

**FALL 2008 RAPTOR MIGRATION STUDY IN THE
BRIDGER MOUNTAINS, MONTANA**



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

March 2009

**FALL 2008 RAPTOR MIGRATION STUDY
IN THE BRIDGER MOUNTAINS, MONTANA**

Report prepared by:

Jeff P. Smith and Mike C. Neal

Counts conducted by:

Amy Seaman, Michaela Hitchcock, and John Bell

Project coordinated by:

HawkWatch International, Inc.

Principal Investigator: Dr. Jeff P. Smith

2240 South 900 East, Salt Lake City, Utah 84106

(801) 484-6808



March 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.....	4
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: 2008.	21
Appendix D. Daily observation effort and fall raptor migration counts by species in the Bridger Mountains, MT: 2008.....	23
Appendix E. Annual observation effort and fall raptor migration counts by species in the Bridger Mountains, MT: 1991–2008.	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: 1992–2007 versus 2008.	8
Table 2.	Fall counts by age class and immature : adult ratios for selected species of migrating raptors in the Bridger Mountains, MT: 1992–2007 versus 2008.	9
Table 3.	First and last observation, bulk passage, and median passage dates by species for migrating raptors in the Bridger Mountains, MT in 2008, with a comparison of 2008 and 1992–2007 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: 1992–2007 versus 2008.	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: 1992–2008. 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: 1992–2008. 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: 1992–2008. 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: 1992–2008. 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: 1992–2008. 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: 1992–2007 versus 2008.	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 2008 count, which marked the 18th 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 2008. 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, Amy Seaman and Michaela Hitchcock (see Appendix B for a complete observer history). Amy received preseason training in Utah and both received on-site training with HWI Conservation Science Director, Jeff Smith, and trained local volunteers. Former site observer and local volunteer, John Bell, served as a regular substitute observer during the season and assisted with orientation of the new observers. HWI Founder Steve Hoffman and long-time enthusiast John Parker also occasionally assisted with the count. In addition, a new, young, local enthusiast, Arthur (“AV”) Sagar, spent considerable time on the hill this season learning about the migration and assisting the official counters. 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 2008 follows Hoffman and Smith (2003). In comparing 2008 annual statistics against means and 95% confidence intervals for previous seasons, we equate significance with a 2008 value falling outside the bounds of the confidence interval for the associated mean.

RESULTS AND DISCUSSION

WEATHER SUMMARY

Compared to the past 11 seasons (the period for which detailed weather records have been compiled and analyzed), inclement weather and attendant difficult access conditions hampered observations at a slightly below average level in 2008, fully precluding 10 days of observation (1997–2007 average of 11.8 days) and reducing observations to ≤ 4 hours on only 2 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 32% 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 23%, and mostly cloudy or overcast skies on 45%. The 1997–2007 averages for the site are 37% fair, 34% transitional, and 29% mostly cloudy to overcast, indicating that 2008 was significantly cloudier than usual. The proportion of active days that included rain and/or snow showers was average (13% vs. average of 14%), whereas the proportion that included some visibility reducing fog and/or haze was above average (38% vs. average of 31%). Due to the increase in cloudiness and fog/haze, the observers’ estimates suggested that visibility was significantly below average in 2008 (65–71 km vs. averages of 75–80 km); reflecting record low visibility to the west.

Data collected in 2008 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 91% of the active observation days, moderate winds (12–29 kph) on 7%, and strong winds on 2%, compared to the 1997–2007 averages of 79%, 19%, and 2%, respectively. In terms of wind

directions, SW–W, W, W–NW, NE–SE winds average most common at this site, in that order of prevalence. This was only partially true in 2008. Steady W winds were much more common than usual in 2008, prevailing on 52% of the active days compared to the 1997–2007 average of only 28% (plus another 5% of the active days featured primarily W winds but with significant periods of calm/variable winds [average 1%]). In contrast, the other three most common patterns were all substantially less common than usual in 2008: SW–W 16% vs. average of 28%, W–NW 2% vs. average of 12%, and NE–SE 4% vs. average of 8%).

The temperature during active observation periods averaged 10.8°C (the average of daily values, which in turn were averages of hourly readings), ranging from -3.1–21.6°C. The daily average is slightly below the long-term average of 11.9°C, and the high end of the range represents a record low. The on-site barometric pressure during active observation periods averaged 30.72 inHg (the average of daily values, which in turn were averages of hourly readings), ranging from 30.18–31.06 inHg. All of these values are among the highest recorded since 2000, when we began recording barometric pressure data at the site, and the average represents a record high. The observers subjectively rated only 18% of the active days as featuring predominantly good to excellent thermal lift conditions, which is considerably lower than the 1997–2007 average of 40%.

In summary, inclement weather and difficult access conditions hampered observations at a slightly below average level in 2008. Active observation periods were cloudier and included a greater prevalence of visibility reducing fog/haze than usual, which translated to below-average visibility; however, the prevalence of rain/snow showers during active observations was average. The winds during active observation periods averaged lighter than usual and steady W winds, as opposed to more variable SW–W and W–NW patterns, prevailed much more often than usual. Otherwise, high pressure prevailed more often than usual but the temperature regime was colder than usual, and the observers' subjective assessments of thermal-lift conditions during the season also ranked below average.

OBSERVATION EFFORT

Observations occurred on 56 of 66 days between 27 August and 31 October in 2008. The number of observation days was a significant 10% higher than the 1992–2007 average of $51 \pm 95\%$ CI of 3.9 days, and the number of observation hours (415.49) was a significant 24% higher than the long-term average of 335.85 ± 28.38 hours. The 2008 average of 2.1 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 $1.8 \pm 95\%$ CI of 0.10 observers per hour, due to additional support provided by local volunteers and past HWI affiliates.

FLIGHT SUMMARY

The observers tallied 1,777 migrating raptors of 15 species during the 2008 season (Table 1; see Appendix D for daily count records). The total count was a significant 28% below average and represents the second lowest count yet recorded, ranking ahead of only the first count in 1991 (see Appendix E for annual summaries). The low total count primarily reflects a low count of only 1,003 Golden Eagles, which is the second lowest count for this species yet recorded (ahead of only 2006 when 934 were tallied). Otherwise, no record low or high species-specific counts or unusual sightings occurred in 2008.

The flight was composed of 59% eagles, 23% accipiters, 8% buteos, 5% falcons, 3% harriers, 1% unidentified raptors, and <1% each of Ospreys and vultures (Figure 2). The proportion of harriers was significantly above average, reflecting a 47% higher than average count of Northern Harriers. 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 2008, adjusted passage rates were significantly above average only for the uncommon Swainson's Hawk, whereas passage rates were significantly below average for Turkey Vultures, Ospreys, all three accipiters, Red-tailed Hawks, Rough-legged Hawks, Golden Eagles, Bald Eagles, and American Kestrels (Table 1, Figures 3–7). Regression analyses updated through 2008 (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 ($P = 0.09$) declining trend for adults and a highly significant declining trend for non-adults. Marginally significant linear declining trends also were indicated for Sharp-shinned Hawks, Cooper's Hawks, and American Kestrels (Figures 4 and 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 rebound in 2007 and particularly 2008 back to the levels seen from 1993–2000 (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 trends were indicated.

Smith et al. (2008a) present trend analyses of data collected through 2005 for most of the long-term, on-going, 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 2008. 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 2008.

Differences between the RPI results and those presented herein that clearly relate to addition of three more years of data include: a) addition of two low counts in 2007 and 2008 resulted in a new marginally significant overall decline for Sharp-shinned Hawks (Figure 4); b) three more years of near record-low passage rates for Golden Eagles rendered a highly significant linear declining trend through 2008 (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 c) three 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 ($P = 0.13$) second-order model fit that tracked an increasing pattern through 1998 but a decline thereafter. Farmer et al. (2008) and Farmer and Smith (in review) highlight recent evidence of widespread declines across North America of this otherwise common and ubiquitous species.

Age Ratios

Immature : adult ratios were below average in 2008 for 7 of 8 species for which relevant age-specific data were available, significantly so for Cooper's Hawks, Northern Goshawks, Red-tailed Hawks, and Bald Eagles (Table 2). Moreover, for all species exhibiting below-average age ratios, the counts of identified immature birds were below average, suggesting that the low age ratios may be indicative of low productivity in 2008. That said, for several of these species, the proportions of unaged birds were

significantly different from average (Table 2) and, therefore, these statistics must be considered with caution. For most species, the counts of identified adults also were, to varying degrees, below average, suggesting that the low total counts recorded for most species were due to a combination of both low productivity and low adult survival in 2008. The Sharp-shinned Hawk was the only exception to below average age ratios in 2008. In this case, the count of identified immature birds essentially matched the long-term average, whereas the count of identified adults was well below average. This suggests that for this species overall productivity may have been decent in the northern Rocky Mountains in 2008, but adult survival appears to have suffered.

