declining trend for adults and a highly significant declining trend for immatures/subadults. A marginally significant linear declining trend was also indicated for American Kestrels (Figure 7). A significant ( $P \leq 0.05$ ) second order, or quadratic, trend was indicated for Swainson's Hawks, tracking a sharp initial drop between 1992 and 1993, then a relatively stable pattern of modest counts through 2000, generally lower counts for the next six years, and then a slight rebound in 2007 back to the levels seen from 1993–2000 (Figure 5). Of course, tracking trends for this species must be considered very cautiously due to the very low average counts (Table 1, Appendix E). A marginally significant, concave, quadratic trend was also indicated for Prairie Falcons, tracking a gradual declining pattern to a record low in 2002, then a sharp increase for the next three years to a new record high in 2005; however, passage rates of this species declined again after that, with the 2007 rate dropping back down to near average levels (Figure 7). No other significant trends were indicated.

Smith et al. (2008a) present trend analyses of data collected through 2005 for most of the long-term, ongoing, autumn migration studies in western North America, including the Bridger Mountains. These analyses (hereafter called the Raptor Population Index or "RPI" analyses; see <http://www.rpi-project.org>) are based on a more sophisticated analytical approach (also see Farmer et al. 2007) than that represented in Hoffman and Smith (2003) and used herein to present analyses updated through 2007. Among other refinements, this new approach both fits polynomial trajectories to the complete series of annual count indices and allows for estimating rates of change between various periods, while also allowing for assessments of trend significance and precision. Note, however, that restrictions related to the mathematical assumptions behind the new approach precluded analyzing data for rare species, which in this case included Turkey Vultures, Ospreys, all buteos except Red-tailed and Rough-legged Hawks, and all falcons except American Kestrels. Otherwise, with a few notable exceptions, the overall patterns of change and derived trend estimates suggested by the new modeling technique generally yielded similar inferences as those derived using the simpler methodology of Hoffman and Smith (2003) and presented herein to provide trend assessments updated through 2007.

Differences between the RPI results and those presented herein that clearly relate to addition of two more years of data include: a) two more years of near record-low passage rates for Golden Eagles rendered a highly significant linear declining trend through 2007 (Figure 6), whereas the RPI analysis indicated only a marginally a significant overall decline and a second-order model fit that tracked a recent upswing from 2003 to 2005; and b) two more years of low passage rates for American Kestrels rendered a marginally significant overall decline (Figure 7), whereas the RPI analyses indicated no significant overall trend but a near significant ( $P = 0.013$ ) second-order model fit that tracked an increasing pattern through 1998 but a decline thereafter. The only other noteworthy difference in results is that the RPI analysis indicated a marginally significant decline for Cooper's Hawks, whereas the Hoffman and Smith update through 2007 did not, despite two years of declining rates in 2006 and 2007.

At the 2007 joint meeting of the Raptor Research Foundation and Hawk Migration Association of North America in Allentown, Pennsylvania, a special symposium on American Kestrels was convened to draw attention to evidence of widespread declines of this otherwise common and ubiquitous species. The proceedings of this symposium is expected to be published in the *Journal of Raptor Research* later this year, and will include another manuscript that specifically summarizes migration trend data for the species from across the continent, including the Bridger Mountains (Farmer and Smith in review).

### **Age Ratios**

Immature : adult ratios were below average in 2007 for all nine species for which relevant age-specific data were available, significantly so for all three accipiters, Red-tailed Hawks, and Bald Eagles (Table 2).



Moreover, for all species except Broad-winged Hawks, the counts of identified immature/subadult birds were below average, suggesting that the low age ratios may be indicative of low productivity in 2007. However, for most species, the counts of identified adults were above average, such that the low age ratios also may be at least partly indicative of good adult survival and recruitment since 2006.

### **Seasonal Timing**

The 2007 median passage date for Golden Eagles of 12 October was only 1 day later than average; however, the overall combined-species median passage date of 10 October was a significant 3 days later than average (Table 2). The combined-species seasonal activity pattern confirmed an unusually high, late activity spike during the second week of October, corresponding to the peak activity period for Golden Eagles; however, another significantly above-average activity spike occurred earlier than usual in late September, corresponding to the peak activity period for the two smaller accipiters, and periods of significantly below average activity occurred in mid-September, early October, and during the third week of October (Figure 8). The spike in accipiter activity in late September followed shortly after the first major snow event of the season; the major lull in activity during the first week of October corresponded to three days of missed observations due to heavy snowfall; and the primary peak in Golden Eagle activity followed shortly thereafter. Otherwise, at the species level, four species showed significantly early median passage dates in 2007 (Osprey, Sharp-shinned Hawk, Rough-legged Hawk, and Bald Eagle) and seven species showed significantly late timing (Northern Harrier, Cooper's Hawk, Red-tailed Hawk, Ferruginous Hawk, and the three larger falcon species; Table 2).

Age- and sex-specific data revealed additional details (Table 3). Curiously, although the species-level assessment for Sharp-shinned hawks indicated significantly early passage, the age-specific indicators for both adults and immatures indicated significantly late timing. The only explanation for this discrepancy is uneven attention to ageing through the season, with a bias in favor of successful ageing late in the season. This bias is consistent with new observers experiencing a fairly steep learning curve, whereby ageing takes a second seat to identifying species early on. Given that immature birds tend to pass through first in the fall (Table 3), this potential bias also may have contributed to indications of generally low immature : adult ratios (Table 2). In somewhat the opposite vein, however, the species-level indicator for Red-tailed Hawks suggested significantly late timing, and this indication was mimicked for adults, but the age-specific indicator for immature birds suggested significantly early timing.

### **RESIDENT RAPTORS**

Eight species were recorded as displaying resident behavior in 2007: Golden and Bald Eagles, Red-Tailed, Sharp-shinned and Cooper's Hawks, American Kestrels, Merlins, and Prairie Falcons.

As usual, resident Golden Eagles were observed throughout the season. During the first half of the season, they were seen on almost a daily basis, but less frequently during October. One family group of at least four individuals (two adults, one immature, and one subadult) frequented the area from north of Tilly to south of the observation point, usually west of the ridge. They were often observed on the slopes of Tilly, either hunting or displaying to possible migrants. All were at one time seen escorting migrants, although this behavior as well as displaying was usually observed only in the adults. Golden Eagles were also recorded displaying over Ross Peak, but the observers were unsure whether these individuals were part of the Tilly family.

A family group of Red-tailed Hawks, including at least one adult and two immatures, were seen frequently during the first month of observations, with the last sighting of an apparently local bird recorded on 28 September. Members of this family were usually seen hunting on the Tilly ridge or farther down slope, and occasionally escorting migrants through the area.

At least one family group of Sharp-shinned Hawks, including a pair of adults and at least one juvenile, frequented the area. Resident activity was recorded from 27 August through 28 October, but less frequently later in the season. These birds were observed on both sides of the ridge around the observation area and farther north, occasionally hunting on the west slope of Tilly, and were the most likely of all species to attack our owl decoy. In addition, an adult was often seen perched just below camp in the mornings and evenings on the east side of the ridge.

A pair of American Kestrels was seen frequently in the area, most often during hikes up the mountain on a dead snag in the Bridger Bowl area. During observations, they were seen all the way over onto the west slope of Tilly. The pair was first observed on 27 August and last seen on 7 September. They were occasionally seen escorting various migrants through the area, including other kestrels, Ospreys, and Golden Eagles, and in late August showed territoriality against a resident Sharp-shinned Hawk. The kestrels were the second most frequent resident to attack our owl decoy.

Other species occasionally seen displaying non-migratory behavior included Cooper's Hawks, Merlins, Prairie Falcons, and Bald Eagles. On three occasions between 4 and 26 September, a Cooper's Hawk was observed moving up from the south or east, diving at the owl decoy, and either continuing north or perching on the slope of Tilly. A Prairie Falcon was observed on 6 September flying north and then back to west of the observation point. Several possible transient-resident Merlins were seen on 7 September playing south of the cache cabin on the east side of the ridge.

This is a fairly typical resident assemblage for the site.

## **VISITATION**

The fall migration site along the Bridger Range is a popular destination for Bozeman locals, as well as for raptor enthusiasts from the surrounding area. Visitors for the tenth annual Bridger Raptor Festival were primarily from the Bozeman area, but some folks visited from surrounding states. The festival was very well attended again this year, with HWI's Executive Director, Caroline Goldman, Membership and PR Coordinator, Emily Turner, and Research Assistant, Adam Hutchins, in attendance. Although the rigors of the hike kept many people from actually hiking up to the watchsite, many did make the hike on the primary field-trip day and were treated to a solid flight of birds. Otherwise, though, unfortunately this year's observers were not properly instructed concerning this one facet of our operations and so did not keep visitor logs for the season, so we cannot report an accurate assessment of visitor numbers in 2007.

In 2007, 397 hourly assessments by the primary observers of visitor disturbance resulted in the following ratings: 94% none, 5% low, 1% moderate, and <1% high, which indicates a slightly below average level of visitor disturbance for this site.

