FALL 2014 RAPTOR MIGRATION STUDY IN THE BRIDGER MOUNTAINS, MONTANA

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

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Report prepared by:
Bret Davis, Mikaela Howie, David Oleyar & Steve Hoffman

Counts conducted by:
Bret Davis & Mikaela Howie

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

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

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 1991, with standardized, full-season 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 (Appendix A ptrovides scientific names of all raptor species observed at this 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 count results of the 2014 season, which marked the 23rd consecutive full-season autumn count of migratory raptors at the site.

The Bridger Mountains Project was one of seven long-term, annual fall migration counts conducted or co-sponsored by HWI in North America during 2014. 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 population 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 predictable lift, attracting 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 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 m x 5 m concrete platform located approximately 50 m north of an avalanche cache/ski patrol hut. The site is accessed by walking along a primitive dirt road for 2.5 km (780 m rise in elevation) to the top of the Bridger chairlift, then continuing westward a few hundred meters along a 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 2014 observations began 1 September and continued through 8 November 2014. This was extended beyond the typical last observation day of 5 November due to a strong flight of Golden Eagles (approximately 200) recorded at Mount Lorette on 2-3 November, as well as unusually prolonged dry, warm weather for this time of year. Observations typically began at 0900 H and ended at 1700 H Mountain Standard Time (MST). Both observers received on-site training with Montana Audubon Executive Director, Steve Hoffman. Local enthusiasts (and expert observers) Matt Keefer and Ben Rosemeyer, as well as long-time volunteer John Parker periodically assisted with the counts. In addition, other local enthusiasts, especially from the local Sacajawea Audubon Chapter, joined the count sporadically (Paulette Epple, Martha Collins, Steve Crouch and others).

Throughout the 2013 and 2014 migration seasons 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 prominent peak to the north (Tilly Peak; approximately 600 m from the observation point). In previous years (1992-2012) only a single, nearby owl was used. The near owl was outfitted with a freely rotating head, which may have contributed to the great success in luring passing raptors. Unfortunately, the far owl was vandalized and destroyed on 13 October. On some days the observers made an effort to be less conspicuous by keeping a low profile and piling brush behind them (to the south) to break up their outlines as viewed by oncoming raptors. We found this method to be fruitful, especially in getting closer looks at the migrating birds.

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 for each hour of observation on the half hour.

4. Predominant direction, altitude, and horizontal distance from the lookout of the migratory flight during each hour.

5. Total minutes observed and the mean number of observers present during each hour (included designated observers plus volunteers/visitors who contributed substantially to the count [actively scanning, pointing out birds, recording data, etc.] for more than 10 minutes in a given hour).

6. A subjective visitor-disturbance rating (high, moderate, low, none) for each hour.

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

Calculation of "adjusted" (to standardize sampling periods and adjusted for incompletely identified birds) passage rates (migrants counted per 100 hours of observation) and analysis of trends, updated through 2014, follows Hoffman and Smith (2003). In comparing 2014 annual statistics against means and 95% confidence intervals for previous seasons, we determined significance when a 2014 value fell outside the 95% confidence interval of the associated mean.

RESULTS AND DISCUSSION

WEATHER SUMMARY:

Inclement weather and/or attendant difficult access fully precluded 11 days of observation during the 2014 season. No count was conducted on 7 November, despite excellent weather conditions for migration. Large, low-lying stratus clouds often settled over the Bridger Mountains (for hours or days at a time), during persistent storms. In addition, inclement weather was a factor in reducing total daily

observation hours to less than four on three additional days (see Appendix C for 2014 daily weather records).

Overall, 2014 was unusually warm and dry season. A single wildfire was noted in the Elkhorn Mountains from 7-10 October, creating noticeable haze in the Gallatin Valley. The fall colors (displayed prominently by the aspens and cottonwoods) were exceptional this year, reaching their peak from 9-15 October. Inversions were common on the ridge, and some mornings the Bridger Ridge would be above a thick layer of clouds that often filled the Bridger Canyon to the east.

OBSERVATION EFFORT:

Observations were conducted on 57 of 69 days between 1 September and 8 November, 2014. The number of observation days was 10% above the 1992-2013 average of 52 ± 3.1 days, and the total number of observation hours (399.7) was well above the 95% confidence interval of the long-term mean of 346 ± 24 hours. This can be attributed, in part, to two additional late-season days of observation, on 6 and 8 November, contributing 10.25 additional hours. The 2014 average of 2.2 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 1992-2013 average of 1.9.

FLIGHT SUMMARY:

The observers tallied 2,879 migrating raptors of 17 species during the 2014 season (see Appendix E for complete annual season totals since the project's inception in 1991). This year's total count is 16.8% above the 1992 – 2013 average of 2,379 migrating raptors.

The 2014 flight was comprised of 46.5% eagles, 26.1% accipiters, 13.6% buteos, 7.3% falcons, 3.9% harriers, 2.2% unidentified raptors, and 0.5% Ospreys and vultures. The most numerous species were: Golden Eagles (42% of total count), Sharp-shinned Hawks (15%), Red-tailed Hawks (8%), Cooper's Hawks (7%), and American Kestrels (5%). All other species each comprised < 4% of the total.

The decoy owls attracted 11 of the 17 species of migrant raptors; the Bald Eagle, Turkey Vulture, Broad-winged Hawk, Osprey, Ferruginous Hawk, and Swainson's Hawk were not fooled. Accipiters and falcons were the most enthusiastic about attacking the owl, but Red-tailed Hawks, Northern Harriers, and Rough-legged Hawks would sometimes make a pass on the decoy as well. Accipiters were the most oblivious to the observers when attacking the close owl; however, falcons also frequently accosted the near owl.

LONG TERM TRENDS:

Regression analyses of the counts since 1992, and updated through 2014 (after Hoffman and Smith 2003) revealed significant long-term increases for the three species: Turkey Vulture, Broad-winged Hawk, and Peregrine Falcon (Figs. 2, 4 & 8). Turkey Vultures and Peregrine Falcons have been increasing across North America for several decades now, so no surprise there. For Peregrine Falcons, 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). For Turkey Vultures a combination of a warming climate and human influences on the landscape have benefited this primarily tropical species. Broad-winged Hawks have been showing long-term declines in eastern North

America, but have increased for the past 20 years in the West (Smith et al. 2008). The reason(s) for their increase in western North America is unknown.

Bridger counts are showing statistical long-term declines in three species: Northern Goshawk, Golden Eagle, and Bald Eagle (Figs. 3, 5, 6 & 7). However, although we have serious concerns about the long-term population health of the first two species, we are not at all concerned about the Bald Eagle. This species is an uncommonly late migrant, and thus the timing of our counts do not coincide with this species' peak migration period; thus we are not obtaining a reliable index of Bald Eagle populations with our count methods. And, with the acceleration of global warming it is likely that autumn Bald Eagle migration has started shifting later into November and December, thus yielding fewer birds counted during our standard observation period. It is a well-known fact that Bald Eagles throughout most the United States and Canada are either stable or increasing, and most populations in the lower 48 states have been steadily increasing since the early 1980's.

Both goshawks and Golden Eagles are likely being affected by habitat degradation. For goshawks it is likely a decline in the extent of its preferred nesting and foraging habitat, mature and old-growth forest. This is likely due to a combination of intensive logging, widespread beetle kill, and devastating large scale wildfires. However, it is important to note that the goshawk is an irruptive species, and large numbers have been documented moving south out of Canada after an abrupt crash in their primary prey species, the snowshoe hare and Ruffed Grouse. In 2014 goshawk counts totaling 59 birds in the Bridgers represent the third largest in the 23-year history of the project, possibly suggesting the beginning of an irruption. The strong flight of immature goshawks this year suggests that prey numbers to the north were excellent in 2014, perhaps near their peak. The numbers and age composition of the migrant goshawk count in the Bridgers in 2015 will be of great interest!

Regression analyses revealed a highly significant ($P<0.00001$) linear (downward) trend for Golden Eagles at the species level, tracking a steady decline since 1992 (but especially since 1999; see Figure 5). This decline suggests a widespread drop of 35-40% in northern Golden Eagle populations since the late 1990's. As yet, no cause has been definitively documented, but it is likely due to degradation of sage-steppe habitat, expanding oil and gas development (especially within sage-steppe habitats), and widespread decline in their primary prey species (especially jackrabbits). 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 reveals similar declines for *both* adults and non-adults ($P<0.01$; Figure 5).

Smith et al. (2008a) present trend analyses for data collected through 2005 for most of the long-term, ongoing autumn migration studies in western North America, including the Bridger Mountains. These and subsequent analyses (reported as part of the Raptor Population Index or "RPI" analyses; see http://www.rpi-project.org for updated trend graphs using this more complex method) 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 2014. 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 providing assessments of trend significance and precision. Please note, however, that restrictions related to the mathematical assumptions behind this

approach precludes 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. However, with few notable exceptions, the overall patterns of population change and derived trend estimates for each species as calculated by this more complex method generally yielded similar results to those derived from the simpler methodology used herein (and described more fully in Hoffman and Smith (2003).

