FALL 2011 RAPTOR MIGRATION STUDY IN THE BRIDGER MOUNTAINS, MONTANA

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

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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 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. Beginning in 2009 Montana Audubon took the lead in coordinating 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 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 2011 count, which marked the 20th consecutive full-season autumn count of migratory raptors at the site. The Bridger Mountains Project was one of seven long-term, annual migration counts conducted or co-sponsored by HWI in North America during 2011. 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 assessing 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 narrow 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 Bridger Ridge, about 25 km northeast 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 west a few hundred meters along a footpath to the crest of the ridge, and then north 50 meters to the observation site.

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 2011 observations began 1 September and continued through 4 November 2011. 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 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 also assisted with the count for one day. 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 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 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 actively contributed to the count [active scanning, pointing out birds, recording data, etc.] for more than 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. The exact numbers of visitors were also recorded for each 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 2011 follows Hoffman and Smith (2003). In comparing 2011 annual statistics against means and 95% confidence intervals for previous seasons, we determine significance when a 2011 value falls outside the bounds of the confidence interval for the associated mean.

Results and Discussion

WEATHER SUMMARY

Inclement weather and attendant difficult access fully precluded 9 days of observation during the 2011 season. This is slightly lower than the 1997-2010 (the period in which detailed daily weather record have been collected and analyzed) average of 11.6 days. In addition, inclement weather was a factor in reducing the total observation hours in a day to less than four on six different days (average is 5.2 days; see Appendix C for daily weather records).

During periods of active observation skies were recorded as fair 37% of the time, 25% transitional, and 39% mostly cloudy – overcast. Comparison with the averages of 37% fair, 33% transitional, and 30% mostly cloudy-overcast suggests that the 2011 season was similar to the average number of days with fair skies, but above average for overcast days not inclement enough to preclude observation. Unlike the 14-year average of 31% of weather observations including fog or haze, the 2011 season experienced 53% fog/haze. Fires in the area created smoke and haze that surrounded the Bridger Mountain until early October, when a multi-day rain and snowstorm moved in and cleared the smoke for the remainder of the season. This resulted in the estimated visibility being reduced to a record low 62-63 km (average 77-81 km). Snow and rain were also slightly more prevalent than the average (19% vs. average of 14%).

The predominant speed of prevailing winds was light (<12 kph), being recorded 74% of active observation, while moderate winds (12-29 kph) were recorded during 26% of days. In comparison, the 1997-2010 averages are 81% light, 17% moderate, and 2% strong. Prevailing wind direction was from SW-W, occurring 39% of active observation periods, with winds from W occurring 35% of observation

periods. These wind statistics, combined with observers subjectively rating the thermal lift as "good to excellent" only 25% of the time, suggests that conditions were particularly good in 2011 for spotting migrants flying lower (and within visible range) using ridge-lift.

OBSERVATION EFFORT

Observations were conducted on 57 of 66 days between 1 September and 5 November in 2011. The number of observation days was 12% over the 1998-2010 average of 51 ± 95% CI of 3.4 days, and the number of observation hours (411) was 21% above the long-term average of 340.1 ± 25.5 hours. The 2011 average of 1.97 observers per hour (including official and guest observers; value is a mean of daily values, which are in turn means of hourly values) was similar to the 1992-2010 average of 1.9.

FLIGHT SUMMARY

The observers tallied 2,863 migrating raptors of 17 species during the 2011 season (Table 1; see Appendix D for daily count records). This total count is 21% above the long-term average. The 2011 count for the Northern Goshawk was the only species significantly below average.

The 2011 flight was comprised of 52% eagles, 29% accipiters, 9% buteos, 6% falcons, 2% harriers, 1% osprey, and 1% unidentified raptors (Figure 2). The most numerous species were the Golden Eagle (50% of total count), Sharp-shinned Hawk (20%), Cooper's Hawk (8%), Red-tailed Hawk (7%), and American Kestrel (3%). All other species each comprised ≤ 2% of the total.

Passage Rates and Long-Term Trends

In 2011 adjusted passage rates were significantly above average for Osprey, Sharp-shinned Hawk, Red-tailed Hawk, Merlin, and Prairie Falcon. Conversely, passage rates were significantly below average for Northern Goshawk, Rough-legged Hawk, Golden Eagle and Bald Eagle (Table 1, Figures 3-9). The total count and adjusted passage rate for Sharp-shinned Hawk was the second highest in the history of this count (see Appendix E for yearly counts). Regression analyses updated through 2011 (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, with 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 non-adults. Although American Kestrels were observed in numbers slightly above average for the second year in a row, the long-term trend is still a linear downward projection (Figure 9). Northern Goshawks, at the species level, are experiencing a quadratic negative decline, while age-class analysis shows a linear long-term decline of adults (Figures 4 & 8). Bald Eagles are also showing a long-term linear decline at the species level (Figure 7), although this trend is likely due to delayed migration timing as a result of warming autumn conditions causing a later formation of ice on lakes and reservoirs to the north of the Bridgers.

Smith et al. (2008a) present 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) 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 2011. 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 includes 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).

Age Ratios

Immature:adult ratios were above average for 6 of 9 species for which relevant age-specific data were available, and significantly so for Northern Goshawk and Peregrine Falcon (Table 2). Unlike the Northern Goshawk, for which the ratio could have been more a function of significantly lower annual counts (especially for adults) and adjusted passage rate, the Peregrine Falcon was observed in record numbers (Appendix E). While the total peregrine count was the highest ever recorded at this site, the number of adults identified was comparable to the average (Table 2). The elevated number of immature Peregrine Falcons suggests enhanced breeding success in 2011. The only species to exhibit a significant decrease in the proportion of immatures/subadults (relative to the average) was the Golden Eagle. However, this should be interpreted with caution due to an elevated percentage of migrants that could not be reliably aged (Table 2).

Seasonal Timing

During the 2011 season the Northern Goshawk was the only species to show a significantly early passage date (Table 3). Conversely, Osprey, Northern Harrier, Rough-legged Hawk, Golden Eagle, and Bald Eagle all exhibited passage dates significantly later than the 20-year average (Table 3). The combined-species median passage date was only 3 days later than the average date of 7 October and followed the overall timing pattern that has been observed over the 20-year study fairly closely, with most of the deviation occurring during the middle portion of October (Table 3, Figure 10). The median passage date for Golden Eagles was a significant 6 days after the long-term average passage date of 12 October (Table 3). Analysis of migration timing with respect to Golden Eagle age classes showed immatures exhibiting a highly significant 5-day later median passage date of 14 October. In comparison, the adult Golden Eagles' median passage date of 18 October was only slightly later than average.

RESIDENT RAPTORS

This year's crew recorded 10 different species displaying resident behavior: Sharp-shinned Hawk, Cooper's Hawk, Northern Goshawk, Red-tailed Hawk, Golden Eagle, Bald Eagle, Turkey Vulture, American Kestrel, Prairie Falcon, and Peregrine Falcon.

Sharp-shinned Hawks - Resident Sharp-shinned Hawks were seen regularly beginning on 2 September. Two immature individuals were frequently seen together over North Bowl in the morning as well as hunting along the ridgeline and harassing the decoy owl and local American Kestrels. These birds were last seen together on 13 September when it is likely that one individual moved out of the area while the second remained for another nine days and was last observed on 22 September. An adult was also regularly seen in the area until 27 September.

Cooper's Hawk - A least one adult and one immature Cooper's Hawk were identified as residents. On 11 September an immature was seen on three occasions hunting the east side of the ridge and perched near the observation platform. An adult was seen on 3 September heading north along the ridge, and then again on 2 October.

Northern Goshawk - A resident adult Northern Goshawk was observed in the area on eight days between 10 September and 29 October. It was most frequently seen hunting low along the ridgeline.

Red-tailed Hawk - Four Red-tailed Hawks (two light-morph immatures, one adult light morph, and one dark-morph adult) were identified as residents and were seen throughout the observation area beginning

on 2 September. The immatures were seen daily until 9 September, while the adults remained in the area through 1 October.

Golden Eagle - Two resident adult Golden Eagles resided in the area throughout the observation period. They were frequently seen together with one hatch-year bird, which was last seen on 4 October. These residents were very active and were consistently seen escorting migrating eagles and buteos, as well as hunting the northern Bridger and Bangtail Mountains. From 22-25 September a sub-adult Golden Eagle was observed every day acting in a non-migratory fashion. It was never seen outside of that four-day window.

Bald Eagle - On 21 September two adult Bald Eagles were observed together flying north over the observation platform and out of sight over Ross Peak.

Turkey Vulture - Two Turkey Vultures were observed together, flying northwest toward the "treed ridges" on 5 September.

American Kestrel - At least two American Kestrels (one male and one female) were noted as resident, and were seen almost daily from 2-24 September. They were seen throughout the area, but most frequently low on the east side and around "Tilly".

Prairie Falcon - A resident Prairie Falcon was first seen on 7 September. While most commonly seen hunting the west side of Tilly, on 9 September it was observed on multiple occasions kiting over the counting station for several minutes at a time. On 3 November two individuals were seen together throughout the day hunting up and down the ridge. This was the only time two individuals were observed together acting in a non-migratory manner.

