

**FALL 2009 RAPTOR MIGRATION STUDY IN THE
BRIDGER MOUNTAINS, MONTANA**



**Montana Audubon, Helena, Montana
&
HawkWatch International, Salt Lake City, Utah**

December 2009

**FALL 2009 RAPTOR MIGRATION STUDY
IN THE BRIDGER MOUNTAINS, MONTANA**

Report prepared by:

Caitlin Kroeger and Jeff P. Smith

Counts conducted by:

Caitlin Kroeger and Jason Minné

Project coordinated by:

Montana Audubon Society

Project Coordinator: Steve Hoffman

Montana Audubon State Office, P.O. Box 595, Helena, MT 59624

(406) 443-3949

&

HawkWatch International, Inc.

Principal Investigator: Dr. Jeff P. Smith

2240 South 900 East, Salt Lake City, Utah 84106

(801) 484-6808

December 2009

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.....	6
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: 2009.....	21
Appendix D. Daily observation effort and fall raptor migration counts by species in the Bridger Mountains, MT: 2009.....	23
Appendix E. Annual observation effort and fall raptor migration counts by species in the Bridger Mountains, MT: 1991–2009.....	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: 1992–2008 versus 2009.....	8
Table 2.	Fall counts by age class and immature : adult ratios for selected species of migrating raptors in the Bridger Mountains, MT: 1992–2008 versus 2009.....	9
Table 3.	First and last observation, bulk passage, and median passage dates by species for migrating raptors in the Bridger Mountains, MT in 2009, with a comparison of 2009 and 1992–2008 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: 1992–2008 versus 2009.....	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: 1992–2009. 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: 1992–2009. 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: 1992–2009. 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: 1992–2009. 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: 1992–2009. Dashed lines indicate significant ($P \leq 0.10$) regressions.....	17
Figure 8.	Combined-species passage volume by five-day periods for migrating raptors in the Bridger Mountains, MT: 1992–2008 versus 2009.....	18
Figure 9.	Passage volume by five-day periods for migrating Golden Eagles in the Bridger Mountains, MT: 1992–2008 versus 2009.....	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 2009 count, which marked the 19th consecutive full-season autumn count of migratory raptors at the site.

The Bridger Mountains project was 1 of 9 long-term, annual migration counts conducted or co-sponsored by HWI in North America during 2009. 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 concrete 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 early September through late October in 2009. Due to temporary loss of road access subsequent to a forest fire at the base of Bridger Bowl, observations on 27 September were conducted from another site approximately 3.2 km south of Flathead Pass and approximately 22 km north of the traditional site. Observations typically began at 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 (see Appendix B for a complete observer history). Both observers received one day of on-site training with Montana Audubon Executive Director, Steve Hoffman, and additional training with trained local volunteers. Local enthusiast Matt Keefer and long-time enthusiast John Parker occasionally assisted with the count. 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. The exact numbers of visitors were also recorded for each hour 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 2009 follows Hoffman and Smith (2003). In comparing 2009 annual statistics against means and 95% confidence intervals for previous seasons, we equate significance with a 2009 value falling outside the bounds of the confidence interval for the associated mean.

RESULTS AND DISCUSSION

WEATHER SUMMARY

Compared to the past 12 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 2009, fully precluding 12 days of observation (1997–2008 average of 11.8 days) and reducing observations to ≤ 4 hours on 3 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 37% of the active observation 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 36%, and mostly cloudy or overcast skies on 27%. The 1997–2008 averages for the site are 37% fair, 33% transitional, and 31% mostly cloudy to overcast, suggesting that 2009 featured slightly fewer overcast days during active observation periods than is typical for the site. The proportion of active days that included rain and/or snow showers was, however, above average (20% vs. average of 14%), as was the prevalence of visibility reducing fog and/or haze (36% of the active days vs. average of 31%). Despite higher than average rain/snow showers and fog/haze, the observers’ estimates suggested that visibility during active observations was at a record high in 2009 (88–90 km vs. averages of 75–80 km).

Data collected in 2009 during active observations indicated wind-speed conditions similar to most recent seasons; i.e., a relatively high prevalence of light as opposed to moderate winds. Light winds (< 12 kph) prevailed on 84% of the active observation days, moderate winds (12–29 kph) on 16%, and strong winds on 0%, compared to the 1997–2008 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 partially true in 2009. SW–NW and SE–SW winds were more prevalent than usual in 2009, prevailing on 20% and 9% of the active days compared to the 1997–2008 average of only 5% and 3%, respectively. The four most common patterns all diverged from average values in 2009: SW–W higher at 41% vs. average of 27%, W entirely absent vs. average of 30%, W–NW lower at 5% vs. average of 11%, and NE–SE higher at 14% vs. average of 8%.

The temperature during active observation periods averaged 8.7°C (the average of daily values, which in turn were averages of hourly readings), ranging from -3.9–18.1°C. The daily average is a record low (1997–2008 average of 11.8°C) as is the maximum value. The observers subjectively rated only 26% of the active days as featuring predominantly good to excellent thermal lift conditions, which is lower than the 1997–2008 average of 38%. Low thermal-lift ratings partly reflect snow depths in the Bridgers that ranged from 2–20 inches for the rest of the season after the first snow day on 30 September.

In summary, inclement weather and difficult access conditions hampered observations at an average level in 2009. Active observation periods featured a slight shift from overcast skies to more transitional skies compared to average, but higher prevalence of scattered rain/snow showers and fog/haze than usual; however, the latter did not translate to a reduction in average visibility. The winds during active observation periods were predominantly light and from the SW–W, which is typical for the site; however, while SW–W, SW–NW, and SE–SW winds prevailed more often than usual in 2009, days when steadier W winds prevailed were entirely absent (usually second most common) and W–NW winds also were less prevalent than usual. The temperature regime was colder than usual, with a record-low average and high temperature. The observers' subjective assessments of thermal-lift conditions during the season also ranked below average.

OBSERVATION EFFORT

Observations occurred on 44 of 56 days between 6 September and 31 October in 2009. The number of observation days was a significant 14% lower than the 1992–2008 average of $51 \pm 95\%$ CI of 3.7 days, and the number of observation hours (306.25) was a significant 10% lower than the long-term average of 340.53 ± 28.193 hours. The 2009 average of 2.06 observers per hour (including official and guest observers; value is mean of daily values, which are in turn means of hourly values) exceeded the long-term average of $1.9 \pm 95\%$ CI of 0.10 observers per hour, due to additional support provided by local volunteers.

FLIGHT SUMMARY

The observers tallied 1,388 migrating raptors of 16 species during the 2009 season (Table 1; see Appendix D for daily count records). The total count was a significant 43% below average and represents the lowest count yet recorded, including in comparison to 1991 when the total observation effort was 38% lower (see Appendix E for annual summaries). The low total count primarily reflects record low counts of only 638 Golden Eagles and 27 Bald Eagles, but counts also were significantly below average for all three accipiters, Red-tailed Hawks, American Kestrels, and Merlins. In contrast, the count of Peregrine Falcons rose to a new record high of 23 birds and the counts of Broad-winged Hawks, Ospreys, and Prairie Falcons also were significantly above average (Table 1).

The flight was composed of 48% eagles, 27% accipiters, 11% buteos, 7% falcons, 4% harriers, 1% Ospreys, and 2% unidentified raptors (Figure 2). The most numerous species were the Golden Eagle (46% of the total count), Sharp-shinned Hawk (17%), Cooper's Hawk (8%), Red-tailed Hawk (5%), Northern Harrier (4%), and American Kestrel (3%). All other species each comprised $\leq 2\%$ of the total.

Passage Rates and Long-term Trends

In 2009, adjusted passage rates were significantly above average for the Osprey, Broad-winged Hawk, Prairie Falcon, and Peregrine Falcon. Conversely, passage rates were significantly below average for

Turkey Vultures, all three accipiters, Red-tailed Hawks, Golden Eagles, Bald Eagles, American Kestrels, and Merlins (Table 1, Figures 3–7). Regression analyses updated through 2009 (after Hoffman and Smith 2003) revealed a highly significant ($P \leq 0.01$) second order, or quadratic, trend for Golden Eagles at the species level, tracking a mostly stable pattern through about 1999, but an accelerating decline since then (Figure 6). Age-specific analyses further revealed a similar accelerating decline for adults ($P = 0.003$) but only a highly significant linear decline for immatures/subadults. Significant linear declines also were indicated for Sharp-shinned Hawks, Cooper’s Hawks, and American Kestrels (Figures 4 and 7). A significant, trough-shaped quadratic trend was indicated for Swainson’s Hawks, tracking a sharp initial drop between 1992 and 1993, a relatively stable pattern of modest counts through 2000, generally lower counts for the next six years, and then a recent, modest rebound (Figure 5). Note, however, that tracking trends for this species must be considered very cautiously due to the very low average counts (Table 1, Appendix E). No other significant ($P \leq 0.10$) 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 complex analytical approach (also see Farmer et al. 2007) than that represented in Hoffman and Smith (2003) and used herein to present analyses updated through 2009. 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).

Differences between the RPI results and those presented herein that clearly relate to addition of four more years of data include: a) addition of low counts from 2007–2009 resulted in a new significant overall decline for Sharp-shinned Hawks (Figure 4); b) four more years of near-record-low and record-low passage rates translated to a now highly significant and accelerating decline for Golden Eagles through 2009 (Figure 6); and c) four more years of low passage rates for American Kestrels now translate to a significant long-term decline, although the passage rates of this species have increased gradually since 2006 (Figure 7). Farmer et al. (2008) and Farmer and Smith (in press) highlight recent evidence of widespread declines across North America among kestrels, an otherwise common and ubiquitous species.