Seasonal Timing

The 2008 median passage date for Golden Eagles of 15 October was a significant 4 days later than average (Table 3). The only other species that showed significantly late passage in 2008 were the Northern Goshawk and Merlin, whereas five species showed significantly early timing (Northern Harrier, Sharp-shinned Hawk, Cooper's Hawk, Rough-Legged Hawk, and American Kestrel). The combined-species seasonal activity pattern confirmed an unusual dearth of activity during the 11–15 October five-day period, followed by an unusually high and late spike in activity during the following five-day period, as well as on the last day of the count (Figure 8). These patterns largely mimic the Golden Eagle activity pattern, with the major mid-October spike in activity occurring during a three-day window between fronts that brought heavy snowfall and peak Golden Eagle activity. Another above-average activity spike occurred in mid-September, however, and corresponded to early peak passage of Northern Harriers, the two smaller accipiters, and American Kestrels (Figure 8). Early and frequent snow squalls likely contributed to early passage of these species.

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 3 October and occasionally thereafter until the end of the season.

Resident Sharp-shinned Hawks, including at least two immature birds and an adult male, were seen regularly from 27 August until 6 October. The immatures often were seen dog-fighting to the west of the observation point as well as west of Tilly Peak to the north of the observation point. The adult male often escorted migrants through the area. An adult Cooper's Hawk was first seen in the area on 9 September "playing" with a Sharp-shinned Hawk on the west slope of Tilly, and was seen frequently thereafter until 26 September.

Resident Red-tailed Hawks, including two light morph adults and two light-morph immatures, were seen from 28 August until 24 October. They were seen mostly low on the east side of the ridge below and north of the observation point to Tilly peak. These birds occasionally escorted migrants through the area, and the observers often saw and heard them during their daily hike up to the observation point.

Two adults and one first-year Golden Eagle resided in the area throughout the season. They were seen mostly above the treed ridge far to the northwest of the observation point, but they also spent time south of the observation point above Saddle Peak. The adult male was often seen displaying in typical roller-coaster fashion, and all three birds were seen dog-fighting and occasionally escorting migrants through the area. One immature Bald Eagle was seen on 31 August and one adult Bald Eagle was seen on 5 September exhibiting resident behavior.

A pair of American Kestrels resided in the area from 27 August through 19 September, hunting in various areas around the observation point and occasionally attacking the owl decoy. At least one Prairie

Falcon routinely patrolled the ridgeline from 17 October until the end of the season. Two Peregrine Falcons, an immature and an adult, exhibited resident behavior between 29 August and 2 September. The adult both hunted in the area and showed territorial behavior such as chasing a Golden Eagle. The two birds also were seen circling above and perching on Saddle Peak.

This is a fairly typical resident assemblage for the site.

VISITATION

Throughout the course of the season, 175 individuals signed the visitor logs kept at the watchsite. Most visitors hailed from nearby areas of Montana, most from the Bozeman area; however, other guests visited from seven other states (Montana, Idaho, Wyoming, Ohio, Illinois, Texas, and Rhode Island) and Wickford, England 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 group that hiked up to the observation site with HWI Founder and now Director of Montana Audubon, Steve Hoffman. HWI Membership and PR Coordinator, Laura Kohn, also attended the festival this year to help promote the project and our work.

In 2008, 432 hourly assessments by the primary observers of visitor disturbance resulted in the following ratings: 90% none, 8% low, <1% moderate, and <1% high, which indicates an average level of visitor disturbance for this site.

ACKNOWLEDGMENTS

Funding for the 2008 project was provided by the Arthur and Elaine Johnson Foundation, Fanwood Foundation, Walbridge Fund, Sacajawea Audubon Society, and HWI private donors and members. Gallatin National Forest, especially Bev Dixon, and Bridger Bowl Ski Area, especially Randy Elliot, provided essential logistical support. In addition, we are especially thankful this year for new 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 for arranging this incredible new connection for us and to Deb Stratford, Kate and Ron Vargas, and Johnnie Corrie for their help arranging for and providing the two local cabins the crew lived in during the season. We are also grateful for the participation and interest of Bridger to Bangtail Coalition Board Member Gary Sagar and especially his son AV Sagar, who spent considerable time on the hill learning and assisting our official counters. Additional thanks go to Jeff Pentel, Steve Hoffman, John Parker, and John Bell 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 review. Migration counts indicate widespread declines of American Kestrels (*Falco sparverius*) in North America. *Journal of Raptor Research*, 2008 Special Issue on American Kestrels.
- 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: 1992–2007 versus 2008.

SPECIES	COUNTS			RAPTORS/100 HRS		
	1992–2007 ¹	2008	% CHANGE	1992–2007 ¹	2008	% CHANGE
Turkey Vulture	0.8 ± 0.76	0	-100	0.5 ± 0.40	0.0	-100
Osprey	6 ± 2.0	4	-33	2.8 ± 0.96	1.6	-43
Northern Harrier	48 ± 25.2	47	-3	15.3 ± 8.15	13.6	-11
Sharp-shinned Hawk	338 ± 55.3	222	-34	127.3 ± 18.96	78.3	-38
Cooper's Hawk	169 ± 36.2	115	-32	124.8 ± 25.28	74.3	-40
Northern Goshawk	34 ± 10.8	22	-36	12.2 ± 4.39	4.6	-62
Unknown small accipiter ²	27 ± 22.6	43	+57	–	–	–
Unknown large accipiter ²	4 ± 2.4	10	+159	–	–	–
Unknown accipiter	26 ± 8.9	3	-88	–	–	–
TOTAL ACCIPITERS	581 ± 91.0	415	-29	–	–	–
Broad-winged Hawk	9 ± 4.6	7	-24	4.6 ± 2.40	3.9	-15
Swainson's Hawk	2 ± 1.4	8	+256	1.1 ± 0.82	2.9	+154
Red-tailed Hawk	108 ± 25.1	75	-31	38.7 ± 8.23	24.6	-37
Ferruginous Hawk	3 ± 1.0	1	-61	0.9 ± 0.32	0.3	-68
Rough-legged Hawk	34 ± 10.1	32	-5	25.4 ± 7.21	20.2	-20
Unidentified buteo	12 ± 3.4	10	-18	–	–	–
TOTAL BUTEOS	168 ± 34.5	133	-21	–	–	–
Golden Eagle	1,432 ± 143.4	1,003	-30	564.5 ± 48.13	304.9	-46
Bald Eagle	83 ± 11.5	43	-48	33.0 ± 4.70	10.9	-67
Unidentified eagle	7 ± 3.8	10	+51	–	–	–
TOTAL EAGLES	1,521 ± 148.2	1,056	-31	–	–	–
American Kestrel	71 ± 20.3	46	-35	61.5 ± 16.88	31.4	-49
Merlin	10 ± 2.9	10	+3	7.3 ± 1.94	5.7	-21
Prairie Falcon	14 ± 2.1	13	-6	9.1 ± 1.84	8.0	-12
Peregrine Falcon	9 ± 2.4	5	-43	7.2 ± 2.01	5.1	-29
Gyr Falcon	0.1 ± 0.12	0	-100	–	–	–
Unknown small falcon ²	5 ± 7.4	2	-56	–	–	–
Unknown large falcon ²	3 ± 3.3	6	+75	–	–	–
Unknown falcon	5 ± 2.2	2	-61	–	–	–
TOTAL FALCONS	113 ± 24.0	84	-25	–	–	–
Unidentified raptor	28 ± 6.8	38	+38	–	–	–
GRAND TOTAL	2,465 ± 257.6	1,777	-28	–	–	–

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: 1992–2007 versus 2008.