Noteworthy short-term changes in migration counts revealed in 2014 show that most raptor species are experiencing a modest resurgence in numbers, perhaps due to relatively good soil moisture conditions in recent years and concomitant increases in their primary prey (especially voles). In 2014 we tallied record numbers of both Merlins (28) and Rough-legged Hawks (84). We also recorded the second highest count in the history of the project for both Red-tailed Hawks (239) and Northern Harriers (112). Furthermore we documented the third highest count of American Kestrels (138) and Bald Eagles (106). All three accipiter species made a strong showing as well, with counts well above average and total accipiter numbers the 4th highest on record. In fact, the only species in which counts were substantially below average was the Golden Eagle (1222 vs. an avg. of 1341).

AGE RATIOS:

Of the nine species for which relevant age-specific data were available, the immature:adult ratio was significantly above average only for the Broad-winged Hawk (Table 1), and significantly below average for only the Bald Eagle. However, although not statistically significant, the Northern Harrier age ratio in 2014 was oddly skewed toward adults when compared to the long-term mean. This result is unexpected, since the harrier count total was the 2nd highest ever in the Bridgers, suggesting an exceptional breeding season in 2014.

SEASONAL TIMING:

During the 2014 season the Turkey Vulture, Osprey, Sharp-shinned Hawk, Northern Goshawk, Broad-winged Hawk, Red-tailed Hawk, Bald Eagle, Merlin, and Prairie Falcon showed significantly later passage dates. Conversely, the Rough-legged Hawk and Peregrine Falcon both exhibited passage dates significantly earlier than the long-term average (Table 2). It is interesting to note that the nine species exhibiting a significantly later flight showed, on average, nearly a 6-day delay in the timing of their migration. The only exceptions were the Broad-winged Hawk and Peregrine Falcon, which are relatively rare raptors on Bridger Ridge; thus trends in seasonal timing for these species should be interpreted with care. It should be noted that immature accipiters are consistently observed migrating 5-10 days (on average) in advance of the adults of the same species. Most other raptor species show a similar age-specific differential pattern.

RESIDENT RAPTORS:

As is typical at the Bridger site, this year's observers 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 17 October. At least one immature was regularly seen 1-6 September. A confirmed adult was observed 15 September through 6 October.

Cooper's Hawk - One Cooper's Hawk was identified as a resident. An immature was observed from 1-19 September, mobbing decoy owls and harassing migrants as well as local Sharp-shinned Hawks.

Northern Goshawk – A resident immature Northern Goshawk was spotted on 1-2 September, as well as on 22 September, and 20 and 23 October. A single adult and an unknown-age Northern Goshawk displayed resident behavior on 31 October and 5 November, respectively.

Red-tailed Hawk – At least two immature and one adult light-morph Red-tailed Hawks were identified as residents. The two immatures were likely siblings. All birds were seen regularly from 1-8 September, 15-25 September, and 3-10 October. Later in the season the adults were seen sporadically on five more occasions through 1 November.

Golden Eagle - A pair of resident adult Golden Eagles, as well as at least one sub-adult and two juveniles, were in the area throughout the observation period,. The adult pair often used a perch in the evening on the west side of Tilly Peak. These residents were very active, consistently escorting migrating eagles and buteos; they also were frequently observed hunting the Bridger and Bangtail Mountains. Central to their identification as residents was their frequent territorial "rollercoaster" displays, which they engaged in frequently to discourage any potential interlopers.

American Kestrel - Both male and female resident American Kestrels were seen daily from 1-16 September, most often in the morning on the east side of the ridge hunting and harassing other birds. As many as three individuals (2 male and 1 female) were seen at a single time, and we suggest that more could have possibly resided in the area.

Prairie Falcon – Resident Prairie Falcons were seen regularly throughout the field season, at times strongly drawn to the decoy owl. A pair was seen together on 19 September, but otherwise only a single resident bird was observed throughout the season.

Peregrine Falcon - At least one adult Peregrine Falcon was observed on 2 and 19 September. On 1 September an adult pair was observed from the observation point at sunset, long after the count period had ended.

VISITATION:

Throughout the 2014 season a total of 147 individuals signed the visitor sign-in log kept at the observation platform. It is estimated that this documents approximately half the total number of visitors. Most visitors were from the greater Bozeman area, and a large number of guests were enjoying other forms of recreation along the ridge when they reached the observation platform. Regardless of motivation for visiting the platform, the great majority of people were eager to learn about the migration. However, many people did make the hike on a regular basis to observe the raptor migration, and some even traveled to Bozeman from quite distant locales to enjoy the migration.

The 18th annual Bridger RaptorFest, held on the weekend of 4-5 October, attracted an exceptional attendance record again in 2014, with an estimated 5,000 participants. The weather was excellent both days. Keynote speaker Peter Sherrington, Founder and Principal Investigator for the Mount Lorette eagle-counting site near Lethbridge, Alberta, visited the observation point throughout both days. Saturday, 4 October, turned out to be the record Golden Eagle day for the season, with 107 recorded (see Appendix D for daily observation results).

A total of 411 hourly assessments of visitor disturbance were recorded during the 2014 season. Of these subjective assessments, 89.8% were recorded as none, 7.5% low, 2.4% moderate, and 0.2% high. Several local newspaper articles were written about the 2014 Bridger Hawk Watch, and multiple reporters made the trek the observation point on a number of occasions.

RAFFLE:

The 2014 season marked the first time in which a raffle fundraiser for the project was held. The prizes were two free season ski passes at Bridger Bowl. The two passes were generously donated by Bridger Bowl, and raffle tickets were sold primarily by local Sacajawea Audubon Society volunteers and Montana Audubon staff. The funds generated helped support the 2014 Bridger count.

SIMULTANEOUS COUNTS:

On two occasions counts were performed at other locations in the vicinity of the Bridger Ridge in addition to the main site at the helicopter pad. On 8 September Bret Davis and David Laufenberg (official observer on Bridger Ridge in 2010) counted from the top of Tilly's Peak for the final two hours of the day. During this time, surprisingly, the raptors seen from the two locales were not well correlated, suggesting that a great many raptors are missed from both observation points. On 19 October Steve Hoffman observed from the crest of the Bridger ridge above Johnson Canyon, just south of Flathead Pass and about 15 miles to the north of the helicopter pad at Bridger Bowl. Once again, the results showed that less than half of the birds were observed from both points.

OTHER WILDLIFE:

The Bridger Mountains can be considered part of the Greater Yellowstone Ecosystem, and a hot-bed for wildlife. Throughout the season various wildlife species (in addition to the raptors) were observed, including several mammal species and many other birds.

Throughout the season white-tailed and mule deer were often observed from the observation point. A large herd of elk was also present in Bridger Canyon. The elk herd was spotted only once on the Bridger Bowl grounds, in late October to the east and below the observation point. A weasel (either short-tailed or long-tailed) was observed from the helicopter pad on three different occasions: on 7 September it was chasing a chipmunk, on 12 September it was being harassed by a Northern Flicker, and on 3 October it was hunting in the brush nearby.

Mountain goats were a common sight from the observation point throughout the season. During the first week of the count a large herd of 20 – 30 individuals was often seen on the south face of Sacajawea Peak, where an expanse of green vegetation was visible from the pad. Small family groups and individuals were also present. A single individual was often seen walking by the observation point or hanging around

the ski-patrol hut. A family group of seven, with two adults and five young, was seen multiple times during the first week of October.

Other wildlife that grew accustomed to the field team's presence was a Dusky Grouse and a red squirrel, the latter making its home a short distance west of the observation point. Ravens were 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 flying around playfully all season long.

Diurnal raptors were not the only birds that utilized the Bridger Ridge as a fall migration flyway in 2014. A variety of waterfowl was observed: flocks of 9 and 7 Snow Geese were noted on 27 and 30 October; a group of six Canada Geese were recorded on 14 September; unknown single waterbirds were seen on 9 September and 2 October; single Common Loons were observed on 1 September and 6 October; and a group of five loons were spotted on 19 October, and an unknown number of loons detected on 25 October. Finally, a flock of five Herring Gulls (four adults and a single juvenile) were observed migrating south on 9 October.

Migrating small birds were noted as well. Among these were White-throated Swifts, seen as a flock on 17 September, and a single individual on 25 September. Unknown swifts or swallows were observed in three separate migrating flocks of 20 – 30 on 5-6 September. Flocks of migrating Mountain Bluebirds were seen often during the middle two weeks of September. Transient birds observed in the local woodlands included: Rufous Hummingbird, Swainson's Thrush, and Wilson's, Townsend's and Yellow-rumped warblers. A variety of flocking finches, including Rosy-finches, Pine Grosbeaks, Red Crossbills, and Pine Siskins were seen often during the latter half of the field season, with some migrating siskins noted at the end of the first week of the field season. The Rosy-finch flight was especially spectacular this season, with large flocks numbering in the hundreds frequently observed. On several occasions the flocks would fly close to the observers, and even land on the ground to feed within 10 feet of the observers. Bohemian Waxwings migrated by in flocks (10 – 50) frequently, beginning in late October and continuing to the end of the field season. Other birds that showed migratory behavior were Clark's Nutcrackers, Common Ravens, American Crows, and American Robins.

Dragonflies on their migration were noted as well, although not counted. It is estimated that they were moving through in the tens or single digits most strongly during the first week of the season. The last individuals were observed on 20 September. The dragonflies were predominately blue or green in color, and were often preyed upon by migrant and resident American Kestrels.