Age Ratios

Immature : adult ratios were above average in 2009 for 7 of 9 species for which relevant age-specific data were available, significantly so for all three accipiters, Golden Eagles, and Peregrine Falcons (Table 2). For most species exhibiting above-average age ratios, the counts of identified immature and adult birds were both below average, suggesting that the high age ratios are more indicative of low adult survivorship than high productivity and juvenile recruitment for these species in 2009. Note, however, that the proportions of unaged Cooper’s Hawks and Northern Harriers were significantly above average in 2009 (Table 2), so for these species the age-ratio statistics must be considered with caution. The Sharp-shinned Hawk, Broad-winged Hawk, and Peregrine Falcon were the only three species that had more identified immatures birds than average in 2009. This suggests that productivity may have been decent for these species in 2009, but clearly the almost 50% reduction in the number of identified adults was the primary driver of the high age ratio for Sharp-shinned Hawks and suggested that adult survivorship and/or recruitment from the previous year were low in 2009.

Seasonal Timing

At the species level, there were no significantly late median passage dates in 2009; however, seven species showed significantly early passage dates (Table 3), including Northern Harriers, all three accipiters, Broad-winged Hawks, Bald Eagles, and Peregrine Falcons. The combined-species median passage date of 26 September also was a highly significant 11 days earlier than average, and the seasonal activity pattern confirmed unusually high activity between 11 and 25 September (Figure 8). This peak was followed by an atypical shortage of activity until a late spike occurred from 21–25 October. The early activity largely mimics early peak passage of accipiters, Northern Harriers, and American Kestrels, with the major late September spike in activity occurring several days before a major front that brought heavy snowfall. For Golden Eagles, the 2009 species-level median passage date of 14 October was a non-significant two days later than average (Table 3) and the median passage date for non-adults of 6 October was a non-significant two days earlier than average; however, the median passage date for adults of 17 October was a significant four days later than average. The seasonal passage pattern for the species further indicated typical flight volume through the first five days of October, below average activity through the middle 15 days of October, and then above average activity for the remainder of the season, with relative passage volume significantly above average during the last 5-day period (Figure 9). This suggests that the low number of Golden Eagles seen this season and the overall significant and recently accelerating decline of adults, in particular, may be at least partly related to delayed passage beyond our standard survey period. In fact, although only a casual analysis at this point, the median passage dates of adult Golden Eagles at this site have shifted from mostly early October in the early to mid-1990s to mostly mid-October in the 2000s.

RESIDENT RAPTORS

This year's crew recorded nine different species as displaying resident behavior: Northern Harrier, Sharp-shinned Hawk, Cooper's Hawk, Red-tail Hawk, Golden Eagle, Bald Eagle, American Kestrel, Prairie Falcon, and Peregrine Falcon.

One resident, brown Northern Harrier was first seen on 9 September and occasionally thereafter until 24 September.

Resident Sharp-shinned Hawks, including at least two immature birds and an adult male, were seen regularly from 6–25 September. The immatures often chased each other or other raptors to the east of the observation point and were also seen on the way up the trail or perching in trees southeast of Tilly. The adult male was often seen on the southwest side of Tilly. An immature Cooper's Hawk resided in the area from 6–28 September and was seen escorting a Northern Harrier north of the observation site and stooping on the decoy owl.

Resident Red-tailed Hawks, including at least one adult and two immature light morphs, were seen from 6 September until 28 October, mostly low on the east side of the ridge below and north of the observation point to Tilly Peak.

Two adult and one hatch-year Golden Eagles resided in the area throughout the season. They were seen mostly between the treed ridge far to the northwest of the observation point and north of Tilly, but they also spent time southeast of the observation point above Saddle Peak and occasionally perching on the east slope of Tilly. The adult male often displayed in typical roller-coaster fashion on the west and east side of the observation point, and the family group was occasionally seen flying low over trees with the immature following the adults and chirping. An adult Bald Eagle was seen on 22 September flying north and disappearing low behind the ridge in front of Ross Peak.

A male American Kestrel resided in the area from 8–28 September, hunting in various areas around the observation point and often seen perched on the southeast slope of Tilly. At least one Prairie Falcon routinely patrolled the ridgeline from 16 September until the end of the season. At least one immature

Peregrine Falcon exhibited resident behavior from 18–24 September, seen on three occasions flying north and once perching in a tree.

This is a fairly typical resident assemblage for the site.

VISITATION

Throughout the course of the season, 86 individuals signed the visitor logs kept at the watchsite; however, at least three times as many people passed through the site but did not sign the visitor log. Most visitors hailed from nearby areas of Montana, primarily from the Bozeman area, with some from Billings, Livingston, and Gardiner. Other guests visited from four other states (Arizona, Colorado, Delaware, and Vermont) and enjoyed the spectacle of the fall migration! The eleventh annual Bridger Raptor Festival once again coincided with opening ticket sales for the Bridger Bowl Ski Area, and as a result well over a thousand people were exposed to the festival, including a sizeable ornithology class from Rocky Mountain College that hiked up to the observation site.

In 2009, 305 hourly assessments by the primary observers of visitor disturbance resulted in the following ratings: 82% none, 15% low, 3% moderate, and <1% high, which indicates an average level of visitor disturbance for this site.

ACKNOWLEDGMENTS

Funding for the 2009 project was provided by the USDA Forest Service–Gallatin National Forest, Bridger Bowl Ski Area, Sacajawea Audubon Society, Montana Audubon, Frank and Irmeli Smith, and Paul and Nancy Heymann. Special thanks to Randy Elliot of Bridger Bowl who provided essential logistical support and to Doug Wales for additional logistical support. We are also especially thankful for support provided by the Bridger to Bangtail Coalition in the form of housing and other logistical support provided to our two official observers. Special thanks to Candace Hamlin, Deb Stratford, and Johnnie Corrie for their help arranging for and providing the local cabin the crew lived in during the season. We also thank Jeff Pentel, Matt Keefer, Lisa Baril, John Parker, John Bell, and Mark Donahue for their observational and/or logistical assistance.

LITERATURE CITED

- Bildstein, K. L. 2001. Why migratory birds of prey make great biological indicators. Pages 169–179 in K. L. Bildstein and D. Klem, Jr. (Editors), *Hawkwatching in the Americas*. Hawk Migration Association of North America, North Wales, Pennsylvania, U.S.A.
- Bildstein, K. L., J. P. Smith, E. Ruelas Inzunza, and R. R. Veit (Editors). 2008. State of North America's birds of prey. Series in Ornithology No. 3. Nuttall Ornithological Club, Cambridge, Massachusetts, and American Ornithologists' Union, Washington, DC USA.
- Farmer, C. J., L. J. Goodrich, E. Ruelas Inzunza, and J. P. Smith. 2008. Conservation status of North America's birds of prey. Pages 303–420 in K. L. Bildstein, J. P. Smith, and E. Ruelas Inzunza, and R. R. Veit (Editors), *State of North America's birds of prey*. Series in Ornithology No. 3. Nuttall Ornithological Club, Cambridge, Massachusetts, and American Ornithologists' Union, Washington, DC USA.
- Farmer, C. J., D. J. T. Hussell, and D. Mizrahi. 2007. Detecting population trends in migratory birds of prey. *Auk* 124:1047–1062.
- Farmer, C. J., and J. P. Smith. In press. Migration counts indicate widespread declines of American Kestrels (*Falco sparverius*) in North America. *Journal of Raptor Research* 43(4).

- Hoffman, S. W., and J. P. Smith. 2003. Population trends of migratory raptors in western North America, 1977–2001. *Condor* 105:397–419.
- Hoffman, S. W., J. P. Smith, and T. D. Meehan. 2002. Breeding grounds, winter ranges, and migratory routes of raptors in the Mountain West. *Journal of Raptor Research* 36:97–110.
- Omland, K. S., and S. W. Hoffman. 1996. Seasonal, diel, and spatial dispersion patterns of Golden Eagle autumn migration in southwestern Montana. *Condor* 98:633–636.
- Smith, J. P., C. J. Farmer, S. W. Hoffman, G. S. Kaltenecker, K. Z. Woodruff, and P. Sherrington. 2008 a. Trends in autumn counts of migratory raptors in western North America. Pages 217–252 *in* K. L. Bildstein, J. P. Smith, E. Ruelas Inzunza, and R. R. Veit (Editors), *State of North America's birds of prey*. Series in Ornithology No. 3. Nuttall Ornithological Club, Cambridge, Massachusetts, and American Ornithologists' Union, Washington, DC USA.
- Smith, J. P., C. J. Farmer, S. W. Hoffman, C. A. Lott, L. J. Goodrich, J. Simon, C. Riley, and E. Ruelas Inzunza. 2008 b. Trends in autumn counts of migratory raptors around the Gulf of Mexico, 1995–2005. Pages 253–278 *in* K. L. Bildstein, J. P. Smith, E. Ruelas Inzunza, and R. R. Veit (Editors), *State of North America's birds of prey*. Series in Ornithology No. 3. Nuttall Ornithological Club, Cambridge, Massachusetts, and American Ornithologists' Union, Washington, DC USA.
- Zalles, J. I., and K. L. Bildstein (Editors). 2000. *Raptor watch: a global directory of raptor migration sites*. BirdLife Conservation Series No. 9. BirdLife International, Cambridge, U.K., and Hawk Mountain Sanctuary Association, Kempton, Pennsylvania, U.S.A.

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: 1992–2008 versus 2009.