	TOTAL AND AGE-CLASSIFIED COUNTS						IMMATURE : ADULT			
	1992–2007 AVERAGE			2008			% UNKNOWN AGE		RATIO	
	TOTAL	IMM.	ADULT	TOTAL	IMM.	ADULT	1992–2007 ¹	2008	1992–2007 ¹	2008
Northern Harrier	48	23	12	47	6	10	29 ± 6.0	66	3.5 ± 3.65	0.6
Sharp-shinned Hawk	338	61	129	222	60	82	44 ± 7.1	36	0.5 ± 0.11	0.7
Cooper’s Hawk	169	45	58	115	25	45	39 ± 5.8	39	0.8 ± 0.28	0.6
Northern Goshawk	34	13	14	22	2	5	25 ± 10.0	68	1.6 ± 0.56	0.4
Broad-winged Hawk	9	2	3	7	1	4	40 ± 19.7	29	1.0 ± 0.86	0.3
Red-tailed Hawk	108	34	50	75	12	53	23 ± 4.5	13	0.7 ± 0.35	0.2
Golden Eagle	1432	547	522	1003	432	420	26 ± 4.5	15	1.1 ± 0.18	1.0
Bald Eagle	83	29	52	43	8	29	3 ± 16.2	14	0.6 ± 0.13	0.3

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 2008, with a comparison of 2008 and 1992–2007 average median passage dates.

SPECIES	2008				1992–2007
	FIRST OBSERVED	LAST OBSERVED	BULK PASSAGE DATES ¹	MEDIAN PASSAGE DATE ²	MEDIAN PASSAGE DATE ³
Osprey	31-Aug	25-Sep	–	–	16-Sep ± 3.1
Northern Harrier	31-Aug	20-Oct	31-Aug – 3-Oct	17-Sep	23-Sep ± 4.4
Sharp-shinned Hawk	30-Aug	31-Oct	13-Sep – 20-Oct	26-Sep	01-Oct ± 1.7
Cooper’s Hawk	29-Aug	30-Oct	11-Sep – 3-Oct	20-Sep	24-Sep ± 3.2
Northern Goshawk	18-Sep	31-Oct	24-Sep – 31-Oct	17-Oct	09-Oct ± 5.0
Broad-winged Hawk	17-Sep	30-Sep	17-Sep – 30-Sep	18-Sep	20-Sep ± 2.0
Swainson’s Hawk	12-Sep	24-Sep	12-Sep – 24-Sep	17-Sep	14-Sep ± 7.8
Red-tailed Hawk	31-Aug	25-Oct	8-Sep – 7-Oct	20-Sep	22-Sep ± 2.4
Ferruginous Hawk	28-Sep	28-Sep	–	–	05-Oct ± 15.4
Rough-legged Hawk	29-Sep	30-Oct	9-Oct – 29-Oct	19-Oct	21-Oct ± 1.6
Golden Eagle	30-Aug	31-Oct	25-Sep – 29-Oct	15-Oct	11-Oct ± 2.1
Bald Eagle	2-Sep	31-Oct	9-Sep – 30-Oct	15-Oct	15-Oct ± 2.7
American Kestrel	27-Aug	25-Oct	8-Sep – 2-Oct	18-Sep	22-Sep ± 2.2
Merlin	24-Sep	30-Oct	24-Sep – 29-Oct	19-Oct	04-Oct ± 3.2
Prairie Falcon	3-Sep	31-Oct	4-Sep – 27-Oct	26-Sep	24-Sep ± 4.4
Peregrine Falcon	20-Sep	30-Sep	20-Sep – 30-Sep	26-Sep	25-Sep ± 2.6
All species	6-Sep	31-Oct	15-Sep – 25-Oct	6-Oct	07-Oct ± 1.6

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.

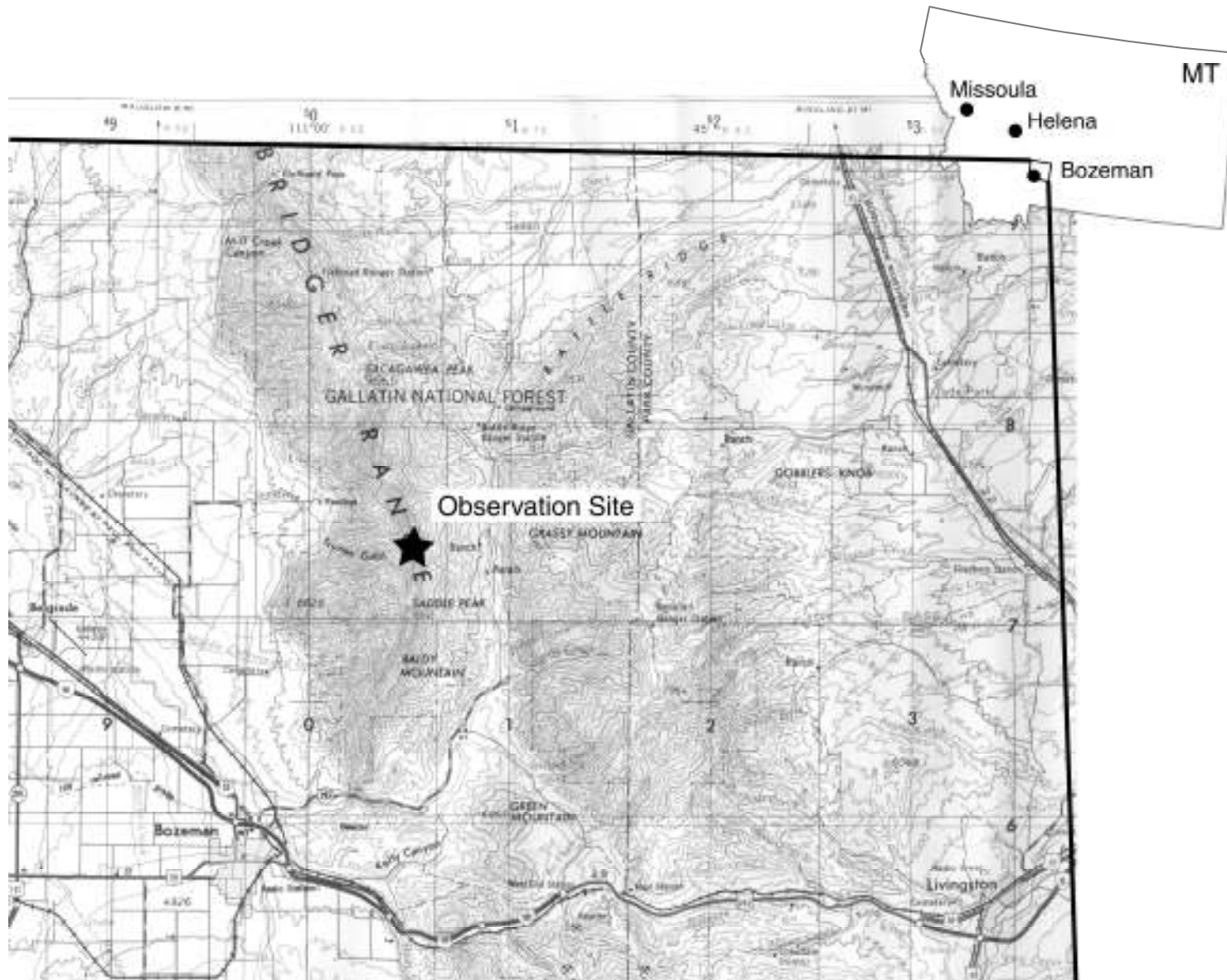


Figure 1. Location of the Bridger Mountains Raptor Migration Project study site.