Peregrine Falcon - On 19 September a Peregrine Falcon of unknown age was observed hunting while flying north on the west side of the ridge.

VISITATION

Throughout the 2011 season 32 individuals signed the visitor sign-in log kept at the observation platform. Many of these were repeat visitors and it is estimated that four times this many people passed by the site without signing in. 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. The 19th annual Bridger RaptorFest attracted an exceptional turn-out again in 2011, although inclement weather resulted in only a few brave souls making the hike to the observation station. A total of 418 hourly assessments of visitor disturbance were recorded during the 2011 season. Of these subjective assessments 93% were recorded as none, 5% low, and 1% each for moderate and high.

ACKNOWLEDGMENTS

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Table 1. Annual fall-migration counts and adjusted passage rates (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) by species in the Bridger Mountains, MT: 1992–2010 versus 2011.

SPECIES	COUNTS			RAPTORS/100 HRS		
	1992–2010[1]	2011	%CHANGE	1992–2010[1]	2011	%CHANGE
Turkey Vulture	0.8 ± 0.7	5	525	0.3 ± 0.3	1.9	533
Osprey	6 ± 1.8	14	133	2.4 ± 0.7	4.9	104
Northern Harrier	50 ± 21.3	59	18	15.8 ± 6.9	16.5	4.4
Sharp-shinned Hawk	326 ± 49.0	565	73	123.5 ± 17.8	176.5	439
Cooper's Hawk	165 ± 31.6	221	34	122.8 ± 22.8	132.3	7.7
Northern Goshawk	32 ± 9.4	15	-54	11.2 ± 3.8	4.7	-58
Unknown small Accipiter[2]	28 ± 16.6	22	-21	–	–	
Unknown large Accipiter[2]	7 ± 3.9	3	-57	–	–	
Unknown Accipiter	24 ± 8.0	12	-50	–	–	
Total Accipiters	565 ± 81.3	838	48	–	–	
Broad-winged Hawk	10 ± 4.6	12	20	5.2 ± 2.4	5.3	1.9
Swainson's Hawk	3 ± 1.3	2	-33	1.2 ± 0.7	0.7	-42
Red-tailed Hawk	109 ± 22.9	202	85	38.4 ± 7.7	57.4	49
Ferruginous Hawk	2 ± 0.9	2	0	0.9 ± 0.3	0.5	-44
Rough-legged Hawk	33 ± 8.4	28	-15	24.2 ± 6.4	10.6	-56
Unidentified Buteo	12 ± 3.0	4	-67	–	–	
Total Buteos	169 ± 30.1	250	48	–	–	
Golden Eagle	1354 ± 151.8	1431	6	525.8 ± 58.7	451.4	-14
Bald Eagle	76 ± 12.2	68	-11	28.5 ± 4.9	13.4	-53
Unidentified eagle	6 ± 3.3	0	-	–	–	
Total Eagles	1436 ± 159.5	1499	4	–	–	
American Kestrel	69 ± 17.5	99	43	58.9 ± 14.6	68.6	16
Merlin	10 ± 2.5	17	70	6.8 ± 1.6	9.7	43
Prairie Falcon	14 ± 1.9	19	36	9.4 ± 1.6	9.5	1.0
Peregrine Falcon	9 ± 2.6	24	167	7.4 ± 2.0	15.0	103
Gyrfalcon	0.1 ± 0.1	0	-	–	–	
Unkown small Falcon[2]	4 ± 5.1	0	-	–	–	
Unkown large Falcon[2]	4 ± 2.3	0	-	–	–	
Unknown Falcon	5 ± 2.0	2	-60	–	–	
Total Falcons	111 ± 20.5	161	45	–	–	
Unidentified Raptor	27 ± 6.0	37	37	–	–	
Grand Total	2366 ± 251.0	2863	21	–	–	

[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: 1992–2010 versus 2011.

	Total and Age-classified Counts						% Unknown Age		Immature : Adult Ratio	
	1992–2010 Average			2011						
	Total	Imm.	Adult	Total	Imm.	Adult	1992–2010[1]	2011	1992–2010[1]	2011
Northern Harrier	50	23	12	59	43	7	32 ± 7.2	15	3.3 ± 3.1	6.1
Sharp-shinned Hawk	326	62	123	565	147	232	43 ± 6.0	33	0.5 ± 0.1	0.6
Cooper's Hawk	165	44	56	221	70	69	39 ± 5.0	37	0.9 ± 0.3	1.0
Northern Goshawk	32	12	12	15	8	3	27 ± 9.5	27	1.7 ± 0.5	2.7
Broad-winged Hawk	10	2	4	12	2	6	36 ± 17.1	33	0.9 ± 0.7	0.3
Red-tailed Hawk	109	34	50	202	53	71	23 ± 4.0	39	0.7 ± 0.3	0.7
Golden Eagle	1354	527	486	1431	382	412	26 ± 4.0	45	1.2 ± 0.2	0.9
Bald Eagle	76	26	47	68	21	43	3 ± 14.8	6	0.6 ± 0.1	0.5
Peregrine Falcon	9	0.6	4	24	7	5	53 ± 14.8	50	0.3 ± 0.3	1.4

[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 ratio.

Table 3. First and last observation, bulk passage, and median passage dates by species for migrating raptors in the Bridger Mountains, MT in 2011, with a comparison of 2011 and 1992–2010 average median passage dates.

	2011				1992–2010
Species	First Observed	Last Observed	Bulk Passage Dates[1]	Median Passage Date[2]	Mean Passage Date[3]
Turkey Vulture	2-Sep	9-Oct	2-Sep – 9-Oct	13-Sep	19-Sep ±
Osprey	5-Sep	5-Oct	7-Sep – 4-Oct	24-Sep	16-Sep ± 2.8
Northern Harrier	4-Sep	23-Oct	7-Sep – 3-Oct	28-Sep	22-Sep ± 3.9
Sharp-shinned Hawk	2-Sep	3-Nov	10-Sep – 19-Oct	2-Oct	1-Oct ± 1.7
Cooper's Hawk	4-Sep	27-Oct	10-Sep – 3-Oct	25-Sep	24-Sep ± 2.8
Northern Goshawk	7-Sep	25-Oct	8-Sep – 25-Oct	27-Sep	8-Oct ± 5.6
Broad-winged Hawk	13-Sep	10-Oct	13-Sep – 3-Oct	23-Sep	19-Sep ± 1.9
Swainson's Hawk	10-Sep	13-Sep	–	-	15-Sep ± 5.2
Red-tailed Hawk	2-Sep	4-Nov	8-Sep – 17-Oct	24-Sep	22-Sep ± 2.0
Ferruginous Hawk	11-Sep	13-Oct	–	-	5-Oct ± 15.4
Rough-legged Hawk	9-Oct	4-Nov	13-Oct – 4-Nov	29-Oct	21-Oct ± 1.4
Golden Eagle	2-Sep	4-Nov	1-Oct – 28-Oct	18-Oct	12-Oct ± 1.8
Bald Eagle	3-Sep	4-Nov	25-Sep – 4-Nov	27-Oct	15-Oct ± 2.6
American Kestrel	2-Sep	23-Oct	6-Sep – 3-Oct	26-Sep	22-Sep ± 2.1
Merlin	6-Sep	30-Oct	9-Sep – 28-Oct	11-Oct	6-Oct ± 3.5
Prairie Falcon	7-Sep	30-Oct	12-Sep – 29-Oct	29-Sep	25-Sep ± 3.7
Peregrine Falcon	5-Sep	14-Oct	8-Sep – 4-Oct	27-Sep	25-Sep ± 2.4
All species	6-Sep	4-Nov	13-Sep – 26-Oct	10-Oct	7-Oct ± 1.8

[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.

