FALL 2001 RAPTOR MIGRATION STUDY IN THE BRIDGER MOUNTAINS, MONTANA

HawkWatch International, Inc.
Salt Lake City, Utah

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INTRODUCTION

The Bridger Mountains Raptor Migration Project in southwestern Montana is an ongoing effort to monitor long-term population trends of raptors using this northern portion of the Rocky Mountain migratory flyway (*sensu* Hoffman et al. in press). Fred Tilly discovered that the Bridger Range was an important fall flyway for raptors. He conducted limited migration counts in 1979, 1980, and 1982. HawkWatch International (HWI) then initiated full-season counts in 1991, with standardized annual monitoring commencing in 1992. This flyway is noted for large concentrations of Golden Eagles. 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 from the 2001 season, which marked the 11th consecutive full-season autumn count of migratory raptors at the site.

The Bridger project was 1 of 15 long-term, annual migration counts (12 fall, 3 spring) and 1 of 8 migration banding studies (6 fall, 2 spring) conducted or co-sponsored by HWI in North America during 2001. The primary objective of these efforts is to track long-term population trends of diurnal raptors throughout primarily western North America (Smith and Hoffman 2000). Raptors feed atop food pyramids, inhabit most ecosystems, occupy large home ranges, and are sensitive to environmental contamination and other human disturbances. Therefore, they serve as important biological indicators of ecosystem health (Cade et al. 1988, Bednarz et al. 1990a, Bildstein 2001). Moreover, due to the remoteness and widespread distribution of most raptor populations, migration counts likely represent the most cost-effective and efficient method for monitoring the regional status and trends of multiple raptor species (Bednarz and Kerlinger 1989, Titus et al. 1989, Bildstein et al. 1995, Dunn and Hussell 1995, Dixon et al. 1998, Smith and Hoffman 2000, Zalles and Bildstein 2000).

STUDY SITE

The Bridger Mountains are a relatively small range that runs primarily along a north–south axis. From Sacagawea 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 the lift that attracts southbound migrating raptors each fall.

The observation site was a helicopter-landing platform atop the Bridger Bowl Ski Area at an elevation of 2,610 m (45° 49.022' N, 110° 55.778' W; Figure 1). The site lies within the Gallatin National Forest on the east slope of the mountain range, about 25 km north of Bozeman and 3 km north of Saddle Peak. The helicopter pad is a 5 m x 5 m wooden platform located approximately 50 m north of an avalanche cache/ski patrol hut. The site is accessed by following a primitive dirt road for 2.5 km (780 m rise in elevation) to the top of the Bridger chairlift, then continuing a short way along a footpath to the observation site at the top of the ridge.

Primary vegetation on top of the Bridger Mountains includes Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*). Limber pine (*Pinus flexilis*) and white-bark pine (*Pinus albicaulis*) also are present. The primary observation site is near tree line. Forested zones are interspersed among rocky bluffs and talus slopes.

METHODS

Weather permitting, two official or designated observers conducted standardized daily counts of migrating raptors from a single, traditional observation site from late August through late October. Observations typically began between 0830–1000 hrs and ended between 1600–1700 hrs Mountain Standard Time (MST). Official observers Ryan Wagner and Jeff Maurer had two and four previous

seasons of experience counting migrating raptors, respectively (see Appendix A for a complete history of official observer participation). Local volunteers occasionally served as substitute observers and other visitors also occasionally assisted with spotting migrants.

The observers routinely recorded the following data:

1. Species, age, sex, and color morph of each migrant raptor, whenever possible and applicable (Appendix B lists common and scientific names for all species, information about the applicability of age, sex, and color morph distinctions, and two-letter codes used to identify species in some tables and figures).
2. Hour of passage for each migrant; e.g., the 1000–1059 hrs MST.
3. Wind speed and direction, air temperature, percent cloud cover, predominant cloud type(s), presence or of precipitation, visibility, and an assessment of thermal-lift conditions, recorded for each hour of observation on the half hour.
4. Predominant direction, altitude, and distance from the lookout of the flight during each hour.
5. Total minutes observed and the mean number of observers present during each hour (included designated observers plus volunteers/visitors who actively contributed to the count [active scanning, pointing out birds, recording data, etc.] for more than 10 minutes in a given hour), recorded on the hour.
6. A subjective visitor-disturbance rating for each hour, recorded on the hour.
7. Daily start and end times for each official observer.

The observers used high quality 7–10x binoculars to assist in spotting and identifying birds. Clark and Wheeler (1987), Dunne et al. (1988), and Wheeler and Clark (1995) served as primary identification references. Assessments of wind speed, cloud type, cloud cover, and flight altitude followed guidelines published by the Hawk Migration Association of North America (HMANA). Assessments of thermal lift conditions as poor, fair, good, or excellent involved subjective evaluations of solar intensity, wind speed, and migrant behavior. All weather variables were recorded on-site.

The observers classified as residents and excluded from daily counts any raptor that exhibited hunting, territorial display, or perching behaviors for extended periods. The observers occasionally recorded as migrants birds that were not moving in a southerly direction, if such birds otherwise displayed migrant characteristics; i.e., continuous flight without stopping or substantially changing directions for several kilometers. Such birds may be dispersing juveniles or adults dispersing relatively short-distances from nesting territories to favored wintering grounds in the same general region. However, we also know from recent satellite telemetry work that species such as Golden Eagles, Prairie Falcons and Ferruginous Hawks frequently "migrate" in non-standard directions to take advantage of favored post-breeding and wintering grounds (Steenhof et al. 1984, personal communication; Watson and Pierce 2000; HWI unpublished data).

For purposes of examining long-term variation in annual count statistics, I manipulated the count data to standardize annual sampling periods and adjust for daily variation in observation effort. The seasonal and daily duration of observation effort can greatly affect count statistics (Hussell 1985, Kerlinger 1989, Bednarz et al. 1990b), and both have varied in the Bridgers during the course of the study, particularly during the first several years of observations. To generally adjust for variation in sampling effort due to inclement weather and other unforeseeable events, before analyzing population trends I converted counts to annual passage rates for each species (adjusted total count / total hours of observation for a given year * 100 = raptors/100 hrs). To further standardize seasonal sampling effort, I defined a consistent annual sample period following conventions proposed by Bednarz and Kerlinger (1989) and Bednarz et al.

(1990b). Specifically, I converted counts to passage rates on a daily basis (raptors/10 hours of observation) to adjust for daily variation in sampling effort, summed daily rates by Julian date across all years, and defined standardized passage periods for each species by eliminating approximately 2.5% from each extreme of the cumulative passage-rate distributions. Because entire count days must be either included or excluded, the defined sample period for a given species included between 95–100% of the detected number of migrants. For some species, the sample periods defined in this way encompassed dates earlier or later than periods of continuous observations. In these cases, I further restricted the adjusted sample periods to between approximate mean starting and ending dates of continuous observations for 1992–2001: 8 September – 29 October.

The observers commonly identified distant or otherwise poorly observed migrants only to genus or other common non-specific groupings (e.g., unidentified eagle or buteo, which each can include multiple genera). Such identifications sometimes constitute a sizeable proportion of the birds seen, especially for accipiters, varying with observer experience and weather conditions. Excluding these birds from population trend analyses may render inaccurate assessments of true flight volume. Accordingly, in preparation for examining trends in annual passage rates, I adjusted the daily counts by distributing incompletely identified birds across relevant species in proportion to the relative abundance of birds identified to each species that day. Hereafter, I refer to as "adjusted" any data based on counts adjusted for incompletely identified birds and/or truncated to standardized annual sampling periods.

In most cases, I limit the analyses in this report to comparing 2001 annual statistics against means ± 95% confidence intervals (CI) for previous seasons, in which case I equate significance with a 2001 value falling outside of the CI for the associated mean. As a general practice, I exclude 1991 data from all long-term comparisons because during this year counts were made from a several different sites, which means the data are not directly comparably to those from subsequent seasons. To provide additional context, I refer to but do not provide in-depth details concerning recently completed analyses of long-term trends in adjusted annual passage rates (manuscript in review for publication). These analyses involved linear and quadratic regressions examining trends in annual passage rates for 1992–2001. I refer to the results of these analyses as not significant ($P > 0.10$), marginally significant ($P < 0.10$), significant ($P \leq 0.05$), or highly significant ($P < 0.01$).

RESULTS

WEATHER SUMMARY

Inclement weather entirely precluded observations on five days and severely restricted (<4 hours) observations on seven other days (see Appendix C for daily weather summaries). Wildfire threat and snow-avalanche danger precluded two other days of observation. This loss of observation time due to weather and related effects matches the average for the past four seasons. Otherwise, the 2001 season featured proportionately more active observation days when mostly cloudy to overcast skies prevailed (38%) and less transitional weather (i.e., skies turned from fair to mostly cloudy or overcast during the day, or vice versa; 29%) than the previous four seasons (average 31% and 37%, respectively). However, the most pronounced difference was that, regardless of the predominant sky condition, 2001 featured a high proportion of days hampered by fog/haze and/or rain/snow (fair skies with fog/haze [mostly wildfire smoke] – 16% of days versus 1997–2000 average of 7%; transitional skies with fog/haze/rain/snow – 16% vs. 6% previously; mostly cloudy to overcast days with fog/haze/rain/snow – 28% vs. 14% previously). The difference did not appear to adversely alter the average estimated visibility, however (72–76 km vs. 1997–2005 average of 75–80 km).

In terms of wind conditions, 2001 featured an above-average proportion of days when light winds (<12 kph) prevailed (88% vs. 1997–2000 average of 70%), and relative reductions in moderate (12% vs. 25% average) and strong winds (>28 kph; 0% vs. 5% average). As is typical, southwesterly to westerly winds were most common (present during a significant portion of 68% of the active observation days), but 2001 featured slightly less southwesterly winds and more northwesterly winds than the average pattern (16% of days included northwest winds vs. 11% previously).

