FALL 2001 RAPTOR MIGRATION STUDY IN THE WELLSVILLE MOUNTAINS OF NORTHERN UTAH

HawkWatch International, Inc.
Salt Lake City, Utah

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INTRODUCTION

The Wellsville Mountains Raptor Migration Project in northern Utah is an ongoing effort to monitor long-term population trends of raptors using this northwestern portion of the Rocky Mountain Flyway (*sensu* Hoffman et al. in press). Steve Hoffman and Wayne Potts discovered the Wellsville fall site in 1976 and conducted season-long counts from 1977 through 1979 (Hoffman and Potts 1985). The migration count was suspended from 1980 to 1986, and then reestablished by HawkWatch International (HWI) in 1987. The 25-year span of this effort is a longer period than for any other similar monitoring project in the western United States. To date, 17 species of raptors have been observed migrating along the Wellsville Mountains, with annual counts typically ranging between 2,500 and 5,000 migrants. This report summarizes count results from the 2001 season, which marked the 15th consecutive and 18th overall standardized, full-season, autumn count of migratory raptors at the site.

The Wellsville project was 1 of 15 long-term, annual migration counts (12 fall, 3 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 Wellsville Mountains are situated northeast of the Great Salt Lake, 16 km west of Logan, Utah (41°41'18" N, 112°02'54" W; Figure 1). The single, traditional observation point is located at 2,617 m (8,585 ft) near the northern end of the Wellsville range (Figure 1) and provides a panoramic view in all directions. The lookout is reached by a 5.6 km (3.5 mi) hike up Deep Canyon Trail and then another 1 km (0.6 mi) hike to the north along the ridgetop. The trailhead begins just west of Mendon.

The Wellsvilles are an exceptionally steep, isolated ridge oriented in a north-south direction. Agriculture is the dominant land use in the expansive valleys below. The Great Salt Lake lies 31 km to the southwest. The predominant vegetation types on the slopes of the ridge are subalpine fir (*Abies lasiocarpa*), quaking aspen (*Populus tremuloides*), Douglas fir (*Pseudotsuga menziesii*), bigtooth maple (*Acer grandidentatum*), Rocky Mountain maple (*Acer glabrum*), and Sitka Mountain-ash (*Sorbus sitchensis*). The ridgetop supports few trees, with primary vegetation along the ridgetop consisting of grasses and sagebrush (*Artemisia tridentata*). Consequently, the lookout affords exceptional unobstructed views in all directions.

Many factors make the Wellsville lookout ideal for observing consistent fall flights of migrating raptors. Several ridges to the north serve as "leading lines" (Geyr von Schweppenburg 1963) funneling migrating raptors into the Wellsvilles. In addition, the Great Salt Lake and Great Salt Desert to the west probably serve as barriers to migration. Most species of raptors prefer not to fly over large expanses of water and inhospitable habitat (Kerlinger 1989). If this holds true for raptors navigating the Great Salt Lake, they would most likely divert their migratory flight around either side of the Bonneville Basin (Hoffman 1985), and the Wellsville range is the first ridge northeast of the lake. Migrating raptors find consistent updrafts along steep slopes such as those in the Wellsvilles because ridges deflect winds upward. These

updrafts, combined with rising thermals from the plains below, provide lift that the raptors use to reduce the need for powered flight. By reducing the amount of flapping flight, birds may migrate great distances while minimizing energetic output (Haugh 1972).

METHODS

Two official observers conducted standardized daily counts of migrating raptors from a single, traditional observation site. Observations typically began between 0830 and 0930 hrs Mountain Standard Time (MST) and ended between 1630 and 1730 hrs MST. Neither observer had previous experience counting migrating hawks, but both had good general birding skills and either received preseason training at HWI's Goshute (NV) migration site or early-season, on-the-job training from trained HWI staff and volunteers (see Appendix A for a complete history of observer participation). Visitors also occasionally assisted with spotting and identifying 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 hour, always using Mountain Standard Time.
3. Wind speed and direction, air temperature, barometric pressure, percent cloud cover, predominant cloud type(s), presence of precipitation, visibility estimates, 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 or experienced 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.

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 their nesting territories to favored wintering grounds in the same general region. However, band-return studies and recent satellite telemetry work indicate that species such as Prairie Falcons, Ferruginous Hawks, and Golden Eagles frequently "migrate" in non-standard directions to take advantage of favored

post-breeding and wintering grounds (Steenhof et al. 1984, Watson and Pierce 2000, K. Steenhof personal communication, HWI unpublished data).

The seasonal and daily duration of observation effort can greatly affect count statistics (Hussell 1985, Kerlinger 1989, Bednarz et al. 1990b). To generally reduce potential biases caused by variation in sampling effort due to inclement weather and other unforeseeable events, I convert annual counts to passage rates (total count / total hours of observation * 100 = raptors / 100 hrs) for examining long-term population trends. In addition, because both seasonal and daily effort varied considerably during the first several years of the project, I generally limit comparisons of current and past data to 1991–2001, or in the case of age and sex statistics, to 1992–2001 because pre-1992 class data have not yet been computerized.

Examining trends in annual passage rates across the entire study period also is of interest, however. For this purpose, I standardized seasonal sampling effort 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. I then summed daily rates by Julian date across all years, and defined standardized passage periods for each species as the period during which 95% of migrants passed, 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 often included >95% of the detected number of migrants. For some species, the sample periods defined in this way encompassed dates earlier or later than mean starting and ending dates for observations. In these cases, I further restricted the adjusted sample periods to near minimum starting and ending dates of continuous observations: 2 September – 20 October.

Observers commonly identify 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, prior to analyzing trends in annual passage rates, I also 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 passage rates based on counts truncated to standardized annual sampling periods and adjusted for incompletely identified birds as “adjusted” passage rates.

Previously, HWI had also standardized for variation in daily sampling effort by eliminating counts collected outside the period 1000–1559 hrs MST, which was the limit of coverage during the 1970s. However, recent careful examination of comparative results revealed that this adjustment had little effect on the conclusions rendered, and therefore I have dropped this adjustment.

In most cases, I limit the analyses presented 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 95% CI for the associated mean. To provide additional context, I also 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 included two basic components: *t*-tests (or U-tests where appropriate) comparing mean annual passage rates for 1977–1979 and 1981–2001, and linear or quadratic regressions examining trends in annual passage rates for 1987–2001. I commonly 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 AND DISCUSSION

WEATHER

Heavy rain or snow precluded observations on 6 days, including the last day of the season, 31 October (compared to 7–21 days from 1997–2000—the temporal basis for comparison henceforth) and severely restricted observations (<4 hrs) on only one other day (1–7 days previously; see Appendix C for daily weather records). Rain or snow occurred on only 7% of the active observation days (4–22% previously, average 13%). Otherwise, mostly cloudy to overcast skies predominated on 18% of days (12–20% previously). Transitional weather (i.e., skies changed from primarily fair to mostly cloudy or overcast during the day) occurred on 27% of days (16–41% previously), but a relatively low proportion of these days included some fog, haze, or thundershowers during the day (7% of all days). Fair skies prevailed on 59% of days (43–62% previously) and a moderate proportion of these days included some fog, haze, or thundershowers during the day (20% of all days). Light winds (<12 kph) prevailed on 15%, moderate winds (12–28 kph) on 70%, and strong winds (28 kph) on 15% of days. The comparative averages during the previous four seasons were 58%, 31%, and 11%, indicating that 2001 featured stronger winds than usual. In terms of wind directions, days featuring primarily southwesterly winds predominated (71% of days), which is typical for the site (66% on average for 1997–2000). However, another 20% of days featured variable southwesterly to northwesterly winds and no days featured primarily northeasterly winds, which is not typical (average 5% and 8%, respectively, from 1997–2000). Daily-average (mean of hourly readings) temperatures averaged 15°C, ranging from -1 to 30°C, which is typical for the site. Daily-average (mean of hourly readings) barometric pressure averaged 30.27, ranging from 28.10 to 30.52. Daily-average (mean of hourly readings) visibility averaged 75–78 km (23–94 km previously). The proportion of days rated as good to excellent for thermal lift was average (59% compared to an average of 57% previously).

In summary, the weather in 2001 was average to mild in most respects; however, the winds were overall stronger than usual, west to northwesterly winds were more prevalent than usual, and northeasterly winds, although usually uncommon, almost never occurred in 2001.

OBSERVATION EFFORT

The 2001 season commenced seven days later than usual due to personnel-availability limitations. Otherwise, the observers worked on 59 of 64 possible observation days between 28 August and 30 October (Table 1). Despite the late start, the number of observation days was a significant 11% higher than the 1977–2000 average of 53 ± 95% CI of 3.7 days, and the number of observation hours (488.00) was a significant 38% higher than the 1977–2000 average of 354.13 ± 95% CI of 27.476 hours. The increase in observation effort was due to mild weather and increased daily effort by dedicated observers. The late start undoubtedly caused the observers to miss some early flight activity (generally a small portion of the total), but may have inflated annual passage rate estimates slightly due to proportionately lower coverage of low-activity periods. In contrast, the increased daily effort would typically result in slightly higher numbers of birds detected but proportionally lower passage rates due to increased coverage of early and late hours when flights are typically slow. Thus, in terms of unadjusted, annual counts and passage rates, the two variations in effort may have largely offset one another. Note, however, that the missing first week of data is irrelevant with regard to adjusted counts and passage rates, because the early truncation data was 2 September.