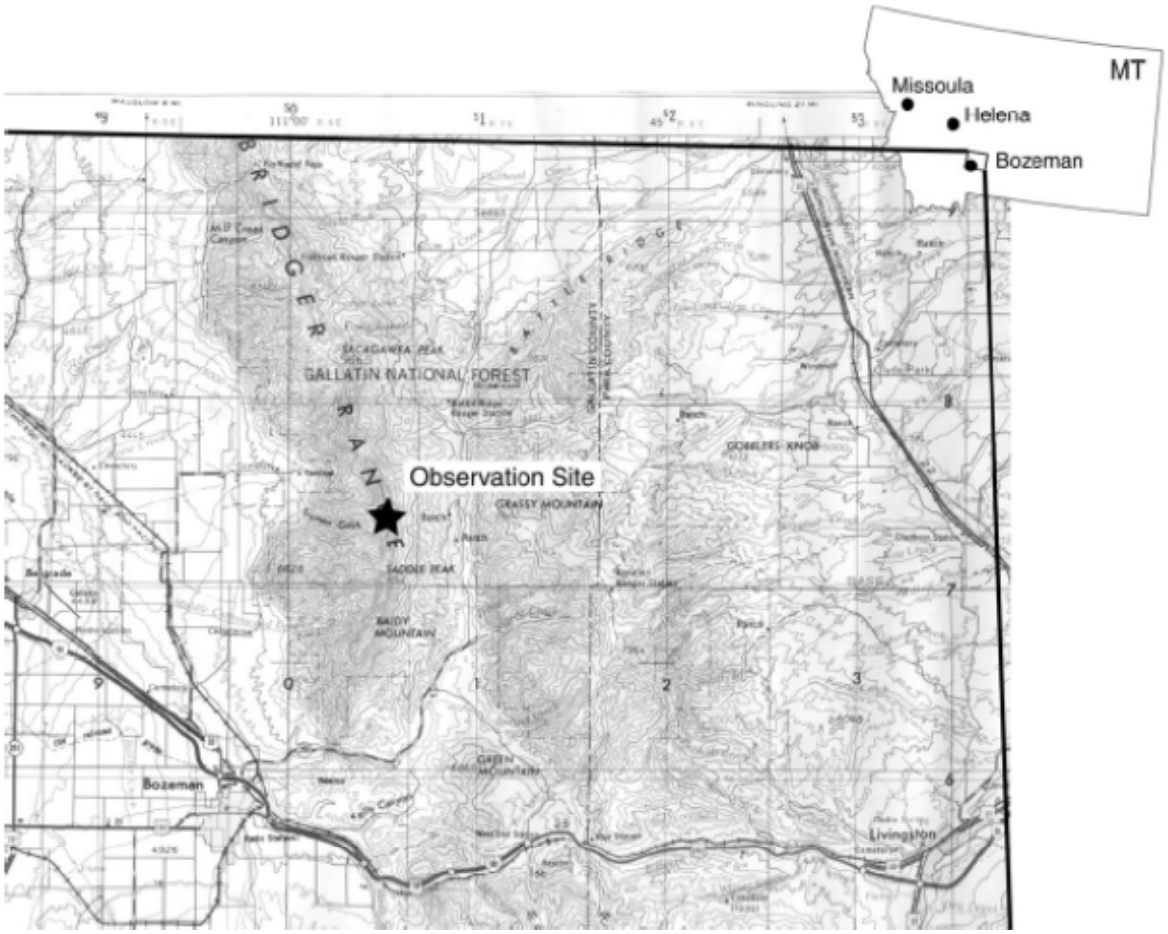

Figure 1. Location of the Bridger Mountains Raptor Migration Project study site.

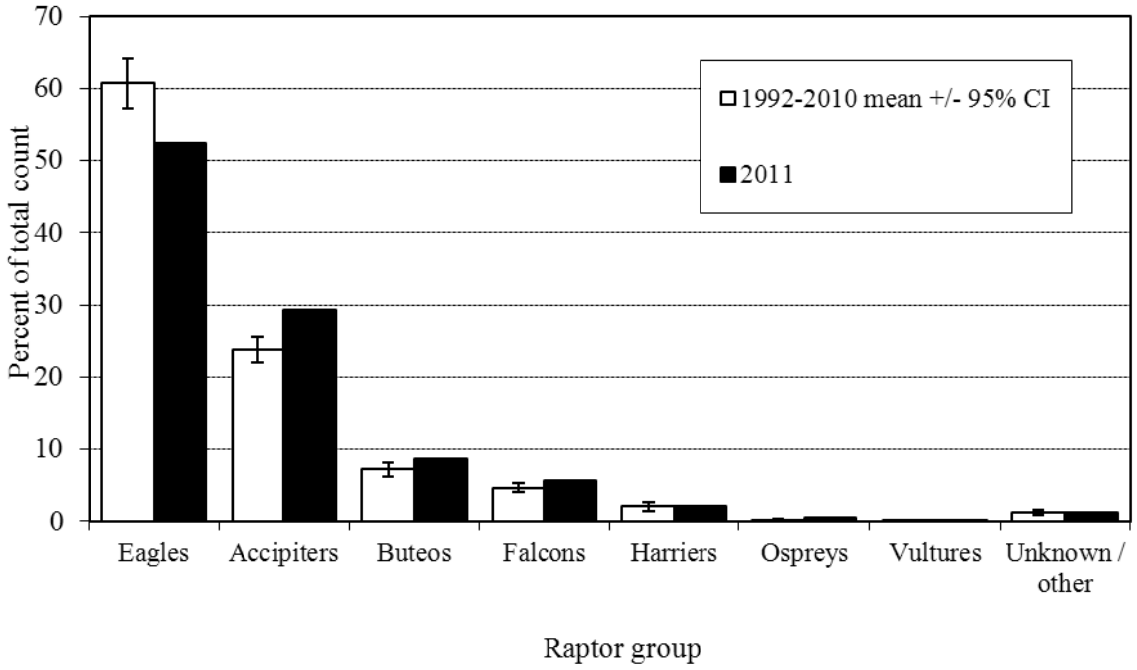

Figure 2. Composition of the fall raptor migration in the Bridger Mountains by major species groups: 1992-2010 versus 2011.

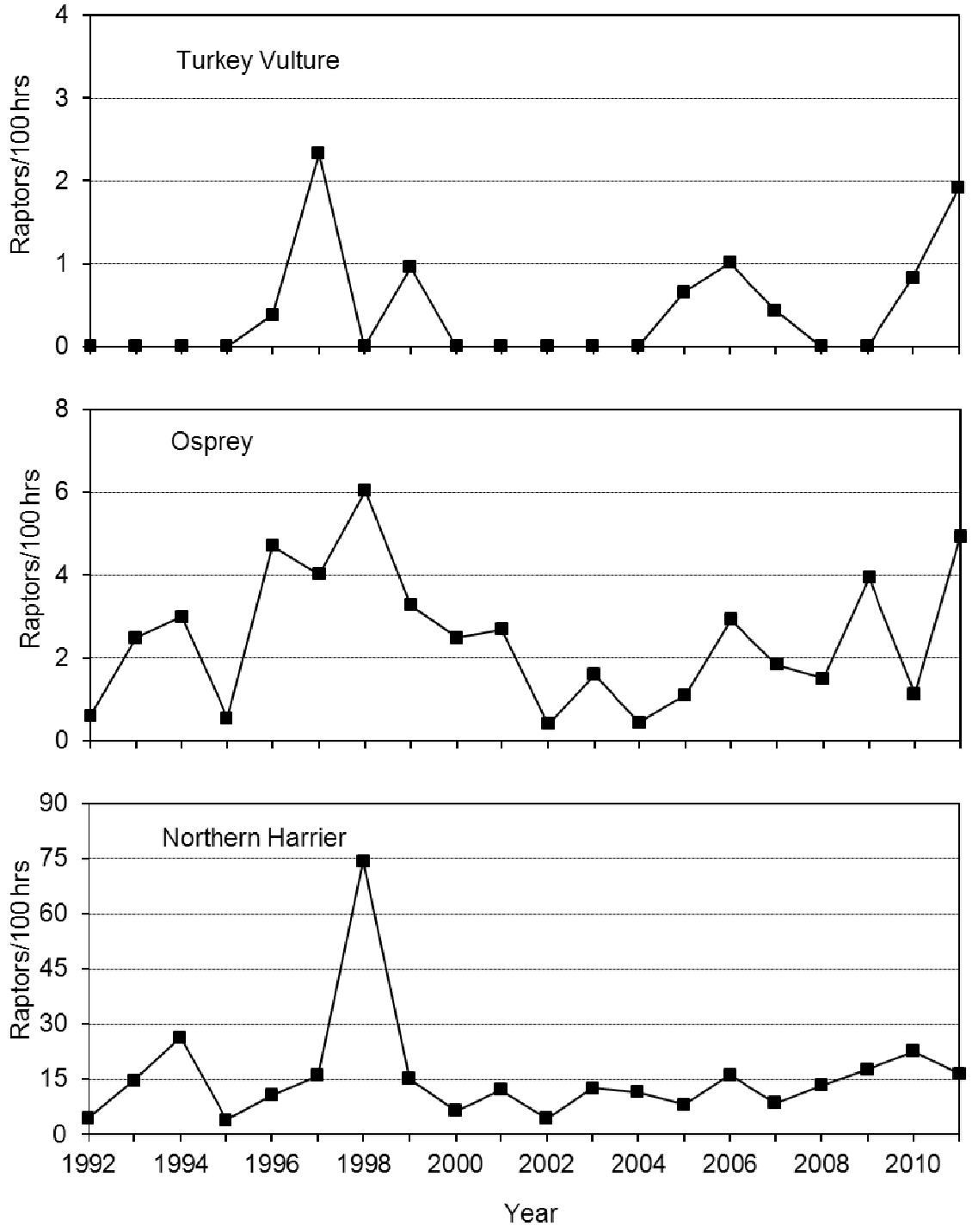

Figure 3. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Turkey Vultures, Ospreys, and Northern Harriers in the Bridger Mountains, MT: 1992–2011.

