FALL 2003 RAPTOR MIGRATION STUDY IN THE WELLSVILLE MOUNTAINS OF NORTHERN UTAH

HawkWatch International, Inc.
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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 that migrate through the Wasatch Mountains along the western margin of the Rocky Mountain Flyway (Hoffman and Smith 2003). 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. Annual counts have occurred at the site since then, except in 2002 when logistical difficulties intervened. 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 2003 season, which marked the 19th standardized, full-season, autumn count of migratory raptors at the site.

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

Weather permitting, two official or designated observers conducted standardized daily counts of migrating raptors from a single, traditional observation site from late August through October. Observations typically began between 0830 and 0930 hrs Mountain Standard Time (MST) and ended between 1630 and 1730 hrs MST. Official observer Anthony Sandoval, new to full-season migration counting, attended preseason training and served the entire season. Official observers Jason Ferrell and Mark Fogg, also new to migration counting, received on-site training, with Jason serving for the first four

weeks of the season and Mark assisting during the last two weeks. Official observer David Tidhar returned for his second season of counting in the Wellsvilles and served for the last seven weeks of the season. Visitors also occasionally assisted with spotting and identifying migrants.

Data gathering and recording followed standardized protocols used at all HWI migration sites (Hoffman and Smith 2003). 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.

Because both seasonal and daily effort varied considerably during the first several years of the project, I generally limit basic data comparisons to the years 1991–2003, or in the case of age and sex statistics, to 1992–2003 because pre-1992 class data are not fully computerized. In comparing 2003 annual statistics against means and 95% confidence intervals for previous seasons, I equate significance with a 2003 value falling outside the bounds of the confidence interval for the associated mean. For analysis of long-term count trends, calculation of "adjusted" passage rates (i.e., migrants counted per 100 hours of observation, adjusted to standardize sampling periods and account for incompletely identified birds) and the trend analyses follow Hoffman and Smith (2003) and utilize data from the entire study period.

RESULTS AND DISCUSSION

WEATHER

Compared to the past five seasons, in 2003 inclement weather substantially hampered relatively few days of observation, with only 5 days fully precluded (1997–2001 average of 11 days) and another 2 days reduced to less than four fours of observation by excessive rain or snow (average 4 days; see Appendix C for 2003 daily weather records). However, the array of sky conditions recorded on active observation days in 2003 was slightly more unsettled than the average pattern since 1997. Fair skies prevailed on 52% of the active observation days (average 57%) and an average proportion of these days included some fog, haze, or scattered thundershowers during the day (26% of all days). Transitional weather (i.e., skies changed from primarily fair to mostly cloudy or overcast during the day, or vice versa) occurred on 23% of the active observation days (average 26%) and a slightly below average proportion of these days included some fog, haze, scattered thundershowers or rain/snow during the day (11% of days; average 15%). Mostly cloudy to overcast skies predominated on 24% of days (average 17%) and an above

average proportion of these days included some fog, haze, scattered thundershowers or rain/snow during the day (15% of days; average 9%).

Light winds (<12 kph) prevailed on 32%, moderate winds (12–28 kph) on 59%, and strong winds (28 kph) on 9% of the active observation days. The comparative averages during the previous five seasons were 50%, 39%, and 11%, indicating that 2003 featured a significant shift from light to moderate winds compared to the average pattern. In terms of wind directions, conditions were more variable than the 1997–2001 average pattern, with northwesterly winds more common than usual (31% of active days with some northwesterly component versus 1997–2001 average of 12%) and south to southwesterly winds (typically the dominant wind direction) proportionally less common than usual. Especially moderate northwesterly winds also concentrate migrating raptors along western ridges, so the observed shifts in wind strength and direction in 2003 away from the light, southwesterly wind pattern that typically prevails in the Wellsvilles most likely did not influence the detectable migration to a great degree.

The daily-average (mean of hourly readings) temperature averaged 16.6°C, ranging from –3.9 to 28.3°C, which is the highest average and second highest minimum recorded since 1997. The daily-average (mean of hourly readings) barometric pressure averaged 28.62 in Hg, ranging from 27.79 to 30.08 in Hg, which is 5% lower than the 2001 average (the extent of record-keeping for this on-site measure). The proportion of days rated as good to excellent for thermal lift in 2003 also was only slightly below average (55%; average 58%).

In summary, the weather in 2003 was similar to the average pattern for 1997–2001; however, it was slightly warmer overall than usual and the winds were stronger and more frequently out of the west to northwest than usual. A similar shift in wind conditions was evident in 2001.

OBSERVATION EFFORT

The observers worked on 65 of 71 possible observation days between 22 August and 31 October. The number of observation days was a significant 22% higher than the 1977–2001 average of 53 ± 95% CI of 3.6 days, and the number of observation hours (495.53) was a significant 37% higher than the 1977–2001 average of 361.57 ± 95% CI of 29.73 hours. Relatively mild weather contributed to the increase in observation effort. Increased effort often results in higher numbers of birds detected but proportionally lower passage rates due to increased coverage of slow flight times.

The 2003 average of 1.83 observers per hour (includes official and guest observers; value is mean of daily values, which are in turn means of hourly values) is 6% lower than the 1977–2001 average of 1.95 ± 95% CI of 0.251 observers/hr.

FLIGHT SUMMARY

The observers tallied 3,632 migrant raptors of 16 species during the 2003 season (Table 1, and see Appendix D for daily count records). The 2003 flight was composed of 39% accipiters, 27% buteos, 16% falcons, 12% Northern Harriers, 4% eagles, and <1% each of Ospreys, Turkey Vultures, and unidentified raptors (Figure 2). These proportions reflect significantly higher than average representation of buteos and harriers, and significantly lower than average representation of falcons, Ospreys, and vultures. The most numerous species were the Sharp-shinned Hawk (24% of the total count), Red-tailed Hawk (23%), American Kestrel (14%), Cooper's Hawk (12%), and Northern Harriers (12%).

The total combined-species count was 12% below the 1991–2001 average. Moreover, below-average counts occurred for 12 of 17 species usually seen at the site, with the differences significant for eight species (Table 1). Most notably, the count of American Kestrels fell to a record low; the Osprey count was the lowest since 1987; and the Cooper's Hawk count was the third lowest since 1977 (see Appendix E for annual effort and count summaries). However, stark contrasts to these low counts included the third highest counts recorded to date for Northern Harriers and Peregrine Falcons, and the second highest count

for Northern Goshawks. Counts were also 19% and 23% above the 1991–2001 averages for Red-tailed Hawks and Prairie Falcons, respectively, with the latter difference significant.