The temperature during active observation periods averaged 12.5°C (the average of daily values, which in turn were averages of hourly readings), ranging from -4.3–29.6°C. The daily average is the second warmest and the daily maximum the warmest for the past five seasons. The on-site barometric pressure during active observation periods averaged 30.05 in Hg (the average of daily values, which in turn were averages of hourly readings), ranging from 29.17–30.52 in Hg. Comparative data were available only for 2000, which showed a lower average (29.88) and maximum (30.31) than in 2001. Fifty-three percent of the active observation days received a median (of hourly ratings) thermal-lift rating of fair to poor and 47% good to excellent, which is average for the site.

In summary, the sky condition data suggested that the 2001 season featured proportionately more overcast skies, fog/haze, and rain/snow during active observation periods than the past four seasons, and a slightly higher prevalence of northwesterly winds also was consistent with greater stormy-weather flow from the northwest. In contrast, however, the wind velocity, temperature, and barometric pressure data suggested that relatively balmy (warmer, lighter winds, and higher pressure) conditions prevailed more frequently than in previous years. This discrepancy suggests that the 2001 season featured greater contrasts in weather conditions through the season than is typical.

OBSERVATION EFFORT

The observers worked on 58 of 66 possible observation days between 27 August and 31 October (Table 1). The number of observation days and hours were 23 and 14% higher than the 1992–2000 averages, respectively (Table 1), but were 2% above and 5% below the 1997–2000 averages, respectively. The 1997 season is when we began to employ a standardized observation period of 27 August to 31 October. One day of observation was missed during the time when primary observer Ryan Wagner was ill, and observations were reduced to less than 4 hours on two other days due to personnel limitations.

The 2001 average of 1.4 observers per hour (includes official and guest observers; value is mean of daily values, which are in turn means of hourly values) was a significant 26% lower than the 1992–2000 average (1.9 ± 95% CI of 0.10). This decline was due to two factors. First, a personnel recruitment glitch (the selected individual arrived on site but quit after the first day due to an inability to handle the daily site-access hike) resulted in our being short-handed for the first two weeks and last seven days of the season. Second, shortly after the second primary observer, Jeff Maurer, arrived on site, Ryan Wagner fell ill and missed 12 days of work. Local volunteers helped fill in some of the gaps, but more than half of the daily counts were conducted by a single observer. This undoubtedly resulted in a lower overall count than would have occurred had the usual two observers been present more of the time. Ultimately, the effect of lower observer numbers can be modeled in a multivariate context; however, no such adjustment is reflected in the results presented herein.

FLIGHT SUMMARY

The observers tallied 2,211 migrant raptors of 15 species during the 2001 season (Table 1, and see Appendix D for daily count records). The count of Broad-winged Hawks (38) reached a record high for the site (see Appendix E for annual count summaries). The 2001 flight was composed of 63% eagles, 20% accipiters, 10% buteos, 4% falcons, 2% harriers, <1% each Ospreys and unidentified raptors. These values represent a significantly higher than average proportion of buteos and a significantly lower than

average proportion of accipiters (Figure 2). The most numerous species were the Golden Eagle (60% of the total count), Sharp-shinned Hawk (12%), Cooper's Hawk (5%), and Red-tailed Hawk (5%). All other species each comprised <5% of the total.

Adjusted passage rates were below average for 13 of 17 commonly observed species in 2001, significantly so for Sharp-shinned Hawks, Cooper's Hawks, Swainson's Hawks, Golden Eagles, and Bald Eagles (Table 1). Only Broad-winged Hawks and Prairie Falcons showed significantly above average rates (Table 1). Regression analyses indicated a marginally significant long-term increasing trend for Broad-winged Hawks (see Smith et al. 2001), marginally significant decreasing trends for Swainson's Hawks and Golden Eagles, and no significant trends for the remaining species (Figures 3–7). The apparent declining trend for Swainson's Hawks may be an artifact of beginning the series with a very high count in 1992 (Figure 5). Otherwise, most species have shown a distinct downturn since 1998 or 1999 (Figures 3–7). Most other HWI monitoring sites in the West show the same pattern of low counts in 2001 and downturns during the last 3–4 years, which probably reflects the cumulative effects of the prolonged drought and extensive wildfires that have plagued the West since 1997/1998.

Among nine species for which comparisons were possible, four species showed below average immature : adult ratios, four species showed below average ratios, and Golden Eagles matched the long-term average (Table 2). However, counts of immature birds were well below average for all species except Broad-winged Hawks and Peregrine Falcons (Table 2). Thus, it would appear that poor nesting success and juvenile recruitment probably contributed to the generally low counts, but the abundance of migrating adults generally was much lower than average also, perhaps indicating that the extended drought also reduced adult survival.

No consistent pattern of variation in seasonal timing emerged this season (Tables 3 and 4). Earlier than average timing appeared slightly more prevalent than late timing, however, possibly reflecting a tendency for early departure due to atypically poor (drought related) foraging conditions on breeding grounds.

RESIDENT RAPTORS

The observers recorded data on local, non-migrating birds reliably only through mid-September, so this season's records were incomplete. To this point, the apparent local community included 1 immature Northern Harrier seen in late August; at least two Sharp-shinned Hawks (at least 1 immature) seen regularly; possibly one Cooper's Hawks seen in late August; at least two adult and four immature light-morph Red-tailed Hawks seen regularly; probably one family group of two adult, one first-year, and one subadult Golden Eagles seen regularly; possibly one immature Bald Eagle seen once in mid-September; a pair of American Kestrels seen regularly; and probably at least one Prairie Falcon seen several times. This is a typical assemblage of local birds for the site, except that local Northern Goshawks also are frequently seen.

VISITOR ATTENDANCE

The fall migration site along the Bridger Range is a popular destination for Bozeman locals, as well as for raptor enthusiasts from the surrounding area. Ninety-seven individuals signed the visitor logs in 2001, 57 during the sixth annual Bridger Raptor Festival, which for the first time in several years was accompanied by decent weather.

Beginning with the fall 2001 season, HWI adopted a new approach to quantifying the influence of visitors on counts at all of its project sites. Encouraging visitation and achieving positive public education and outreach are important goals for all HWI projects; however, during migration counts, visitors can represent a distraction for the official observers that may compromise the integrity of the count. Tolerating a certain level of distraction in the interest of positive outreach is a tradeoff that we gladly accept as part of our operations; however, because the distraction potential fluctuates considerably

through time, it is important that the data we record include a means of quantifying the distraction potential through statistical modeling. Previously, at each site we had the observers estimate the number of visitors present during each hour of active counts. Two primary problems confounded use of this system for quantifying the visitor-distraction factor.

First, during busy periods (in terms of birds to count or visitors present) tracking visitors often became a difficult task for the observers. This difficulty led to both inconsistent estimation and, in some cases, in and of itself represented an unnecessary distraction. Second, careful reflection over the years suggested that simply recording the number of visitors often failed to capture the true effect of specific situations. For example, a single, highly curious, and talkative individual often represents more of a distraction for the observers than a large group of relatively quiet visitors.

In an effort to overcome these limitations, we have adopted a new system for recording visitor effects, whereby the observers record a subjective, visitor-distraction rating for each hour (none, low, moderate, or high). The new system still requires that the observers keep track of the effects of visitors through the hour, but the task is much easier without having to specify numbers. Furthermore, the new rating system allows the observers to incorporate a broader range of input to generate a more representative index of true visitor effects on their performance. Thus, although data-recording protocol changes such as this can be troublesome with regard to analysis of long-term trends, we believe that in the end this new approach to estimating visitor-distraction effects will significantly improve the integrity of our count systems.

In 2001 at the Bridger site, 391 hourly assessments of visitor disturbance resulted in the following ratings: 84% none, 15% low, 1% moderate, and 0% high.

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Table 1. Observation effort, annual fall-migration counts, and adjusted passage rates (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) by species in the Bridger Mountains, MT: 1992–2000 versus 2001.

	1992–2000[1]	2001	%CHANGE	1992–2000[1]	2001	%CHANGE
Start date	3-Sep ± 4.4	27-Aug				
End date	30-Oct ± 0.9	31-Oct				
Observation days	47 ± 6.8	58	+23			
Observation hours	304.37 ± 49.433	347.49	+14			
SPECIES	COUNTS			RAPTORS/100HRS		
Turkey Vulture	1 ± 1.3	0	-100	0.6 ± 0.70	0.0	-100
Osprey	8 ± 3.1	6	-25	4.0 ± 1.55	2.6	-34
Northern Harrier	64 ± 45.3	36	-44	18.5 ± 13.47	13.6	-27
Sharp-shinned Hawk	407 ± 108.4	274	-33	147.6 ± 33.20	106.4	-28
Cooper's Hawk	203 ± 59.4	120	-41	155.0 ± 43.99	101.3	-35
Northern Goshawk	43 ± 16.0	26	-40	15.0 ± 7.18	8.6	-42
Unknown accipiter	40 ± 6.0	27	-32	–	–	–
TOTAL ACCIPITERS	693 ± 161.0	447	-36	–	–	–
Broad-winged Hawk	10 ± 6.7	38	+289	5.1 ± 2.94	21.7	+325
Swainson's Hawk	4 ± 2.3	0	-100	1.6 ± 1.49	0.0	-100
Red-tailed Hawk	123 ± 49.9	117	-5	42.5 ± 14.31	40.3	-5
Ferruginous Hawk	3 ± 1.5	3	+8	0.9 ± 0.48	1.1	+19
Rough-legged Hawk	39 ± 15.4	57	+45	28.9 ± 10.48	40.8	+41
Unidentified buteo	14 ± 4.5	6	-57	–	–	–
TOTAL BUTEOS	192 ± 67.4	221	+15	–	–	–
Golden Eagle	1712 ± 189.5	1330	-22	637.9 ± 37.86	537.4	-16
Bald Eagle	91 ± 16.3	58	-36	33.4 ± 7.16	21.3	-36
Unidentified eagle	9 ± 5.9	2	-78	–	–	–
TOTAL EAGLES	1812 ± 181.4	1390	-23	–	–	–
American Kestrel	96 ± 28.5	62	-35	77.7 ± 21.00	61.9	-20
Merlin	11 ± 4.3	9	-21	7.3 ± 2.56	6.6	-9
Prairie Falcon	14 ± 2.7	14	+1	8.6 ± 2.03	10.9	+27
Peregrine Falcon	9 ± 3.6	8	-15	8.0 ± 3.45	7.3	-9
Gyrfalcon	0.1 ± 0.2	0	-100	–	–	–
Unknown falcon	6 ± 2.7	3	-48	–	–	–
TOTAL FALCONS	137 ± 37.2	96	-30	–	–	–
Unidentified raptor	31 ± 9.9	15	-51	–	–	–
GRAND TOTAL	2938 ± 418.6	2211	-25	–	–	–

[1] Mean ± 95% confidence interval.