The 2001 average of 1.98 observers per hour (includes official and guest observers; value is mean of daily values, which are in turn means of hourly values) is 1% higher than the 1977–2000 average of 1.95 ± 95% CI of 0.267 observers/hr.

FLIGHT SUMMARY

The observers tallied 2,976 migrant raptors of 17 species during the 2000 season (Table 1, and see Appendix D for daily count records). No record high or low counts occurred this season, although the count of Merlins (20) was the second highest for the study (see Appendix E for annual effort and count summaries).

The 2001 flight was composed of 48% accipiters, 23% falcons, 15% buteos, 8% Northern Harriers, 4% eagles, and <1% each of Ospreys, Turkey Vultures, and unidentified raptors (Figure 2). These proportions reflect significantly higher than representation of accipiters and significantly lower than average representation of buteos. The most numerous species were the Sharp-shinned Hawk (26% of the total count), American Kestrel (21%), Cooper's Hawk (18%), and Red-tailed Hawk (12%).

Annual passage rates were more than 25% below the 1991–2000 averages for all species except Peregrine Falcons (an insignificant 12% above average), with the differences significant for all species except Rough-legged Hawks (Table 1). Statistical analyses of adjusted passage rates from 1977–1979 versus 1987–2001 showed marginally to highly significant increases for Turkey Vulture, Osprey, Broad-winged Hawk, Swainson's Hawk, Red-tailed Hawk, Ferruginous Hawk, Merlin, and Peregrine Falcon, and significant to highly significant decreases for Northern Goshawk, Golden Eagle, and American Kestrel (Figures 3–7). In contrast, linear regression analyses of adjusted passage rates from 1987–2001 showed significant trends only for Peregrine Falcons (continued increase; Figure 7); however, marginally significant or significant quadratic trends were indicated for six species (Osprey, Cooper's Hawk, Swainson's, Red-tailed and Ferruginous Hawks, and American Kestrel). In all cases, the quadratic trends tracked a convex pattern of increases in the late 1980s and early 1990s followed by declines beginning in the mid to late 1990s (Figures 3–5, 7). Furthermore, though not statistically significant, several other species also showed this pattern to some degree (e.g., Turkey Vulture [Figure 3] and Golden Eagle [Figure 6]).

Five of seven species with sufficient data for comparisons showed lower than average immature : adult ratios in 2001, with the differences significant for Northern Goshawk, Red-tailed Hawk, and Peregrine Falcon (Table 2). Moreover, all seven species showed lower than average counts of young birds; significantly higher than average ratios for Cooper's Hawks and Golden Eagles were due to proportionately higher drops in the numbers of adults. This suggests that low productivity and juvenile recruitment may have contributed to the almost universally low total counts. In fact, declines in the abundance of most species since 1997 probably reflect the cumulative effects of the prolonged drought and extensive wildfires that have plagued much of the west during the past 2–3 years. Recent declines are also shown for several species at HWI's Goshute Mountains site in Nevada (Vekasy and Smith 2002).

The combined-species median passage date of 21 September matched the 1991–2000 mean (Table 3). However, the seasonal distribution pattern shows distinctly reduced activity during early September, but higher than average activity during mid and late September (primarily due to large waves of Sharp-shinned, Cooper's and Red-tailed Hawks) and, to a lesser degree, the third week of October (primarily due to a late wave of Sharp-shinned Hawks; Figure 8). Moreover, at the species level, four species showed significantly later than average median passage dates (Turkey Vulture Osprey, Northern Harrier, and Red-tailed Hawk), while four other species showed significantly early timing (Cooper's Hawk, Northern Goshawk, Ferruginous Hawk, and Golden Eagle; Table 3). The indication of early timing for the first four species may partly reflect the late start of observations, because each of these species frequently shows at least modest activity during late August. Otherwise, the only consistent species-group pattern was that all three accipiters showed at least slightly early timing (Table 3). Age-specific median passage dates conformed to the species level indications for Northern Harriers, Cooper's Hawks, Northern Goshawks, Red-tailed Hawks, and immature Golden Eagles, but indicated disparate results for

Sharp-shinned Hawks and adult Golden Eagles (Table 4). The Sharp-shinned Hawk age data indicated the opposite pattern for both adults and immatures (late passage) compared to the species-level result. This suggests that the observers' ability to age this species improved during the season. This could reflect improving ability, but if so, one would expect the same result to apply to the Cooper's Hawk, which is both similar looking and shows similar passage timing. Alternatively, the detectability of sharp-shins may have improved during the season due to unique changes in the species' predominant flight paths or altitudes.

RESIDENT RAPTORS

This season, resident raptors included a family of Red-tailed Hawks (two adults and an immature) that were routinely seen on the east side of the ridge through the first week of October. A family of American Kestrels (two adults, an immature male, and two immature females) and a single adult Sharp-shinned Hawk were seen throughout September to the north and west of the count site. Two Cooper's Hawks (one adult and one immature) frequented the Deep Canyon area during September. Five Golden Eagles (two adults, one subadult, and two immatures) were present throughout the season, generally to the west of the ridge and over the adjacent agricultural fields. This is a fairly typical assemblage for the site; however, the abundance of Red-tailed Hawks was considerably less than last season, and local goshawks and Peregrine Falcons have been recorded in previous years.

VISITATION

A total of 139 individuals visited the project site in 2001, with six making repeat visits; this is an above-average visitation rate for the site. Most visitors originated in Utah, but others came from Nevada, Oregon, Alaska, and Idaho. Organized groups included a class from the School of Natural Learning in Mendon, Utah, and a high school science class from Providence, Utah. Interacting with visitors, affording them an opportunity to experience field research first hand, and instilling in them a passion for raptors is one of the most rewarding aspects of HWI's migration projects. It is therefore very gratifying for HWI to see high visitation levels.

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 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 either birds to count or visitors present) tracking visitor numbers 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 simply 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 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 Wellsvilles, 503 hourly assessments of visitor disturbance resulted in the following ratings: 76% none, 14% low, 7% moderate, and 3% high. At the Wellsvilles, dealing effectively with visitors has never been a huge problem because of modest visitation rates and flight volumes; however, unlike at many other HWI sites where on-site educators facilitate visitor interactions, the Wellsville observers must themselves deal with all aspects of visitor coordination. Moreover, our Wellsville observers have historically been relatively novice individuals with regard to migration counting, and are therefore perhaps inherently less well equipped to interact with visitors and maintain a consistent count effort. For these reasons, when occasional groups or highly interactive guests do visit the site, the potential for observer distraction can be significant. Thus, it was gratifying to see that the disturbance ratings recorded in 2001 indicated primarily a low to nonexistent effect.

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Table 1. Annual counts and passage rates by species: 1991–2000 versus 2001.

	COUNTS			BIRDS / 100 HRS		
SPECIES	1991–2000[1]	2001	% CHANGE	1991–2000[1]	2001	% CHANGE
Turkey Vulture	29 ± 7.2	26	-9	7.3 ± 1.79	5.3	-27
Osprey	34 ± 4.7	27	-19	8.7 ± 1.53	5.5	-37
Northern Harrier	331 ± 67.7	230	-30	85.3 ± 17.84	47.1	-45
Sharp-shinned Hawk	938 ± 92.1	764	-19	241.3 ± 22.46	156.6	-35
Cooper's Hawk	621 ± 85.9	545	-12	160.5 ± 24.86	111.7	-30
Northern Goshawk	26 ± 10.9	15	-41	6.4 ± 2.47	3.1	-52
Unknown small accipiter[2]	–	87	–	–	17.8	–
Unknown large accipiter[2]	–	2	–	–	0.4	–
Unidentified accipiter	56 ± 19.0	0	–	14.5 ± 4.63	0.0	–
TOTAL ACCIPITERS	1640 ± 181.3	1413	-14	422.7 ± 47.98	289.5	-31
Broad-winged Hawk	5 ± 2.5	1	-81	1.3 ± 0.61	0.2	-84
Swainson's Hawk	229 ± 108.0	61	-73	60.8 ± 30.45	12.5	-79
Red-tailed Hawk	743 ± 136.6	357	-52	191.5 ± 35.80	73.2	-62
Ferruginous Hawk	14 ± 3.5	6	-56	3.6 ± 1.01	1.2	-65
Rough-legged Hawk	2 ± 1.0	2	-5	0.6 ± 0.28	0.4	-26
Unidentified buteo	21 ± 6.4	19	-8	5.3 ± 1.54	3.9	-26
TOTAL BUTEOS	1013 ± 219.6	446	-56	263.0 ± 61.98	91.4	-65
Golden Eagle	210 ± 57.7	122	-42	53.6 ± 13.14	25.0	-53
Bald Eagle	5 ± 2.8	0	-100	1.3 ± 0.66	0.0	-100
TOTAL EAGLES	216 ± 59.4	122	-43	54.9 ± 13.49	25.0	-54
American Kestrel	909 ± 180.0	623	-31	232.9 ± 42.49	127.7	-45
Merlin	14 ± 2.9	8	-42	3.5 ± 0.69	1.6	-54
Prairie Falcon	19 ± 4.3	16	-16	5.0 ± 1.31	3.3	-34
Peregrine Falcon	11 ± 3.6	16	+40	2.9 ± 0.93	3.3	+12
Unknown small falcon[2]	–	6	–	–	1.2	–
Unknown large falcon[2]	–	6	–	–	1.2	–
Unidentified falcon	3 ± 1.7	2	–	0.8 ± 0.43	0.4	–
TOTAL FALCONS	957 ± 178.1	677	-29	245.1 ± 41.97	138.7	-43
Unidentified raptor	15 ± 6.5	15	+1	3.8 ± 1.67	3.1	-19
GRAND TOTAL	4233 ± 561.7	2956	-30	1090.8 ± 149.45	605.7	-44

[1] Mean ± 95% confidence interval.