Adjusted passage rates were significantly above long-term (1977–2001) averages only for Northern Harriers, Red-tailed Hawks, and Peregrine Falcons, whereas passage rates were significantly below average for nine species (Table 1). Regression analyses of adjusted passage rates since 1987 indicated marginally ($P \leq 0.10$) to highly ($P \leq 0.01$) significant quadratic trends for five species (Turkey Vulture, Osprey, Cooper's Hawk, Swainson's Hawk, and American Kestrel), which track a common hill-shaped pattern with increases through the mid-1990s followed by declines (Figures 3–7). A similar pattern is shown for several other species for which a partial "rebound" in 2003 precluded a significant regression fit to the long-term pattern. This common pattern likely reflects the influence of long-term, regional drought cycles (Hoffman and Smith 2003); however, the current decline among American Kestrels may be a continuation of a longer-term decline (Figure 7). The only other significant, species-level regression trend for 1987–2003 was a highly significant increase for Peregrine Falcons, which continues a strong, widespread increasing pattern for this species that began in the 1980s (Hoffman and Smith 2003).

Six of 10 species with data suited to such comparisons showed below average immature : adult ratios in 2003, but significantly so only for Peregrine Falcons (Table 2). Moreover, the low age ratio for peregrines was due to a high abundance of identified adults, which may be an artifact of a significantly lower than average proportion of unknown-age birds (Table 2). Similarly, a low age ratio for Northern Goshawks was not due to low abundance of immature birds, but rather a proportionally greater increase in the abundance of identified adults. Four species showed above average age ratios in 2003, with the differences significant for Northern Harriers, Cooper's Hawks, and Red-tailed Hawks. For Northern Harriers and Red-tailed Hawks, the high age ratios were clearly due primarily to high abundance of immature birds, suggesting that good productivity and juvenile recruitment in 2003 contributed to the high counts for these two species. For Cooper's Hawks, however, the abundance of both adults and immatures was below average, but much more so for adults than immatures. Thus, overall there was little evidence of significant declines in the abundance of immature birds during fall 2003, suggesting that juvenile recruitment may have been at least average for most species using the Wellsville flyway in 2003.

The combined-species median passage date of 26 September was a significant 4 days later than the 1991–2001 average (Table 3). This shift is evident in the seasonal activity pattern in the form of generally below average flight volume through the first three weeks of September and significantly above average flight volume during the last 10 days of September (Figure 8). At the species level, 8 of 14 species for which a comparison was possible showed significantly later than average median passage dates in 2003, while only Golden Eagles showed significantly early timing (Table 3). Age- and sex-specific data provided further clarification for seven species (Table 4). Only immature birds were significantly late among Northern Harriers and the three accipiter species, whereas both age classes of Red-tailed Hawks were significantly later than usual. Furthermore, adult harriers as a group were slightly earlier than average, but sex-specific data indicated that adult males were significantly earlier than average while adult females were significantly later than average. Age-specific data indicated that only adult Golden Eagles were significantly earlier than usual. Sex-specific data indicated that only female American Kestrels were significantly later than usual. Thus, overall there appeared to be a tendency for late passage in 2003, but primarily among immature birds and females.

RESIDENT RAPTORS

This season's resident community included one family of Red-tailed Hawks comprised of a pair of adults, one light and one dark morph, and at least two light-morph immature birds. The adults were present throughout the season, while the young birds were not seen after 5 October. A family of Golden Eagles, including one first-year bird, was seen regularly throughout the season. Three immature Northern Harriers were seen almost daily until 21 September, while sightings of possible resident adult harriers

were rare. At least one immature Sharp-shinned Hawk was seen frequently through 16 September, often attacking a plastic owl. An immature Cooper's Hawk was spotted several times mid-season circling around and flying low in the canyons or in the camp area. An immature Northern Goshawk was witnessed moving north on 18 September, but may well have been dispersing through the area. An apparently local adult goshawk was spotted several times later in the season. At least one pair of American Kestrels regularly visited the observation area until 12 September, often stooping on the owl.

This local assemblage is largely similar to the past several years, with some notable exceptions. These include the commonness of young harriers; the absence of Peregrine Falcons, adult Sharp-shinned and Cooper's Hawks, and obvious immature kestrels; and only a single, moderate-sized family of red-tails.

VISITATION

A total of 104 individuals visited the project site in 2003, which is a fairly typical visitation rate for this site. Most visitors originated in Utah, but others came from Indiana, Colorado, Alaska, Oregon, and Washington. Organized groups included the Bridgerland Audubon Society and a local high school class. 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 good visitation levels.

In 2003, 511 hourly assessments of visitor disturbance resulted in the following ratings: 89% none, 8% low, 1% moderate, and 1% 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 2003 indicated primarily a low to nonexistent effect.

ACKNOWLEDGMENTS

Funding for this project was provided by the USDA Forest Service–Wasatch-Cache National Forest, Bureau of Reclamation–Upper Colorado Regional Office, and HWI members. We also extend are deepest appreciation to Carolyn Barcus and friends for horse-packing water and food to the site for the crew, to Randy and Julie Stacey for providing a staging area for supply transfers, to Eric and Maureen Wagner for housing the observers on days off and weather days, and to Jean Lown and Bryan Dixon for their assistance with the count.

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Table 1. Unadjusted counts and adjusted passage rates by species: 1991–2001 versus 2003.

	COUNTS			BIRDS / 100 HRS		
SPECIES	1991–2001[1]	2003	% CHANGE	1991–2001[1]	2003	% CHANGE
Turkey Vulture	28 ± 6.6	18	-37	6.3 ± 1.54	2.1	-67
Osprey	33 ± 4.4	14	-57	11.4 ± 2.69	5.7	-50
Northern Harrier	322 ± 63.8	441	+37	81.1 ± 13.84	111.1	+37
Sharp-shinned Hawk	922 ± 88.9	869	-6	288.2 ± 26.94	257.4	-11
Cooper's Hawk	614 ± 78.8	440	-28	188.0 ± 25.10	126.7	-33
Northern Goshawk	25 ± 10.1	33	+34	7.2 ± 1.89	8.2	+15
Unknown small accipiter2	87	64	-26	–	–	–
Unknown large accipiter2	2	1	-50	–	–	–
Unidentified accipiter	51 ± 19.9	6	–	–	–	–
TOTAL ACCIPITERS	1620 ± 168.9	1413	-13	–	–	–
Broad-winged Hawk	5 ± 2.4	1	-79	1.9 ± 0.82	0.5	-77
Swainson's Hawk	214 ± 102.2	102	-52	71.5 ± 39.23	36.0	-50
Red-tailed Hawk	707 ± 141.3	841	+19	167.8 ± 32.53	201.2	+20
Ferruginous Hawk	13 ± 3.4	12	-8	2.9 ± 0.90	2.9	-1
Rough-legged Hawk	2 ± 0.9	0	-100	0.7 ± 0.28	0.0	-100
Unidentified buteo	21 ± 5.8	35	+70	–	–	–
TOTAL BUTEOS	962 ± 222.8	991	+3	–	–	–
Golden Eagle	202 ± 54.5	154	-24	58.9 ± 14.12	36.2	-39
Bald Eagle	5 ± 2.7	1	-79	1.0 ± 0.45	0.3	-73
TOTAL EAGLES	207 ± 56.2	155	-25	–	–	–
American Kestrel	883 ± 170.6	515	-42	301.3 ± 41.66	165.4	-45
Merlin	13 ± 2.8	13	-2	3.3 ± 0.74	3.7	+11
Prairie Falcon	19 ± 3.9	23	+23	4.4 ± 1.10	5.4	+22
Peregrine Falcon	12 ± 3.4	17	+44	2.5 ± 0.88	4.3	+74
Unknown small falcon[2]	6	1	-83	–	–	–
Unknown large falcon[2]	6	1	-83	–	–	–
Unidentified falcon	3 ± 1.5	1	–	–	–	–
TOTAL FALCONS	931 ± 168.6	571	-39	–	–	–
Unidentified raptor	15 ± 5.9	29	+96	–	–	–
GRAND TOTAL	4117 ± 556.7	3632	-12	–	–	–

[1] Mean ± 95% confidence interval.