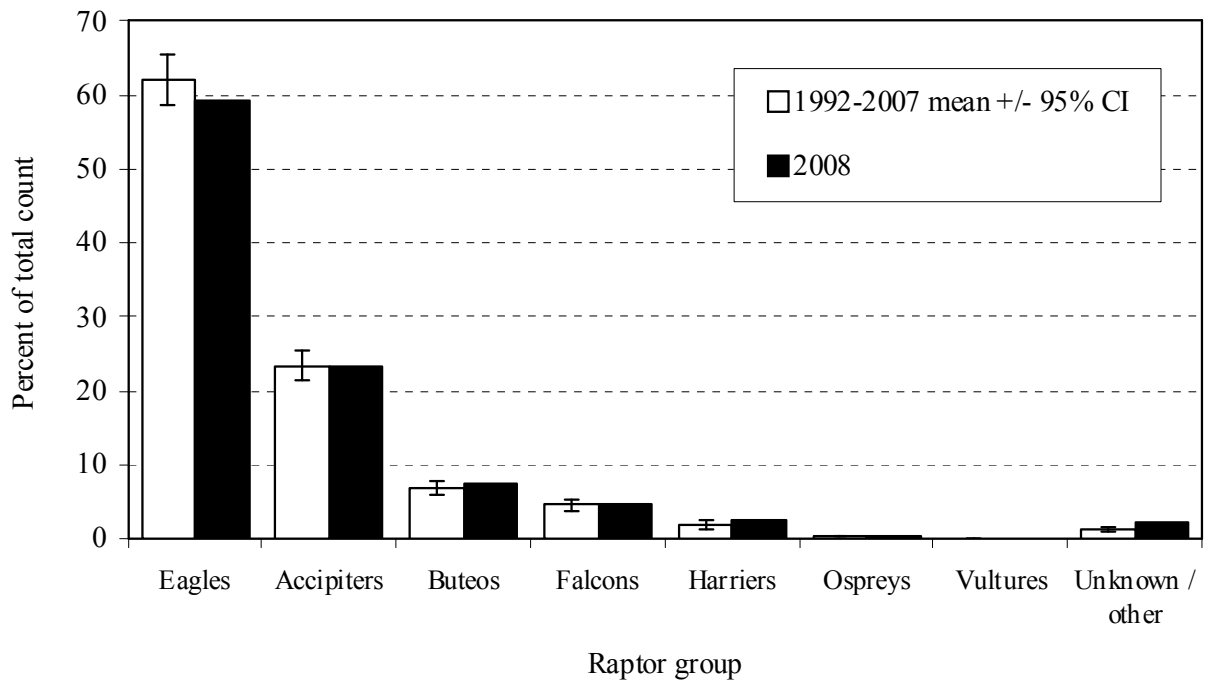


Figure 2. Composition of the fall raptor migration in the Bridger Mountains by major species groups: 1992–2007 versus 2008.

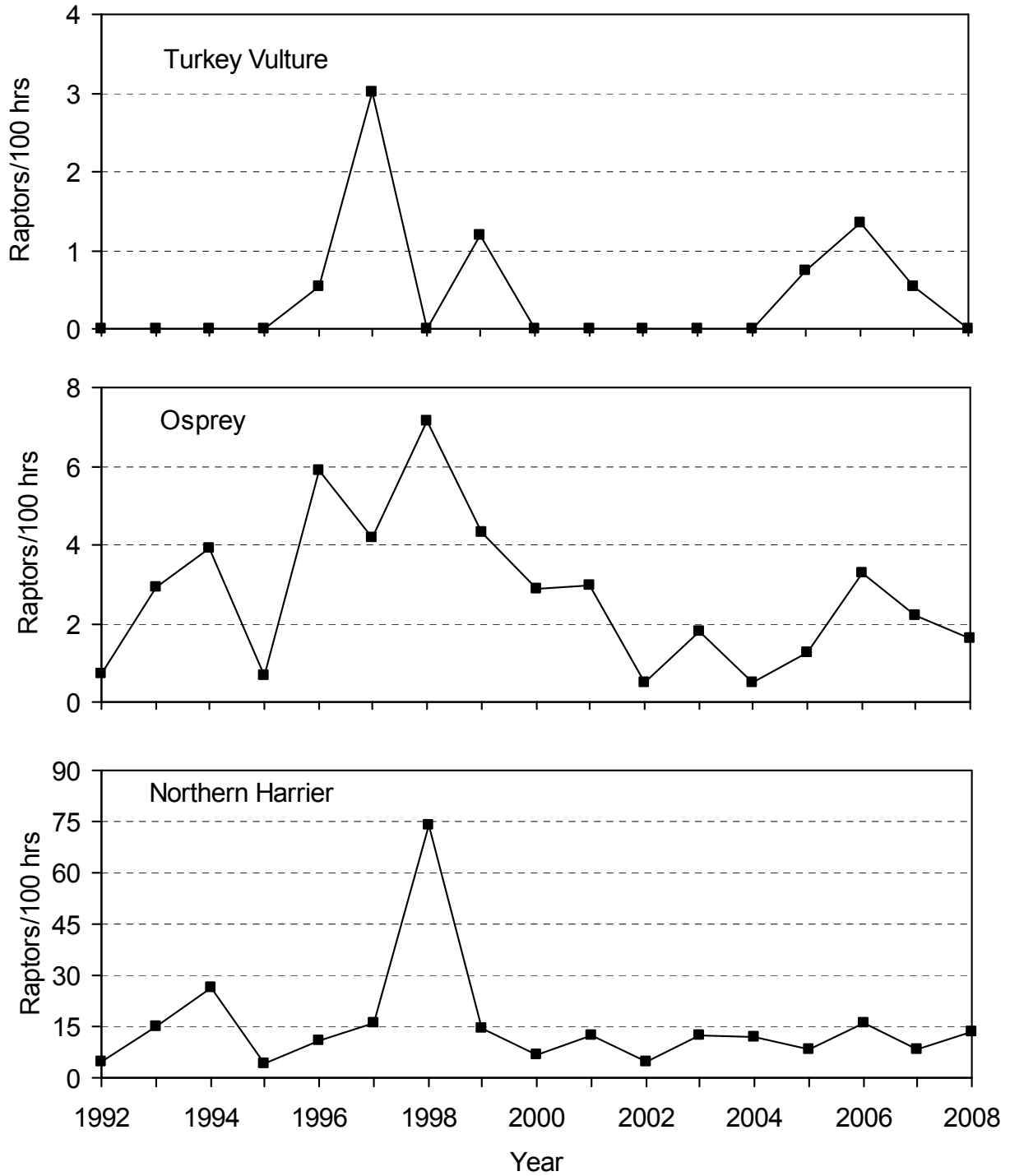


Figure 3. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Turkey Vultures, Ospreys, and Northern Harriers in the Bridger Mountains, MT: 1992–2008. Dashed lines indicate significant ($P \leq 0.10$) regressions.

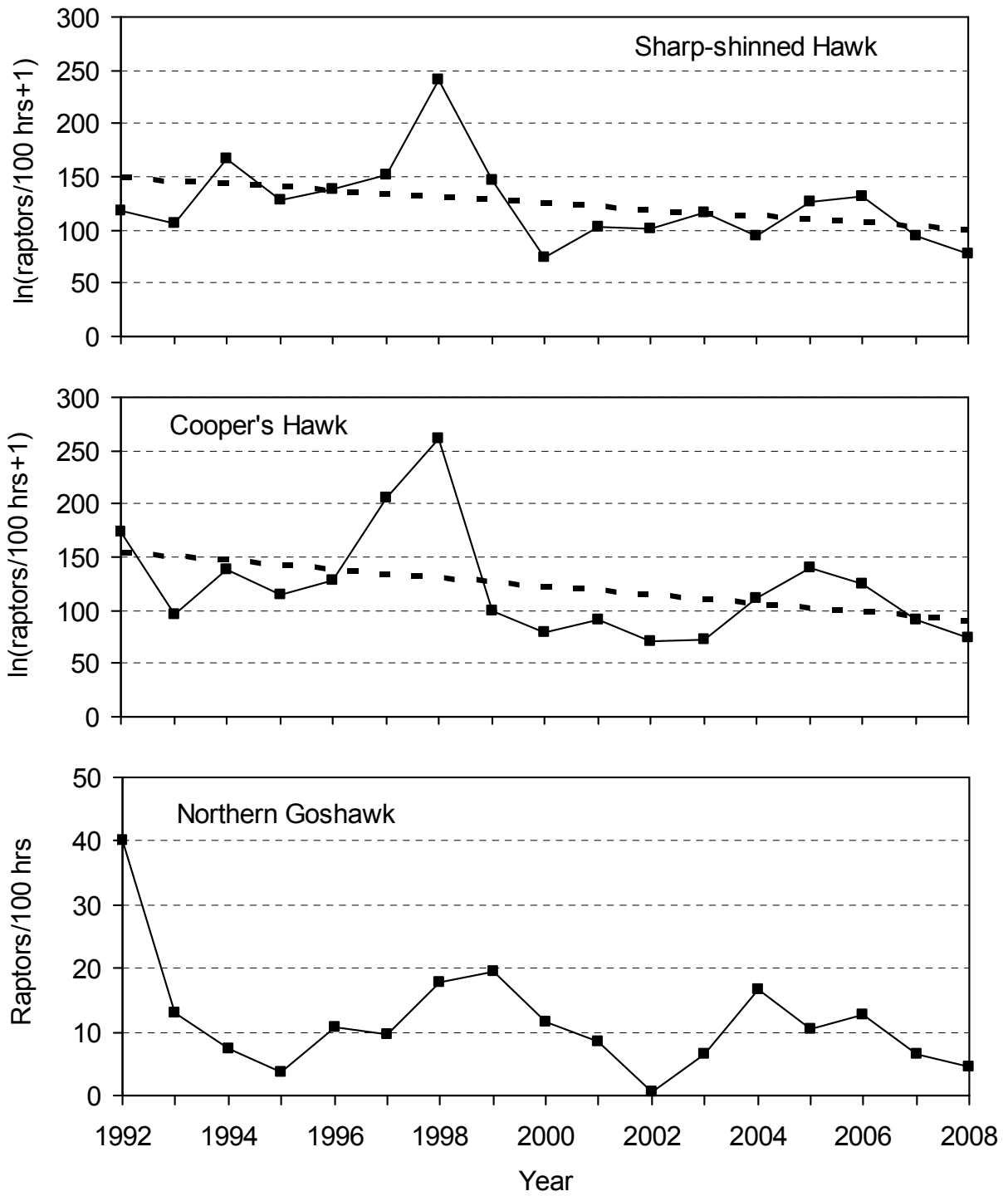


Figure 4. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks in the Bridger Mountains, MT: 1992–2008. Dashed lines indicate significant ($P \leq 0.10$) regressions.