SPECIES	COUNTS			RAPTORS/100 HRS		
	1992–2008 ¹	2009	%CHANGE	1992–2008 ¹	2009	%CHANGE
Turkey Vulture	0.8 ± 0.72	0	-100	0.4 ± 0.38	0.0	-100
Osprey	6 ± 1.9	9	+55	2.8 ± 0.91	4.2	+53
Northern Harrier	48 ± 23.6	52	+8	15.2 ± 7.66	17.7	+17
Sharp-shinned Hawk	331 ± 53.7	230	-31	124.5 ± 18.69	81.1	-35
Cooper’s Hawk	166 ± 34.5	113	-32	121.8 ± 24.45	83.6	-31
Northern Goshawk	33 ± 10.3	13	-61	11.8 ± 4.21	4.6	-61
Unknown small accipiter ²	29 ± 20.0	6	-80	–	–	–
Unknown large accipiter ²	5 ± 2.5	6	+30	–	–	–
Unknown accipiter	24 ± 8.7	7	-71	–	–	–
TOTAL ACCIPITERS	571 ± 87.6	375	-34	–	–	–
Broad-winged Hawk	9 ± 4.3	33	+262	4.6 ± 2.26	16.3	+258
Swainson’s Hawk	3 ± 1.5	4	+55	1.2 ± 0.80	1.7	+38
Red-tailed Hawk	106 ± 23.9	75	-30	37.9 ± 7.90	27.9	-26
Ferruginous Hawk	2 ± 1.0	2	-19	0.9 ± 0.31	0.7	-22
Rough-legged Hawk	34 ± 9.5	30	-11	25.1 ± 6.80	28.8	+15
Unidentified buteo	12 ± 3.2	10	-17	–	–	–
TOTAL BUTEOS	166 ± 32.7	154	-7	–	–	–
Golden Eagle	1407 ± 143.5	638	-55	549.2 ± 54.22	254.6	-54
Bald Eagle	80 ± 11.7	27	-66	31.1 ± 4.98	10.6	-66
Unidentified eagle	7 ± 3.6	4	-41	–	–	–
TOTAL EAGLES	1494 ± 149.2	669	-55	–	–	–
American Kestrel	70 ± 19.3	45	-36	59.7 ± 16.23	39.9	-33
Merlin	10 ± 2.7	4	-59	7.2 ± 1.83	3.1	-56
Prairie Falcon	14 ± 2.0	17	+23	9.3 ± 1.76	11.9	+28
Peregrine Falcon	9 ± 2.3	23	+168	7.0 ± 1.90	16.6	+136
Gyrfalcon	0.1 ± 0.12	0	-100	–	–	–
Unknown small falcon ²	4 ± 6.4	3	-29	–	–	–
Unknown large falcon ²	4 ± 2.9	3	-20	–	–	–
Unknown falcon	5 ± 2.1	4	-20	–	–	–
TOTAL FALCONS	111 ± 22.8	99	-11	–	–	–
Unidentified raptor	28 ± 6.5	30	+7	–	–	–
GRAND TOTAL	2425 ± 254.7	1388	-43	–	–	–

¹ Mean ± 95% confidence interval.

² 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: 1992–2008 versus 2009.

	TOTAL AND AGE-CLASSIFIED COUNTS							IMMATURE : ADULT			
	1992–2008 AVERAGE			2009			% UNKNOWN AGE		RATIO		
	TOTAL	IMM.	ADULT	TOTAL	IMM.	ADULT	1992–2008 ¹	2009	1992–2008 ¹	2009	
Northern Harrier	48	22	12	52	16	4	31 ± 7.1	62	3.3 ± 3.45	4.0	
Sharp-shinned Hawk	331	61	126	230	67	65	44 ± 6.7	43	0.5 ± 0.11	1.0	
Cooper’s Hawk	166	43	57	113	38	17	39 ± 5.4	51	0.8 ± 0.26	2.2	
Northern Goshawk	33	12	13	13	7	2	28 ± 10.6	31	1.5 ± 0.54	3.5	
Broad-winged Hawk	9	2	3	33	4	22	39 ± 18.6	21	1.0 ± 0.81	0.2	
Red-tailed Hawk	106	32	50	75	19	32	22 ± 4.3	32	0.7 ± 0.34	0.6	
Golden Eagle	1407	540	516	638	304	155	25 ± 4.3	28	1.1 ± 0.17	2.0	
Bald Eagle	80	27	50	27	11	16	3 ± 16.3	0	0.6 ± 0.13	0.7	
Peregrine Falcon	9	0.4	4	23	4	6	51 ± 16.3	57	0.2 ± 0.28	0.7	

¹ 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 2009, with a comparison of 2009 and 1992–2008 average median passage dates.

SPECIES	2009				1992–2008
	FIRST OBSERVED	LAST OBSERVED	BULK PASSAGE DATES ¹	MEDIAN PASSAGE DATE ²	MEDIAN PASSAGE DATE ³
Osprey	8-Sep	6-Oct	8-Sep – 6-Oct	15-Sep	16-Sep ± 3.1
Northern Harrier	7-Sep	21-Oct	9-Sep – 25-Sep	16-Sep	23-Sep ± 4.2
Sharp-shinned Hawk	6-Sep	31-Oct	10-Sep – 17-Oct	23-Sep	01-Oct ± 1.7
Cooper’s Hawk	6-Sep	26-Oct	9-Sep – 26-Sep	16-Sep	24-Sep ± 3.0
Northern Goshawk	9-Sep	25-Oct	11-Sep – 25-Sep	16-Sep	10-Oct ± 4.8
Broad-winged Hawk	12-Sep	26-Sep	16-Sep – 25-Sep	16-Sep	20-Sep ± 1.9
Swainson’s Hawk	7-Sep	18-Sep	–	–	15-Sep ± 5.2
Red-tailed Hawk	6-Sep	24-Oct	8-Sep – 3-Oct	22-Sep	21-Sep ± 2.3
Ferruginous Hawk	12-Sep	13-Sep	–	–	05-Oct ± 15.4
Rough-legged Hawk	16-Sep	31-Oct	3-Oct – 25-Oct	21-Oct	20-Oct ± 1.5
Golden Eagle	6-Sep	31-Oct	23-Sep – 26-Oct	14-Oct	12-Oct ± 2.0
Bald Eagle	11-Sep	22-Oct	12-Sep – 21-Oct	3-Oct	15-Oct ± 2.5
American Kestrel	6-Sep	18-Oct	10-Sep – 26-Sep	21-Sep	22-Sep ± 2.1
Merlin	8-Sep	17-Oct	–	–	05-Oct ± 3.7
Prairie Falcon	10-Sep	25-Oct	10-Sep – 23-Oct	25-Sep	24-Sep ± 4.1
Peregrine Falcon	7-Sep	21-Oct	10-Sep – 13-Oct	17-Sep	25-Sep ± 2.4
All species	6-Sep	31-Oct	12-Sep – 23-Oct	26-Sep	07-Oct ± 1.5

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

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

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

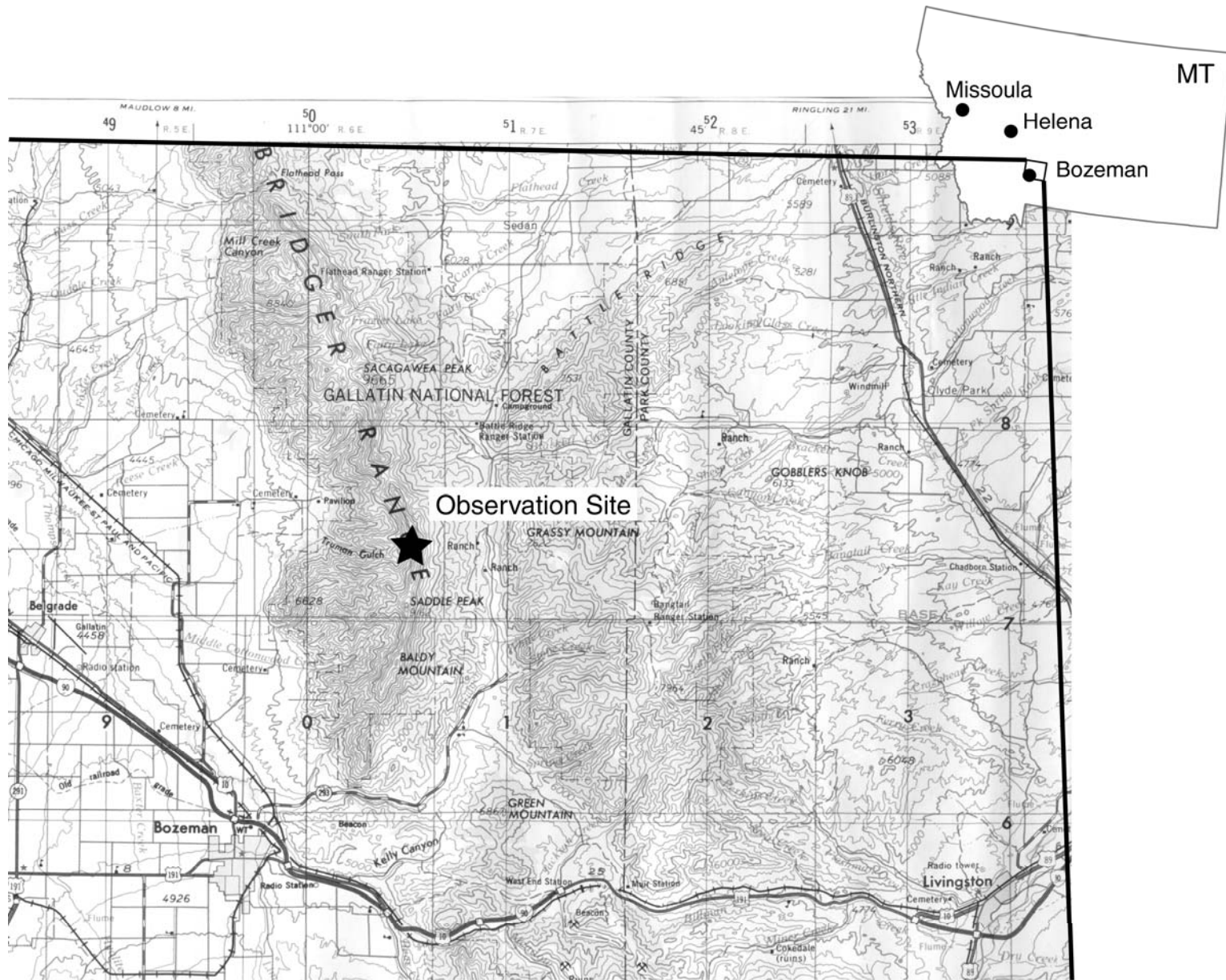


Figure 1. Location of the Bridger Mountains Raptor Migration Project study site.