## **ACKNOWLEDGMENTS**

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**Table 1. Annual fall-migration counts and adjusted passage rates (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) by species in the Bridger Mountains, MT: 1992–2005 versus 2007.**

SPECIES	COUNTS			RAPTORS/100HRS		
	1992–2006 <sup>1</sup>	2007	%CHANGE	1992–2006 <sup>1</sup>	2007	%CHANGE
Turkey Vulture	0.8 ± 0.8	1	+25	0.5 ± 0.4	1	+19
Osprey	6 ± 2.2	5	-17	2.9 ± 1.0	2	-24
Northern Harrier	50 ± 26.8	30	-40	15.7 ± 8.7	9	-46
Sharp-shinned Hawk	342 ± 58.6	277	-19	131.5 ± 20.4	94	-29
Cooper’s Hawk	170 ± 38.6	151	-11	127.1 ± 26.6	91	-28
Northern Goshawk	35 ± 11.4	20	-43	12.6 ± 4.6	7	-48
Unknown small accipiter <sup>2</sup>	29 ± 26.5	18	-38	–	–	–
Unknown large accipiter <sup>2</sup>	4 ± 2.7	6	+71	–	–	–
Unknown accipiter	27 ± 9.0	5	-82	–	–	–
TOTAL ACCIPITERS	588 ± 96.2	477	-19	–	–	–
Broad-winged Hawk	10 ± 4.8	5	-48	4.7 ± 2.4	1	-73
Swainson’s Hawk	2 ± 1.5	3	+36	1.1 ± 0.9	1	-9
Red-tailed Hawk	107 ± 26.7	130	+21	38.6 ± 8.8	40	+3
Ferruginous Hawk	2 ± 1.0	5	+108	0.9 ± 0.3	2	+72
Rough-legged Hawk	35 ± 10.6	19	-45	26.2 ± 7.5	13	-49
Unidentified buteo	12 ± 3.6	11	-11	–	–	–
TOTAL BUTEOS	168 ± 36.9	173	+3	–	–	–
Golden Eagle	1,444 ± 151.1	1,247	-14	572.1 ± 48.9	450	-21
Bald Eagle	82 ± 12.3	85	+3	33.6 ± 5.0	34	0
Unidentified eagle	7 ± 4.0	0	-100	–	–	–
TOTAL EAGLES	1,534 ± 156.2	1,332	-13	–	–	–
American Kestrel	73 ± 21.2	41	-44	64.5 ± 18.0	30	-54
Merlin	10 ± 3.1	9	-8	7.4 ± 2.1	6	-20
Prairie Falcon	14 ± 2.3	17	+24	9.5 ± 2.1	10	+5
Peregrine Falcon	9 ± 2.6	8	-10	7.3 ± 2.1	6	-21
Gyr Falcon	0.1 ± 0.2	0	-100	–	–	–
Unknown small falcon <sup>2</sup>	5 ± 8.7	2	-60	–	–	–
Unknown large falcon <sup>2</sup>	4 ± 3.8	3	-14	–	–	–
Unknown falcon	5 ± 2.3	2	-63	–	–	–
TOTAL FALCONS	115 ± 25.3	82	-28	–	–	–
Unidentified raptor	28 ± 7.2	17	-40	–	–	–
GRAND TOTAL	2,489 ± 271.0	2,117	-15	–	–	–

<sup>1</sup> Mean ± 95% confidence interval.

<sup>2</sup> Designations used for the first time in 2001.

**Table 2. Fall counts by age class and immature : adult ratios for selected species of migrating raptors in the Bridger Mountains, MT: 1992–2006 versus 2007.**

	TOTAL AND AGE-CLASSIFIED COUNTS						IMMATURE : ADULT			
	1992–2006 AVERAGE			2007			% UNKNOWN AGE		RATIO	
	TOTAL	IMM.	ADULT	TOTAL	IMM.	ADULT	1992–2006 <sup>1</sup>	2007	1992–2006 <sup>1</sup>	2007
Northern Harrier	50	24	11	30	8	17	30 ± 6.2	17	3.72 ± 3.88	0.47
Sharp-shinned Hawk	342	64	133	277	24	69	43 ± 6.9	66	0.51 ± 0.12	0.35
Cooper’s Hawk	170	46	58	151	18	69	39 ± 6.2	42	0.88 ± 0.28	0.26
Northern Goshawk	35	13	14	20	5	8	24 ± 10.6	35	1.63 ± 0.59	0.63
Broad-winged Hawk	10	2	3	5	2	3	43 ± 20.3	0	1.04 ± 0.93	0.67
Red-tailed Hawk	107	34	49	130	23	76	23 ± 4.8	24	0.71 ± 0.37	0.30
Golden Eagle	1444	550	522	1247	493	526	26 ± 4.8	18	1.11 ± 0.19	0.94
Bald Eagle	82	29	51	85	23	61	3 ± 16.6	1	0.62 ± 0.14	0.38
Peregrine Falcon	9	0.5	4	8	0	7	51 ± 16.6	13	0.21 ± 0.30	0.00

<sup>1</sup> Mean ± 95% confidence interval. For age ratios, note that the long-term mean immature : adult ratio is an average of annual ratios and may differ from the value obtained by dividing long-term 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 observation, bulk passage, and median passage dates by species for migrating raptors in the Bridger Mountains, MT in 2007, with a comparison of 2007 and 1992–2006 average median passage dates.**

SPECIES	2007				1992–2006
	FIRST OBSERVED	LAST OBSERVED	BULK PASSAGE DATES <sup>1</sup>	MEDIAN PASSAGE DATE <sup>2</sup>	MEDIAN PASSAGE DATE <sup>3</sup>
Turkey Vulture	15-Sep	15-Sep	–	–	19-Sep <sup>4</sup>
Osprey	3-Sep	27-Sep	3-Sep – 27-Sep	9-Sep	16-Sep ± 3.0
Northern Harrier	30-Aug	24-Oct	8-Sep – 11-Oct	30-Sep	22-Sep ± 4.6
Sharp-shinned Hawk	27-Aug	28-Oct	11-Sep – 12-Oct	27-Sep	01-Oct ± 1.8
Cooper’s Hawk	28-Aug	29-Oct	25-Sep – 16-Oct	9-Oct	23-Sep ± 2.8
Northern Goshawk	9-Sep	27-Oct	15-Sep – 18-Oct	12-Oct	09-Oct ± 5.4
Broad-winged Hawk	30-Aug	30-Sep	30-Aug – 30-Sep	19-Sep	20-Sep ± 2.2
Swainson’s Hawk	1-Sep	17-Sep	–	–	14-Sep ± 7.8
Red-tailed Hawk	28-Aug	29-Oct	3-Sep – 12-Oct	26-Sep	21-Sep ± 2.5
Ferruginous Hawk	8-Oct	24-Oct	8-Oct – 24-Oct	18-Oct	29-Sep ± 15.7
Rough-legged Hawk	8-Oct	27-Oct	8-Oct – 27-Oct	14-Oct	21-Oct ± 1.5
Golden Eagle	27-Aug	29-Oct	25-Sep – 25-Oct	12-Oct	11-Oct ± 2.2
Bald Eagle	13-Sep	28-Oct	25-Sep – 24-Oct	12-Oct	15-Oct ± 2.8
American Kestrel	27-Aug	10-Oct	4-Sep – 28-Sep	21-Sep	22-Sep ± 2.3
Merlin	9-Sep	25-Oct	9-Sep – 25-Oct	12-Oct	03-Oct ± 3.1
Prairie Falcon	28-Aug	24-Oct	2-Sep – 18-Oct	1-Oct	23-Sep ± 4.6
Peregrine Falcon	26-Sep	27-Oct	26-Sep – 27-Oct	30-Sep	25-Sep ± 2.7
All species	6-Sep	29-Oct	15-Sep – 24-Oct	10-Oct	07-Oct ± 1.7

<sup>1</sup> Dates between which the central 80% of the flight passed; values are given only for species with annual counts ≥5 birds.

<sup>2</sup> Date by which 50% of the flight had passed; values are given only for species with annual counts ≥5 birds.

<sup>3</sup> Mean of annual values ± 95% confidence interval in days; calculated only for species with annual counts ≥5 birds for ≥3 years.

<sup>4</sup> Data for 1997 only.