[2] Designations used for the first time in 2001.

Table 2. Annual counts by age classes and immature : adult ratios for selected species: 1992–2001 versus 2003.

	Total and Age-classified Counts								Immature : Adult Ratio	
	1992–2001 Average			2003			% Unknown Age			
	Total	Imm.	Adult	Total	Imm.	Adult	1992–2001[1]	2003	1992–2001[1]	2003
Northern Harrier	311	164	82	441	318	75	21 ± 4.5	11	2.34 ± 0.950	4.24
Sharp-shinned Hawk	915	352	371	869	330	355	21 ± 6.1	21	1.06 ± 0.378	0.93
Cooper's Hawk	613	236	222	440	219	108	26 ± 9.2	26	1.30 ± 0.457	2.03
Northern Goshawk	25	12	7	33	20	10	28 ± 12.5	9	2.91 ± 1.249	2.00
Broad-winged Hawk	4	1	2	1	1	0	40 ± 72.8	0	0.86 ± 0.996	1.00
Red-tailed Hawk	687	273	333	841	512	287	12 ± 3.1	5	0.84 ± 0.337	1.78
Ferruginous Hawk	13	3	3	12	2	4	58 ± 19.9	50	2.63 ± 2.719	0.50
Golden Eagle	193	90	87	154	74	75	8 ± 2.2	3	1.12 ± 0.238	0.99
Bald Eagle	4	3	1	1	1	0	10 ± 12.3	0	2.50 ± 2.874	1.00
Peregrine Falcon	12	2	2	17	3	7	66 ± 9.2	41	1.20 ± 0.517	0.43

[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 2003, with a comparison of 2003 and 1991–2001 average median passage dates.

	2003				1991–2001
Species	First Date Observed	Last Date Observed	Bulk Passage Dates[1]	Median Passage Date[2]	Median Passage Date[3]
Turkey Vulture	22-Aug	9-Oct	22-Aug – 9-Oct	2-Sep	08-Sep ± 6.8
Osprey	27-Aug	3-Oct	13-Sep – 30-Sep	21-Sep	13-Sep ± 2.0
Northern Harrier	22-Aug	28-Oct	9-Sep – 20-Oct	27-Sep	25-Sep ± 2.5
Sharp-shinned Hawk	22-Aug	28-Oct	16-Sep – 14-Oct	28-Sep	26-Sep ± 2.1
Cooper's Hawk	22-Aug	28-Oct	13-Sep – 8-Oct	26-Sep	25-Sep ± 2.4
Northern Goshawk	18-Sep	28-Oct	22-Sep – 25-Oct	5-Oct	26-Sep ± 5.3
Broad-winged Hawk	26-Sep	26-Sep	–	–	22-Sep ± 1.6
Swainson's Hawk	22-Aug	21-Oct	26-Aug – 30-Sep	25-Sep	16-Sep ± 5.2
Red-tailed Hawk	22-Aug	29-Oct	1-Sep – 21-Oct	25-Sep	21-Sep ± 1.7
Ferruginous Hawk	22-Aug	21-Oct	6-Sep – 20-Oct	24-Sep	16-Sep ± 5.4
Golden Eagle	23-Aug	29-Oct	4-Sep – 20-Oct	28-Sep	02-Oct ± 1.9
Bald Eagles	26-Sep	26-Sep	–	–	09-Oct ± 12.2
American Kestrel	22-Aug	21-Oct	7-Sep – 5-Oct	24-Sep	19-Sep ± 2.5
Merlin	5-Sep	20-Oct	6-Sep – 19-Oct	29-Sep	01-Oct ± 2.8
Prairie Falcon	24-Aug	28-Oct	2-Sep – 11-Oct	21-Sep	14-Sep ± 4.8
Peregrine Falcon	23-Aug	4-Oct	27-Aug – 1-Oct	19-Sep	11-Sep ± 3.8
Total	22-Aug	29-Oct	6-Sep – 16-Oct	26-Sep	22-Sep ± 1.2

[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: 1991–2001 versus 2003.

	2003	1991–2001 MEAN ± 95% CI (DAYS)	2003	1991–2001 MEAN ± 95% CI (DAYS)
	ADULT		IMMATURE / SUBADULT	
Northern Harrier	30-Sep	01-Oct ± 3.2	29-Sep	23-Sep ± 3.0
Sharp-shinned Hawk	7-Oct	02-Oct ± 2.9	25-Sep	17-Sep ± 3.0
Cooper's Hawk	30-Sep	01-Oct ± 3.1	24-Sep	19-Sep ± 3.0
Northern Goshawk	3-Oct	28-Sep ± 10.9	4-Oct	26-Sep ± 7.6
Red-tailed Hawk	7-Oct	26-Sep ± 1.1	21-Sep	14-Sep ± 2.5
Golden Eagle	29-Sep	05-Oct ± 2.2	29-Sep	01-Oct ± 2.8
Peregrine Falcon	22-Sep	09-Sep ± 13.7	–	25-Sep ±
	MALE		FEMALE	
Northern Harrier adult	29-Sep	03-Oct ± 2.9	17-Oct	25-Sep ± 4.5
American Kestrel	25-Sep	24-Sep ± 2.7	21-Sep	14-Sep ± 2.7

