FALL 2013 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 portion of the Rocky Mountain Flyway (Omland and Hoffman 1996, Hoffman and Smith 2003, Smith et al. 2008a). HawkWatch International (HWI) initiated counts at the site in autumn 1991, with standardized, full-season annual monitoring commencing in 1992. Beginning in 2009 Montana Audubon took the lead in coordinating these important 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 migrating raptors have been recorded along the Bridger Mountains, with annual counts typically ranging between 2,000 and 3,500 migrants. This report summarizes count results of the 2013 season, which marked the 22nd consecutive full-season autumn count of migratory raptors at the site.

The 2013 field season was characterized by the total immersion in the project by the crew, who mostly lived on the crest of the Bridger Ridge adjacent to the study site. The Bridger Mountains Project was one of eight long-term, annual fall migration counts conducted or co-sponsored by HWI in North America in 2013. 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 important 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 narrow range that run 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 predictable lift, attracting southbound migrating raptors each fall. The observation site is a helicopter landing platform atop Bridger Bowl Ski Area, at an elevation of 2,610 m (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 5 x 5 m concrete platform located approximately 50 m north of a ski patrol hut. The site is accessed by walking along a primitive dirt road for 3 km (780 m rise in elevation) to the top of the Bridger chairlift, then continuing westward a few hundred meters along a narrow footpath to the crest of the ridge, and then north for 50 meters to the observation site.

METHODS

Since this project's inception, two designated observers have conducted standardized daily counts of migrating raptors from a single, traditional observation site from approximately late August/early September through late October/early November. In 2013 observations began 1 September and continued through 2 November 2013. Observations typically began at 0900 H and ended at 1700 H Mountain Standard Time (MST). This was the second consecutive full season of migration counting at this site for both official observers (see Appendix B for the complete observer history at this site), and the only consecutive seasons in which the Bridger count was conducted by an identical team of observers. Both observers received considerable training with Montana Audubon Executive Director, Steve Hoffman. Local raptor enthusiasts (and expert observers) Matt Keefer and Ben Rosemeyer, as well as long-time volunteer John Parker occasionally assisted with the counts. Other local enthusiasts also joined the count sporadically (Paulette Epple, Martha Collins and many others), especially individuals associated with the local Sacajawea Audubon Chapter.

In both 2013 and 2012 two decoy owls were used to lure passing raptors; one was located approximately 5 m directly north of the observation point, and another atop the next prominent peak to the north (referred to as Tilly Peak, approximately 600 m from the observation point). In previous years only a single, nearby owl was used. Kalon Baughan, one of the two official observers, took many digital photographs to augment the identification process. 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. Estimated predominant direction, altitude, and horizontal distance from the lookout of the migratory raptor 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 substantially to the count [actively 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.

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

Calculation of "adjusted" (to standardized sampling periods and adjusted for incompletely identified birds) passage rates (migrants counted per 100 hours of observation) and analysis of trends, updated through 2013, follows Hoffman and Smith (2003). In comparing 2013 annual statistics against means and 95% confidence intervals for previous seasons, we determined significance when a 2013 value fell outside the bounds of the 95% confidence interval for the associated mean.

RESULTS AND DISCUSSION

WEATHER SUMMARY

Inclement weather and/or difficult access fully precluded observation on 16 days during the 2013 season. Low-lying stratus clouds often settled over the Bridger Mountains (for hours or days at a time), and persistent storms were largely responsible. The 16 days without any observations was much higher than the 1997-2012 (the period in which detailed daily weather records have been collected and analyzed) average of 11.3 days. In addition, inclement weather was a factor in reducing the total daily observation

period to less than four hours on five additional days (average is 5.3 days; see Appendix C for 2013 daily weather records).

During periods of active observation, skies were recorded as fair 20% of the time, transitional 42% of the time, and mostly cloudy/overcast 38% of the time. Comparison with the long-term mean values (37% fair, 32% transitional and 31% mostly cloudy/overcast) indicates the 2013 season experienced substantially cloudier weather than average. In sharp contrast to the 16-year average of 33% of weather observations including fog or haze, the 2013 season experienced 52% fog/haze. Persistent forest wildfires in the area created thick smoke and haze that surrounded the Bridger Mountain on most days until mid-September, when a strong storm brought snowfall and cleared the smoke for much of the remainder of the season. The persistent smoke resulted in the estimated visibility being slightly reduced to 70-75 km (average 73-78 km). During active observation days (not including days in which severe weather precluded observation), snow and rain conditions were about average in 2013, comprising 12% of hourly weather observations, as compared to the long-term average of 14%.

The predominant speed of prevailing winds was light (<12kph on 86% of active observation days), while moderate winds (12-29 kph) were recorded 14% of days. These percentages were close to the 1997-2012 averages of 81% light, 18% moderate, and 1% strong. Prevailing wind direction was from SW-W (62% of all observation days). These wind statistics, combined with observers' subjective rating of thermal lift as "good to excellent" only 19% of the time (compared to the long-term average of 35%), suggest that conditions were particularly good in 2013 for spotting migrants, due to generally weaker thermal lift conditions and thus predominantly lower-altitude flight trajectories. The primary reason for this was persistent, dense forest fire smoke early in the season, followed by early snowfall and persistent snow cover beginning 17 September, both of which greatly reduced the strength of thermal lift.

OBSERVATION EFFORT

Observations were conducted on 50 of 66 days between 1 September and 5 November, 2013. The number of observation days was 3% below the 1992-2012 average of 52 ± 3.2 days, and the number of observation hours (336) was slightly below the average, but within the 95% confidence interval of the long-term mean of 347.0 ± 24.9 hours. The 2013 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 1992-2012 average of 1.9.

FLIGHT SUMMARY

A total of 2,315 migrating raptors of 17 species was tallied during the 2013 season (see Appendix C for daily count records). This total count is 3% below the long-term average for Bridger Ridge.

The 2013 flight was comprised of 52% eagles, 24% accipiters, 12% buteos, 7% falcons, 2% harriers, 1% unidentified raptors, and 1% Ospreys and vultures. The most numerous species were: Golden Eagles (49% of total count), Sharp-shinned Hawks (15%), Red-tailed Hawks (8%), Cooper's Hawks (7%), and American Kestrels (4%). All other species each comprised < 4% of the total.

The decoy owls lured in every observed species of migrant raptor except the Bald Eagle, Turkey Vulture, Broad-winged Hawk, Osprey, Ferruginous Hawk, and Swainson's Hawk. Accipiters and falcons were most enthusiastic about attacking the owl, but Red-tailed Hawks, Northern Harriers, and Rough-legged

Hawks would occasionally make a pass on the decoy as well. Accipiters were the most oblivious to the observers when attacking the close owl; however, a Peregrine Falcon and multiple Merlins also accosted the nearby owl. A single adult migrant Golden Eagle and one of the resident pair of Golden Eagles attacked the more distant owl. The only raptor observed to make physical contact with the near owl in 2013 was a Red-tailed Hawk (possible Harlan's subspecies) that swiped at the plastic owl's head on 8 October.

LONG-TERM RAPTOR POPULATION TRENDS

Total counts for the Broad-winged Hawk and Turkey Vulture were the highest in the 22-year history of this count (48 and 16 individuals, respectively). Regression analyses updated through 2013 (after Hoffman and Smith 2003) reveal that both species are experiencing significant ($P<0.1$) population upswings (Figures 2 & 4); please note, however, that these are relatively rare species on Bridger Ridge and thus statistical determination of long-term trends for these species should be used with caution. Turkey Vultures made a surprising showing in 2013, with numbers well above average.

Another Montana-based fall migration hawk watch, located on the MPG Ranch in the northern Bitterroot Valley, observed record numbers of migrating raptors for any Montana hawk watch site, with 5,077 migrants in the 2013 season (compared to the Bridger record of 3,532 in 1998; see Appendix E for complete history of seasonal count totals). The MPG site also recorded an amazing total of 1,861 Turkey Vultures, almost entirely during the late September-early October period, when the Bridger Mountains (and the entire Rocky Mountain Front) were obscured by low clouds caused by persistent, multi-day storm systems. Some have hypothesized that this unique, prolonged weather pattern may have altered the typical migratory flight path of Turkey Vultures and redirected them through the Bitterroot Valley, where flight conditions were apparently considerably better than anywhere else in the region.

Also noteworthy this fall in the Bridgers were relatively high counts of Ospreys (second highest in the history of the project; see Appendix E), but exceptionally low counts of Northern Harriers (lowest in six years; see Appendix E). Low numbers of Northern Harriers may have been due to widespread drought conditions in 2013, substantially reducing vegetative cover required by these ground-nesters.

Regression analyses revealed a highly significant ($P<0.00001$) negative trend for Golden Eagles at the species level, tracking a dramatic decline (particularly since 1999; see Figure 5). These data reveal a widespread drop of 35-40% in northern Golden Eagle populations since the late 1990's. As yet, no cause has been clearly documented, but the Bridger counts, as well as similar findings across much of the West have recently motivated additional federal and state agency funding to thoroughly investigate the status and trends of Golden Eagle populations (and the threats facing them) across the western US. It is important to note that age-specific analyses of Golden Eagle trends reveal similar declines for *both* adults and non-adults ($P<0.01$; Figure 5).