Local, resident passerines were recorded. These were (in no particular order) Mountain Chickadee, Clark's Nutcracker, American Robin, Pine Siskin, Dusky Grouse, Dark-eyed Junco, Black-billed Magpie, Mountain Bluebird, American Pipit, Cassin's Finch, Three-toed Woodpecker, White-winged Crossbill, Pine Grosbeak, Townsend's Solitaire, Common Raven, Red-breasted Nuthatch, Ruby-crowned Kinglet, Hairy Woodpecker, Northern Flicker, Steller's Jay, and Rock Wren. On 4 September a Townsend's Solitaire was observed with a metal USGS band on the right leg.

OBSERVATION OF WING-TAGGED GOLDEN EAGLE:

A single migrating Golden Eagle was observed in 2014 with prominent wing tags: HY (hatch-year) #236. The bird was captured and tagged by RaptorView Research Institute's field crew at Nora Ridge, MT (near

Rogers Pass) at midday on 12 October, and observed flying over Bridger Bowl in mid-morning on 13 October.

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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: 1992–2013 versus 2014.

	Total and Age-classified Counts						% Unknown Age		Immature : Adult Ratio	
	1992–2013 Average			2014						
	Total	Imm.	Adult	Total	Imm.	Adult	1992–2013[1]	2014	1992–2013[1]	2014
Northern Harrier	50	24	12	112	41	22	31 ± 6.5	44	3.3 ± 2.67	1.9
Sharp-shinned Hawk	344	70	132	422	73	150	42 ± 5.5	47	0.6 ± 0.11	0.5
Cooper's Hawk	168	47	56	203	45	58	39 ± 4.5	49	0.9 ± 0.24	0.8
Northern Goshawk	31	12	12	59	25	13	26 ± 8.4	36	1.7 ± 0.48	1.9
Broad-winged Hawk	13	3	6	22	8	5	36 ± 14.8	41	0.8 ± 0.60	1.6
Red-tailed Hawk	122	36	57	239	73	116	23 ± 3.8	21	0.7 ± 0.27	0.6
Golden Eagle	1343	509	487	1222	459	436	26 ± 3.8	27	1.1 ± 0.17	1.1
Bald Eagle	76	27	47	106	26	63	3 ± 13.3	16	0.6 ± 0.11	0.4
Peregrine Falcon	12	1.4	5	23	2	12	50 ± 13.3	39	0.3 ± 0.25	0.2

[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 2014, with a comparison of 2014 and 1992–2013 average median passage dates.

	2014				1992–2013
Species	First Observed	Last Observed	Bulk Passage Dates[1]	Median Passage Date[2]	Mean Passage Date[3]
Turkey Vulture*	1-Sep	5-Oct	–	21-Sep	17-Sep ± 2.6
Osprey	16-Sep	7-Oct	16-Sep – 7-Oct	24-Sep	17-Sep ± 2.6
Northern Harrier	2-Sep	1-Nov	9-Sep – 18-Oct	23-Sep	22-Sep ± 3.5
Sharp-shinned Hawk	1-Sep	8-Nov	8-Sep – 18-Oct	6-Oct	30-Sep ± 1.7
Cooper's Hawk	1-Sep	6-Nov	6-Sep – 15-Oct	24-Sep	24-Sep ± 2.5
Northern Goshawk	5-Sep	8-Nov	19-Sep – 31-Oct	17-Oct	8-Oct ± 4.9
Broad-winged Hawk	15-Sep	15-Oct	17-Sep – 7-Oct	24-Sep	20-Sep ± 1.8
Swainson's Hawk	23-Sep	25-Sep	–	–	15-Sep ± 4.0
Red-tailed Hawk	1-Sep	5-Nov	5-Sep – 20-Oct	24-Sep	22-Sep ± 1.8
Ferruginous Hawk*	4-Sep	22-Oct	4-Sep – 22-Oct	6-Oct	5-Oct ±
Rough-legged Hawk	4-Oct	5-Nov	14-Oct – 1-Nov	19-Oct	21-Oct ± 1.4
Golden Eagle	2-Sep	6-Nov	3-Oct – 25-Oct	14-Oct	13-Oct ± 1.7
Bald Eagle	3-Sep	8-Nov	29-Sep – 3-Nov	19-Oct	16-Oct ± 2.5
American Kestrel	1-Sep	23-Oct	6-Sep – 5-Oct	20-Sep	21-Sep ± 2.0
Merlin	1-Sep	6-Nov	4-Sep – 25-Oct	15-Oct	6-Oct ± 3.4
Prairie Falcon	3-Sep	6-Nov	4-Sep – 30-Oct	3-Oct	25-Sep ± 3.2
Peregrine Falcon	2-Sep	8-Oct	5-Sep – 5-Oct	20-Sep	25-Sep ± 2.2
All species	6-Sep	8-Nov	13-Sep – 25-Oct	–	7-Oct ± 1.6

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

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

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

* <5 birds in annual count.

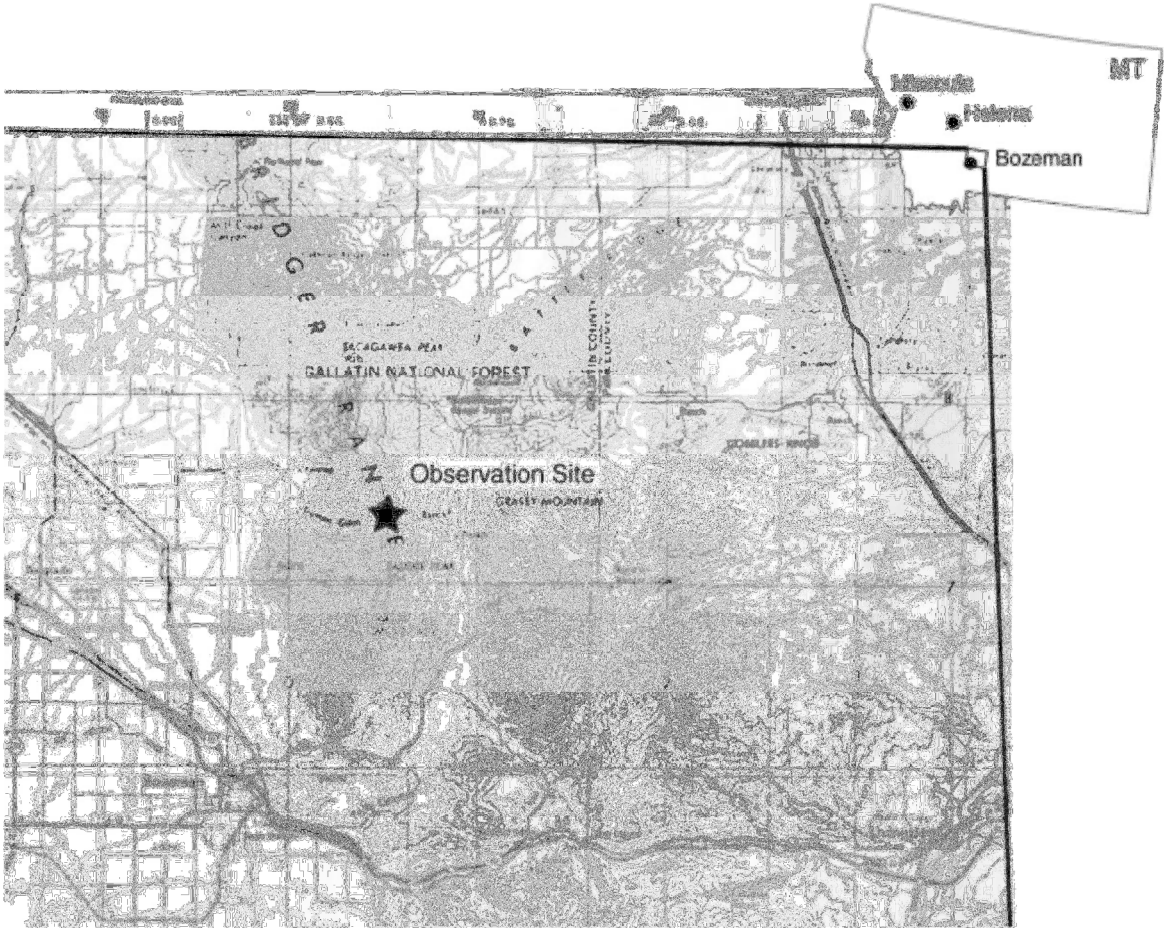

Figure 1. Location of the Bridger Mountains Raptor Migration Project study site.

