

# **FALL 2010 RAPTOR MIGRATION STUDY IN THE BRIDGER MOUNTAINS, MONTANA**



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

**May 2011**

**FALL 2010 RAPTOR MIGRATION STUDY  
IN THE BRIDGER MOUNTAINS, MONTANA**

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**May 2011**

## 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.....	4
Resident Raptors.....	4
Visitation.....	4
Acknowledgments.....	5
Literature Cited.....	6
Tables.....	7
Figures.....	10
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: 2010.....	21
Appendix D. Daily observation effort and fall raptor migration counts by species in the Bridger Mountains, MT: 2010.....	23
Appendix E. Annual observation effort and fall raptor migration counts by species in the Bridger Mountains, MT: 1991–2010.....	26

## 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: 1992–2009 versus 2010.....	7
Table 2.	Fall counts by age class and immature: adult ratios for selected species of migrating raptors in the Bridger Mountains, MT: 1992–2009 versus 2010.....	8
Table 3.	First and last observation, bulk passage, and median passage dates by species for migrating raptors in the Bridger Mountains, MT in 2010, with a comparison of 2010 and 1992–2009 average median passage dates.....	9

## LIST OF FIGURES

Figure 1.	Location of the Bridger Mountains Raptor Migration Project study site.....	10
Figure 2.	Composition of the fall raptor migration in the Bridger Mountains by major species groups: 1992–2009 versus 2010.....	11
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: 1992–2010. Dashed lines indicate significant ( $P \leq 0.10$ ) regressions.....	12
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– 2010. Dashed lines indicate significant ( $P \leq 0.10$ ) regressions.....	13
Figure 5.	Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for five buteo species in the Bridger Mountains, MT, 1992–2010. Dashed lines show significant ( $P \leq 0.10$ ) regressions.....	14
Figure 6.	Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Golden Eagles (separated by all birds, non-adults, and adults) in the Bridger Mountains, MT: 1992–2010. Dashed lines indicate significant ( $P \leq 0.10$ ) regression.....	15
Figure 7.	Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Bald Eagles in the Bridger Mountains, MT: 1992–2010. Dashed lines indicate significant ( $P \leq 0.10$ ) regression.....	16
Figure 8.	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: 1992–2010. Dashed lines indicate significant ( $P \leq 0.10$ ) regressions.....	17
Figure 9.	Combined-species passage volume by five-day periods for migrating raptors in the Bridger Mountains, MT: 1992–2009 versus 2010.....	18
Figure 9.	Passage volume by five-day periods for migrating Golden Eagles in the Bridger Mountains, MT: 1992–2009 versus 2010.....	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 2010 count, which marked the 19th consecutive full-season autumn count of migratory raptors at the site. The Bridger Mountains project was one of nine long-term, annual migration counts conducted or co-sponsored by HWI in North America during 2010. 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 Sacajawea 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 consistent 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 crest 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 designated observers conducted standardized daily counts of migrating raptors from a single, traditional observation site from late August through late October in 2010. One of the official observers extended the count to 1 November 2010. Observations typically began at 0900 H and ended at 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 at this site). Both observers received 2 days of on-site and off-site training with Montana Audubon Executive Director, Steve Hoffman. Local enthusiast Matt Keefer and long-time enthusiast John Parker occasionally assisted with the count. Local expert Beth Madden assisted with the count for one day as well. Data gathering and recording followed standardized protocols used at all HWI migration sites (Hoffman and Smith 2003). The observers routinely recorded the following data each day:

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 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 2010 follows Hoffman and Smith (2003). In comparing 2010 annual statistics against means and 95% confidence intervals for previous seasons, we equate significance with a 2010 value falling outside the bounds of the confidence interval for the associated mean.

## RESULTS AND DISCUSSION

### WEATHER SUMMARY

This past season, 12 full days of observations were precluded due to inclement weather and difficult access. This is on par with the average of 11.6 days taken during the last 13 years for which weather data has been compiled and analyzed, from 1997-2009. In addition, we try to take into account when weather or difficult access reduces observations to  $\leq 4$  hours per day. This occurred a total of eight days this past season, which was high compared to the average of 2.5 days taken during the same time period (see Appendix C for daily weather records).

During full days of active observations, skies were recorded 35% of the time as predominantly fair, 35% as transitional (i.e., cloud cover changed from clear or partly cloudy to mostly cloudy or overcast during the day, or vice versa), and 30% as mostly cloudy or overcast. In comparison, the averages for the site are 37% fair, 33% transitional, and 30% mostly cloudy to overcast, suggesting that the skies in 2010 were less predominantly fair and more transitional. The observers estimated visibility distances in the range of 92-95 km (vs. average 76-80 km), which puts this estimate at a record high for a second straight year. The prevalence of visibility due to fog and/or haze was slightly less than the average (28% of active days vs. average of 32%), as was the proportion of days that included rain and/or snow showers (12% vs. average of 14%). Lastly, observers subjectively rated only 25% of the active days as featuring predominantly good to excellent thermal lift conditions, which is lower than the 38% average from 1997 to 2009. All of these factors may have played a role in increasing detection rates of migrants.

In 2010, the prevalent winds were light ( $< 12$  kph), dominating 96% of active observational days, opposed to only 4% moderate (12-29 kph). On average (1997-2009), winds are generally 80% light, 18% moderate, and 2% strong. Wind direction mostly prevailed from SW-W, occurring 69% of active observational days. To a far lesser extent, winds also blew from the W (9%), SE-SW (7%), SW-NW (6%), NE-SE (6%), and variable (4%). On average (1997-2009), the prevailing winds have traditionally come from a SW-W (28%), W (27%), and W-NW (11%) directions, accounting for 66% of the

variability. Whereas, when winds blow from other directions, their percent occurrence on average account for less than 10% of the total. Thus, this year's dominating light SW-W and W winds conformed well with the typical prevailing winds. This seemingly good weather for raptor flights, along with favorable visibility for detection, made this year's flight quite strong for most species.

## **OBSERVATION EFFORT**

Observations occurred on 54 of 66 days between 28 August and 1 November in 2010. The number of observation days was a 6% increase over the 1992–2008 average of  $51 \pm 95\%$  CI of 3.7 days, and the number of observation hours (366) increased 8% over the long-term average of  $338.63 \pm 28.193$  hours. The 2010 average of 2.07 observers per hour (including official and guest observers; value is mean of daily values, which are in turn means of hourly values) also exceeded the long-term average of  $1.9 \pm 95\%$  CI of 0.10 observers per hour.

## **FLIGHT SUMMARY**

The observers tallied 2,349 migrating raptors of 17 species during the 2010 season (Table 1; see Appendix D for daily count records). The 2010 counts of Golden and Bald Eagles were again observed below average, but counts of most other species were slightly to significantly above average (Table 1). Numbers of Osprey, Broad-winged, Swainson's, and Rough-legged Hawks, as well as Peregrine Falcons were also below average in 2010. Because these species are often encountered in relatively low annual numbers, inter-annual variability is often inflated as represented by a high percentage of change in one direction or another (Table 1, see also Appendix E for annual summaries).

The 2010 flight was comprised of 52% eagles, 28% accipiters, 10% buteos, 5% falcons, 3% harriers, 1% Ospreys, and 1% unidentified raptors (Figure 2). The most numerous species were the Golden Eagle (50% of the total count), Sharp-shinned Hawk (14%), Cooper's Hawk (9%), Red-tailed Hawk (8%), American Kestrel (4%), and Northern Harrier (3%). All other species each comprised  $\leq 2\%$  of the total (Table 1).

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

In 2010, adjusted passage rates were significantly above average for Northern Harriers and Red-tailed Hawks. Conversely, passage rates were significantly below average for Golden and Bald Eagles (Table 1, Figures 3–8). Regression analyses updated through 2010 (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 1999, but an accelerating decline since then (Figure 6). Age-specific analyses further revealed a similar accelerating decline for adults ( $P = 0.001$ ), and a highly significant linear decline for immatures/subadults. Although American Kestrels were observed in greater numbers this past year, the long-term trend is still linearly projecting downward (Figure 8). Likewise, a quadratic negative decline is being observed for Northern Goshawks (Figure 4). No other significant ( $P \leq 0.10$ ) trends were noted.

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 what was represented in Hoffman and Smith (2003) and used herein to present analyses updated through 2010. 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 analysis method generally yielded similar inferences to those derived using the simpler methodology of Hoffman and Smith (2003).

Differences between the RPI results and those presented herein that clearly relate to the addition of five more years of data include: a) addition of low counts from 2007–2010 resulted in a new significant overall decline for Sharp-shinned Hawks (Figure 4); b) five more years of near-record-low and record-low passage rates translated to a now highly significant and accelerating decline for Golden Eagles through 2010 (Figure 6); and c) five 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 8). Farmer et al. (2008) and Farmer and Smith (2009) 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 2010 for 6 of 9 species for which relevant age-specific data were available (Table 2). For Peregrines, a high percentage of birds were not able to be aged, and the Peregrine count is relatively low on an annual basis (Table 2). With most species, the counts of both adults and immatures were above average, perhaps suggesting that weather aided in funneling migrants through this location, thus sampling a larger proportion of the source population. In contrast, both adult Golden and Bald Eagles exhibited significant decreases compared to the average, whereas the immature counts of both species were quite comparable (Table 2). However, this is where we caution when interpreting annual counts in relation to the overall average because the overall trends for Golden Eagles demonstrate that both age classes are exhibiting similar negative downward trends (Figure 7).

## **Seasonal Timing**

In terms of the 2010 migration phenology, specific species and combined-species "median passage dates" tended to follow the overall averages closely (Table 3, Figure 9). The combined-species median passage date of 5 October was only three days earlier than the average (Table 3). Only two species exhibited noteworthy deviations from the overall median date, the American Kestrel and Merlin. The median passage date for American Kestrels occurred on 14 September, eight days earlier than the average; whereas, the median passage date for Merlins occurred on 11 October, eight days later than the average (Table 3). This year's annual median passage date and flight volume distribution pattern of Golden Eagles was similar to the overall average (Table 3 & Figure 10, respectively).

Weather can be a factor that may explain a lot of inter-annual variability of species migrating through an area from year to year. Biased estimates, resulting in underestimating a migrating species' age-gender related differences, can result if weather causes birds to migrate in a more spatially-dispersed manner, utilizing other pathways, rather than concentrating on a particular ridgeline location during timing of peak migration. HawkWatch International staff are beginning to investigate these issues and hope to soon better understand how weather and phenology interact so that we might learn more about why there is so much variation from year to year.