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

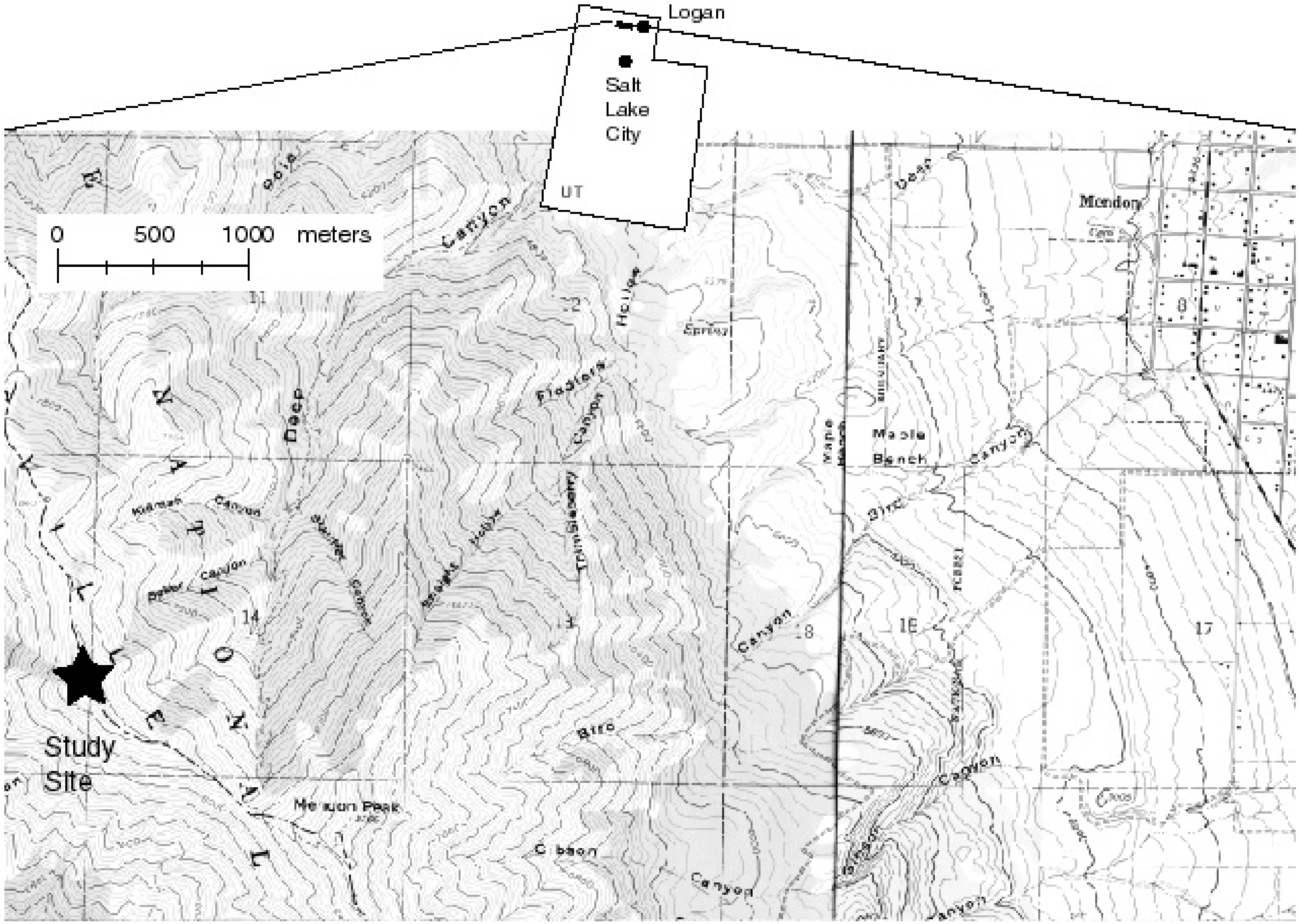

Figure 1. Location of the Wellsville Mountains Raptor Migration Project site in northern Utah.

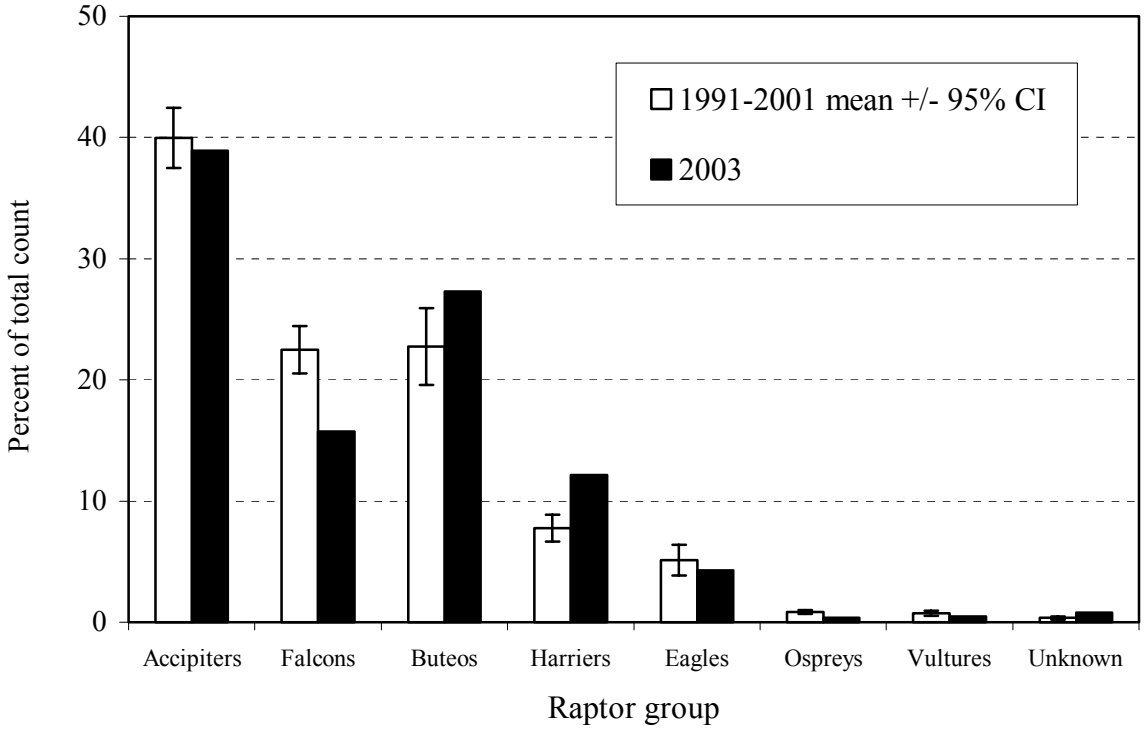

Figure 2. Fall flight composition by major species groups: 1991–2001 versus 2003.