Peregrine Falcons have been on a significant upswing from the all-time lows recorded at this site in the early-to-mid 1990's (Figure 8). These ongoing population increases can be attributed to the long-term population recovery of the species following the official 1972 U.S. ban of harmful organochlorine pesticides (DDT and its derivatives). The Northern Goshawk, both total numbers and just the adults, shows ongoing significant ($P<0.1$) linear declines (Figures 3 & 7). This is likely due to the long-term,

widespread decline in the quality and quantity of its preferred nesting and foraging habitat in the northern Rockies – mature/old-growth mountain forest.

Although the Bald Eagle counts also suggest declines, this finding is most certainly not representative of the species' population health, since most of these birds pass through the region throughout November and December, long after our count season has ended (Figure 6). And, with the acceleration of global climate change it is likely that autumn Bald Eagle migration has shifted even later into November and December in recent years, the most plausible explanation for our observed declining count trends.

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 reported in Hoffman and Smith (2003) and used herein to present trend analyses through 2013. Among other refinements, this new approach fits polynomial trajectories to the complete series of annual count indices, providing estimates of rates of change between various periods while also allowing for assessments of trend significance and precision. Please note, however, that restrictions related to the mathematical assumptions behind this newer approach precludes analyzing trends 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. However, with few notable exceptions, the overall patterns of population change and trend estimates as calculated by the new analysis method generally yielded similar inferences to those derived from the simpler methodology used herein (and described more fully in Hoffman and Smith, 2003).

AGE RATIOS

Of the nine species for which relevant age-specific data were available, immature:adult ratios were significantly above average for both the Sharp-shinned Hawk and Cooper's Hawk (Table 1), with the Cooper's Hawk being well outside the mean. Golden and Bald eagles were the only species that exhibited a significant decrease in the immature:subadult ratio (relative to the long-term average) in 2013.

SEASONAL TIMING

During the 2013 season the Osprey, Northern Harrier, Sharp-shinned Hawk, Cooper's Hawk, Broad-winged Hawk, American Kestrel, Merlin, and Peregrine Falcon showed significantly earlier passage dates (compared to the long-term mean; see Table 2). The median passage dates of the Sharp-shinned Hawk, Merlin, Peregrine Falcon, American Kestrel, Broad-winged Hawk, and Northern Harrier were approximately 10, 8, 8, 11, 6, and 6 days earlier than the long-term mean, respectively (for those six species). Median passage dates of most other raptor species were reasonably close to the long-term mean. Conversely, the Golden Eagle and Bald Eagle both exhibited passage dates significantly later than the long-term average (Table 2). It should be noted that immature small accipiters generally migrate in advance of the adults of the same species.

RESIDENT RAPTORS

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

Sharp-shinned Hawk - Resident Sharp-shinned Hawks were seen daily beginning on 1 September and continuing through 15 September. Two immature individuals were frequently seen together north of the observation point in the morning, hunting along the ridgeline and harassing the decoy owl as well as local and migrant raptors. These birds were last seen on 21 September.

Cooper's Hawk - One Cooper's Hawk was identified as a resident. An immature was observed on eight different days between 2 September and 19 September, mobbing both decoy owls and harassing migrants and local Sharp-shinned Hawks.

Northern Goshawk – A resident adult Northern Goshawk was spotted twice between October 27 and November 2. It was observed below the east side of Bridger Ridge during the morning hike to the observation point.

Red-tailed Hawk – At least one immature and one adult light-morph Red-tailed Hawk were identified as residents. The adult was seen regularly between 4 September and 7 October. The immature was seen between September 6 and September 20, often kiting on the west side of ridge.

Golden Eagle - A pair of resident adult Golden Eagles were noted in the area throughout the observation period, in addition to at least one sub-adult and one immature. The adult pair had a perch on the west side of Tilly that they often used on many evenings. These residents were very active, consistently escorting migrating eagles and buteos through their territory; they also were frequently observed hunting over the Bridger and Bangtail Mountains. Central to their identification as residents was their persistent territorial display flights, characterized by tucking their wings and diving steeply, only to climb quickly, and then repeating this "rollercoaster" display over and over when migrants were passing by. The immature was last observed on the 20th of October.

American Kestrel - Both male and female resident American Kestrels were seen daily between 1 and 14 September, most often in the morning on the east side of the ridge hunting and harassing other birds. As many as three individuals were seen at a single time, and we estimated that at least six individuals were residing around the Bridger Bowl Ski Area east of the observation point.

Prairie Falcon - A resident Prairie Falcon was seen on 27 October, and 1-2 November. This bird often harassed the far decoy owl, and also frequently escorted passing migrants.

Peregrine Falcon - At least one immature and one adult Peregrine Falcon were observed between 13 and 29 September. These falcons aggressively mobbed (sometimes for minutes at a time) the decoy owls, and also escorted passing migrants; they far exceeded all other raptors in their tenacity.

VISITATION

Throughout the 2013 season a total of 152 individuals signed the visitor sign-in log maintained at the observation platform. It is estimated that this accounts for only about 25% 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 stopped briefly at the observation platform. Regardless of their motivation for visiting the platform, most visitors were eager to learn about the migration spectacle. The 17th annual Bridger RaptorFest, held on the weekend of October 5 and 6, once again attracted an exceptional level of interest, with an estimated total of 3,500 attendees in 2013. Weather was fair both days, although unseasonably cold temperatures and deep, fresh snow prevailed throughout the weekend. Hence,a total of only 20 guests signed the visitor log during the weekend.

A total of 353 hourly assessments of visitor disturbance were recorded during the 2013 season. Of these, 94% were recorded as having no disturbance effect, 4% as low disturbance, and 2% moderate.

Several local newspaper articles (in the *Bozeman Chronicle, Mountain Outlaw Magazine* (Big Sky), and *Great Falls Tribune*) were written about the 2013 Bridger Hawk Watch Project. Interviewers visited the observation point on two separate occasions.

NON-DIURNAL RAPTORS AND OTHER WILDLIFE

The Bridger Mountains can be considered part of the Greater-Yellowstone Ecosystem, and as such, harbor a plethora of wildlife species. A Great Horned Owl was heard calling at night occasionally throughout the season, and it was seen at dusk on 11 October. A Saw-whet Owl was heard calling at dawn on the west side of the Bridger Ridge on 24 October. A Pileated Woodpecker was heard calling loudly on 10 October.

A group of three moose, including a mature bull, were regularly seen in a low-lying wetland in Bridger Canyon below and to the east of the observation point during the latter part of the field season, especially in late October. Mountain lion tracks, as well as a black bear with two cubs were observed on the morning hike to the Bridger Ridge on 1 October. Evidence of a weasel scavenging on a carcass near the observation point was noted on 25 October. Also observed in the vicinity were elk, mule and white-tailed deer, and coyotes.

Herds of mountain goats were commonly observed from the observation point throughout the season. During the last two weeks of September they were seen nearly every day. Most often they were in groups of 2 – 4, but a group of 11 goats was observed on 29 September. A nanny and kid were also seen a few times during the latter half of October. A mature billy twice walked within two meters of the observation point, mostly oblivious to the field team.

Other wildlife that grew accustomed to the field team's constant presence were Dusky Grouse, a red squirrel that made its home immediately west of the observation point, and a Mountain Chickadee that quite enjoyed being hand-fed (pumpkin & sunflower seeds) by several different observers on 26-27 October. Ravens were abundant on the Bridger Ridge, and perhaps the most dynamic and ever-present living component of the landscape; they mobbed the decoy owls, harassed (or cavorted with) passing migrant and resident raptors, and generally flew around playfully throughout the season.

Diurnal raptors were not the only birds that utilized the Bridger Ridge as a fall migration flyway in 2013. A variety of waterfowl were observed, including a group of seven Canada Geese on 11 September, approximately 20 Double-crested Cormorants on 2 October, a dozen unidentified waterfowl on 6 September, and Common Loons in groups of six and four, as well as single individuals on 25 October, 26

October, and 29 September, respectively. An unidentified gull was seen on 21 October. A unique and most surprising experience was flushing a resting American Coot from its grass bed high on the east side of the ridge while hiking down late in the evening on 21 October.

A diversity of migrating passerines and other birds was noted as well. An unusually large flight of White-throated Swifts was documented during the first half of September: eight on 3 September, 12 on 10 September, six on 11 September, a pair on 12 September, 10 on 13 September, five groups of approximately a dozen on 21 September, two groups of approximately a dozen on 22 September, and finally a pair on 7 October. A single flock of a dozen Barn Swallows was counted on 1 September. A variety of flocking finches, including Gray-crowned Rosy Finches, Pine Grosbeaks, Red Crossbills, and Pine Siskins were seen often during the latter half of the field season. Bohemian Waxwings migrated through in large flocks of 10 – 50 birds frequently during the last two weeks of the field season.

Migrating dragonflies were noted as well, although not counted. Estimates ranged from dozens to several hundred in a single day. They were flying quite strongly at the start of the field season, dwindling sharply by 22 September. The dragonflies were predominately blue or green in color, and were often preyed upon by migrant and resident American Kestrels.

RARE RAPTORS

A number of Harlan's Red-tailed Hawks and dark-morph Broad-winged Hawks, both relative rarities at Rocky Mountain hawk watches, were observed during the 2013 field season. Single dark-morph Broad-winged Hawks were counted on 12, 13, and 22 September, and 12 October. Individual Harlan's Hawks were counted on 7 September, and 8, 15, and 16 October.