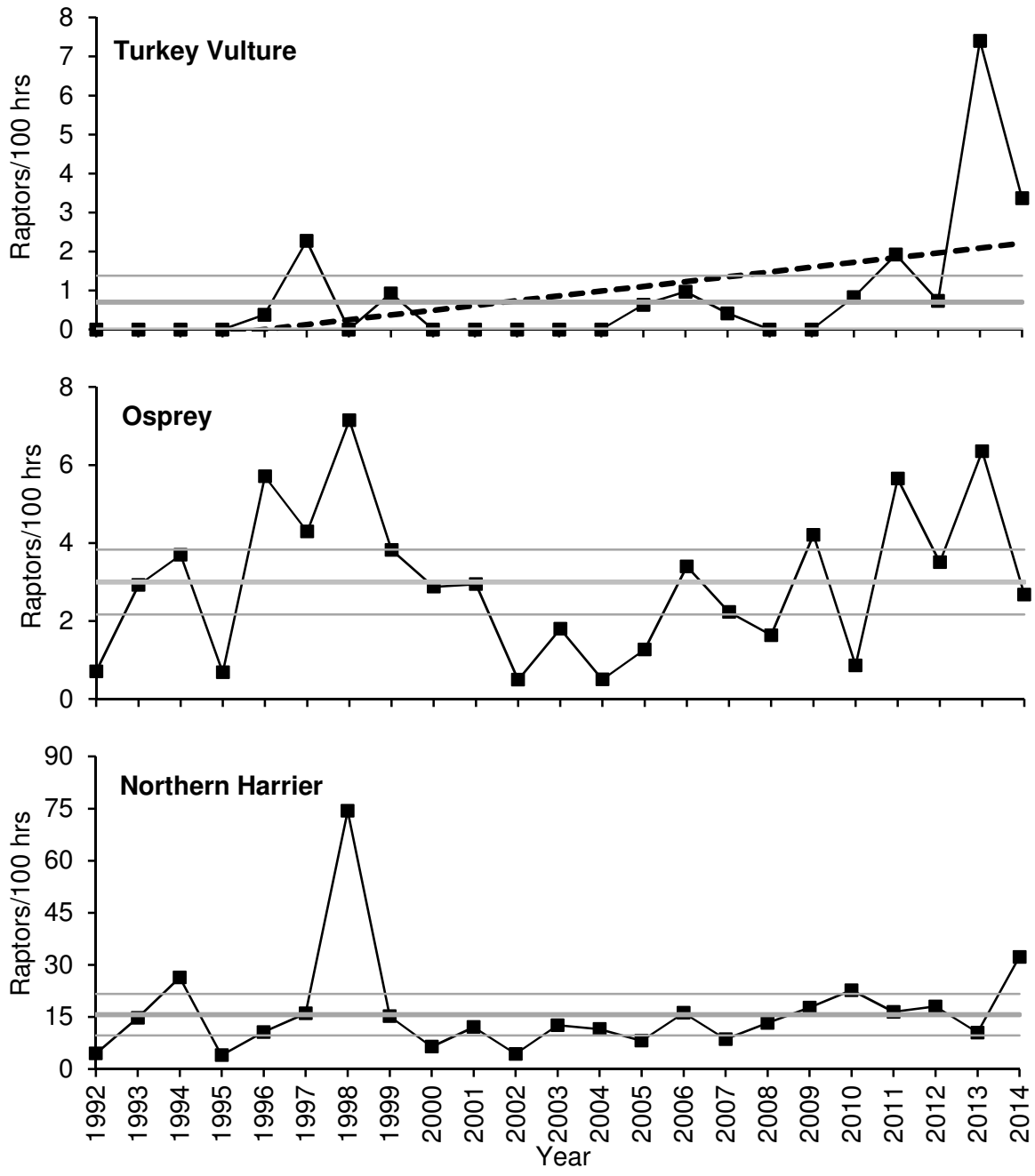

Figure 2. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall migration passage rates for Turkey Vultures, Ospreys, and Northern Harriers in the Bridger Mountains, MT: 1992–2014. Dashed lines indicate statistically significant ($P \leq 0.10$) linear regressions. Thick middle line indicates the historic site average and thin lines indicate the corresponding 95% confidence interval.

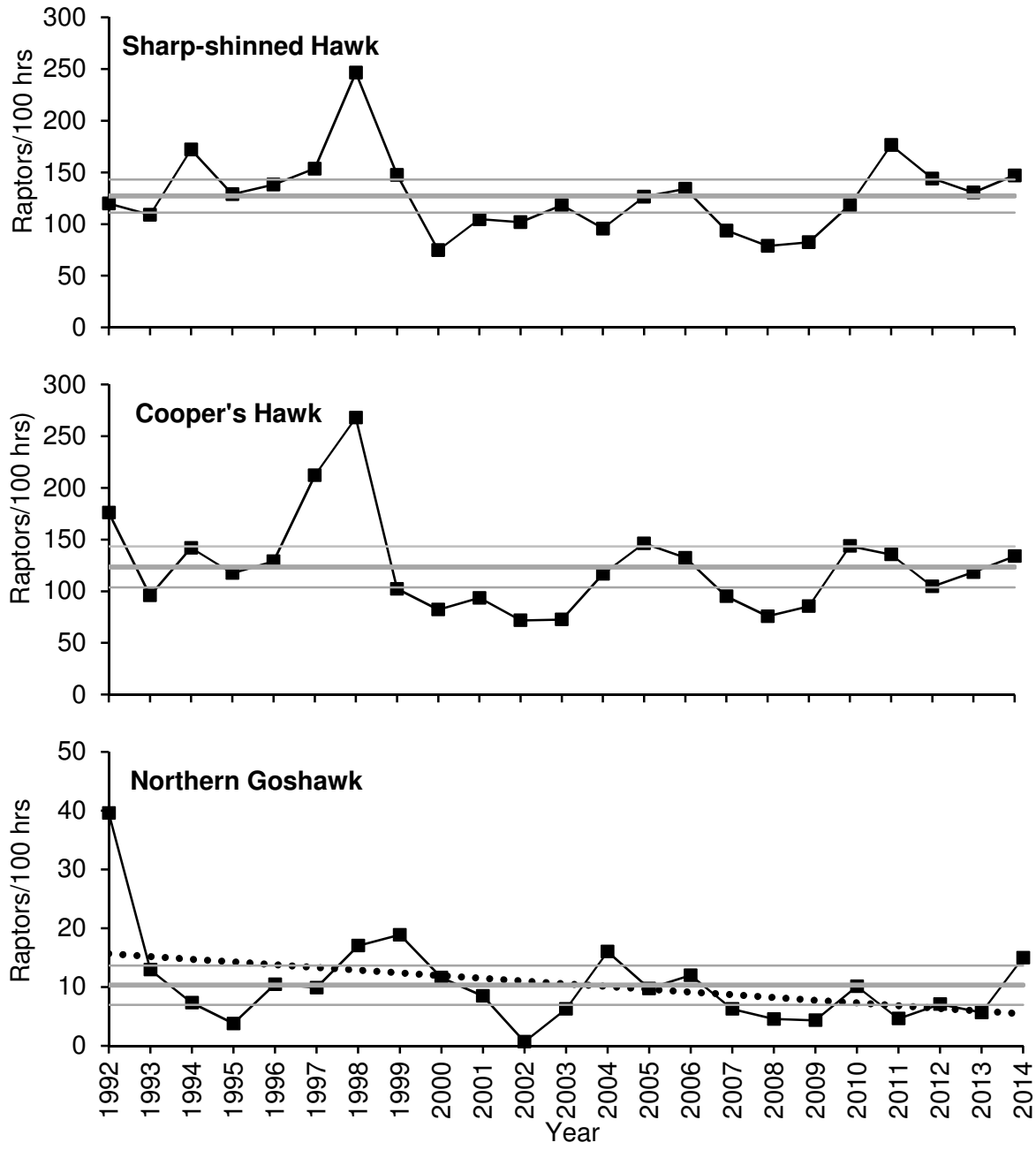

Figure 3. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall migration passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks in the Bridger Mountains, MT: 1992–2014. Dashed lines indicate statistically significant ($P \leq 0.10$) linear regressions. Thick middle line indicates the historic site average and thin lines indicate the corresponding 95% confidence interval.