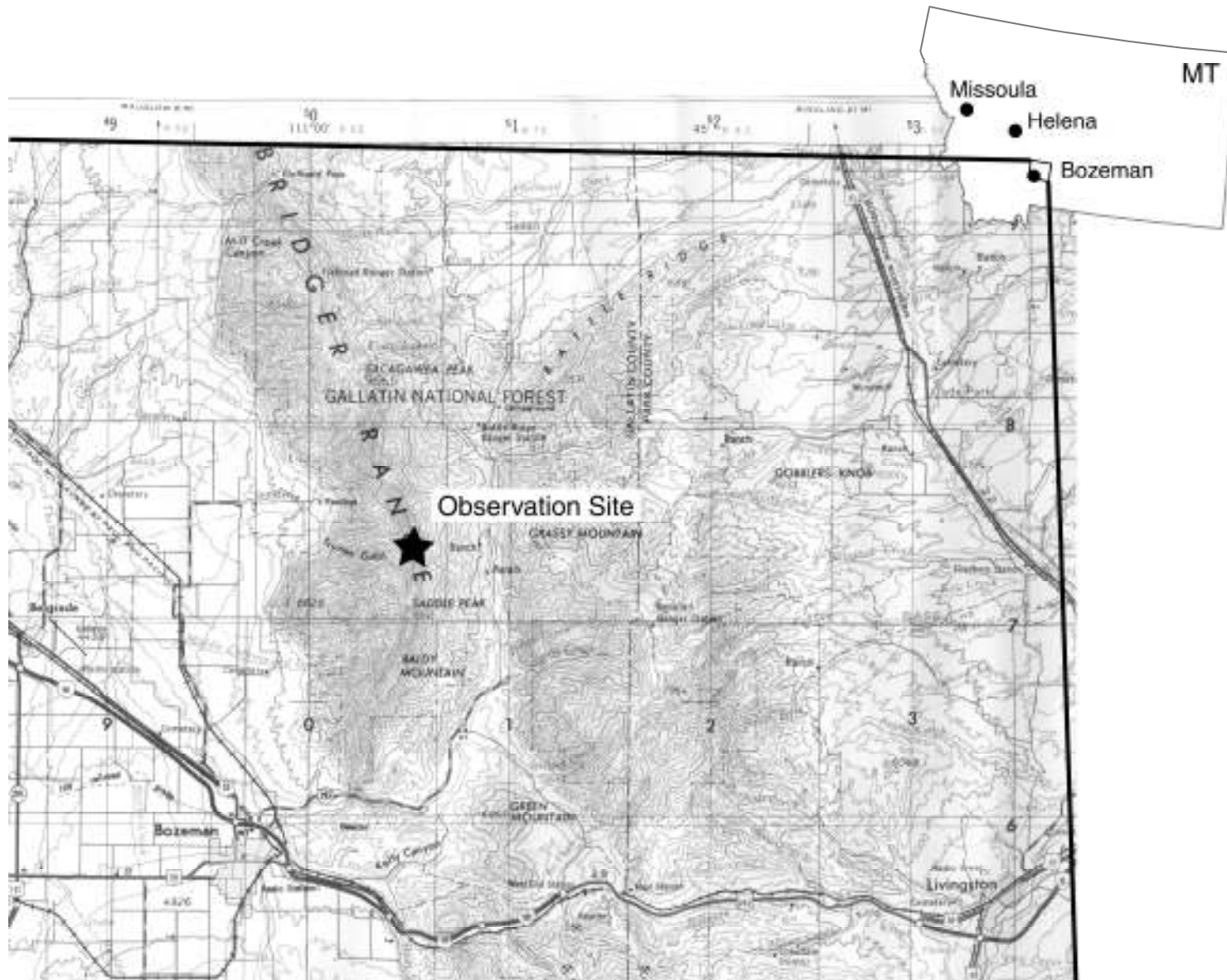
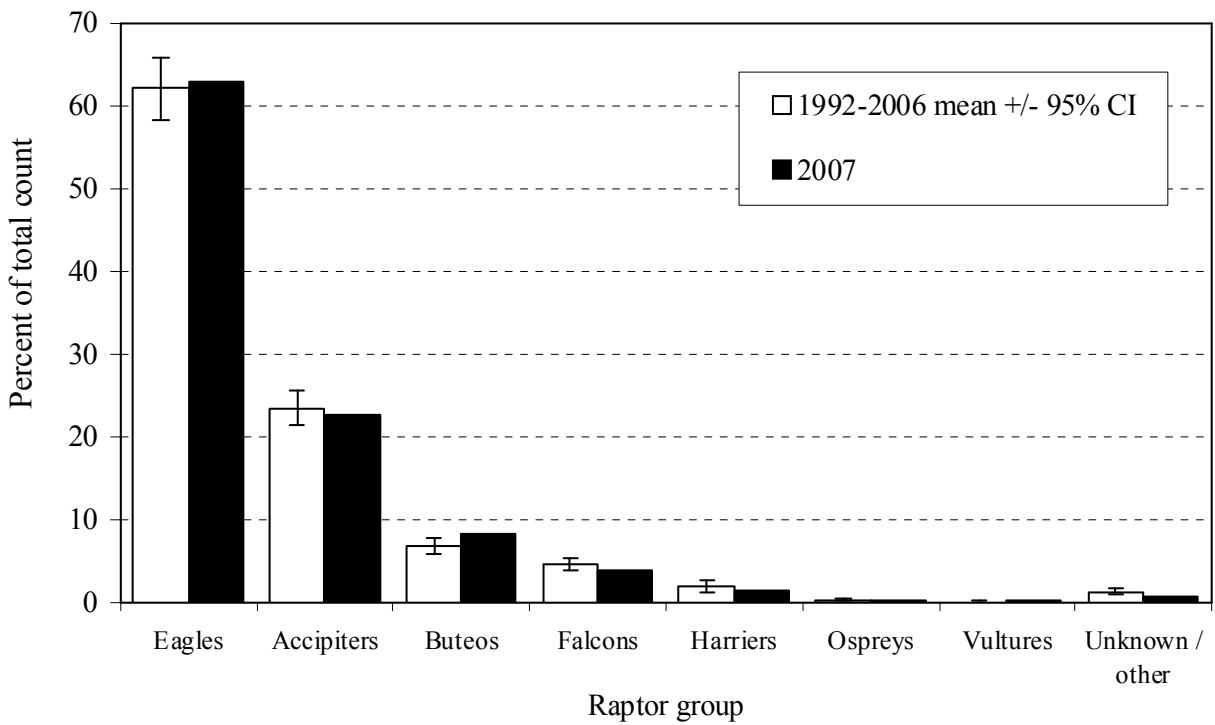
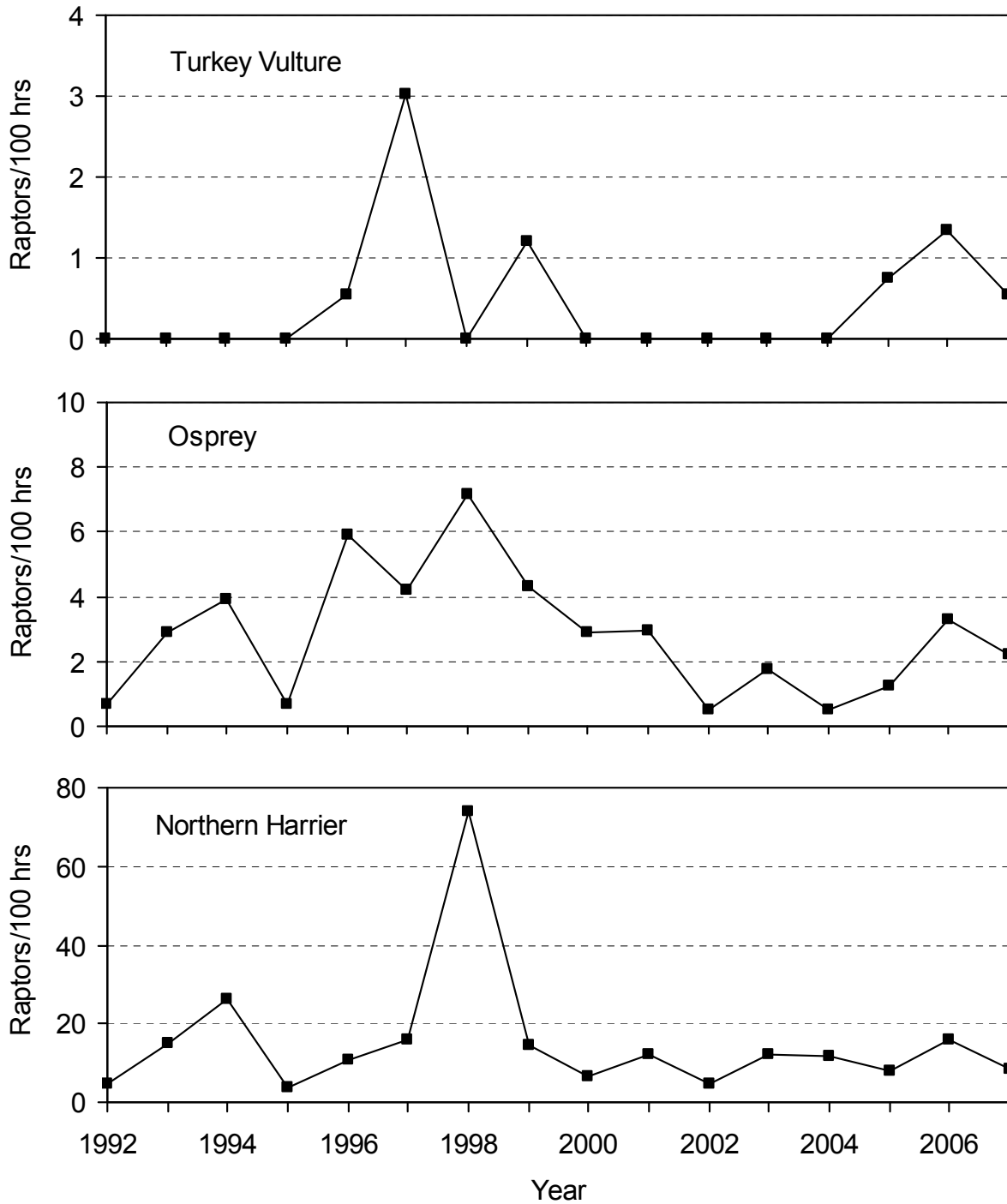


Figure 1. Location of the Bridger Mountains Raptor Migration Project study site.

