FALL 2012 RAPTOR MIGRATION STUDY IN THE BRIDGER MOUNTAINS, MONTANA

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

May 2013

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Report prepared by:
Bret Davis, Kalon Baughan, Markus Mika & Steve Hoffman

Counts conducted by:
Bret Davis & Kalon Baughan

Project coordinated by:
Montana Audubon Society
Project Coordinator: Steve Hoffman
Montana Audubon State Office, P.O. Box 595, Helena, MT 59624
(406) 443-3949
&
HawkWatch International, Inc.
Principal Investigator: Dr. Markus Mika
2240 South 900 East, Salt Lake City, Utah 84106
(801) 484-6808

January 2013

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INTRODUCTION

The Bridger Mountains Raptor Migration Project in southwestern Montana is an ongoing effort to monitor long-term population trends of raptors using this 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. Beginning in 2009, in partnership with HawkWatch international, Montana Audubon took the lead in conducting these annual counts. This flyway is noted for large concentrations of Golden Eagles (see Appendix A for scientific names of all raptor species observed at this site). To date 18 species of raptors have been identified migrating along the Bridger Mountains, with annual totals typically ranging from 2,000 to 3,500 migrants. This report summarizes results of the 2012 count, which marked the 21st consecutive, full-season autumn count of migratory raptors at the site.

The Bridger Mountains Project was one of seven long-term, annual fall migration counts conducted or co-sponsored by HWI in North America during 2012. The primary objective of these efforts is to track long-term population trends of diurnal raptors in western North America and the Gulf Coast region (Hoffman et al. 2002, Hoffman and Smith 2003, Smith et al. 2008a&b). Raptors serve as valuable biological indicators of ecosystem health (Bildstein 2001), and long-term migration monitoring is the most cost-effective and efficient method for assessing regional status and trends of multiple raptor species (Zalles and Bildstein 2000, Bildstein et al. 2008).

STUDY SITE

The Bridger Mountains are a relatively narrow range that runs primarily along a north–south axis. From 50 km northwest of Sacajawea Peak (2,950 meters elevation), the range extends southward for 90 km before meeting the Gallatin Valley 5 km northeast of Bozeman, Montana. Consistent westerly winds collide with the Bridger Range and create strong, predictable 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 meters (45° 49.022' N, 110° 55.778' W; Figure 1). The site is situated within the Gallatin National Forest on the crest of the Bridger Ridge, about 25 km northeast of Bozeman and 3 km north of Saddle Peak. The helicopter pad is a 5m x 5m concrete platform located approximately 50 meters north of an avalanche cache/ski patrol hut. The site is accessed by walking along a primitive dirt road for 3 km (780 meters rise in elevation) to the top of the Bridger chairlift, then continuing westward a few hundred meters along a steep footpath to the crest of the ridge, and finally north for 50 meters to the observation site.

METHODS

Weather permitting, two official observers conducted standardized daily counts of migrating raptors from a single, traditional observation site from late August through late October/early November. In 2012 observations began 1 September and continued through 5 November 2012. Observations typically began at 0900 H and ended at 1700 H Mountain Standard Time (MST). This was the first full season of migration counting at this site for both official observers (see Appendix B for a complete observer history at this site). Both observers received on and off-site training with Montana Audubon Executive Director, Steve Hoffman. Local birding experts Matt Keefer and John Parker occasionally assisted with the counts. In addition, other local volunteers joined the count sporadically (especially members from the local Sacajawea Audubon Chapter). Two plastic decoy owls were used to lure passing raptors; one was located approximately 5 meters directly north of the observation point, and another approximately 400 meters north. (In previous years only a single, nearby owl was used.) 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).

2. Hour of passage for each migrant; e.g., the 1000–1059 H, etc. (Mountain Standard Time).

3. Wind speed and direction, air temperature, percent cloud cover, predominant cloud type(s), presence of precipitation (and type), visibility, and a subjective assessment of thermal lift conditions, recorded for each hour of observation on the half-hour.

4. Predominant direction, altitude, and horizontal distance from the lookout of the migratory 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 contributed to the count [actively scanning, pointing out birds, recording data, etc.] for at least 10 minutes in a given hour), recorded at the end of each hour.

6. A subjective visitor-disturbance rating (high, moderate, low, none) for each hour, recorded at the end of each hour.

7. Daily start and end times for each official observer.

Calculation of "adjusted" (to standardize sampling periods and adjusted for incompletely identified birds) passage rates (migrants counted per 100 hours of observation) and analysis of trends, updated through 2012, is described in detail in Hoffman and Smith (2003). In comparing 2012 annual statistics against means and 95% confidence intervals for previous seasons, we determined significance when a 2012 value fell outside the 95% confidence interval of the associated mean.

RESULTS AND DISCUSSION

WEATHER SUMMARY:

Inclement weather and/or difficult access (due to excessive snow cover) precluded 8 full days of observation during the 2012 season. This is slightly lower than the 1997-2011 average of 11.5 days (for the period in which detailed daily weather records have been collected and analyzed). In addition, inclement weather was a factor in reducing total observation hours in a day to less than four on six additional days (average is 5.3 days; see Appendix C for 2012 daily weather records).

During periods of active observation skies were recorded as fair 36% of the time, 22% transitional, and 41% mostly cloudy/overcast. Comparison with the long-term averages (37% fair, 32% transitional and 31% mostly cloudy/overcast) suggests the 2012 season was similar to the average for fair skies, but above average for overcast days that were not inclement enough to preclude observation. In sharp contrast to the 14-year average of 33% of weather observations including fog or haze, the 2012 season experienced 74% fog/haze. Persistent fires in the area created thick smoke and haze that surrounded the Bridger Mountain

on most days until 13 October, when a multi-day rain and snowstorm finally cleared out the smoke for the remainder of the season. Many local residents expressed the view that 2012 was the worst smoke/fire season in recent memory. This resulted in the estimated average visibility for the season being reduced to a record low 44-47 km (long-term average 76-80 km). Snow/rain conditions were about average in 2012, comprising 14% of hourly weather observations.

The predominant speed of prevailing winds was light (<12 kph), which was recorded 81% of active observation periods, while moderate winds (12-29 kph) were recorded 19% of days. These percentages were almost identical to the 1997-2011 averages of 81% light, 18% moderate, and 1% strong. Prevailing wind direction was from SSW-SW, occurring 31% of active observation periods, with winds from the west occurring 27% of observation periods. These wind statistics, combined with observers subjectively rating the thermal lift as "good to excellent" only 18% of the time, suggests that conditions were particularly favorable in 2012 for spotting migrants, due to generally weaker thermal lift conditions throughout most of the season, and thus generally lower-altitude flight trajectories. The major reason was persistent, dense haze caused by forest fire smoke, which greatly reduced the strength of thermal lift until mid-October.

Due to a calibration error the barometric data recorded for 2012 was not usable.

OBSERVATION EFFORT:

Observations were conducted on 58 of 66 days between 1 September and 5 November in 2012. The number of observation days was 13% above the 1992-2011 average, and the number of observation hours (414) was 21% above the long-term average of 343 ± 25 hours. The 2012 average of 2.1 observers per hour (including official and guest observers; this value is a mean of daily values, which are, in turn, means of hourly values) was similar, but slightly above the 1992-2011 average of 1.9.

FLIGHT SUMMARY:

The observers tallied 2,818 migrating raptors of 17 species during the 2012 season (Table 1; see Appendix D for daily count records). This total count is 18% above the long-term average.

The 2012 flight was comprised of 49% eagles, 26% accipiters, 12% buteos, 8% falcons, 2% harriers, 1% unidentified raptors, and less than 1% Ospreys and vultures (Figure 2). The most numerous species were: Golden Eagles (45% of total count), Sharp-shinned Hawks (16%), Red-tailed Hawks (8%), Cooper's Hawks (6%), and American Kestrels (5%). All other species each comprised ≤ 4% of the total.

The plastic owl decoys lured every species of migrant raptor except the Bald Eagle, Turkey Vulture, and Broad-winged and Swainson's Hawks. Accipiters and falcons were most frequently attracted to the owl, but Red-tailed Hawks, Northern Harriers, and Rough-legged Hawks sometimes stooped upon the owl as well. Accipiters seemed less wary than other raptor species when stooping on the close owl decoy. A single Ferruginous Hawk and an immature Golden Eagle mobbed the more distant owl.

PASSAGE RATES AND LONG-TERM TRENDS:

In 2012 adjusted passage rates were significantly above average for Sharp-shinned Hawk, Red-tailed Hawk, Broad-winged Hawk, Peregrine Falcon, and American Kestrel. Conversely, passage rates were significantly below average only for the Golden Eagle (Table 1, Figures 3-9).

Total counts for the Peregrine Falcon and American Kestrel were the highest in the 21-year history of the count. Also noteworthy were total counts of Red-tailed and Broad-winged Hawks (second highest in history; see Appendix E for yearly counts). Peregrine Falcons are on a significant upswing from the all-time lows recorded in the late 1990's (Figure 9). These ongoing population increases are likely due to the long-term population recovery of the species since the official banning of the use of organochlorine pesticides (such as DDT) in the U.S. in 1972.

Regression analyses updated through 2012 (after Hoffman and Smith 2003) revealed a highly significant ($P<0.00001$) downward linear trend for Golden Eagles at the species level, tracking a steady decline since 1992 (Figure 6). Age-specific trend analyses revealed similar rates of decline for both adults and non-adults ($P<0.01$). These declines suggest eagle populations have plummeted 35-40% since the late 1990's. As yet, no cause has been determined, but the Bridger counts and similar studies elsewhere have recently generated additional federal and state funding to better assess status and trends of Golden Eagle populations (and the threats facing them) across the western US.

The Northern Goshawk, both for all age classes and for adults, shows continued significant ($P<0.1$) linear declines (Figures 4 & 8). Although Bald Eagle counts in the Bridgers suggest declines, this trend result is not likely representative of the species' overall population health, since most Bald Eagles migrate through the area later in November and December, long after the count season has ended. And, with the gradual increase in average fall temperatures during the past 20 years it is likely that the timing of the autumn Bald Eagle migration has been delayed, yielding progressively fewer birds counted during the standardized observation period.