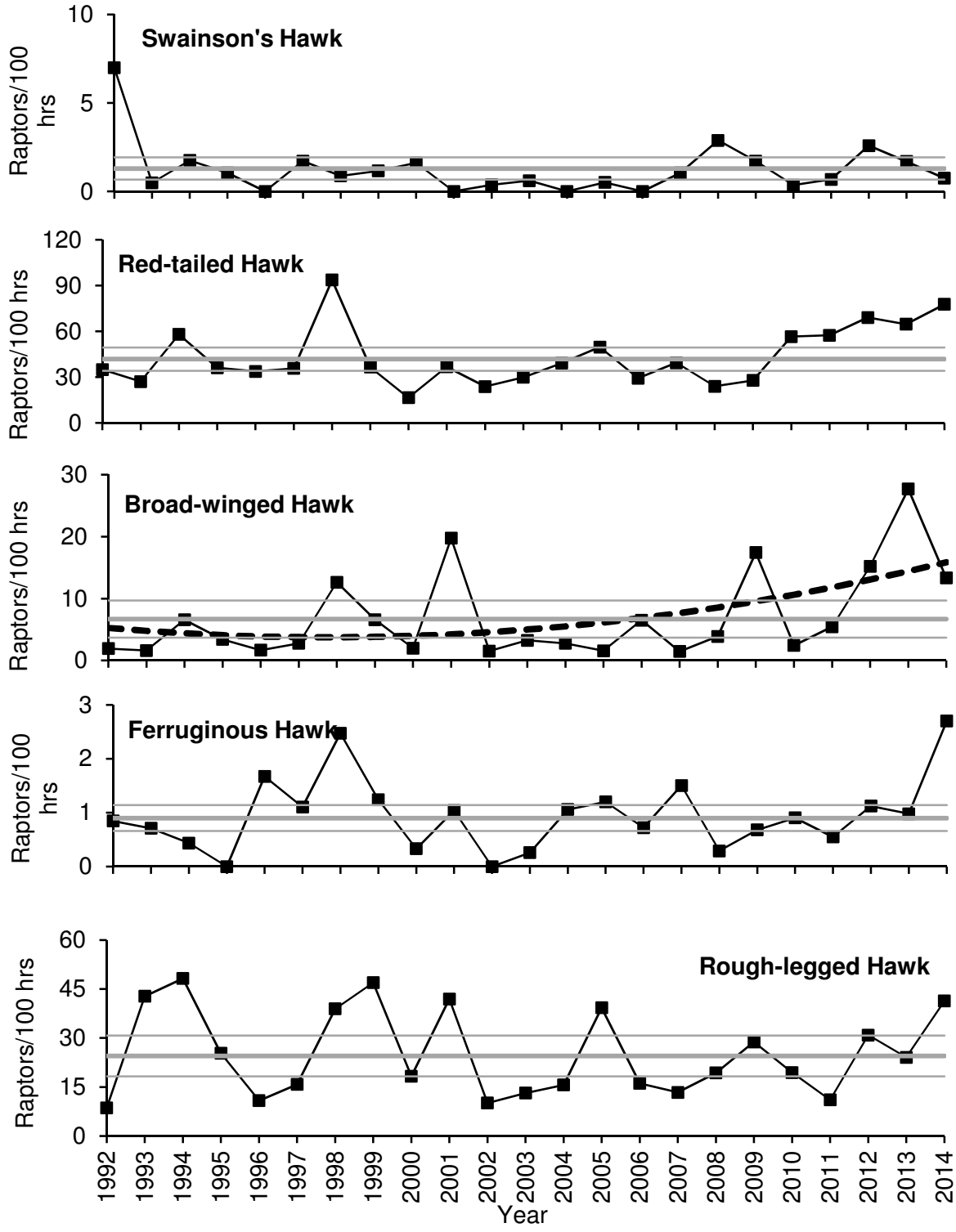

Figure 4. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Swainson's, Red-tailed, Broad-winged, Ferruginous and Rough-legged Hawks in the Bridger Mountains, MT: 1992–2014. Dashed lines indicate statistically significant ($P \leq 0.10$) quadratic regressions. Thick middle line indicates the historic site average and thin lines indicate the corresponding 95% confidence interval.

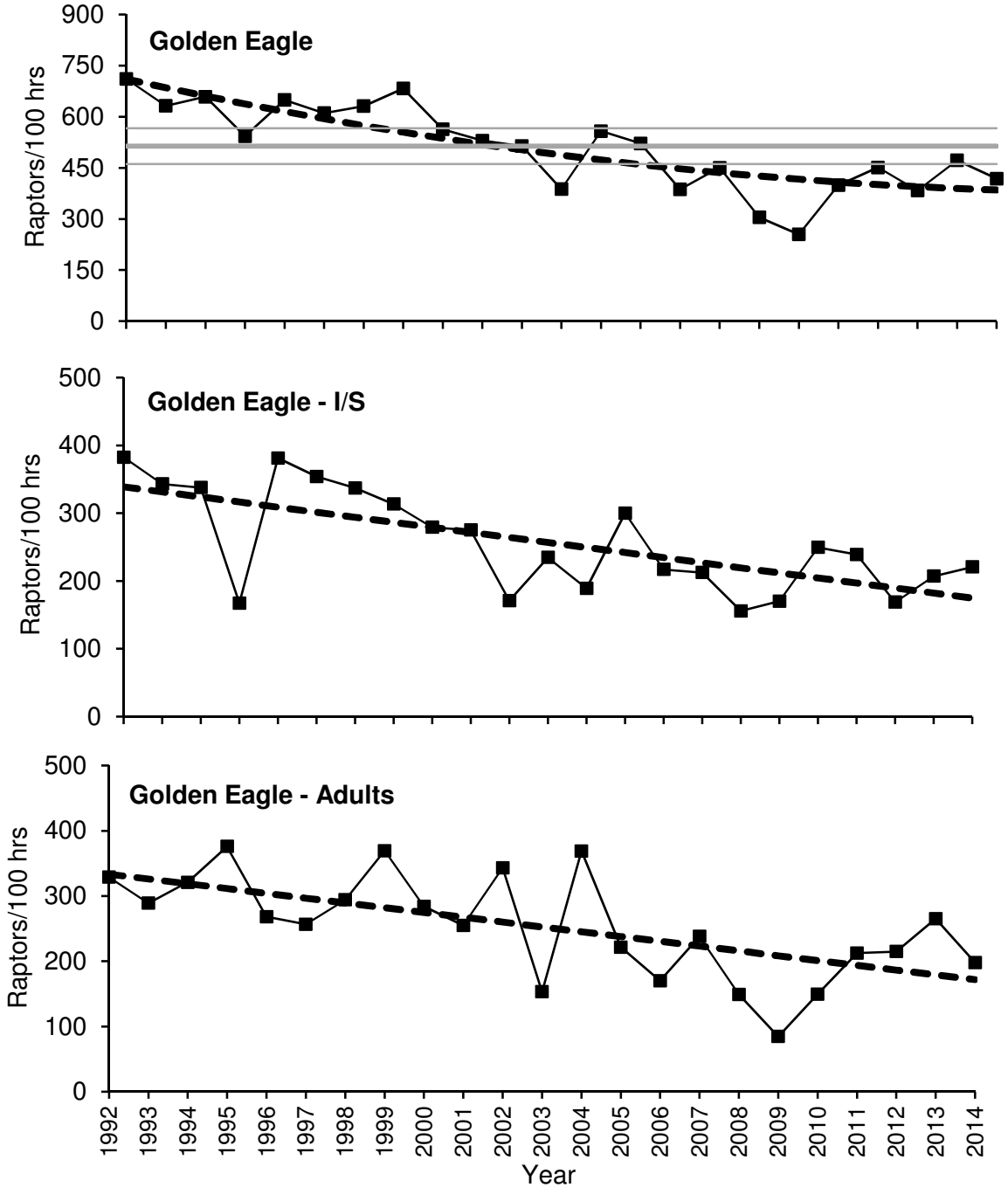

Figure 5. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Golden Eagles (separated by all birds, non-adults, and adults) in the Bridger Mountains, MT: 1992–2014. Dashed lines indicate statistically significant ($P \leq 0.10$) linear regressions. Thick middle line indicates the historic site average and thin lines indicate the corresponding 95% confidence interval.

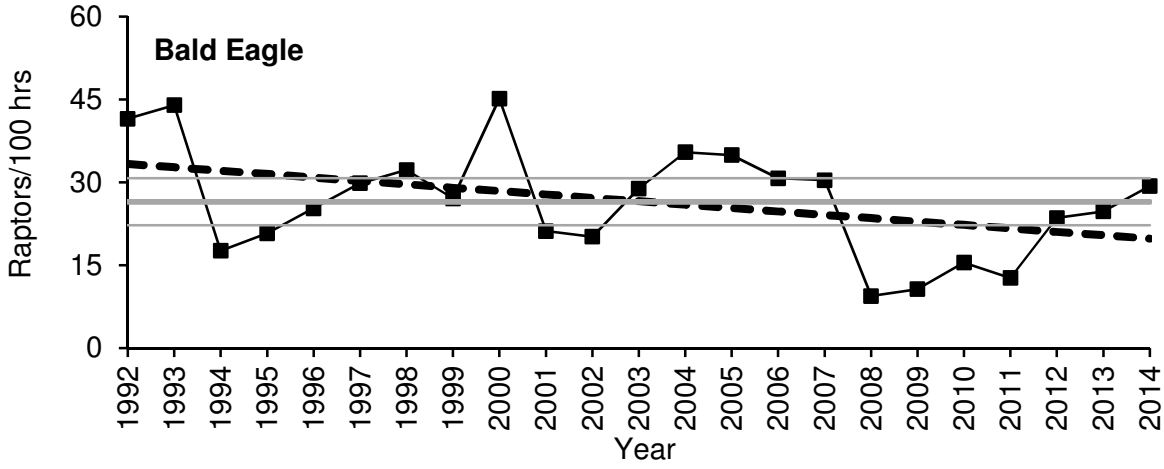

Figure 6. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Bald Eagles in the Bridger Mountains, MT: 1992–2014. Dashed lines indicate statistically significant ($P \leq 0.10$) linear regressions. Thick middle line indicates the historic site average and thin lines indicate the corresponding 95% confidence interval.