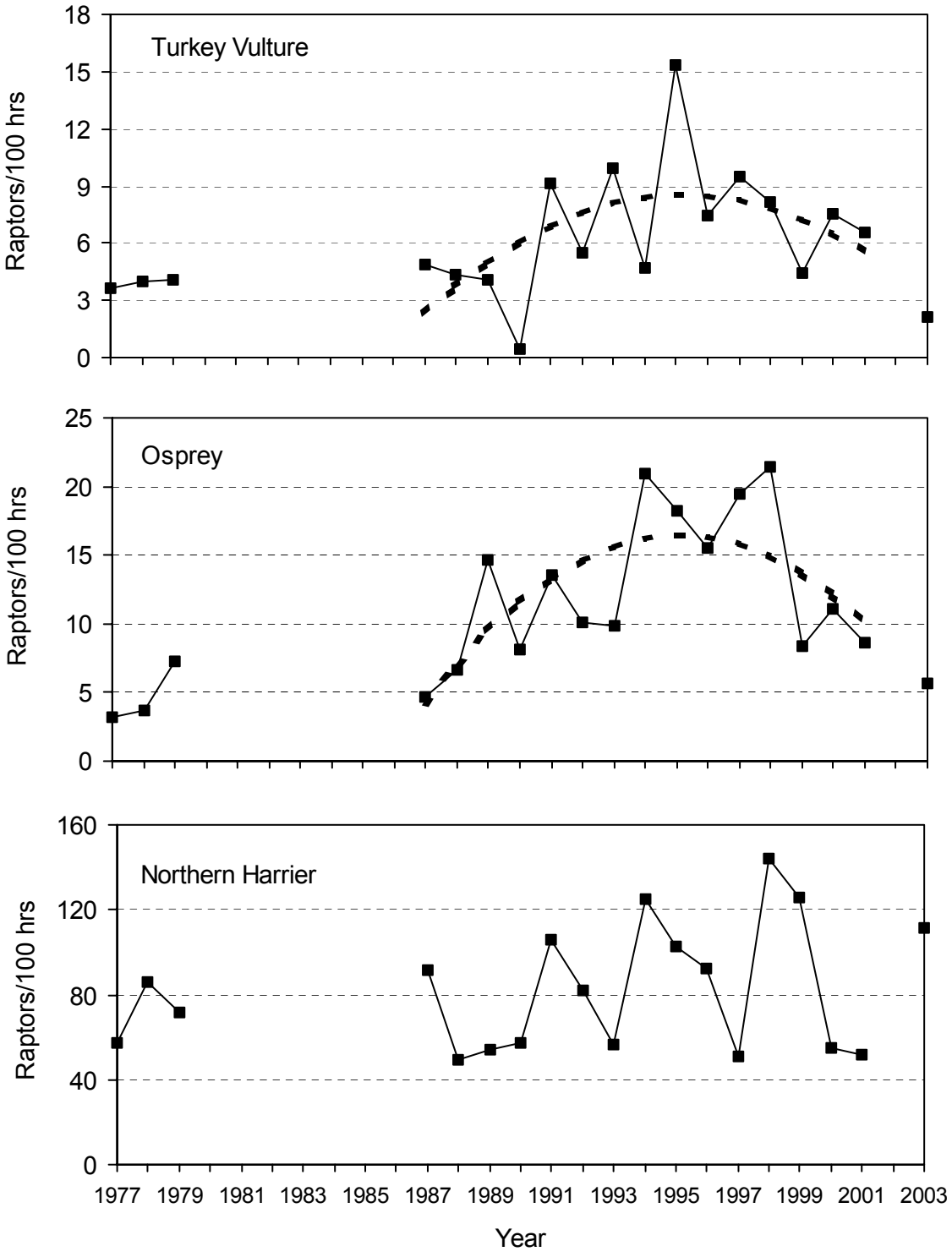

Figure 3. Adjusted annual passage rates for Turkey Vultures, Ospreys, and Northern Harriers: 1977–2003. Dotted lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

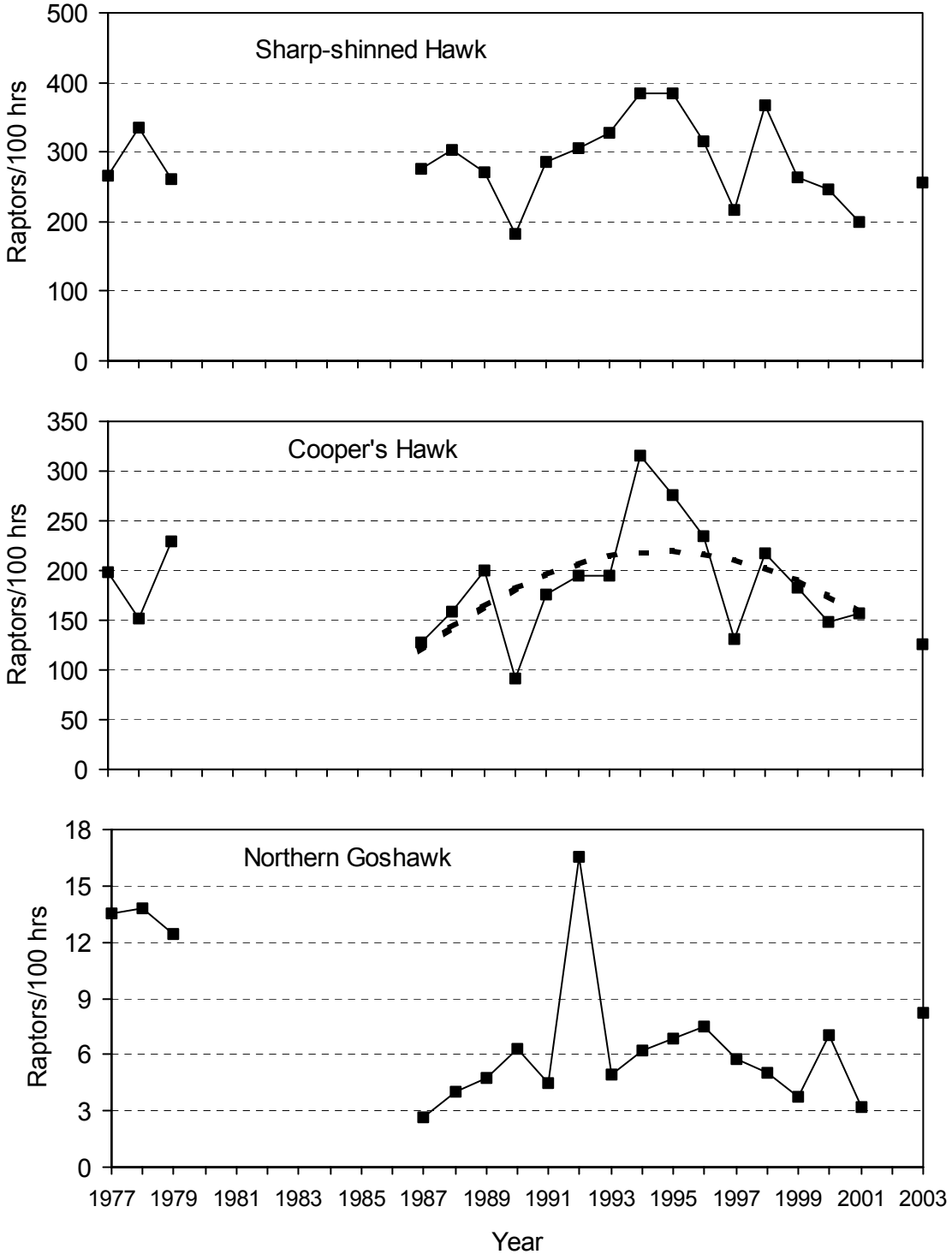

Figure 4. Adjusted annual passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks: 1977–2003. Dotted lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