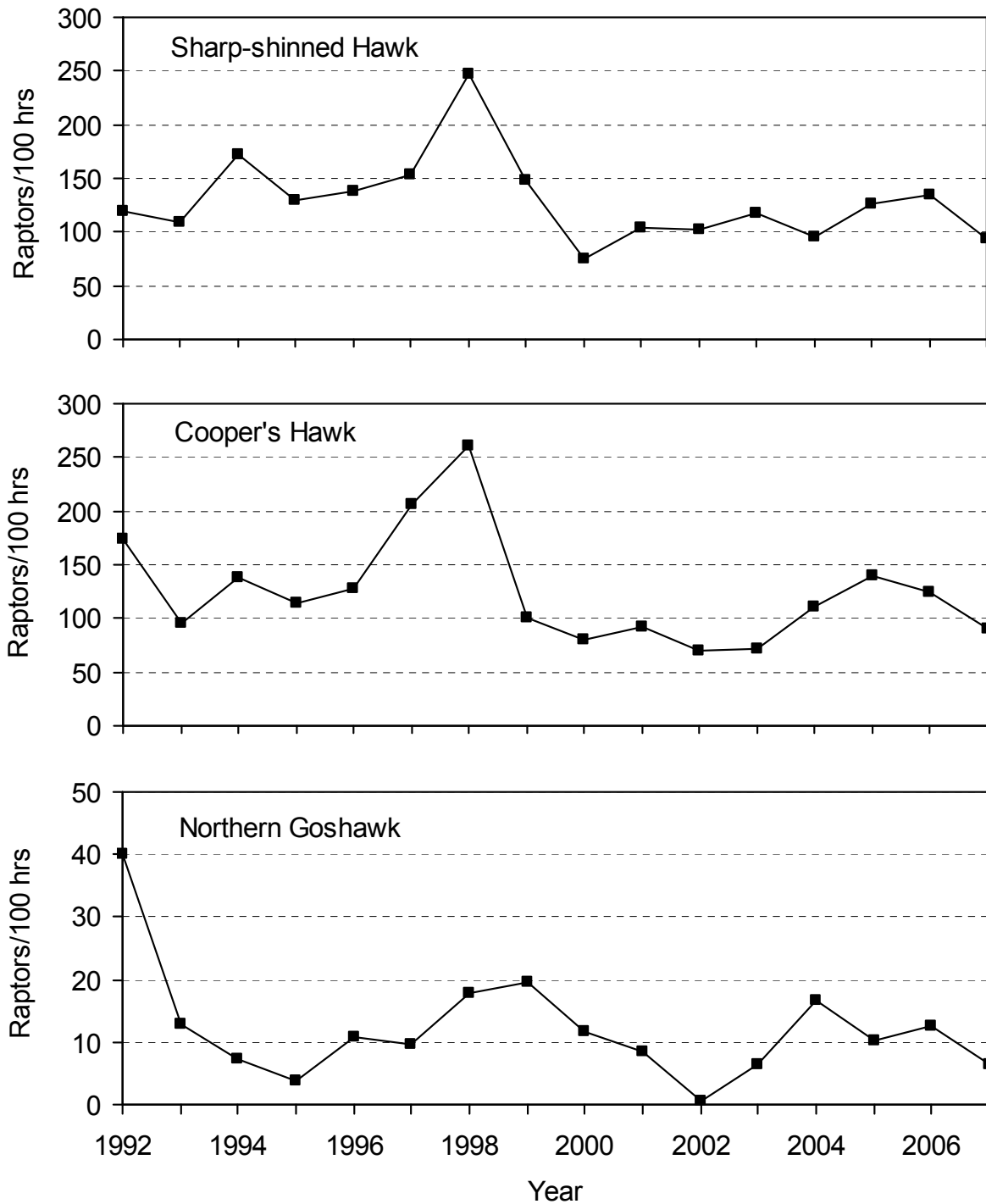


**Figure 2. Composition of the fall raptor migration in the Bridger Mountains by major species groups: 1992–2006 versus 2007.**





**Figure 3. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Turkey Vultures, Ospreys, and Northern Harriers in the Bridger Mountains, MT: 1992–2007. Dashed lines indicate significant ( $P \leq 0.10$ ) regressions.**



**Figure 4. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks in the Bridger Mountains, MT: 1992–2007. Dashed lines indicate significant ( $P \leq 0.10$ ) regressions.**

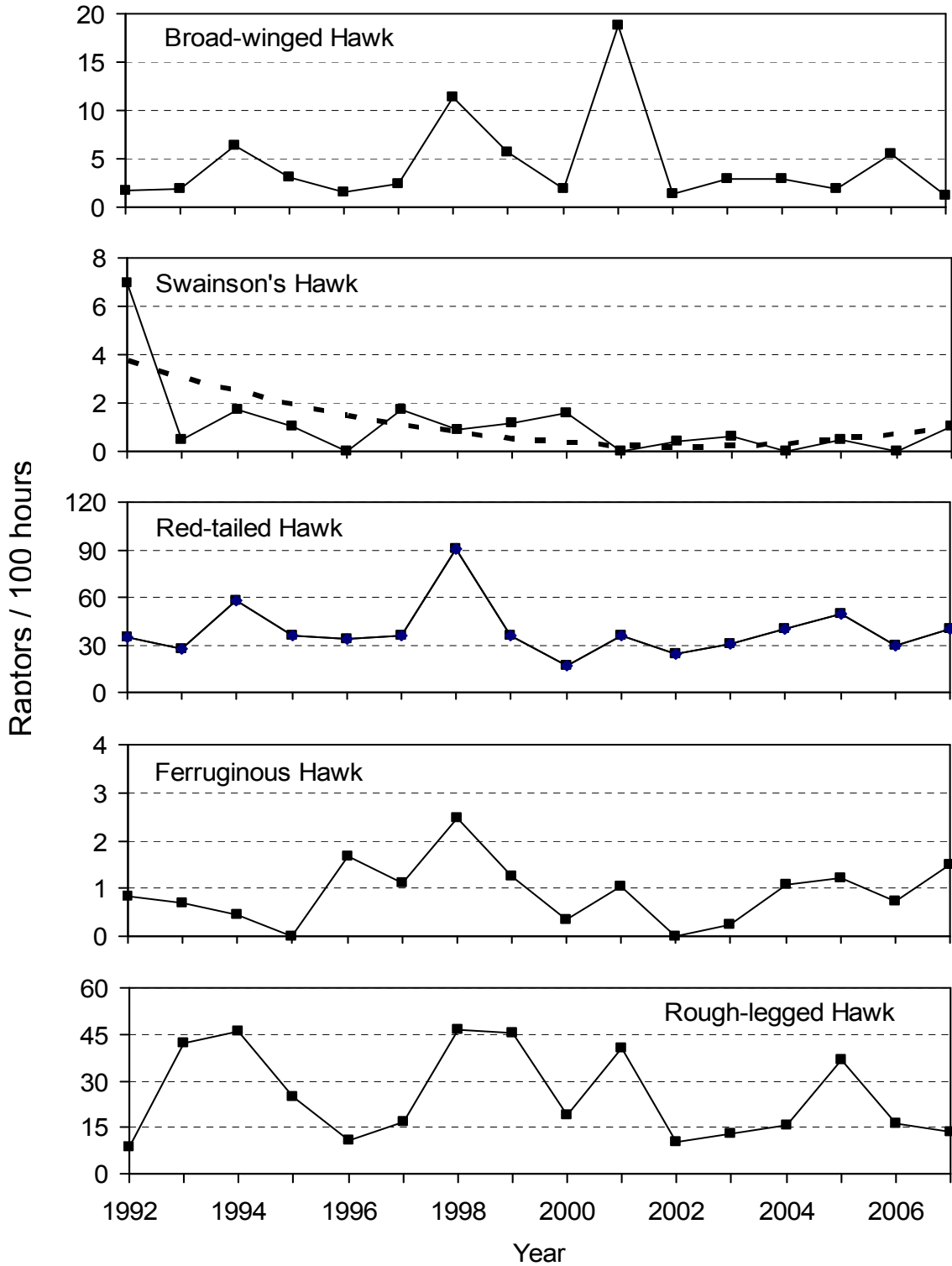
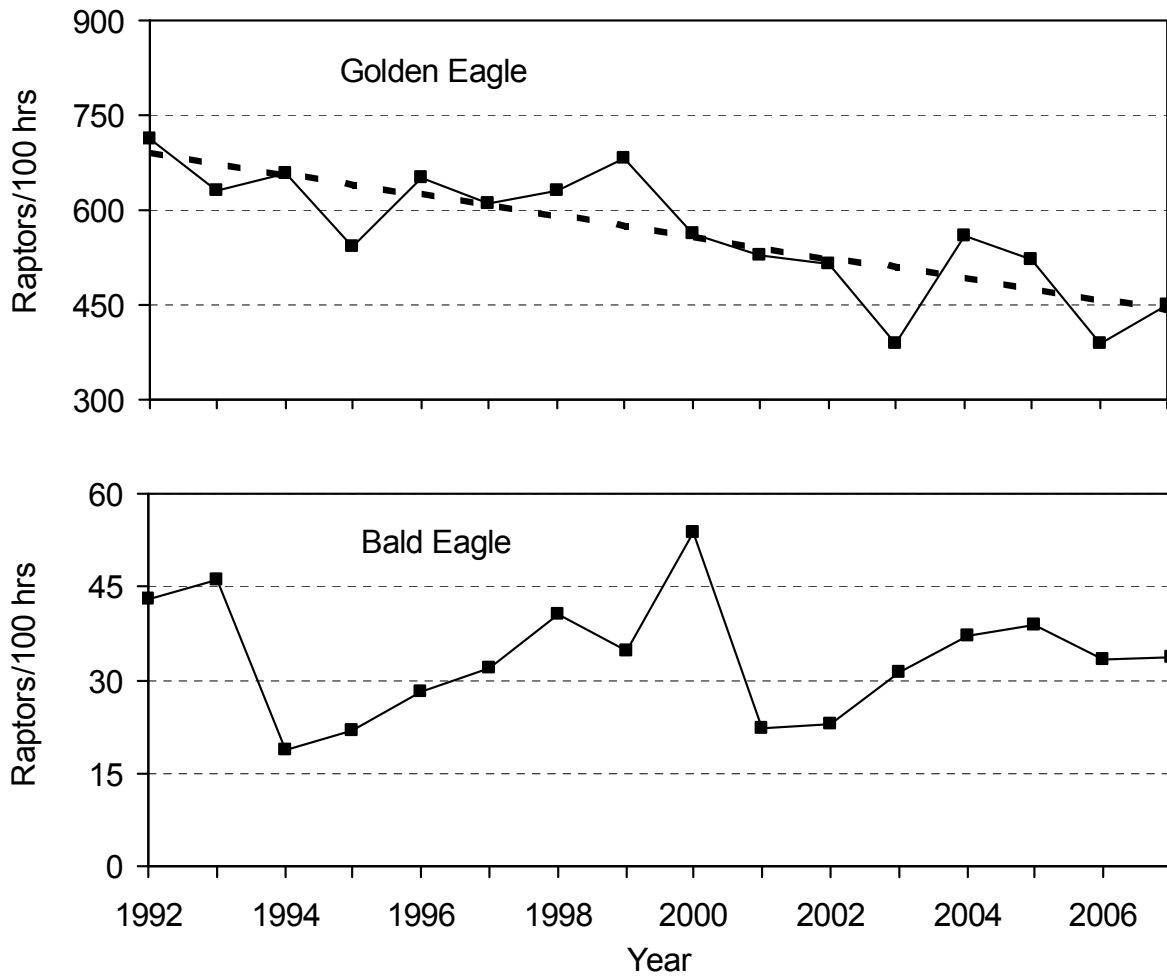