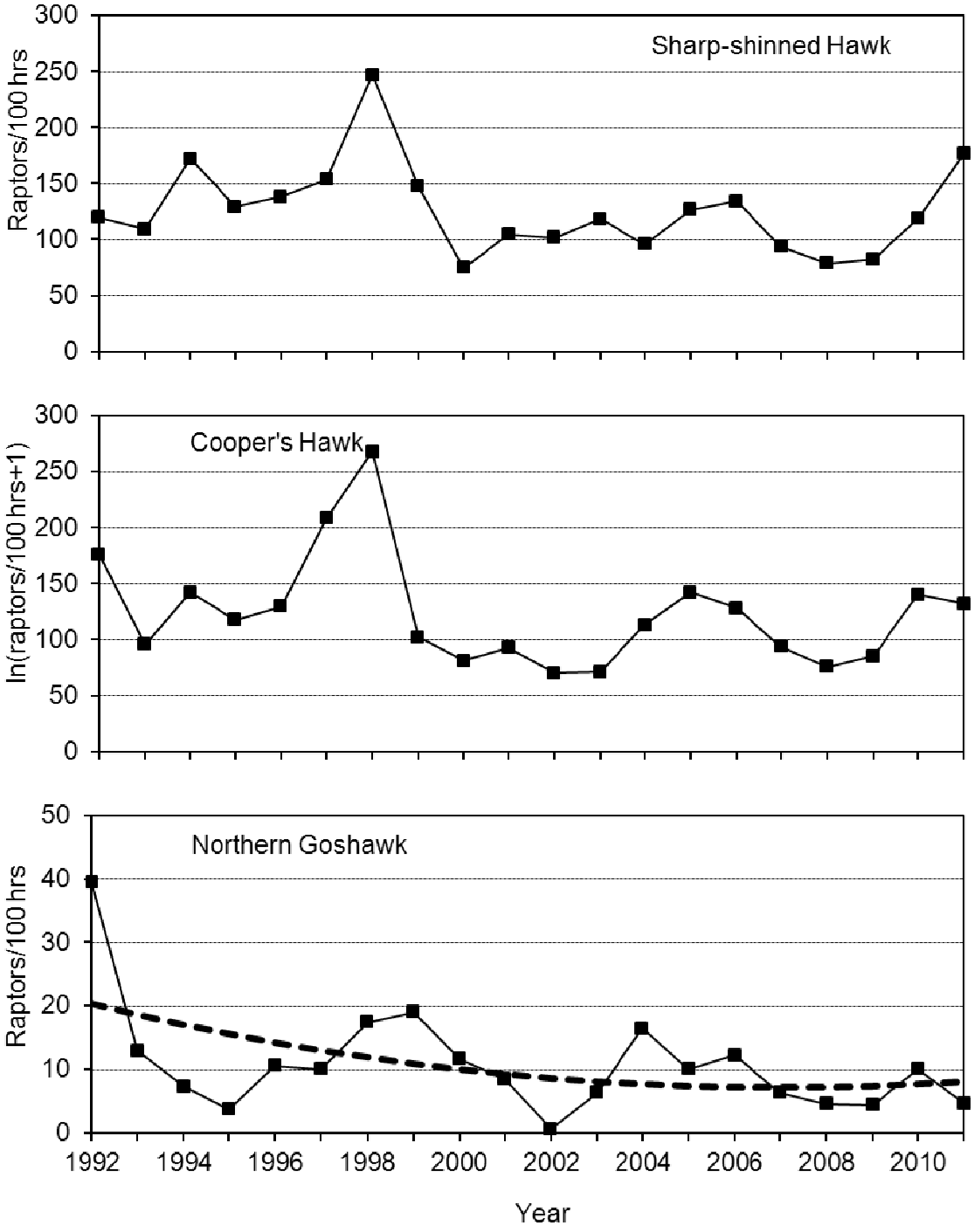

Figure 4. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks in the Bridger Mountains, MT: 1992–2011. Dashed lines indicate significant ($P \leq 0.10$) linear regressions.

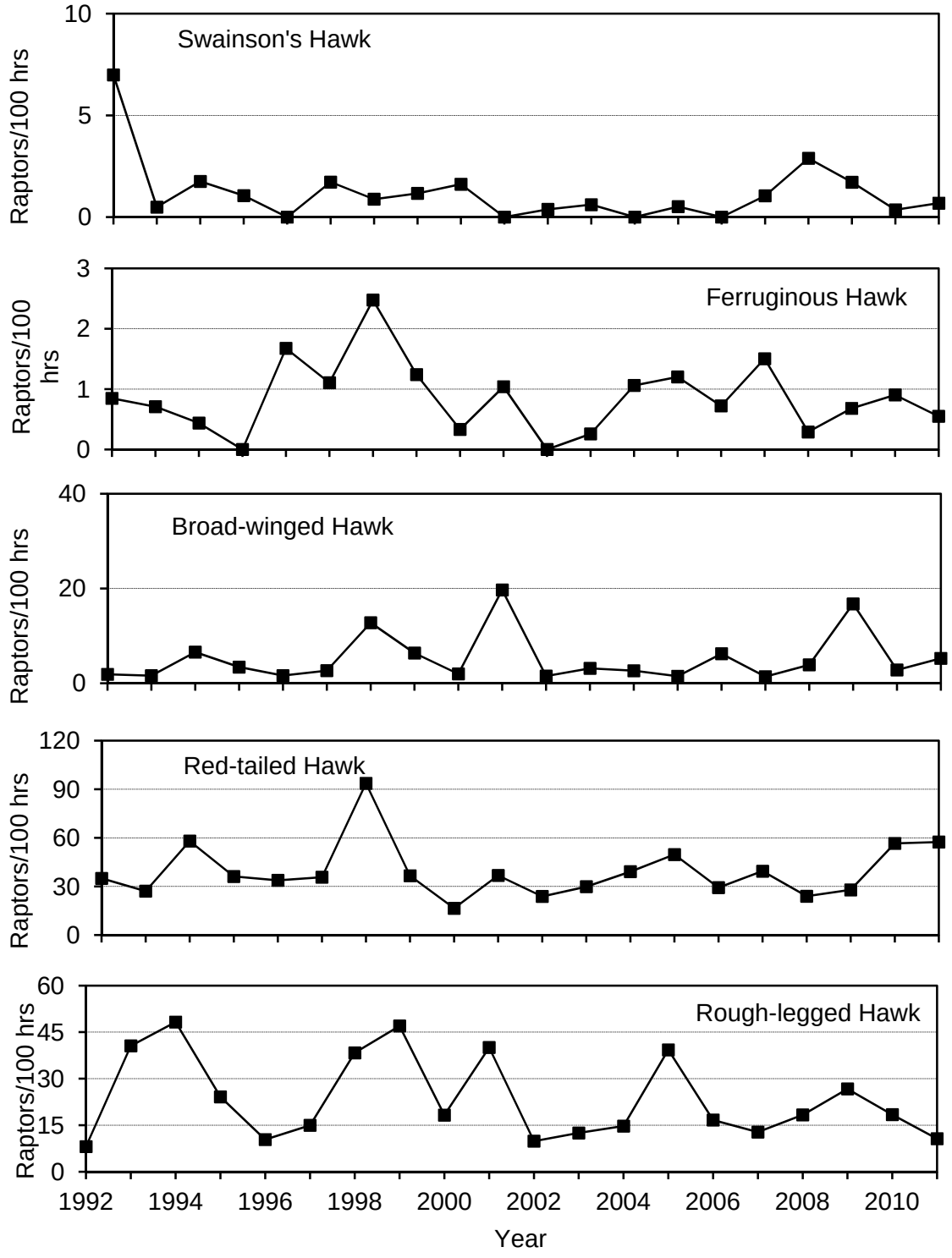

Figure 5. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Broad-winged, Swainson's, Red-tailed, Ferruginous, and Rough-legged Hawks in the Bridger Mountains, MT: 1992–2011.