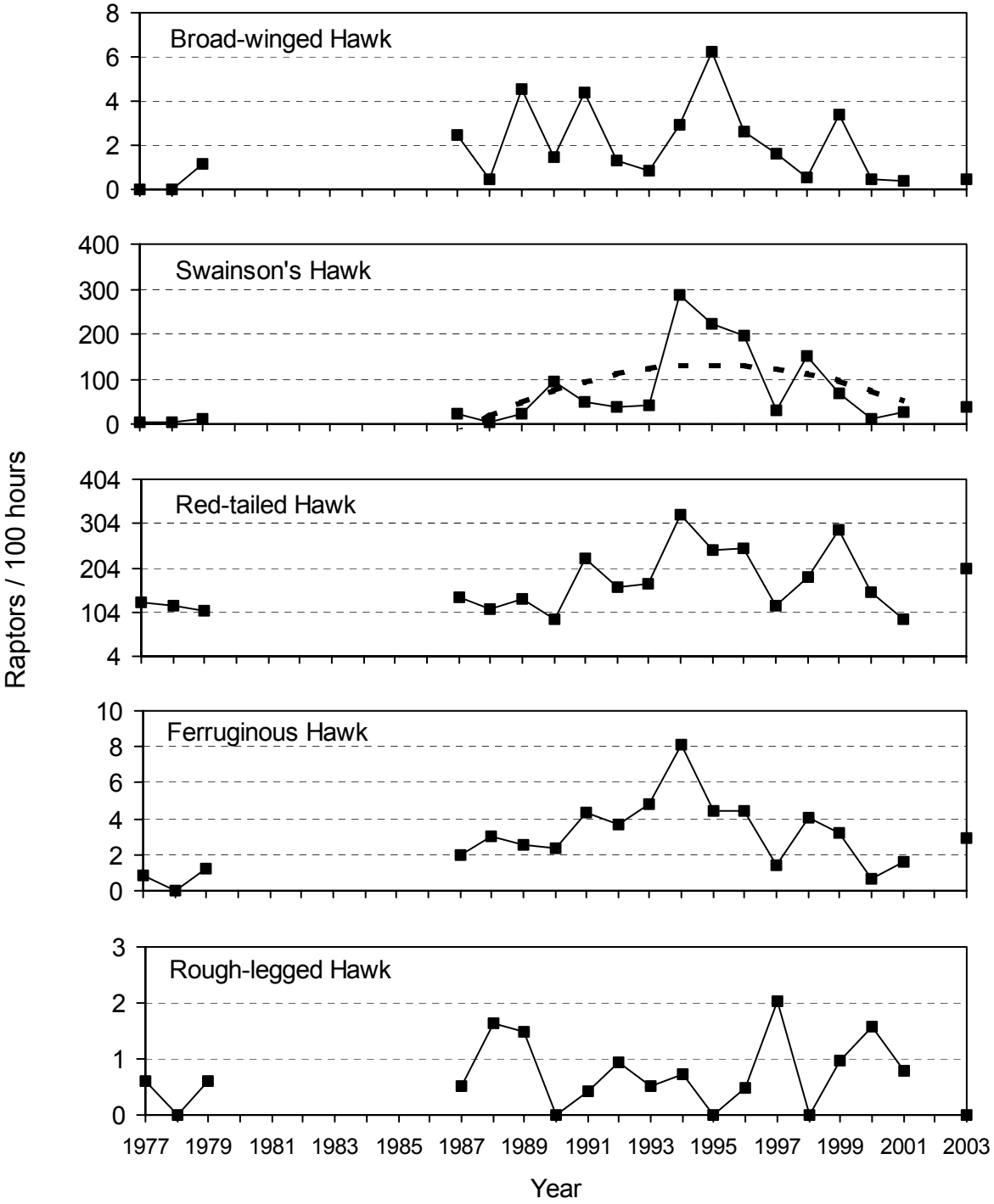

Figure 5. Adjusted annual passage rates for Broad-winged, Swainson's, Red-tailed, Ferruginous, and Rough-legged Hawks: 1977–2003. Dotted lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

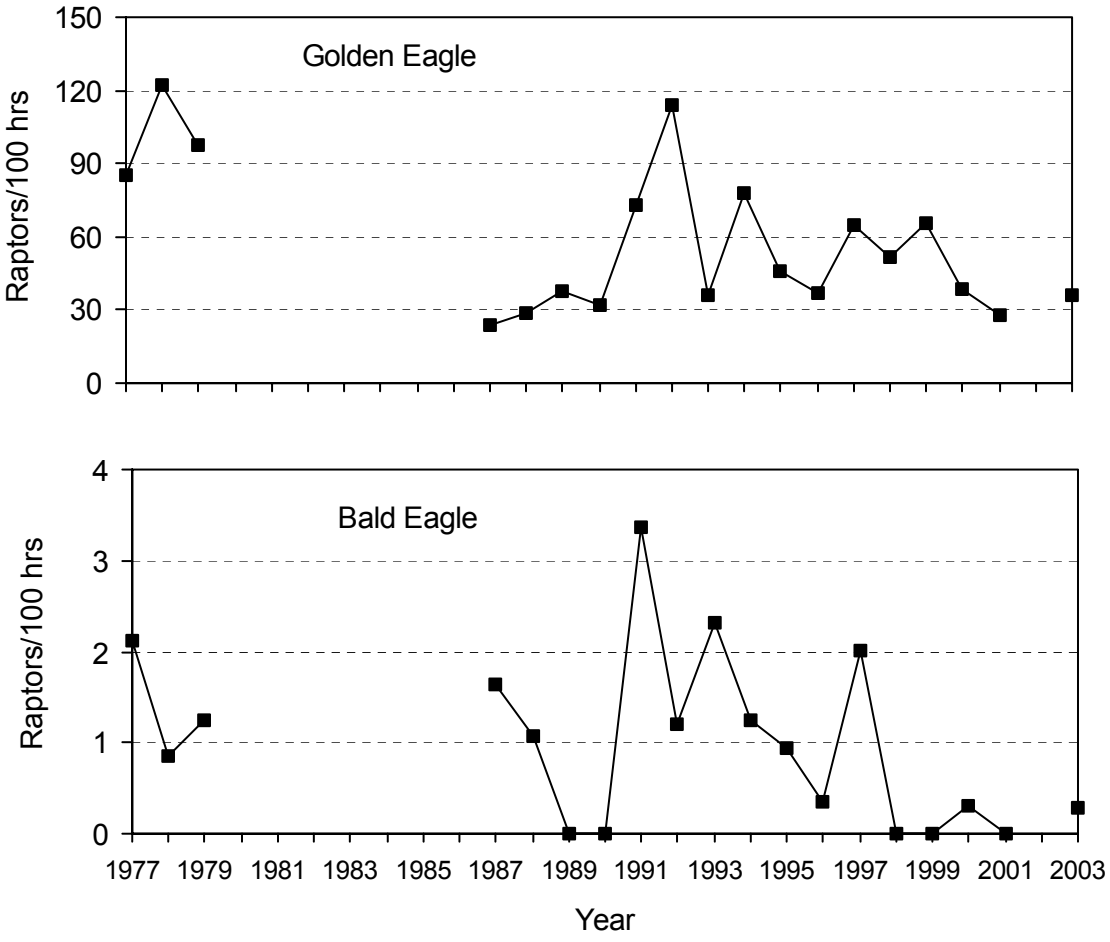

Figure 6. Adjusted annual passage rates for Golden and Bald Eagles: 1977–2003. Dotted lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