Table 2. Fall counts by age class and immature : adult ratios for selected species of migrating raptors in the Bridger Mountains, MT: 1992–2000 versus 2001.

	Total and Age-classified Counts								Immature : Adult	
	1992–2000 Average			2001			% Unknown Age		Ratio	
	Total	Imm.	Adult	Total	Imm.	Adult	1992–2000[1]	2001	1992–2000[1]	2001
Northern Harrier	64	33	13	36	13	7	32 ± 8.5	44	5.3 ± 6.37	1.9
Sharp-shinned Hawk	407	87	157	274	56	60	40 ± 9.6	58	0.6 ± 0.13	0.9
Cooper's Hawk	203	62	59	120	33	30	40 ± 8.8	48	1.0 ± 0.34	1.1
Northern Goshawk	43	16	19	26	6	10	18 ± 8.8	38	1.7 ± 0.92	0.6
Broad-winged Hawk	10	2	3	38	3	12	30 ± 25.0	61	1.3 ± 1.38	0.3
Red-tailed Hawk	123	45	49	117	23	57	23 ± 5.8	32	0.8 ± 0.61	0.4
Golden Eagle	1712	695	638	1330	435	387	22 ± 5.8	38	1.1 ± 0.21	1.1
Bald Eagle	91	32	57	58	25	33	2 ± 20.2	0	0.6 ± 0.16	0.8
Peregrine Falcon	9	0	6	8	2	5	51 ± 20.2	13	0.02 ± 0.02	0.4

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

Table 3. First and last observation, bulk passage, and median passage dates by species for migrating raptors in the Bridger Mountains, MT in 2001, with a comparison of 2001 and 1992–2000 average median passage dates.

	2001				1992–2000
Species	First Observed	Last Observed	Bulk Passage Dates[1]	Median Passage Date[2]	Median Passage Date[3]
Osprey	4-Sep	26-Sep	4-Sep – 26-Sep	15-Sep	14-Sep ± 4.0
Northern Harrier	2-Sep	21-Oct	11-Sep – 30-Sep	16-Sep	19-Sep ± 5.1
Sharp-shinned Hawk	27-Aug	30-Oct	12-Sep – 8-Oct	24-Sep	30-Sep ± 1.9
Cooper's Hawk	29-Aug	7-Oct	10-Sep – 30-Sep	15-Sep	22-Sep ± 3.0
Northern Goshawk	16-Sep	30-Oct	23-Sep – 29-Oct	16-Oct	7-Oct ± 7.2
Broad-winged Hawk	15-Sep	1-Oct	15-Sep – 26-Sep	16-Sep	19-Sep ± 2.9
Red-tailed Hawk	27-Aug	31-Oct	28-Aug – 6-Oct	16-Sep	19-Sep ± 3.3
Ferruginous Hawk	16-Sep	5-Oct	–	–	28-Sep ± 15.7
Rough-legged Hawk	3-Oct	31-Oct	16-Oct – 29-Oct	20-Oct	20-Oct ± 1.9
Golden Eagle	27-Aug	31-Oct	27-Sep – 22-Oct	6-Oct	11-Oct ± 3.2
Bald Eagle	9-Sep	30-Oct	20-Sep – 29-Oct	15-Oct	15-Oct ± 3.3
American Kestrel	27-Aug	7-Oct	10-Sep – 1-Oct	21-Sep	20-Sep ± 3.4
Merlin	16-Sep	28-Oct	16-Sep – 28-Oct	30-Sep	30-Sep ± 3.7
Prairie Falcon	10-Sep	24-Oct	11-Sep – 8-Oct	24-Sep	23-Sep ± 7.4
Peregrine Falcon	22-Sep	6-Oct	22-Sep – 6-Oct	27-Sep	23-Sep ± 3.3
All species	27-Aug	31-Oct	15-Sep – 22-Oct	5-Oct	7-Oct ± 1.8

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

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

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

Table 4. Median passage dates by age for selected species of migrating raptors in the Bridger Mountains, MT: 1992–2000 versus 2001.

	ADULT		IMMATURE	
SPECIES	1992–2000[1]	2001	1992–2000[1]	2001
Northern Harrier	29-Sep ± 4.7	18-Sep	21-Sep ± 7.6	25-Sep
Sharp-shinned Hawk	6-Oct ± 2.4	1-Oct	24-Sep ± 3.8	19-Sep
Cooper's Hawk	1-Oct ± 3.9	18-Sep	19-Sep ± 4.1	16-Sep
Northern Goshawk	7-Oct ± 11.9	23-Oct	29-Sep ± 6.0	24-Sep
Broad-winged Hawk	17-Sep ± 2.0	17-Sep	24-Sep ± 15.7	–
Red-tailed Hawk	25-Sep ± 3.7	24-Sep	19-Sep ± 5.2	18-Sep
Golden Eagle	14-Oct ± 2.7	11-Oct	10-Oct ± 3.5	7-Oct
Bald Eagle	17-Oct ± 3.4	17-Oct	17-Oct ± 3.1	17-Oct
Peregrine Falcon	22-Sep ± 1.7	29-Sep	–	–

Note: Median passage dates are the dates by which 50% of the flight passed; values are given only for species with annual counts ≥5 birds.

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

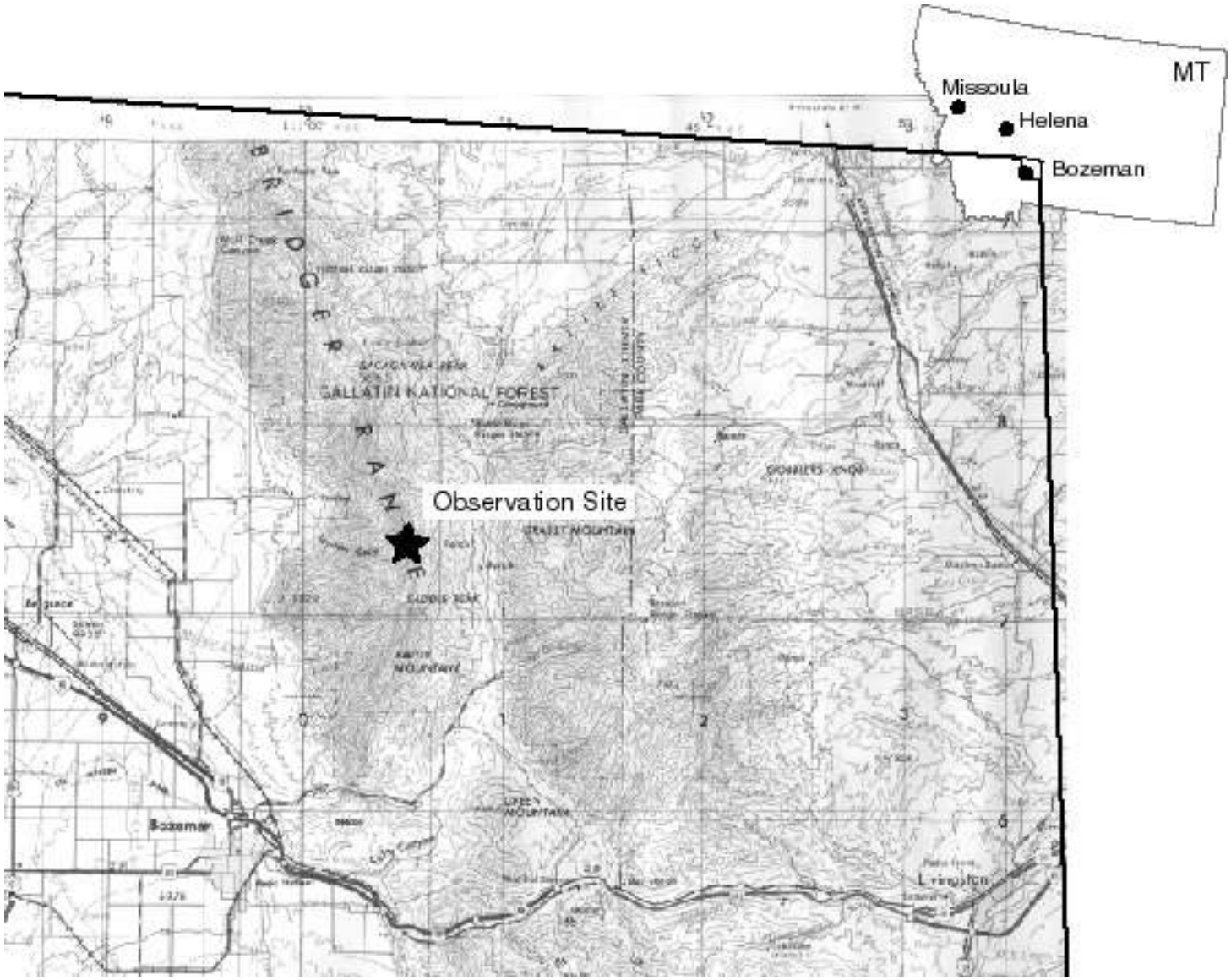

Figure 1. Location of the Bridger Mountains Raptor Migration Project study site.