WING-TAGGED GOLDEN EAGLES

Three migrating Golden Eagles were observed in 2013 displaying prominent wing tags: an unknown-aged individual on 16 October with blue tags on both wings, another unknown-aged eagle on 18 October with an orange tag on the left wing and blue/green tag on the right wing, and finally a subadult on 6 October with a white wing tag on at least the left wing. It is our understanding that the blue tags originated from the Raptor View Research Institute's project on Nora Ridge, MT (near Rogers Pass), under the guidance of Rob Domenech. The orange/green combination was likely a bird tagged by Dave Bittner's Wildlife Research Institute at Rogers Pass. Finally, the white-tagged bird likely originated from Craighead Beiringia South's research on breeding eagles in Park County, MT.

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Table 1. Fall counts by age class and immature:adult ratios for selected species of migrating raptors in the Bridger Mountains, MT: 1992–2012 versus 2013.

	Total and Age-classified Counts								Immature : Adult Ratio	
	1992–2012 Average			2013			% Unknown Age			
	Total	Imm.	Adult	Total	Imm.	Adult	1992–2012[1]	2013	1992–2012[1]	2013
Northern Harrier	51	24	12	34	17	10	32 ± 6.7	18	3.3 ± 2.80	1.7
Sharp-shinned Hawk	344	66	132	354	139	128	43 ± 5.5	25	0.5 ± 0.10	1.1
Cooper's Hawk	168	46	56	160	68	48	40 ± 4.6	28	0.9 ± 0.25	1.4
Northern Goshawk	32	12	12	16	9	6	27 ± 8.6	6	1.7 ± 0.51	1.5
Broad-winged Hawk	12	2	5	48	14	16	35 ± 15.5	38	0.8 ± 0.64	0.9
Red-tailed Hawk	119	36	54	180	40	111	24 ± 3.9	16	0.7 ± 0.28	0.4
Golden Eagle	1353	515	486	1131	387	501	26 ± 3.9	21	1.1 ± 0.17	0.8
Bald Eagle	76	27	47	74	22	50	3 ± 13.9	3	0.6 ± 0.12	0.4
Peregrine Falcon	11	1.3	5	29	2	17	51 ± 13.9	34	0.3 ± 0.27	0.1

[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 2. First and last observation, bulk passage, and median passage dates by species for migrating raptors in the Bridger Mountains, MT in 2013, with a comparison of 2013 and 1992–2012 average median passage dates.

	2013				1992–2012
Species	First Observed	Last Observed	Bulk Passage Dates[1]	Median Passage Date[2]	Mean Passage Date[3]
Turkey Vulture	1-Sep	1-Oct	–	–	–
Osprey	8-Sep	28-Sep	9-Sep – 22-Sep	13-Sep	17-Sep ± 2.7
Northern Harrier	2-Sep	27-Oct	5-Sep – 12-Oct	13-Sep	23-Sep ± 3.5
Sharp-shinned Hawk	1-Sep	2-Nov	6-Sep – 19-Oct	23-Sep	1-Oct ± 1.6
Cooper's Hawk	1-Sep	18-Oct	7-Sep – 7-Oct	21-Sep	24-Sep ± 2.6
Northern Goshawk	10-Sep	2-Nov	11-Sep – 27-Oct	12-Oct	8-Oct ± 5.2
Broad-winged Hawk	8-Sep	12-Oct	12-Sep – 28-Sep	15-Sep	20-Sep ± 1.8
Swainson's Hawk	8-Sep	7-Oct	–	–	15-Sep ± 4.0
Red-tailed Hawk	1-Sep	2-Nov	5-Sep – 9-Oct	21-Sep	22-Sep ± 1.9
Ferruginous Hawk	6-Sep	20-Sep	–	–	5-Oct ±
Rough-legged Hawk	5-Oct	2-Nov	12-Oct – 27-Oct	22-Oct	21-Oct ± 1.5
Golden Eagle	1-Sep	2-Nov	30-Sep – 22-Oct	16-Oct	13-Oct ± 1.7
Bald Eagle	1-Sep	2-Nov	14-Sep – 2-Nov	20-Oct	15-Oct ± 2.6
American Kestrel	2-Sep	21-Oct	5-Sep – 6-Oct	12-Sep	22-Sep ± 1.9
Merlin	6-Sep	2-Nov	11-Sep – 23-Oct	23-Sep	6-Oct ± 3.2
Prairie Falcon	4-Sep	27-Oct	4-Sep – 27-Oct	23-Sep	25-Sep ± 3.4
Peregrine Falcon	2-Sep	7-Oct	6-Sep – 29-Sep	17-Sep	25-Sep ± 2.1
All species	1-Sep	2-Nov	10-Sep – 21-Oct	–	7-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.

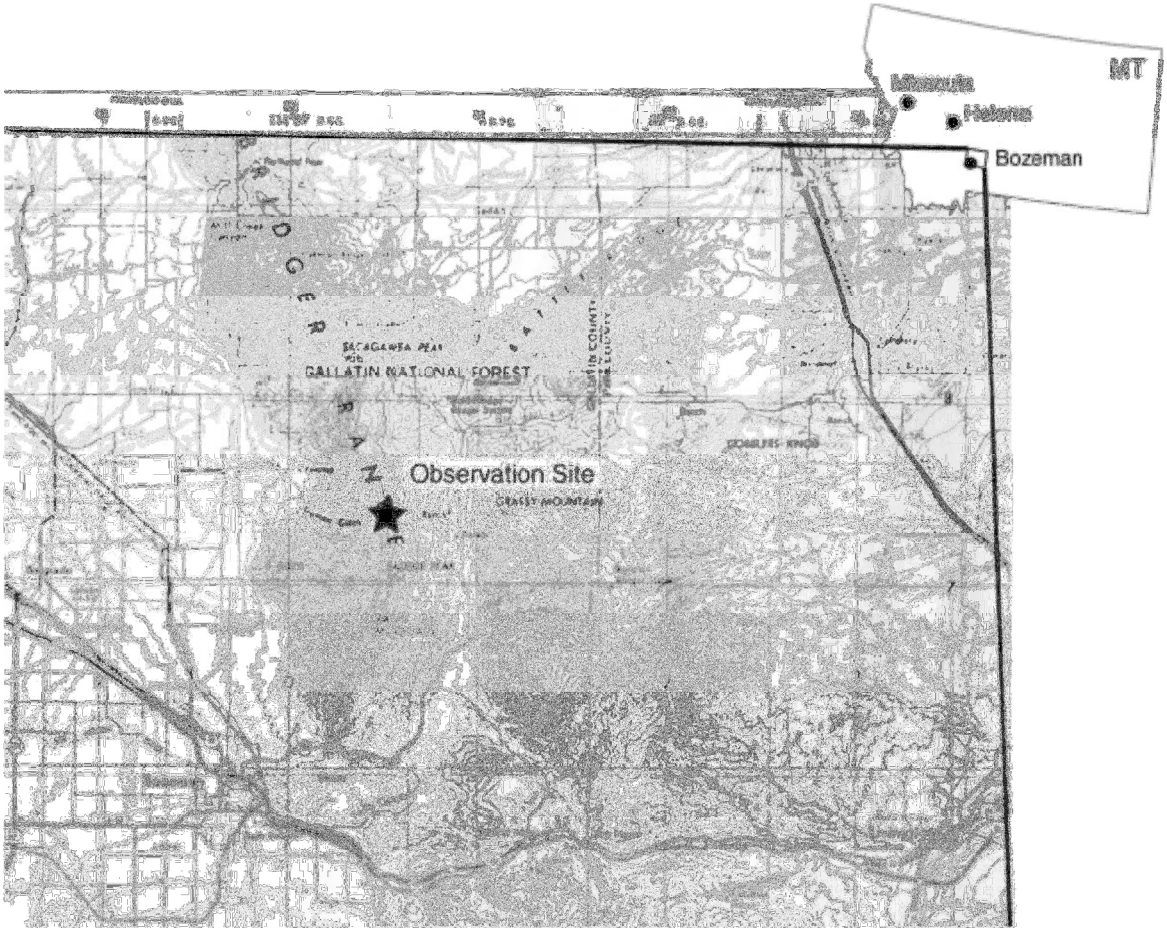

Figure 1. Location of the Bridger Mountains Raptor Migration Project study site.