Smith et al. (2008a) presented trend analyses for 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) were based on a more complex analytical approach (also see Farmer et al. 2007) than what was reported in Hoffman and Smith (2003) and used in this report. Among other refinements, this new approach fits polynomial trajectories to the complete series of annual count indices, and allows for estimating rates of change between various periods while also providing assessments of trend significance and precision. Please note, however, that restrictions related to the mathematical assumptions behind the new approach precludes analysis of data for rare species, which in this case includes Turkey Vultures, Ospreys, all buteos except Red-tailed and Rough-legged Hawks, and all falcons except American Kestrels. Otherwise, with few notable exceptions, the overall patterns of change and derived trend estimates resulting from the new analysis method yielded similar inferences to those derived from the simpler methodology of Hoffman and Smith (2003).

AGE RATIOS:

The proportion of juveniles (also referred to as "immatures") in the fall population may provide important clues regarding the breeding success for the current year. Hence we record this information as accurately as possible each year (see Table 2 for a summary of age ratio data collected in 2012). Observations showed that immature:adult ratios were above average for three of nine species for which relevant age-specific data were available, and significantly so for Bald Eagle. In contrast, species showing a significant decrease in the proportion of immatures/subadults (relative to the average) in 2012 included the Golden Eagle, Northern Goshawk, and Sharp-shinned Hawk.

SEASONAL TIMING:

During the 2012 season Sharp-shinned Hawk and Cooper's Hawks showed significantly earlier passage dates (Table 3). Conversely, the Osprey, Northern Goshawk, Broad-winged Hawk, Red-tailed Hawk and Merlin all exhibited passage dates significantly later than the 20-year average for those species (Table 3). The combined-species median passage date was four days earlier than the average date of 6 October, and generally followed the overall seasonal pattern observed over the 20-year study period, with most of the deviation occurring in mid-October (Table 3, Figure 10). The median passage date for Golden Eagles was only one day later than the 20-year average of 12 October (Table 3). Analysis of migration timing in 2012 with respect to Golden Eagle age classes showed median passage dates for immature and adults of 7 and 13 October, respectively. Both these values are within the 95% CI of the mean.

RESIDENT RAPTORS:

This year's crew recorded nine species that displayed resident behavior: Sharp-shinned Hawk, Cooper's Hawk, Northern Goshawk, Red-tailed Hawk, Golden Eagle, Bald Eagle, American Kestrel, Prairie Falcon, and Peregrine Falcon.

Sharp-shinned Hawk - Resident Sharp-shinned Hawks were seen regularly beginning on 1 September. Two immature individuals were frequently seen together north of the observation point in the morning, as well as hunting along the ridgeline and harassing the decoy owl, as well as local and migrant raptors. These birds were last seen on 26 September.

Cooper's Hawk - One Cooper's Hawk was identified as a resident. On 4 and 6 September an immature was seen mobbing decoy owls and harassing migrant and local Sharp-shinned Hawks.

Northern Goshawk - An immature resident Northern Goshawk was observed periodically throughout the fall. It was first was seen regularly between 2 and 13 September, often mobbing decoy owls and escorting passing migrants, and later seen between 29 September and 12 October exhibiting similar behavior. A resident adult Northern Goshawk was observed in the area on 14 October mobbing the decoy owl. It should be noted that a hiker photographed an adult Northern Goshawk in Truman Gulch on the west side of the ridge at about the same time.

Red-tailed Hawk - Three Red-tailed Hawks (one light morph adult pair, one light-morph immature) were identified as residents. The pair was seen regularly together between 9 September and 19 October. The immature was distinctly marked, and was seen between 4 and 26 September, often kiting on the west side of the ridge.

Golden Eagle - A pair of resident adult Golden Eagles were in the area throughout the observation period, as well as at least one sub-adult and one immature. The adult pair used a perch many evenings on the west side of Tilly Mountain. These residents were very active, consistently escorting migrating eagles and buteos as they flew south; they were also frequently observed hunting both the Bridger and Bangtail Mountains. The subadult was present until 20 October, and the immature was last seen on 29 September. The immature was especially playful with Ravens, taking turns chasing and being chased. In addition, on 29 October at least six Golden Eagles were observed feeding on a large carcass near Sacajawea Peak. Some of these were likely residents, while others may have been migrants stopping to feed along the way.

Bald Eagle - An adult Bald Eagle was seen on 1 and 2 September flying in a westerly direction perpendicular to the Bridger Ridge.

American Kestrel - Both male and female resident American Kestrels were seen between 1 and 17 September, most often in the morning on the east side of the ridge hunting and harassing other birds. As many as four individuals were seen at one time, and it was thought that at least six may have resided east of the observation point.

Prairie Falcon - A resident Prairie Falcon was seen on 9 and 29 September. On one occasion it appeared from the west side of the ridge to stoop on the decoy owl. On another it came out of the west to escort a migrating Broad-winged Hawk, and then turned back west toward the valley.

Peregrine Falcon - At least two residents were observed: one immature and one adult. Both appeared on 2 September; the immature was last observed on 11 September, and the adult on 17 September. Both would attack decoy owls persistently (sometimes up to several minutes of dive-bombing and screaming), and were often observed hunting along the ridge north of the observation point.

VISITATION:

Throughout the 2012 season a total of 214 individuals signed the visitor sign-in log maintained at the observation platform. It is estimated that this represents approximately 90% of the total number of visitors. Most visitors were from the greater Bozeman area, and a large number of guests were enjoying other forms of recreation along the ridge when they reached the observation platform. Regardless of their motivation, most visitors were eager to learn about the raptor migration and the project. The 19th annual Bridger RaptorFest attracted an exceptional turn-out again in 2012, with an estimated 4,800 attendees. Weather was fair both days (although cold), and 50 guests signed the visitor log during the weekend.

A total of 427 hourly assessments of visitor disturbance were recorded during the 2012 season. Of these subjective assessments, 80% were recorded as none, 12% low, 7% moderate, and 1% high.

ACKNOWLEDGMENTS

Generous funding for the 2012 field season was provided by the USDA Forest Service–Gallatin National Forest (coordinated by Beverly Dixon), Sacajawea Audubon Society, NaturEner USA, LLC (wind energy company; support facilitated by Greg Copeland), Sadie & Rob Pariseau, Clyde & Cheryl Wootton, and Montana Audubon. Randy Elliot and Doug Wales of Bridger Bowl deserve special thanks for providing essential logistical support. We also wish to thank Matt Keefer and John Parker 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: 1992–2011 versus 2012.

SPECIES	COUNTS			RAPTORS/100 HRS		
	1992–2011[1]	2012	%CHANGE	1992–2011[1]	2012	%CHANGE
Turkey Vulture	1 ± 0.75	2	100	0.4 ± 0.30	0.7329	72
Osprey	6 ± 1.9	9	50	2.9 ± 0.86	3.6162	25
Northern Harrier	51 ± 20.2	64	25	15.8 ± 6.57	18.034	14
Sharp-shinned Hawk	338 ± 52.1	452	34	126.1 ± 17.66	144.08	14
Cooper's Hawk	168 ± 30.5	180	7	123.3 ± 21.61	106	-14
Northern Goshawk	32 ± 9.1	33	3	10.6 ± 3.62	7.1863	-32
Unknown small accipiter[2]	28 ± 15.1	40	43	–	–	–
Unknown large accipiter[2]	6 ± 3.6	6	0	–	–	–
Unknown accipiter	23 ± 7.7	12	-48	–	–	–
Total accipiters	579 ± 81.7	723	25	–	–	–
Broad-winged Hawk	10 ± 4.4	37	270	5.5 ± 2.44	16.29	196
Swainson's Hawk	3 ± 1.3	8	167	1.2 ± 0.68	2.5921	117
Red-tailed Hawk	113 ± 23.5	238	111	39.3 ± 7.51	69.037	76
Ferruginous Hawk	2 ± 0.8	4	100	0.9 ± 0.26	1.1224	32
Rough-legged Hawk	33 ± 8.0	42	27	23.5 ± 6.44	29.08	24
Unidentified buteo	12 ± 2.9	12	0	–	–	–
Total buteos	174 ± 29.7	341	96	–	–	–
Golden Eagle	1358 ± 144.2	1272	-6	522.1 ± 56.19	383.56	-27
Bald Eagle	76 ± 11.6	92	21	27.2 ± 4.78	24.22	-11
Unidentified eagle	6 ± 3.2	12	100	–	–	–
Total eagles	1439 ± 151.5	1376	-4	–	–	–
American Kestrel	71 ± 16.8	147	107	60.4 ± 14.28	100.12	66
Merlin	10 ± 2.5	16	60	6.7 ± 1.50	6.7438	0
Prairie Falcon	14 ± 1.8	16	14	9.4 ± 1.50	10.253	9
Peregrine Falcon	10 ± 2.8	34	240	7.9 ± 2.07	23.614	199
Gyrfalcon	0.1 ± 0.10	0	-100	–	–	–
Unknown small falcon[2]	4 ± 4.6	3	-25	–	–	–
Unknown large falcon[2]	3 ± 2.2	8	167	–	–	–
Unknown falcon	5 ± 1.9	2	-60	–	–	–
Total falcons	114 ± 20.0	226	98	–	–	–
Unidentified raptor	28 ± 5.8	77	175	–	–	–
Grand Total	2391 ± 243.0	2818	18	–	–	–

[1] Mean ± 95% confidence interval.

[2] Designations used for the first time in 2002.

Table 2. Fall counts by age class and immature:adult ratios for selected species of migrating raptors in the Bridger Mountains, MT: 1992–2011 versus 2012.