Figure 5. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Broad-winged, Swainson's, Red-tailed, Ferruginous, and Rough-legged Hawks in the Bridger Mountains, MT: 1992–2007. Dashed lines indicate significant ( $P \leq 0.10$ ) regressions.



**Figure 6. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Golden and Bald Eagles in the Bridger Mountains, MT: 1992–2007. Dashed lines indicate significant ( $P \leq 0.10$ ) regressions.**

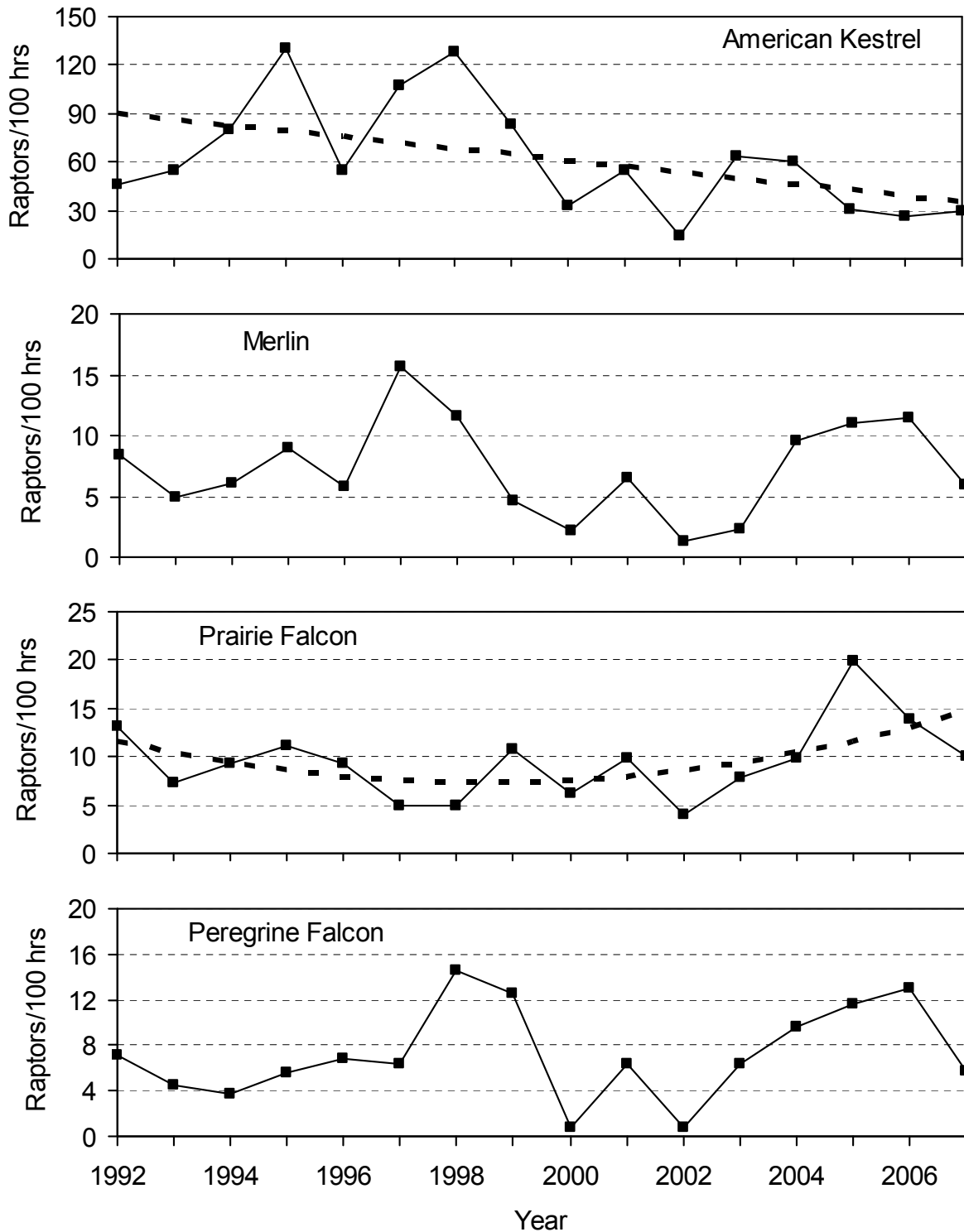
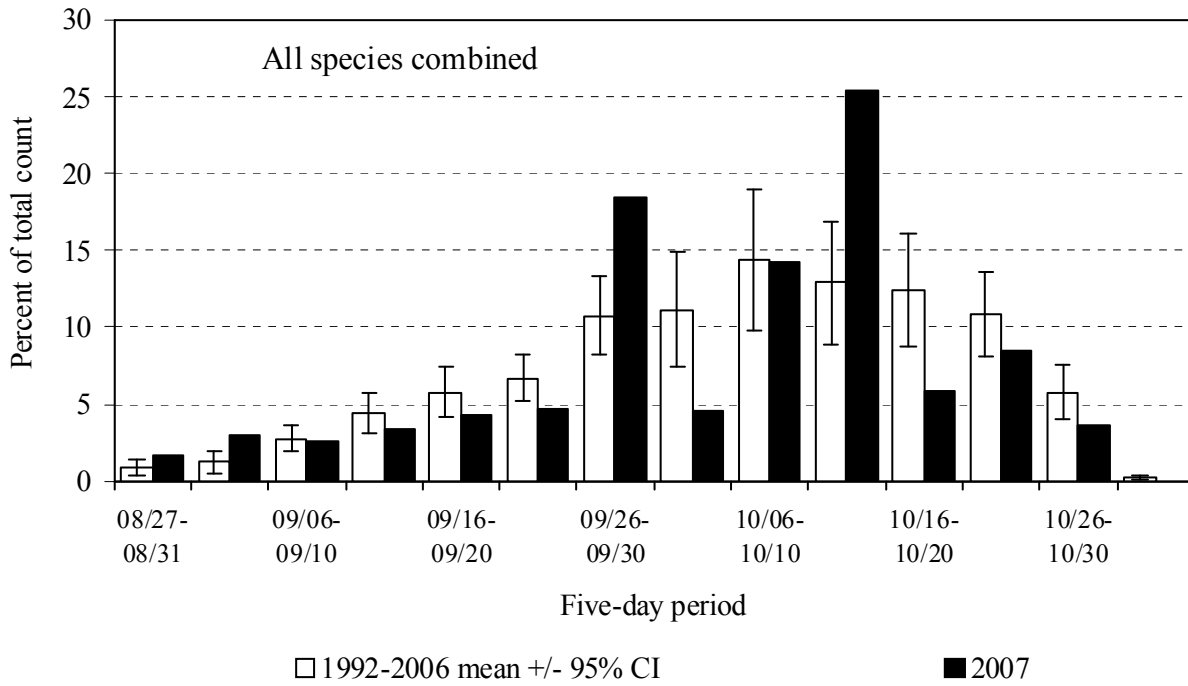


Figure 7. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons in the Bridger Mountains, MT: 1992–2007. Dashed lines indicate significant ( $P \leq 0.10$ ) regressions.