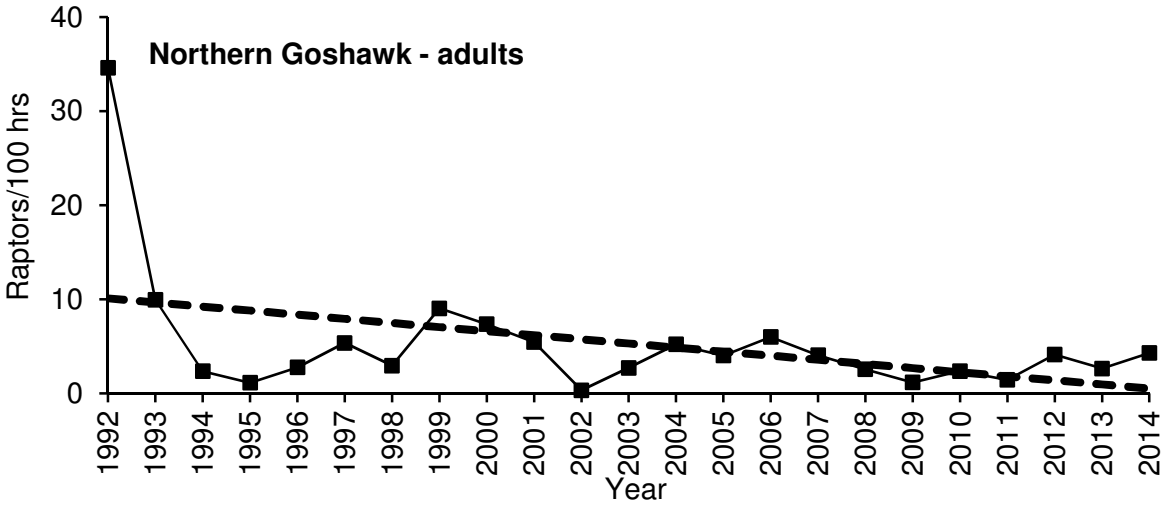

Figure 7. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for adult Northern Goshawks in the Bridger Mountains, MT: 1992–2014. Dashed lines indicate statistically significant ($P \leq 0.10$) linear regressions.

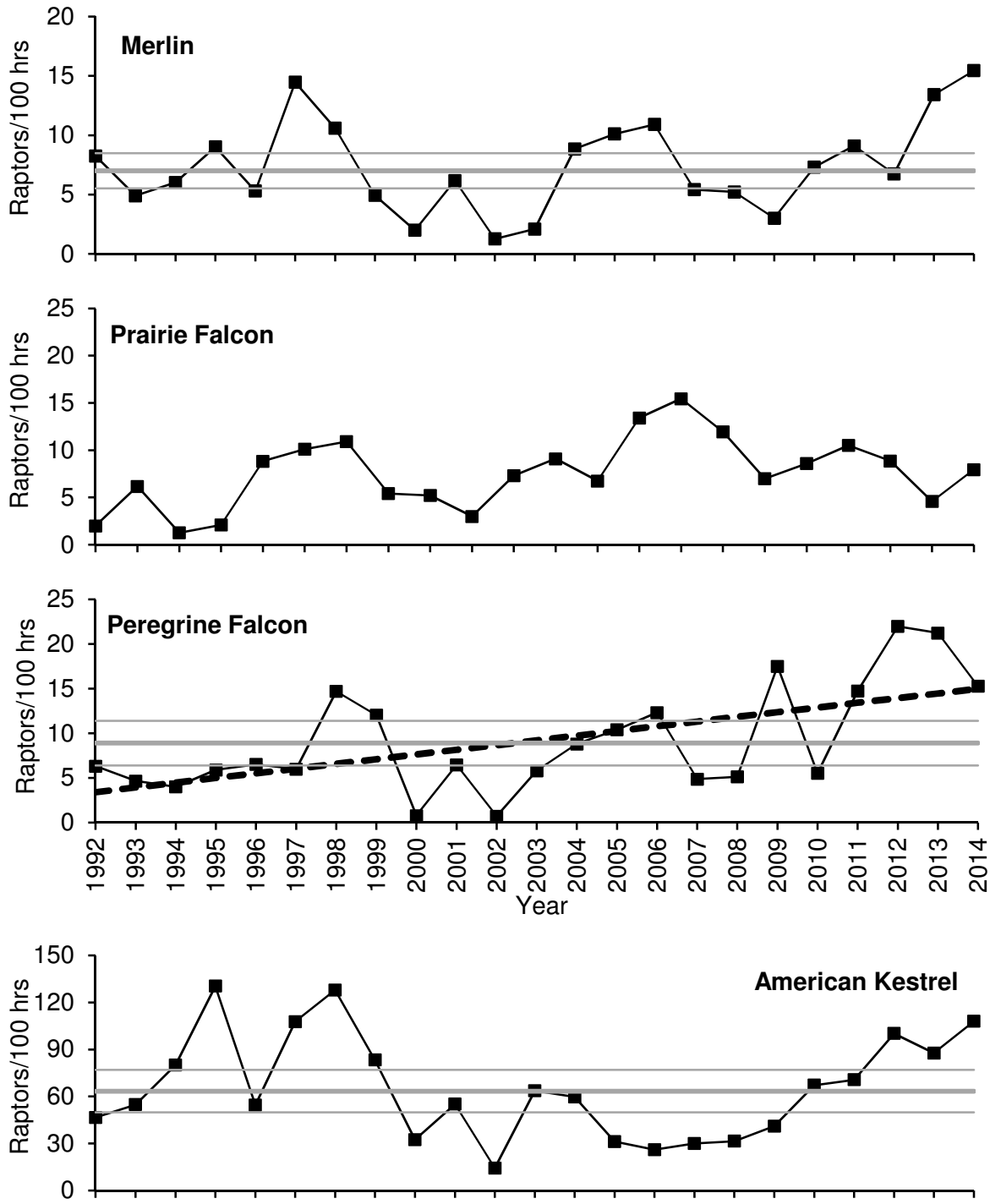

Figure 8. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Merlins, Prairie Falcons, Peregrine Falcons, and American Kestrels in the Bridger Mountains, MT: 1992–2014. Dashed lines indicate statistically significant ($P \leq 0.10$) linear regressions. Thick middle line indicates the historic site average and thin lines indicate the corresponding 95% confidence interval.

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)
2013: Two observers throughout: Bret Davis (0), Kalon Baughan (0)
2013: Two observers throughout: Bret Davis (1), Kalon Baughan (1)
2014: Two observers throughout: Bret Davis (2), Mikaela Howie (0)

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

Appendix C. Daily observation effort, visitor disturbance ratings, weather records, and flight summaries for the Bridger Mountains Raptor Migration Project: 2014.

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	2.6	0	mc-ovc-clr	6.7	sw-w	8.0	30.12	4	89	87	0	1.1
2-Sep	8.00	1.9	0	pc-clr	11.6	sw-w, calm/var	12.0	30.05	2	90	96	1	2.3
3-Sep	8.17	1.9	0	clr-ovc-mc	17.1	sw-w, calm/var	8.1	29.96	4	54	76	1	1.3
4-Sep	8.00	2.4	0	ovc-mc-clr	7.2	sw-w	7.0	30.21	3	100	98	2	2.4
5-Sep	8.00	2.0	0									2	6.1
6-Sep	8.00	2.4	0	clr	4.8	sw-w	8.4	30.31	1	92	78	1	5.8
7-Sep	8.00	1.9	0	clr-pc, haze	14.4	sw-w	11.5	30.15	3	86	59	2	2.8
8-Sep	8.00	2.0	0	clr-mc, haze	9.7	sw-w	12.8	30.07	1	78	52	3	7.8
9-Sep	2.42	1.9	0	ovc, haze, fog	4.8	calm/var	9.5	30.06	4	33	29	1	5.4
10-Sep	1.25	1.0	0	ovc, fog	9.7	sw-w	7.3	30.11	4	28	22	1	2.4
11-Sep	0.00												
12-Sep	8.00	1.9	0	clr, haze	14.2	sw-w, calm/var	1.6	30.20	2	100	99	2	1.8
13-Sep	7.42	2.2	0	mc-ovc, haze	4.0	sw-w, calm/var	4.9	30.17	3	87	83	2	2.3
14-Sep	7.25	2.5	0	mc-clr, haze	10.3	sw-w, calm/var	6.3	30.18	2	52	46	2	7.3
15-Sep	8.00	2.5	0	clr, haze	10.5	sw-w, calm/var	8.6	30.26	1	47	37	2	3.9
16-Sep	8.00	2.0	0	ovc, haze	10.7	sw-w	12.6	30.23	4	48	60	2	4.0
17-Sep	8.00	2.0	0	clr-mc-ovc, haze	6.8	sw-w	13.6	30.18	2	46	46	2	8.3
18-Sep	0.00												
19-Sep	8.00	2.5	0	ovc-mc, haze	16.8	sw-w	10.4	30.14	4	35	34	3	5.6
20-Sep	8.00	3.2	0	clr, haze	4.9	sw-w, ne	7.7	30.35	2	92	92	2	9.5
21-Sep	8.00	3.5	0	clr-mc-ovc	14.0	ne-se	10.5	30.30	3	100	80	1	2.4
22-Sep	6.00	2.0	0	ovc, rain	16.1	sw-w	10.8	30.31	4	97	90	1	1.3
23-Sep	7.50	2.0	0	pc, haze	8.7	sw-w	10.4	30.24	1	49	44	2	14.7
24-Sep	7.67	1.9	0	mc-pc-clr, haze	9.6	sw-w	13.6	30.24	1	84	89	2	6.7
25-Sep	8.00	2.0	0	clr, haze	7.2	se-sw	15.0	30.18	1	89	93	3	10.8
26-Sep	7.33	2.0	1	transition, haze, rain	7.4	w, calm/var	14.1	30.14	3	86	54	3	11.9
27-Sep	0.00												
28-Sep	0.00												
29-Sep	5.00	2.8	0	ovc, fog	3.3	sw-w	6.3	29.98	4	23	56	2	3.6
30-Sep	0.00												
1-Oct	0.00												
2-Oct	5.00	1.9	0	ovc, fog, rain-snow	8.5	sw-w	2.8	30.05	4	21	84	1	1.2
3-Oct	7.75	2.4	0	mc, haze	16.8	w	0.1	30.25	3	94	91	2	6.5
4-Oct	7.75	4.0	0	pc-mc, haze	13.1	sw-w	5.2	30.16	3	98	99	3	22.8