	Total and Age-classified Counts								Immature : Adult	
	1992–2011 Average			2012			% Unknown Age		Ratio	
	Total	Imm.	Adult	Total	Imm.	Adult	1992–2011[1]	2012	1992–2011[1]	2012
Northern Harrier	51	24	12	64	23	16	32 ± 7.0	39	3.4 ± 2.93	1.4
Sharp-shinned Hawk	338	66	129	452	67	203	43 ± 5.8	40	0.5 ± 0.11	0.3
Cooper's Hawk	168	45	57	180	52	48	39 ± 4.8	44	0.9 ± 0.26	1.1
Northern Goshawk	32	12	12	33	11	14	27 ± 9.0	24	1.7 ± 0.52	0.8
Broad-winged Hawk	10	2	4	37	7	21	36 ± 16.3	24	0.8 ± 0.67	0.3
Red-tailed Hawk	113	35	51	238	58	123	24 ± 4.1	24	0.7 ± 0.29	0.5
Golden Eagle	1358	520	482	1272	415	568	27 ± 4.1	23	1.2 ± 0.18	0.7
Bald Eagle	76	26	47	92	45	45	3 ± 14.0	2	0.6 ± 0.12	1.0
Peregrine Falcon	10	1.0	4	34	9	21	53 ± 14.0	12	0.3 ± 0.28	0.4

[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 ratios.

Table 3. First and last observation, bulk passage, and median passage dates by species for migrating raptors in the Bridger Mountains, MT in 2012, with a comparison of 2012 and 1992–2011 average median passage dates.

	2012				1992–2011
Species	First Observed	Last Observed	Bulk Passage Dates[1]	Median Passage Date[2]	Mean Passage Date[3]
Turkey Vulture	19-Sep	19-Sep	–	–	15-Sep ±
Osprey	12-Sep	29-Sep	12-Sep – 29-Sep	20-Sep	16-Sep ± 2.8
Northern Harrier	3-Sep	22-Oct	6-Sep – 13-Oct	24-Sep	22-Sep ± 3.7
Sharp-shinned Hawk	1-Sep	4-Nov	9-Sep – 14-Oct	27-Sep	30-Sep ± 1.7
Cooper's Hawk	1-Sep	30-Oct	6-Sep – 29-Sep	18-Sep	23-Sep ± 2.7
Northern Goshawk	1-Sep	3-Nov	6-Sep – 31-Oct	15-Oct	6-Oct ± 5.4
Broad-winged Hawk	12-Sep	1-Oct	17-Sep – 29-Sep	24-Sep	19-Sep ± 1.8
Swainson's Hawk	2-Sep	15-Sep	2-Sep – 15-Sep	11-Sep	14-Sep ± 5.2
Red-tailed Hawk	2-Sep	5-Nov	8-Sep – 10-Oct	25-Sep	21-Sep ± 1.9
Ferruginous Hawk	6-Sep	7-Oct	–	–	4-Oct ±
Rough-legged Hawk	7-Oct	31-Oct	12-Oct – 28-Oct	19-Oct	20-Oct ± 1.5
Golden Eagle	1-Sep	5-Nov	24-Sep – 30-Oct	13-Oct	12-Oct ± 1.8
Bald Eagle	1-Sep	5-Nov	17-Sep – 2-Nov	14-Oct	14-Oct ± 2.8
American Kestrel	1-Sep	2-Oct	4-Sep – 27-Sep	19-Sep	21-Sep ± 2.0
Merlin	3-Sep	31-Oct	3-Sep – 30-Oct	11-Oct	5-Oct ± 3.4
Prairie Falcon	4-Sep	27-Oct	8-Sep – 27-Oct	20-Sep	24-Sep ± 3.5
Peregrine Falcon	8-Sep	2-Oct	9-Sep – 27-Sep	24-Sep	24-Sep ± 2.2
All species	6-Sep	5-Nov	10-Sep – 26-Oct	2-Oct	6-Oct ± 1.7

[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.

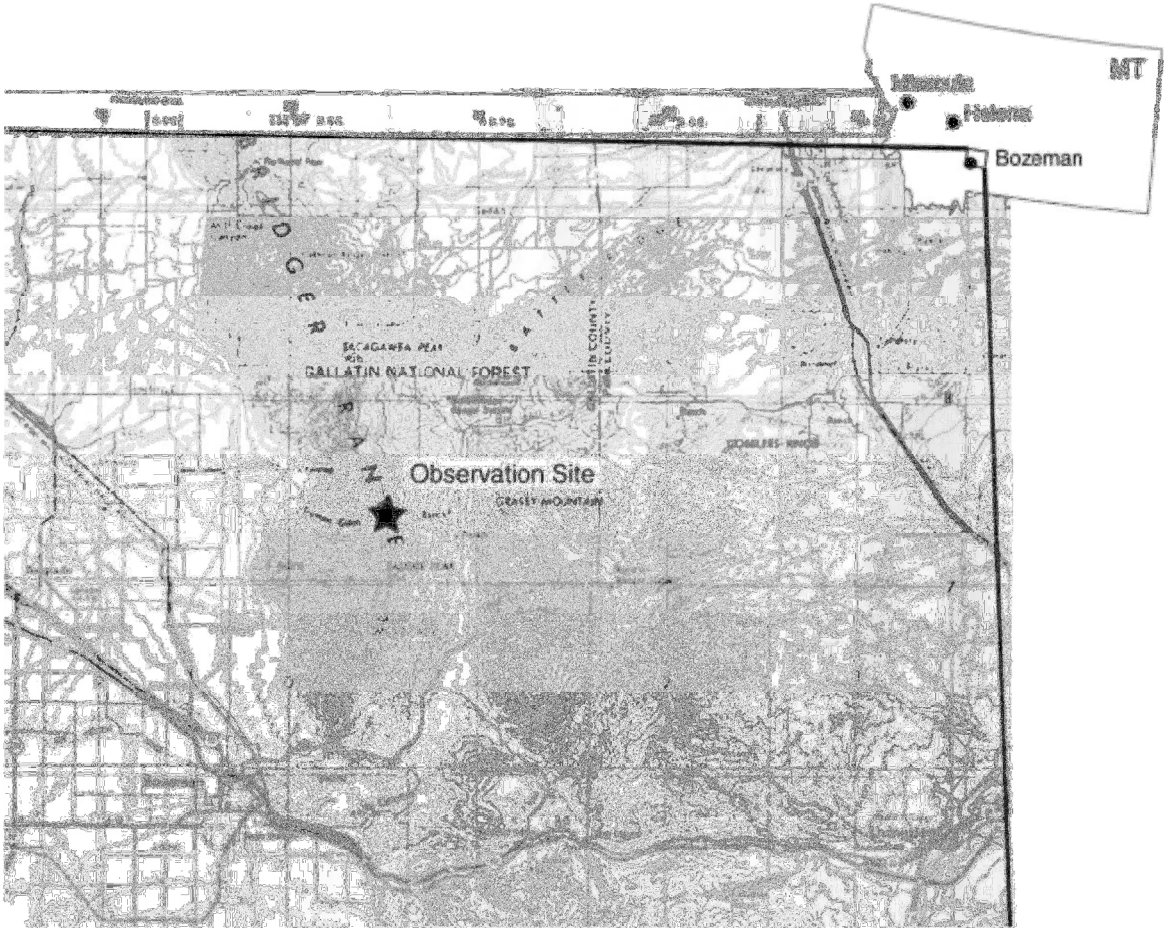

Figure 1. Location of the Bridger Mountains Raptor Migration Project study site.

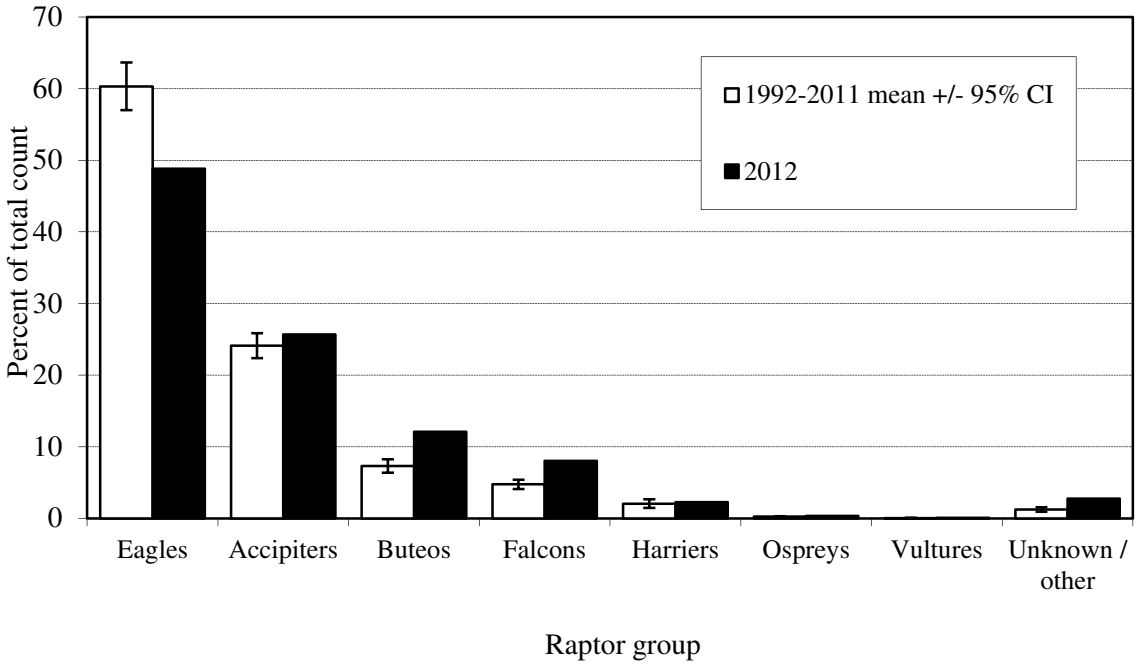

Figure 2. Composition of the fall raptor migration in the Bridger Mountains by major species groups: 1992-2011 versus 2012.