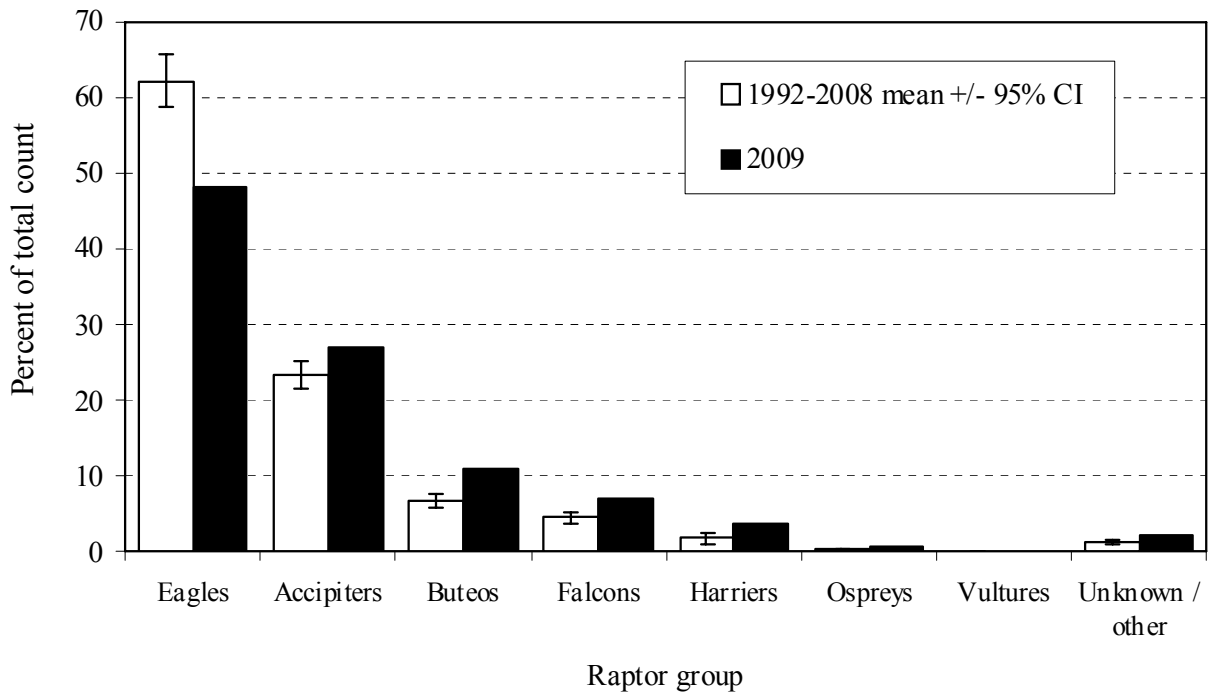


Figure 2. Composition of the fall raptor migration in the Bridger Mountains by major species groups: 1992–2008 versus 2009.

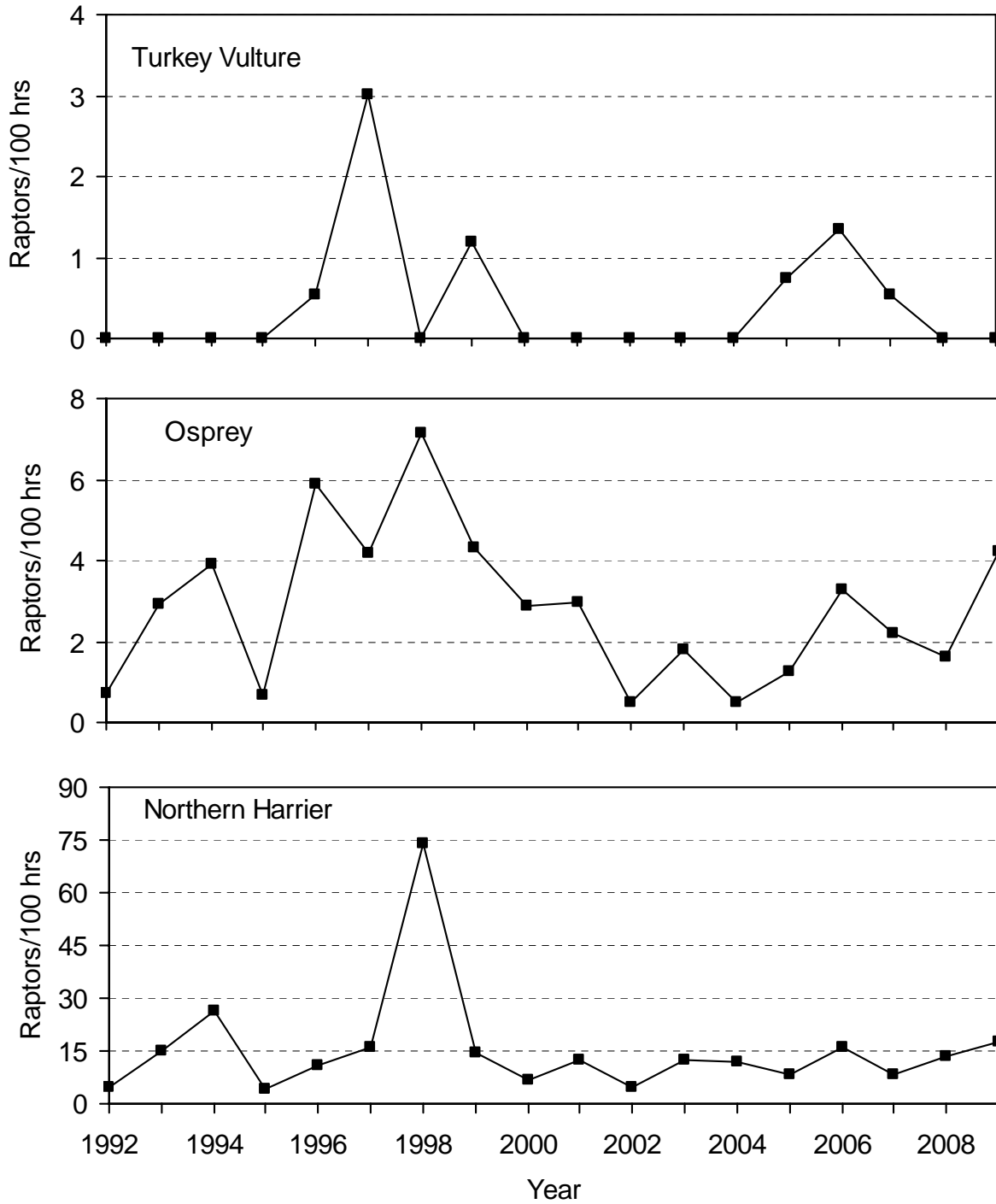


Figure 3. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Turkey Vultures, Ospreys, and Northern Harriers in the Bridger Mountains, MT: 1992–2009. Dashed lines indicate significant ($P \leq 0.10$) regressions.