## **RESIDENT RAPTORS**

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

Resident Sharp-shinned Hawks were seen from 1 September through 13 October, including at least two immature birds. Immature residents were noted mobbing and escorting migrant raptors on three occasions, and stooped on the decoy owl at least twice in September. An adult was seen in the area twice in late September, and an immature as late as 13 October.

A resident immature Cooper's Hawk was observed only once, on 4 September.

An adult Northern Goshawk was seen flying north on three occasions between 7-15 September. An immature Northern Goshawk was observed on at least six days between 7 September and 27 October; it mobbed a migrant Red-tailed Hawk on 27 September, and stooped on the owl once.

Resident Red-tailed Hawks (3 immature light morph birds, 1 adult dark, and 1 adult light) circled and hunted above Tilly Ridge and throughout the observation area from 2 September through 2 October.

Both adult (2 individuals) and immature resident Golden Eagles were observed throughout the observation period. As the season progressed, the adult and the immature birds were often seen flying and interacting (chasing and playing) together. On 24 September an immature was observed dropping and catching a bloody object approximately 20 times over the valley to the west for 10 minutes. They were often seen west of Ross flying above the Treed Ridge.

At least two American Kestrels, a male and a female, resided near the Bridger observation point from 2-26 September. They were consistently observed hunting near the ridgeline (especially over "Tilly").

A resident Prairie Falcon was observed flying north along the ridge only once, on 4 September, and a resident Peregrine Falcon was also seen moving north on 3 September.

## **OTHER WILDLIFE OBSERVATIONS**

This season marked the first recorded sighting of a Pileated Woodpecker and a Williamson's Sapsucker on the Bridger ridge. A Pileated Woodpecker was seen and/or heard on 4, 8, 24 September and 12 October. The Williamson's Sapsucker was seen on 2 October east of the observation site. Mountain goats were seen on four different occasions (2-12 individuals/group). On 30 September a large black bear was observed actively stalking two mountain goats (one adult and one kid) headed south down Tilly Ridge toward the observation site after 1600 MST. A partial-albino Dark-eyed Junco was seen on 21 September, 5 meters north of the observation site. Small flocks of American White Pelicans were seen migrating south on two occasions. Numerous flocks of various passerine species were observed at the site throughout the migration count period, including several flocks of Gray-crowned Rosy Finches and Bohemian Waxwings in late October.

## **VISITATION**

Throughout the course of the season, 86 individuals signed the visitor logs kept at the watch site. 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) to enjoy the spectacle of the fall migration! The 12th annual Bridger RaptorFest once again coincided with opening ticket sales for the Bridger Bowl Ski Area, and as a result well over 1,000 people participated in the festival. In 2010, 381 hourly assessments by the primary observers of visitor disturbance resulted in the following ratings: 80% none, 16% low, 4% moderate, and 1% high, indicating an average level of visitor disturbance for this site, but slightly above last year.

## ACKNOWLEDGMENTS

Funding for the 2010 project was provided by the USDA Forest Service–Gallatin National Forest, Sacajawea Audubon Society, and Montana Audubon. Special thanks to Randy Elliot and Doug Wales of Bridger Bowl for providing essential logistical support. We are also especially thankful for support provided by the Bridger-to-Bangtail Coalition for their tremendous effort in securing housing and other logistical support for our two official observers. Special thanks to Candace Hamlin for her help in arranging local housing, and to Greg and Lauren Cummings, and Ron and Kate Vargas for providing comfortable living quarters. We also thank Matt Keefer, John Parker, and Beth Madden for their observational and/or logistical assistance.

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**Table 1. Annual fall-migration counts and adjusted passage rates (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) by species in the Bridger Mountains, MT: 1992–2009 versus 2010.**

SPECIES	COUNTS			RAPTORS/100 HRS		
	1992–2009 <sup>1</sup>	2010	%CHANGE	1992–2009 <sup>1</sup>	2010	%CHANGE
Turkey Vulture	0.7 ± 0.69	2	+177	0.4 ± 0.36	1.1	176
Osprey	6 ± 1.9	3	-50	2.4 ± 0.73	1.1	-54
Northern Harrier	49 ± 22.3	77	+59	15.3 ± 7.23	22.7	+48
Sharp-shinned Hawk	326 ± 51.8	336	+3	122.1 ± 18.24	118.5	-3
Cooper's Hawk	163 ± 33.0	207	+27	119.7 ± 23.42	137.4	+15
Northern Goshawk	32 ± 9.9	33	+2	11.1 ± 3.97	10.1	-9
Unknown small accipiter <sup>2</sup>	27 ± 18.3	40	+49	–	–	–
Unknown large accipiter <sup>2</sup>	5 ± 2.3	22	+360	–	–	–
Unknown accipiter	24 ± 8.4	25	+6	–	–	–
TOTAL ACCIPITERS	560 ± 85.3	663	+18	–	–	–
Broad-winged Hawk	10 ± 4.8	5	-52	5.3 ± 2.55	2.8	-47
Swainson's Hawk	3 ± 1.4	1	-63	1.3 ± 0.75	0.4	-72
Red-tailed Hawk	105 ± 22.8	178	+70	37.9 ± 7.72	57.4	+51
Ferruginous Hawk	2 ± 0.9	3	+23	0.9 ± 0.29	0.9	+4
Rough-legged Hawk	33 ± 8.9	31	-7	23.7 ± 6.28	19.3	-19
Unidentified buteo	12 ± 3.0	20	+67	–	–	–
TOTAL BUTEOS	166 ± 30.9	238	+44	–	–	–
Golden Eagle	1364 ± 159.1	1171	-14	532.9 ± 60.35	399.0	-25
Bald Eagle	77 ± 12.5	50	-35	30.0 ± 5.20	16.7	-44
Unidentified eagle	7 ± 3.4	1	-85	–	–	–
TOTAL EAGLES	1448 ± 166.9	1222	-16	–	–	–
American Kestrel	68 ± 18.3	87	+27	58.6 ± 15.45	65.2	+11
Merlin	9 ± 2.6	12	+27	6.9 ± 1.73	6.4	-7
Prairie Falcon	14 ± 1.9	18	+29	9.2 ± 1.63	10.8	+18
Peregrine Falcon	9 ± 2.7	8	-15	7.6 ± 2.07	5.2	-32
Gyr Falcon	0.1 ± 0.11	0	-100	–	–	–
Unknown small falcon <sup>2</sup>	4 ± 5.7	3	-27	–	–	–
Unknown large falcon <sup>2</sup>	4 ± 2.6	2	-45	–	–	–
Unknown falcon	5 ± 2.0	0	-100	–	–	–
TOTAL FALCONS	110 ± 21.6	130	+18	–	–	–
Unidentified raptor	28 ± 6.2	14	-50	–	–	–
GRAND TOTAL	2367 ± 265.3	2349	-1	–	–	–

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

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

**Table 2. Fall counts by age class and immature : adult ratios for selected species of migrating raptors in the Bridger Mountains, MT: 1992–2009 versus 2010.**

	TOTAL AND AGE-CLASSIFIED COUNTS						IMMATURE : ADULT			
	1992–2009 AVERAGE			2010			% UNKNOWN AGE		RATIO	
	TOTAL	IMM.	ADULT	TOTAL	IMM.	ADULT	1992–2009 <sup>1</sup>	2010	1992–2009 <sup>1</sup>	2010
Northern Harrier	49	22	11	77	41	21	33 ± 7.4	19	3.4 ± 3.25	2.0
Sharp-shinned Hawk	326	61	123	336	76	133	44 ± 6.3	38	0.5 ± 0.12	0.6
Cooper's Hawk	163	43	55	207	59	75	40 ± 5.3	35	0.9 ± 0.29	0.8
Northern Goshawk	32	12	13	33	20	7	28 ± 10.0	18	1.6 ± 0.56	2.9
Broad-winged Hawk	10	2	4	5	1	4	38 ± 17.6	0	0.9 ± 0.76	0.3
Red-tailed Hawk	105	32	49	178	79	55	23 ± 4.2	25	0.7 ± 0.32	1.4
Golden Eagle	1364	527	496	1171	528	305	25 ± 4.2	29	1.1 ± 0.19	1.7
Bald Eagle	77	27	48	50	23	24	3 ± 15.4	6	0.6 ± 0.12	1.0
Peregrine Falcon	9	0.6	4	8	1	1	52 ± 15.4	75	0.2 ± 0.27	1.0