[2] These categories represent new distinctions initiated as standard practice in 2001 (see Appendix B for classification details).

Table 2. Annual counts by age classes and immature : adult ratios for selected species: 1992–2000 versus 2001.

	Total and Age-classified Counts						% Unknown Age		Immature : Adult Ratio	
	1992–2000 Average			2001						
	Total	Imm.	Adult	Total	Imm.	Adult	1992–2000[1]	2001	1992–2000[1]	2001
Northern Harrier	320	170	84	230	108	68	21 ± 5.0	23	2.42 ± 1.046	1.59
Sharp-shinned Hawk	931	362	374	764	268	344	21 ± 6.8	20	1.09 ± 0.417	0.78
Cooper's Hawk	620	236	232	545	231	127	25 ± 10.1	34	1.24 ± 0.495	1.82
Northern Goshawk	26	13	7	15	6	6	29 ± 13.9	20	3.12 ± 1.315	1.00
Broad-winged Hawk	5	1	2	1	0	1	–	–	–	–
Red-tailed Hawk	724	296	343	357	68	249	12 ± 3.4	11	0.91 ± 0.350	0.27
Ferruginous Hawk	13	4	3	6	0	0	54 ± 19.9	100	2.63 ± 2.719	–
Golden Eagle	201	93	93	122	68	38	7 ± 2.1	13	1.04 ± 0.209	1.79
Peregrine Falcon	12	2	2	16	1	6	67 ± 10.0	56	1.33 ± 0.512	0.17

[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 observed, bulk passage, and median passage dates by species for 2001, with a comparison of 2001 and 1991–2000 average median passage dates.

	2001				1991–2000
Species	First Date Observed	Last Date Observed	Bulk Passage Dates[1]	Median Passage Date[2]	Median Passage Date[3]
Turkey Vulture	28-Aug	1-Oct	28-Aug – 28-Sep	27-Sep	5-Sep ± 6.2
Osprey	30-Aug	7-Oct	31-Aug – 28-Sep	17-Sep	11-Sep ± 2.0
Northern Harrier	28-Aug	30-Oct	9-Sep – 19-Oct	28-Sep	24-Sep ± 2.7
Sharp-shinned Hawk	28-Aug	29-Oct	14-Sep – 19-Oct	25-Sep	25-Sep ± 2.4
Cooper's Hawk	28-Aug	27-Oct	14-Sep – 6-Oct	19-Sep	25-Sep ± 2.4
Northern Goshawk	3-Sep	28-Oct	3-Sep – 24-Oct	12-Sep	27-Sep ± 5.1
Broad-winged Hawk	18-Sep	18-Sep	–	–	21-Sep ± 1.6
Swainson's Hawk	2-Sep	1-Oct	10-Sep – 28-Sep	14-Sep	15-Sep ± 5.7
Red-tailed Hawk	28-Aug	20-Oct	7-Sep – 14-Oct	26-Sep	19-Sep ± 1.4
Ferruginous Hawk	7-Sep	19-Sep	7-Sep – 19-Sep	9-Sep	16-Sep ± 5.8
Rough-legged Hawk	15-Oct	17-Oct	–	–	–
Golden Eagle	28-Aug	24-Oct	4-Sep – 19-Oct	27-Sep	1-Oct ± 1.9
American Kestrel	28-Aug	19-Oct	4-Sep – 1-Oct	18-Sep	18-Sep ± 2.7
Merlin	28-Aug	16-Oct	28-Aug – 16-Oct	2-Oct	29-Sep ± 3.0
Prairie Falcon	28-Aug	18-Oct	28-Aug – 10-Oct	15-Sep	13-Sep ± 5.3
Peregrine Falcon	28-Aug	4-Oct	28-Aug – 1-Oct	10-Sep	10-Sep ± 4.1
Total	28-Aug	30-Oct	8-Sep – 16-Oct	21-Sep	21-Sep ± 1.3

[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 and sex classes for selected species: 1991–2000 versus 2001.

	1991–2000 MEAN ± 95% CI (DAYS)	2001	1991–2000 MEAN ± 95% CI (DAYS)	2001
SPECIES	ADULT		IMMATURE / SUBADULT	
Northern Harrier	29-Sep ± 3.6	3-Oct	24-Sep ± 3.6	23-Sep
Sharp-shinned Hawk	30-Sep ± 2.6	9-Oct	16-Sep ± 3.2	19-Sep
Cooper's Hawk	30-Sep ± 3.2	26-Sep	18-Sep ± 3.3	18-Sep
Northern Goshawk	30-Sep ± 11.5	13-Sep	28-Sep ± 6.3	2-Sep
Red-tailed Hawk	25-Sep ± 1.1	28-Sep	12-Sep ± 2.6	17-Sep
Golden Eagle	4-Oct ± 2.4	5-Oct	30-Sep ± 2.9	25-Sep
Peregrine Falcon	–	1-Sep	–	
	MALE		FEMALE	
Northern Harrier adult	29-Sep ± 8.3	11-Oct	23-Sep ± 12.4	3-Oct
American Kestrel	23-Sep ± 3.0	25-Sep	13-Sep ± 3.0	14-Sep

Note: Median passage date is the date by which 50% of the flight had passed; values are based only on annual counts ≥ 5 birds.

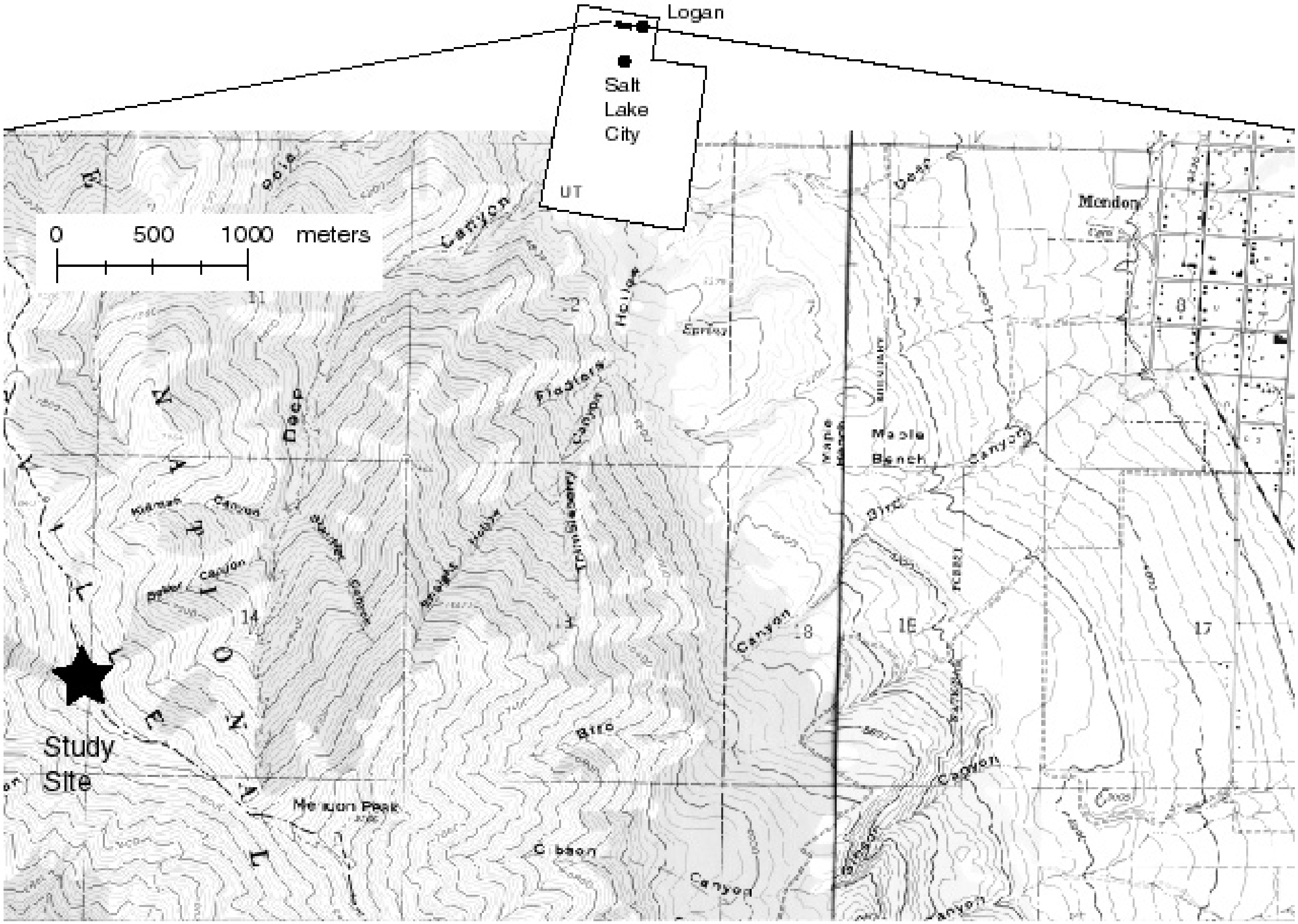

Figure 1. Location of the Wellsville project site in northern Utah.