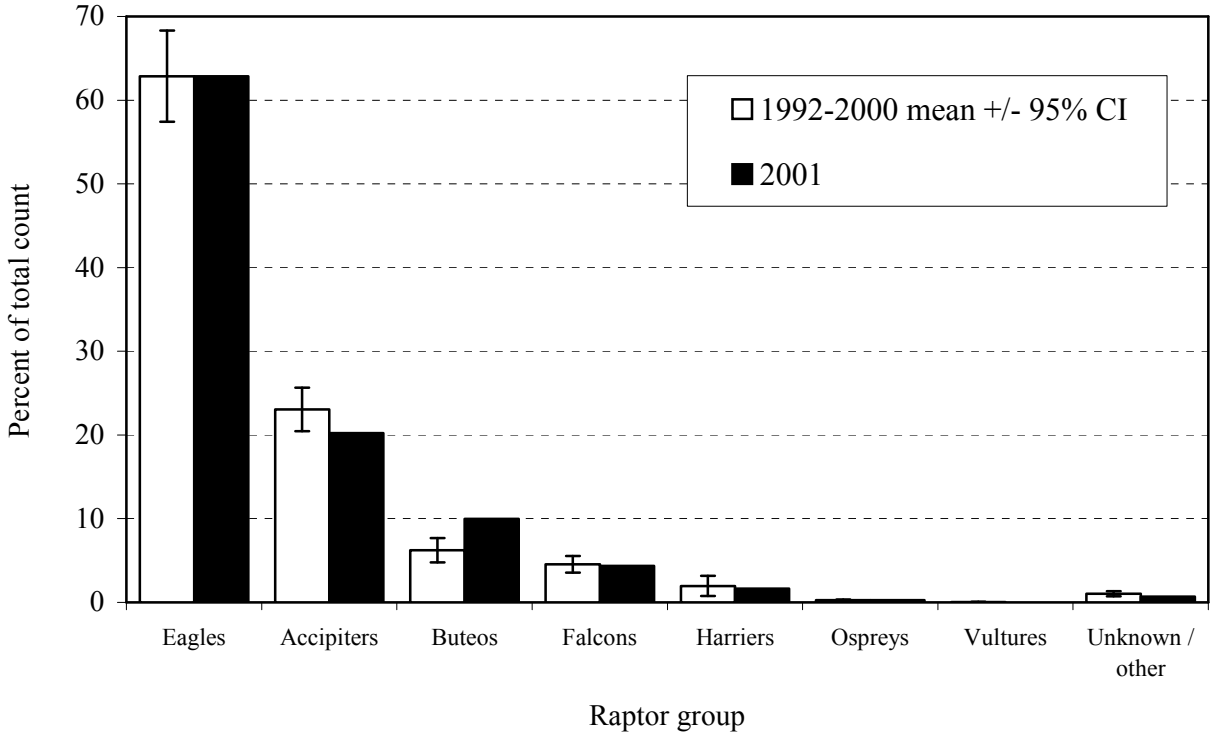

Figure 2. Composition of the fall raptor migration in the Bridger Mountains by major species groups: 1992–2000 versus 2001.

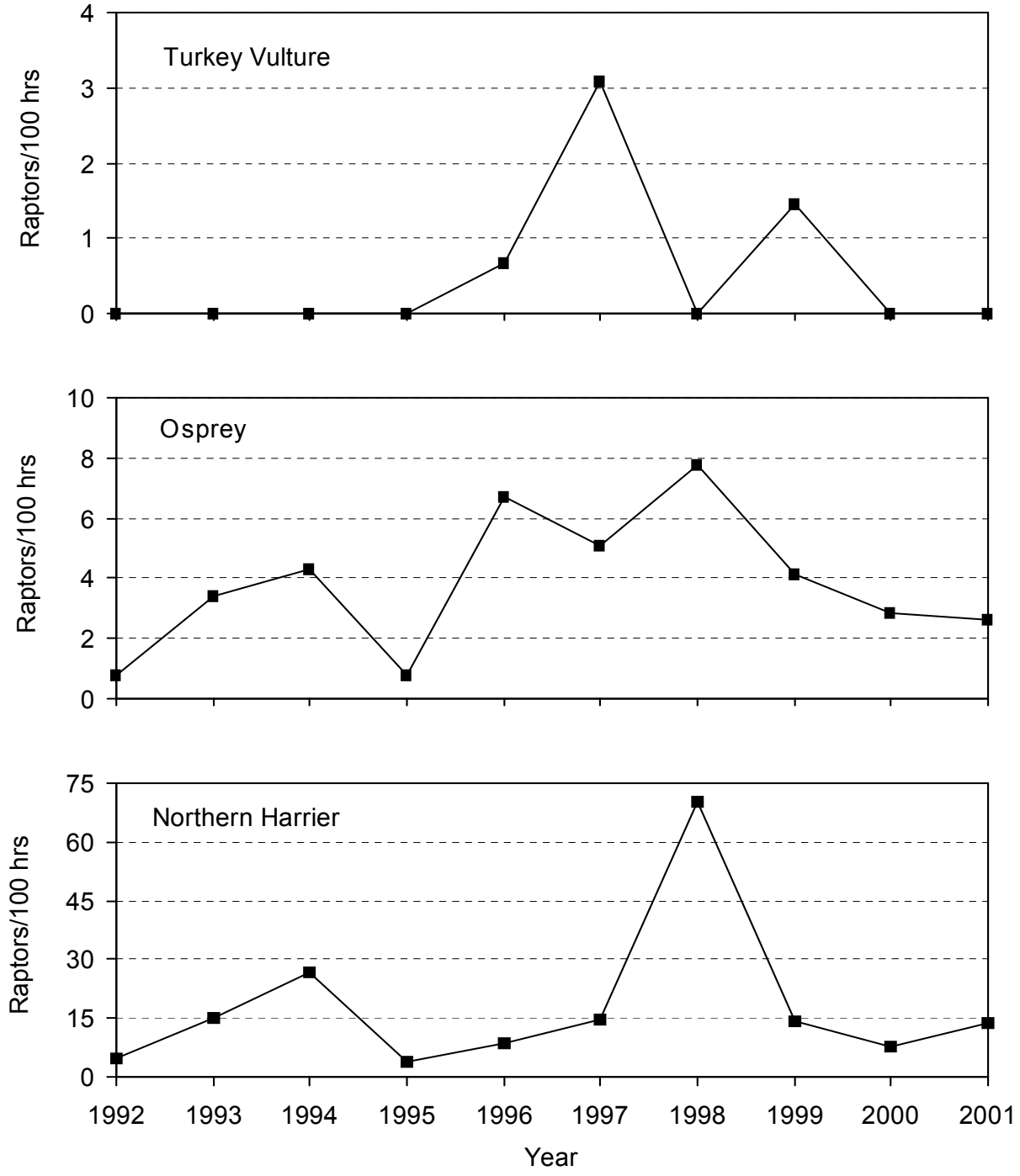

Figure 3. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Turkey Vultures, Ospreys, and Northern Harriers in the Bridger Mountains, MT: 1992–2001. Dashed lines indicate significant ($P \leq 0.10$) regressions.

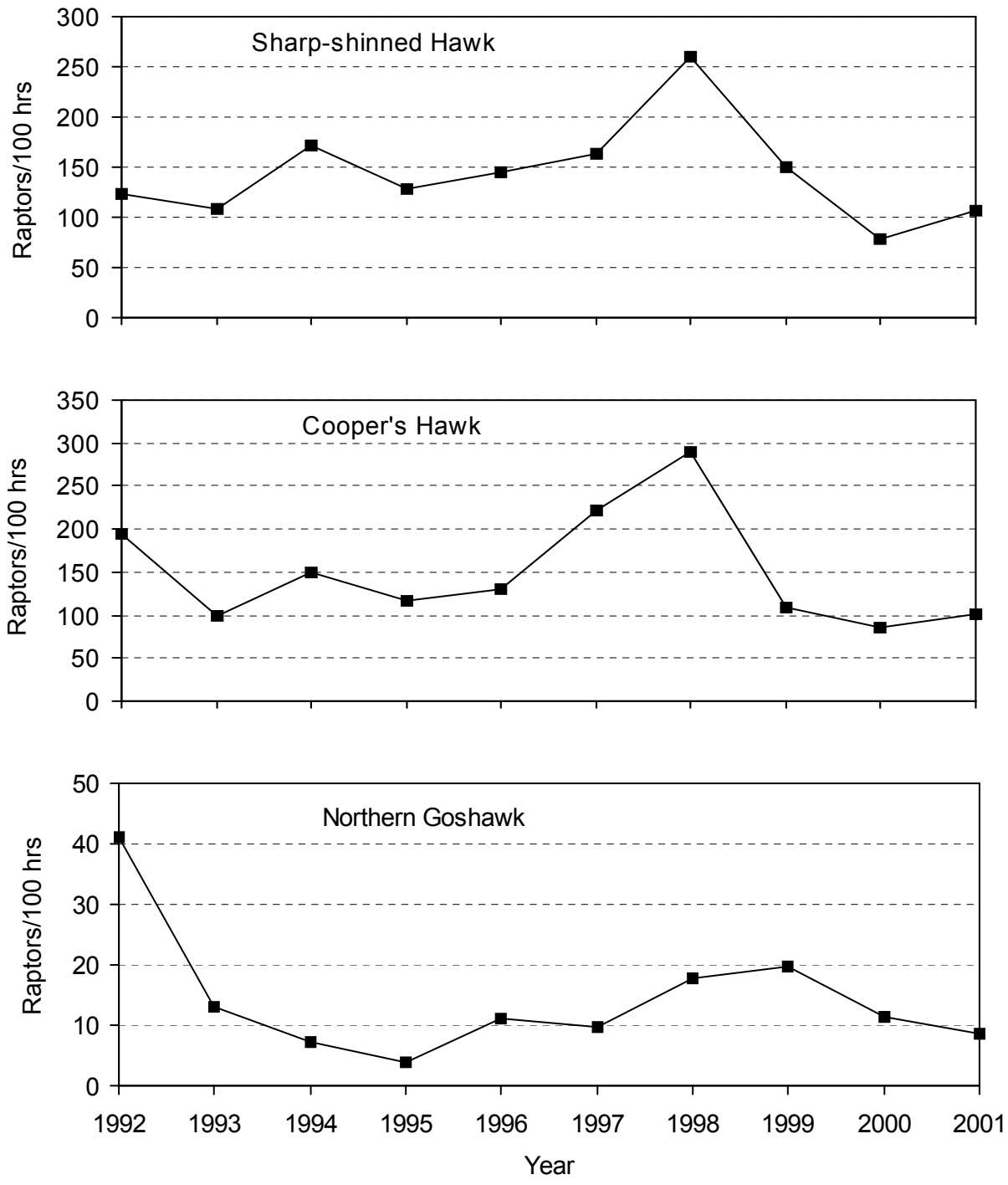

Figure 4. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks in the Bridger Mountains, MT: 1992–2001. Dashed lines indicate significant ($P \leq 0.10$) regressions.