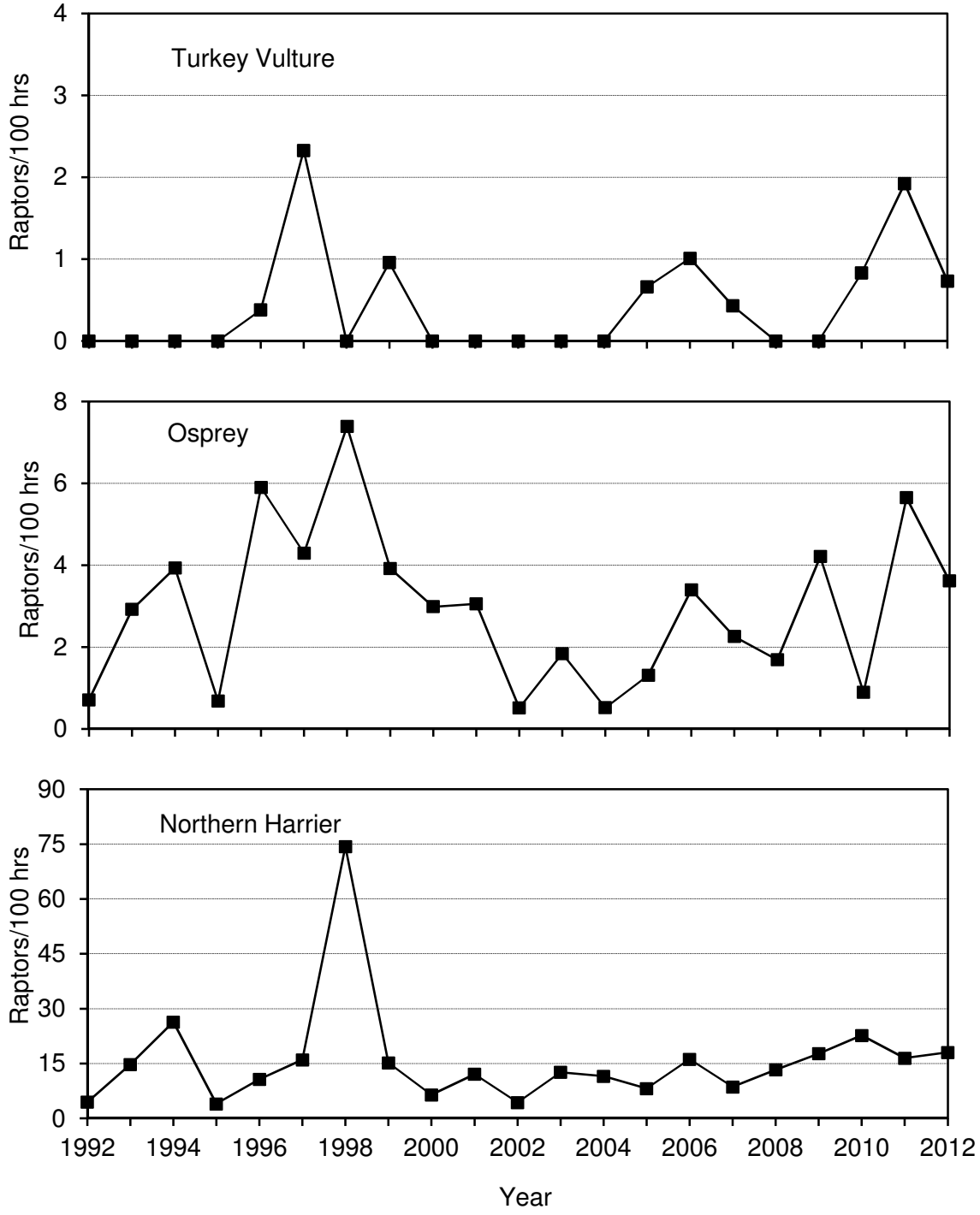

Figure 3. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall migration passage rates for Turkey Vultures, Ospreys, and Northern Harriers in the Bridger Mountains, MT: 1992–2012.

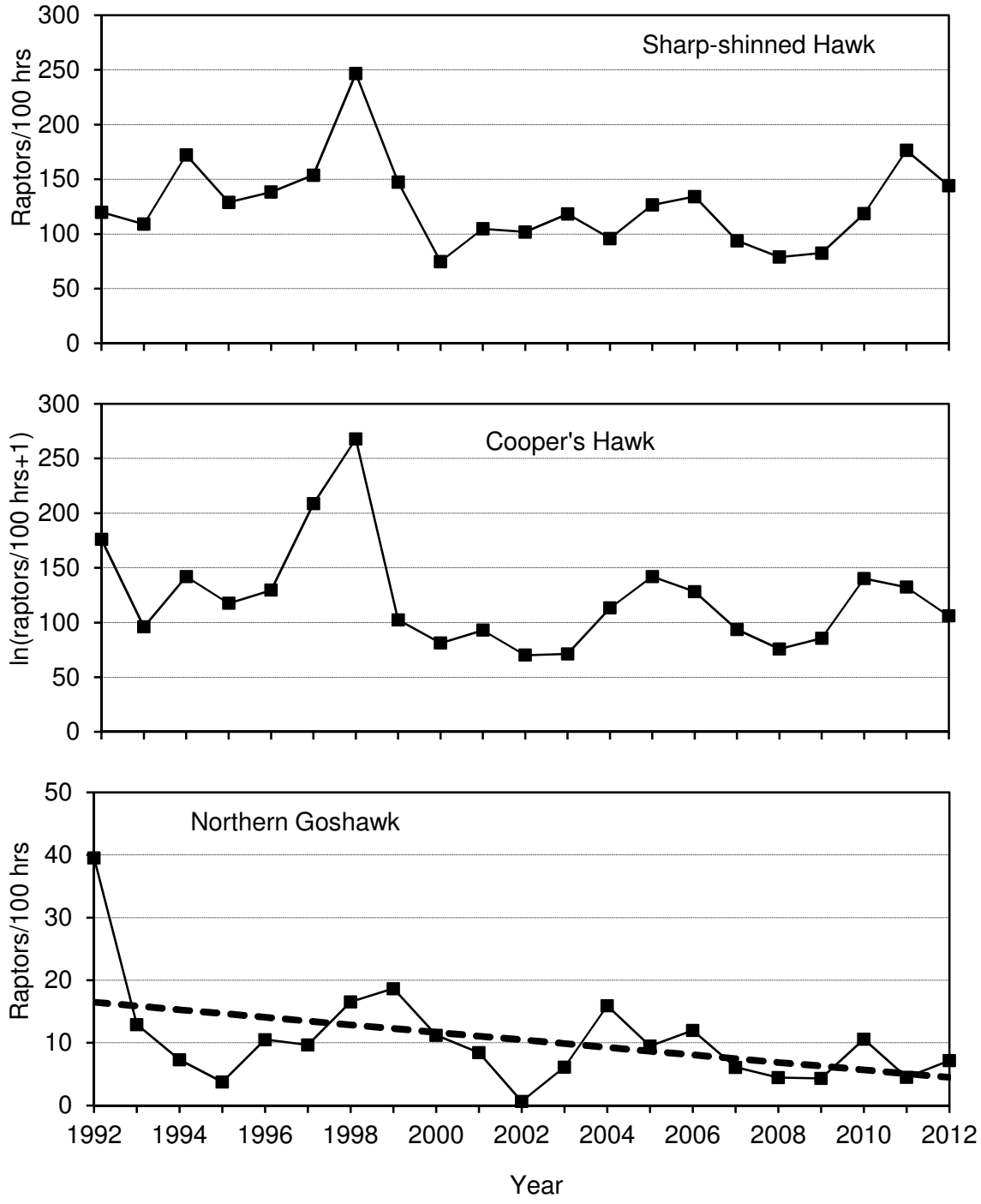

Figure 4. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall migration passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks in the Bridger Mountains, MT: 1992–2012. Dashed lines indicate statistically significant ($P \leq 0.10$) linear regressions.

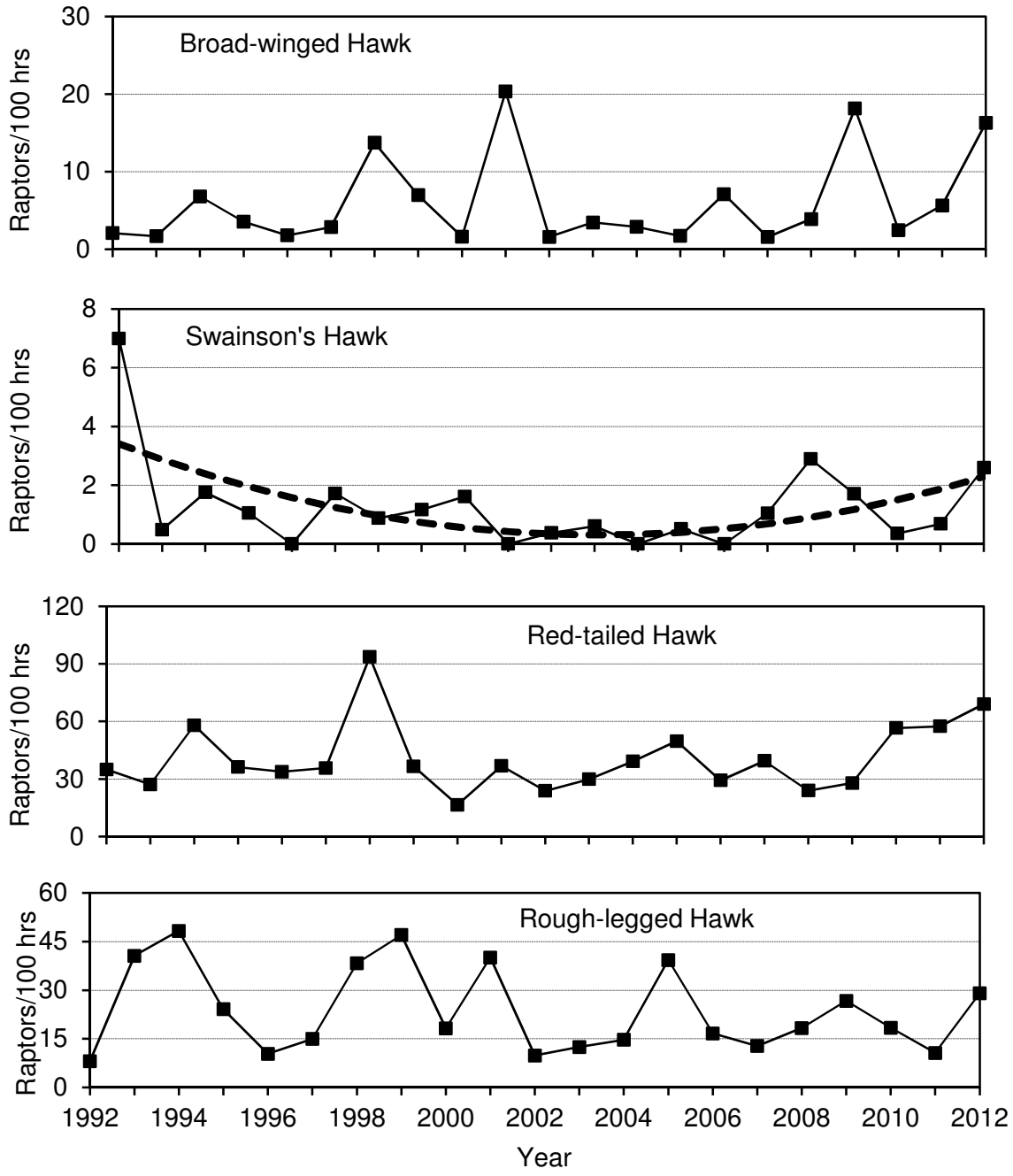

Figure 5. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Broad-winged, Swainson's, Red-tailed, Ferruginous and Rough-legged Hawks in the Bridger Mountains, MT: 1992–2012. Dashed lines indicate statistically significant ($P \leq 0.10$) regressions.