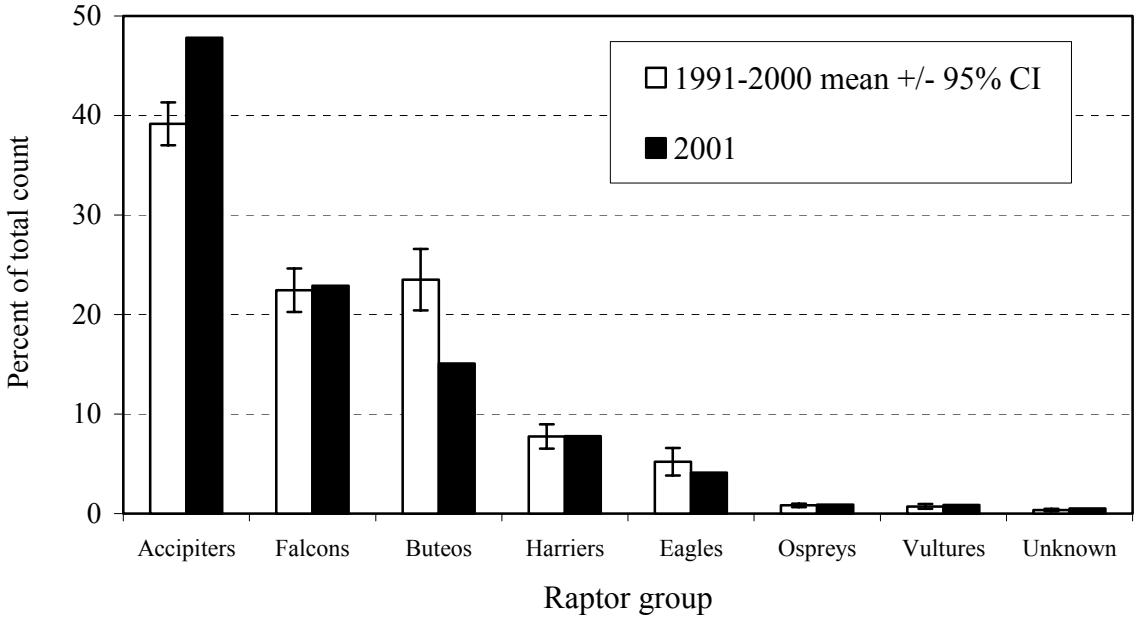

Figure 2. Fall flight composition by major species groups: 1991–2000 versus 2001.

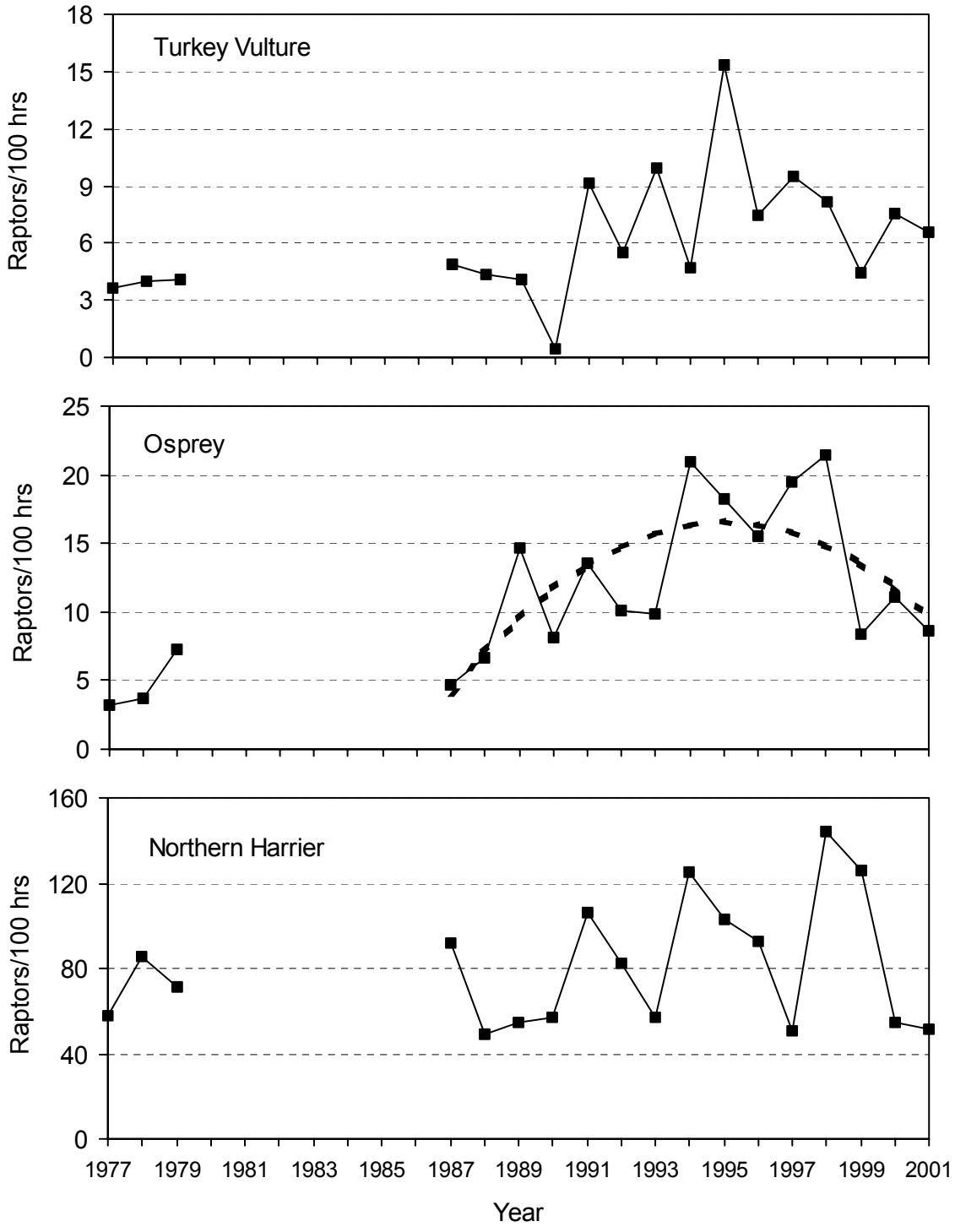

Figure 3. Adjusted annual passage rates for Turkey Vultures, Ospreys, and Northern Harriers: 1977–2001. Dotted lines indicate significant regression fits.

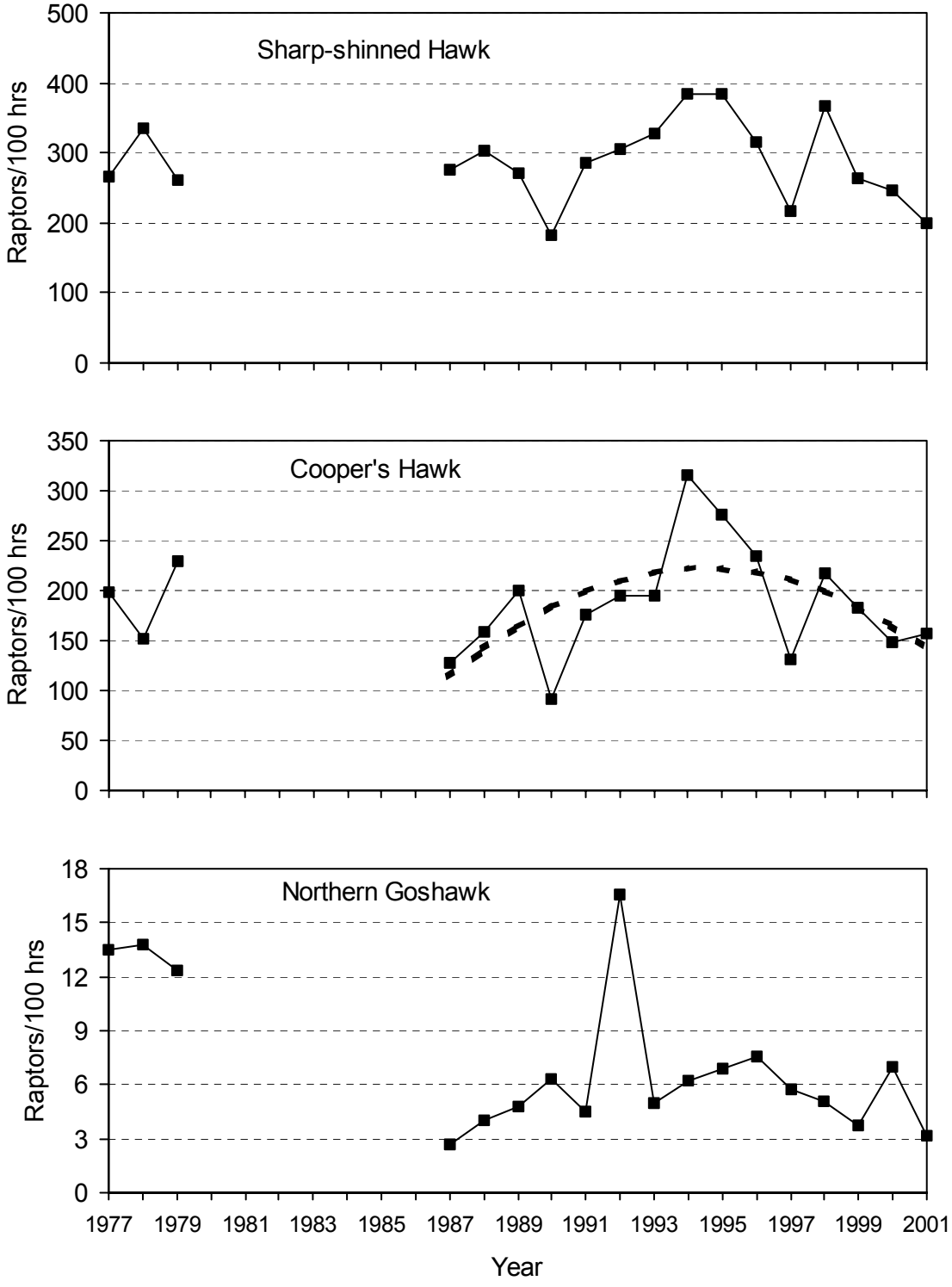

Figure 4. Adjusted annual passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks: 1977–2001. Dotted lines indicate significant regression fits.