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

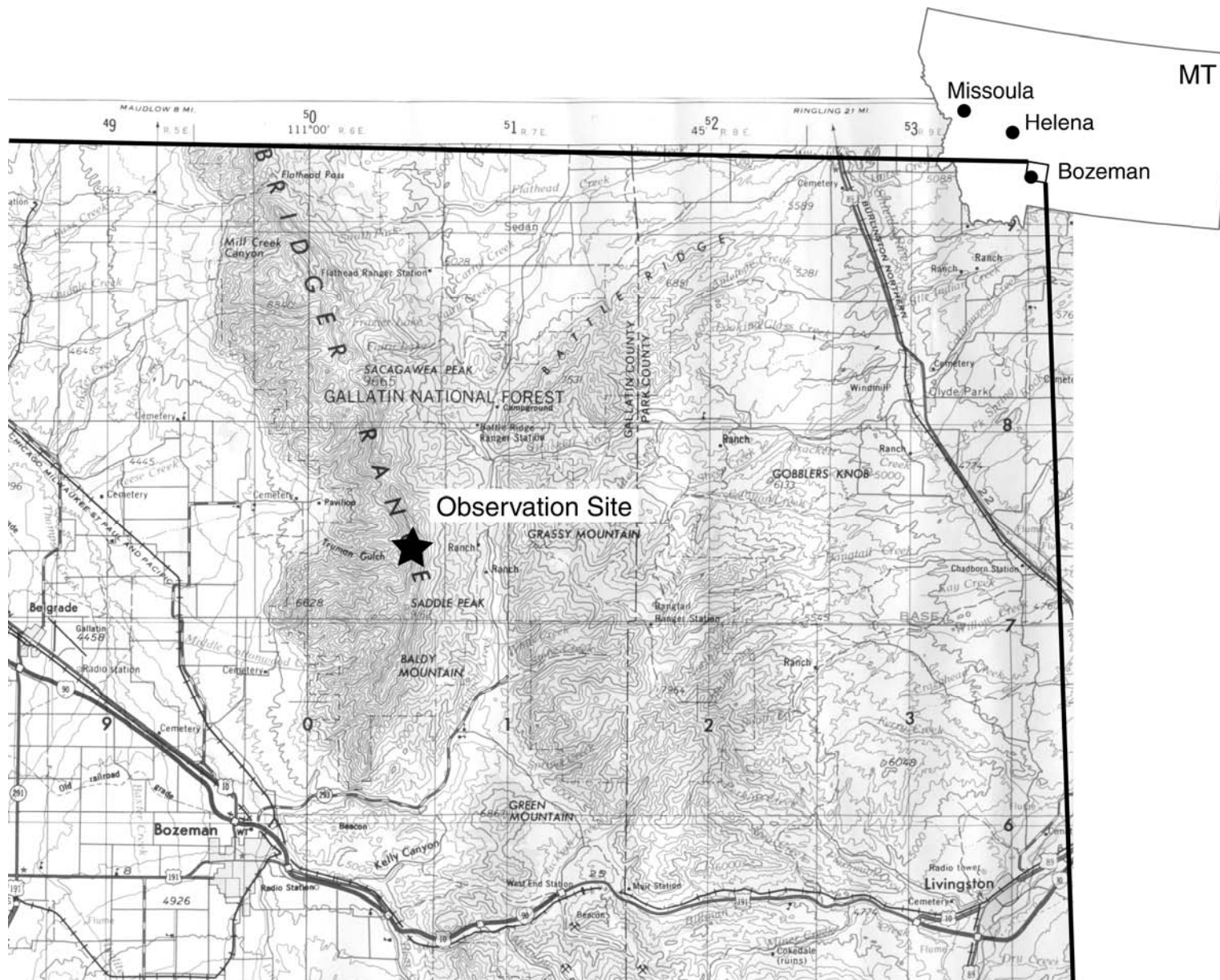
**Table 3. First and last observation, bulk passage, and median passage dates by species for migrating raptors in the Bridger Mountains, MT in 2010, with a comparison of 2010 and 1992–2009 average median passage dates.**

SPECIES	2010				1992–2009
	FIRST OBSERVED	LAST OBSERVED	BULK PASSAGE DATES <sup>1</sup>	MEDIAN PASSAGE DATE <sup>2</sup>	MEDIAN PASSAGE DATE <sup>3</sup>
Osprey	3-Sep	13-Oct	–	–	16-Sep ± 3.1
Northern Harrier	2-Sep	23-Oct	4-Sep – 7-Oct	15-Sep	20-Sep ± 3.9
Sharp-shinned Hawk	2-Sep	30-Oct	12-Sep – 15-Oct	1-Oct	01-Oct ± 1.7
Cooper’s Hawk	31-Aug	22-Oct	8-Sep – 9-Oct	26-Sep	24-Sep ± 2.8
Northern Goshawk	2-Sep	20-Oct	5-Sep – 15-Oct	17-Sep	13-Oct ± 5.6
Broad-winged Hawk	7-Sep	7-Oct	7-Sep – 7-Oct	14-Sep	19-Sep ± 1.9
Swainson’s Hawk	2-Sep	2-Sep	–	–	15-Sep ± 5.2
Red-tailed Hawk	2-Sep	23-Oct	4-Sep – 7-Oct	24-Sep	24-Sep ± 2.0
Ferruginous Hawk	3-Sep	13-Oct	–	–	05-Oct ± 15.4
Rough-legged Hawk	23-Sep	30-Oct	30-Sep – 28-Oct	21-Oct	22-Oct ± 1.4
Golden Eagle	31-Aug	1-Nov	26-Sep – 19-Oct	13-Oct	14-Oct ± 1.8
Bald Eagle	4-Sep	1-Nov	2-Oct – 29-Oct	19-Oct	18-Oct ± 2.6
American Kestrel	2-Sep	12-Oct	4-Sep – 4-Oct	14-Sep	22-Sep ± 2.1
Merlin	4-Sep	23-Oct	4-Sep – 23-Oct	11-Oct	04-Oct ± 3.5
Prairie Falcon	5-Sep	29-Oct	5-Sep – 19-Oct	28-Sep	27-Sep ± 3.7
Peregrine Falcon	7-Sep	2-Oct	7-Sep – 2-Oct	26-Sep	27-Sep ± 2.4
All species	31-Aug	1-Nov	11-Sep – 18-Oct	5-Sep	08-Oct ± 1.8

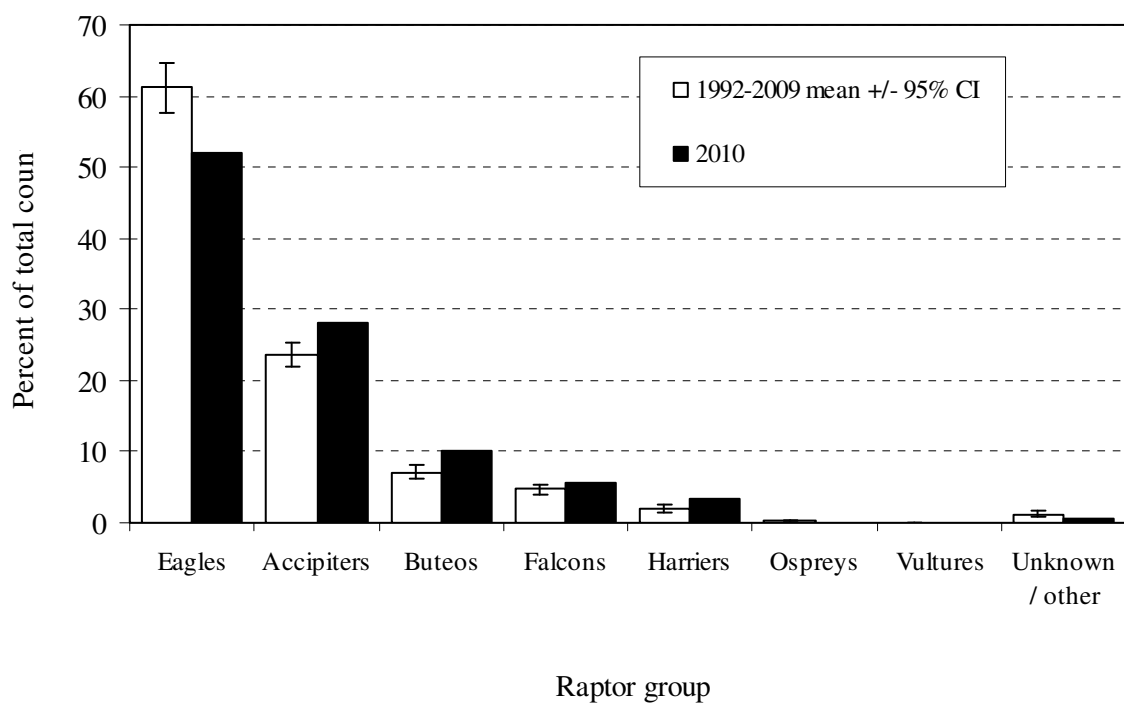
<sup>1</sup> Dates between which the central 80% of the flight passed; values are given only for species with annual counts ≥5 birds.

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

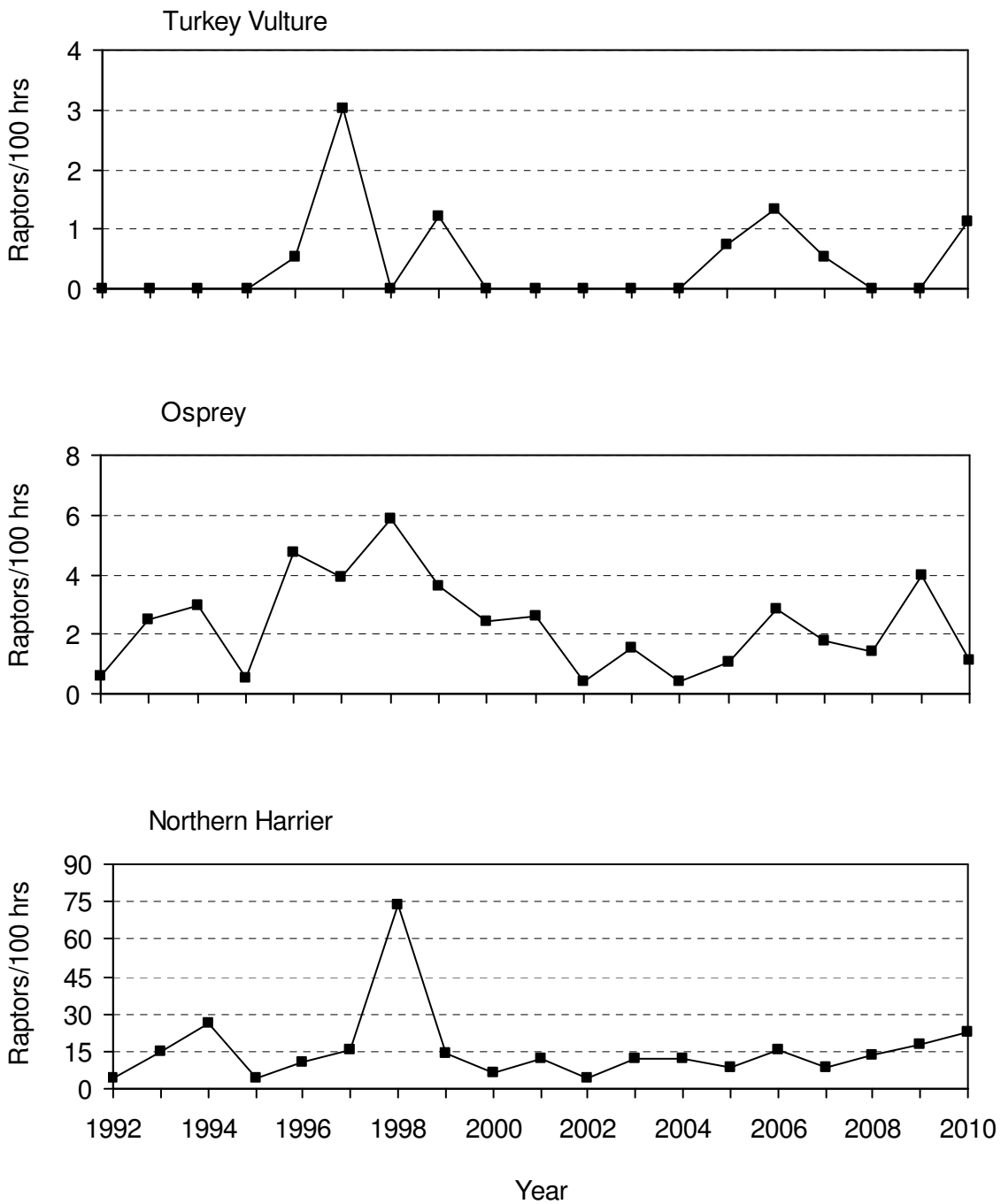
<sup>3</sup> Mean of annual values ± 95% confidence interval in days; calculated only for species with annual counts ≥5 birds for ≥3 years.