**Figure 8. Passage volume by five-day periods for migrating Golden and Bald Eagles in the Bridger Mountains, MT: 1992–2006 versus 2007.**

**Appendix A. Common and scientific names, species codes, and regularly applied age, sex, and color-morph classifications for all diurnal raptor species observed during fall migration in the Bridger Mountains, MT.**

COMMON NAME	SCIENTIFIC NAME	SPECIES CODE	AGE <sup>1</sup>	SEX <sup>2</sup>	COLOR MORPH <sup>3</sup>
Turkey Vulture	<i>Cathartes aura</i>	TV	U	U	NA
Osprey	<i>Pandion haliaetus</i>	OS	U	U	NA
Northern Harrier	<i>Circus cyaneus</i>	NH	A I Br U	M F U	NA
Sharp-shinned Hawk	<i>Accipiter striatus</i>	SS	A I U	U	NA
Cooper's Hawk	<i>Accipiter cooperii</i>	CH	A I U	U	NA
Northern Goshawk	<i>Accipiter gentilis</i>	NG	A I U	U	NA
Unknown small accipiter	<i>A. striatus</i> or <i>cooperii</i>	SA	U	U	NA
Unknown large accipiter	<i>A. cooperii</i> or <i>gentilis</i>	LA	U	U	NA
Unknown accipiter	<i>Accipiter</i> spp.	UA	U	U	NA
Broad-winged Hawk	<i>Buteo platypterus</i>	BW	A I U	U	D L U
Swanson's Hawk	<i>Buteo swainsoni</i>	SW	U	U	D L U
Red-tailed Hawk	<i>Buteo jamaicensis</i>	RT	A I U	U	D L U
Ferruginous Hawk	<i>Buteo regalis</i>	FH	A I U	U	D L U
Rough-legged Hawk	<i>Buteo lagopus</i>	RL	U	U	D L U
Unknown buteo	<i>Buteo</i> spp.	UB	U	U	D L U
Golden Eagle	<i>Aquila chrysaetos</i>	GE	I, S, NA, A, U <sup>4</sup>	U	NA
Bald Eagle	<i>Haliaeetus leucocephalus</i>	BE	I, S1, S2, NA, A, U <sup>5</sup>	U	NA
Unknown eagle	<i>Aquila</i> or <i>Haliaeetus</i> spp.	UE	U	U	NA
American Kestrel	<i>Falco sparverius</i>	AK	U	M F U	NA
Merlin	<i>Falco columbarius</i>	ML	AM Br	AM U	NA
Prairie Falcon	<i>Falco mexicanus</i>	PR	U	U	NA
Peregrine Falcon	<i>Falco peregrinus</i>	PG	A I U	U	NA
Gyrfalcon	<i>Falco rusticolus</i>	GY	A I U	U	W G D
Unknown small falcon	<i>F. sparverius</i> or <i>columbarius</i>	SF	U	U	NA
Unknown large falcon	<i>F. mexicanus</i> or <i>peregrinus</i>	LF	U	U	NA
Unknown falcon	<i>Falco</i> spp.	UF	U	U	NA
Unknown raptor	Falconiformes	UU	U	U	NA

<sup>1</sup> Age codes: A = adult, I = immature (HY), Br = brown (adult female or immature), U = unknown age.

<sup>2</sup> Sex codes: M = male, F = female, U = unknown.

<sup>3</sup> Color morph codes: D = dark or rufous, G = gray; L = light, W = white; U – unknown, NA = not applicable.

<sup>4</sup> 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.

<sup>5</sup> 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. A history of primary observers for the Bridger Mountains Raptor Migration Project.**

- 1991:** Variable teams throughout: Kristian Shawn Omland (0), Phil West (1), LisaBeth Daly (2), Craig Limpach (1)
- 1992:** Two observers throughout: Emily Teachout (1), Phil West (2)
- 1993:** Two observers throughout: Adam Kaufman (0), Anne-Marie Gillesberg (0)
- 1994:** Two observers throughout: Chris Gill (0), Stephanie Schmidt (1)
- 1995:** Two observers throughout: Scott Harris (0), Sue Thomas (0)
- 1996:** Two observers throughout: Jason Beason (0), Niels Maumenee (0)
- 1997:** Two observers throughout: Jason Beason (1), Patty Scifres (0)
- 1998:** Two observers throughout: Jason Beason (2), Mike Neal (0)
- 1999:** Two observers throughout: Mike Neal (2), Greg Levandoski (1)
- 2000:** Two observers throughout: Ryan Wagner (1), Tracy Elsey (0)
- 2001:** Two observers throughout: Ryan Wagner (2), Jeff Maurer (4)
- 2002:** Two observers throughout: Matt Proett (0), Marg Lomow (2; half season), Maureen Essen (0; half season)
- 2003:** Two observers throughout: Samantha Burrell (0), Carl Bullock (0)
- 2004:** Two observers throughout: Allison Peterson (0), John Bell (0)
- 2005:** Two observers throughout: Corey Michell (0), Beau Fairchild (0)
- 2006:** Two observers throughout: Brian Cook (0), Jamie Granger (0)
- 2007:** Two observers throughout: Jody Vogeler (0), Brenden McGugin (0)

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Note: Numbers in parentheses indicate number of full-seasons of previous raptor migration monitoring experience.



**Appendix C. Daily observation effort, visitor disturbance ratings, weather records, and flight summaries for the Bridger Mountains Raptor Migration Project: 2007.**

DATE	OBS. HOURS	OBSRVR / HOUR <sup>1</sup>	MEDIAN	PREDOMINANT WEATHER <sup>3</sup>	WIND	WIND DIRECTION	TEMP (°C) <sup>1</sup>	BAROM.	MEDIAN	VISIB.	VISIB.	MEDIAN	BIRDS / HOUR
			VISITOR DISTURB <sup>2</sup>		SPEED (KPH) <sup>1</sup>			PRESS. (IN HG) <sup>1</sup>	THERMAL LIFT <sup>4</sup>	WEST (KM) <sup>1</sup>	EAST (KM) <sup>1</sup>	FLIGHT DISTANCE <sup>5</sup>	
27-Aug	1.67	3.0	0	clr-pc, haze	2.7	w	23.3	30.57	3	90	60	1	2.4
28-Aug	4.17	2.3	0	clr-pc, haze	3.3	w	20.4	30.76	3	60	30	1	1.4
29-Aug	7.50	1.8	0	clr, haze	6.2	w	21.2	30.86	3	56	43	1	0.8
30-Aug	7.67	1.0	0	clr-mc, haze	2.7	w	27.8	30.94	3	76	51	2	1.3
31-Aug	7.00	1.0	0	mc-ovc	8.7	sse, w	20.1	30.77	3	60	70	3	1.4
1-Sep	8.00	2.0	0	pc	7.3	w	21.7	30.89	2	90	80	2	2.0
2-Sep	8.00	2.0	0	clr	5.9	sw, w	23.8	30.90	2	90	80	1	2.9
3-Sep	8.00	2.0	0	clr, haze	5.9	sw, w	23.5	30.90	3	45	38	2	0.9
4-Sep	5.25	2.0	0	mc-ovc	11.0	w	21.1	30.65	4	90	58	1	1.3
5-Sep	7.00	1.0	0	ovc, AM fog	14.4	e	15.1	30.63	4	37	22	1	1.3
6-Sep	6.00	2.0	0	ovc, AM fog	8.1	w	13.4	30.68	3	63	48	2	0.3
7-Sep	8.00	1.5	0	clr, haze	8.7	w	15.6	30.66	1	69	69	2	2.8
8-Sep	7.50	2.0	0	ovc, AM fog/snow	8.0	e, se	9.1	30.86	3	53	49	1	1.1
9-Sep	7.50	2.0	0	ovc, scat AM fog	5.9	var	6.3	30.85	4	32	59	1	0.7
10-Sep	8.25	2.1	0	clr-pc	10.3	w	11.2	31.00	2	90	90	2	2.1
11-Sep	3.50	2.0	0	clr, haze	6.6	w	14.6	30.87	2	31	36	1	2.6
12-Sep	8.50	1.0	0	clr, haze	10.7	w	17.9	30.67	2	4	4	1	0.8
13-Sep	8.00	2.0	0	clr, AM fog	3.9	e	13.7	30.80	3	62	42	1	2.4
14-Sep	8.00	1.0	0	clr-pc	13.8	e	15.6	30.76	4	50	52	1	1.0
15-Sep	8.00	2.0	0	clr	5.0	sw, w	16.8	30.77	2	79	57	2	3.5
16-Sep	7.50	2.6	0	clr-ovc, scat PM rain	6.0	w	16.0	30.57	3	62	44	2	3.7
17-Sep	8.00	2.0	0	clr-mc, haze	10.4	w	11.9	30.52	2	29	29	1	2.4
18-Sep	8.25	1.9	0	pc-ovc	5.0	se, w	8.9	30.59	3	84	90	1	2.2
19-Sep	5.00	1.0	0	ovc, PM rain	12.3	e	8.4	30.57	3	50	2	1	1.0
20-Sep	8.00	2.0	0	pc-ovc	13.8	w	10.9	30.41	3	90	87	3	2.5
21-Sep	8.00	1.0	0	clr	14.2	wsw, w	6.9	30.62	3	90	90	2	4.1
22-Sep	6.33	2.1	0	ovc, scat PM rain	14.3	sw, w	10.6	30.49	3	79	73	2	0.9
23-Sep	0.00			weather day: rain/snow									
24-Sep	0.00			weather day: snow									
25-Sep	8.00	2.0	0	clr-pc	13.9	w	5.1	30.66	1	94	94	2	7.5
26-Sep	8.75	2.3	0	pc-mc	15.5	w	6.9	30.67	2	100	95	2	9.4
27-Sep	8.00	2.0	0	clr-mc	5.2	w	12.8	30.69	2	90	90	2	15.8
28-Sep	8.25	2.2	0	mc-ovc	5.9	w	14.0	30.30	2	99	81	2	9.0
29-Sep	0.00			weather day: snow									
30-Sep	8.25	2.5	0	pc-mc	5.4	w	5.3	30.64	2	100	98	1	13.0
1-Oct	6.00	2.0	0	ovc	13.6	w	6.5	30.44	2	85	61	3	10.0
2-Oct	6.25	2.0	0	mc-ovc	12.3	w	3.1	30.55	3	53	83	2	2.2
3-Oct	0.00			weather day: snow									
4-Oct	7.00	2.0	0	ovc	10.6	ne, se	3.1	30.30	4	13	67	1	3.3
5-Oct	0.00			weather day: snow									
6-Oct	0.00			weather day: snow									
7-Oct	3.00	2.0	0	ovc	21.3	w	0.8	30.51	4	29	23	1	0.3
8-Oct	8.00	1.0	0	clr-pc	6.3	w	8.3	30.64	2	100	100	2	11.0
9-Oct	8.00	1.8	0	clr	18.3	e, se	10.9	30.83	3	100	100	1	2.5
10-Oct	8.00	1.0	0	pc-ovc	8.7	e, s	14.3	30.49	2	90	84	1	23.9
11-Oct	7.50	1.9	0	pc-ovc	7.4	calm, w	6.9	30.61	2	88	82	2	9.6
12-Oct	8.00	1.0	0	pc-ovc	2.2	calm/var	11.5	30.42	3	100	100	1	11.8
13-Oct	8.00	1.9	1	ovc	4.5	e, w	7.4	30.54	3	88	77	1	11.5