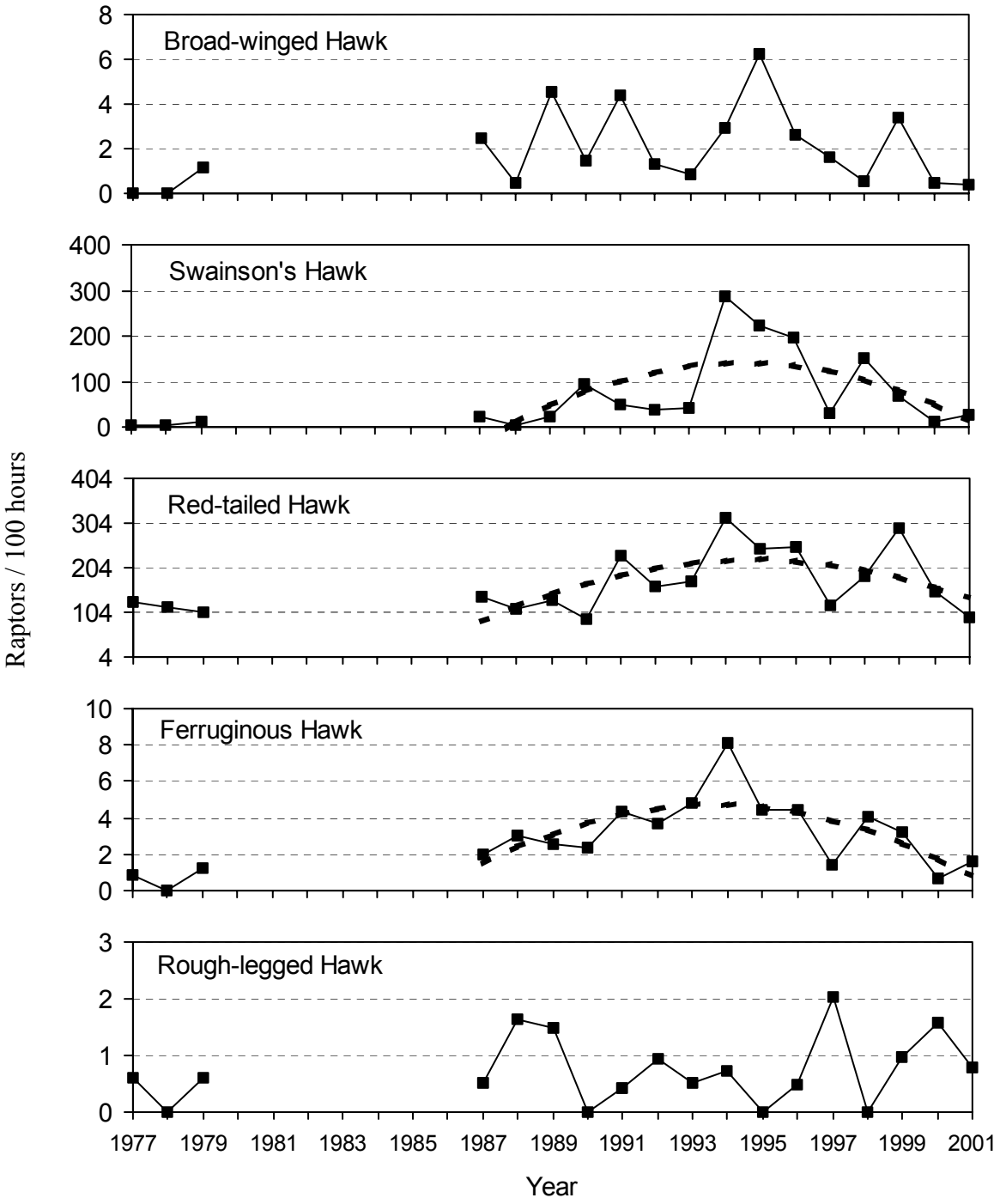

Figure 5. Adjusted annual passage rates for Broad-winged, Swainson's, Red-tailed, Ferruginous, and Rough-legged Hawks: 1977–2001. Dotted lines indicate significant regression fits.

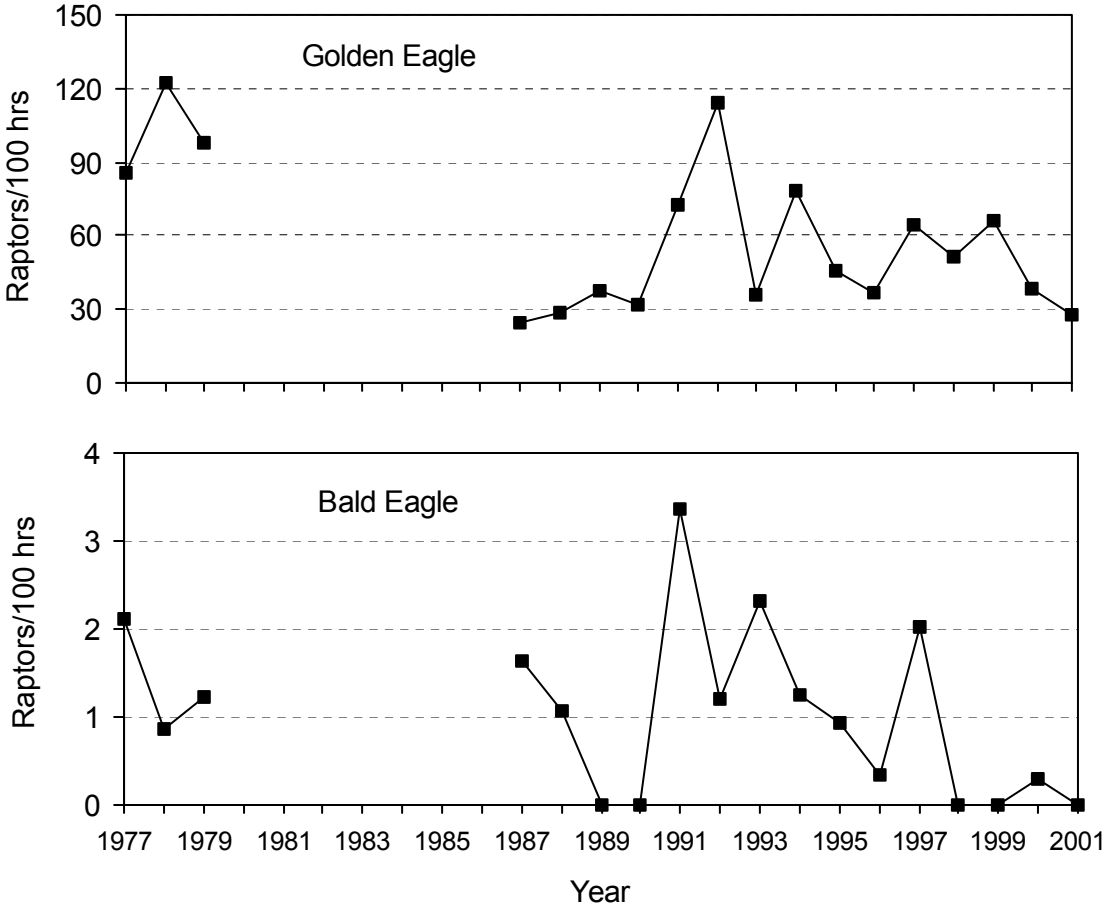

Figure 6. Adjusted annual passage rates for Golden and Bald Eagles: 1977–2001.