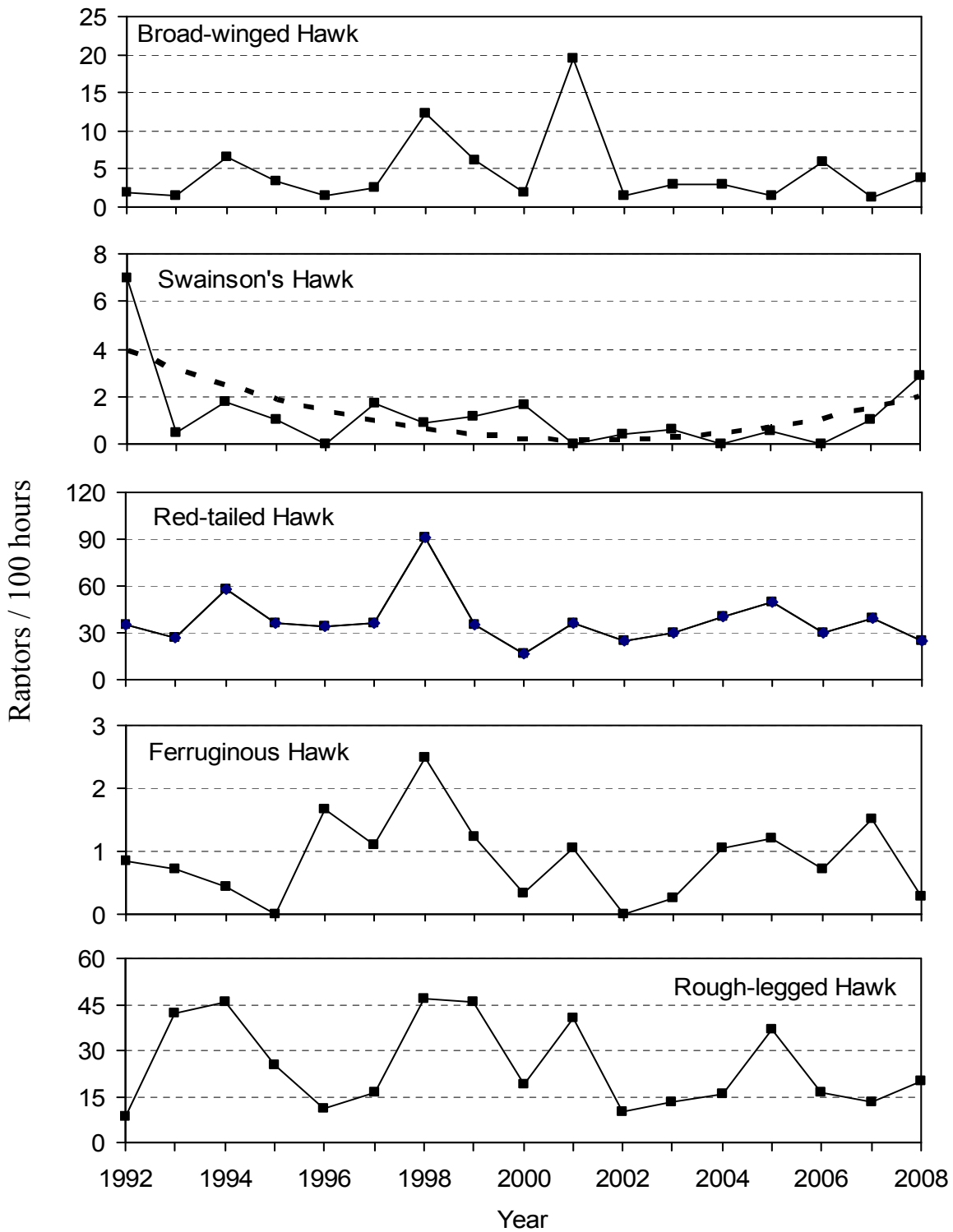


Figure 5. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Broad-winged, Swainson's, Red-tailed, Ferruginous, and Rough-legged Hawks in the Bridger Mountains, MT: 1992–2008. Dashed lines indicate significant ($P \leq 0.10$) regressions.

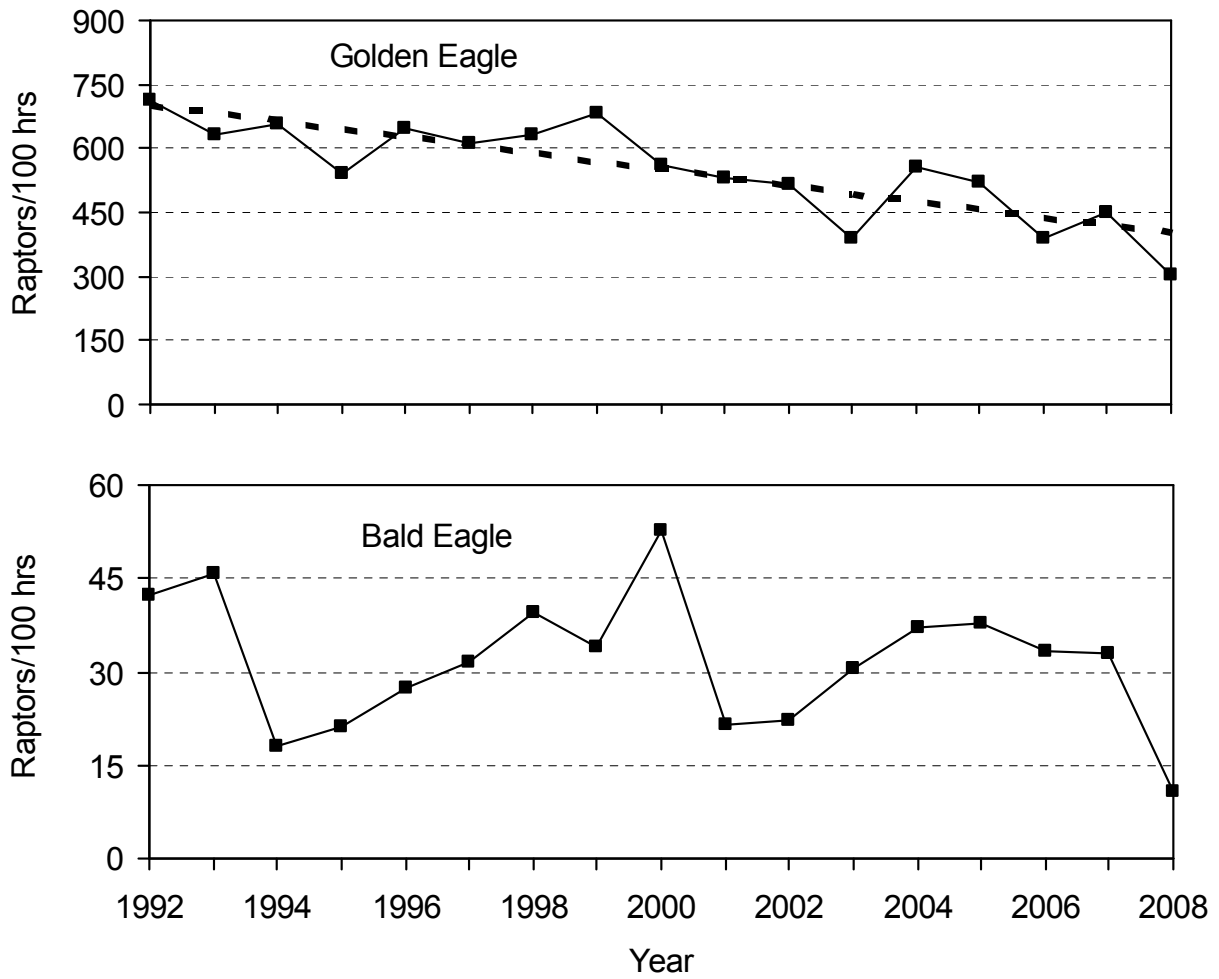


Figure 6. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Golden and Bald Eagles in the Bridger Mountains, MT: 1992–2008. Dashed lines indicate significant ($P \leq 0.10$) regressions.