Appendix C. continued

DATE	OBS. HOURS	OBSRVR / HOUR <sup>1</sup>	MEDIAN VISITOR DISTURB <sup>2</sup>	PREDOMINANT WEATHER <sup>3</sup>	WIND SPEED (KPH) <sup>1</sup>	WIND DIRECTION	TEMP (°C) <sup>1</sup>	BAROM. PRESS. (IN HG) <sup>1</sup>	MEDIAN THERMAL LIFT <sup>4</sup>	VISIB. WEST (KM) <sup>1</sup>	VISIB. EAST (KM) <sup>1</sup>	MEDIAN FLIGHT DISTANCE <sup>5</sup>	BIRDS / HOUR
14-Oct	8.00	1.6	1	clr-pc	2.3	w	10.6	30.65	2	100	100	1	17.0
15-Oct	8.00	1.0	0	clr	3.4	e, w	12.3	30.48	3	100	100	2	18.0
16-Oct	7.00	2.0	0	mc-ovc	6.0	w	13.1	30.19	3	90	79	1	11.1
17-Oct	0.00			weather day: snow									
18-Oct	8.00	2.0	0	mc-ovc	7.5	sw, w	0.2	30.29	3	96	84	2	5.8
19-Oct	2.75	1.0	0	ovc	10.7	w	3.2	30.16	-	9	86	-	0.0
20-Oct	0.00			weather day: snow									
21-Oct	3.00	2.0	0	mc-ovc	16.0	w	-0.8	30.78	3	77	77	1	1.0
22-Oct	1.00	2.0	0	ovc	16.7	w	1.0	30.89	4	57	62	-	0.0
23-Oct	8.00	1.0	0	clr-mc	16.5	w	9.4	31.14	3	97	100	1	0.5
24-Oct	8.00	1.0	0	clr	9.7	w	13.4	30.86	1	100	100	2	11.0
25-Oct	8.00	2.0	0	pc-ovc	8.2	e, w	9.7	30.67	2	99	85	2	10.5
26-Oct	0.00			weather day: snow									
27-Oct	7.00	2.0	0	clr	8.4	w	6.8	30.89	3	100	100	2	1.1
28-Oct	8.00	2.0	0	mc-ovc, haze	11.5	sw, w	9.5	30.93	2	90	69	2	6.0
29-Oct	8.00	2.0	0	pc-ovc	9.1	w	9.2	30.23	3	90	90	1	2.8
30-Oct	0.00			weather day: snow									
31-Oct	0.00			weather day: snow									

<sup>1</sup> Average of hourly records.

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

<sup>3</sup> 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 = thunderstorms.

<sup>4</sup> 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.

<sup>5</sup> 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. Daily observation effort and fall raptor migration counts by species in the Bridger Mountains, MT: 2007.

DATE	HOURS	SPECIES <sup>1</sup>																				BIRDS							
		TV	OS	NH	SS	CH	NG	SA	LA	UA	BW	SW	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	GY	SF	LF	UF	UU	TOTAL
27-Aug	1.67	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	4	2.4
28-Aug	4.17	0	0	0	1	1	0	0	0	0	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	6	1.4
29-Aug	7.50	0	0	0	2	1	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	6	0.8
30-Aug	7.67	0	0	1	3	0	0	1	0	0	1	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	1	10	1.3
31-Aug	7.00	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	10	1.4
01-Sep	8.00	0	0	0	1	2	0	1	1	0	1	1	3	0	0	0	5	0	0	1	0	0	0	0	0	0	0	16	2.0
02-Sep	8.00	0	0	0	0	1	0	0	0	1	0	0	3	0	0	2	12	0	0	1	0	1	0	0	0	0	2	23	2.9
03-Sep	8.00	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	4	0	0	0	0	0	0	0	0	0	0	7	0.9
04-Sep	5.25	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	4	0	0	1	0	0	0	0	0	0	0	7	1.3
05-Sep	7.00	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	6	0	0	0	0	1	0	0	0	0	0	9	1.3
06-Sep	6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0.3
07-Sep	8.00	0	1	1	5	0	0	0	0	0	0	1	3	0	0	0	7	0	0	3	0	0	0	0	0	0	1	22	2.8
08-Sep	7.50	0	0	1	2	2	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	8	1.1
09-Sep	7.50	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	5	0.7
10-Sep	8.25	0	0	0	8	0	0	0	0	0	0	0	2	0	0	1	5	0	0	0	1	0	0	0	0	0	0	17	2.1
11-Sep	3.50	0	0	1	5	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	9	2.6
12-Sep	8.50	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	0	1	0	0	0	0	0	7	0.8
13-Sep	8.00	0	0	1	5	1	0	0	0	0	0	0	6	0	0	0	4	1	0	1	0	0	0	0	0	0	0	19	2.4
14-Sep	8.00	0	0	1	4	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	8	1.0
15-Sep	8.00	1	0	1	13	0	1	0	0	0	0	0	3	0	0	0	5	1	0	2	0	0	0	0	0	1	0	28	3.5
16-Sep	7.50	0	0	0	5	3	0	1	0	0	0	0	2	0	0	2	10	1	0	2	0	1	0	0	1	0	0	28	3.7
17-Sep	8.00	0	0	0	5	0	0	0	0	0	0	1	1	0	0	0	9	1	0	2	0	0	0	0	0	0	0	19	2.4
18-Sep	8.25	0	1	0	1	1	0	0	0	0	0	0	2	0	0	1	10	0	0	2	0	0	0	0	0	0	0	18	2.2
19-Sep	5.00	0	0	2	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	1.0
20-Sep	8.00	0	0	0	17	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	20	2.5
21-Sep	8.00	0	0	0	10	0	0	0	0	0	0	0	10	0	0	0	10	0	0	3	0	0	0	0	0	0	0	33	4.1
22-Sep	6.33	0	0	0	3	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	6	0.9
23-Sep	0.00																												
24-Sep	0.00																												
25-Sep	8.00	0	0	0	7	4	0	2	1	0	0	0	5	0	0	1	31	5	0	1	0	1	0	0	1	0	0	60	7.5
26-Sep	8.75	0	0	0	12	6	0	0	0	0	0	0	15	0	0	1	40	3	0	4	0	0	1	0	0	0	0	82	9.4
27-Sep	8.00	0	1	3	55	13	0	4	2	0	1	0	11	0	0	0	23	0	0	9	1	0	2	0	0	1	0	126	15.8
28-Sep	8.25	0	0	2	17	8	1	2	0	0	0	0	7	0	0	0	32	2	0	1	0	1	0	0	0	1	0	74	9.0
29-Sep	0.00																												
30-Sep	8.25	0	0	2	9	19	0	0	0	0	1	0	12	0	0	0	60	2	0	0	0	1	1	0	0	0	0	107	13.0