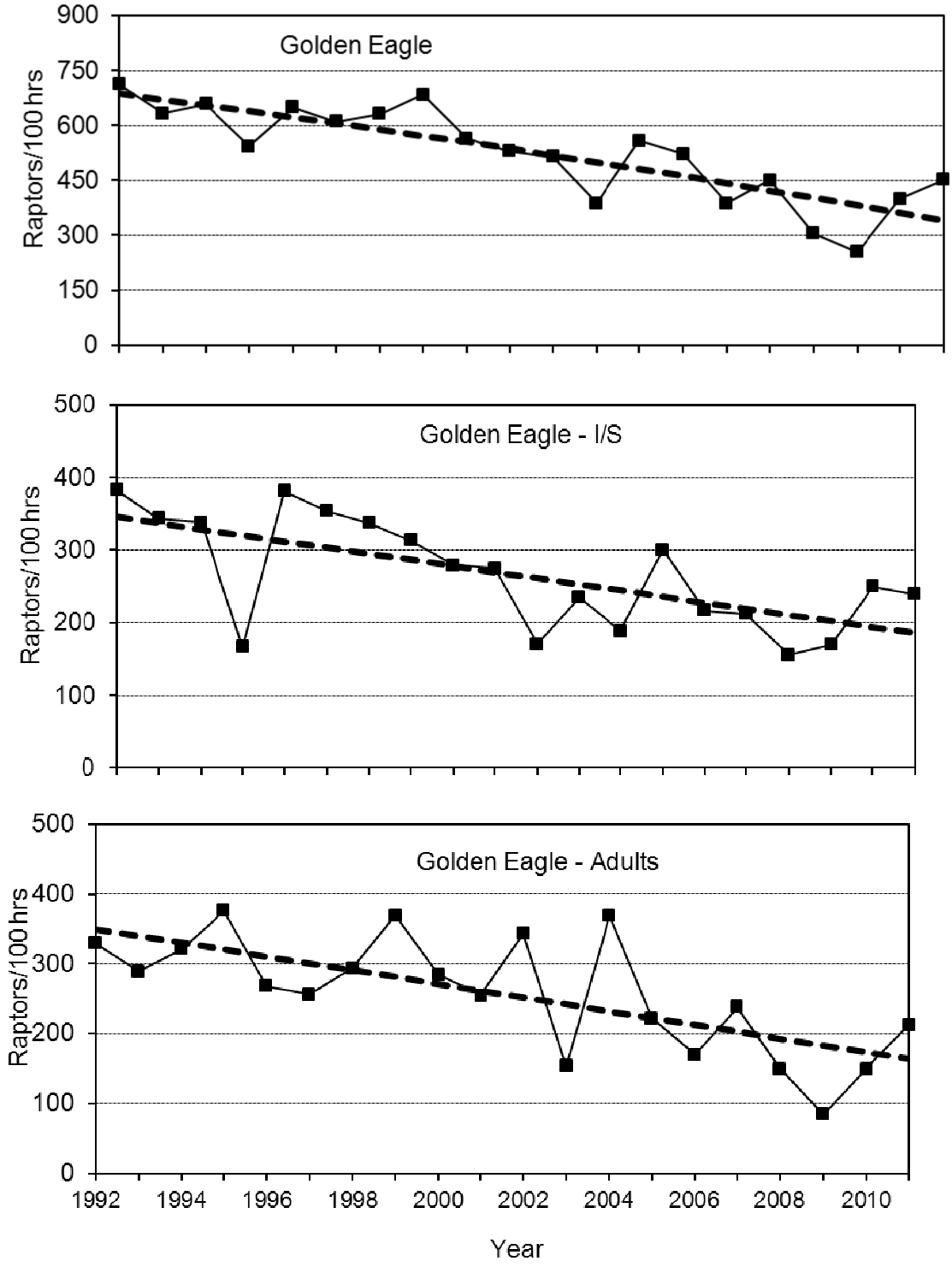

Figure 6. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Golden Eagles (separated by all birds, non-adults, and adults) in the Bridger Mountains, MT: 1992–2011. Dashed lines indicate significant ($P \leq 0.10$) linear regressions.

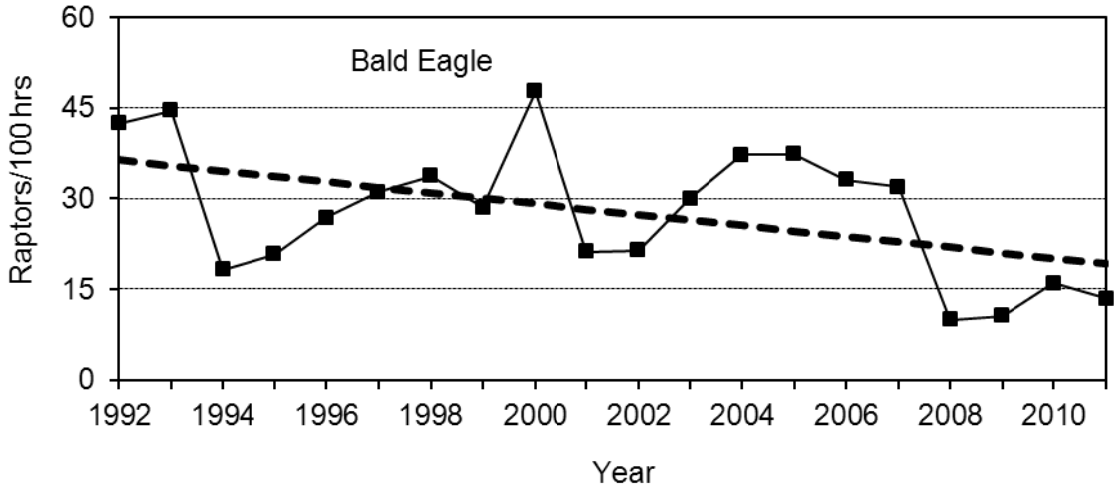

Figure 7. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Bald Eagles in the Bridger Mountains, MT: 1992–2011. Dashed lines indicate significant ($P \leq 0.10$) linear regressions.

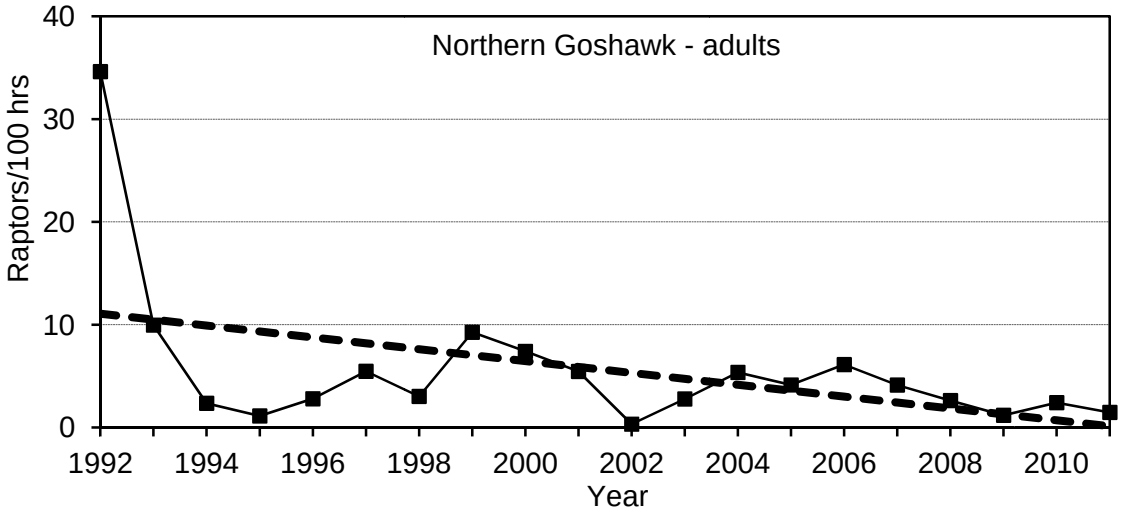

Figure 8. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for adult Northern Goshawks in the Bridger Mountains, MT: 1992–2011. Dashed lines indicate significant ($P \leq 0.10$) linear regressions.

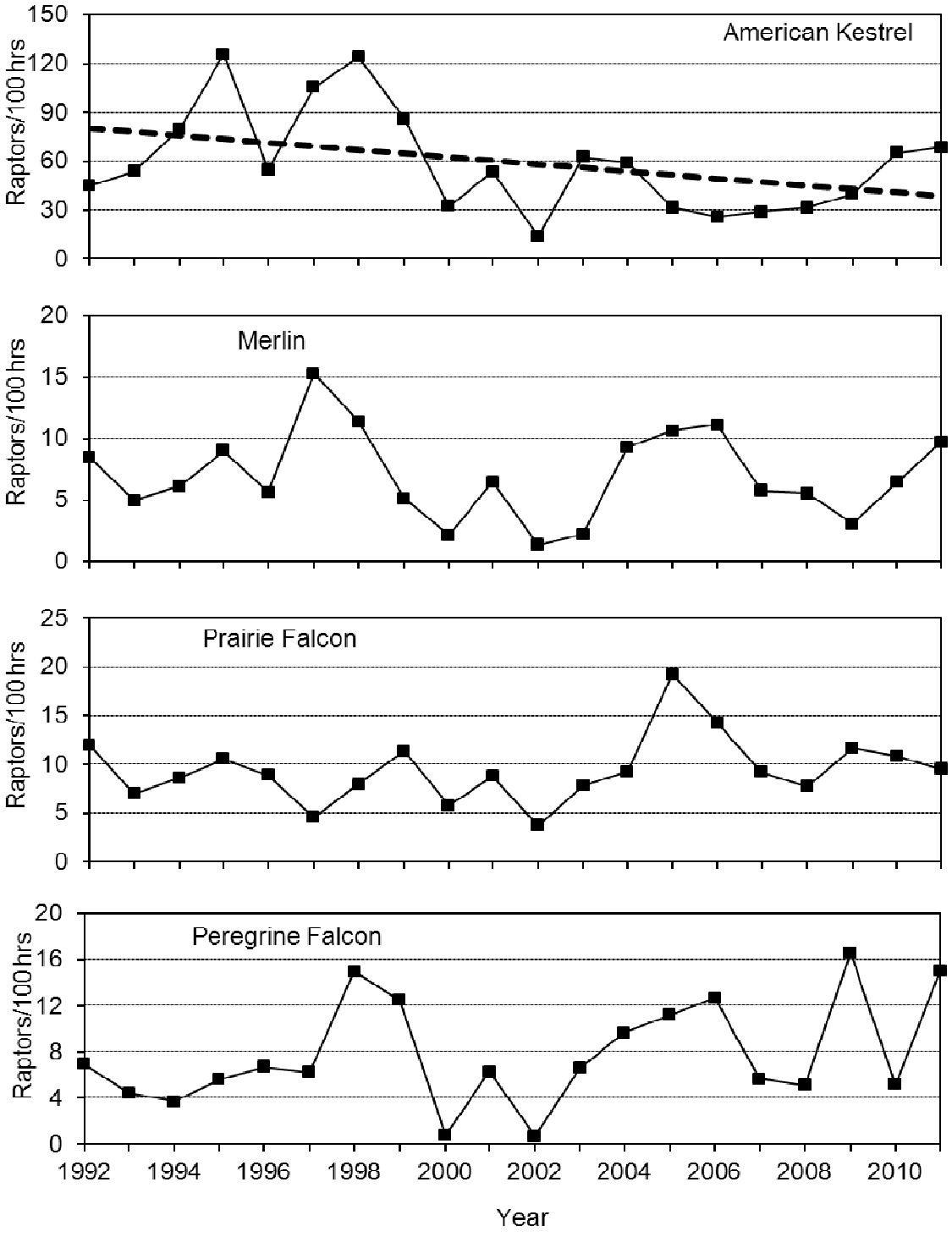

Figure 9. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons in the Bridger Mountains, MT: 1992–2011. Dashed lines indicate significant ($P \leq 0.10$) linear regressions.