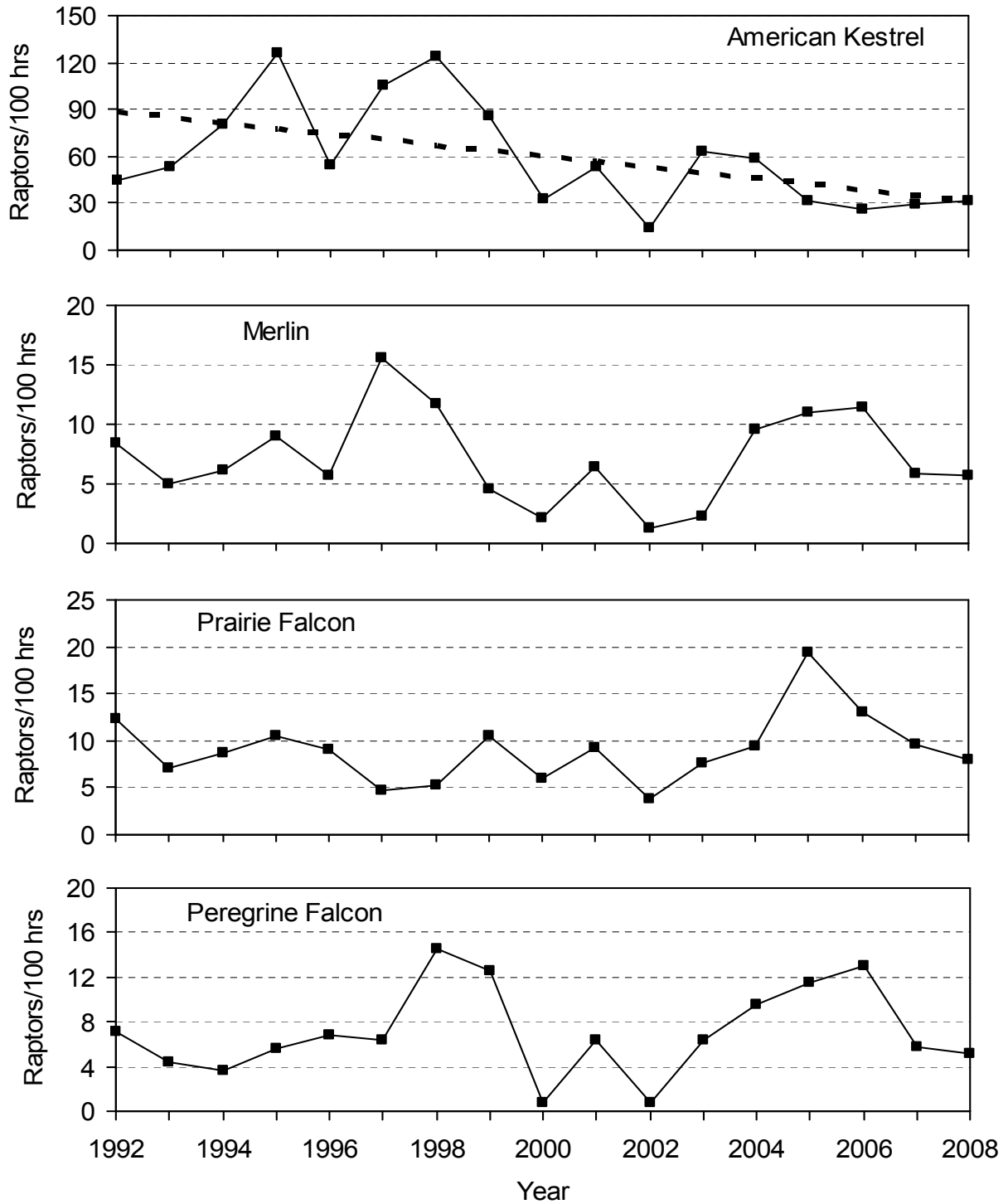


Figure 7. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons in the Bridger Mountains, MT: 1992–2008. Dashed lines indicate significant ($P \leq 0.10$) regressions.

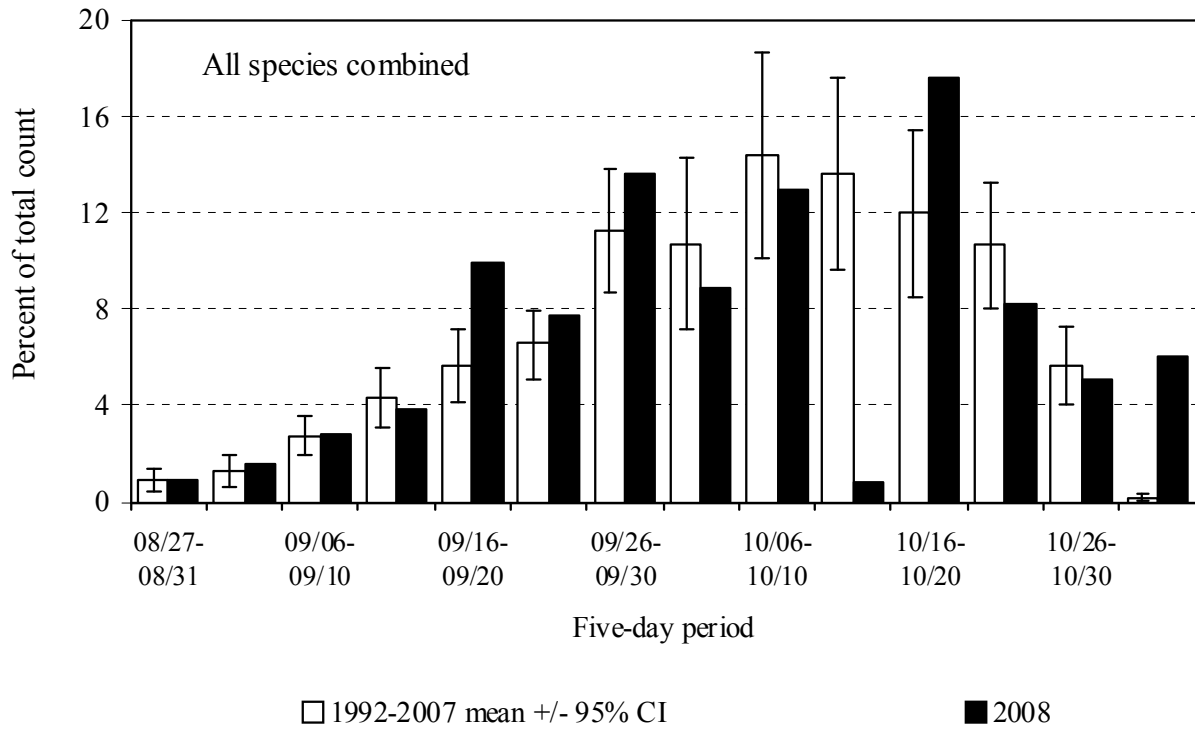


Figure 8. Passage volume by five-day periods for migrating Golden and Bald Eagles in the Bridger Mountains, MT: 1992–2007 versus 2008.

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)

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: 2008.