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	7.75	3.8	1.5	ovc-pc, haze	9.9	sw-w	7.3	30.15	2	92	95	2	10.7
6-Oct	7.83	2.0	0	ovc-mc	13.1	w	8.3	30.07	1	91	94	2	13.1
7-Oct	8.00	1.9	0	pc-mc	10.0	sw-w	9.8	30.13	2	91	95	2	7.0
8-Oct	7.33	1.9	0	mc, haze	11.2	sw-w	8.2	30.13	2	94	93	3	6.8
9-Oct	6.25	2.0	0	ovc-mc, fog, haze	24.2	ne-se	7.0	30.12	4	51	49	1	8.5
10-Oct	8.00	2.0	0	mc-clr-pc, haze	5.9	w	6.5	30.12	3	77	70	2	12.3
11-Oct	5.33	4.1	0	ovc	11.1	sw-w	6.9	30.00	4	77	76	2	12.6
12-Oct	0.00												
13-Oct	7.17	2.0	0	ovc	15.1	sw-w	0.2	30.11	4	100	100	2	14.1
14-Oct	7.67	2.1	0	ovc	13.8	sw-w	4.6	30.05	4	97	91	2	15.4
15-Oct	7.25	2.2	0	ovc-mc	19.1	sw-w	7.3	29.84	4	97	81	3	21.2
16-Oct	7.67	1.0	0	ovc	7.7	w, calm/var	0.4	30.09	4	97	93	1	7.0
17-Oct	7.83	2.0	0	clr-pc-mc	3.2	sw-w	6.1	30.10	3	100	94	1	16.2
18-Oct	8.00	2.0	1	ovc-pc, haze	10.4	w	6.1	30.11	2	85	85	3	12.1
19-Oct	8.00	2.4	0	clr	12.4	sw-w	5.5	30.14	2	81	83	3	4.5
20-Oct	8.00	2.0	0	clr, haze	9.8	sw-w	7.5	30.07	3	79	79	3	5.4
21-Oct	0.00												
22-Oct	7.50	2.0	0	clr-mc	15.9	w	1.1	30.03	3	100	100	3	8.9
23-Oct	6.67	2.1	0	ovc, snow	17.1	w, calm/var	3.1	30.00	4	86	88	3	9.2
24-Oct	0.00												
25-Oct	7.83	2.3	0	clr-pc-ovc	9.5	sw-w, calm/var	6.4	30.01	4	78	78	3	12.3
26-Oct	0.00												
27-Oct	7.08	1.7	0	ovc, snow	11.7	w	-2.5	29.95	4	47	87	2	3.1
28-Oct	7.58	2.0	0	pc	15.7	w, calm/var	-2.1	30.06	3	91	98	3	4.4
29-Oct	5.00	1.9	0	ovc	13.9	w, calm/var	0.6	30.10	4	79	87	2	1.4
30-Oct	6.83	2.0	0	ovc-mc, haze	8.9	w, calm/var	3.1	30.23	3	98	96	1	4.0
31-Oct	6.75	2.6	0	mc, haze	11.9	w, calm/var	5.0	29.97	2	83	88	2	3.6
1-Nov	6.50	3.1	0	mc	16.3	ne-se, calm/var	6.3	29.78	3	76	76	1	6.2
2-Nov	0.00												
3-Nov	4.00	2.0	0	mc-ovc, snow	18.4	w	-3.2	30.05	4	82	77	2	4.0
4-Nov	3.58	2.0	0	mc-ovc	18.4	w, calm/var	-0.4	30.04	4	67	90	0	0.8
5-Nov	7.50	2.0	0	ovc	15.8	w, calm/var	0.3	30.22	4	66	77	3	2.1
6-Nov	6.25	1.9	0	ovc-mc	12.4	w	4.0	30.13	4	84	86	2	4.0
7-Nov	0.00												
8-Nov	4.00	1.0	0	pc	5.0	w	2.3		4	100	100	0	1.0

[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: 2014.

		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	1	0	0	1	1	0	0	0	0	0	0	4	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	9	1.1
2-Sep	8.00	0	0	2	2	0	0	0	0	0	0	0	7	0	0	0	1	0	0	5	0	0	1	0	0	0	0	0	18	2.3
3-Sep	8.17	0	0	0	2	1	0	0	0	0	0	0	1	0	0	0	1	1	0	2	1	1	1	0	0	0	0	0	11	1.3
4-Sep	8.00	0	0	0	0	1	0	0	0	0	0	0	10	1	0	0	4	0	0	1	1	1	0	0	0	0	0	0	19	2.4
5-Sep	8.00	0	0	5	8	11	1	1	0	0	0	0	11	0	0	0	6	0	0	4	0	0	1	0	0	0	0	1	49	6.1
6-Sep	8.00	0	0	2	7	11	2	1	0	1	0	0	10	0	0	1	2	0	0	6	0	1	1	0	0	0	0	1	46	5.8
7-Sep	8.00	0	0	0	9	0	0	0	0	0	0	0	4	0	0	0	3	0	0	4	0	0	1	0	0	0	0	1	22	2.8
8-Sep	8.00	2	0	1	16	4	0	3	0	0	0	0	15	0	0	3	3	0	0	12	0	0	2	0	0	0	0	1	62	7.8
9-Sep	2.42	0	0	8	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	13	5.4
10-Sep	1.25	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3	2.4
11-Sep	0.00																													
12-Sep	8.00	0	0	0	3	1	0	0	0	0	0	0	2	0	0	2	5	0	0	0	0	0	1	0	0	0	0	0	14	1.8
13-Sep	7.42	0	0	1	2	4	1	0	0	0	0	0	5	0	0	1	2	1	0	0	0	0	0	0	0	0	0	0	17	2.3
14-Sep	7.25	0	0	3	8	8	0	4	0	0	0	0	8	1	0	0	5	5	1	7	0	0	1	0	0	0	0	2	53	7.3
15-Sep	8.00	1	0	5	6	3	0	2	0	0	1	0	6	0	0	0	6	0	0	1	0	0	0	0	0	0	0	0	31	3.9
16-Sep	8.00	0	1	2	9	5	0	0	0	0	0	0	3	0	0	0	1	1	1	8	0	0	0	0	1	0	0	0	32	4.0
17-Sep	8.00	0	0	3	15	8	2	3	0	0	2	0	10	0	0	2	6	0	0	12	1	1	0	0	0	1	0	0	66	8.3
18-Sep	0.00																													
19-Sep	8.00	0	1	0	7	10	1	0	0	0	0	0	6	0	0	3	7	1	0	8	0	0	1	0	0	0	0	0	45	5.6
20-Sep	8.00	1	1	9	10	17	0	0	1	0	0	0	8	0	0	2	4	0	0	16	0	0	0	0	0	0	0	7	76	9.5
21-Sep	8.00	0	0	7	6	1	0	0	0	0	0	0	2	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	19	2.4
22-Sep	6.00	0	0	1	1	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	2	0	1	0	0	0	8	1.3
23-Sep	7.50	0	1	3	23	13	1	5	0	0	8	1	15	0	0	5	15	0	0	10	0	1	2	0	0	1	0	6	110	14.7
24-Sep	7.67	0	0	3	9	8	2	2	0	0	1	0	4	0	0	0	8	1	0	7	1	0	1	0	0	0	1	3	51	6.7
25-Sep	8.00	0	0	1	17	14	1	10	0	0	3	1	12	0	0	3	10	1	0	5	0	1	2	0	0	0	0	5	86	10.8
26-Sep	7.33	1	0	3	32	21	2	7	2	0	1	0	5	0	0	0	3	0	0	10	0	0	0	0	0	0	0	0	87	11.9
27-Sep	0.00																													
28-Sep	0.00																													
29-Sep	5.00	0	1	1	3	2	1	0	0	0	0	0	1	0	0	0	6	1	1	0	0	0	0	0	0	1	0	0	18	3.6
30-Sep	0.00																													