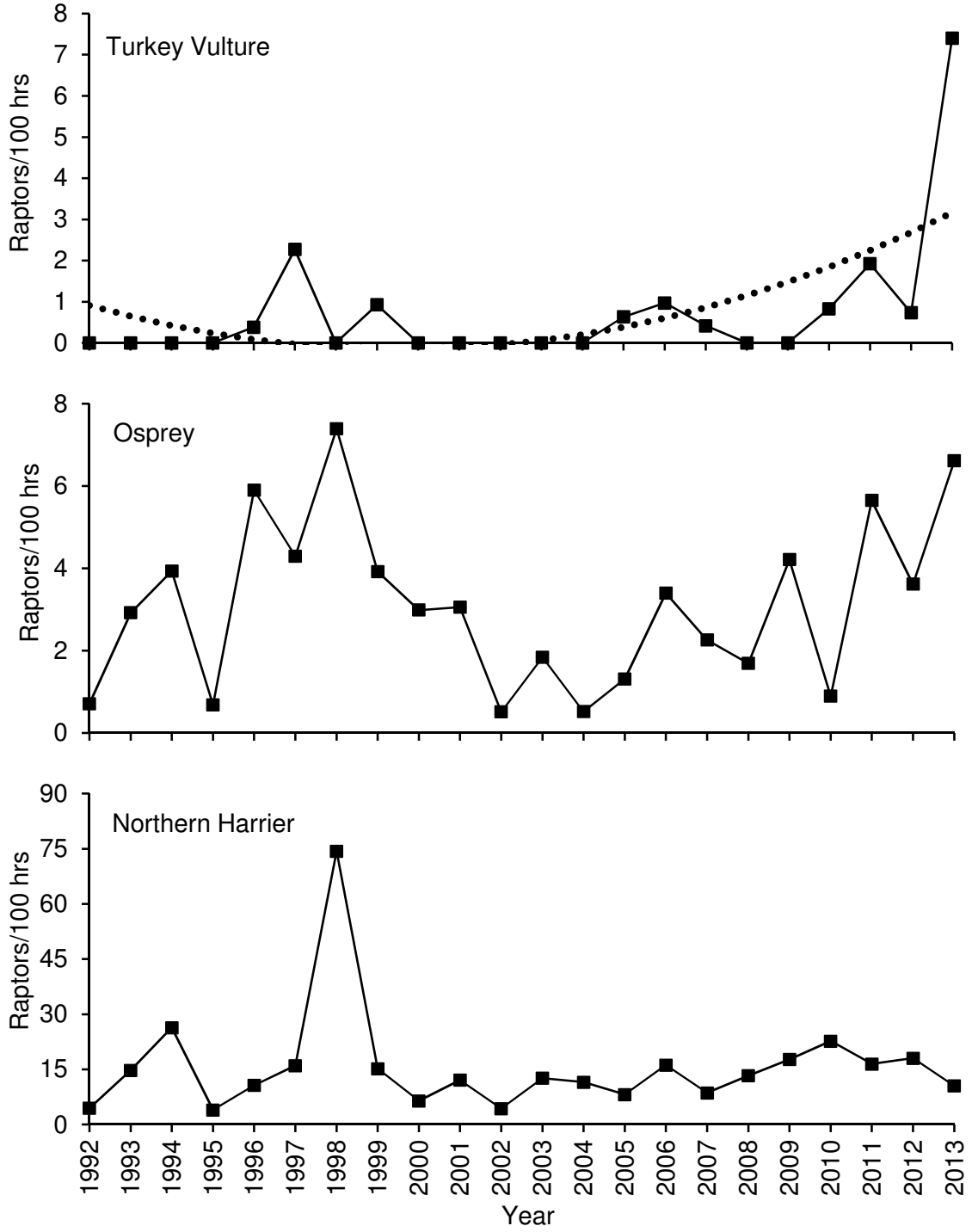

Figure 2. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall migration passage rates for Turkey Vultures, Ospreys, and Northern Harriers in the Bridger Mountains, MT: 1992–2013. Dashed lines indicate statistically significant ($P \leq 0.10$) quadratic regressions.

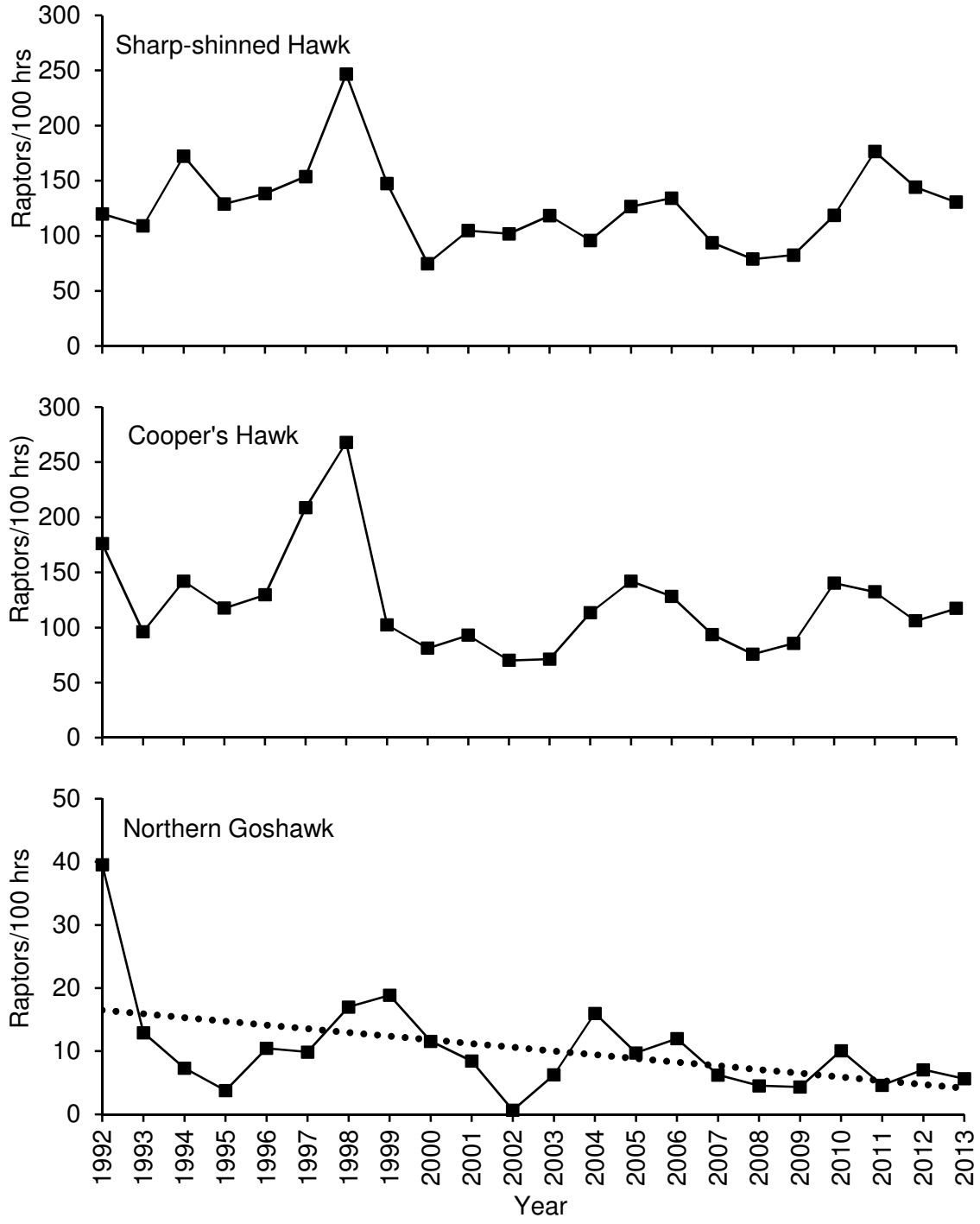

Figure 3. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall migration passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks in the Bridger Mountains, MT: 1992–2013. Dashed lines indicate statistically significant ($P \leq 0.10$) linear regressions.