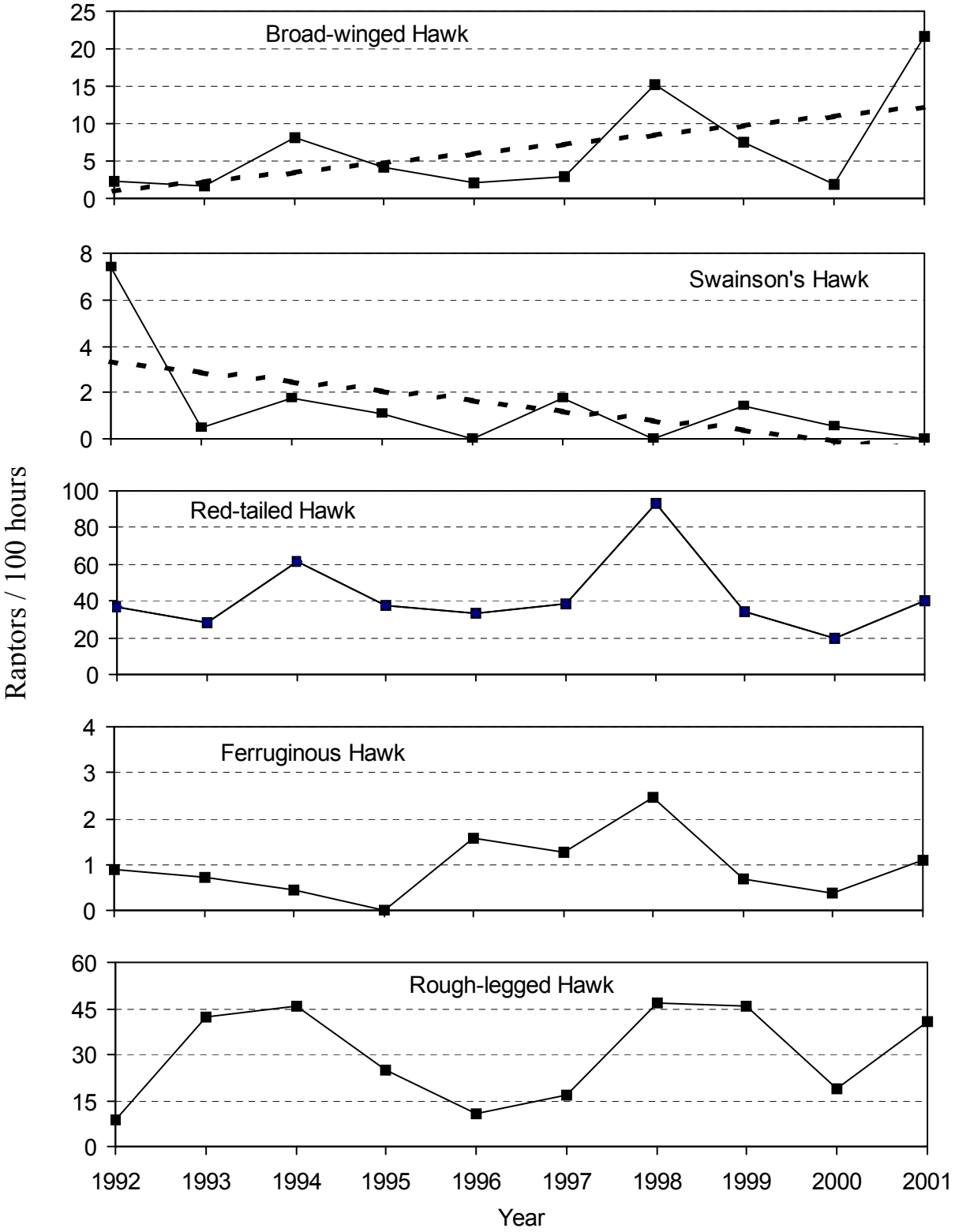

Figure 5. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Broad-winged, Swainson's, Red-tailed, Ferruginous, and Rough-legged Hawks in the Bridger Mountains, MT: 1992–2001. Dashed lines indicate significant ($P \leq 0.10$) regressions.

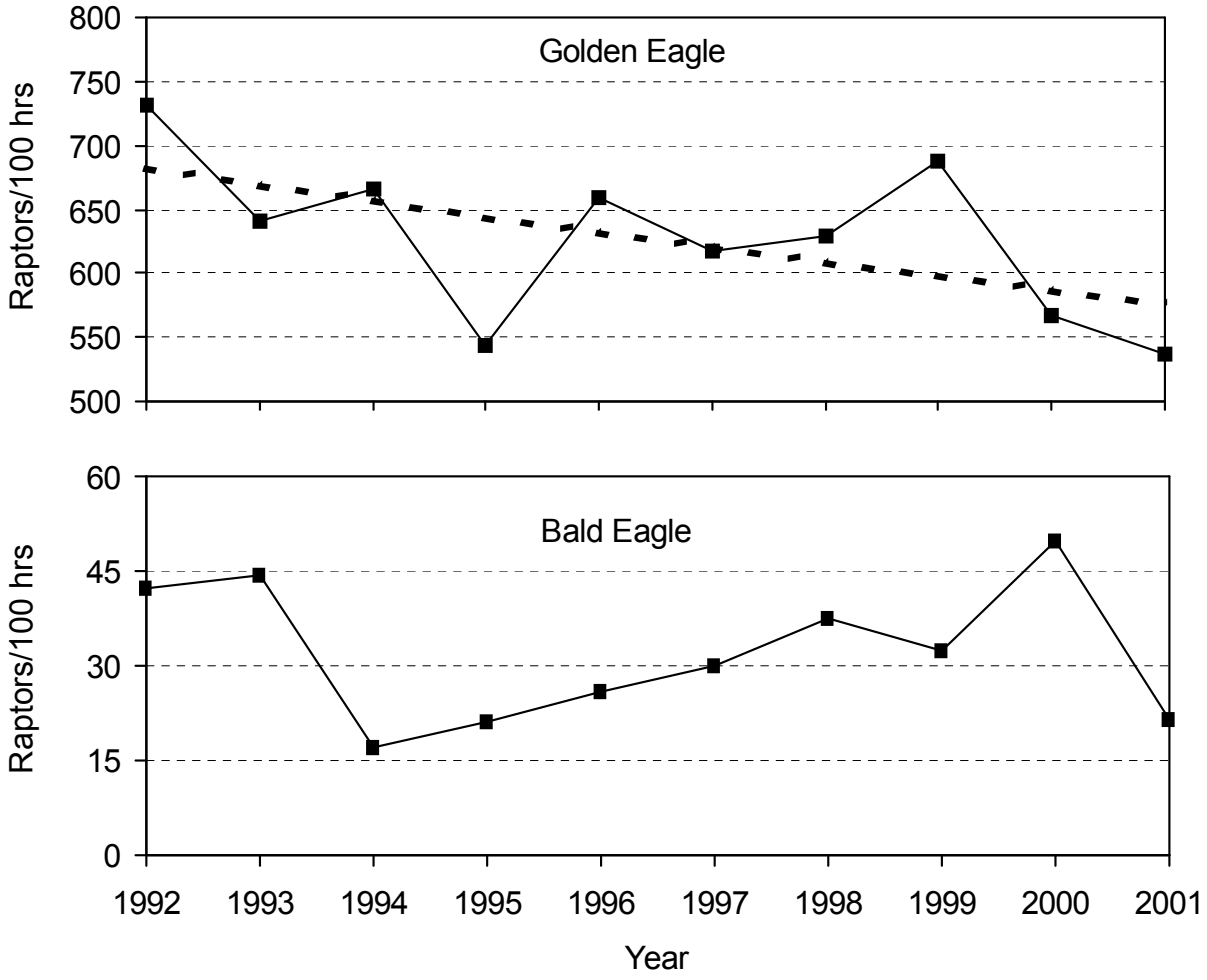

Figure 6. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for Golden and Bald Eagles in the Bridger Mountains, MT: 1992–2001. Dashed lines indicate significant ($P \leq 0.10$) regressions.