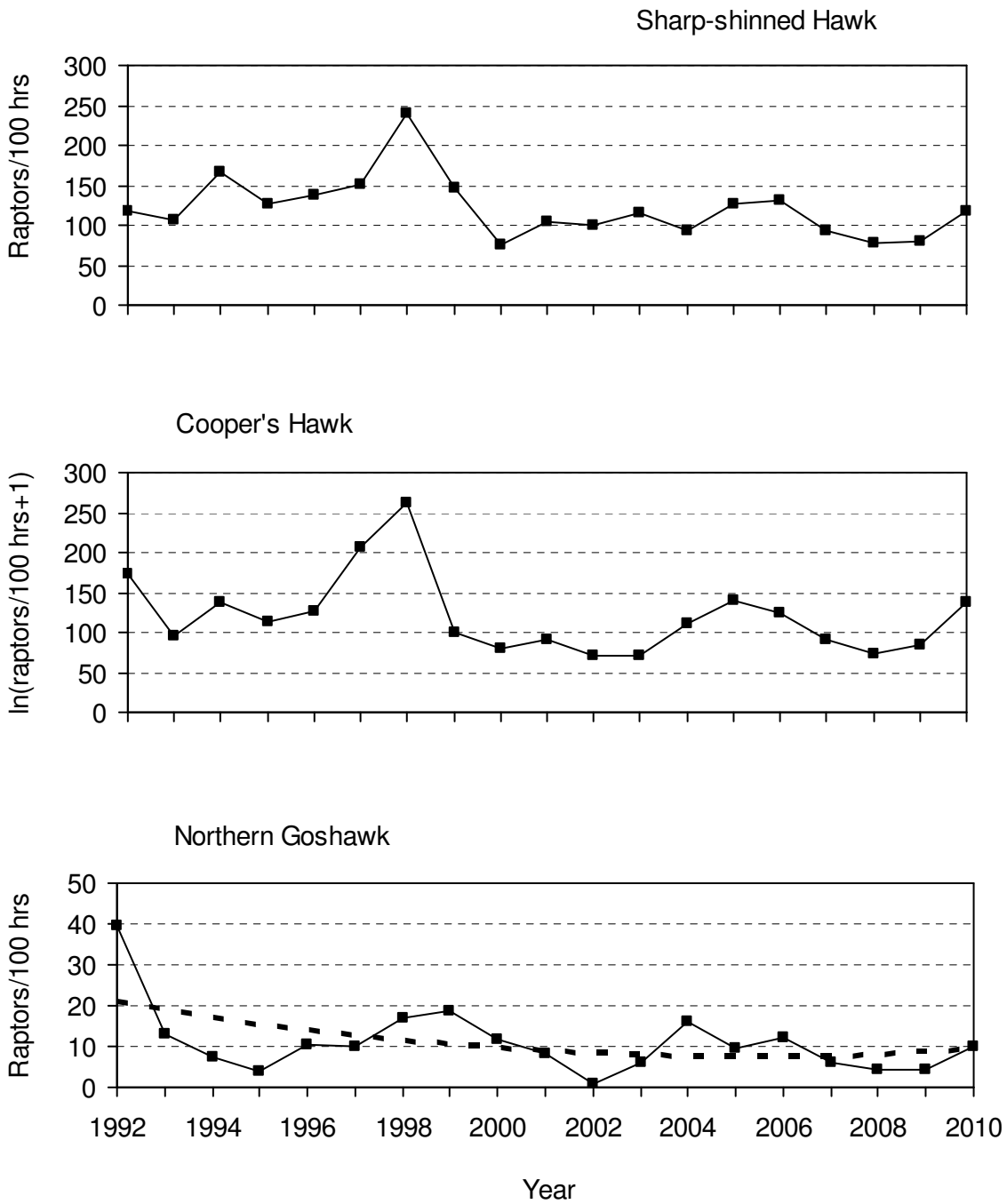
**Figure 1. Location of the Bridger Mountains Raptor Migration Project study site.**



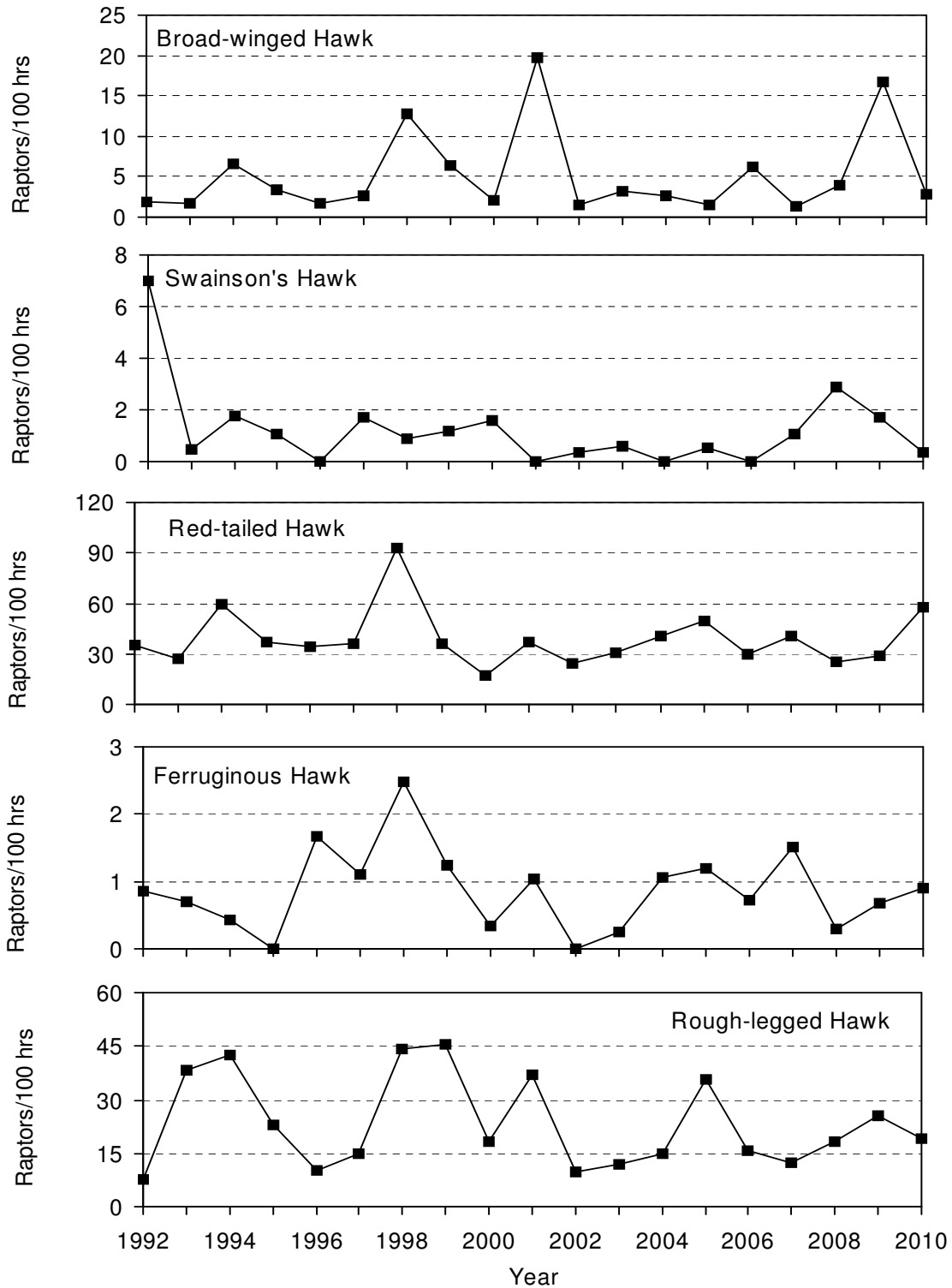
**Figure 2. Composition of the fall raptor migration in the Bridger Mountains by major species groups: 1992–2009 versus 2010.**