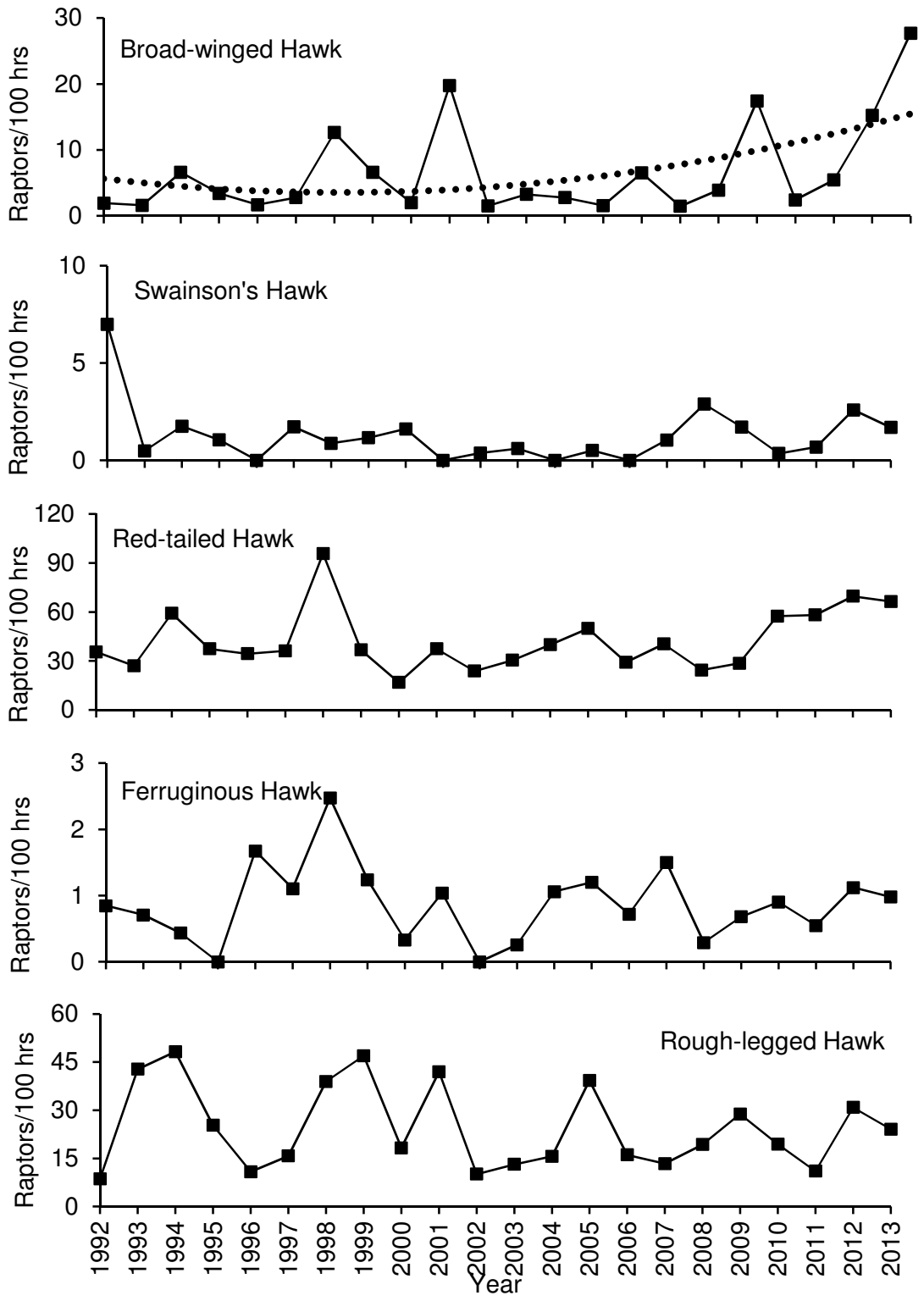

Figure 4. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Broad-winged, Swainson's, Red-tailed, Ferruginous and Rough-legged Hawks in the Bridger Mountains, MT: 1992–2013. Dashed lines indicate statistically significant ($P \leq 0.10$) quadratic regressions.

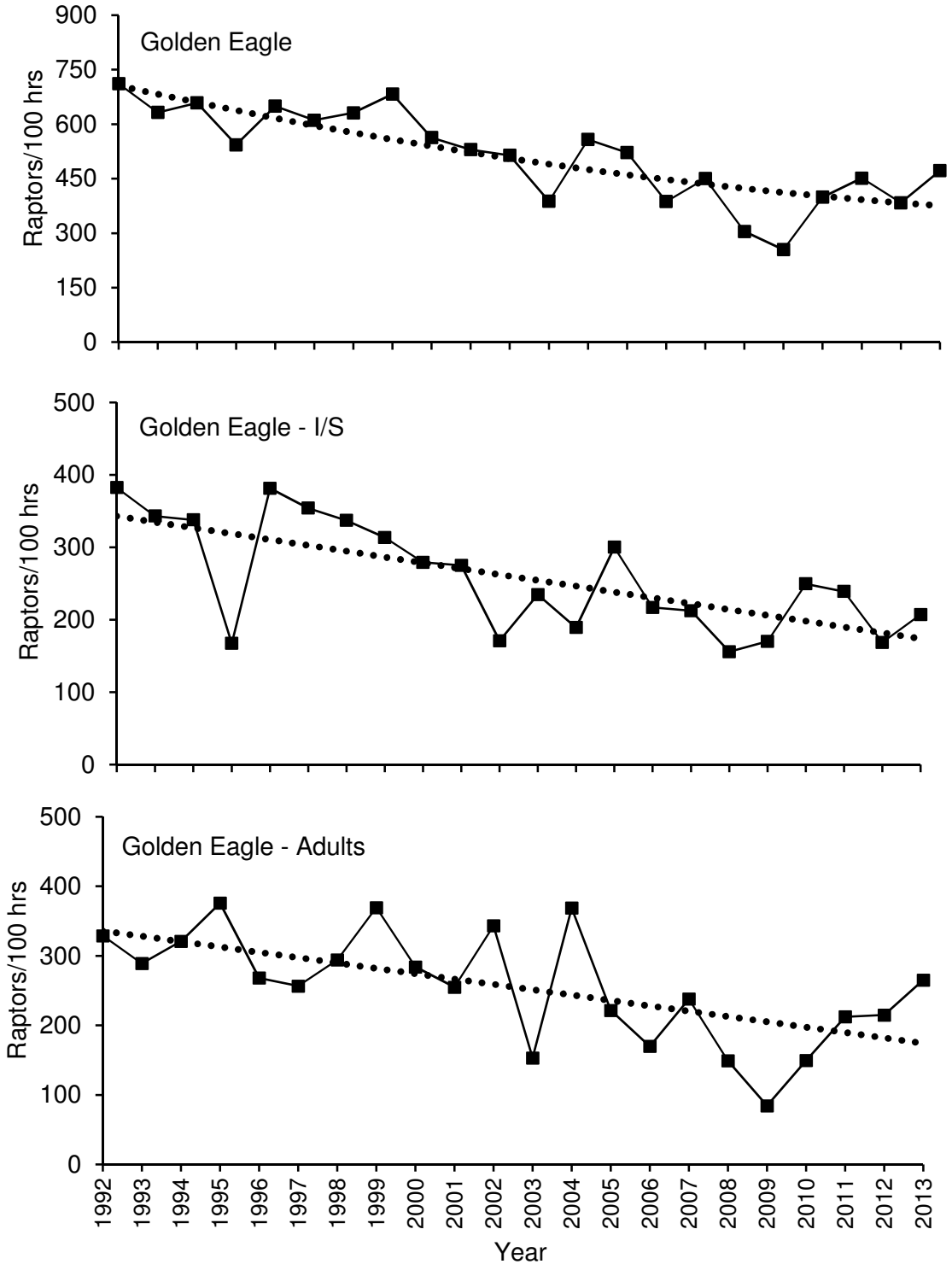

Figure 5. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Golden Eagles (separated by all birds, non-adults, and adults) in the Bridger Mountains, MT: 1992–2013. Dashed lines indicate statistically significant ($P \leq 0.10$) linear regressions.

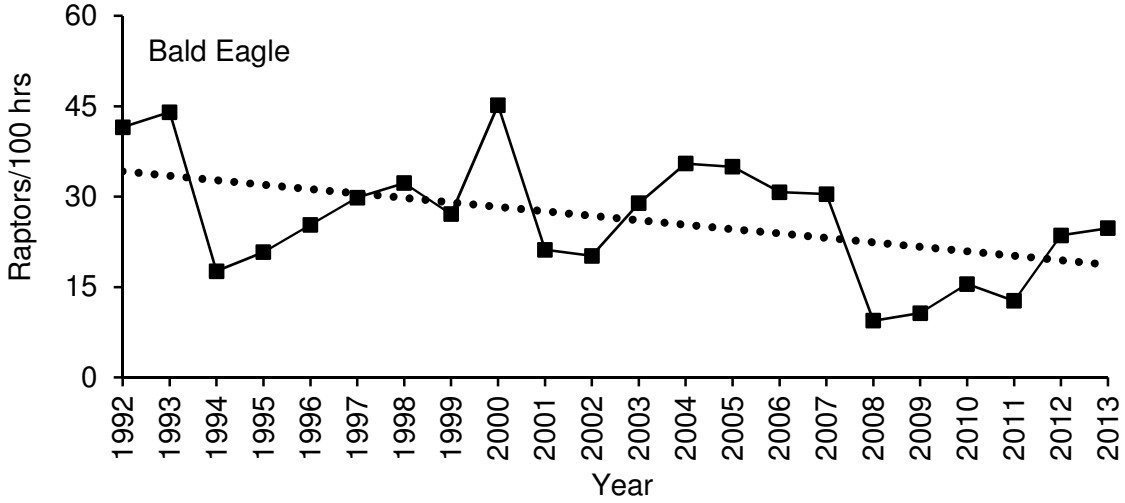

Figure 6. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Bald Eagles in the Bridger Mountains, MT: 1992–2013. Dashed lines indicate statistically significant ($P \leq 0.10$) linear regressions.

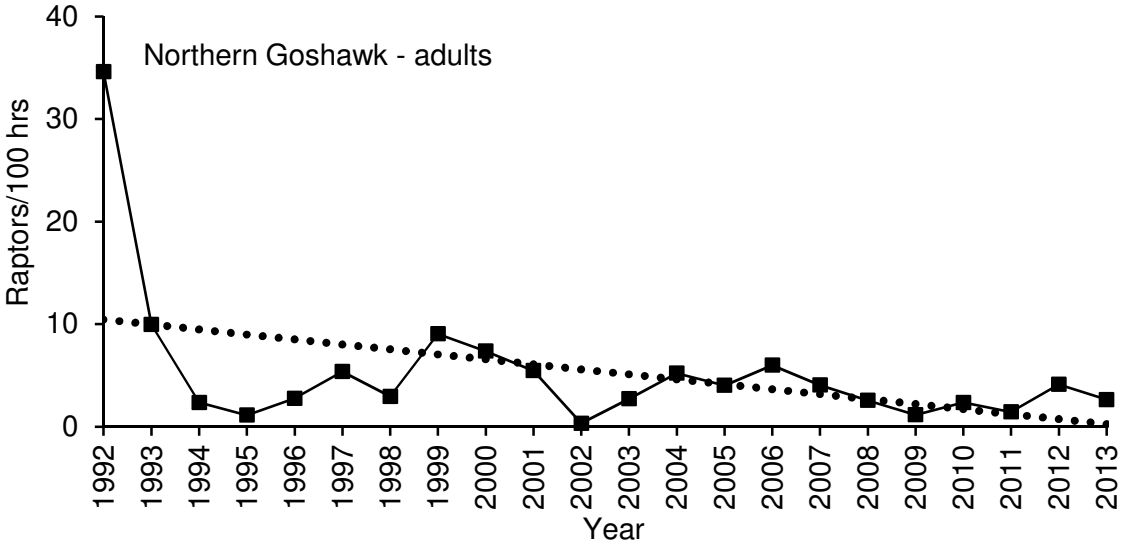

Figure 7. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for adult Northern Goshawks in the Bridger Mountains, MT: 1992–2013. Dashed lines indicate statistically significant ($P \leq 0.10$) linear regressions.