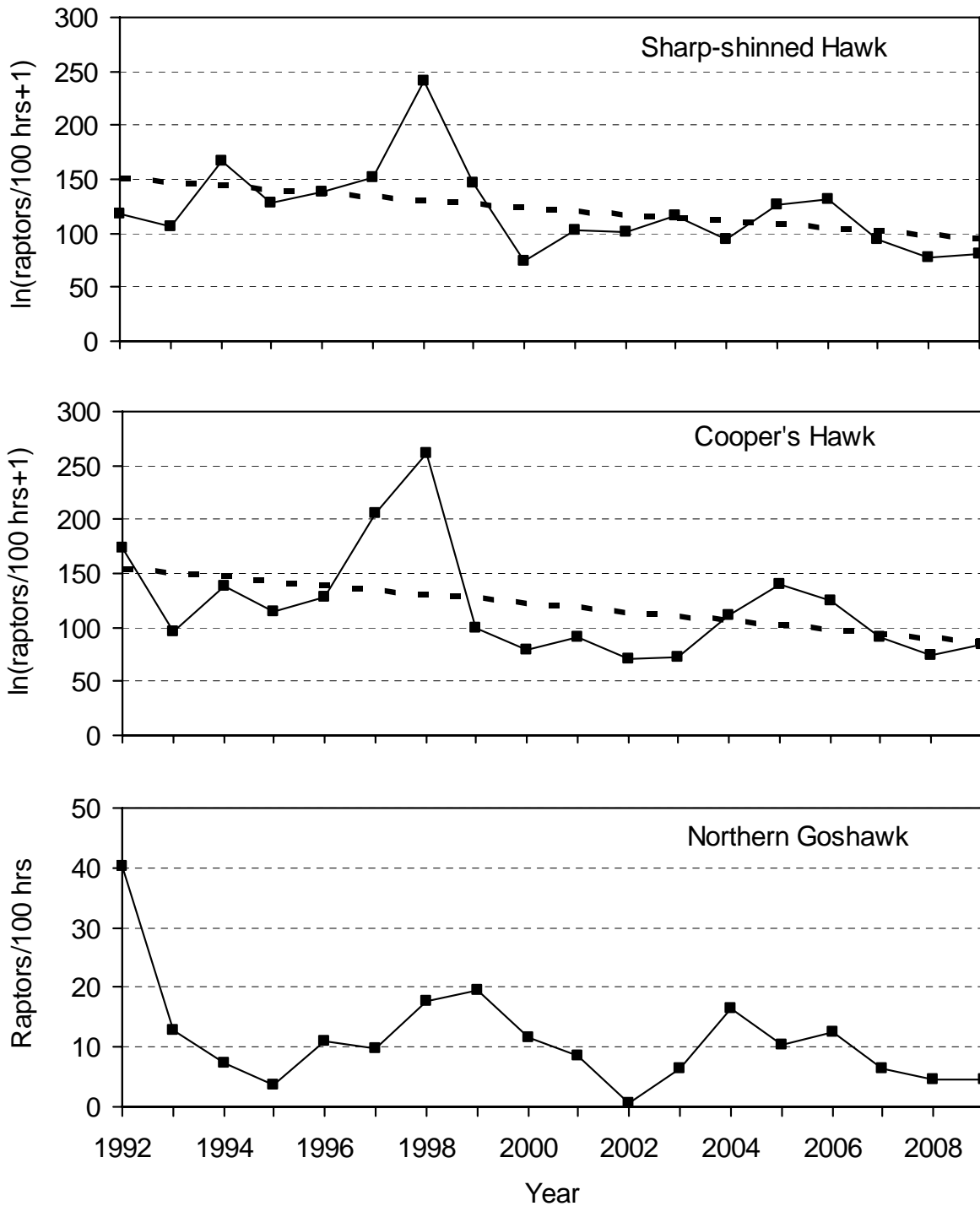


Figure 4. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks in the Bridger Mountains, MT: 1992–2009. Dashed lines indicate significant ($P \leq 0.10$) regressions.

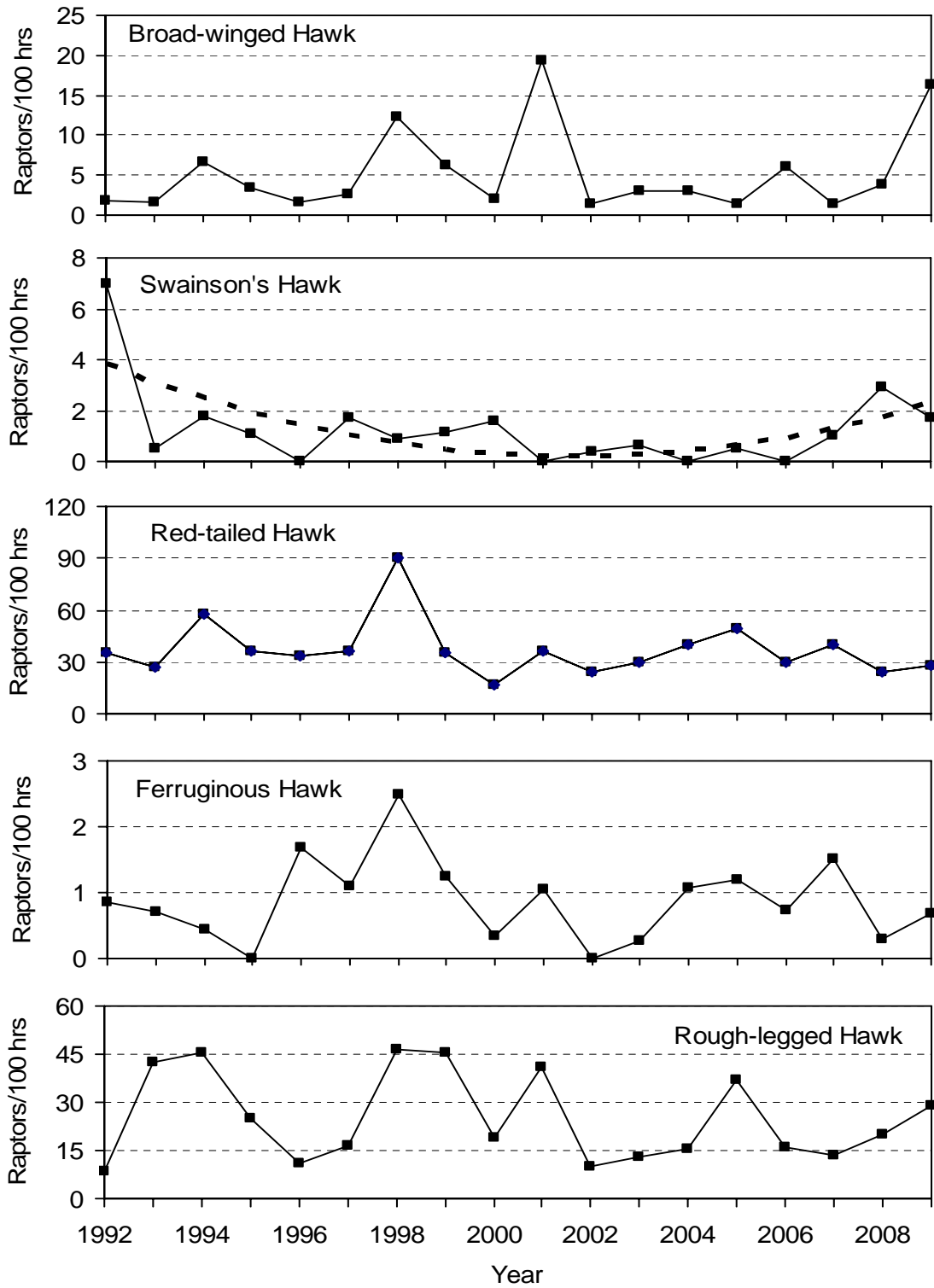


Figure 5. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Broad-winged, Swainson's, Red-tailed, Ferruginous, and Rough-legged Hawks in the Bridger Mountains, MT: 1992–2009. Dashed lines indicate significant ($P \leq 0.10$) regressions.

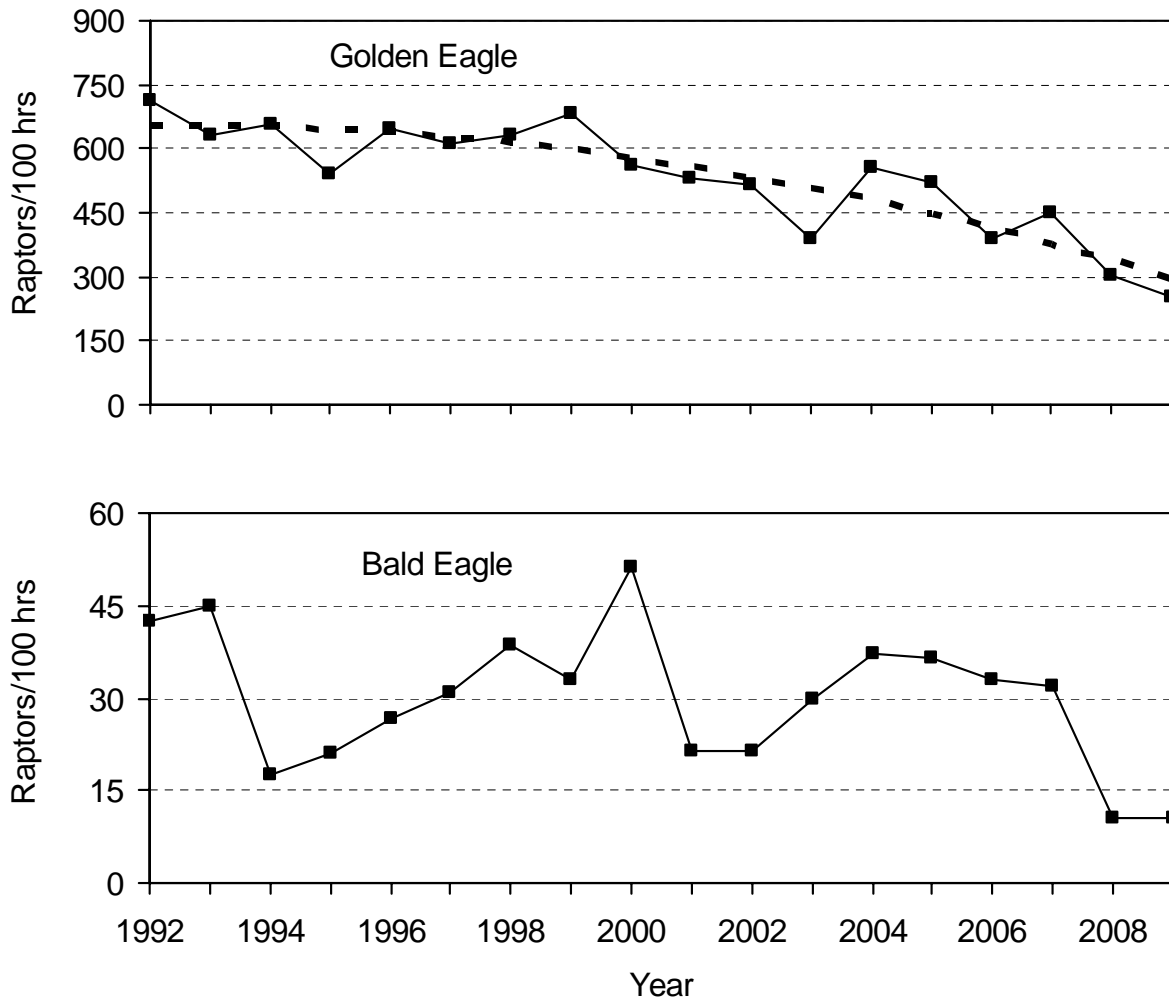


Figure 6. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Golden and Bald Eagles in the Bridger Mountains, MT: 1992–2009. Dashed lines indicate significant ($P \leq 0.10$) regressions.