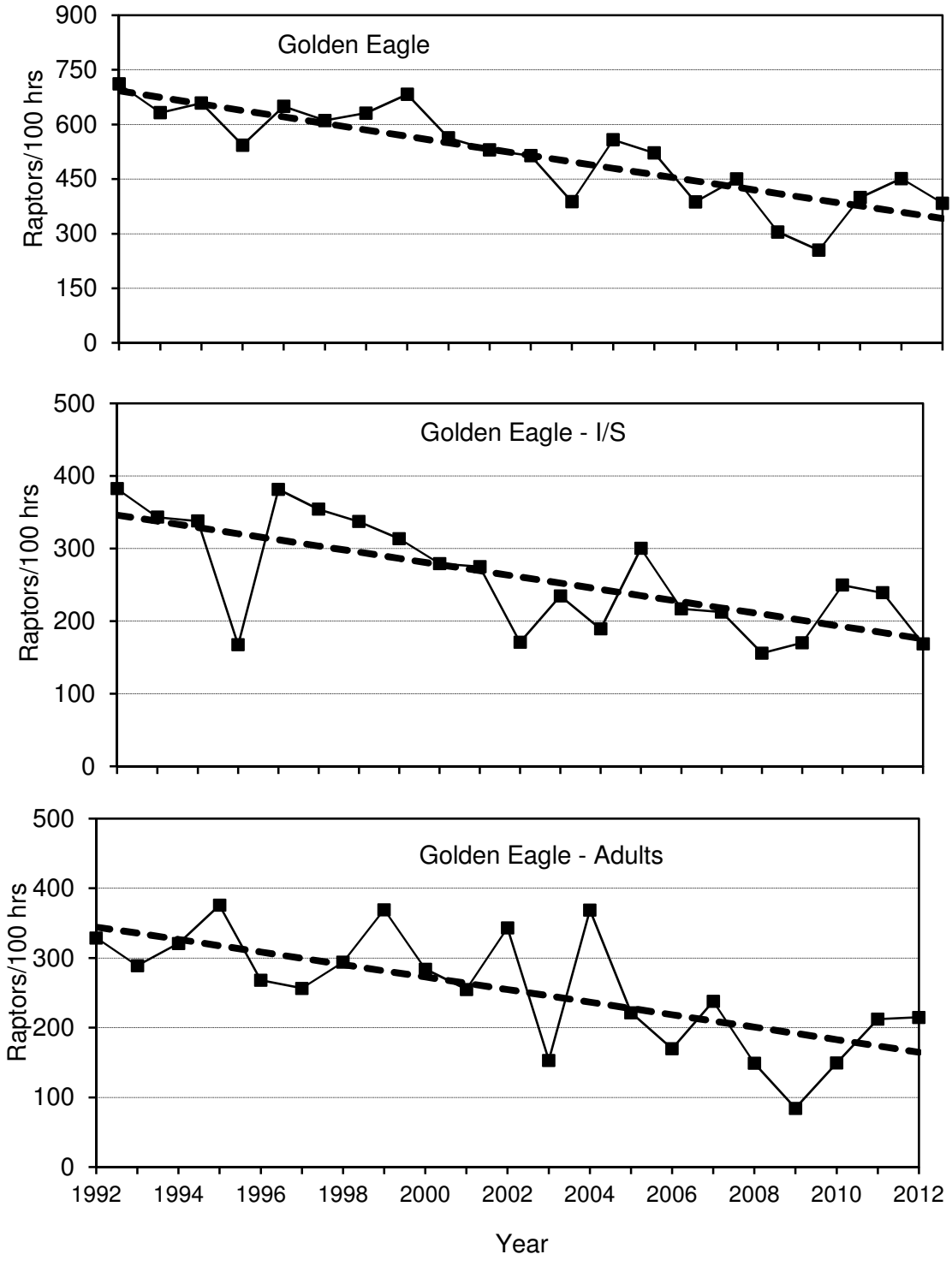

Figure 6. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Golden Eagles (separated by all birds, non-adults, and adults) in the Bridger Mountains, MT: 1992–2012. Dashed lines indicate statistically significant ($P \leq 0.10$) linear regressions.

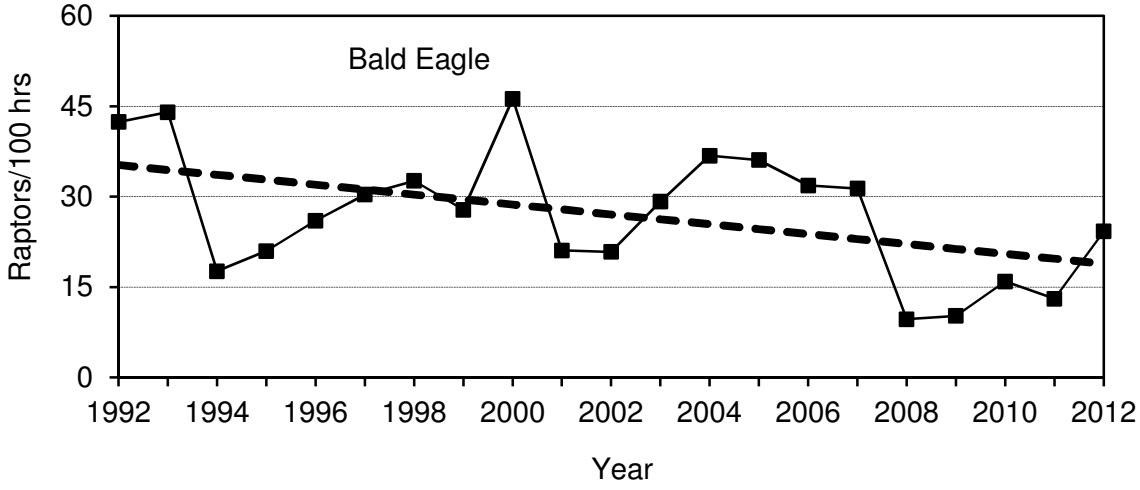

Figure 7. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Bald Eagles in the Bridger Mountains, MT: 1992–2012. Dashed lines indicate statistically significant ($P \leq 0.10$) linear regressions.

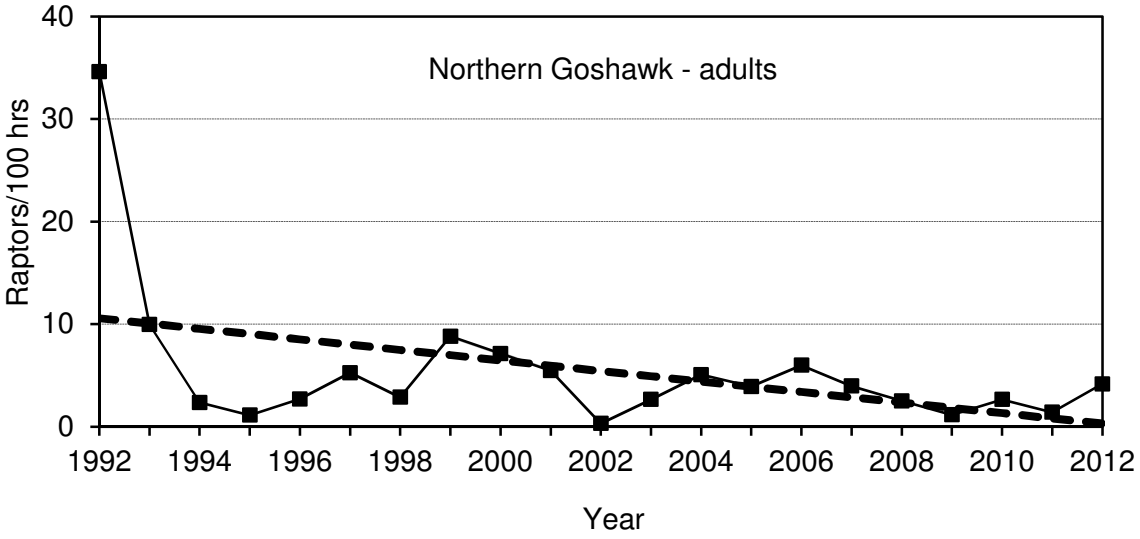

Figure 8. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for adult Northern Goshawks in the Bridger Mountains, MT: 1992–2012. Dashed lines indicate statistically significant ($P \leq 0.10$) linear regressions.