DATE	OBS. HOURS	OBSRVR / HOUR ¹	MEDIAN	PREDOMINANT WEATHER ³	WIND		TEMP (°C) ¹	BAROM.	MEDIAN	VISIB.	VISIB.	MEDIAN	BIRDS / HOUR
			VISITOR DISTURB ²		SPEED (KPH) ¹	DIRECTION		PRESS. (IN HG) ¹	THERMAL LIFT ⁴	WEST (KM) ¹	EAST (KM) ¹	FLIGHT DISTANCE ⁵	
27-Aug	8.33	1.0	0	ovc, scat PM rain/snow		w	10.0	30.50	4	30.5	29.5	2	0.1
28-Aug	5.75	1.0	0	clr-pc		w	10.9	30.74	2	52.1	55.7	-	0.0
29-Aug	7.92	1.0	0	clr-pc		w	16.9	30.79	2	57.0	57.0	2	1.1
30-Aug	9.75	1.0	0	mc-ovc, AM haze		ssw-w	21.6	30.50	3	60.0	60.0	2	0.6
31-Aug	7.75	2.0	0	clr-mc		n-e	17.0	30.35	3	48.7	47.8	1	2.6
01-Sep	0.00			Weather Day: fog/rain/snow									
02-Sep	7.17	2.6	0	clr-ovc		sw, calm	8.0	30.84	3	90.6	65.6	2	0.3
03-Sep	8.00	3.0	0	mc-ovc, AM snow	2.2	var	11.3	30.72	4	71.7	65.6	3	0.6
04-Sep	5.67	2.9	0	ovc, fog, blowing snow	3.4	calm/var	7.8	30.69	4	37.5	40.5	2	0.2
05-Sep	7.58	2.0	0	mc-ovc, fog, blowing snow	4.8	w-nw	9.0	30.70	4	53.3	42.5	-	0.5
06-Sep	0.00			Weather Day: fog/rain									
07-Sep	0.00			Weather Day: fog/rain									
08-Sep	7.83	3.0	0	clr	8.1	e-se, nw	10.6	30.70	3	96.0	80.0	2	3.2
09-Sep	7.83	2.9	0	clr	4.1	sw-nw	17.0	30.50	3	79.5	67.5	2	2.6
10-Sep	0.00			Weather Day: fog/rain/snow									
11-Sep	8.00	2.0	0	pc-ovc, AM fog	1.4	var	10.8	30.75	4	53.0	41.5	2	2.3
12-Sep	8.00	2.0	0	clr	7.7	w	13.9	30.60	2	100.0	100.0	3	4.5
13-Sep	6.75	2.0	0	ovc, AM fog/snow	3.1	sw-w	8.3	30.81	4	36.3	36.3	2	0.1
14-Sep	7.83	2.5	1.5	clr, pm haze	6.7	w	13.6	30.91	3	87.0	70.5	2	1.8
15-Sep	8.00	2.0	0	pc, haze	5.1	w	18.0	31.00	1	86.5	78.5	3	3.1
16-Sep	8.00	2.0	0	clr, haze	3.8	w	19.3	30.97	1	78.9	58.3	2	3.6
17-Sep	8.00	1.8	0	clr, haze	3.1	sw-w	20.1	30.88	1	84.0	50.5	2	5.9
18-Sep	8.00	2.0	0	clr-pc	5.9	e-se, w	19.7	30.84	2	55.0	90.5	2	5.0
19-Sep	7.75	3.0	0	clr-ovc, haze, PM scat rain	3.7	sw-w	17.6	30.86	3	80.9	54.1	2	4.6
20-Sep	5.75	2.7	0	pc-ovc, haze	6.8	se	18.1	30.66	3	83.8	47.5	2	11.1
21-Sep	4.00	2.0	0	ovc, scat rain/ts	7.0	wsww	7.9	30.42	4	53.8	46.4	2	1.0
22-Sep	7.00	1.9	0	ovc, scat snow	7.1	w	8.0	30.51	4	70.5	54.5	2	2.3
23-Sep	7.50	2.0	0	clr-pc	7.7	w	5.8	30.73	2	88.9	84.4	3	2.9
24-Sep	7.83	2.5	0	mc-ovc	4.0	w	14.8	30.78	3	85.0	58.0	2	4.0
25-Sep	8.33	2.0	0	ovc	2.4	w	16.4	30.71	4	75.5	60.0	2	2.5
26-Sep	8.00	2.0	2.5	clr-pc, haze	3.2	w	13.9	30.85	3	78.5	48.0	2	12.6
27-Sep	8.00	2.0	1	pc-ovc, AM haze	4.3	ssw, w-nw	15.8	30.82	3	78.5	73.5	2	3.5
28-Sep	8.00	2.5	0	clr-pc, haze	2.8	w, calm	14.1	30.99	3	75.0	67.5	1	6.5
29-Sep	8.00	1.9	0	clr, haze	1.3	w, calm	16.9	31.02	2	85.5	69.5	2	5.1
30-Sep	6.92	1.9	0	clr, pm haze	2.3	wnw, calm	19.6	30.78	3	77.3	78.2	2	4.5
01-Oct	8.00	2.0	0	pc-mc	4.1	w	17.9	30.95	4	80.0	68.0	2	1.1
02-Oct	8.00	2.8	0	pc-mc, haze	2.4	se, s, w	18.7	30.69	3	75.0	62.0	2	4.6
03-Oct	8.00	2.5	0	mc-ovc, haze	2.7	w, calm	14.7	30.49	4	73.0	68.0	2	8.0
04-Oct	7.50	2.5	1	ovc, blowing snow	5.0	w	10.8	30.18	4	82.7	77.7	2	2.1
05-Oct	4.00	2.1	2.5	ovc, snow	2.5	w	5.3	30.37	4	40.0	40.0	1	0.8
06-Oct	8.00	1.9	0	mc-ovc	7.1	w	4.5	30.67	3	90.0	80.0	2	2.6
07-Oct	7.75	1.8	0	mc-ovc	9.7	sw, w	9.7	30.60	4	80.0	77.8	2	3.7
08-Oct	7.50	2.0	0	clr-pc	6.3	w	3.9	30.64	4	80.0	78.3	2	9.3
09-Oct	6.75	2.6	0	clr-pc	30.8	e	0.1	30.27	4	62.8	68.3	2	15.9
10-Oct	0.00			Weather Day: fog/snow									
11-Oct	0.00			Weather Day: fog/snow									
12-Oct	0.00			Weather Day: fog/snow									
13-Oct	0.00			Weather Day: fog/snow									

Appendix C. continued

DATE	OBS. HOURS	OBSRVR / HOUR ¹	MEDIAN	PREDOMINANT WEATHER ³	WIND	WIND DIRECTION	TEMP (°C) ¹	BAROM.	MEDIAN	VISIB.	VISIB.	MEDIAN	BIRDS / HOUR
			VISITOR DISTURB ²		SPEED (KPH) ¹			PRESS. (IN HG) ¹	THERMAL LIFT ⁴	WEST (KM) ¹	EAST (KM) ¹	FLIGHT DISTANCE ⁵	
14-Oct	6.00	2.0	0	ovc, blowing snow	7.0	w	2.9	30.70	4	38.1	38.1	2	2.3
15-Oct	7.50	2.7	0	mc-ovc, PM haze	3.1	w	5.9	30.69	4	68.3	62.2	2	13.5
16-Oct	0.00			Weather Day: fog/snow									
17-Oct	8.00	2.0	0	mc-ovc	6.9	w	5.5	30.85	4	88.0	79.5	1	12.5
18-Oct	8.00	2.0	0	mc	7.9	w	7.2	30.63	4	75.0	90.0	1	8.9
19-Oct	7.00	2.0	0	ovc	1.0	calm	6.8	30.78	4	41.7	57.2	1	5.9
20-Oct	6.50	1.8	0	pc-ovc, PM blowing snow	5.8	sw	8.0	30.59	4	67.5	39.4	2	4.0
21-Oct	0.00			Weather Day: fog/snow									
22-Oct	6.00	1.8	0	clr-ovc, blowing snow	15.6	w	-3.1	30.89	4	80.0	77.5	1	4.7
23-Oct	7.25	2.0	0	pc-ovc	6.6	w	5.0	30.68	4	80.0	80.0	1	5.1
24-Oct	7.00	2.0	0	ovc	13.2	w	3.6	30.63	4	80.0	80.0	2	7.9
25-Oct	6.00	2.0	0	mc-ovc	16.0	w	4.7	30.58	4	71.4	72.9	2	3.8
26-Oct	8.00	2.0	0	clr-mc, haze	11.8	w	-1.5	31.06	4	70.0	70.0	2	2.6
27-Oct	7.50	2.0	0	pc-mc, haze	12.1	w	6.1	31.01	4	73.8	75.0	1	1.2
28-Oct	8.00	2.0	0	clr	4.6	sw	8.4	31.03	4	80.0	80.0	1	0.6
29-Oct	8.00	2.0	0	mc-ovc	9.2	w	8.7	30.72	4	78.9	77.8	2	4.1
30-Oct	8.00	2.0	0	ovc	6.8	w	6.8	30.70	3	67.5	90.0	2	7.1
31-Oct	8.00	2.4	0	ovc	6.5	ssw, w	9.0	30.87	4	87.0	65.0	2	6.3

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: 2008.