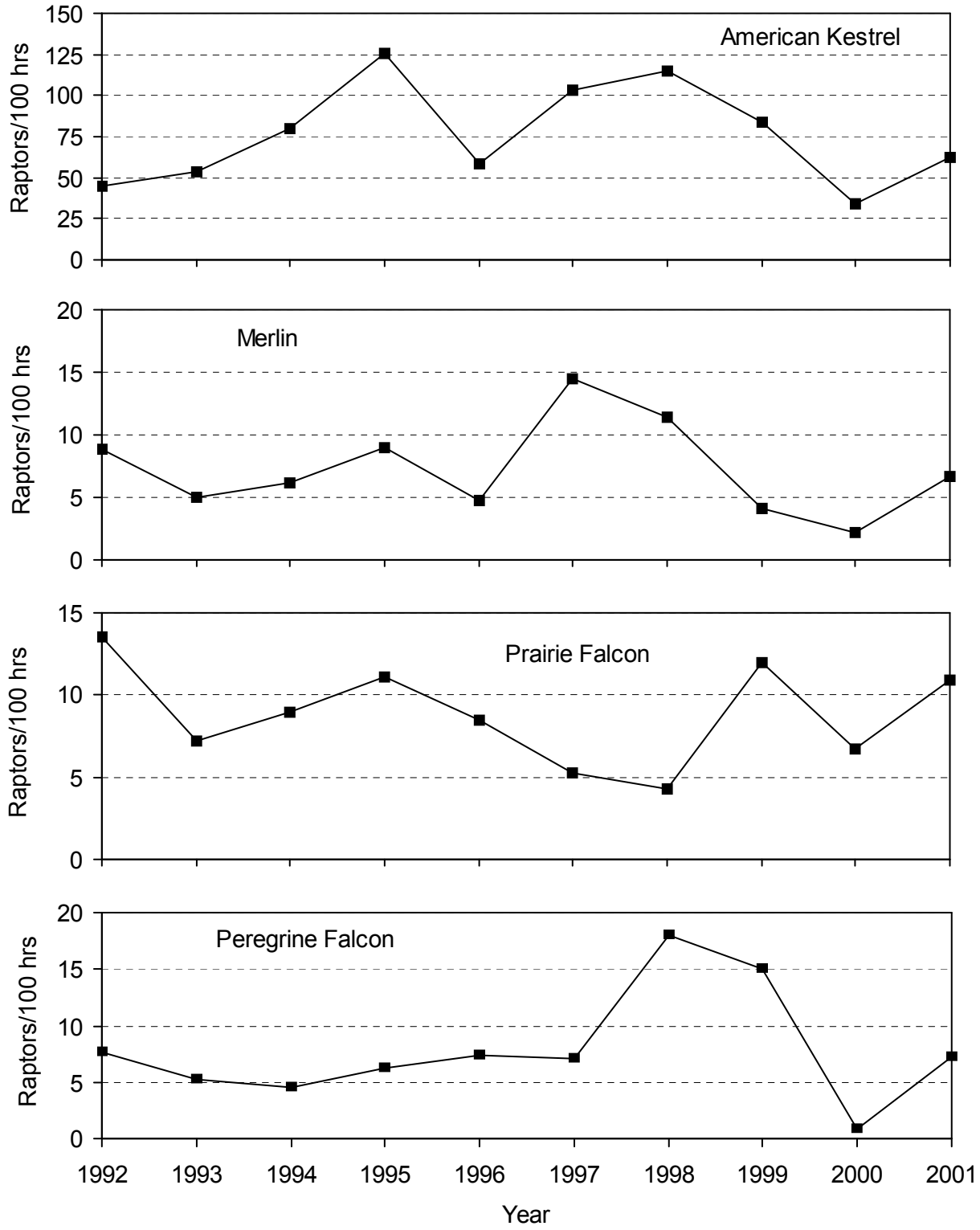

Figure 7. Adjusted (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) fall-migration passage rates for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons in the Bridger Mountains, MT: 1992–2001. Dashed lines indicate significant ($P \leq 0.10$) regressions.

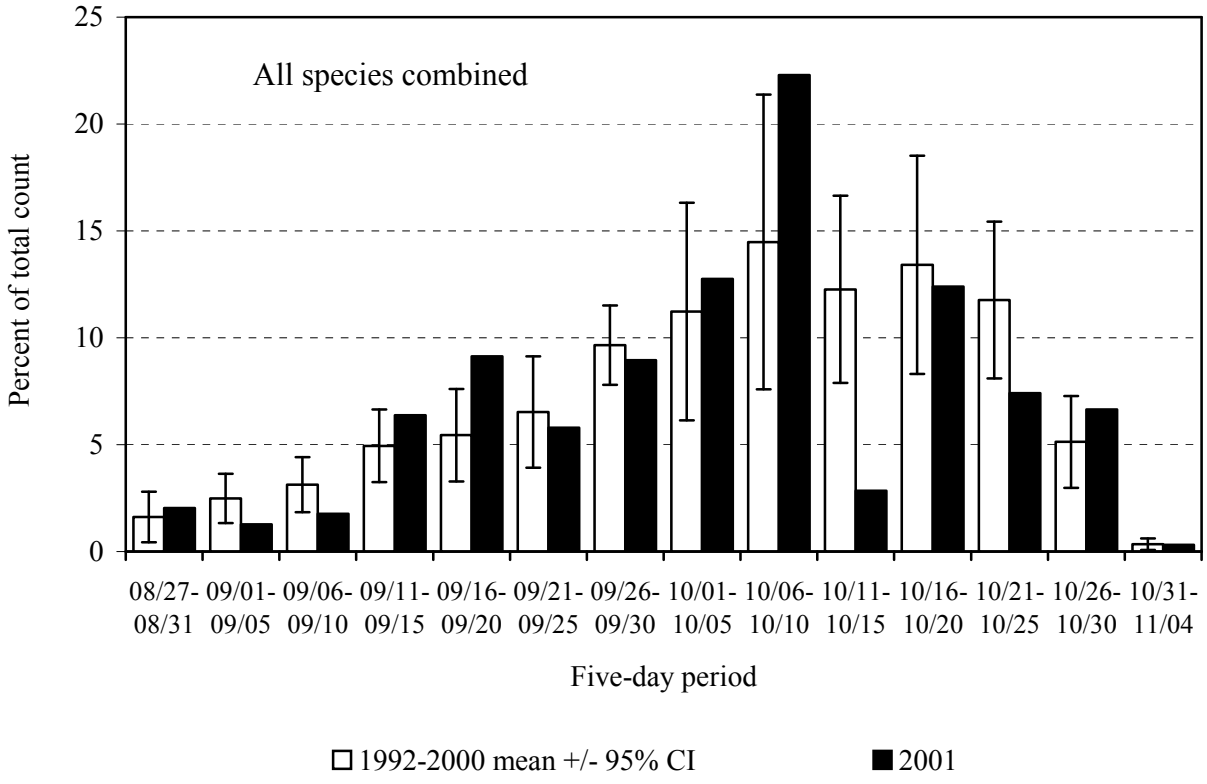

Figure 8. Combined-species, passage volume by five-day periods for migrating raptors in the Bridger Mountains, MT: 1992–2000 versus 2001.

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

1991: Kristian Shawn Omland (0), Phil West (1), LisaBeth Daly (2), Craig Limpach (1)

1992: Emily Teachout (1), Phil West (2)

1993: Adam Kaufman (0), Anne-Marie Gillesberg (0)

1994: Chris Gill (0), Stephanie Schmidt (1)

1995: Scott Harris (0), Sue Thomas (0)

1996: Jason Beason (0), Niels Maumenee (0)

1997: Jason Beason (1), Patty Scifres (0)

1998: Jason Beason (2), Mike Neal (0)

1999: Mike Neal (2), Greg Levandoski (1)

2000: Ryan Wagner (1), Tracy Elsey (0)

2001: Ryan Wagner (2), Jeff Maurer (4)

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

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

Common Name	Scientific Name	Species Code	Age[1]	Sex[2]	Color Morph[3]
Turkey Vulture	*Cathartes aura*	TV	U	U	NA
Osprey	*Pandion haliaetus*	OS	U	U	NA
Northern Harrier	*Circus cyaneus*	NH	A I Br U	M F U	NA
Sharp-shinned Hawk	*Accipiter striatus*	SS	A I U	U	NA
Cooper's Hawk	*Accipiter cooperii*	CH	A I U	U	NA
Northern Goshawk	*Accipiter gentilis*	NG	A I U	U	NA
Unknown small accipiter	*A. striatus* or *cooperii*	SA	U	U	NA
Unknown large accipiter	*A. cooperii* or *gentilis*	LA	U	U	NA
Unknown accipiter	*Accipiter* spp.	UA	U	U	NA
Broad-winged Hawk	*Buteo platypterus*	BW	A I U	U	D L U
Swanson's Hawk	*Buteo swainsoni*	SW	U	U	D L U
Red-tailed Hawk	*Buteo jamaicensis*	RT	A I U	U	D L U
Ferruginous Hawk	*Buteo regalis*	FH	A I U	U	D L U
Rough-legged Hawk	*Buteo lagopus*	RL	U	U	D L U
Unknown buteo	*Buteo* spp.	UB	U	U	D L U
Golden Eagle	*Aquila chrysaetos*	GE	I, S, NA, A, U[4]	U	NA
Bald Eagle	*Haliaeetus leucocephalus*	BE	I, S1, S2, NA, A, U[5]	U	NA
Unknown eagle	*Aquila* or *Haliaeetus spp.*	UE	U	U	NA
American Kestrel	*Falco sparverius*	AK	U	M F U	NA
Merlin	*Falco columbarius*	ML	AM Br	AM U	NA
Prairie Falcon	*Falco mexicanus*	PR	U	U	NA
Peregrine Falcon	*Falco peregrinus*	PG	A I U	U	NA
Gyrfalcon	*Falco rusticolus*	GY	A I U	U	W G D
Unknown small falcon	*F. sparverius* or *columbarius*	SF	U	U	NA
Unknown large falcon	*F. mexicanus* or *peregrinus*	LF	U	U	NA
Unknown falcon	*Falco* spp.	UF	U	U	NA
Unknown raptor	Falconiformes	UU	U	U	NA

[1] Age codes: A = adult, I = immature (HY), Br = brown (adult female or immature), U = unknown age.

[2] Sex codes: M = male, F = female, U = unknown.

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

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

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

Appendix C. Daily observation effort, visitor disturbance ratings, weather records, and flight summaries for the Bridger Mountains Raptor Migration Project: 2001.