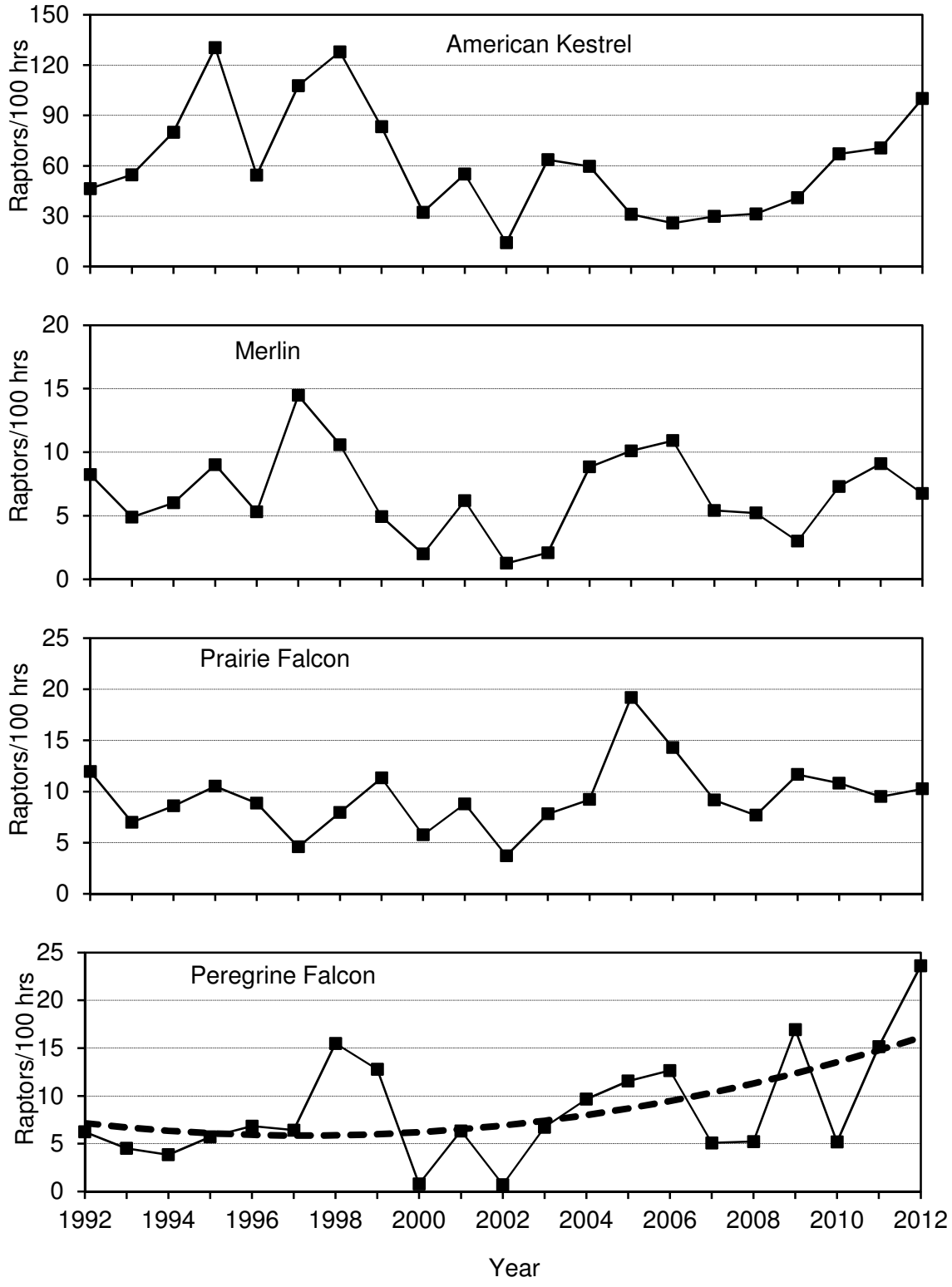

Figure 9. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons in the Bridger Mountains, MT: 1992–2012. Dashed lines indicate statistically significant (P ≤0.10) regressions.

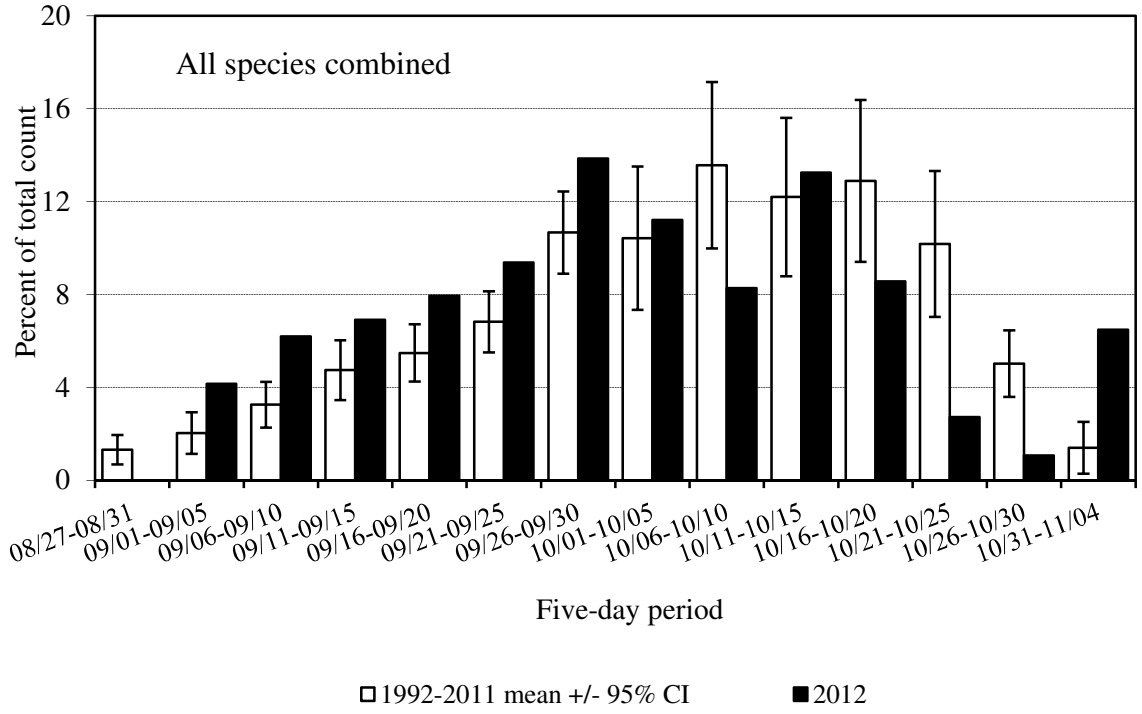

Figure 10. Combined-species passage volume by five-day periods for migrating raptors in the Bridger Mountains, MT: 1992–2011 versus 2012.

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

[1] Age codes: A = adult, I = immature, 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 weak 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 usually a dark terminal band on tail; NA = Not adult: unknown age immature/subadult; A = Adult: includes near adult with dark flecks in head and weak dark tail tip, and adult with completely white head and tail; U = Unknown.

Appendix B. A complete 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)
2011: Two observers throughout: Brian Connelly (3), John Martineau (0)
2012: Two observers throughout: Bret Davis (0), Kalon Baughan (0)

Note: Numbers in parentheses indicate the 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: 2012.

DATE	OBS. HOURS	OBSRVR /HOUR[1]	MEDIAN VISITOR DISTURB[2]	PREDOMINANT WEATHER[3]	WIND SPEED (KPH)[1]	WIND DIRECTION	TEMP (^{0}C)[1]	MEDIAN THERMAL LIFT[4]	VISIB. WEST (KM)[1]	VISIB. EAST (KM)[1]	MEDIAN FLIGHT DISTANCE[5]	BIRDS /HOUR
1-Sep	6.75	2.0	2	pc-ovc, haze, t-storm	6.3	sw	17.4	4	46	48	2	2.1
2-Sep	8.00	2.6	2	clr, haze	9.7	w, sw	12.2	3	47	28	2	3.3
3-Sep	8.00	2.0	1.5	clr, haze	9.1	w, wsw	11.3	4	13	15	2	3.0
4-Sep	8.00	2.3	0	clr, haze	8.6	w, wsw, sw	14.0	3	31	33	1	6.5
5-Sep	7.50	2.0	0	clr, haze	5.4	sw, wsw, sw	14.9	3	12	18	1	1.6
6-Sep	7.50	2.0	0	ovc, haze	5.7	ene, w	12.7	4	96	74	2	4.5
7-Sep	8.00	2.0	0	clr, haze	5.8	sw, ssw, w	12.4	2	67	52	2	3.6
8-Sep	8.00	2.0	1	clr, haze	4.0	w	16.6	2	63	53	2	5.5
9-Sep	8.00	3.1	0	clr, mc, ovc, haze	5.5	wsw, w, sw	17.2	4	76	78	2	6.8
10-Sep	8.00	2.0	0	clr, haze	6.1	w, wsw	16.2	4	41	25	1	6.0
11-Sep	8.00	2.0	0	ovc, mc, clr PM, haze	5.3	wsw, wnw, w	9.7	3	27	29	1	3.1
12-Sep	8.00	2.0	0	clr, haze	5.3	w	7.9	2	63	58	3	4.0
13-Sep	8.00	1.9	0	clr, haze	6.4	wsw, w	12.6	1	41	40	3	4.6
14-Sep	8.00	2.0	0	clr, pc PM, haze	4.9	w	17.8	2	60	59	3	6.4
15-Sep	7.00	2.0	0	clr, haze	4.7	wsw, w	17.9	3	20	22	3	3.6
16-Sep	5.00	2.0	2	ovc, haze	3.5	w	10.8	4	11	11	2	1.0
17-Sep	8.00	2.0	0	pc, clr, haze	4.6	sw, wsw, w	11.2	2	36	36	2	7.6
18-Sep	8.00	2.0	0	clr, haze	7.0	wsw, w	14.7	3	28	27	3	8.8
19-Sep	8.00	2.0	0	pc, mc, ovc PM, haze	5.6	wsw, sw	14.1	3	22	23	2	7.6
20-Sep	8.00	2.0	0	clr, ovc PM, haze	6.3	sw, wsw,	14.8	4	8	8	2	5.8
21-Sep	8.00	2.0	0	clr, haze	3.1	n	15.9	1	41	22	2	6.1
22-Sep	8.00	2.0	0	clr, haze	6.1	e, ene, n	15.5	3	35	30	1	3.6
23-Sep	8.00	2.0	0	mc, ovc, haze	10.2	ene, e, ne, ene	15.4	4	10	10	1	8.5
24-Sep	8.00	2.0	0	clr, pc, ovc late PM, haze	7.1	w, sw, wsw	15.2	3	17	17	2	8.8
25-Sep	8.00	2.0	0	mc, ovc, haze, t-storms	5.7	wsw, w	13.9	4	8	8	1	6.6
26-Sep	8.00	2.0	0	ovc, mc PM, haze	4.2	wsw, w,	15.1	2	10	10	2	10.6
27-Sep	8.00	4.3	0	clr, haze	5.0	sw, w	13.7	3	9	8	3	10.4
28-Sep	8.00	2.0	1	clr, pc PM, haze	6.3	sw, ssw, w, wsw	14.4	2	8	8	3	7.0
29-Sep	7.33	2.0	0	ovc, haze	7.9	wsw, sw, w	13.2	4	15	15	2	15.0
30-Sep	8.00	2.0	0	pc, ovc, haze	6.1	sw, wsw	9.6	3	16	15	3	7.8
1-Oct	8.00	2.0	0	ovc, mc, pc, haze	8.4	wsw, w	10.8	4	14	23	3	16.4
2-Oct	7.80	2.0	0	mc, pc, haze	8.6	sw, wsw	11.5	4	42	45	3	15.4
3-Oct	0.00	0.0		Weather Day: fog/rain								
4-Oct	0.00	0.0		Weather Day: fog/rain								