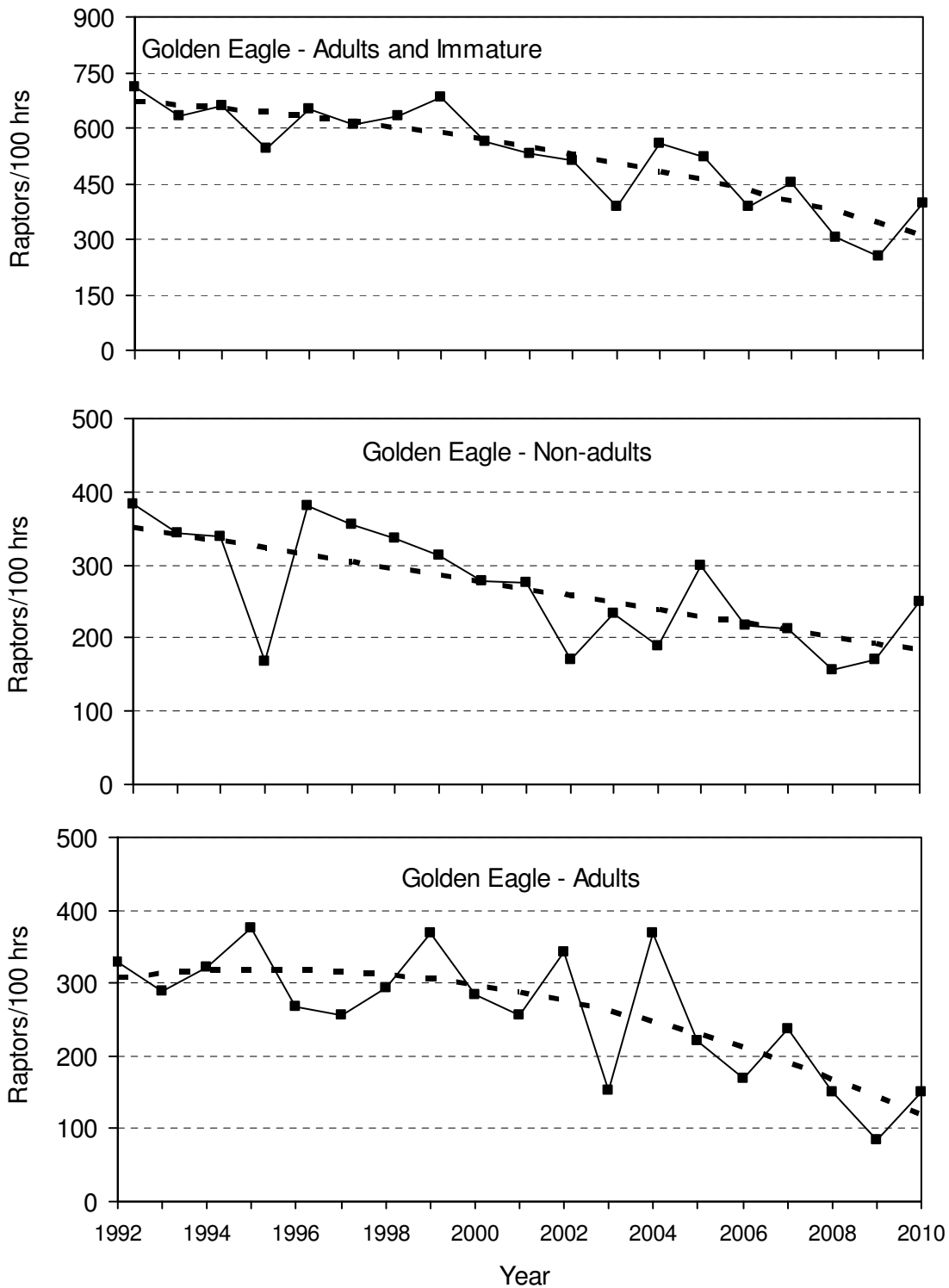
**Figure 3. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Turkey Vultures, Ospreys, and Northern Harriers in the Bridger Mountains, MT: 1992–2010. Dashed lines indicate significant ( $P \leq 0.10$ ) regressions.**



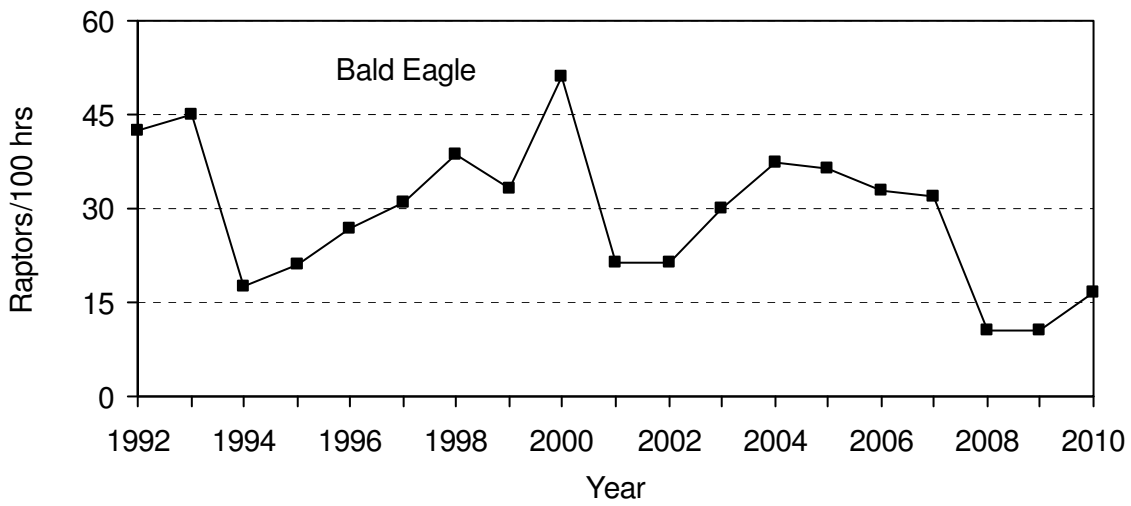
**Figure 4.** Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks in the Bridger Mountains, MT: 1992–2010. Dashed lines indicate significant ( $P \leq 0.10$ ) regressions.



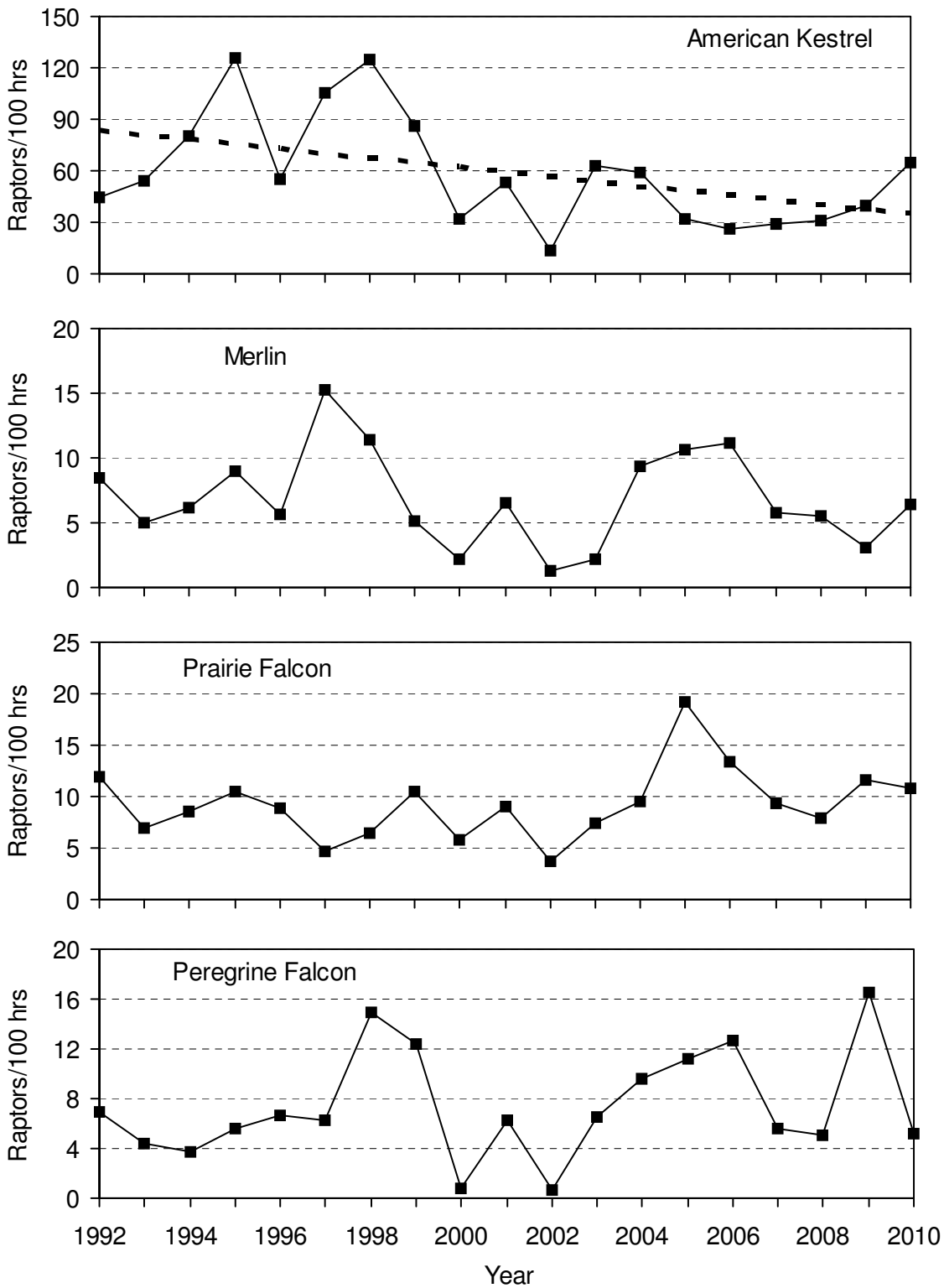
**Figure 5.** Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Broad-winged, Swainson's, Red-tailed, Ferruginous, and Rough-legged Hawks in the Bridger Mountains, MT: 1992–2010. Dashed lines indicate significant ( $P \leq 0.10$ ) regressions.



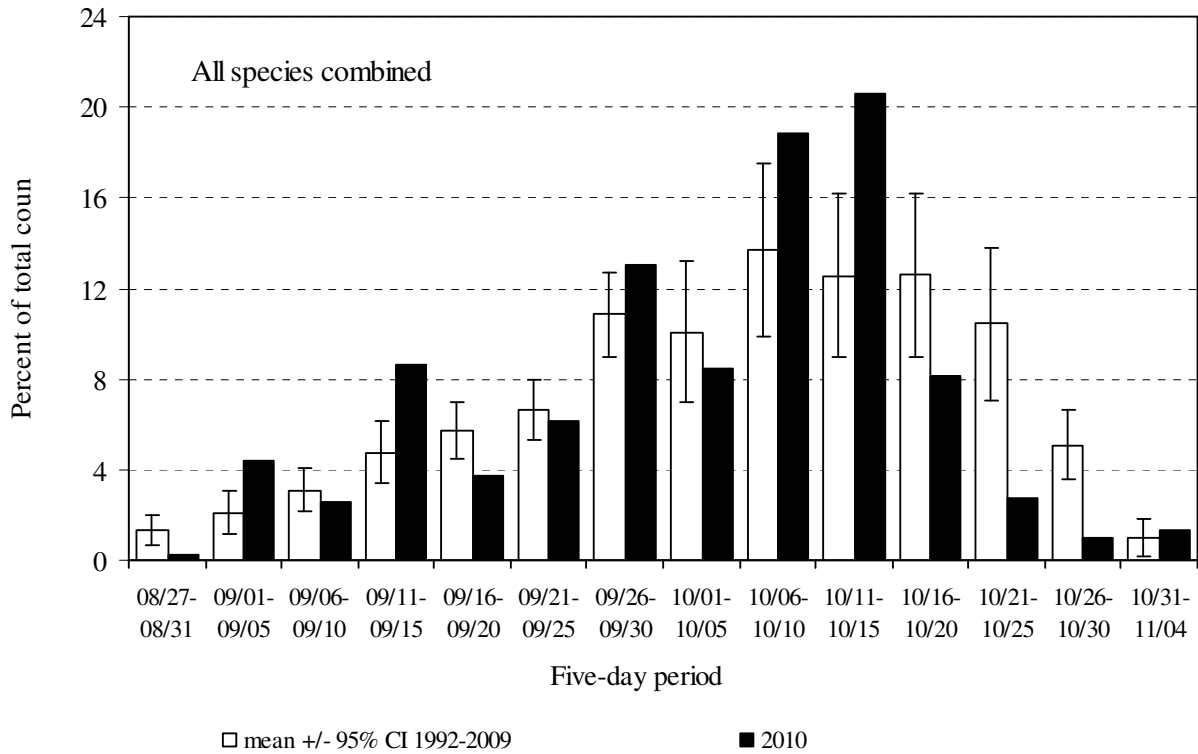
**Figure 6. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Golden Eagles (separated by all birds, non-adults, and adults) in the Bridger Mountains, MT: 1992–2010. Dashed lines indicate significant ( $P \leq 0.10$ ) regressions.**