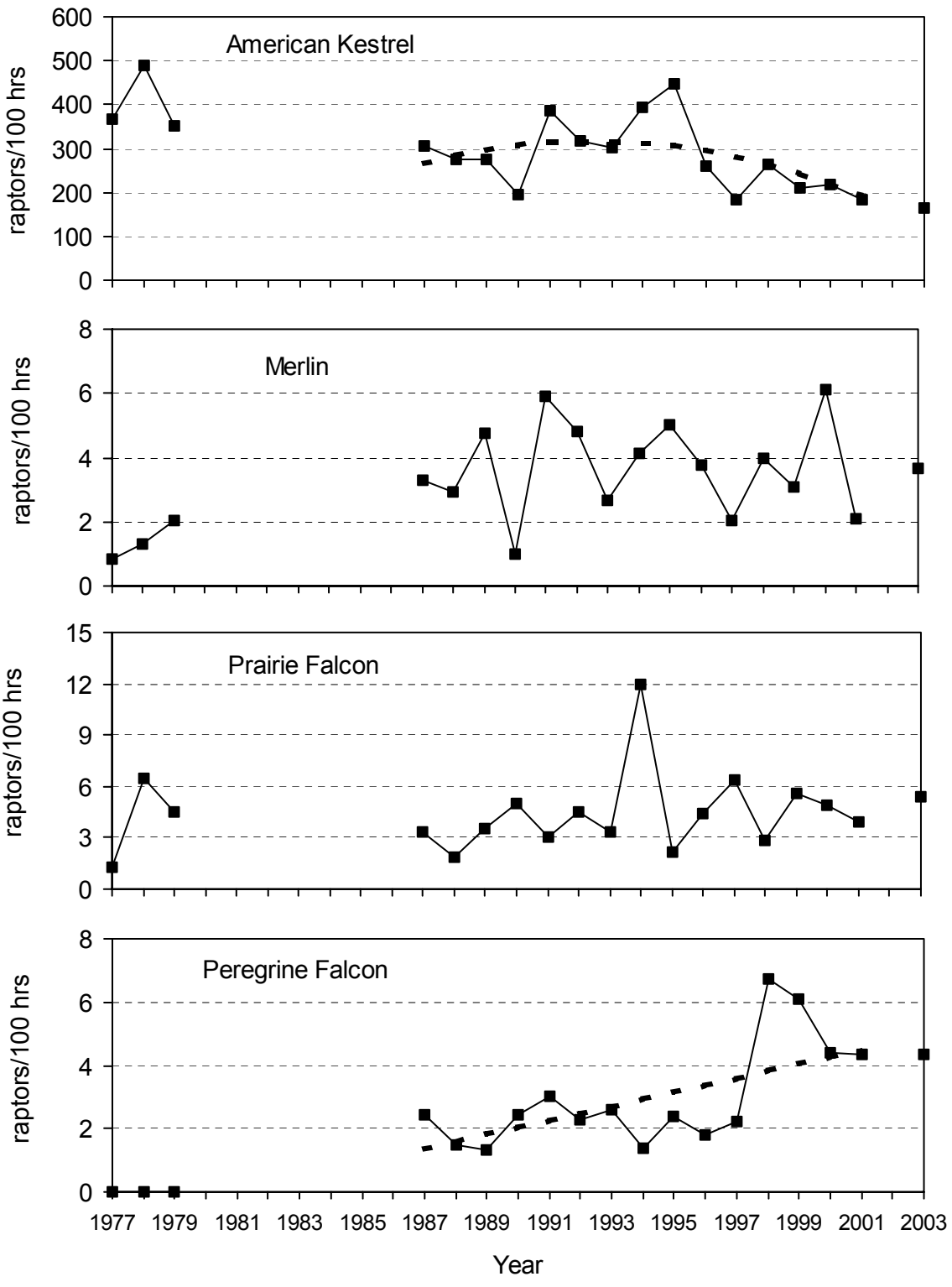

Figure 7. Adjusted annual passage rates for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons: 1977–2003. Dotted lines indicate significant ($P \leq 0.10$) linear or quadratic regressions.

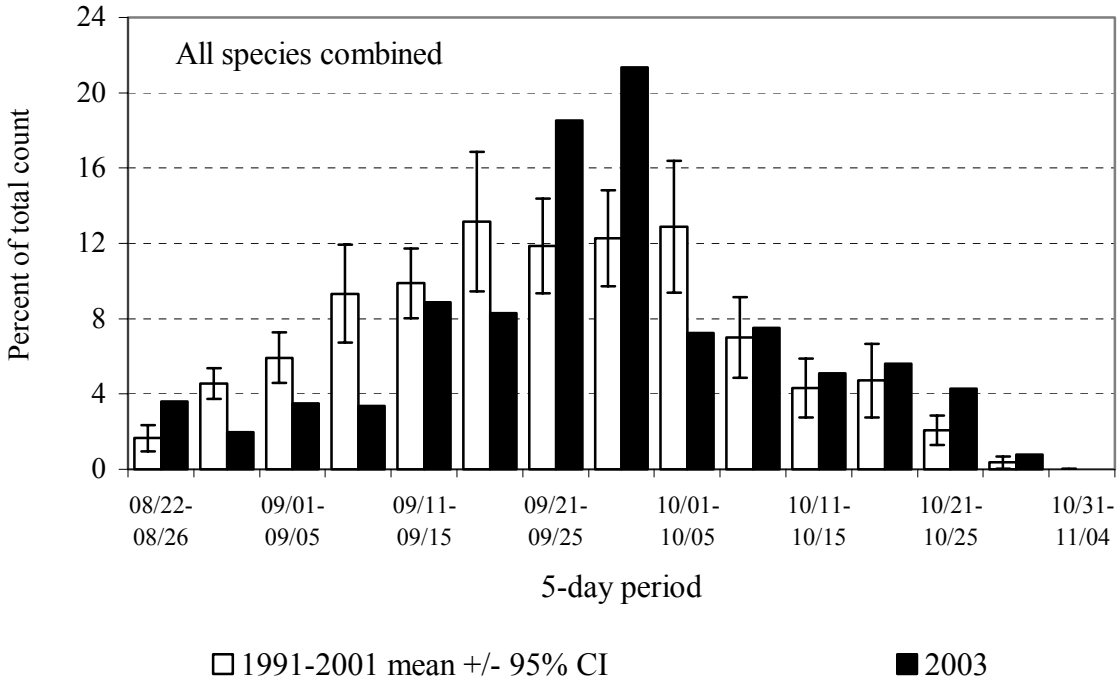

Figure 8. Combined-species passage volume by five-day periods: 1991–2001 versus 2003.

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)

2003: Two observers throughout: David Tidhar (1), Jason Ferrell (0), Anthony Sandoval (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: 2003.