Appendix C. (continued)

DATE	OBS. HOURS	OBSRVR /HOUR[1]	MEDIAN VISITOR DISTURB[2]	PREDOMINANT WEATHER[3]	WIND SPEED (KPH)[1]	WIND DIRECTION	TEMP (^{0}C)[1]	MEDIAN THERMAL LIFT[4]	VISIB. WEST (KM)[1]	VISIB. EAST (KM)[1]	MEDIAN FLIGHT DISTANCE[5]	BIRDS /HOUR
5-Oct	0.00	0.0		Weather Day: fog/rain								
6-Oct	8.00	2.0	1	clr, pc	10.1	w, wsw, sw	-1.5	4	64	58	3	10.3
7-Oct	8.00	2.0	2	mc, ovc PM	25.2	wsw	2.8	4	68	52	2	12.3
8-Oct	8.00	2.0	0	ovc, fog, haze	8.4	wsw	3.3	4	5	5	3	3.0
9-Oct	8.00	2.0	0	ovc, pc	6.3	w, wsw	3.3	4	62	47	1	3.4
10-Oct	8.00	2.0	0	clr, haze	6.6	wsw, s	5.9	3	32	33	2	7.1
11-Oct	7.75	2.0	0	clr, fog, haze	5.5	sw, w	5.9	4	32	23	1	5.2
12-Oct	8.50	2.7	0	clr, haze	9.0	wsw, sw	7.9	3	47	45	2	24.5
13-Oct	3.50	2.8	1.5	mc, ovc, fog, snow	12.4	wsw, w, sw	2.6	4	23	14	2	12.3
14-Oct	7.00	2.7	1	mc, ovc, haze AM	12.4	wsw, sw	5.7	4	80	62	2	3.1
15-Oct	0.00	0.0		Weather Day: fog/snow								
16-Oct	0.00	0.0		Weather Day: fog/snow								
17-Oct	6.00	2.0	0	ovc, mc	20.1	wsw, w	-1.9	4	88	90	2	7.0
18-Oct	8.25	2.6	0	pc, ovc PM	11.9	w, wsw	1.0	3	76	88	3	17.8
19-Oct	7.50	2.0	0	ovc	13.9	w	7.0	4	98	93	3	6.7
20-Oct	6.75	2.6	0	pc, mc, ovc PM	7.4	w	3.1	4	58	57	3	2.4
21-Oct	7.75	2.0	0	ovc, mc, mid-day	6.0	ene, e	-0.1	4	82	94	2	6.8
22-Oct	3.00	2.0	0	ovc, fog	18.2	e	-0.4	4	35	26	1	2.3
23-Oct	0.00	0.0		Weather Day: fog/snow								
24-Oct	0.00	0.0		Weather Day: fog/snow								
25-Oct	0.00	0.0		Weather Day: fog/snow								
26-Oct	5.25	2.4	1.5	ovc	7.2	w, wsw	-4.3	4	80	100	3	2.9
27-Oct	3.00	2.0	0	ovc, snow, fog	7.8	w	-3.6	4	44	33	0	1.0
28-Oct	7.50	2.0	0	ovc, fog, snow	12.4	w	1.7	4	91	91	0	0.5
29-Oct	3.92	2.0	0	ovc, fog, rain	14.4	w	3.5	4	69	60	1	2.0
30-Oct	8.00	2.0	0	mc, ovc	11.5	w	5.7	4	98	86	2	12.4
31-Oct	6.50	2.0	0	ovc, mc PM	8.1	w, wsw	9.1	4	93	94	2	5.7
1-Nov	3.00	2.0	0	ovc, rain	7.8	w	5.0	4	95	83	1	0.7
2-Nov	4.33	2.0	0	ovc	7.3	w, wsw	-0.5	4	70	65	2	3.2
3-Nov	7.50	1.4	0	mc, pc, ovc PM	10.0	w	2.6	4	84	81	2	3.9
4-Nov	7.50	2.2	0	ovc, fog AM, snow AM	11.3	w	1.4	4	57	75	2	1.6
5-Nov	3.00	1.8	0	ovc	11.2	w	6.0	4	80	80	3	4.3

[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: 2012.

		Species[1]																											Birds	
Date	Hours	TV	OS	NH	SS	CH	NG	SA	LA	UA	BW	SW	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	GY	SF	LF	UF	UU	Total	/ hour
1-Sep	6.75	0	0	0	2	6	1	0	0	0	0	0	0	0	0	0	2	1	1	1	0	0	0	0	0	0	0	0	14	2.1
2-Sep	8.00	0	0	0	5	4	0	0	0	0	0	1	5	0	0	0	2	2	0	3	0	0	0	0	0	1	0	3	26	3.3
3-Sep	8.00	0	0	1	5	4	1	0	0	0	0	0	1	0	0	0	7	0	0	2	2	0	0	0	0	1	0	0	24	3.0
4-Sep	8.00	0	0	0	4	2	1	1	1	0	0	1	7	0	0	2	4	2	1	17	0	1	0	0	2	0	0	6	52	6.5
5-Sep	7.50	0	0	2	3	1	0	1	0	0	0	0	3	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	12	1.6
6-Sep	7.50	0	0	4	1	7	2	0	0	0	0	2	4	1	0	0	4	1	0	4	1	0	0	0	0	0	0	3	34	4.5
7-Sep	8.00	0	0	3	4	8	0	0	0	1	0	0	4	0	0	0	2	0	0	7	0	0	0	0	0	0	0	0	29	3.6
8-Sep	8.00	0	0	1	9	12	0	2	0	0	0	0	6	0	0	0	6	1	1	2	0	1	2	0	0	0	0	1	44	5.5
9-Sep	8.00	0	0	2	20	6	1	0	0	0	0	0	9	0	0	0	6	1	0	5	0	0	2	0	0	0	0	2	54	6.8
10-Sep	8.00	0	0	0	3	8	0	0	0	2	0	2	9	0	0	2	8	0	0	9	0	0	2	0	1	0	0	2	48	6.0
11-Sep	8.00	0	0	1	4	2	0	0	0	1	0	0	5	0	0	0	4	0	0	4	0	0	2	0	0	0	0	2	25	3.1
12-Sep	8.00	0	1	2	4	5	0	0	1	1	1	0	4	0	0	0	4	1	0	1	0	0	2	0	0	0	1	4	32	4.0
13-Sep	8.00	0	2	1	10	5	4	1	0	0	1	1	2	0	0	1	4	0	0	1	0	0	1	0	0	0	0	3	37	4.6
14-Sep	8.00	0	0	1	6	10	0	1	0	1	0	0	7	0	0	0	9	1	0	5	0	1	1	0	0	2	0	6	51	6.4
15-Sep	7.00	0	0	1	2	1	0	1	0	0	0	1	9	0	0	0	8	0	0	0	0	1	0	0	0	0	0	1	25	3.6
16-Sep	5.00	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	5	1.0
17-Sep	8.00	0	0	2	13	10	0	0	0	0	5	0	11	0	0	1	5	4	0	2	0	4	0	0	0	0	1	3	61	7.6
18-Sep	8.00	0	0	3	10	13	1	2	0	1	2	0	10	0	0	0	11	0	0	16	0	0	1	0	0	0	0	0	70	8.8
19-Sep	8.00	2	2	0	20	4	0	0	0	2	3	0	3	1	0	0	11	3	0	6	0	1	1	0	0	1	0	1	61	7.6
20-Sep	8.00	0	0	1	14	7	0	0	0	0	4	0	3	1	0	0	5	0	0	10	0	0	1	0	0	0	0	0	46	5.8
21-Sep	8.00	0	0	1	7	5	1	3	0	1	1	0	11	0	0	0	8	2	0	1	0	1	1	0	0	0	0	6	49	6.1
22-Sep	8.00	0	0	3	11	4	0	0	0	0	1	0	1	0	0	0	4	1	0	2	1	0	0	0	0	0	0	1	29	3.6
23-Sep	8.00	0	1	11	18	8	0	0	0	0	6	0	4	0	0	0	7	3	0	2	0	0	8	0	0	0	0	0	68	8.5
24-Sep	8.00	0	0	4	17	10	0	0	0	0	2	0	7	0	0	0	16	3	0	9	0	0	0	0	0	0	0	2	70	8.8
25-Sep	8.00	0	0	0	16	8	0	1	0	0	1	0	7	0	0	1	2	1	0	12	1	0	3	0	0	0	0	0	53	6.6
26-Sep	8.00	0	1	4	27	6	0	1	0	0	1	0	15	0	0	0	12	4	0	8	1	0	3	0	0	0	0	2	85	10.6
27-Sep	8.00	0	0	3	28	3	0	0	0	0	2	0	10	0	0	0	26	2	0	7	0	0	1	0	0	1	0	0	83	10.4
28-Sep	8.00	0	0	1	12	0	0	0	0	0	3	0	12	0	0	1	26	1	0	0	0	0	0	0	0	0	0	0	56	7.0
29-Sep	7.33	0	2	0	27	8	0	2	0	1	3	0	7	0	0	0	54	2	0	2	0	0	1	0	0	0	0	1	110	15.0
30-Sep	8.00	0	0	1	11	3	1	0	0	0	0	0	6	0	0	0	38	0	0	1	0	0	0	0	0	0	0	1	62	7.8

Appendix D. (continued)