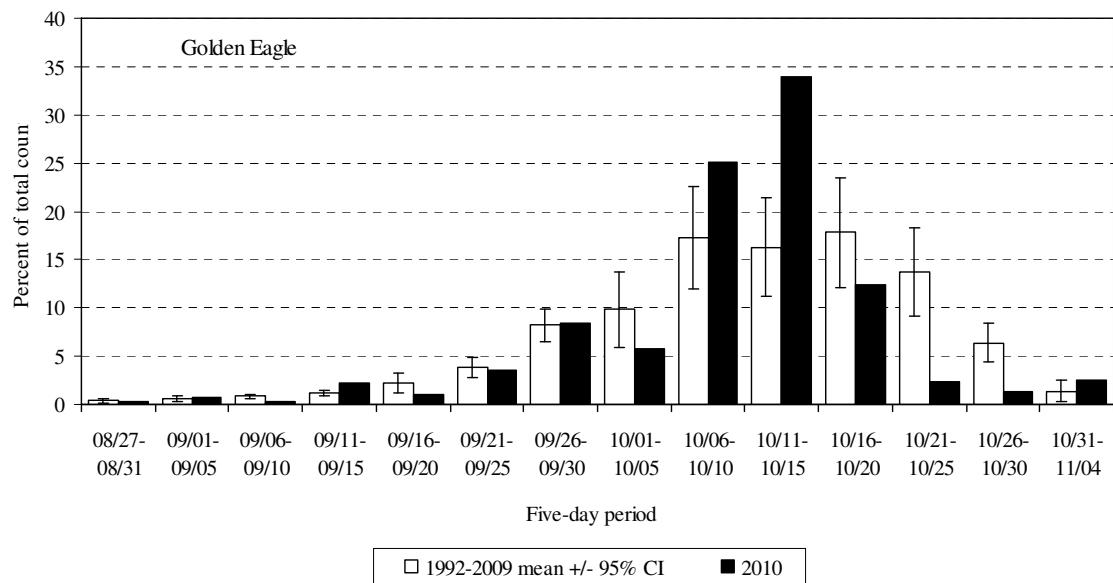
**Figure 7. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Bald Eagles in the Bridger Mountains, MT: 1992–2010. Dashed lines indicate significant ( $P \leq 0.10$ ) regressions.**



**Figure 8. 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: 1992–2010. Dashed lines indicate significant ( $P \leq 0.10$ ) regressions.**



**Figure 9. Combined-species passage volume by five-day periods for migrating raptors in the Bridger Mountains, MT: 1992–2009 versus 2010.**



**Figure 10. Passage volume by five-day periods for migrating Golden Eagles in the Bridger Mountains, MT: 1992–2009 versus 2010.**

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

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

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

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

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

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

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

## **Appendix B. A history of primary observers for the Bridger Mountains Raptor Migration Project.**

- 1991:** Variable teams throughout: Kristian Shawn Omland (0), Phil West (1), LisaBeth Daly (2), Craig Limpach (1)
- 1992:** Two observers throughout: Emily Teachout (1), Phil West (2)
- 1993:** Two observers throughout: Adam Kaufman (0), Anne-Marie Gillesberg (0)
- 1994:** Two observers throughout: Chris Gill (0), Stephanie Schmidt (1)
- 1995:** Two observers throughout: Scott Harris (0), Sue Thomas (0)
- 1996:** Two observers throughout: Jason Beason (0), Niels Maumenee (0)
- 1997:** Two observers throughout: Jason Beason (1), Patty Scifres (0)
- 1998:** Two observers throughout: Jason Beason (2), Mike Neal (0)
- 1999:** Two observers throughout: Mike Neal (2), Greg Levandoski (1)
- 2000:** Two observers throughout: Ryan Wagner (1), Tracy Elsey (0)
- 2001:** Two observers throughout: Ryan Wagner (2), Jeff Maurer (4)
- 2002:** Two observers throughout: Matt Proett (0), Marg Lomow (2; half season), Maureen Essen (0; half-season)
- 2003:** Two observers throughout: Samantha Burrell (0), Carl Bullock (0)
- 2004:** Two observers throughout: Allison Peterson (0), John Bell (0)
- 2005:** Two observers throughout: Corey Michell (0), Beau Fairchild (0)
- 2006:** Two observers throughout: Brian Cook (0), Jamie Granger (0)
- 2007:** Two observers throughout: Jody Vogeler (0), Brenden McGugin (0)
- 2008:** Two observers throughout: Amy Seaman (0), Michaela Hitchcock (0), John Bell (2)
- 2009:** Two observers throughout: Caitlin Kroeger (0), Jason Minné (0)
- 2010:** Two observers throughout: Jamie Hogberg (0), David Laufenberg (0)

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

### Appendix C. Daily observation effort, visitor disturbance ratings, weather records, and flight summaries for the Bridger Mountains Raptor Migration Project: 2010.

DATE	OBS. HOURS	OBSRVR /HOUR <sup>1</sup>	MEDIAN VISITOR DISTURB <sup>2</sup>	PREDOMINANT WEATHER <sup>3</sup>	WIND SPEED (KPH) <sup>1</sup>	WIND DIRECTION	TEMP (°C) <sup>1</sup>	BAROM. PRESS. (IN HG) <sup>1</sup>	MEDIAN THERMAL LIFT <sup>4</sup>	VISIB. WEST (KM) <sup>1</sup>	VISIB. EAST (KM) <sup>1</sup>	MEDIAN FLIGHT DISTANCE <sup>5</sup>	BIRDS /HOUR
28-Aug 1.58	2.0	0		ovc, rain	12.5	sw-w, e-se	6.3	26.63	4	18	100	1	0.0
29-Aug 0.00				Weather Day: fog/rain									
30-Aug 0.00				Weather Day: fog									
31-Aug 6.83	2.0	0		mc-ovc	4.9	sw-nw	5.7	26.84	4	74	79	2	0.7
1-Sep 0.00				Weather Day: fog/rain									
2-Sep 8.00	2.0	1		pc-clr, haze AM	4.3	wse-w	9.2	27.09	2	100	100	3	2.1
3-Sep 8.00	2.0	0		clr-pc	4.0	sw-w	17.8	27.05	2	100	100	3	1.9
4-Sep 8.00	2.8	0		clr-ovc	4.6	sw-w	18.0	26.86	3	96	100	3	8.3
5-Sep 3.83	2.0	0		ovc, fog/snow	3.3	sw-nw	4.9	26.65	4	42	65	1	1.6
6-Sep 7.42	2.0	0		pc-ovc	3.2	sw-w	4.8	26.83	3	97	98	1	0.5
7-Sep 7.50	2.0	0		pc-mc	5.4	ne-se	12.9	26.81	3	99	98	3	6.3
8-Sep 3.50	2.0	0		ovc	7.6	sse-sw	14.8	26.70	4	92	92	2	2.9
9-Sep 0.00				Weather Day: fog/snow									
10-Sep 0.00				Weather Day: fog/snow									
11-Sep 8.00	2.0	0		clr	6.6	sw-w	9.3	26.90	2	100	100	3	3.4
12-Sep 8.00	2.0	1.5		clr	2.7	sw-w	12.8	26.99	2	100	100	3	8.9
13-Sep 7.33	2.0	0		clr-pc	3.3	sw-w	16.0	26.98	2	98	100	3	9.4
14-Sep 7.00	2.0	0		pc-ovc	9.7	ne-e	12.9	26.88	4	92	94	2	3.3
15-Sep 8.00	2.0	0		pc-ovc	2.0	sw-w	10.4	26.94	3	100	90	3	1.6
16-Sep 6.50	2.8	0		ovc	5.5	sw-w	10.5	26.87	4	94	99	2	0.9
17-Sep 4.50	1.2	0		mc-ovc	1.8	sw-w	9.7	26.89	4	88	71	1	0.4
18-Sep 3.50	2.0	0		pc-ovc	3.0	sw-w	15.0	26.87	3	88	92	1	0.3
19-Sep 8.00	2.6	0		clr-pc, haze PM	5.7	s-sw	18.5	26.76	3	90	81	4	9.0
20-Sep 8.00	2.0	0		pc-ovc	5.0	s-sw	6.6	26.72	4	100	99	2	0.9
21-Sep 7.00	2.0	0		mc-ovc	2.0	sw-w	8.1	26.70	3	98	98	3	1.4
22-Sep 0.00				Weather Day: fog/rain				29.85					
23-Sep 7.83	2.0	0		pc-ovc, fog AM	5.1	sw-w	7.0	26.78	3	88	92	3	4.2
24-Sep 8.00	2.1	0		mc-ovc	6.1	sw-w	7.4	26.98	4	99	98	3	3.6
25-Sep 8.00	2.7	0		clr-pc	7.3	sw-w	13.6	27.13	2	100	100	3	9.1
26-Sep 8.00	2.5	2		clr-ovc	6.7	sw-w	16.2	26.98	3	100	99	4	9.1
27-Sep 8.00	2.0	0		pc	5.0	sw-w	15.8	27.08	3	100	100	3	9.8
28-Sep 7.00	2.0	0		clr, haze	6.9	sw-w	16.8	26.95	3	97	98	4	3.1
29-Sep 8.00	2.0	0		clr, haze AM	1.0	sw-w	13.4	27.02	3	91	98	4	8.9
30-Sep 7.67	2.0	0		clr	1.3	sw, nw-n PM	15.9	26.99	2	100	100	3	8.1
1-Oct 8.00	2.0	0		clr	14.4	ne-e	8.9	27.08	3	100	100	2	4.5
2-Oct 8.00	2.9	1.5		clr	3.5	s-sw	15.8	27.05	2	100	100	2	7.6
3-Oct 8.00	2.6	1.5		clr-pc, haze AM	4.8	s-sw-w	19.7	26.94	2	98	98	3	5.5
4-Oct 7.50	2.0	0		pc-ovc, rain PM,	7.4	sw-w	12.0	26.83	3	98	94	3	7.7