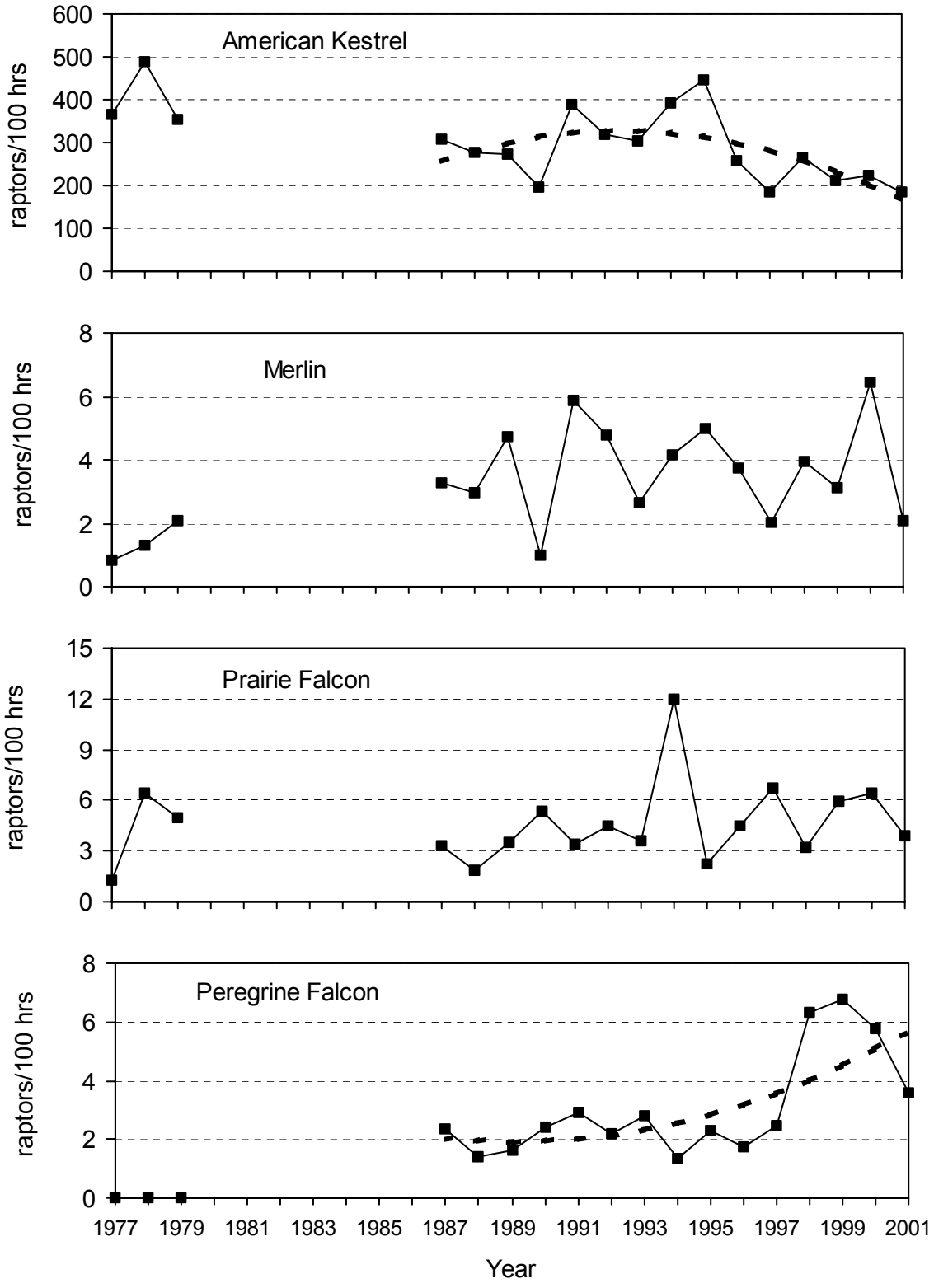

Figure 7. Adjusted annual passage rates for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons: 1977–2001. Dotted lines indicate significant regression fits.

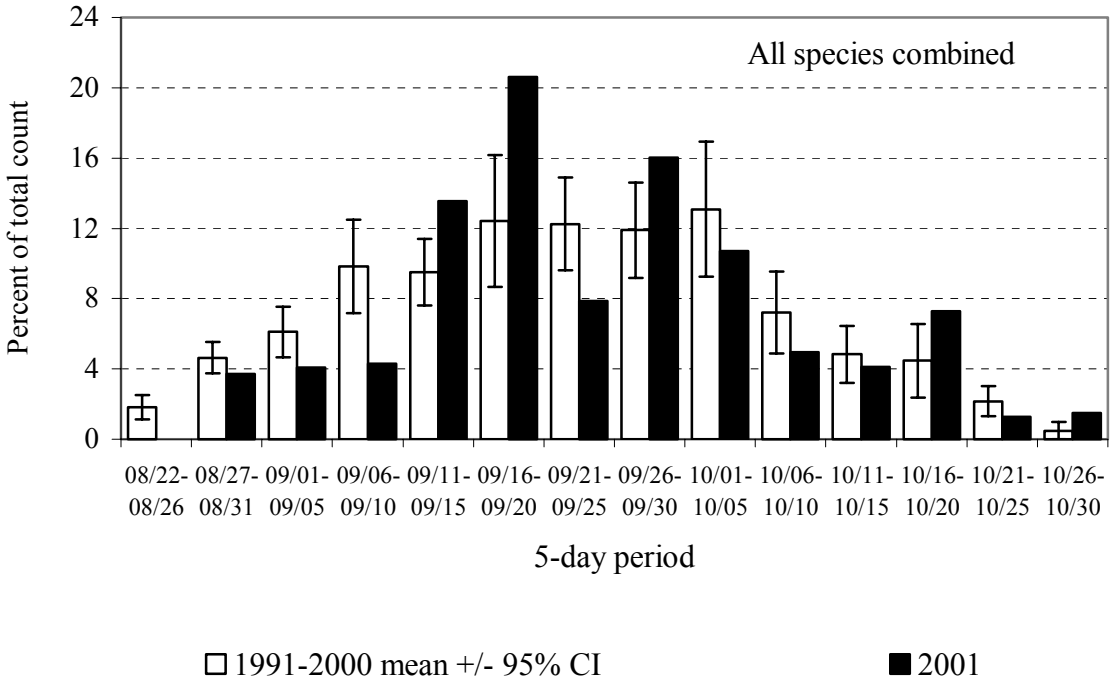

Figure 8. Combined-species passage volume by five-day periods: 1991–2000 versus 2001.

Appendix A. History of official observer participation.

1977: Single observer throughout: Wayne Potts (0)[1]

1978: Single observer throughout: 5–6 rotating observers (0)

1979: Single observer throughout: 5–6 rotating observers (0)

1987: Single observer throughout: Joe DiDonato (1), Fred Tilly (16), and Allen Hale (2)

1988: Single observer throughout: Scott Stoleson (0)

1989: Single observer throughout: LisaBeth Daly (1)

1990: Single observer throughout: Jane Kidd (0)

1991: Two observers throughout: Jim Daly (4) and Bernd Rindermann (0)

1992: Two observers throughout: Shawn Farry (0) and Frank A. LaSorte (0)

1993: Two observers throughout: Rob Clemens (1), Chris Berger—1st half (0), Andy Day—2nd half (0)

1994: Two observers throughout: Susan Salafsky (1) and Mari Remsberg (0)

1995: Two observers throughout: Sean O'Connor (1) and Paul Archibald (0)

1996: Two observers throughout: Susan Thomas (1) Scott Harris (1)

1997: Two observers throughout: Julie Heath (0), Doug Cooper (0), and Rob Wilson (1)

1998: Two observers throughout: David Tidhar (0) and Wendy Peacock (0)

1999: Two observers throughout: Jorge Canaca (0) and Laura Lutz (0)

2000: Two observers throughout: Darlene Kilpatrick (0) and Paula Shannon (0)

2001: Two observers throughout: Peter Cole (0) and Lisa Sheffield (0)

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[1] Numbers in parentheses indicate the number of previous full-seasons of experience conducting migratory raptor counts.

Appendix B. Common and scientific names, species codes, and regularly applied age, sex, and color-morph classifications.