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
27-Aug	8.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0.1
28-Aug	5.75	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
29-Aug	7.92	0	0	0	0	1	0	0	4	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	3	9	1.1	
30-Aug	9.75	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	1	0	0	6	0.6	
31-Aug	7.75	0	1	8	2	1	0	0	0	0	0	6	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	20	2.6	
01-Sep	0.00																													
02-Sep	7.17	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0.3	
03-Sep	8.00	0	0	0	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0	0	1	0	0	0	0	0	0	5	0.6	
04-Sep	5.67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0.2	
05-Sep	7.58	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	4	0.5	
06-Sep	0.00																													
07-Sep	0.00																													
08-Sep	7.83	0	0	9	3	2	0	0	0	0	0	3	0	0	4	1	0	1	0	1	0	0	0	0	0	1	25	3.2		
09-Sep	7.83	0	0	1	5	4	0	0	0	0	0	3	0	0	1	2	0	3	0	1	0	0	0	0	0	0	20	2.6		
10-Sep	0.00																													
11-Sep	8.00	0	1	2	5	5	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	2	18	2.3		
12-Sep	8.00	0	1	1	4	10	0	1	0	0	0	1	11	0	0	3	0	0	4	0	0	0	0	0	0	0	36	4.5		
13-Sep	6.75	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1		
14-Sep	7.83	0	0	1	3	1	0	1	0	0	0	1	0	0	2	0	1	4	0	0	0	0	0	0	0	0	14	1.8		
15-Sep	8.00	0	0	1	5	1	0	0	0	2	0	1	0	0	8	0	0	1	0	0	0	0	0	0	1	0	25	3.1		
16-Sep	8.00	0	0	0	6	4	0	0	1	1	0	0	1	0	0	12	0	0	3	0	0	0	0	0	0	0	1	29	3.6	
17-Sep	8.00	0	0	2	19	4	0	1	1	0	2	3	0	0	5	1	0	2	0	0	0	0	0	0	0	0	7	47	5.9	
18-Sep	8.00	0	0	1	7	13	1	1	0	0	3	0	3	0	1	7	0	0	3	0	0	0	0	0	0	0	0	40	5.0	
19-Sep	7.75	0	0	2	8	7	0	0	0	1	1	4	0	0	7	0	0	1	0	1	0	0	0	0	1	3	36	4.6		
20-Sep	5.75	0	0	2	15	10	1	7	1	0	0	1	5	0	2	12	1	1	3	0	0	1	0	0	1	1	64	11.1		
21-Sep	4.00	0	0	0	1	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	4	1.0		
22-Sep	7.00	0	0	0	4	2	0	2	0	0	0	0	0	0	1	7	0	0	0	0	0	0	0	0	0	0	16	2.3		
23-Sep	7.50	0	0	0	4	3	0	1	1	0	0	2	0	0	2	8	1	0	0	0	0	0	0	0	0	0	22	2.9		
24-Sep	7.83	0	0	4	8	7	1	1	0	0	0	1	0	0	7	0	0	1	1	0	0	0	0	0	0	0	31	4.0		
25-Sep	8.33	0	1	0	4	1	0	2	0	0	0	0	0	0	9	0	0	0	0	0	1	0	1	2	0	0	21	2.5		
26-Sep	8.00	0	0	4	22	11	0	10	0	0	0	0	5	0	0	38	0	1	5	0	2	1	0	0	0	2	101	12.6		
27-Sep	8.00	0	0	0	3	0	0	2	0	0	0	0	6	0	0	14	0	0	1	1	0	1	0	0	0	0	28	3.5		
28-Sep	8.00	0	0	0	15	5	0	4	0	0	0	0	3	1	0	24	0	0	0	0	0	0	0	0	0	0	52	6.5		
29-Sep	8.00	0	0	2	11	3	0	1	0	0	0	0	3	0	1	18	0	0	1	0	0	0	0	0	0	1	41	5.1		
30-Sep	6.92	0	0	1	2	3	0	0	0	0	1	0	0	0	1	18	1	0	2	0	0	1	0	0	0	1	31	4.5		

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
01-Oct	8.00	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	9	1.1
02-Oct	8.00	0	0	1	2	3	1	1	1	0	0	0	2	0	0	1	14	1	0	3	1	0	0	0	0	1	0	5	37	4.6
03-Oct	8.00	0	0	2	6	4	0	3	0	0	0	0	4	0	1	0	41	2	1	0	0	0	0	0	0	0	0	64	8.0	
04-Oct	7.50	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	14	0	0	0	0	0	0	0	0	0	0	16	2.1	
05-Oct	4.00	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	3	0.8	
06-Oct	8.00	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	16	1	0	0	0	0	0	0	0	1	0	21	2.6	
07-Oct	7.75	0	0	1	2	0	1	1	0	0	0	0	2	0	0	0	20	0	0	1	0	1	0	0	0	0	0	29	3.7	
08-Oct	7.50	0	0	0	2	2	1	0	0	0	0	0	0	0	0	65	0	0	0	0	0	0	0	0	0	0	0	70	9.3	
09-Oct	6.75	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0	98	3	0	1	0	0	0	0	0	0	1	107	15.9	
10-Oct	0.00																													
11-Oct	0.00																													
12-Oct	0.00																													
13-Oct	0.00																													
14-Oct	6.00	0	0	0	1	0	1	0	0	0	0	0	0	2	0	6	0	3	0	0	0	0	0	0	0	0	1	14	2.3	
15-Oct	7.50	0	0	1	7	0	3	0	0	0	0	0	1	0	4	1	78	3	1	0	1	0	0	0	0	0	1	101	13.5	
16-Oct	0.00																													
17-Oct	8.00	0	0	0	10	0	1	1	0	0	0	0	3	0	2	0	80	2	0	0	0	1	0	0	0	0	0	100	12.5	
18-Oct	8.00	0	0	0	4	0	0	0	0	0	0	0	0	1	1	64	0	0	0	0	1	0	0	0	0	0	0	71	8.9	
19-Oct	7.00	0	0	0	1	0	1	0	0	0	0	0	0	6	0	30	1	0	1	1	0	0	0	0	0	0	0	41	5.9	
20-Oct	6.50	0	0	1	2	0	1	1	0	0	0	0	0	1	0	17	2	0	0	0	1	0	0	0	0	0	0	26	4.0	
21-Oct	0.00																													
22-Oct	6.00	0	0	0	1	0	0	0	0	0	0	0	0	1	0	24	2	0	0	0	0	0	0	0	0	0	0	28	4.7	
23-Oct	7.25	0	0	0	3	2	0	1	0	0	0	0	0	1	0	27	3	0	0	0	0	0	0	0	0	0	0	37	5.1	
24-Oct	7.00	0	0	0	5	1	0	0	0	0	0	0	0	0	0	47	0	1	0	0	0	0	0	1	0	0	0	55	7.9	
25-Oct	6.00	0	0	0	3	0	0	0	0	0	0	0	1	0	0	13	3	1	1	0	0	0	0	0	0	0	1	23	3.8	
26-Oct	8.00	0	0	0	3	0	0	0	0	0	0	0	0	5	0	11	0	0	0	2	0	0	0	0	0	0	0	21	2.6	
27-Oct	7.50	0	0	0	0	0	1	0	1	0	0	0	0	0	0	5	0	0	0	1	1	0	0	0	0	0	0	9	1.2	
28-Oct	8.00	0	0	0	1	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	5	0.6	
29-Oct	8.00	0	0	0	0	2	2	0	0	0	0	0	0	3	0	22	3	0	0	1	0	0	0	0	0	0	0	33	4.1	
30-Oct	8.00	0	0	0	2	2	3	1	0	0	0	0	0	1	0	43	4	0	0	1	0	0	0	0	0	0	0	57	7.1	
31-Oct	8.00	0	0	0	3	0	3	0	0	0	0	0	0	0	0	41	1	0	0	0	1	0	0	0	0	0	1	50	6.3	
Total	415.49	0	4	47	222	115	22	43	10	3	7	8	75	1	32	10	1003	43	10	46	10	13	5	0	2	6	2	38	1777	4.3

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: 1991–2008.

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

¹ Designations used for the first time in 2002.