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	0.00																												
2-Oct	5.00	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4	0	0	0	0	1	0	0	0	0	0	0	6	1.2
3-Oct	7.75	0	0	0	3	5	0	1	0	0	0	0	8	0	0	1	25	2	2	0	0	0	0	0	0	0	0	3	50	6.5
4-Oct	7.75	1	0	1	13	14	3	2	0	1	0	0	14	0	2	2	107	5	0	1	1	1	1	0	0	0	0	8	177	22.8
5-Oct	7.75	1	0	1	18	3	3	3	0	0	1	0	3	3	0	1	32	2	1	3	3	0	2	0	0	0	0	3	83	10.7
6-Oct	7.83	0	0	0	12	2	1	0	0	1	0	0	2	1	0	0	79	2	0	1	0	0	0	0	0	0	0	2	103	13.1
7-Oct	8.00	0	1	2	6	1	3	0	0	0	2	0	6	0	0	2	31	0	1	1	0	0	0	0	0	0	0	0	56	7.0
8-Oct	7.33	0	0	4	4	1	0	1	0	0	1	0	1	1	0	3	27	1	0	2	0	0	1	0	0	0	0	3	50	6.8
9-Oct	6.25	0	0	2	2	0	0	0	2	0	0	0	0	0	2	0	42	1	0	0	1	1	0	0	0	0	0	0	53	8.5
10-Oct	8.00	0	0	2	18	6	2	0	0	0	0	0	6	0	1	0	50	3	0	5	2	0	0	0	0	0	0	3	98	12.3
11-Oct	5.33	0	0	1	8	0	0	0	0	0	0	0	0	0	0	0	55	1	0	0	0	0	0	0	0	0	0	2	67	12.6
12-Oct	0.00																												
13-Oct	7.17	0	0	0	6	1	0	0	0	0	0	0	2	0	2	0	84	3	0	0	1	0	0	0	0	0	0	2	101	14.1
14-Oct	7.67	0	0	3	20	2	3	1	0	0	0	0	5	0	3	0	68	5	2	1	5	0	0	0	0	0	0	0	118	15.4
15-Oct	7.25	0	0	0	25	1	1	3	0	3	1	0	1	0	2	0	101	12	0	0	2	0	0	0	0	0	0	2	154	21.2
16-Oct	7.67	0	0	13	5	2	4	0	0	0	0	0	3	0	6	0	19	2	0	0	0	0	0	0	0	0	0	0	54	7.0
17-Oct	7.83	0	0	7	42	0	4	0	0	0	0	0	9	0	25	0	33	4	0	0	1	0	0	0	0	0	0	2	127	16.2
18-Oct	8.00	0	0	4	6	3	0	1	0	0	0	0	4	0	3	3	64	4	0	2	0	0	0	0	0	1	0	2	97	12.1
19-Oct	8.00	0	0	2	4	1	1	0	0	0	0	0	2	0	2	0	18	3	0	0	0	1	0	0	0	0	0	2	36	4.5
20-Oct	8.00	0	0	2	2	2	1	0	0	0	0	0	3	0	2	2	25	1	0	0	2	0	0	0	0	0	0	1	43	5.4
21-Oct	0.00																												
22-Oct	7.50	0	0	0	0	0	0	0	0	1	0	0	5	1	1	0	48	8	0	0	2	0	0	0	0	0	0	1	67	8.9
23-Oct	6.67	0	0	0	3	0	0	2	0	0	0	0	1	0	1	0	51	2	0	1	0	0	0	0	0	0	0	0	61	9.2
24-Oct	0.00																												
25-Oct	7.83	0	0	4	13	8	4	1	0	0	0	0	4	0	6	0	52	3	0	0	1	0	0	0	0	0	0	0	96	12.3
26-Oct	0.00																												
27-Oct	7.08	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0	17	1	0	0	0	0	0	0	0	0	0	0	22	3.1
28-Oct	7.58	0	0	0	0	1	2	0	0	0	0	0	1	0	6	0	17	4	0	0	1	1	0	0	0	0	0	0	33	4.4
29-Oct	5.00	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	2	1	2	0	0	0	0	0	0	0	0	0	7	1.4
30-Oct	6.83	0	0	2	2	0	2	0	0	0	0	0	0	0	5	0	12	3	0	0	0	1	0	0	0	0	0	0	27	4.0
31-Oct	6.75	0	0	1	4	0	6	0	0	0	0	0	3	0	1	1	6	2	0	0	0	0	0	0	0	0	0	0	24	3.6
1-Nov	6.50	0	0	1	6	2	0	0	0	0	0	0	2	0	7	0	17	5	0	0	0	0	0	0	0	0	0	0	40	6.2
2-Nov	0.00																												
3-Nov	6.50	0	0	1	6	2	0	0	0	0	0	0	2	0	7	0	17	5	0	0	0	0	0	0	0	0	0	0	40	6.2
4-Nov	3.58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	3	0.8
5-Nov	7.50	0	0	0	0	0	2	0	0	0	0	0	1	0	3	0	9	1	0	0	0	0	0	0	0	0	0	0	16	2.1
6-Nov	6.25	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	15	5	0	0	1	1	0	0	0	0	0	0	25	4.0
7-Nov	0.00																												
8-Nov	4.00	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	4	1.0
Total	331.83	5	6	94	377	172	56	48	5	6	22	2	176	7	84	33	1200	105	11	102	25	10	15	0	2	4	1	59	2627	7.9

[1] See Appendix A for species codes.

Appendix E. Annual observation effort and fall raptor migration counts by species in the Bridger Mountains, MT: 1991–2014.

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

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

Appendix E. (continued)

	1998	1999	2000	2001	2002	2003	2004
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
Unknown small accipiter[1]	-	-	-	0	11	29	32
Unknown 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
Unknown small falcon[1]	-	-	-	0	0	0	3
Unknown 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
Start date	27-Aug	27-Aug	27-Aug	27-Aug	6-Sep	28-Aug	2-Sep
End date	31-Oct	29-Oct	29-Oct	31-Oct	31-Oct	1-Nov	4-Nov
Observation days	48	45	56	56	44	54	57
Observation hours	300.83	331.25	384.59	415.49	306.25	366.00	411.42
Raptors / 100 hours	674.8	538.3	550.5	427.7	453.2	641.8	695.9
SPECIES			RAPTOR COUNTS				
Turkey Vulture	1	2	1	0	0	2	5
Osprey	2	7	5	4	9	3	14
Northern Harrier	22	50	30	47	52	77	59
Sharp-shinned Hawk	228	344	277	222	230	336	565
Cooper's Hawk	153	182	151	115	113	207	221
Northern Goshawk	22	33	20	22	13	33	15
Unknown small accipiter[1]	92	10	18	43	6	40	22
Unknown large accipiter[1]	4	0	6	10	6	22	3
Unknown accipiter	27	0	5	3	7	25	12
Total accipiters	526	569	477	415	375	663	838
Broad-winged Hawk	3	12	5	7	33	5	12
Swainson's Hawk	0	0	3	8	4	1	2
Red-tailed Hawk	108	89	130	75	75	178	202
Ferruginous Hawk	2	3	5	1	2	3	2
Rough-legged Hawk	40	21	19	32	30	31	28
Unidentified buteo	27	2	11	10	10	20	4
Total buteos	180	127	173	133	154	238	250
Golden Eagle	1061	859	1247	1003	638	1171	1431
Bald Eagle	75	74	85	43	27	50	68
Unidentified eagle	1	1	0	10	4	1	0
Total eagles	1137	934	1332	1056	669	1222	1499
American Kestrel	20	38	41	46	45	87	99
Merlin	7	15	9	10	4	12	17
Prairie Falcon	20	22	17	13	17	18	19
Peregrine Falcon	8	15	8	5	23	8	24
Gyrfalcon	0	0	0	0	0	0	0
Unknown small falcon[1]	27	0	2	2	3	3	0
Unknown large falcon[1]	13	1	3	6	3	2	0
Unknown falcon	13	0	2	2	4	0	2
Total falcons	108	91	82	84	99	130	161
Unidentified raptor	54	3	17	38	30	14	37
Grand Total	2030	1783	2117	1777	1388	2349	2863

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

Appendix E. (continued)

	2012	2013	2014	Mean
Start date	1-Sep	1-Sep	1-Sep	31-Aug
End date	5-Nov	5-Nov	8-Nov	30-Oct
Observation days	58	50	57	51
Observation hours	414.38	335.76	399.67	339.74
Raptors / 100 hours	680.0	688.9	720.4	718.1
SPECIES				RAPTOR COUNTS
Turkey Vulture	2	16	8	2
Osprey	9	13	6	6
Northern Harrier	64	34	112	49
Sharp-shinned Hawk	452	354	422	333
Cooper's Hawk	180	160	203	165
Northern Goshawk	33	16	59	31
Unknown small accipiter[1]	40	28	54	29
Unknown large accipiter[1]	6	2	5	6
Unknown accipiter	12	5	7	24
Total accipiters	723	565	750	571
Broad-winged Hawk	37	48	22	13
Swainson's Hawk	8	4	2	3
Red-tailed Hawk	238	180	239	118
Ferruginous Hawk	4	3	8	3
Rough-legged Hawk	42	34	84	32
Unidentified buteo	12	17	37	12
Total buteos	341	286	392	180
Golden Eagle	1272	1131	1222	1341
Bald Eagle	92	74	106	75
Unidentified eagle	12	3	11	6
Total eagles	1376	1208	1339	1421
American Kestrel	147	104	138	74
Merlin	16	21	28	10
Prairie Falcon	16	8	13	14
Peregrine Falcon	34	29	23	12
Gyrfalcon	0	0	0	0
Unknown small falcon[1]	3	1	2	3
Unknown large falcon[1]	8	2	4	3
Unknown falcon	2	0	1	4
Total falcons	226	165	209	118
Unidentified raptor	77	28	63	31
Grand Total	2818	2315	2879	2379

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