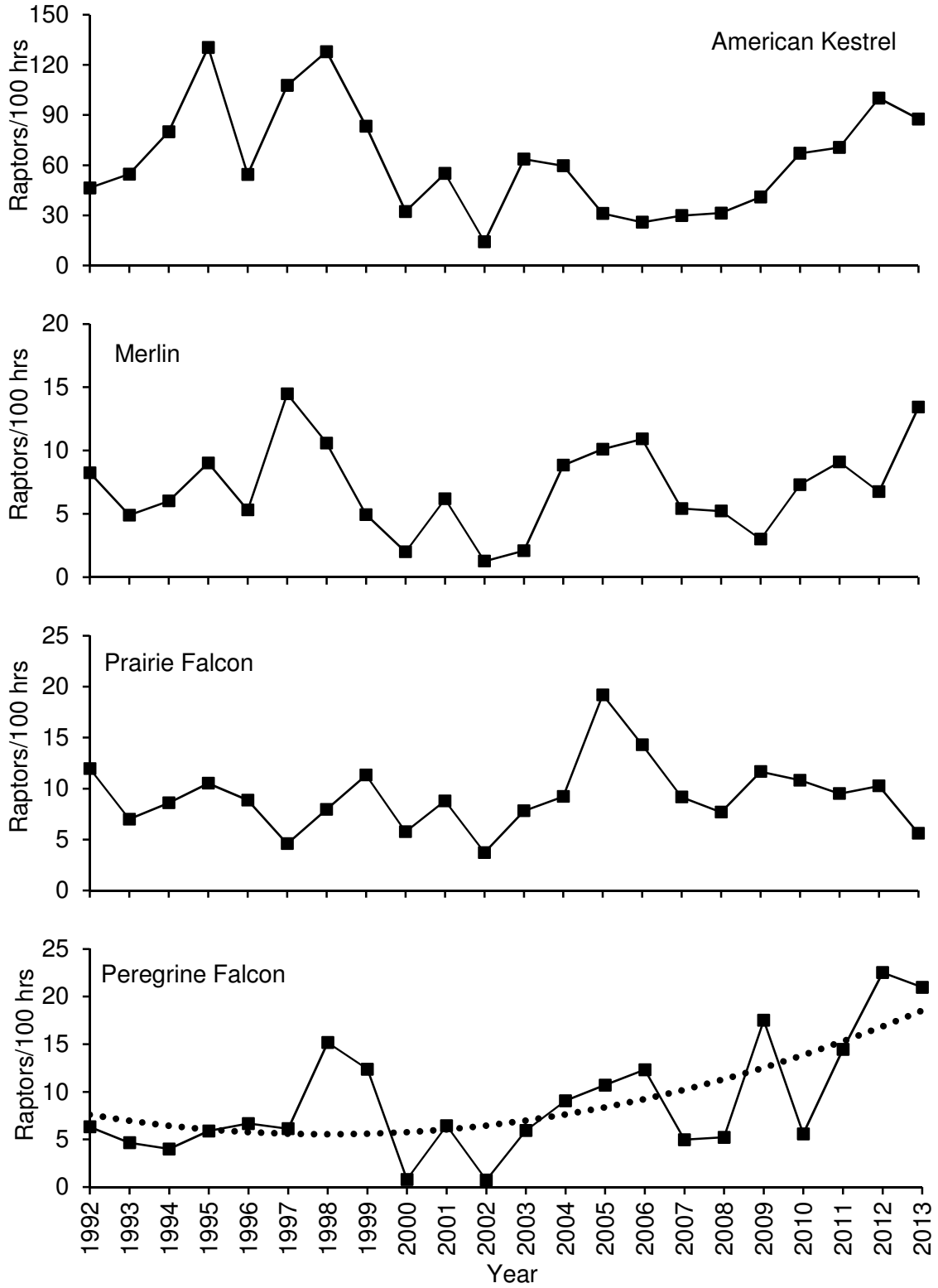

Figure 8. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons in the Bridger Mountains, MT: 1992–2013. Dashed lines indicate statistically significant (P ≤0.10) quadratic regressions.

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)
2013: Two observers throughout: Bret Davis (1), Kalon Baughan (1)

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: 2013.

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	8.00	2.0	0	clr-mc-clr, haze	2.9	w, var, wsw	19.1	30.29	3	40	45	2	2.4
2-Sep	7.75	2.4	0	ovc, haze	4.4	ese, e, wsw	22.1	30.24	4	22	21	1	1.5
3-Sep	8.00	2.0	0	clr-ovc, haze	4.6	wsw	17.2	30.32	3	15	22	2	3.5
4-Sep	8.00	2.0	0	mc-pc, haze	5.3	w, wsw	15.3	30.37	2	76	60	2	3.4
5-Sep	6.25	2.0	0	ovc-pc-clr, haze	8.4	var, wsw, w	16.1	30.32	4	70	65	2	4.0
6-Sep	8.00	2.0	0	clr-ovc, haze	6.2	var, ssw, var	17.9	30.29	2	66	76	2	4.0
7-Sep	6.25	2.0	0	ovc, rain-t-storms	2.6	variable	16.9	30.29	2	58	63	2	5.6
8-Sep	7.25	2.6	0	mc-ovc, haze, rain	6.1	wsw	14.0	30.18	3	51	59	3	7.0
9-Sep	8.00	2.0	0	ovc-mc-ovc-mc	8.6	wsw, sw	11.6	30.18	4	67	70	0	1.5
10-Sep	8.00	2.0	0	clr, haze	4.3	se, w	11.4	30.29	2	69	69	3	8.1
11-Sep	8.00	2.0	0	clr, haze	18.2	se, s	13.6	30.38	4	84	75	1	11.5
12-Sep	8.00	2.0	0	mc-ovc, haze	13.6	e	13.1	30.34	4	78	71	1	3.9
13-Sep	8.00	2.0	0	clr-ovc	5.7	wsw, var	14.7	30.14	4	88	91	2	4.3
14-Sep	4.92	1.6	0	ovc, haze	12.2	sse, var, ese	14.2	30.21	4	49	28	2	8.7
15-Sep	2.75	2.0	2	mc	14.8	variable	13.8	30.22	3	40	70	0	0.7
16-Sep	6.00	2.1	0	clr-ovc	3.5	w	13.0	30.16	3	62	57	2	5.8
17-Sep	0.00	0.0		weather day: snow/fog									
18-Sep	0.00	0.0		weather day: snow/fog									
19-Sep	6.50	2.0	0	mc-clr, fog in A.M.	7.8	w	5.0	30.21	3	70	70	1	4.9
20-Sep	8.00	1.9	0	clr	1.6	var, e	7.4	30.12	1	70	70	1	6.0
21-Sep	8.00	2.5	1.5	pc-mc, haze	7.1	ssw, w, sw	14.1	29.95	3	69	68	3	10.5
22-Sep	7.75	2.0	0	pc-mc-ovc-pc, haze	7.9	var, w	11.2	29.85	3	49	52	2	10.2
23-Sep	5.00	2.5	1	mc-pc	11.3	w, wsw	8.9	30.01	4	100	100	3	5.2
24-Sep	2.00	2.0	0	ovc	8.7	ssw	7.3	30.00	4	100	87	1	0.5
25-Sep	0.00	0.0		weather day: snow									
26-Sep	0.00	0.0		weather day: snow									
27-Sep	2.58	1.5	0	ovc, fog	12.5	w	2.3	29.95	4	100	100	1	2.7
28-Sep	7.00	2.0	0	ovc, fog	13.2	sw, s, sw	2.7	29.99	4	100	100	2	3.3
29-Sep	3.50	2.0	0	ovc	14.3	variable	4.5	29.81	4	100	74	2	2.6
30-Sep	1.50	1.0	0	ovc	6.5	w	-1.0	29.85	4	100	100	2	4.0
1-Oct	8.17	1.7	0	clr-mc-ovc	5.5	sw	4.4	30.00	3	100	100	2	4.5
2-Oct	7.50	3.0	0	ovc, fog	3.1	w, e	3.8	30.05	4	13	13	1	4.4
3-Oct	0.00	0.0		weather day: snow									
4-Oct	0.00	0.0		weather day: snow									