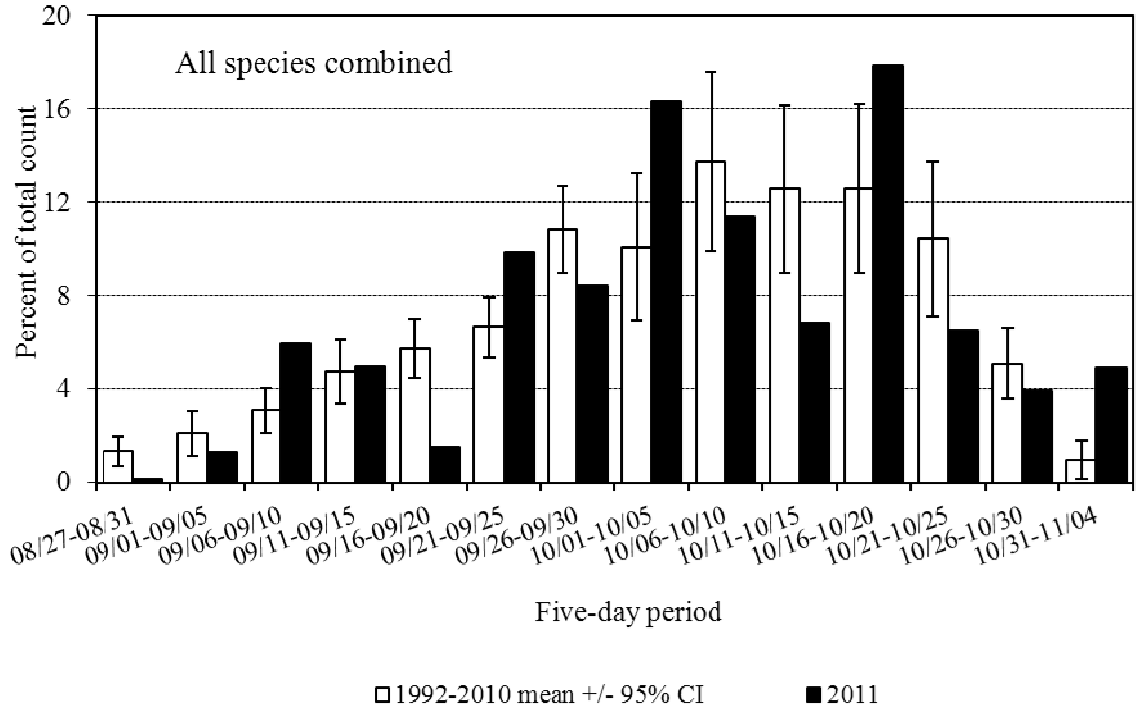

Figure 10. Combined-species passage volume by five-day periods for migrating raptors in the Bridger Mountains, MT: 1992–2010 versus 2011.

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 (HY), Br = brown (adult female or immature), U = unknown age.
[2] Sex codes: M = male, F = female, U = unknown.
[3] Color morph codes: D = dark or rufous, G = gray; L = light, W = white; U – unknown, NA = not applicable.
[4] Golden Eagle age codes: I = Immature: juvenile or first-year bird, bold white wing patch visible below, bold white in tail, no molt; S = Subadult: white wing patch variable or absent, obvious white in tail and molt or tawny bar visible on upper wing; NA = Not adult: unknown age immature/subadult; A = Adult: no white in wings or tail; U = Unknown.
[5] Bald Eagle age codes: I = Immature: juvenile or first-year bird, dark breast and tawny belly; S1 = young Subadult: Basic I and II plumages, light belly, upside-down triangle on back; S2 = older Subadult: Basic III plumage, head mostly white with osprey-like dark eye line and dark band on tail; NA = Not adult: unknown age immature/subadult; A = Adult: includes near adult with dark flecks in head and dark tail tip, and adult with white head and tail; U = Unknown.

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

1991: Variable teams throughout: Kristian Shawn Omland (0), Phil West (1), LisaBeth Daly (2), Craig Limpach (1)
1992: Two observers throughout: Emily Teachout (1), Phil West (2)
1993: Two observers throughout: Adam Kaufman (0), Anne-Marie Gillesberg (0)
1994: Two observers throughout: Chris Gill (0), Stephanie Schmidt (1)
1995: Two observers throughout: Scott Harris (0), Sue Thomas (0)
1996: Two observers throughout: Jason Beason (0), Niels Maumenee (0)
1997: Two observers throughout: Jason Beason (1), Patty Scifres (0)
1998: Two observers throughout: Jason Beason (2), Mike Neal (0)
1999: Two observers throughout: Mike Neal (2), Greg Levandoski (1)
2000: Two observers throughout: Ryan Wagner (1), Tracy Elsey (0)
2001: Two observers throughout: Ryan Wagner (2), Jeff Maurer (4)
2002: Two observers throughout: Matt Proett (0), Marg Lomow (2; half season), Maureen Essen (0; half-season)
2003: Two observers throughout: Samantha Burrell (0), Carl Bullock (0)
2004: Two observers throughout: Allison Peterson (0), John Bell (0)
2005: Two observers throughout: Corey Michell (0), Beau Fairchild (0)
2006: Two observers throughout: Brian Cook (0), Jamie Granger (0)
2007: Two observers throughout: Jody Vogeler (0), Brenden McGugin (0)
2008: Two observers throughout: Amy Seaman (0), Michaela Hitchcock (0), John Bell (2)
2009: Two observers throughout: Caitlin Kroeger (0), Jason Minné (0)
2010: Two observers throughout: Jamie Hogberg (0), David Laufenberg (0)
2011: Two observers throughout: Brian Connelly (3), John Martineau (0)

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

Appendix C. Daily observation effort, visitor disturbance ratings, weather records, and flight summaries for the Bridger Mountains Raptor Migration Project: 2011.