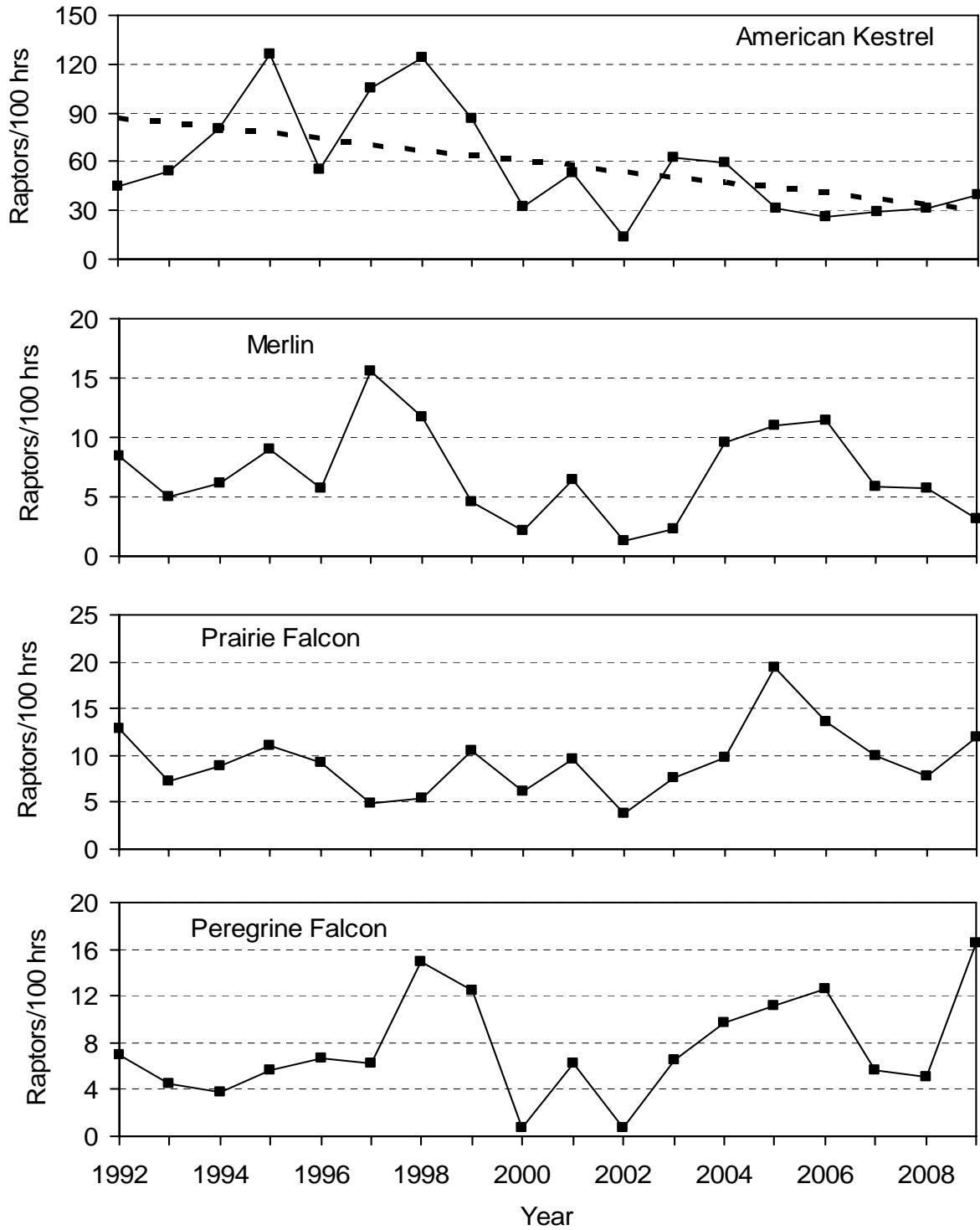


Figure 7. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons in the Bridger Mountains, MT: 1992–2009. Dashed lines indicate significant ($P \leq 0.10$) regressions.

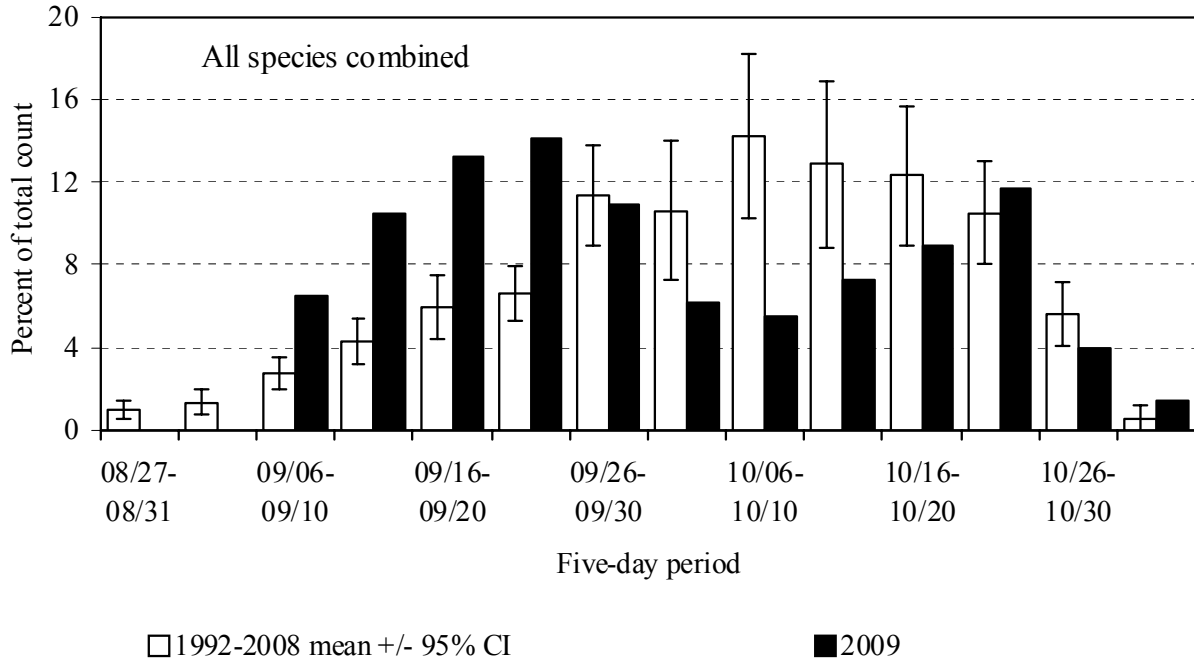


Figure 8. Combined-species passage volume by five-day periods for migrating raptors in the Bridger Mountains, MT: 1992–2008 versus 2009.

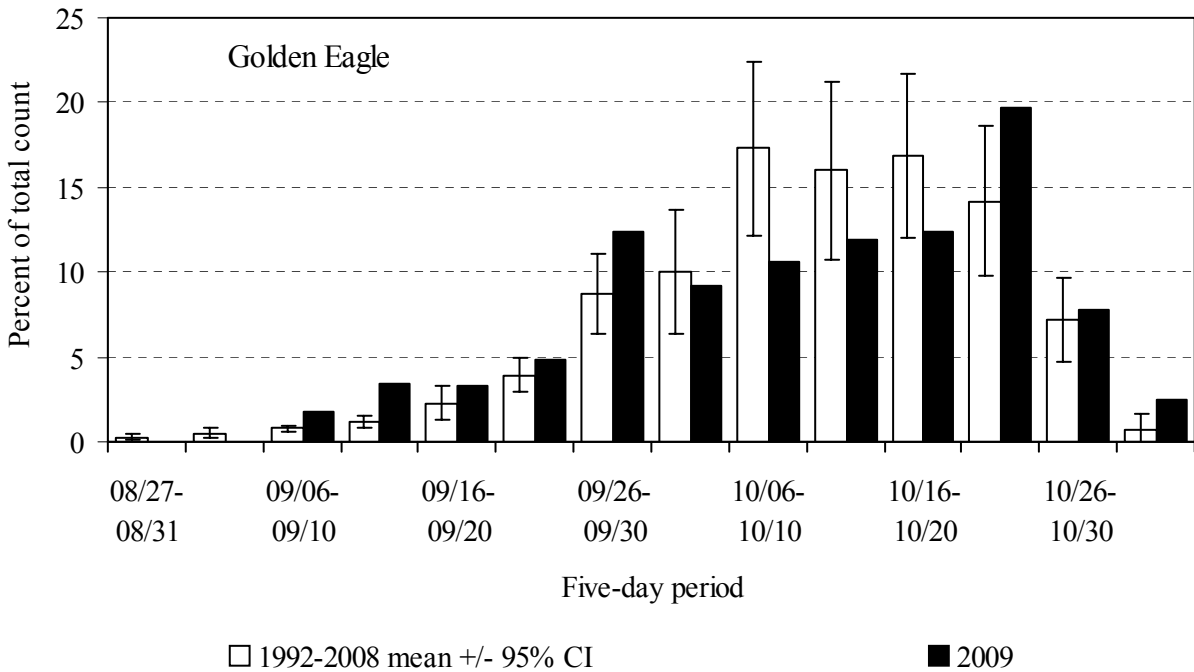


Figure 9. Passage volume by five-day periods for migrating Golden Eagles in the Bridger Mountains, MT: 1992–2008 versus 2009.