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	8.00	2.0	0	pc-mc	11.0	w	0.4	30.26	4	100	100	1	13.9
6-Oct	8.00	2.6	0	clr-pc	6.6	wsw, w	4.8	30.26	4	100	100	2	12.1
7-Oct	8.00	2.0	0	mc-clr-mc-ovc	6.4	w, ssw, wsw, w	6.0	30.00	3	100	100	2	25.8
8-Oct	4.33	2.0	0	mc-ovc, fog, snow	6.0	w	2.2	29.88	4	72	62	2	12.2
9-Oct	7.17	2.4	0	pc-mc	11.4	e	0.9	29.99	4	100	100	1	3.2
10-Oct	6.00	2.0	0	ovc, fog	2.4	w	6.0	29.86	4	85	85	1	1.2
11-Oct	7.00	1.9	0	ovc-mc-clr, fog, snow	5.6	w	1.7	29.99	4	91	86	2	2.4
12-Oct	7.00	3.6	0	ovc, fog, snow	2.2	se, ese	3.7	30.03	4	49	59	2	13.6
13-Oct	0.00	0.0		weather day: snow									
14-Oct	0.00	0.0		weather day: snow									
15-Oct	5.00	2.0	0	clr, fog	9.8	w	-2.1	30.16	4	67	29	2	18.6
16-Oct	7.67	2.0	0	mc-ovc, fog, snow	5.1	wsw, w	0.8	30.06	4	79	83	2	16.6
17-Oct	0.00	0.0		weather day: snow/fog									
18-Oct	6.92	1.8	0	mc-clr	9.1	wsw, w	-2.7	30.11	3	100	66	2	19.4
19-Oct	7.25	2.0	0	pc-ovc	9.6	w	1.5	30.04	4	82	86	3	15.0
20-Oct	4.42	2.0	0	ovc	3.5	w	1.5	30.10	4	58	43	2	2.7
21-Oct	8.00	2.0	0	ovc-pc-clr	7.5	w	1.7	30.17	3	67	73	2	6.5
22-Oct	8.00	1.8	0	clr	8.1	w	5.0	30.20	3	100	100	2	7.9
23-Oct	7.25	1.8	0	clr	4.7	w	4.7	30.23	3	100	100	2	4.3
24-Oct	7.50	2.3	0	clr, haze in P.M.	3.1	sw, w	5.8	30.23	2	68	66	2	3.9
25-Oct	7.83	2.0	0	clr, haze	8.4	w, var	2.0	30.28	2	64	55	1	2.2
26-Oct	8.00	1.8	0	clr	13.7	w	3.3	30.27	3	82	87	1	2.3
27-Oct	7.83	2.0	0	pc-ovc	9.2	w, e	3.0	29.95	2	80	70	1	4.0
28-Oct	0.00	0.0		weather day: snow									
29-Oct	0.00	0.0		weather day: snow									
30-Oct	0.00	0.0		weather day: snow									
31-Oct	0.00	0.0		weather day: snow									
1-Nov	6.00	1.6	0	ovc-pc	8.9	w	-1.3	30.10	4	78	55	2	2.5
2-Nov	7.92	2.3	0	ovc	11.4	wsw, w, wsw	2.6	29.81	4	87	77	2	5.9
3-Nov	0.00	0.0		weather day: snow									
4-Nov	0.00	0.0		weather day: snow									
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: 2013.

		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	8.00	5	0	0	4	3	0	1	0	0	0	0	2	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	19	2.4
2-Sep	7.75	1	0	2	1	3	0	0	0	0	0	0	2	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	12	1.5
3-Sep	8.00	3	0	0	5	6	0	0	1	0	0	0	5	0	0	0	6	0	0	1	0	0	1	0	0	0	0	0	28	3.5
4-Sep	8.00	0	0	1	6	0	0	0	0	0	0	0	9	0	0	0	3	0	0	6	0	1	0	0	0	1	0	0	27	3.4
5-Sep	6.25	0	0	2	11	1	0	0	0	0	0	0	5	0	0	0	1	0	0	4	0	0	1	0	0	0	0	0	25	4.0
6-Sep	8.00	1	0	0	10	2	0	1	0	0	0	0	7	1	0	0	2	0	0	5	1	0	1	0	0	0	0	1	32	4.0
7-Sep	6.25	1	0	3	2	6	0	0	0	0	0	0	14	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	35	5.6
8-Sep	7.25	0	1	2	14	6	0	0	0	0	3	1	11	0	0	0	7	1	0	5	0	0	0	0	0	0	0	0	51	7.0
9-Sep	8.00	0	1	0	4	2	0	0	0	0	0	0	1	1	0	0	1	2	0	0	0	0	0	0	0	0	0	0	12	1.5
10-Sep	8.00	1	2	4	21	6	1	1	0	0	0	0	9	0	0	3	4	0	0	7	1	0	3	0	0	0	0	2	65	8.1
11-Sep	8.00	0	1	3	33	5	1	0	0	0	1	1	7	0	0	0	6	1	0	27	2	0	0	0	1	1	0	2	92	11.5
12-Sep	8.00	0	3	2	2	1	0	0	0	0	3	1	5	0	0	0	3	3	0	4	1	0	3	0	0	0	0	0	31	3.9
13-Sep	8.00	0	0	1	3	5	1	0	0	0	12	0	3	0	0	0	2	0	0	0	0	0	1	0	0	0	0	6	34	4.3
14-Sep	4.92	0	0	3	3	8	1	0	0	1	9	0	4	0	0	0	6	1	0	4	0	2	0	0	0	0	0	1	43	8.7
15-Sep	2.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0.7
16-Sep	6.00	0	0	0	8	10	1	0	0	0	3	0	6	0	0	0	1	1	0	1	1	0	2	0	0	0	0	1	35	5.8
17-Sep	0.00																													
18-Sep	0.00																													
19-Sep	6.50	0	0	0	8	10	0	2	0	1	1	0	1	0	0	2	4	1	0	1	0	0	0	0	0	0	0	1	32	4.9
20-Sep	8.00	0	2	0	9	9	1	0	0	0	1	0	7	1	0	0	6	2	0	2	1	0	5	0	0	0	0	2	48	6.0
21-Sep	8.00	0	1	0	23	15	0	1	0	0	4	0	11	0	0	0	16	3	0	5	3	0	0	0	0	0	0	2	84	10.5
22-Sep	7.75	1	1	0	19	14	0	3	0	1	5	0	4	0	0	4	5	2	0	9	2	2	4	0	0	0	0	3	79	10.2
23-Sep	5.00	2	0	0	5	6	0	1	0	0	0	0	6	0	0	0	4	0	0	0	1	1	0	0	0	0	0	0	26	5.2
24-Sep	2.00	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.5
25-Sep	0.00																													
26-Sep	0.00																													
27-Sep	2.58	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	7	2.7
28-Sep	7.00	0	1	0	3	2	0	0	0	0	3	0	4	0	0	0	7	0	0	0	0	0	2	0	0	0	0	1	23	3.3
29-Sep	3.50	0	0	0	0	3	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	9	2.6
30-Sep	1.50	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4	0	0	0	0	0	0	0	0	0	0	1	6	4.0

Appendix D. (continued)

Date	Hours	Species[1]																										Total	Birds / hour
		TV	OS	NH	SS	CH	NG	SA	LA	UA	BW	SW	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	GY	SF	LF	UF	UU		
1-Oct	8.17	1	0	0	6	2	0	0	0	0	0	0	7	0	0	0	18	1	1	1	0	0	0	0	0	0	0	0	37	4.5
2-Oct	7.50	0	0	0	3	2	0	1	0	0	0	0	2	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	33	4.4
3-Oct	0.00																													
4-Oct	0.00																													
5-Oct	8.00	0	0	1	12	7	0	1	0	0	1	0	4	0	2	1	82	0	0	0	0	0	0	0	0	0	0	0	111	13.9
6-Oct	8.00	0	0	0	20	9	0	1	0	0	0	0	6	0	0	0	55	1	0	4	0	0	0	0	0	0	0	1	97	12.1
7-Oct	8.00	0	0	1	34	7	1	9	0	0	0	1	7	0	0	1	140	0	0	3	0	0	1	0	0	0	0	1	206	25.8
8-Oct	4.33	0	0	0	6	5	0	1	0	0	0	0	5	0	0	0	35	0	0	1	0	0	0	0	0	0	0	0	53	12.2
9-Oct	7.17	0	0	1	2	0	0	0	0	0	0	0	3	0	0	0	13	1	0	2	1	0	0	0	0	0	0	0	23	3.2
10-Oct	6.00	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	2	2	0	1	0	0	0	0	0	0	0	0	7	1.2
11-Oct	7.00	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	11	3	0	0	0	0	0	0	0	0	0	1	17	2.4
12-Oct	7.00	0	0	4	8	2	0	0	0	0	2	0	1	0	4	0	66	5	1	0	2	0	0	0	0	0	0	0	95	13.6
13-Oct	0.00																													
14-Oct	0.00																													
15-Oct	5.00	0	0	0	4	0	0	0	0	0	0	0	1	0	0	1	86	1	0	0	0	0	0	0	0	0	0	0	91	18.2
16-Oct	7.67	0	0	0	4	0	1	0	1	1	0	0	2	0	3	2	113	0	0	0	0	0	0	0	0	0	0	0	127	16.6
17-Oct	0.00																													
18-Oct	6.92	0	0	1	14	3	0	0	0	0	0	0	0	0	3	1	106	4	1	0	1	0	0	0	0	0	0	0	134	19.4
19-Oct	7.25	0	0	1	9	0	1	1	0	0	0	0	1	0	1	0	90	5	0	0	0	0	0	0	0	0	0	0	109	15.0
20-Oct	4.42	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	8	2	0	0	0	0	0	0	0	0	0	0	12	2.7
21-Oct	8.00	0	0	0	7	0	0	1	0	0	0	0	4	0	6	0	29	3	0	1	1	0	0	0	0	0	0	0	52	6.5
22-Oct	8.00	0	0	0	8	0	1	3	0	1	0	0	4	0	2	1	40	2	0	0	0	1	0	0	0	0	0	0	63	7.9
23-Oct	7.25	0	0	0	7	0	1	0	0	0	0	0	0	0	3	0	13	5	0	0	1	0	0	0	0	0	0	1	31	4.3
24-Oct	7.50	0	0	0	9	0	1	0	0	0	0	0	0	0	0	0	17	1	0	0	0	0	0	0	0	0	0	1	29	3.9
25-Oct	7.83	0	0	0	2	0	0	0	0	0	0	0	3	0	4	0	5	2	0	0	1	0	0	0	0	0	0	0	17	2.2
26-Oct	8.00	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	15	2	0	0	0	0	0	0	0	0	0	0	18	2.3
27-Oct	7.83	0	0	1	0	0	1	0	0	0	0	0	0	0	3	0	19	6	0	0	0	1	0	0	0	0	0	0	31	4.0
28-Oct	0.00																													
29-Oct	0.00																													
30-Oct	0.00																													
31-Oct	0.00																													
1-Nov	6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	14	0	0	0	0	0	0	0	0	0	0	0	15	2.5
2-Nov	7.92	0	0	0	1	0	1	0	0	0	0	0	1	0	1	0	32	10	0	0	1	0	0	0	0	0	0	0	47	5.9
3-Nov	0.00																													
4-Nov	0.00																													
5-Nov	0.00																													
Total	335.76	16	13	34	354	160	16	28	2	5	48	4	180	3	34	17	1131	74	3	104	21	8	29	0	1	2	0	28	2313	

[1] See Appendix A for species codes.