DATE	OBS. HOURS	OBSRVR /HOUR[1]	MEDIAN VISITOR DISTURB[2]	PREDOMINANT WEATHER[3]	WIND SPEED (KPH)[1]	WIND DIRECTION	TEMP (^{0}C)[1]	BAROM. PRESS. (IN HG)[1]	MEDIAN THERMAL LIFT[4]	VISIB. WEST (KM)[1]	VISIB. EAST (KM)[1]	MEDIAN FLIGHT DISTANCE[5]	BIRDS /HOUR
1-Sep	0.00	0.0		Weather Day: fog									
2-Sep	8.00	2.1	0	clr	10.6	w, wsw	12.1		3	63	64	0	1.1
3-Sep	8.00	2.0	0	clr	6.3	e, nnw	9.0	30.34	2	78	78	0	0.3
4-Sep	8.00	2.0	0	clr, haze	6.4	wsw	14.3	30.29	2	62	46	0	1.0
5-Sep	8.00	2.0	0	pc, clr, mc, haze	7.1	wsw, w	17.3	30.24	2	49	48	3	2.4
6-Sep	8.00	2.0	0	clr, haze	6.7	wsw, w	16.0	30.38	2	60	58	3	4.3
7-Sep	8.00	2.0	0	clr, pc, mc, haze	8.0	ene, ese	17.1	30.45	2	50	50	3	4.1
8-Sep	8.00	1.0	0	clr, pc, mc, ovc, haze	6.2	ese	16.7	30.41	3	47	45	3	3.3
9-Sep	8.00	2.0	0	pc, haze	15.2	ene, ese	16.3	30.37	3	63	55	3	5.3
10-Sep	8.00	2.0	0	clr, haze	10.8	ese, ene, e	15.7	30.31	3	60	60	3	4.5
11-Sep	8.00	2.0	0	mc, haze	5.8	wsw	17.8	30.23	3	53	52	2	4.1
12-Sep	8.00	2.3	0	clr, pc, haze	7.3	w, wsw	15.6	30.28	2	25	27	2	4.9
13-Sep	8.00	1.9	0	clr, pc, haze	4.8	wsw	14.3	30.29	3	37	38	3	5.8
14-Sep	0.00	0.0		Weather Day: fog/rain									
15-Sep	8.00	1.0	0	clr, pc, mc, haze	5.8	wsw, w	14.3	30.08	3	35	40	3	3.1
16-Sep	0.00	0.0		Weather Day: fog/rain									
17-Sep	4.50	1.0	0	ovc, haze	11.2	wsw, w	5.7	30.06	4	51	60	0	1.6
18-Sep	8.00	2.0	0	ovc	11.0	wsw, w	6.9	30.21	4	52	61	2	1.5
19-Sep	6.50	2.0	0	ovc, rain	14.9	w	7.5	30.09	4	69	76	2	1.1
20-Sep	8.00	2.0	0	pc	3.0	e, s, w	8.2	30.24	2	100	100	2	2.3
21-Sep	8.00	2.0	0	clr, haze	7.1	wsw, w	8.9	30.25	3	71	68	3	7.6
22-Sep	8.00	2.0	0	clr, pc, ovc, haze	11.7	wsw, w	13.6	30.29	3	75	66	3	7.9
23-Sep	8.00	2.5	0	mc, haze	7.5	w	16.0	30.34	2	38	63	3	10.5
24-Sep	8.00	2.0	0	clr, haze	5.4	e, ese, w	19.0	30.28	1	47	45	3	5.4
25-Sep	8.00	2.4	0	clr, pc, haze	7.6	wsw, w	18.1	30.10	2	47	57	2	4.0
26-Sep	8.00	3.0	0	clr, haze	9.7	wsw, w	11.6	30.19	3	59	57	3	5.3
27-Sep	8.00	2.0	0	pc, clr	9.3	wsw, w, sw	15.7	30.22	2	79	79	4	8.6
28-Sep	8.00	2.0	0	pc, clr, haze	8.5	wsw, w	10.4	30.27	2	60	43	3	4.1
29-Sep	8.00	2.0	0	clr, haze	13.8	e, wnw, w	8.1	30.31	3	68	68	2	6.1
30-Sep	8.00	1.3	0	pc, mc, haze	7.0	w	16.0	30.25	3	66	67	3	6.0
1-Oct	8.00	2.0	1.5	pc, mc, ovc, haze	8.0	wsw	17.2	30.19	3	62	63	3	19.4
2-Oct	5.92	2.9	1	ovc, ts, rain	1.8	ssw, w, sw	12.1	30.17	4	84	100	3	3.5
3-Oct	8.00	2.5	0	pc, mc, ovc, haze	7.0	se, wsw, sse, ssw	15.0	30.18	4	47	48	3	30.4
4-Oct	8.00	2.0	0	ovc, haze	8.6	sw, wsw, w	9.9	29.95	4	80	80	3	4.5

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]	BAROM. PRESS. (IN HG)[1]	MEDIAN THERMAL LIFT[4]	VISIB. WEST (KM)[1]	VISIB. EAST (KM)[1]	MEDIAN FLIGHT DISTANCE[5]	BIRDS /HOUR
5-Oct	7.00	1.8	0	ovc, rain pm	17.8	ese, se	5.2	29.75	4	52	63	0	1.9
6-Oct	0.00	0.0		Weather Day: fog/rain									
7-Oct	0.00	0.0		Weather Day: fog/snow									
8-Oct	4.00	2.0	2	ovc, fog, ts mid-day	4.2	ese, w	2.0	30.19	4	8	14	0	0.0
9-Oct	8.25	2.4	0	clr	8.9	w	-0.6	30.05	3	97	84	3	21.5
10-Oct	8.00	1.9	0	clr, ovc, snow pm	8.3	w, wsw	1.6	29.89	4	47	57	3	18.8
11-Oct	0.00	0.0		Weather Day: fog/rain									
12-Oct	8.00	2.0	0	ovc	12.3	w	0.1	30.08	4	93	61	3	9.6
13-Oct	8.00	2.0	0	ovc	10.8	w	-0.5	30.05	4	60	60	3	9.0
14-Oct	8.00	1.3	0	ovc, pc pm, fog, snow am	10.2	wsw, w	3.1	30.05	4	53	69	0	5.3
15-Oct	3.75	1.8	0	ovc, rain mid-day	10.7	w	2.8	30.00	4	18	23	3	1.3
16-Oct	0.00	0.0		Weather Day: fog/rain									
17-Oct	8.00	2.0	0	pc, ovc, mc	12.5	w	-3.5	30.23	3	84	81	3	20.9
18-Oct	8.00	2.0	0	clr, haze	11.8	w	0.8	30.30	3	100	95	2	14.4
19-Oct	8.00	2.0	0	mc, ovc	9.3	w	6.5	30.05	4	100	92	2	3.4
20-Oct	8.00	2.0	0	mc, ovc	8.4	w	3.7	30.08	4	100	80	3	25.4
21-Oct	6.50	2.0	0	ovc, snow	11.1	w	1.7	30.16	4	33	47	3	6.5
22-Oct	8.00	2.0	0	ovc, mc	12.9	w	3.0	30.13	4	97	98	4	13.4
23-Oct	7.50	2.0	0	mc, ovc	11.4	w	3.8	30.10	3	97	91	3	4.1
24-Oct	1.50	2.0	0	ovc, fog	4.5	wsw, se	0.8	29.94	4	38	31	1	0.7
25-Oct	3.00	2.0	0	ovc, snow	5.3	w	-7.8	30.10	4	28	31	1	2.0
26-Oct	3.50	1.0	0	pc	15.8	w	-6.8	30.02	4	100	94	3	10.9
27-Oct	7.00	2.0	0	mc, pc pm	10.8	w	-3.4	30.02	3	82	69	3	3.7
28-Oct	7.00	2.4	0	mc, ovc, haze	9.6	w, wnw	-1.0	30.09	4	60	52	2	2.1
29-Oct	7.00	2.0	0	ovc, pc pm, snow am	16.8	w	-2.3	29.99	4	42	55	0	0.4
30-Oct	7.00	2.0	0	pc, clr	12.4	wsw, w	2.3	30.12	3	99	97	3	4.3
31-Oct	0.00	0.0		Weather Day: rain/snow									
1-Nov	2.75	1.0	0	ovc, snow	7.2	w, wnw	-8.4	30.07	4	6	25	3	4.7
2-Nov	7.75	2.0	0	pc, clr	13.8	w	-5.5	30.17	4	100	100	3	1.5
3-Nov	8.00	2.6	0	ovc	9.1	w	0.2	29.85	4	82	81	2	5.8
4-Nov	7.00	2.0	0	pc, mc, ovc, haze	7.9	sw, wsw, w	1.6	29.66	3	90	48	3	10.0
5-Nov	0.00	0.0		Weather Day: snow									

[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: 2011.

		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	0.00																													
2-Sep	8.00	1	0	0	2	0	0	0	0	0	0	0	2	0	0	0	3	0	0	1	0	0	0	0	0	0	0	0	9	1.1
3-Sep	8.00	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0.3
4-Sep	8.00	0	0	2	2	1	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	8	1.0
5-Sep	8.00	0	1	1	8	1	0	0	0	0	0	0	3	0	0	0	3	0	0	0	0	0	1	0	0	0	0	1	19	2.4
6-Sep	8.00	0	0	1	9	4	0	0	0	0	0	0	5	0	0	0	5	0	0	8	1	0	0	0	0	0	0	1	34	4.3
7-Sep	8.00	0	1	2	12	4	1	0	0	0	0	0	5	0	0	0	3	0	0	4	0	1	0	0	0	0	0	0	33	4.1
8-Sep	8.00	0	0	3	8	4	1	0	0	0	0	0	7	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	26	3.3
9-Sep	8.00	0	1	1	10	4	0	0	1	0	0	0	16	0	0	0	4	1	0	3	1	0	0	0	0	0	0	0	42	5.3
10-Sep	8.00	0	0	3	13	6	0	0	0	0	0	1	7	0	0	0	2	0	0	4	0	0	0	0	0	0	0	0	36	4.5
11-Sep	8.00	0	0	2	11	4	0	0	0	0	0	0	7	1	0	0	5	1	0	1	0	0	0	0	0	0	0	1	33	4.1
12-Sep	8.00	2	1	1	11	8	0	1	0	0	0	0	7	0	0	0	3	0	0	2	0	1	1	0	0	0	0	1	39	4.9
13-Sep	8.00	0	0	1	13	11	2	2	0	0	5	1	4	0	0	0	2	0	0	3	0	1	1	0	0	0	0	0	46	5.8
14-Sep	0.00																													
15-Sep	8.00	0	0	1	7	5	0	1	0	0	0	0	1	0	0	0	4	2	0	3	0	1	0	0	0	0	0	0	25	3.1
16-Sep	0.00																													
17-Sep	4.50	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	7	1.6
18-Sep	8.00	0	1	1	5	3	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	12	1.5
19-Sep	6.50	0	0	0	0	3	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	7	1.1
20-Sep	8.00	0	0	2	2	9	0	1	0	0	0	0	1	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	18	2.3
21-Sep	8.00	0	1	4	17	14	3	0	0	2	1	0	8	0	0	0	5	1	0	2	0	1	1	0	0	0	0	1	61	7.6
22-Sep	8.00	0	0	4	9	7	0	2	0	0	3	0	14	0	0	0	16	1	0	3	1	1	1	0	0	0	0	1	63	7.9
23-Sep	8.00	0	2	0	19	16	1	0	0	2	0	0	12	0	0	0	17	0	0	5	2	2	1	0	0	0	0	5	84	10.5
24-Sep	8.00	0	0	0	10	7	0	0	0	0	0	0	7	0	0	0	9	1	0	8	0	0	0	0	0	0	0	1	43	5.4
25-Sep	8.00	0	0	0	14	4	0	0	0	1	0	0	3	0	0	0	2	2	0	5	0	0	0	0	0	0	0	1	32	4.0
26-Sep	8.00	0	0	0	17	5	1	2	0	0	0	0	4	0	0	0	5	0	0	6	0	0	2	0	0	0	0	0	42	5.3
27-Sep	8.00	0	0	1	26	9	0	6	0	1	0	0	0	0	0	1	12	0	0	10	1	1	0	0	0	0	0	1	69	8.6
28-Sep	8.00	0	0	2	11	6	0	0	0	0	1	0	1	0	0	0	6	2	0	2	0	1	0	0	0	0	0	1	33	4.1
29-Sep	8.00	0	0	7	17	7	0	0	0	0	0	0	1	0	0	0	15	1	0	0	0	0	1	0	0	0	0	0	49	6.1
30-Sep	8.00	0	1	1	12	9	1	0	0	0	0	0	3	0	0	0	16	2	0	0	0	0	1	0	0	0	0	2	48	6.0