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
Red-shouldered Hawk	*Buteo lineatus*	RS	A I 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
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, L = light, 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: 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
28-Aug	8.75	2.00	0	clr/haze	7	w-nw	29.8	28.10	1	62	57	2	4.6
29-Aug	9.00	1.86	0	pc-mc, haze	15	sw	25.3	30.27	3	60	61	2	4.7
30-Aug	9.00	1.89	0	ovc-pc/haze	4	var	24.6	30.32	4	79	78	2	0.9
31-Aug	9.00	1.00	0	pc, haze, ts	23	ssw-sw	20.3	30.32	2	80	80	2	2.2
1-Sep	8.00	1.90	0	clr-pc, haze	24	sw	22.1	30.34	2	80	79	2	2.6
2-Sep	9.00	3.28	1	clr-pc	18	sw	23.2	30.39	2	80	80	1	4.1
3-Sep	9.00	2.78	1	clr	16	sw	24.0	30.44	2	80	80	1	4.3
4-Sep	8.75	1.00	0	pc	20	ssw-sw	25.2	30.40	3	80	80	2	2.7
5-Sep	0.00			rain/snow									
6-Sep	0.00			rain/snow									
7-Sep	8.25	2.00	0	pc-ovc/fog/snow	33	sw-nw	10.8	30.12	4	73	68	2	6.3
8-Sep	9.00	2.00	0	clr	4	var	8.6	30.30	1	80	80	1	4.4
9-Sep	8.00	3.00	1	clr	13	s-sw	12.9	30.36	2	80	80	1	1.1
10-Sep	9.00	2.00	0	clr	22	s-sw	16.9	30.39	2	80	80	1	2.9
11-Sep	9.00	1.83	0	clr-mc	20	s-sw	21.0	30.47	2	80	78	1	2.8
12-Sep	8.00	1.00	0	mc-ovc	15	var	21.5	30.35	4	80	70	1	2.6
13-Sep	9.00	2.41	1	clr-pc, haze	24	sse-sw	18.0	30.31	2	80	76	2	3.7
14-Sep	9.00	1.00	0	clr-pc, haze	21	sw	16.4	30.40	1	80	80	2	10.0
15-Sep	9.00	5.00	2	clr/haze	12	sw	17.1	30.34	1	80	69	2	25.7
16-Sep	9.00	5.08	2	pc-mc	16	s-sw	17.9	30.24	2	80	76	1	24.6
17-Sep	3.00	2.83	2	mc-ovc	4	wsw	17.3	30.28	4	67	73	1	3.7
18-Sep	9.00	1.23	0	clr/haze	16	sw	14.4	30.32	2	80	80	2	12.2
19-Sep	9.00	2.00	0	clr	18	s-sw	16.7	30.29	2	80	74	1	18.6
20-Sep	9.00	1.86	0	clr	23	sw	17.2	30.41	2	80	78	2	11.1
21-Sep	9.00	1.00	0	clr-pc	21	s-sw	18.8	30.40	2	80	80	1	8.6
22-Sep	9.00	2.46	1	clr	9	calm, sw-w	17.7	30.46	1	80	78	2	7.9
23-Sep	8.50	2.44	1	clr	9	calm, sw	17.6	30.49	1	80	80	1	2.6
24-Sep	9.00	2.22	0	clr-pc, haze	15	sw	19.1	30.51	1	78	60	2	3.8
25-Sep	8.00	1.94	0	clr-pc, haze	17	s-sw	20.4	30.34	2.5	78	65	1	3.6
26-Sep	8.75	1.00	0	clr/haze	19	s-sw	17.7	30.33	2	80	69	1	25.7
27-Sep	8.50	1.80	0	clr	23	s-sw	18.2	30.34	2	80	80	1	5.8
28-Sep	8.75	1.80	0	pc-mc	26	ssw-sw	19.4	30.26	3	80	80	1	11.2
29-Sep	8.75	2.17	0	clr-pc	2	calm, w-nw	15.7	30.41	1	80	78	2	4.3
30-Sep	9.00	2.00	0	clr	5	calm/var, sw-w	16.7	30.52	1	80	78	1.5	7.1
1-Oct	9.00	2.00	0	clr	14	sw-wnw	15.7	30.43	1	80	76	2	17.0
2-Oct	8.00	1.94	0	clr	16	var, sw-wnw	14.9	30.35	1	80	78	var	2.1
3-Oct	8.75	1.00	0	clr	17	sw-wnw	13.2	30.32	2	80	78	1	5.4
4-Oct	8.50	1.74	0	clr	23	sw-wnw	12.6	30.19	2	80	73	1	7.6
5-Oct	8.50	1.00	0	clr	18	ssw-sw	9.7	30.23	2	80	76	1	4.1
6-Oct	9.00	2.08	0	pc-mc	26	s-sw	13.1	30.22	3	80	69	1	4.4
7-Oct	8.75	3.00	1	clr-mc	33	sw	13.1	30.23	3	80	80	1	6.6
8-Oct	7.50	2.00	0	ovc	15	ssw-w	13.4	30.12	4	80	80	1	2.8
9-Oct	0.00			ts/rain									
10-Oct	8.00	2.19	1	clr-mc, haze	27	s-sw	3.4	30.25	3	80	73	1	3.4
11-Oct	0.00			rain/snow									
12-Oct	7.00	0.96	0	pc-ovc	32	sw-wsw	0.7	30.20	3	80	80	1	2.0
13-Oct	8.00	1.94	0	mc-clr	32	wsw-wnw	5.1	30.16	3.5	80	80	2.5	0.3
14-Oct	8.50	3.00	1	pc-mc	53	sw	8.1	30.10	4	80	76	2	6.8
15-Oct	8.50	2.00	0	clr-pc	19	ssw-sw	7.3	30.44	2	80	80	1	5.6
16-Oct	8.25	1.83	0	pc	23	sw	12.3	30.39	2.5	80	78	1	7.8

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
17-Oct	8.75	1.00	0	mc-ovc	8	sw-wnw	12.6	30.26	4	80	76	1	1.3
18-Oct	8.50	1.83	0	clr-pc, haze	24	sw-w	5.4	30.28	2	80	64	1	3.1
19-Oct	8.50	1.00	0	clr	38	sw	8.8	30.26	4	80	80	1	10.0
20-Oct	8.00	1.94	0	pc-mc	19	sw	11.5	30.14	2	80	80	1	3.6
21-Oct	8.25	2.00	0	mc	16	ssw-sw	12.6	30.10	3	80	78	1	1.9
22-Oct	6.50	2.00	0	ovc, scat snow	27	sw-w	6.1	30.05	4	50	52	1	1.5
23-Oct	0.00			rain/snow									
24-Oct	7.00	1.00	0	clr-mc	33	sw	-0.9	30.16	3	80	77	1	0.9
25-Oct	7.50	1.90	0	pc-mc	32	sw	4.4	30.36	4	80	80	1	0.8
26-Oct	8.00	1.00	0	pc, PM haze	20	s-ssw	10.3	30.50	2	80	80	1	1.6
27-Oct	7.50	2.94	2.5	pc	27	s-sw	11.9	30.29	2.5	80	75	2	1.3
28-Oct	7.75	2.00	0	clr-ovc	21	s-sw	11.9	30.30	2.5	80	60	1	2.2
29-Oct	6.25	1.50	0	mc-ovc	21	s-sw	12.9	30.40	3	60	60	1	0.5
30-Oct	4.25	2.00	0	ovc, PM rain	35	ssw-sw	10.8	30.12	4	60	60	2	0.2

[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 = thunder storms.

[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 hours and unadjusted raptor counts by species: 2001.

		Species[1]																									Birds
Date	Hours	TV	OS	NH	SS	CH	NG	SA	LA	UA	BW	SW	RT	FH	RL	UB	GE	BE	AK	ML	PR	PG	SF	LF	UF	UU	Total	/ hour
28-Aug	8.75	7	0	3	2	2	0	0	0	0	0	0	2	0	0	3	4	0	10	1	2	2	1	0	0	1	40	4.6
29-Aug	9.00	0	0	4	9	0	0	0	0	0	0	0	7	0	0	0	1	0	16	0	0	1	1	0	0	3	42	4.7
30-Aug	9.00	0	1	0	0	2	0	1	0	0	0	0	1	0	0	0	1	0	2	0	0	0	0	0	0	0	8	0.9
31-Aug	9.00	0	3	0	5	0	0	0	0	0	0	0	7	0	0	0	2	0	2	0	0	0	0	1	0	0	20	2.2
01-Sep	8.00	0	0	4	3	2	0	2	0	0	0	0	5	0	0	0	1	0	4	0	0	0	0	0	0	0	21	2.6
02-Sep	9.00	1	0	1	4	3	0	1	0	0	0	1	8	0	0	0	3	0	12	0	1	2	0	0	0	0	37	4.1
03-Sep	9.00	0	1	1	3	5	3	4	0	0	0	2	3	0	0	0	0	0	16	0	0	0	0	0	1	0	39	4.3
04-Sep	8.75	0	0	0	4	5	2	0	0	0	0	0	1	0	0	0	1	0	10	0	0	1	0	0	0	0	24	2.7
05-Sep	0.00																											
06-Sep	0.00																											
07-Sep	8.25	0	0	2	8	5	0	2	0	0	0	3	6	1	0	1	3	0	18	0	0	0	0	2	1	0	52	6.3
08-Sep	9.00	0	0	8	10	3	1	0	0	0	0	0	3	1	0	0	2	0	10	0	2	0	0	0	0	0	40	4.4
09-Sep	8.00	0	2	1	0	2	0	1	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	9	1.1
10-Sep	9.00	0	1	4	2	4	1	1	0	0	0	1	8	1	0	0	1	0	1	0	1	0	0	0	0	0	26	2.9
11-Sep	9.00	0	1	2	5	3	0	0	0	0	0	1	2	0	0	1	1	0	7	0	0	2	0	0	0	0	25	2.8
12-Sep	8.00	0	0	6	1	2	0	0	0	0	0	0	3	0	0	0	0	0	9	0	0	0	0	0	0	0	21	2.6
13-Sep	9.00	0	0	5	5	7	1	1	0	0	0	1	4	0	0	0	3	0	5	0	0	1	0	0	0	0	33	3.7
14-Sep	9.00	0	0	3	24	17	1	4	1	0	0	2	4	0	0	0	1	0	30	0	0	1	0	2	0	0	90	10.0
15-Sep	9.00	0	3	13	49	42	0	10	0	0	0	24	15	1	0	0	2	0	68	0	1	0	1	0	0	2	231	25.7
16-Sep	9.00	1	1	4	50	81	0	6	0	0	0	2	13	0	0	1	5	0	55	0	1	1	0	0	0	0	221	24.6
17-Sep	3.00	0	0	1	6	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	11	3.7
18-Sep	9.00	0	2	0	31	35	0	9	0	0	1	4	21	1	0	0	2	0	3	0	0	0	0	0	0	1	110	12.2
19-Sep	9.00	2	4	5	28	41	0	2	0	0	0	6	26	1	0	1	3	0	47	1	0	0	0	0	0	0	167	18.6
20-Sep	9.00	1	0	7	23	39	0	2	0	0	0	3	7	0	0	0	2	0	15	0	1	0	0	0	0	0	100	11.1
21-Sep	9.00	0	1	5	21	20	0	3	0	0	0	0	6	0	0	1	2	0	18	0	0	0	0	0	0	0	77	8.6
22-Sep	9.00	0	0	8	15	18	0	6	0	0	0	0	3	0	0	0	2	0	18	0	0	0	0	0	0	1	71	7.9
23-Sep	8.50	0	0	3	5	8	0	4	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	22	2.6
24-Sep	9.00	0	0	6	9	7	0	1	0	0	0	0	6	0	0	0	3	0	1	0	1	0	0	0	0	0	34	3.8
25-Sep	8.00	0	0	2	11	6	0	1	0	0	0	0	4	0	0	0	2	0	3	0	0	0	0	0	0	0	29	3.6
26-Sep	8.75	0	2	8	53	36	1	3	0	0	0	0	7	0	0	0	5	0	109	0	0	1	0	0	0	0	225	25.7
27-Sep	8.50	0	1	4	12	8	0	1	0	0	0	0	4	0	0	0	5	0	12	0	0	1	0	0	0	1	49	5.8
28-Sep	8.75	12	2	4	10	8	0	4	0	0	0	5	21	0	0	1	5	0	25	0	0	1	0	0	0	0	98	11.2
29-Sep	8.75	0	0	10	2	7	0	4	0	0	0	0	8	0	0	0	3	0	1	0	0	0	0	1	0	2	38	4.3
30-Sep	9.00	0	0	9	5	14	0	2	0	0	0	1	4	0	0	3	5	0	19	0	1	0	0	0	0	1	64	7.1
01-Oct	9.00	2	0	13	48	29	0	5	0	0	0	5	26	0	0	0	2	0	20	1	0	1	0	0	0	1	153	17.0
02-Oct	8.00	0	0	0	3	2	0	0	0	0	0	0	6	0	0	1	0	0	5	0	0	0	0	0	0	0	17	2.1