H	SPECIES <sup>1</sup>																				BIRDS					
	SS	CH	NG	SA	LA	UA	BW	SW	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	GY	SF	LF	UF	UU	TOTAL	/HOUR
0	10	6	0	0	0	0	0	0	4	0	0	0	38	1	0	0	0	1	0	0	0	0	0	0	60	10.0
0	2	1	0	0	0	0	0	0	2	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	14	2.2
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	1	1	0	0	0	0	0	0	2	0	0	1	15	3	0	0	0	0	0	0	0	0	0	0	23	3.3
0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0.3
0	8	4	3	0	0	0	0	0	1	1	3	0	63	4	0	0	0	1	0	0	0	0	0	0	88	11.0
3	2	3	0	0	0	0	0	0	0	1	1	0	6	3	0	0	0	1	0	0	0	0	0	0	20	2.5
4	15	22	0	0	0	2	0	0	3	0	0	0	130	8	0	4	0	2	0	0	0	0	0	1	191	23.9
4	9	7	2	1	0	0	0	0	2	0	3	0	43	0	0	0	1	0	0	0	0	0	0	0	72	9.6
0	8	9	3	0	1	0	0	0	6	0	2	0	54	10	0	0	1	0	0	0	0	0	0	0	94	11.8
1	1	2	0	0	0	0	0	0	1	0	0	1	81	4	0	0	0	0	0	0	0	0	0	1	92	11.5
0	3	8	2	0	0	0	0	0	2	0	4	0	106	8	0	0	1	1	1	0	0	0	0	0	136	17.0
0	6	9	2	0	1	0	0	0	1	0	0	0	116	7	0	0	1	1	0	0	0	0	0	0	144	18.0
1	7	4	1	1	0	0	0	0	1	0	0	0	55	6	0	0	0	0	1	0	0	1	0	0	78	11.1
0	0	0	1	0	0	1	0	0	2	2	1	0	35	3	0	0	0	1	0	0	0	0	0	0	46	5.8
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	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3	1.0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	4	0.5
1	5	4	0	2	0	0	0	0	1	1	2	0	64	6	0	0	0	1	0	0	0	0	1	0	88	11.0
0	3	3	1	2	0	0	0	0	2	0	1	0	66	3	0	0	2	0	1	0	0	0	0	0	84	10.5
0	0	1	1	0	0	0	0	0	1	0	2	0	2	0	0	0	0	0	1	0	0	0	0	0	8	1.1
0	2	2	0	0	0	0	0	0	0	0	0	0	41	3	0	0	0	0	0	0	0	0	0	0	48	6.0
0	0	2	0	0	0	0	0	0	1	0	0	0	19	0	0	0	0	0	0	0	0	0	0	0	22	2.8
0	277	151	20	18	6	5	5	3	130	5	19	11	1,247	85	0	41	9	17	8	0	2	3	2	17	2,117	5.5

Interpretation of species codes.

**Appendix E. Annual observation effort and fall raptor migration counts by species in the Bridger Mountains, MT: 1991–2007.**

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Start date	15-Sep	6-Sep	9-Sep	13-Sep	10-Sep	1-Sep	27-Aug	27-Aug	27-Aug	27-Aug
End date	3-Nov	28-Oct	31-Oct	30-Oct	2-Nov	30-Oct	31-Oct	31-Oct	31-Oct	31-Oct
Observation days	32	39	46	36	42	53	62	56	57	52
Observation hours	191.1	242.58	298.50	239.25	269.17	378.25	422.92	339.33	358.24	335.40
Raptors / 100 hours	926.7	1000.1	872.0	1025.3	824.0	808.5	796.1	1040.9	871.8	630.9
SPECIES	RAPTOR COUNTS									
Turkey Vulture	3	0	0	0	0	1	6	0	2	0
Osprey	2	2	5	5	1	14	12	13	9	6
Northern Harrier	19	13	41	59	10	38	66	230	52	20
Sharp-shinned Hawk	88	248	279	364	304	436	480	612	442	190
Cooper's Hawk	87	175	124	134	131	206	347	343	149	109
Northern Goshawk	27	96	39	17	10	37	36	50	61	34
Unknown small accipiter <sup>1</sup>	–	–	–	–	–	–	–	–	–	–
Unknown large accipiter <sup>1</sup>	–	–	–	–	–	–	–	–	–	–
Unknown accipiter	70	35	27	20	33	51	53	49	39	35
TOTAL ACCIPITERS	272	554	469	535	478	730	916	1054	691	368
Broad-winged Hawk	0	2	3	11	5	5	5	20	13	3
Swainson's Hawk	1	11	0	3	2	0	6	2	3	3
Red-tailed Hawk	26	67	65	110	79	106	130	277	121	45
Ferruginous Hawk	3	1	1	1	0	5	4	7	4	1
Rough-legged Hawk	9	10	54	48	29	17	23	66	77	26
Unidentified buteo	14	8	19	15	18	13	20	13	3	8
TOTAL BUTEOS	53	99	142	188	133	146	188	385	221	86
Golden Eagle	1280	1579	1699	1500	1322	1871	1844	1516	1870	1429
Bald Eagle	43	95	124	41	57	79	93	95	91	128
Unidentified eagle	5	2	17	0	25	14	0	15	5	3
TOTAL EAGLES	1328	1676	1840	1541	1404	1964	1937	1626	1966	1560
American Kestrel	33	38	54	67	117	82	146	141	113	39
Merlin	2	10	7	7	12	9	26	17	8	3
Prairie Falcon	9	14	10	10	14	16	10	12	20	9
Peregrine Falcon	1	7	6	4	7	10	10	18	18	1
Gyr Falcon	0	0	0	0	0	0	0	0	1	0
Unknown small falcon <sup>1</sup>	–	–	–	–	–	–	–	–	–	–
Unknown large falcon <sup>1</sup>	–	–	–	–	–	–	–	–	–	–
Unknown falcon	5	3	2	4	2	5	17	8	6	4
TOTAL FALCONS	50	72	79	92	152	122	209	196	166	56
Unidentified raptor	44	10	27	33	40	43	33	28	16	20
GRAND TOTAL	1771	2426	2603	2453	2218	3058	3367	3532	3123	2116

<sup>1</sup> Designations used for the first time in 2002.

Appendix E. continued

	2001	2002	2003	2004	2005	2006	2007	MEAN
Start date	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-AUG	31-AUG
End date	31-Oct	31-Oct	31-Oct	27-Oct	31-Oct	29-Oct	29-OCT	29-OCT
Observation days	58	52	64	48	48	45	56	50
Observation hours	347.49	365.84	443.18	316.70	300.83	331.25	384.59	327.33
Raptors / 100 hours	636.3	556.0	517.6	655.2	674.8	538.6	550.5	760.4
SPECIES	RAPTOR COUNTS							
Turkey Vulture	0	0	0	0	1	2	1	1
Osprey	6	2	5	1	2	7	5	6
Northern Harrier	36	15	54	39	22	50	30	47
Sharp-shinned Hawk	274	288	416	229	228	344	277	323
Cooper's Hawk	120	103	132	142	153	182	151	164
Northern Goshawk	26	2	23	41	22	33	20	34
Unknown small accipiter <sup>1</sup>	–	11	29	32	92	10	18	27
Unknown large accipiter <sup>1</sup>	–	4	4	9	4	0	6	4
Unknown accipiter	27	5	0	7	27	0	5	28
TOTAL ACCIPITERS	447	413	604	460	526	569	477	563
Broad-winged Hawk	38	3	9	6	3	12	5	9
Swainson's Hawk	0	1	2	0	0	0	3	2
Red-tailed Hawk	117	78	113	100	108	89	130	104
Ferruginous Hawk	3	0	1	3	2	3	5	3
Rough-legged Hawk	57	11	22	20	40	21	19	32
Unidentified buteo	6	9	6	18	27	2	11	12
TOTAL BUTEOS	221	102	153	147	180	127	173	162
Golden Eagle	1330	1359	1226	1196	1061	859	1247	1423
Bald Eagle	58	55	93	79	75	74	85	80
Unidentified eagle	2	15	4	2	1	1	0	7
TOTAL EAGLES	1390	1429	1323	1277	1137	934	1332	1510
American Kestrel	62	16	102	65	20	38	41	69
Merlin	9	2	4	11	7	15	9	9
Prairie Falcon	14	6	15	12	20	22	17	14
Peregrine Falcon	8	1	10	10	8	15	8	8
Gyr Falcon	0	0	0	0	0	1	0	0
Unknown small falcon <sup>1</sup>	–	0	0	3	27	0	2	5
Unknown large falcon <sup>1</sup>	–	1	3	3	13	1	3	3
Unknown falcon	3	4	1	9	13	0	2	5
TOTAL FALCONS	96	30	135	113	108	92	82	109
Unidentified raptor	15	43	20	38	54	3	17	28
GRAND TOTAL	2211	2034	2294	2075	2030	1784	2117	2425

<sup>1</sup> Designations used for the first time in 2002.