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	1	1	50	20	1	2	0	1	0	0	14	0	0	0	56	0	0	7	0	1	1	0	0	0	0	0	155	19.4
2-Oct	5.92	0	1	1	6	7	0	1	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	21	3.5
3-Oct	8.00	0	1	13	89	26	0	1	0	4	1	0	24	0	0	0	55	1	0	14	2	1	6	0	0	0	0	5	243	30.4
4-Oct	8.00	0	1	1	17	3	0	2	0	0	0	0	2	0	0	0	6	2	0	0	0	0	1	0	0	0	0	1	36	4.5
5-Oct	7.00	0	1	0	4	0	0	0	1	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	13	1.9
6-Oct	0.00																													
7-Oct	0.00																													
8-Oct	4.00	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
9-Oct	8.25	2	0	0	22	2	0	0	1	0	0	0	9	0	2	0	134	1	0	1	0	1	1	0	0	0	0	1	177	21.5
10-Oct	8.00	0	0	0	9	0	0	0	0	0	1	0	2	0	1	0	133	0	0	1	1	0	0	0	0	0	1	1	150	18.8
11-Oct	0.00																													
12-Oct	8.00	0	0	0	4	0	0	0	0	0	0	0	3	0	0	0	68	0	0	2	0	0	0	0	0	0	0	0	77	9.6
13-Oct	8.00	0	0	0	4	1	0	0	0	0	0	0	0	1	1	0	64	0	0	0	1	0	0	0	0	0	0	0	72	9.0
14-Oct	8.00	0	0	1	5	2	0	0	0	1	0	0	2	0	0	1	28	0	0	0	0	0	1	0	0	0	0	1	42	5.3
15-Oct	3.75	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	5	1.3
16-Oct	0.00																													
17-Oct	8.00	0	0	0	18	2	0	0	0	0	0	0	7	0	0	0	135	2	0	0	0	0	0	0	0	0	0	3	167	20.9
18-Oct	8.00	0	0	0	19	0	0	0	0	0	0	0	6	0	4	0	83	1	0	0	0	0	0	0	0	0	0	2	115	14.4
19-Oct	8.00	0	0	1	7	2	0	0	0	0	0	0	0	0	0	0	14	1	0	0	1	1	0	0	0	0	0	0	27	3.4
20-Oct	8.00	0	0	0	17	0	0	0	0	0	0	0	1	0	1	0	178	0	0	0	3	2	0	0	0	0	0	1	203	25.4
21-Oct	6.50	0	0	0	4	0	1	0	0	0	0	0	1	0	1	0	35	0	0	0	0	0	0	0	0	0	0	0	42	6.5
22-Oct	8.00	0	0	0	9	1	0	0	0	0	0	0	4	0	5	0	80	7	0	1	0	0	0	0	0	0	0	0	107	13.4
23-Oct	7.50	0	0	1	5	0	2	0	0	0	0	0	2	0	0	0	16	3	0	1	0	0	0	0	0	0	1	0	31	4.1
24-Oct	1.50	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	0	1	0.7
25-Oct	3.00	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	6	2.0
26-Oct	3.50	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	30	3	0	0	0	0	0	0	0	0	0	2	38	10.9
27-Oct	7.00	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	22	3	0	0	0	0	0	0	0	0	0	0	26	3.7
28-Oct	7.00	0	0	0	4	0	0	0	0	0	0	0	0	0	1	0	6	1	0	0	2	1	0	0	0	0	0	0	15	2.1
29-Oct	7.00	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	0.4
30-Oct	7.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	3	0	0	1	1	0	0	0	0	0	2	30	4.3
31-Oct	0.00																													
1-Nov	2.75	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	6	3	0	0	0	0	0	0	0	0	0	0	13	4.7
2-Nov	7.75	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	8	1	0	0	0	0	0	0	0	0	0	0	12	1.5
3-Nov	8.00	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0	35	6	0	0	0	0	0	0	0	0	0	1	46	5.8
4-Nov	7.00	0	0	0	0	0	0	0	0	0	0	0	2	0	4	0	50	14	0	0	0	0	0	0	0	0	0	0	70	10.0
5-Nov	0.00																													
Total	411.42	5	14	59	565	221	15	22	3	12	12	2	202	2	28	4	1431	68	0	99	17	19	24	0	0	0	2	37	2863	

[1] See Appendix A for interpretation of species codes.

Appendix E. Annual observation effort and fall raptor migration counts by species in the Bridger Mountains, MT: 1991–2011.

	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[1]	-	-	-	-	-	-	-
Unkown 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
Unkown small falcon[1]	-	-	-	-	-	-	-
Unkown 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
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[1]	-	-	-	0	11	29	32
Unkown large accipiter[1]	-	-	-	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
Gyrfalcon	0	1	0	0	0	0	0
Unkown small falcon[1]	-	-	-	0	0	0	3
Unkown large falcon[1]	-	-	-	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

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

Appendix E. continued

	2005	2006	2007	2008	2009	2010	2011	Mean
Start date	27-Aug	27-Aug	27-Aug	27-Aug	6-Sep	28-Aug	2-Sep	30-Aug
End date	31-Oct	29-Oct	29-Oct	31-Oct	31-Oct	1-Nov	4-Nov	29-Oct
Observation days	48	45	56	56	44	54	57	50
Observation hours	300.83	331.25	384.59	415.49	306.25	366.00	411.42	332.62
Raptors / 100 hours	674.8	538.3	550.5	427.7	453.2	641.8	695.9	722.5
SPECIES	RAPTOR COUNTS							
Turkey Vulture	1	2	1	0	0	2	5	1
Osprey	2	7	5	4	9	3	14	6
Northern Harrier	22	50	30	47	52	77	59	49
Sharp-shinned Hawk	228	344	277	222	230	336	565	314
Cooper's Hawk	153	182	151	115	113	207	221	161
Northern Goshawk	22	33	20	22	13	33	15	32
Unkown small accipiter[1]	92	10	18	43	6	40	22	28
Unkown large accipiter[1]	4	0	6	10	6	22	3	7
Unknown accipiter	27	0	5	3	7	25	12	26
Total accipiters	526	569	477	415	375	663	838	551
Broad-winged Hawk	3	12	5	7	33	5	12	10
Swainson's Hawk	0	0	3	8	4	1	2	3
Red-tailed Hawk	108	89	130	75	75	178	202	104
Ferruginous Hawk	2	3	5	1	2	3	2	3
Rough-legged Hawk	40	21	19	32	30	31	28	32
Unidentified buteo	27	2	11	10	10	20	4	13
Total buteos	180	127	173	133	154	238	250	164
Golden Eagle	1061	859	1247	1003	638	1171	1431	1350
Bald Eagle	75	74	85	43	27	50	68	74
Unidentified eagle	1	1	0	10	4	1	0	6
Total eagles	1137	934	1332	1056	669	1222	1499	1431
American Kestrel	20	38	41	46	45	87	99	68
Merlin	7	15	9	10	4	12	17	9
Prairie Falcon	20	22	17	13	17	18	19	14
Peregrine Falcon	8	15	8	5	23	8	24	9
Gyrfalcon	0	0	0	0	0	0	0	0
Unkown small falcon[1]	27	0	2	2	3	3	0	4
Unkown large falcon[1]	13	1	3	6	3	2	0	4
Unknown falcon	13	0	2	2	4	0	2	5
Total falcons	108	91	82	84	99	130	161	108
Unidentified raptor	54	3	17	38	30	14	37	28
Grand Total	2030	1783	2117	1777	1388	2349	2863	2337

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