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 ¹	SEX ²	COLOR MORPH ³
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 ⁴	U	NA
Bald Eagle	<i>Haliaeetus leucocephalus</i>	BE	I, S1, S2, NA, A, U ⁵	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
Gyr Falcon	<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

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, G = gray; L = light, W = white; U – unknown, NA = not applicable.

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

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

Appendix B. 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)
- 2008:** Two observers throughout: Amy Seaman (0), Michaela Hitchcock (0), John Bell (2)
- 2009:** Two observers throughout: Caitlin Kroeger (0), Jason Minné (0)

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: 2009.

DATE	OBS. HOURS	OBSVR / HOUR ¹	MEDIAN	PREDOMINANT WEATHER ³	WIND		BAROM.		MEDIAN	VISIB.	VISIB.	MEDIAN	BIRDS / HOUR
			VISITOR DISTURB ²		SPEED (KPH) ¹	WIND DIRECTION	TEMP (°C) ¹	PRESS. (IN HG) ¹	THERMAL LIFT ⁴	WEST (KM) ¹	EAST (KM) ¹	FLIGHT DISTANCE ⁵ / HOUR	
06-Sep	7.75	2.9	1	pc-mc	8.3	sw	16.0		3	100	100	2	2.7
07-Sep	8.00	2.0	0	pc-ovc, PM rain	3.1	sw-w/calm	14.9	26.21	3	100	100	2	1.9
08-Sep	7.92	2.0	1	clr	6.2	sw-nw	11.2	26.26	3	100	100	3	1.1
09-Sep	8.00	2.0	0	clr-pc	3.0	swsw-nw	18.1	26.35	2	100	100	2	2.5
10-Sep	8.00	2.0	0	clr-ovc	4.0	sw-wsw	13.9	26.47	3	100	100	2	3.1
11-Sep	7.75	2.0	0	clr-pc	4.0	ene-e	10.3	26.57	2	100	100	1	4.4
12-Sep	8.00	2.0	1	clr	10.1	ne-ese	10.6	26.32	3	100	100	2	3.0
13-Sep	8.00	2.0	0	AM ovc/fog, PM pc-mc	1.8	ene-e, wsw-nw	12.3	26.03	3	76	91	2	3.1
14-Sep	7.67	2.0	0	clr-mc	2.7	sw-wnw	15.6	26.21	2	100	98	2	3.7
15-Sep	8.00	2.1	0	pc	8.7	ene-e	17.4	26.50	2	97	87	2	4.4
16-Sep	8.00	2.4	0	clr-pc	4.5	ne-ese	17.1	26.54	3	100	100	2	13.5
17-Sep	8.00	2.3	0	clr-pc, PM ts	2.7	sw-nw	17.6	26.41	2	100	100	2	4.0
18-Sep	8.00	1.0	0	clr-pc	3.6	ene-ese/var	16.2	26.44	2	100	100	2	3.3
19-Sep	8.00	2.0	0	clr-mc	5.5	sw-wnw	17.7	26.26	3	100	100	2	1.9
20-Sep	7.92	2.0	0	mc-ovc, AM fog, PM snow	9.5	sw-nw	7.2	26.22	4	73	79	1	0.3
21-Sep	8.00	2.0	0	clr-pc	5.5	sw	4.3	26.50	3	100	100	1	0.4
22-Sep	8.00	2.0	0	clr	4.4	sw-nw	9.1	26.60	2	100	100	1	3.8
23-Sep	8.00	2.0	0	clr	3.5	ene-e	13.6	26.59	2	100	100	2	4.1
24-Sep	8.00	2.0	0	clr, PM haze	3.1	wsw-nw	15.7	26.44	2	100	100	2	4.9
25-Sep	8.00	3.1	1	clr/haze	3.2	w-wnw	14.4	26.44	3	74	74	2	11.5
26-Sep	6.83	2.9	0	pc-mc, haze	10.0	sw	13.6	26.30	2	98	86	3	14.8
27-Sep	5.50	2.0	0	clr/haze	3.7	sw-wsw	15.1		2	96	60	1	2.0
28-Sep	8.00	2.0	0	clr-mc, haze	3.1	sw-w, ese-se	12.6	26.18	3	86	78	1	2.5
29-Sep	8.00	2.0	1.5	pc-ovc, haze	8.9	sw-w/var	15.0	26.02	3	90	89	2	2.4
30-Sep	0.00			Weather Day: snow									
01-Oct	4.25	2.0	0	ovc, fog/snow	5.5	sw-w	-1.4	26.17	4	11	65	2	1.6
02-Oct	8.00	2.0	0	clr-mc	6.2	sw-w	2.7	26.11	3	100	100	1	2.6
03-Oct	7.75	2.0	1	mc-ovc	22.7	ene-ese	4.1	25.95	3	100	98	2	7.4
04-Oct	0.00			Weather Day: snow									
05-Oct	0.00			Weather Day: snow									
06-Oct	6.50	2.0	0	pc	11.5	sw-wnw	1.4	26.03	4	100	100	2	11.5
07-Oct	0.00			Weather Day: snow									
08-Oct	0.00			Weather Day: snow									
09-Oct	0.00			Weather Day: no access - snow									
10-Oct	2.67	3.0	0	ovc, snow	1.5	wnw	0.8	26.12	3	1	11	1	0.4
11-Oct	0.00			Weather Day: snow									
12-Oct	5.50	2.0	0	pc-ovc, scat fog	2.6	sw	1.4	25.83	4	74	91	1	2.4
13-Oct	6.33	2.0	0	pc-ovc, scat fog	4.5	se-ssw	6.6	25.91	3	81	85	1	3.2
14-Oct	5.08	2.0	0	mc-ovc, rain/snow	12.0	ssw-sw	7.0	25.93	4	97	94	2	6.3
15-Oct	7.17	2.0	0	ovc, AM fog	6.9	sw	2.9	26.29	4	92	78	3	4.9
16-Oct	6.50	1.6	0	pc-mc	8.3	wsw-w	4.4	26.45	3	100	100	2	3.1
17-Oct	8.00	1.0	1.5	pc	7.9	sw-wsw	8.0	26.31	3	100	99	2	7.0

Appendix C. continued

DATE	OBS. HOURS	MEDIAN		PREDOMINANT WEATHER ³	WIND		BAROM.		MEDIAN	VISIB.	VISIB.	MEDIAN	BIRDS / HOUR
		OBSRVR / HOUR ¹	VISITOR DISTURB ²		SPEED (KPH) ¹	WIND DIRECTION	TEMP (°C) ¹	PRESS. (INHG) ¹	THERMAL LIFT ⁴	WEST (KM) ¹	EAST (KM) ¹	FLIGHT DISTANCE ⁵	
18-Oct	7.33	2.0	0	ovc	6.6	sw	8.3	26.14	3	100	100	2	6.5
19-Oct	0.00			Weather Day: fog/snow									
20-Oct	0.00			Weather Day: fog/snow									
21-Oct	7.83	2.0	0	pc-mc, scat fog	4.5	sw	2.3	26.18	4	79	95	1	7.4
22-Oct	3.50	2.0	0	mc-ovc, AM fog/snow	8.0	sw	2.0	26.20	4	80	88	2	10.9
23-Oct	6.08	2.0	0	mc-ovc, PM snow	13.3	sw-w	2.0	26.04	4	80	86	2	3.9
24-Oct	1.67	2.0	-	ovc, fog/snow	18.0	ssw-sw	-1.5	26.03	4	30	93	-	3.0
25-Oct	5.83	2.0	0	ovc-clr	10.6	sw-w	-2.7	26.25	3	89	90	2	6.5
26-Oct	6.25	2.0	0	mc-ovc	20.6	ssw-wsw	3.7	25.78	4	100	100	3	6.6
27-Oct	0.00			Weather Day: snow									
28-Oct	0.00			Weather Day: snow									
29-Oct	6.67	2.0	0	ovc-pc, fog/snow	2.6	sw-w	-3.9	25.92	4	67	36	2	1.9
30-Oct	0.00			Weather Day: fog/rain/snow									
31-Oct	6.00	2.6	0	mc-ovc	15.3	ssw-sw	4.0	26.05	3	100	100	2	3.2

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 = thunderstorms.

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. Daily observation effort and fall raptor migration counts by species in the Bridger Mountains, MT: 2009.