# Appendix C. continued

DATE	OBS. HOURS	OBSRVR /HOUR <sup>1</sup>	MEDIAN VISITOR DISTURB <sup>2</sup>	PREDOMINANT WEATHER <sup>3</sup>	WIND SPEED (KPH) <sup>1</sup>	WIND DIRECTION	TEMP (°C) <sup>1</sup>	BAROM. PRESS. (IN HG) <sup>1</sup>	MEDIAN THERMAL LIFT <sup>4</sup>	VISIB. WEST (KM) <sup>1</sup>	VISIB. EAST (KM) <sup>1</sup>	MEDIAN FLIGHT DISTANCE <sup>5</sup>	BIRDS /HOUR
5-Oct	0.00			Weather Day: fog/rain									
6-Oct	8.00	2.0	0	clr-pc	7.6	sw-w, e	11.4	27.05	3	100	98	2	4.8
7-Oct	8.50	2.7	0	clr-mc	6.8	sw-w	10.6	26.89	3	100	100	3	26.9
8-Oct	0.00			Weather Day: fog/rain									
9-Oct	8.00	2.0	1	pc-ovc, fog AM	9.3	sw-w	4.2	27.02	4	70	70	3	8.9
10-Oct	8.00	2.0	1	mc-ovc, rain AM	9.1	sw-w	6.4	26.97	4	100	100	3	13.0
11-Oct	0.00			Weather Day: fog/rain									
12-Oct	8.25	2.0	0	clr-mc	11.9	sw-w	0.5	27.08	4	100	100	2	15.4
13-Oct	8.00	2.0	0	pc-ovc	11.6	sw-w	6.9	27.11	4	100	100	2	18.0
14-Oct	8.00	1.8	0	clr-pc	9.6	sw-w	11.0	27.02	2	100	100	2	10.1
15-Oct	8.00	1.9	0	mc-ovc	10.1	sw-w	8.3	26.85	4	100	100	3	16.5
16-Oct	2.00	2.0	1	ovc, snow	6.3	w	0.7	26.91	4	43	67	2	0.5
17-Oct	4.00	2.0	1.5	pc-mc, haze PM	6.5	sw-w	5.3	26.87	3	100	100	3	9.8
18-Oct	8.00	2.0	0	mc, haze	9.3	w	1.8	26.88	4	100	100	2	8.0
19-Oct	8.00	2.0	0	clr-pc, haze	12.9	w	2.1	26.91	4	100	100	2	6.3
20-Oct	8.00	2.0	0	pc	6.1	w	7.8	26.92	4	100	100	2	4.8
21-Oct	8.00	2.0	0	clr, haze	6.6	sw-w	9.6	26.81	3	100	100	2	2.5
22-Oct	7.25	2.0	0	pc-ovc, haze	3.6	var	8.2	26.73	3	82	93	2	1.9
23-Oct	6.50	2.0	0	pc-ovc, haze	5.9	w	4.3	26.66	3	74	98	2	4.8
24-Oct	0.00			Weather Day: fog/rain									
25-Oct	0.00			Weather Day: fog/snow									
26-Oct	0.00			Weather Day: fog/snow									
27-Oct	1.67	2.0	2	ovc	10.3	s-sw	-6.0	26.87	4	100	100	1	0.0
28-Oct	5.75	2.0	1	mc-ovc	9.0	s-sw	-0.3	26.90	4	100	100	1	0.5
29-Oct	4.75	2.0	1	ovc	10.3	sw-w	0.2	26.76	4	100	100	2	1.7
30-Oct	6.00	2.4	1	pc-ovc, haze	3.3	se-sw	2.5	26.70	4	100	100	2	2.2
31-Oct	1.50	2.0	1	ovc, snow	6.7	sw-w	0.3	26.78	4	43	77	1	0.0
1-Nov	5.33	1.0	0	mc	11.4	sw-w	0.4	27.03	4	100	100	2	5.8

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

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

<sup>3</sup> Predominant sky condition during day: clr = clear (0-15% cloud cover); pc = partly cloudy (16-50% cover); mc = mostly cloudy (51-75% cover); ovc = overcast (76-100% cover); ts = thunderstorms.

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

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

# Appendix D. Daily observation effort and fall raptor migration counts by species in the Bridger Mountains, MT: 2010.

DATE	HOURS	SPECIES <sup>1</sup>																									BIRDS			
		TV	OS	NH	SS	CH	NG	SA	LA	UA	BW	SW	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	GY	SF	LF	UF	UU	TOTAL	/HOUR
28-Aug	1.58	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	0.00																													
30-Aug	0.00																													
31-Aug	6.83	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	5	0.7
1-Sep	0.00																													
2-Sep	8.00	0	0	6	2	0	1	0	0	0	0	1	4	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	17	2.1
3-Sep	8.00	0	1	2	4	1	0	0	0	0	0	0	5	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	15	1.9
4-Sep	8.00	0	0	4	7	8	1	0	0	0	0	0	19	0	0	0	5	1	0	18	2	0	0	0	0	0	0	1	66	8.3
5-Sep	3.83	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	6	1.6
6-Sep	7.42	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	4	0.5
7-Sep	7.50	0	0	12	0	7	4	0	1	0	1	0	12	0	0	0	2	0	0	7	0	0	1	0	0	0	0	0	47	6.3
8-Sep	3.50	0	0	1	2	4	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	2.9
9-Sep	0.00																													
10-Sep	0.00																													
11-Sep	8.00	1	0	0	2	0	0	0	0	0	0	0	14	0	0	0	3	0	0	6	0	0	0	0	0	0	0	1	27	3.4
12-Sep	8.00	0	0	1	17	14	1	4	3	3	0	0	7	0	0	1	9	0	0	9	0	0	0	0	0	0	0	2	71	8.9
13-Sep	7.33	0	0	8	17	10	4	2	1	5	2	0	7	0	0	0	10	1	0	2	0	0	0	0	0	0	0	0	69	9.4
14-Sep	7.00	0	0	4	2	4	2	1	1	0	0	0	3	0	0	0	3	0	0	3	0	0	0	0	0	0	0	0	23	3.3
15-Sep	8.00	0	0	0	3	7	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	13	1.6
16-Sep	6.50	0	0	0	1	0	1	0	0	1	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	6	0.9
17-Sep	4.50	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.4
18-Sep	3.50	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.3
19-Sep	8.00	0	0	3	4	23	1	5	2	3	0	0	16	0	0	0	9	0	0	3	0	0	0	0	0	0	0	3	72	9.0
20-Sep	8.00	0	0	0	2	0	0	1	2	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	7	0.9
21-Sep	7.00	0	0	1	1	1	2	0	0	0	0	0	1	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	10	1.4
22-Sep	0.00																													

# Appendix D. continued

DATE	HOURS	SPECIES <sup>1</sup>																								BIRDS				
		TV	OS	NH	SS	CH	NG	SA	LA	UA	BW	SW	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	GY	SF	LF	UF	UU	TOTAL	/HOUR
23-Sep	7.83	0	0	0	5	4	0	2	1	1	0	0	9	0	1	0	7	0	0	1	1	1	0	0	0	0	0	0	33	4.2
24-Sep	8.00	0	0	1	9	2	1	0	0	0	0	0	2	0	0	1	12	0	0	1	0	0	0	0	0	0	0	29	3.6	
25-Sep	8.00	0	0	0	9	16	0	3	1	1	0	0	7	0	0	2	18	1	1	6	1	3	3	0	0	1	0	73	9.1	
26-Sep	8.00	0	0	2	13	10	1	1	1	0	0	0	8	0	0	1	29	0	0	4	0	2	1	0	0	0	0	73	9.1	
27-Sep	8.00	0	0	0	19	7	0	0	4	0	0	0	8	0	0	0	31	0	0	3	1	2	1	0	0	1	0	78	9.8	
28-Sep	7.00	1	0	0	2	1	0	1	0	1	0	0	3	0	0	0	12	0	0	1	0	0	0	0	0	0	0	22	3.1	
29-Sep	8.00	0	0	5	20	12	0	1	0	3	0	0	8	0	0	1	14	0	0	6	0	0	0	0	0	0	1	71	8.9	
30-Sep	7.67	0	0	6	23	8	0	0	0	1	0	0	2	0	3	1	13	0	0	1	0	1	1	0	0	0	2	62	8.1	
1-Oct	8.00	0	0	6	7	0	1	1	0	0	0	0	2	0	2	0	15	2	0	0	0	0	0	0	0	0	0	36	4.5	
2-Oct	8.00	0	0	1	13	12	0	0	0	1	1	0	8	0	0	0	17	2	0	4	0	1	1	0	0	0	0	61	7.6	
3-Oct	8.00	0	0	0	22	11	2	1	0	0	0	0	3	0	0	1	3	0	0	1	0	0	0	0	0	0	0	44	5.5	
4-Oct	7.50	0	0	0	10	3	1	1	0	0	0	0	7	0	0	0	33	2	0	1	0	0	0	0	0	0	0	58	7.7	
5-Oct	0.00																													
6-Oct	8.00	0	0	3	14	6	1	0	0	0	0	0	4	0	2	0	5	1	0	1	1	0	0	0	0	0	0	38	4.8	
7-Oct	8.50	0	0	2	22	11	1	5	2	2	1	0	4	0	2	5	156	10	0	3	0	0	0	0	3	0	0	229	26.9	
8-Oct	0.00																													
9-Oct	8.00	0	0	1	8	3	2	0	1	0	0	0	1	0	1	2	48	2	0	1	0	0	0	0	0	0	1	71	8.9	
10-Oct	8.00	0	0	0	12	1	0	0	0	1	0	0	1	0	0	1	85	0	0	1	1	1	0	0	0	0	0	104	13.0	
11-Oct	0.00																													
12-Oct	8.25	0	0	2	4	3	1	0	0	0	0	0	1	0	0	0	112	0	0	1	0	2	0	0	0	0	1	127	15.4	
13-Oct	8.00	0	1	0	5	1	0	1	0	0	0	0	3	1	0	1	131	0	0	0	0	0	0	0	0	0	0	144	18.0	
14-Oct	8.00	0	0	0	10	0	0	0	0	0	0	0	0	0	1	1	69	0	0	0	0	0	0	0	0	0	0	81	10.1	
15-Oct	8.00	0	0	0	21	8	1	7	0	2	0	0	1	0	2	1	85	1	0	0	1	1	0	0	0	0	1	132	16.5	
16-Oct	2.00	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.5	
17-Oct	4.00	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	34	2	0	0	0	0	0	0	0	0	0	39	9.8	
18-Oct	8.00	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	57	2	0	0	0	1	0	0	0	0	0	64	8.0	
19-Oct	8.00	0	0	1	2	2	0	0	0	0	0	0	0	0	0	0	39	5	0	0	0	1	0	0	0	0	0	50	6.3	