Appendix E. Annual observation effort and fall raptor migration counts by species in the Bridger Mountains, MT: 1991–2013.

	1991	1992	1993	1994	1995	1996	1997	1998
Start date	15-Sep	6-Sep	9-Sep	13-Sep	10-Sep	1-Sep	27-Aug	28-Aug
End date	3-Nov	28-Oct	31-Oct	30-Oct	2-Nov	30-Oct	31-Oct	31-Oct
Observation days	32	39	46	36	42	53	62	56
Observation hours	191.1	242.58	298.50	239.25	269.17	378.25	422.92	339.33
Raptors / 100 hours	926.7	1000.1	871.7	1027.8	824.0	808.5	796.1	1040.9
SPECIES	RAPTOR COUNTS							
Turkey Vulture	3	0	0	0	0	1	6	0
Osprey	2	2	5	5	1	14	12	13
Northern Harrier	19	13	41	59	10	38	66	230
Sharp-shinned Hawk	88	248	279	364	304	436	480	612
Cooper's Hawk	87	175	124	134	131	206	347	343
Northern Goshawk	27	96	39	17	10	37	36	50
Unknown small accipiter[1]	-	-	-	-	-	-	-	-
Unknown large accipiter[1]	-	-	-	-	-	-	-	-
Unknown accipiter	70	35	27	20	33	51	53	49
Total accipiters	272	554	469	535	478	730	916	1054
Broad-winged Hawk	0	2	3	16	5	5	5	20
Swainson's Hawk	1	11	0	3	2	0	6	2
Red-tailed Hawk	26	67	65	110	79	106	130	277
Ferruginous Hawk	3	1	1	1	0	5	4	7
Rough-legged Hawk	9	10	53	48	29	17	23	66
Unidentified buteo	14	8	19	15	18	13	20	13
Total buteos	53	99	141	193	133	146	188	385
Golden Eagle	1280	1579	1699	1500	1322	1871	1844	1516
Bald Eagle	43	95	124	41	57	79	93	95
Unidentified eagle	5	2	17	0	25	14	0	15
Total eagles	1328	1676	1840	1541	1404	1964	1937	1626
American Kestrel	33	38	54	67	117	82	146	141
Merlin	2	10	7	7	12	9	26	17
Prairie Falcon	9	14	10	11	14	16	10	12
Peregrine Falcon	1	7	6	4	7	10	10	18
Gyrfalcon	0	0	0	0	0	0	0	0
Unknown small falcon[1]	-	-	-	-	-	-	-	-
Unknown large falcon[1]	-	-	-	-	-	-	-	-
Unknown falcon	5	3	2	4	2	5	17	8
Total falcons	50	72	79	93	152	122	209	196
Unidentified raptor	44	10	27	33	40	43	33	28
Grand Total	1771	2426	2602	2459	2218	3058	3367	3532

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

Appendix E. (continued)

	1999	2000	2001	2002	2003	2004	2005	2006
Start date	29-Aug	29-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug
End date	31-Oct	29-Oct	31-Oct	27-Oct	31-Oct	27-Oct	31-Oct	29-Oct
Observation days	57	52	58	52	64	48	48	45
Observation hours	358.24	335.40	347.49	365.84	443.18	316.70	300.83	331.25
Raptors / 100 hours	871.8	630.9	636.3	556.0	517.6	655.2	674.8	538.3
SPECIES	RAPTOR COUNTS							
Turkey Vulture	2	0	0	0	0	0	1	2
Osprey	9	6	6	2	5	1	2	7
Northern Harrier	52	20	36	15	54	39	22	50
Sharp-shinned Hawk	442	190	274	288	416	229	228	344
Cooper's Hawk	149	109	120	103	132	142	153	182
Northern Goshawk	61	34	26	2	23	41	22	33
Unknown small accipiter[1]	-	-	0	11	29	32	92	10
Unknown large accipiter[1]	-	-	0	4	4	9	4	0
Unknown accipiter	39	35	27	5	0	7	27	0
Total accipiters	691	368	447	413	604	460	526	569
Broad-winged Hawk	13	3	38	3	9	6	3	12
Swainson's Hawk	3	3	0	1	2	0	0	0
Red-tailed Hawk	121	45	117	78	113	100	108	89
Ferruginous Hawk	4	1	3	0	1	3	2	3
Rough-legged Hawk	77	26	57	11	22	20	40	21
Unidentified buteo	3	8	6	9	6	18	27	2
Total buteos	221	86	221	102	153	147	180	127
Golden Eagle	1870	1429	1330	1359	1226	1196	1061	859
Bald Eagle	91	128	58	55	93	79	75	74
Unidentified eagle	5	3	2	15	4	2	1	1
Total eagles	1966	1560	1390	1429	1323	1277	1137	934
American Kestrel	113	39	62	16	102	65	20	38
Merlin	8	3	9	2	4	11	7	15
Prairie Falcon	20	9	14	6	15	12	20	22
Peregrine Falcon	18	1	8	1	10	10	8	15
Gyrfalcon	1	0	0	0	0	0	0	0
Unknown small falcon[1]	-	-	0	0	0	3	27	0
Unknown large falcon[1]	-	-	0	1	3	3	13	1
Unknown falcon	6	4	3	4	1	9	13	0
Total falcons	166	56	96	30	135	113	108	91
Unidentified raptor	16	20	15	43	20	38	54	3
Grand Total	3123	2116	2211	2034	2294	2075	2030	1783

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

Appendix E. (continued)

	2007	2008	2009	2010	2011	2012	2013	Mean
Start date	27-Aug	27-Aug	6-Sep	28-Aug	2-Sep	1-Sep	1-Sep	31-Aug
End date	29-Oct	31-Oct	31-Oct	1-Nov	4-Nov	5-Nov	5-Nov	30-Oct
Observation days	56	56	44	54	57	58	50	51
Observation hours	384.59	415.49	306.25	366.00	411.42	414.38	335.76	339.92
Raptors / 100 hours	550.5	427.7	453.2	641.8	695.9	680.0	688.9	719.3
SPECIES	RAPTOR COUNTS							
Turkey Vulture	1	0	0	2	5	2	16	1
Osprey	5	4	9	3	14	9	13	6
Northern Harrier	30	47	52	77	59	64	34	50
Sharp-shinned Hawk	277	222	230	336	565	452	354	332
Cooper's Hawk	151	115	113	207	221	180	160	165
Northern Goshawk	20	22	13	33	15	33	16	31
Unknown small accipiter[1]	18	43	6	40	22	40	28	29
Unknown large accipiter[1]	6	10	6	22	3	6	2	6
Unknown accipiter	5	3	7	25	12	12	5	25
Total accipiters	477	415	375	663	838	723	565	572
Broad-winged Hawk	5	7	33	5	12	37	48	11
Swainson's Hawk	3	8	4	1	2	8	4	3
Red-tailed Hawk	130	75	75	178	202	238	180	115
Ferruginous Hawk	5	1	2	3	2	4	3	3
Rough-legged Hawk	19	32	30	31	28	42	34	32
Unidentified buteo	11	10	10	20	4	12	17	12
Total buteos	173	133	154	238	250	341	286	176
Golden Eagle	1247	1003	638	1171	1431	1272	1131	1350
Bald Eagle	85	43	27	50	68	92	74	75
Unidentified eagle	0	10	4	1	0	12	3	6
Total eagles	1332	1056	669	1222	1499	1376	1208	1431
American Kestrel	41	46	45	87	99	147	104	73
Merlin	9	10	4	12	17	16	21	10
Prairie Falcon	17	13	17	18	19	16	8	14
Peregrine Falcon	8	5	23	8	24	34	29	11
Gyrfalcon	0	0	0	0	0	0	0	0
Unknown small falcon[1]	2	2	3	3	0	3	1	4
Unknown large falcon[1]	3	6	3	2	0	8	2	4
Unknown falcon	2	2	4	0	2	2	0	4
Total falcons	82	84	99	130	161	226	165	116
Unidentified raptor	17	38	30	14	37	77	28	31
Grand Total	2117	1777	1388	2349	2863	2818	2315	2382

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