Date	Obs. Hours	Obsrvr / Hour[1]	Median Visitor Disturb[2]	Predominant Weather[3]	Wind Speed (kph)[1]	Wind Direction	Temp (°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
27-Aug	6.00	2.0	0	clr-ovc, haze	1.3	e, w	29.6	30.37	1	57	71	2	2.0
28-Aug	6.25	2.0	0	pc/haze	1.3	calm, sw-w	28.4	30.20	1	60	68	2	2.6
29-Aug	6.75	1.9	0	clr/haze	4.3	e-se	24.0	30.20	2	75	71	2	1.2
30-Aug	6.75	1.0	0	clr/haze	9.8	e, w	22.4	30.17	2	63	63	1	1.2
31-Aug	5.50	1.0	0	ovc-clr, haze	1.6	w	23.9	30.18	2	67	70	2	0.2
1-Sep	5.50	1.0	0	pc-ovc, haze	3.9	w	27.7	30.11	3	80	78	2	0.4
2-Sep	6.00	1.0	0	clr-pc, haze	4.9	w	22.4	30.19	2	67	72	2	0.8
3-Sep	3.50	3.5	0	pc/haze	4.8	w-nw	27.6	30.22	2	85	80	2	1.1
4-Sep	7.50	1.0	0	clr-ovc, haze	6.3	e, calm/w	26.9	30.27	3	71	68	2	2.3
5-Sep	0.00			wildfire danger									
6-Sep	0.00			ovc/rain									
7-Sep	0.58	1.0	0	ovc/snow	2.3	sw-w	4.0	29.93	4	30	2	-	0.0
8-Sep	5.50	1.0	0	mc-ovc, AM fog	2.9	w	7.1	30.18	3	94	80	2	1.1
9-Sep	8.00	1.0	0	clr-pc	6.3	w	12.9	30.16	2	100	98	2	2.3
10-Sep	8.00	1.0	0	clr-pc	6.4	w	16.8	30.25	2	98	94	2	1.9
11-Sep	7.00	1.0	0	clr/haze	1.5	calm/w-nw	15.3	30.39	2	91	77	2	5.6
12-Sep	8.00	1.0	0	pc-ovc, haze	0.8	calm/sw-w	18.9	30.34	4	75	66	2	1.4
13-Sep	6.33	1.0	0	ovc-pc, AM rain	7.1	se	15.4	30.28	3	89	87	2	2.1
14-Sep	1.00	1.0	0	ovc, fog/rain	0.0	calm/n	14.0	30.38	4	6	25	1	1.0
15-Sep	7.75	1.7	1	clr-pc	4.9	sw-w	16.3	30.27	1	88	88	2	9.9
16-Sep	8.00	2.0	1	clr-pc	2.9	w	19.2	30.18	2	96	91	2	9.3
17-Sep	7.50	1.9	0	pc	6.6	calm/w	11.0	30.25	2	96	95	2	7.9
18-Sep	7.25	1.0	0	ovc-pc	10.8	w	13.3	-	2	87	57	2	4.4
19-Sep	6.75	1.0	0	mc-ovc, haze	9.5	ssw-w	13.4	30.06	3	91	86	2	4.1
20-Sep	5.00	1.0	1.5	clr-mc	6.3	sw-w	13.7	30.27	1	96	92	2	1.8
21-Sep	4.50	1.0	0	clr-ovc	3.0	wsw	-	-	1	-	-	3	3.6
22-Sep	3.50	1.0	1	clr	6.5	w	19.0	-	1	100	90	3	4.0
23-Sep	6.25	1.0	0	clr	4.1	var, w-nw	18.4	30.44	1	95	93	3	2.9
24-Sep	7.00	1.0	0	pc-mc	4.3	w	21.4	30.44	1	91	90	2	4.4
25-Sep	7.25	1.0	0	pc-ovc	3.1	var	21.6	30.27	2	93	90	2	6.8
26-Sep	6.25	1.0	0	pc/haze	3.6	w	17.1	30.17	2	47	59	2	8.5
27-Sep	5.00	1.0	1	clr-pc	2.4	sw/calm/var	18.7	30.26	2	100	100	var	8.2
28-Sep	6.00	2.0	1.5	mc-ovc, haze	1.3	w/var	18.6	30.15	3	27	29	2	6.0
29-Sep	0.00			personnel limitation									
30-Sep	7.25	3.9	1	clr/haze	2.0	w	14.7	30.52	1	85	36	2	9.4
1-Oct	7.00	2.0	0	clr/haze	7.4	wnw	15.9	30.29	2	61	45	3	17.7
2-Oct	6.25	2.0	1	clr-mc, haze	7.2	wnw	12.8	30.23	2	73	73	2	4.8
3-Oct	5.50	2.3	0	clr-ovc, haze	0.9	calm/w	14.7	30.25	2	72	72	2	5.6
4-Oct	0.00			snow									
5-Oct	7.25	3.0	0	clr	6.6	wnw	3.0	30.14	3	100	98	2	13.4
6-Oct	8.25	1.6	0	pc-mc	6.9	wnw	9.2	30.07	3	88	79	2	31.3
7-Oct	7.50	1.0	0	pc-ovc, haze	6.9	wnw	9.2	29.99	4	84	81	2	12.8
8-Oct	4.50	1.1	0	ovc, fog/snow	7.2	w-wnw	4.8	29.90	4	32	24	2	9.6
9-Oct	0.00			fog/snow									
10-Oct	7.00	1.9	0	pc, ovc late	11.9	wnw	1.1	30.03	3	100	95	2	13.7
11-Oct	0.00			snow									
12-Oct	2.50	1.5	0	ovc, PM fog	18.0	wnw	-0.5	29.79	4	48	28	2	2.0
13-Oct	6.00	1.5	0	mc-ovc	18.6	sw	1.1	29.70	4	100	100	2	9.7
14-Oct	0.00			snow									

Appendix C. continued

Date	Obs. Hours	Obsrvr / Hour[1]	Median Visitor Disturb[2]	Predominant Weather[3]	Wind Speed (kph)[1]	Wind Direction	Temp (°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
15-Oct	0.00			mc- avalanche hazard									
16-Oct	7.00	1.5	0	mc	8.8	sw-wnw	8.8	30.05	4	100	95	2	6.7
17-Oct	7.00	1.8	0	ovc	6.4	sw-wnw	5.3	29.86	4	100	100	2	19.1
18-Oct	7.50	1.7	0	mc-ovc, scat snow	13.0	wnw	4.0	29.85	4	92	100	2	7.5
19-Oct	3.50	1.4	0	ovc/snow	8.1	wnw	3.0	29.82	4	61	81	2	2.3
20-Oct	2.75	1.8	0	mc-ovc, fog/snow	7.4	w-wnw	5.3	29.80	3	19	11	2	10.5
21-Oct	7.50	1.8	0	mc-ovc	7.7	w-wnw	7.0	29.78	4	92	83	2	7.2
22-Oct	6.75	1.7	0	mc-ovc, PM snow	8.3	wnw	4.4	29.60	4	78	67	2	13.8
23-Oct	4.50	0.8	0	ovc/snow	11.7	sw-wnw	-2.6	29.39	4	41	87	3	1.1
24-Oct	5.33	1.0	0	mc-ovc, AM snow	12.4	sw	-4.3	29.79	4	58	94	2	1.3
25-Oct	2.75	1.0	0	ovc/snow	7.4	sw-wnw	-0.6	29.73	4	38	79	2	1.8
26-Oct	7.00	1.0	0	clr-pc	7.4	sw-wnw	7.5	29.88	3	100	98	2	4.9
27-Oct	8.00	1.0	0	clr-ovc	11.6	sw-wnw	7.6	29.60	2	99	94	2	6.0
28-Oct	6.50	1.0	0	ovc, fog/rain/snow	7.9	sw	4.0	29.71	4	29	68	1	0.9
29-Oct	6.50	1.0	0	mc-ovc	6.0	wnw	7.3	29.82	4	92	98	2	5.2
30-Oct	6.25	1.0	0	ovc, PM rain	7.5	ssw-sw	9.4	29.52	4	83	83	2	4.0
31-Oct	3.50	1.0	0	mc-ovc	14.4	ssw-sw	2.0	29.17	4	100	96	2	2.0

[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: 2001.