Appendix D. continued

		Species[1]																									Birds
Date	Hours	TV	OS	NH	SS	CH	NG	SA	LA	UA	BW	SW	RT	FH	RL	UB	GE	BE	AK	ML	PR	PG	SF	LF	UF	UU	Total	/ hour
03-Oct	8.75	0	0	4	13	8	0	0	0	0	0	0	5	0	0	0	0	0	12	2	1	0	2	0	0	0	47	5.4
04-Oct	8.50	0	1	10	15	10	0	2	0	0	0	0	18	0	0	0	2	0	6	0	0	1	0	0	0	0	65	7.6
05-Oct	8.50	0	0	11	6	4	0	1	0	0	0	0	9	0	0	0	0	0	4	0	0	0	0	0	0	0	35	4.1
06-Oct	9.00	0	0	1	19	5	0	0	0	0	0	0	2	0	0	0	7	0	6	0	0	0	0	0	0	0	40	4.4
07-Oct	8.75	0	1	2	23	5	0	0	1	0	0	0	3	0	0	1	7	0	12	1	1	0	0	0	0	1	58	6.6
08-Oct	7.50	0	0	4	4	1	0	1	0	0	0	0	7	0	0	1	1	0	2	0	0	0	0	0	0	0	21	2.8
09-Oct	0.00																											
10-Oct	8.00	0	0	2	11	5	0	0	0	0	0	0	2	0	0	0	4	0	1	0	2	0	0	0	0	0	27	3.4
11-Oct	0.00																											
12-Oct	7.00	0	0	1	5	2	1	0	0	0	0	0	1	0	0	0	4	0	0	0	0	0	0	0	0	0	14	2.0
13-Oct	8.00	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.3
14-Oct	8.50	0	0	3	7	4	0	0	0	0	0	0	36	0	0	3	5	0	0	0	0	0	0	0	0	0	58	6.8
15-Oct	8.50	0	0	3	25	9	0	0	0	0	0	0	8	0	1	0	1	0	0	1	0	0	0	0	0	0	48	5.6
16-Oct	8.25	0	0	9	48	1	0	0	0	0	0	0	1	0	0	0	2	0	2	1	0	0	0	0	0	0	64	7.8
17-Oct	8.75	0	0	6	0	2	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	11	1.3
18-Oct	8.50	0	0	3	11	2	0	0	0	0	0	0	5	0	0	0	1	0	3	0	1	0	0	0	0	0	26	3.1
19-Oct	8.50	0	0	3	49	13	0	2	0	0	0	0	11	0	0	0	5	0	1	0	0	0	0	0	0	1	85	10.0
20-Oct	8.00	0	0	0	22	2	1	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	29	3.6
21-Oct	8.25	0	0	1	8	1	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	1	0	0	0	16	1.9
22-Oct	6.50	0	0	2	4	0	1	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	10	1.5
23-Oct	0.00																											
24-Oct	7.00	0	0	1	2	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	6	0.9
25-Oct	7.50	0	0	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0.8
26-Oct	8.00	0	0	1	9	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	1.6
27-Oct	7.50	0	0	4	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	1.3
28-Oct	7.75	0	0	8	8	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	2.2
29-Oct	6.25	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0.5
30-Oct	4.25	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	0.2
Total	488.00	26	27	230	764	545	15	87	2	0	1	61	357	6	2	19	122	0	623	8	16	16	6	6	2	15	2956	6.1

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

Appendix E. Annual observation effort and unadjusted raptor counts by species: 1977–1979, 1987–2001.

	1977	1978	1979	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Mean
Start date	6-Aug	6-Sep	6-Sep	7-Sep	2-Sep	3-Sep	28-Aug	25-Aug	23-Aug	24-Aug	26-Aug	22-Aug	23-Aug	22-Aug	23-Aug	25-Aug	23-Aug	28-Aug	25-Aug
End date	26-Nov	1-Nov	17-Oct	20-Oct	20-Oct	20-Oct	20-Oct	24-Oct	25-Oct	26-Oct	26-Oct	25-Oct	25-Oct	25-Oct	25-Oct	31-Oct	26-Oct	30-Oct	25-Oct
Observation days	67	41	41	43	47	47	52	59	63	55	49	62	55	58	54	59	49	59	53
Observation hours	317.17	234.83	242.25	303.50	373.92	315.92	339.00	417.75	428.00	414.25	333.25	407.75	374.25	377.92	358.75	407.83	373.84	488.00	361.57
Raptors / 100 hours	885.0	1257.5	1160.4	968.7	893.8	981.6	699.7	1189.9	1048.1	908.6	1461.7	1389.8	1222.4	712.3	1134.2	1044.8	796.1	605.7	1020.0
Turkey Vulture	6	7	8	11	11	9	1	39	15	28	16	43	33	47	17	28	20	26	20
Osprey	5	8	13	11	17	30	19	34	29	25	44	41	35	39	39	21	28	27	26
Northern Harrier	159	200	173	278	185	172	195	430	330	208	363	362	315	171	443	487	198	230	272
Sharp-shinned Hawk	618	737	570	793	1093	832	546	997	989	1000	901	1217	928	652	1005	901	790	764	852
Cooper's Hawk	457	333	495	362	561	603	260	621	601	596	778	874	701	388	587	577	482	545	546
Northern Goshawk	35	32	30	8	15	15	20	18	74	26	16	23	27	17	14	16	24	15	24
Unknown small accipiter	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	87	–
Unknown large accipiter	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–
Unidentified accipiter	86	53	122	64	26	43	47	59	124	44	70	66	73	22	55	20	31	0	56
TOTAL ACCIPITERS	1196	1155	1217	1227	1695	1493	873	1695	1788	1666	1765	2180	1729	1079	1661	1514	1327	1413	1482
Broad-winged Hawk	0	0	2	5	1	9	4	10	3	2	5	13	7	3	1	7	1	1	4
Swainson's Hawk	19	5	21	44	12	47	188	129	97	91	487	468	419	106	309	155	29	61	149
Red-tailed Hawk	311	258	238	409	403	413	286	908	566	621	891	926	876	430	609	1089	509	357	561
Ferruginous Hawk	2	0	3	6	11	8	6	16	13	15	23	18	15	8	14	13	2	6	10
Rough-legged Hawk	2	0	1	1	4	3	0	1	2	1	2	0	3	6	1	2	3	2	2
Unidentified buteo	10	13	21	12	5	5	34	17	38	26	14	24	33	9	19	23	4	19	18
TOTAL BUTEOS	344	276	286	477	436	485	518	1081	719	756	1422	1449	1353	562	953	1289	548	446	744
Golden Eagle	236	285	237	73	106	119	101	292	423	133	224	163	127	212	154	245	130	122	188
Bald Eagle	5	3	3	5	4	0	0	13	10	10	4	3	2	7	0	2	1	0	4
TOTAL EAGLES	241	288	240	78	110	119	101	305	433	143	228	166	129	219	154	247	131	122	192
American Kestrel	808	970	799	817	862	744	557	1307	1118	888	975	1371	922	524	727	600	660	623	848
Merlin	2	3	5	10	11	15	3	21	17	8	11	17	12	8	11	13	20	8	11
Prairie Falcon	4	15	11	10	7	11	16	13	17	14	33	18	17	23	13	28	14	16	16
Peregrine Falcon	0	0	0	7	5	5	9	10	7	7	6	11	8	9	19	24	13	16	9
Unknown small falcon	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0	6	–
Unknown large falcon	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	6	–
Unidentified falcon	0	0	2	2	1	2	4	2	3	3	0	1	1	3	2	6	9	2	2
TOTAL FALCONS	814	988	817	846	886	777	589	1353	1162	920	1025	1418	960	567	772	671	717	677	887
Unidentified raptors	42	31	57	12	2	16	76	34	10	18	8	8	21	8	30	4	7	15	22
GRAND TOTAL	2807	2953	2811	2940	3342	3101	2372	4971	4486	3764	4871	5667	4575	2692	4069	4261	2976	2956	3645