# Appendix D. continued

DATE	HOURS	SPECIES <sup>1</sup>																									BIRDS			
		TV	OS	NH	SS	CH	NG	SA	LA	UA	BW	SW	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	GY	SF	LF	UF	UU	TOTAL	/HOUR
20-Oct	8.00	0	0	2	4	0	2	0	1	0	0	0	1	0	9	0	16	3	0	0	0	0	0	0	0	0	0	0	38	4.8
21-Oct	8.00	0	0	1	6	0	0	0	0	0	0	0	0	0	1	0	10	1	0	0	1	0	0	0	0	0	0	0	20	2.5
22-Oct	7.25	0	0	0	1	1	0	0	0	0	0	0	1	0	1	1	5	3	0	0	1	0	0	0	0	0	0	0	14	1.9
23-Oct	6.50	0	0	1	5	0	0	0	0	0	0	0	1	0	3	0	13	6	0	0	2	0	0	0	0	0	0	0	31	4.8
24-Oct	0.00																													
25-Oct	0.00																													
26-Oct	0.00																													
27-Oct	1.67																													
28-Oct	5.75	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	3	0.5
29-Oct	4.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	1	0	0	0	1	0	0	0	0	0	0	8	1.7
30-Oct	6.00	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	7	3	0	0	0	0	0	0	0	0	0	0	13	2.2
31-Oct	1.50																													
1-Nov	5.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	1	0	0	0	0	0	0	0	0	0	0	31	5.8
Total	366.00	2	3	77	336	207	33	40	22	25	5	1	178	3	31	20	1171	50	1	87	12	18	8	0	3	2	0	14	2349	6.4

<sup>1</sup> 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: 1991–2010.**

	1991	1992	1993	1994	1995	1996	1997
Start date	15-Sep	6-Sep	9-Sep	13-Sep	10-Sep	1-Sep	27-Aug
End date	3-Nov	28-Oct	31-Oct	30-Oct	2-Nov	30-Oct	31-Oct
Observation days	32	39	46	36	42	53	62
Observation hours	191.1	242.58	298.50	239.25	269.17	378.25	422.92
Raptors / 100 hours	926.7	1000.1	871.7	1027.8	824.0	808.5	796.1
SPECIES	RAPTOR COUNTS						
Turkey Vulture	3	0	0	0	0	1	6
Osprey	2	2	5	5	1	14	12
Northern Harrier	19	13	41	59	10	38	66
Sharp-shinned Hawk	88	248	279	364	304	436	480
Cooper's Hawk	87	175	124	134	131	206	347
Northern Goshawk	27	96	39	17	10	37	36
Unkown small accipiter	-	-	-	-	-	-	-
Unkown large accipiter	-	-	-	-	-	-	-
Unknown accipiter	70	35	27	20	33	51	53
Total accipiters	272	554	469	535	478	730	916
Broad-winged Hawk	0	2	3	16	5	5	5
Swainson's Hawk	1	11	0	3	2	0	6
Red-tailed Hawk	26	67	65	110	79	106	130
Ferruginous Hawk	3	1	1	1	0	5	4
Rough-legged Hawk	9	10	53	48	29	17	23
Unidentified buteo	14	8	19	15	18	13	20
Total buteos	53	99	141	193	133	146	188
Golden Eagle	1280	1579	1699	1500	1322	1871	1844
Bald Eagle	43	95	124	41	57	79	93
Unidentified eagle	5	2	17	0	25	14	0
Total eagles	1328	1676	1840	1541	1404	1964	1937
American Kestrel	33	38	54	67	117	82	146
Merlin	2	10	7	7	12	9	26
Prairie Falcon	9	14	10	11	14	16	10
Peregrine Falcon	1	7	6	4	7	10	10
Gyr Falcon	0	0	0	0	0	0	0
Unkown small falcon	-	-	-	-	-	-	-
Unkown large falcon	-	-	-	-	-	-	-
Unknown falcon	5	3	2	4	2	5	17
Total falcons	50	72	79	93	152	122	209
Unidentified raptor	44	10	27	33	40	43	33
Grand Total	1771	2426	2602	2459	2218	3058	3367

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

Appendix E. continued

	1998	1999	2000	2001	2002	2003	2004
Start date	28-Aug	29-Aug	29-Aug	27-Aug	27-Aug	27-Aug	27-Aug
End date	31-Oct	31-Oct	29-Oct	31-Oct	27-Oct	31-Oct	27-Oct
Observation days	56	57	52	58	52	64	48
Observation hours	339.33	358.24	335.40	347.49	365.84	443.18	316.70
Raptors / 100 hours	1040.9	871.8	630.9	636.3	556.0	517.6	655.2
SPECIES	RAPTOR COUNTS						
Turkey Vulture	0	2	0	0	0	0	0
Osprey	13	9	6	6	2	5	1
Northern Harrier	230	52	20	36	15	54	39
Sharp-shinned Hawk	612	442	190	274	288	416	229
Cooper's Hawk	343	149	109	120	103	132	142
Northern Goshawk	50	61	34	26	2	23	41
Unkown small accipiter	-	-	-	0	11	29	32
Unkown large accipiter	-	-	-	0	4	4	9
Unknown accipiter	49	39	35	27	5	0	7
Total accipiters	1054	691	368	447	413	604	460
Broad-winged Hawk	20	13	3	38	3	9	6
Swainson's Hawk	2	3	3	0	1	2	0
Red-tailed Hawk	277	121	45	117	78	113	100
Ferruginous Hawk	7	4	1	3	0	1	3
Rough-legged Hawk	66	77	26	57	11	22	20
Unidentified buteo	13	3	8	6	9	6	18
Total buteos	385	221	86	221	102	153	147
Golden Eagle	1516	1870	1429	1330	1359	1226	1196
Bald Eagle	95	91	128	58	55	93	79
Unidentified eagle	15	5	3	2	15	4	2
Total eagles	1626	1966	1560	1390	1429	1323	1277
American Kestrel	141	113	39	62	16	102	65
Merlin	17	8	3	9	2	4	11
Prairie Falcon	12	20	9	14	6	15	12
Peregrine Falcon	18	18	1	8	1	10	10
Gyr Falcon	0	1	0	0	0	0	0
Unkown small falcon	-	-	-	0	0	0	3
Unkown large falcon	-	-	-	0	1	3	3
Unknown falcon	8	6	4	3	4	1	9
Total falcons	196	166	56	96	30	135	113
Unidentified raptor	28	16	20	15	43	20	38
Grand Total	3532	3123	2116	2211	2034	2294	2075

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

Appendix E. continued

	2005	2006	2007	2008	2009	2010	Mean
Start date	27-Aug	27-Aug	27-Aug	27-Aug	6-Sep	28-Aug	30-Aug
End date	31-Oct	29-Oct	29-Oct	31-Oct	31-Oct	1-Nov	29-Oct
Observation days	48	45	56	56	44	54	50
Observation hours	300.83	331.25	384.59	415.49	306.25	366.00	332.62
Raptors / 100 hours	674.8	538.3	550.5	427.7	453.2	641.8	722.5
SPECIES	RAPTOR COUNTS						
Turkey Vulture	1	2	1	0	0	2	1
Osprey	2	7	5	4	9	3	6
Northern Harrier	22	50	30	47	52	77	49
Sharp-shinned Hawk	228	344	277	222	230	336	314
Cooper's Hawk	153	182	151	115	113	207	161
Northern Goshawk	22	33	20	22	13	33	32
Unkown small accipiter	92	10	18	43	6	40	28
Unkown large accipiter	4	0	6	10	6	22	7
Unknown accipiter	27	0	5	3	7	25	26
Total accipiters	526	569	477	415	375	663	551
Broad-winged Hawk	3	12	5	7	33	5	10
Swainson's Hawk	0	0	3	8	4	1	3
Red-tailed Hawk	108	89	130	75	75	178	104
Ferruginous Hawk	2	3	5	1	2	3	3
Rough-legged Hawk	40	21	19	32	30	31	32
Unidentified buteo	27	2	11	10	10	20	13
Total buteos	180	127	173	133	154	238	164
Golden Eagle	1061	859	1247	1003	638	1171	1350
Bald Eagle	75	74	85	43	27	50	74
Unidentified eagle	1	1	0	10	4	1	6
Total eagles	1137	934	1332	1056	669	1222	1431
American Kestrel	20	38	41	46	45	87	68
Merlin	7	15	9	10	4	12	9
Prairie Falcon	20	22	17	13	17	18	14
Peregrine Falcon	8	15	8	5	23	8	9
Gyr Falcon	0	0	0	0	0	0	0
Unkown small falcon	27	0	2	2	3	3	4
Unkown large falcon	13	1	3	6	3	2	4
Unknown falcon	13	0	2	2	4	0	5
Total falcons	108	91	82	84	99	130	108
Unidentified raptor	54	3	17	38	30	14	28
Grand Total	2030	1783	2117	1777	1388	2349	2337

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