DATE	HOURS	SPECIES ¹																				TOTAL	/ HOUR							
		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
06-Sep	7.75	0	0	0	7	8	0	0	0	0	0	0	3	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	21	7.75
07-Sep	8.00	0	0	2	2	1	0	1	0	0	0	1	3	0	0	0	2	0	0	0	0	0	2	0	0	0	0	1	15	8.00
08-Sep	7.92	0	1	3	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	1	0	0	0	0	0	0	9	7.92	
09-Sep	8.00	0	0	1	10	3	1	0	1	0	0	0	0	0	0	2	0	0	1	1	0	0	0	0	0	0	0	20	8.00	
10-Sep	8.00	0	0	0	5	5	0	0	0	0	0	0	1	0	0	0	5	0	0	5	0	2	1	0	0	0	1	25	8.00	
11-Sep	7.75	0	0	4	10	7	1	0	1	0	0	0	4	0	0	0	3	1	0	2	0	1	0	0	0	0	0	34	7.75	
12-Sep	8.00	0	1	1	5	3	1	0	0	0	2	0	3	1	0	0	2	2	0	2	0	0	1	0	0	0	0	24	8.00	
13-Sep	8.00	0	2	1	8	3	0	0	0	0	0	0	3	1	0	1	6	0	0	0	0	0	0	0	0	0	0	25	8.00	
14-Sep	7.67	0	0	0	8	7	1	0	0	0	1	1	1	0	0	0	5	1	0	2	0	1	0	0	0	0	0	28	7.67	
15-Sep	8.00	0	1	4	9	8	0	0	0	0	0	0	3	0	0	1	6	0	0	2	0	0	0	0	1	0	0	35	8.00	
16-Sep	8.00	0	1	15	19	20	3	0	1	0	16	1	4	0	1	2	12	2	0	4	0	1	6	0	0	0	0	108	8.00	
17-Sep	8.00	0	1	1	7	4	1	0	1	0	3	0	1	0	0	0	6	1	0	0	0	0	2	0	0	2	1	1	32	8.00
18-Sep	8.00	0	0	1	8	4	0	0	0	0	2	1	2	0	0	1	2	0	0	1	0	1	1	0	0	0	1	1	26	8.00
19-Sep	8.00	0	0	1	4	3	0	0	0	0	0	0	2	0	0	0	1	2	1	1	0	0	0	0	0	0	0	15	8.00	
20-Sep	7.92	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7.92	
21-Sep	8.00	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	3	8.00	
22-Sep	8.00	0	0	0	7	2	0	0	0	0	1	0	7	0	0	0	7	1	0	1	0	1	2	0	0	0	1	30	8.00	
23-Sep	8.00	0	0	1	13	3	1	0	0	0	0	0	5	0	0	0	9	0	0	1	0	0	0	0	0	0	0	33	8.00	
24-Sep	8.00	0	0	4	10	2	1	0	0	0	4	0	2	0	0	0	8	0	0	4	0	0	1	0	0	0	3	39	8.00	
25-Sep	8.00	0	0	8	21	16	1	4	2	6	2	0	6	0	0	3	7	0	0	7	1	2	1	0	0	1	1	3	92	8.00
26-Sep	6.83	0	1	1	22	6	0	0	0	0	2	0	14	0	0	0	41	1	0	6	0	1	0	0	1	0	1	4	101	6.83
27-Sep	5.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	1	0	0	0	0	0	11	5.50	
28-Sep	8.00	0	0	0	7	1	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	20	8.00	
29-Sep	8.00	0	0	0	1	0	0	0	0	0	0	0	0	0	0	16	0	0	1	0	1	0	0	0	0	0	0	19	8.00	
30-Sep	0.00																												0.00	
01-Oct	4.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	7	4.25	
02-Oct	8.00	0	0	0	1	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	21	8.00	
03-Oct	7.75	0	0	0	10	3	0	0	0	0	0	0	1	0	2	1	32	3	0	0	0	1	2	0	1	0	1	57	7.75	
04-Oct	0.00																												0.00	
05-Oct	0.00																												0.00	
06-Oct	6.50	0	1	0	5	0	0	0	0	0	0	0	1	0	0	0	67	1	0	0	0	0	0	0	0	0	0	75	6.50	
07-Oct	0.00																												0.00	
08-Oct	0.00																												0.00	
09-Oct	0.00																												0.00	
10-Oct	2.67	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	0	1	2.67	
11-Oct	0.00																												0.00	

Appendix D. continued

DATE	HOURS	SPECIES ¹																							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	/ HOUR
12-Oct	5.50	0	0	0	0	0	0	0	0	0	0	0	0	1	0	12	0	0	0	0	0	0	0	0	0	0	0	0	13	2.4
13-Oct	6.33	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	15	0	0	0	0	0	1	0	0	0	0	0	20	3.2
14-Oct	5.08	0	0	0	0	0	0	0	0	0	0	0	1	0	0	26	1	1	1	0	0	0	0	0	0	0	2	32	6.3	
15-Oct	7.17	0	0	0	1	1	0	0	0	0	0	0	1	0	0	23	1	1	0	0	0	0	0	0	0	0	7	35	4.9	
16-Oct	6.50	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	15	0	0	0	0	1	0	0	0	0	2	20	3.1	
17-Oct	8.00	0	0	1	13	2	0	0	0	0	0	0	0	2	1	35	1	0	0	1	0	0	0	0	0	0	0	56	7.0	
18-Oct	7.33	0	0	1	7	0	0	0	0	0	0	0	1	0	5	29	2	0	1	0	1	1	0	0	0	0	0	48	6.5	
19-Oct	0.00																													
20-Oct	0.00																													
21-Oct	7.83	0	0	2	3	0	0	0	0	0	0	0	0	4	0	43	5	0	0	0	0	1	0	0	0	0	0	58	7.4	
22-Oct	3.50	0	0	0	0	0	0	0	0	0	0	0	0	1	0	33	2	1	0	0	1	0	0	0	0	0	0	38	10.9	
23-Oct	6.08	0	0	0	0	0	0	0	0	0	0	0	0	1	0	21	0	0	0	0	1	0	0	0	0	0	1	24	3.9	
24-Oct	1.67	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	0	0	0	0	0	0	0	0	0	0	0	5	3.0	
25-Oct	5.83	0	0	0	1	0	1	0	0	1	0	0	0	0	9	0	25	0	0	0	0	1	0	0	0	0	0	38	6.5	
26-Oct	6.25	0	0	0	1	1	0	0	0	0	0	0	0	0	0	37	0	0	0	0	0	0	0	0	0	0	2	41	6.6	
27-Oct	0.00																													
28-Oct	0.00																													
29-Oct	6.67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	13	1.9	
30-Oct	0.00																													
31-Oct	6.00	0	0	0	1	0	0	0	0	0	0	0	0	2	0	16	0	0	0	0	0	0	0	0	0	0	0	19	3.2	
Total	306.25	0	9	52	230	113	13	6	6	7	33	4	75	2	30	10	638	27	4	45	4	17	23	0	3	3	4	30	1388	4.5

¹ See Appendix A for interpretation of species codes.

Appendix E. Annual observation effort and fall raptor migration counts by species in the Bridger Mountains, MT: 1991–2009.

	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 ¹	–	–	–	–	–	–	–	–	–	–
Unknown large accipiter ¹	–	–	–	–	–	–	–	–	–	–
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 ¹	–	–	–	–	–	–	–	–	–	–
Unknown large falcon ¹	–	–	–	–	–	–	–	–	–	–
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

¹ Designations used for the first time in 2002.

Appendix E. continued

	2001	2002	2003	2004	2005	2006	2007	2008	2009	MEAN
Start date	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-AUG	27-Aug	6-Sep	30-Aug
End date	31-Oct	31-Oct	31-Oct	27-Oct	31-Oct	29-Oct	29-OCT	31-Oct	31-Oct	29-Oct
Observation days	58	52	64	48	48	45	56	56	44	50
Observation hours	347.49	365.84	443.18	316.70	300.83	331.25	384.59	415.49	306.25	332.23
Raptors / 100 hours	636.3	556.0	517.6	655.2	674.8	538.6	550.5	427.7	453.2	741.9
SPECIES	RAPTOR COUNTS									
Turkey Vulture	0	0	0	0	1	2	1	0	0	1
Osprey	6	2	5	1	2	7	5	4	9	6
Northern Harrier	36	15	54	39	22	50	30	47	52	47
Sharp-shinned Hawk	274	288	416	229	228	344	277	222	230	318
Cooper's Hawk	120	103	132	142	153	182	151	115	113	161
Northern Goshawk	26	2	23	41	22	33	20	22	13	33
Unknown small accipiter ¹	–	11	29	32	92	10	18	43	6	29
Unknown large accipiter ¹	–	4	4	9	4	0	6	10	6	5
Unknown accipiter	27	5	0	7	27	0	5	3	7	27
TOTAL ACCIPITERS	447	413	604	460	526	569	477	415	375	554
Broad-winged Hawk	38	3	9	6	3	12	5	7	33	9
Swainson's Hawk	0	1	2	0	0	0	3	8	4	3
Red-tailed Hawk	117	78	113	100	108	89	130	75	75	102
Ferruginous Hawk	3	0	1	3	2	3	5	1	2	3
Rough-legged Hawk	57	11	22	20	40	21	19	32	30	32
Unidentified buteo	6	9	6	18	27	2	11	10	10	12
TOTAL BUTEOS	221	102	153	147	180	127	173	133	154	160
Golden Eagle	1330	1359	1226	1196	1061	859	1247	1003	638	1400
Bald Eagle	58	55	93	79	75	74	85	43	27	78
Unidentified eagle	2	15	4	2	1	1	0	10	4	7
TOTAL EAGLES	1390	1429	1323	1277	1137	934	1332	1056	669	1484
American Kestrel	62	16	102	65	20	38	41	46	45	68
Merlin	9	2	4	11	7	15	9	10	4	9
Prairie Falcon	14	6	15	12	20	22	17	13	17	14
Peregrine Falcon	8	1	10	10	8	15	8	5	23	8
Gyr Falcon	0	0	0	0	0	1	0	0	0	0
Unknown small falcon ¹	–	0	0	3	27	0	2	2	3	4
Unknown large falcon ¹	–	1	3	3	13	1	3	6	3	4
Unknown falcon	3	4	1	9	13	0	2	2	4	5
TOTAL FALCONS	96	30	135	113	108	92	82	84	99	107
Unidentified raptor	15	43	20	38	54	3	17	38	30	29
GRAND TOTAL	2211	2034	2294	2075	2030	1784	2117	1777	1388	2389

¹ Designations used for the first time in 2002.