		Species[1]																											
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
27-Aug	6.00	0	0	0	1	0	0	0	0	1	0	0	5	0	0	1	2	0	0	2	0	0	0	0	0	0	0	0	12	2.0
28-Aug	6.25	0	0	0	2	0	0	0	0	2	0	0	9	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	16	2.6
29-Aug	6.75	0	0	0	2	2	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	8	1.2
30-Aug	6.75	0	0	0	1	1	0	0	0	0	0	0	4	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	8	1.2
31-Aug	5.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0.2
01-Sep	5.50	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0.4
02-Sep	6.00	0	0	1	1	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0.8
03-Sep	3.50	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	4	1.1
04-Sep	7.50	0	2	1	1	5	0	0	0	2	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	17	2.3
05-Sep	0.00																													
06-Sep	0.00																													
07-Sep	0.58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
08-Sep	5.50	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	6	1.1
09-Sep	8.00	0	0	1	4	1	0	0	0	3	0	0	0	0	0	0	6	1	0	2	0	0	0	0	0	0	0	0	18	2.3
10-Sep	8.00	0	0	0	3	3	0	0	0	1	0	0	3	0	0	0	2	0	0	2	0	1	0	0	0	0	0	0	15	1.9
11-Sep	7.00	0	0	3	8	8	0	0	0	4	0	0	3	0	0	0	5	1	0	3	0	1	0	0	0	0	1	2	39	5.6
12-Sep	8.00	0	0	0	2	4	0	0	0	0	0	0	2	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	11	1.4
13-Sep	6.33	0	0	0	3	2	0	0	0	1	0	0	1	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	13	2.1
14-Sep	1.00	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1.0
15-Sep	7.75	0	0	4	26	16	0	0	0	1	6	0	13	0	0	0	8	0	0	3	0	0	0	0	0	0	0	0	77	9.9
16-Sep	8.00	0	1	2	19	17	1	0	0	1	7	0	9	1	0	0	5	0	0	8	1	1	0	0	0	0	0	1	74	9.3
17-Sep	7.50	0	0	6	4	12	0	0	0	1	16	0	4	0	0	0	10	0	0	3	0	1	0	0	0	0	1	1	59	7.9
18-Sep	7.25	0	0	0	9	8	0	0	0	1	1	0	1	0	0	0	8	0	0	2	1	0	0	0	0	0	0	1	32	4.4
19-Sep	6.75	0	1	0	13	1	0	0	0	0	1	0	2	0	0	0	6	0	0	2	1	1	0	0	0	0	0	0	28	4.1
20-Sep	5.00	0	0	0	3	0	0	0	0	0	0	0	1	0	0	0	2	1	0	1	0	1	0	0	0	0	0	0	9	1.8
21-Sep	4.50	0	0	0	5	1	1	0	0	1	0	0	1	0	0	1	5	0	0	0	0	0	0	0	0	0	0	1	16	3.6
22-Sep	3.50	0	1	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	3	0	0	1	0	0	0	0	0	14	4.0
23-Sep	6.25	0	0	1	4	4	1	0	0	0	0	0	4	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	18	2.9
24-Sep	7.00	0	0	2	9	4	1	0	0	0	1	0	2	0	0	0	10	0	0	1	1	0	0	0	0	0	0	0	31	4.4
25-Sep	7.25	0	0	2	19	5	2	0	0	1	1	0	2	0	0	0	14	0	0	2	0	1	0	0	0	0	0	0	49	6.8
26-Sep	6.25	0	1	3	17	4	0	0	0	0	2	0	4	0	0	0	17	0	0	5	0	0	0	0	0	0	0	0	53	8.5
27-Sep	5.00	0	0	2	16	2	0	0	0	1	0	0	3	0	0	0	13	0	0	2	0	1	0	0	0	0	1	0	41	8.2
28-Sep	6.00	0	0	0	8	1	0	0	0	0	0	0	2	0	0	0	14	2	0	5	0	1	3	0	0	0	0	0	36	6.0
29-Sep	0.00																													
30-Sep	7.25	0	0	5	19	6	0	0	0	1	1	0	10	0	0	0	14	3	0	5	0	2	1	0	0	0	0	1	68	9.4

Appendix D. continued

		Species[1]																											
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
01-Oct	7.00	0	0	1	13	2	0	0	0	0	2	0	3	0	0	1	95	1	0	4	1	0	1	0	0	0	0	0	124	17.7
02-Oct	6.25	0	0	0	6	1	0	0	0	0	0	0	2	0	0	0	20	0	0	0	0	0	1	0	0	0	0	0	30	4.8
03-Oct	5.50	0	0	0	2	2	0	0	0	1	0	0	1	0	1	0	23	0	0	0	0	1	0	0	0	0	0	0	31	5.6
04-Oct	0.00																													
05-Oct	7.25	0	0	0	5	0	0	0	0	0	0	0	2	2	0	0	81	5	0	1	0	0	0	0	0	0	0	1	97	13.4
06-Oct	8.25	0	0	0	4	0	0	0	0	1	0	0	3	0	0	2	242	3	1	1	0	0	1	0	0	0	0	0	258	31.3
07-Oct	7.50	0	0	0	4	2	0	0	0	1	0	0	3	0	0	0	79	4	1	2	0	0	0	0	0	0	0	0	96	12.8
08-Oct	4.50	0	0	0	11	0	0	0	0	0	0	0	2	0	0	0	29	0	0	0	0	1	0	0	0	0	0	0	43	9.6
09-Oct	0.00																													
10-Oct	7.00	0	0	1	4	0	0	0	0	0	0	0	0	0	3	0	85	3	0	0	0	0	0	0	0	0	0	0	96	13.7
11-Oct	0.00																													
12-Oct	2.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	1	5	2.0
13-Oct	6.00	0	0	0	1	0	1	0	0	0	0	0	1	0	0	1	53	1	0	0	0	0	0	0	0	0	0	0	58	9.7
14-Oct	0.00																													
15-Oct	0.00																													
16-Oct	7.00	0	0	0	2	0	0	0	0	0	0	0	0	0	2	0	40	3	0	0	0	0	0	0	0	0	0	0	47	6.7
17-Oct	7.00	0	0	0	2	0	7	0	0	0	0	0	1	0	3	0	117	3	0	0	0	0	0	0	0	0	0	1	134	19.1
18-Oct	7.50	0	0	0	2	0	2	0	0	0	0	0	0	0	3	0	49	0	0	0	0	0	0	0	0	0	0	0	56	7.5
19-Oct	3.50	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	1	0	0	0	0	0	0	0	0	0	2	8	2.3
20-Oct	2.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	2	0	0	0	0	0	0	0	0	0	0	29	10.5
21-Oct	7.50	0	0	1	1	0	0	0	0	0	0	0	0	0	20	0	30	0	0	0	2	0	0	0	0	0	0	0	54	7.2
22-Oct	6.75	0	0	0	2	0	2	0	0	0	0	0	2	0	9	0	71	6	0	0	1	0	0	0	0	0	0	0	93	13.8
23-Oct	4.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	5	1.1
24-Oct	5.33	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	5	0	0	0	0	1	0	0	0	0	0	0	7	1.3
25-Oct	2.75	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	0	0	0	0	0	0	0	0	0	0	0	5	1.8
26-Oct	7.00	0	0	0	4	0	4	0	0	0	0	0	0	0	6	0	16	4	0	0	0	0	0	0	0	0	0	0	34	4.9
27-Oct	8.00	0	0	0	1	0	1	0	0	2	0	0	0	0	1	0	42	1	0	0	0	0	0	0	0	0	0	0	48	6.0
28-Oct	6.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	1	0	0	0	0	0	0	0	6	0.9
29-Oct	6.50	0	0	0	5	0	1	0	0	0	0	0	0	0	4	0	17	7	0	0	0	0	0	0	0	0	0	0	34	5.2
30-Oct	6.25	0	0	0	3	0	2	0	0	0	0	0	1	0	1	0	16	2	0	0	0	0	0	0	0	0	0	0	25	4.0
31-Oct	3.50	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	5	0	0	0	0	0	0	0	0	0	0	0	7	2.0
Total	347.49	0	6	36	274	120	26	0	0	27	38	0	117	3	57	6	1330	58	2	62	9	14	8	0	0	0	3	15	2211	6.4

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

Appendix E. Annual observation effort and fall raptor migration counts by species in the Bridger Mountains, MT: 1991–2001.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Mean
Start date	15-Sep	6-Sep	9-Sep	13-Sep	10-Sep	1-Sep	27-Aug	28-Aug	29-Aug	29-Aug	27-Aug	2-Sep
End date	3-Nov	28-Oct	31-Oct	30-Oct	2-Nov	30-Oct	31-Oct	31-Oct	31-Oct	29-Oct	31-Oct	30-Oct
Observation days	32	39	46	36	42	53	62	56	57	52	58	48
Observation hours	191.1	242.58	298.50	239.25	269.17	378.25	422.92	339.33	358.24	335.40	347.49	311.11
Raptors / 100 hours	926.7	1000.1	872.0	1672.3	824.0	808.5	796.1	1040.9	871.8	630.9	636.3	916.3
SPECIES	RAPTOR COUNTS											
Turkey Vulture	3	0	0	0	0	1	6	0	2	0	0	1
Osprey	2	2	5	10	1	14	12	13	9	6	6	7
Northern Harrier	19	13	41	109	10	38	66	230	52	20	36	58
Sharp-shinned Hawk	88	248	279	674	304	436	480	612	442	190	274	366
Cooper's Hawk	87	175	124	247	131	206	347	343	149	109	120	185
Northern Goshawk	27	96	39	25	10	37	36	50	61	34	26	40
Unknown accipiter	70	35	27	35	33	51	53	49	39	35	27	41
TOTAL ACCIPITERS	272	554	469	981	478	730	916	1054	691	368	447	633
Broad-winged Hawk	0	2	3	32	5	5	5	20	13	3	38	11
Swainson's Hawk	1	11	0	6	2	0	6	2	3	3	0	3
Red-tailed Hawk	26	67	65	213	79	106	130	277	121	45	117	113
Ferruginous Hawk	3	1	1	2	0	5	4	7	4	1	3	3
Rough-legged Hawk	9	10	54	53	29	17	23	66	77	26	57	38
Unidentified buteo	14	8	19	24	18	13	20	13	3	8	6	13
TOTAL BUTEOS	53	99	142	330	133	146	188	385	221	86	221	182
Golden Eagle	1280	1579	1699	2275	1322	1871	1844	1516	1870	1429	1330	1638
Bald Eagle	43	95	124	57	57	79	93	95	91	128	58	84
Unidentified eagle	5	2	17	0	25	14	0	15	5	3	2	8
TOTAL EAGLES	1328	1676	1840	2332	1404	1964	1937	1626	1966	1560	1390	1729
American Kestrel	33	38	54	133	117	82	146	141	113	39	62	87
Merlin	2	10	7	11	12	9	26	17	8	3	9	10
Prairie Falcon	9	14	10	20	14	16	10	12	20	9	14	13
Peregrine Falcon	1	7	6	8	7	10	10	18	18	1	8	9
Gyrfalcon	0	0	0	0	0	0	0	0	1	0	0	0
Unknown accipiter	5	3	2	8	2	5	17	8	6	4	3	5
TOTAL FALCONS	50	72	79	180	152	122	209	196	166	56	96	125
Unidentified raptor	44	10	27	59	40	43	33	28	16	20	15	30
GRAND TOTAL	1771	2426	2603	4001	2218	3058	3367	3532	3123	2116	2211	2766