		Species[1]																											Birds
Date	Hours	TV	OS	NH	SS	CH	NG	SA	LA	UA	BW	SW	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	GY	SF	LF	UF	UU	Total	/ hour
1-Oct	8.00	0	0	1	19	6	2	4	0	0	1	0	8	0	0	0	78	4	1	2	1	0	0	0	0	2	0	2	131	16.4
2-Oct	7.80	0	0	0	29	1	1	8	0	0	0	0	5	0	0	1	64	0	0	4	0	0	2	0	0	0	0	5	120	15.4
3-Oct	0.00																													
4-Oct	0.00																													
5-Oct	0.00																													
6-Oct	8.00	0	0	1	9	1	0	1	1	0	0	0	4	0	0	2	57	0	0	0	0	0	0	0	0	0	0	6	82	10.3
7-Oct	8.00	0	0	0	11	1	0	3	0	0	0	0	8	1	1	0	65	1	3	0	1	0	0	0	0	0	0	3	98	12.3
8-Oct	8.00	0	0	0	3	0	0	1	0	0	0	0	3	0	1	0	13	2	0	0	0	1	0	0	0	0	0	0	24	3.0
9-Oct	8.00	0	0	0	1	0	0	0	0	0	0	0	6	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	27	3.4
10-Oct	8.00	0	0	3	7	0	0	3	0	1	0	0	4	0	0	0	32	0	0	0	2	2	0	0	0	0	0	3	57	7.1
11-Oct	7.75	0	0	0	7	0	0	1	0	0	0	0	2	0	2	0	27	0	0	0	0	1	0	0	0	0	0	0	40	5.2
12-Oct	8.50	0	0	0	6	0	1	1	0	0	0	0	3	0	2	0	183	7	0	0	0	0	0	0	0	0	0	5	208	24.5
13-Oct	3.50	0	0	1	2	0	0	0	0	0	0	0	2	0	2	0	30	5	1	0	0	0	0	0	0	0	0	0	43	12.3
14-Oct	7.00	0	0	0	4	0	1	0	0	0	0	0	0	0	1	1	12	2	0	0	0	1	0	0	0	0	0	0	22	3.1
15-Oct	0.00																													
16-Oct	0.00																													
17-Oct	6.00	0	0	0	2	0	1	1	0	0	0	0	2	0	2	0	30	4	0	0	0	0	0	0	0	0	0	0	42	7.0
18-Oct	8.25	0	0	4	10	0	2	1	1	0	0	0	2	0	14	0	106	6	0	0	1	0	0	0	0	0	0	0	147	17.8
19-Oct	7.50	0	0	0	12	0	2	0	1	0	0	0	1	0	4	0	24	3	1	0	0	0	0	0	0	0	0	2	50	6.7
20-Oct	6.75	0	0	0	3	0	1	0	0	0	0	0	1	0	2	0	8	0	0	0	1	0	0	0	0	0	0	0	16	2.4
21-Oct	7.75	0	0	0	3	0	0	0	1	0	0	0	0	0	7	0	40	0	1	0	0	0	0	0	0	0	0	1	53	6.8
22-Oct	3.00	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	7	2.3
23-Oct	0.00																													
24-Oct	0.00																													
25-Oct	0.00																													
26-Oct	5.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	7	0	0	0	0	0	0	0	0	0	0	15	2.9
27-Oct	3.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	3	1.0
28-Oct	7.50	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	4	0.5
29-Oct	3.92	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	5	0	0	0	1	0	0	0	0	0	0	0	8	2.0
30-Oct	8.00	0	0	0	0	1	4	0	0	0	0	0	2	0	1	0	83	6	0	0	2	0	0	0	0	0	0	0	99	12.4
31-Oct	6.50	0	0	0	7	0	2	0	0	0	0	0	0	0	1	0	25	1	0	0	1	0	0	0	0	0	0	0	37	5.7
1-Nov	3.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0.7
2-Nov	4.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	1	0	0	0	0	0	0	0	0	0	0	14	3.2
3-Nov	7.50	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	21	3	2	0	0	0	0	0	0	0	0	0	29	3.9
4-Nov	7.50	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	8	3	0	0	0	0	0	0	0	0	0	0	12	1.6
5-Nov	3.00	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	11	1	0	0	0	0	0	0	0	0	0	0	13	4.3
Total	414.38	2	9	64	452	180	33	40	6	12	37	8	238	4	42	12	1272	92	12	147	16	16	34	0	3	8	2	77	2818	6.8

[1] See Appendix A for species codes.

Appendix E. Annual observation effort and fall raptor migration counts by species in the Bridger Mountains, MT: 1991–2012.

	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
Unknown small accipiter[1]	-	-	-	-	-	-	-
Unknown large accipiter[1]	-	-	-	-	-	-	-
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
Gyrfalcon	0	0	0	0	0	0	0
Unknown small falcon[1]	-	-	-	-	-	-	-
Unknown large falcon[1]	-	-	-	-	-	-	-
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

[1] Designations used for the first time in 2002.

Appendix E. (continued)

	1998	1999	2000	2001	2002	2003	2004	2005
Start date	28-Aug	29-Aug	29-Aug	27-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	31-Oct
Observation days	56	57	52	58	52	64	48	48
Observation hours	339.33	358.24	335.40	347.49	365.84	443.18	316.70	300.83
Raptors / 100 hours	1040.9	871.8	630.9	636.3	556.0	517.6	655.2	674.8
SPECIES	RAPTOR COUNTS							
Turkey Vulture	0	2	0	0	0	0	0	1
Osprey	13	9	6	6	2	5	1	2
Northern Harrier	230	52	20	36	15	54	39	22
Sharp-shinned Hawk	612	442	190	274	288	416	229	228
Cooper's Hawk	343	149	109	120	103	132	142	153
Northern Goshawk	50	61	34	26	2	23	41	22
Unknown small accipiter[1]	-	-	-	0	11	29	32	92
Unknown large accipiter[1]	-	-	-	0	4	4	9	4
Unknown accipiter	49	39	35	27	5	0	7	27
Total accipiters	1054	691	368	447	413	604	460	526
Broad-winged Hawk	20	13	3	38	3	9	6	3
Swainson's Hawk	2	3	3	0	1	2	0	0
Red-tailed Hawk	277	121	45	117	78	113	100	108
Ferruginous Hawk	7	4	1	3	0	1	3	2
Rough-legged Hawk	66	77	26	57	11	22	20	40
Unidentified buteo	13	3	8	6	9	6	18	27
Total buteos	385	221	86	221	102	153	147	180
Golden Eagle	1516	1870	1429	1330	1359	1226	1196	1061
Bald Eagle	95	91	128	58	55	93	79	75
Unidentified eagle	15	5	3	2	15	4	2	1
Total eagles	1626	1966	1560	1390	1429	1323	1277	1137
American Kestrel	141	113	39	62	16	102	65	20
Merlin	17	8	3	9	2	4	11	7
Prairie Falcon	12	20	9	14	6	15	12	20
Peregrine Falcon	18	18	1	8	1	10	10	8
Gyrfalcon	0	1	0	0	0	0	0	0
Unknown small falcon[1]	-	-	-	0	0	0	3	27
Unknown large falcon[1]	-	-	-	0	1	3	3	13
Unknown falcon	8	6	4	3	4	1	9	13
Total falcons	196	166	56	96	30	135	113	108
Unidentified raptor	28	16	20	15	43	20	38	54
Grand Total	3532	3123	2116	2211	2034	2294	2075	2030

[1] Designations used for the first time in 2002.

Appendix E. (continued)

	2006	2007	2008	2009	2010	2011	2012	Mean
Start date	27-Aug	27-Aug	27-Aug	6-Sep	28-Aug	2-Sep	1-Sep	31-Aug
End date	29-Oct	29-Oct	31-Oct	31-Oct	1-Nov	4-Nov	5-Nov	29-Oct
Observation days	45	56	56	44	54	57	58	50
Observation hours	331.25	384.59	415.49	306.25	366.00	411.42	414.38	336.37
Raptors / 100 hours	538.3	550.5	427.7	453.2	641.8	695.9	680.0	721.2
SPECIES	RAPTOR COUNTS							
Turkey Vulture	2	1	0	0	2	5	2	1
Osprey	7	5	4	9	3	14	9	6
Northern Harrier	50	30	47	52	77	59	64	49
Sharp-shinned Hawk	344	277	222	230	336	565	452	326
Cooper's Hawk	182	151	115	113	207	221	180	164
Northern Goshawk	33	20	22	13	33	15	33	31
Unknown small accipiter[1]	10	18	43	6	40	22	40	28
Unknown large accipiter[1]	0	6	10	6	22	3	6	6
Unknown accipiter	0	5	3	7	25	12	12	25
Total accipiters	569	477	415	375	663	838	723	564
Broad-winged Hawk	12	5	7	33	5	12	37	10
Swainson's Hawk	0	3	8	4	1	2	8	2
Red-tailed Hawk	89	130	75	75	178	202	238	109
Ferruginous Hawk	3	5	1	2	3	2	4	2
Rough-legged Hawk	21	19	32	30	31	28	42	32
Unidentified buteo	2	11	10	10	20	4	12	12
Total buteos	127	173	133	154	238	250	341	168
Golden Eagle	859	1247	1003	638	1171	1431	1272	1354
Bald Eagle	74	85	43	27	50	68	92	74
Unidentified eagle	1	0	10	4	1	0	12	6
Total eagles	934	1332	1056	669	1222	1499	1376	1434
American Kestrel	38	41	46	45	87	99	147	69
Merlin	15	9	10	4	12	17	16	10
Prairie Falcon	22	17	13	17	18	19	16	14
Peregrine Falcon	15	8	5	23	8	24	34	10
Gyrfalcon	0	0	0	0	0	0	0	0
Unknown small falcon[1]	0	2	2	3	3	0	3	4
Unknown large falcon[1]	1	3	6	3	2	0	8	3
Unknown falcon	0	2	2	4	0	2	2	5
Total falcons	91	82	84	99	130	161	226	111
Unidentified raptor	3	17	38	30	14	37	77	29
Grand Total	1783	2117	1777	1388	2349	2863	2818	2362

[1] Designations used for the first time in 2002.