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
22-Aug	4.16	2.94	0	pc-ovc	14.3	se-sw	28.3	29.87	4	45	45	2	6.5
23-Aug	7.50	2.73	0	pc	11.8	s	21.9	29.98	2	45	45	2	5.3
24-Aug	7.50	2.00	0	pc	17.0	ssw	23.9	30.03	2.5	45	45	2	2.4
25-Aug	7.80	1.00	0	clr-pc	4.1	var, w-wsw	25.8	30.08	1	45	45	2	2.7
26-Aug	8.00	2.00	0	ovc	6.0	s-sw/var	26.0	29.96	1.5	45	45	2	1.8
27-Aug	8.00	2.48	1.5	ovc-pc	8.9	s-w	21.0	29.08	4	45	45	2	2.1
28-Aug	7.75	1.00	0	pc-mc	10.1	sw-wsw	22.6	29.97	3	45	45	2	2.5
29-Aug	1.33	1.00	0	rain	15.0	ne	13.0	28.51	4	35	35	-	0.0
30-Aug	7.91	2.21	0	mc-ovc, AM fog	5.4	wsw-wnw/var	18.0	28.64	4	34	34	2	1.1
31-Aug	8.00	1.98	0	clr-pc	3.9	ne, wsw/var	21.0	28.63	1.5	45	45	2	3.1
1-Sep	8.00	1.00	0	mc-ovc	9.5	s-wsw	22.5	28.63	2	45	45	2	1.9
2-Sep	8.00	2.00	0	pc-mc	7.3	sw-wnw	22.5	28.68	2	45	45	2	5.0
3-Sep	8.00	2.00	0	clr-pc	2.0	var	20.1	28.69	1	45	45	2	2.3
4-Sep	8.00	1.00	0	clr-pc	2.5	sw-wsw, var	20.1	28.91	1.5	45	45	2	2.5
5-Sep	8.00	1.00	0	mc-ovc, haze	3.9	sw-nw	22.9	28.58	4	45	40	2	3.3
6-Sep	8.00	1.88	0	ovc	13.6	ssw-sw	21.3	28.48	4	45	45	2	5.0
7-Sep	9.00	2.33	0	clr-ovc	14.1	ssw-sw	20.8	28.40	3	45	45	2	4.8
8-Sep	8.00	1.00	0	ovc	14.4	ne, wsw-nw	16.6	28.18	4	43	36	2	1.4
9-Sep	6.40	1.90	0	ovc	8.3	ssw-sw	17.5	28.11	4	44	44	1	2.5
10-Sep	0.00			rain/snow									
11-Sep	7.00	1.00	0	pc-mc	12.4	sw	13.6	28.43	3	45	45	2	5.6
12-Sep	7.00	1.00	0	ovc-clr, blowing snow	34.7	sw-w	13.7	28.38	4	38	35	2	3.4
13-Sep	8.50	4.36	0	clr	8.3	ne-e, sw-nw	12.7	28.53	2	45	43	2	18.8
14-Sep	8.00	2.61	0	clr	14.8	ssw-sw	13.3	28.52	2	45	45	2	8.6
15-Sep	8.00	1.00	0	pc, PM haze	21.3	ssw-sw	17.0	28.38	3	45	43	2	3.3
16-Sep	8.00	2.23	0	ovc	29.8	sw	16.1	28.11	4	45	44	2	2.6
17-Sep	0.00			snow									
18-Sep	8.16	2.39	0	clr	95.2	sw-wsw	10.3	28.49	2	44	28	2	10.0
19-Sep	8.00	1.50	0	ovc-pc	11.7	s-sw	12.0	28.41	3	38	43	2	9.1
20-Sep	7.92	2.13	0	clr	7.5	sw	15.0	28.42	2	41	40	2	16.3
21-Sep	8.50	2.20	0	clr	13.9	sw	15.3	28.47	2	40	36	2	16.9
22-Sep	7.75	1.00	0	clr	17.9	ssw-sw	17.1	28.51	2	44	40	1	12.1
23-Sep	7.00	1.00	0	clr	14.5	sw	19.5	28.50	2	45	35	2	11.9
24-Sep	8.25	1.67	0	clr	10.9	ssw-wsw	18.7	28.52	1.5	40	32	2	17.9
25-Sep	7.50	2.25	1	clr	12.2	wsw-nw	18.3	28.48	2	34	21	2	28.4
26-Sep	8.75	1.42	0	clr, haze	361.0	var, sw-wsw	18.9	28.56	1.5	31	25	1	19.0
27-Sep	8.25	3.39	1	clr, haze	182.4	var, sw	22.7	28.54	1	27	20	2	24.4
28-Sep	8.25	1.81	0	clr, haze	13.2	sw	21.3	28.48	1	37	26	1	11.8
29-Sep	8.00	1.00	0	clr, haze	23.4	sw	20.0	28.40	2	41	29	T1	20.5
30-Sep	8.00	1.00	0	clr, haze	14.6	sw	24.5	28.63	2	34	24	2	19.8
1-Oct	7.50	1.81	0	ovc, AM rain, haze	8.6	s-ssw	20.8	28.53	4	30	24	1	2.4
2-Oct	0.00			AM rain, cleared PM									
3-Oct	8.00	1.00	0	mc-ovc, haze	104.6	ne-ene/var	12.7	28.35	3	34	29	3	2.8
4-Oct	8.00	2.00	0	clr, haze	96.5	ene-ne, sw	17.1	28.36	1.5	36	32	T1	16.0
5-Oct	7.75	1.61	0	clr-pc, haze	104.6	sw-wsw	16.6	28.44	2	41	34	2	12.6
6-Oct	0.00			personnel unavailable									
7-Oct	8.25	1.00	0	mc-ovc, rain	14.3	sw	18.1	28.46	4	35	33	1	6.8
8-Oct	8.00	1.91	1.5	clr, haze	18.9	sw	17.2	28.32	2	38	28	1	13.9
9-Oct	8.00	2.00	0	clr, haze	27.5	sw	18.9	28.23	2	31	28	1	9.6
10-Oct	7.50	1.88	0	ovc-clr, haze	15.3	w-nw	4.3	28.18	2	38	31	2	4.3
11-Oct	7.50	1.69	0	clr-pc	19.7	ssw-sw	6.6	28.45	2	43	44	1	7.5
12-Oct	7.75	3.69	1.5	clr-mc	20.3	sw-wsw	11.6	28.39	2	45	45	2	6.8
13-Oct	7.00	1.00	0	clr-pc, haze	17.0	sw	11.9	28.41	2	37	34	2	5.4
14-Oct	7.95	1.00	0	clr-pc	32.7	ssw-sw	8.1	28.35	3	42	37	1	3.3

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	7.90	1.75	0	mc-ovc, haze	20.9	sw	10.3	28.31	4	41	41	2	1.8
16-Oct	7.75	3.00	0	pc-mc, haze	14.7	sw-nw	12.4	28.53	3	37	26	1	3.6
17-Oct	7.75	1.75	0	clr, haze	21.2	sw-nw	16.6	28.71	2	42	30	1	3.5
18-Oct	7.75	2.00	0	clr-ovc, haze	21.0	ssw-sw	19.1	28.64	2.5	25	25	2	3.1
19-Oct	7.25	1.88	0	pc-ovc, haze	23.1	ssw-sw	16.2	28.61	3	41	31	1	3.6
20-Oct	8.00	2.00	0	clr, haze	18.4	s-sw	18.3	28.77	1	35	32	1	12.6
21-Oct	8.00	1.73	0	clr-pc, haze	182.6	ne-ene, sse-ssw	20.5	28.76	1	32	22	3	8.5
22-Oct	8.00	2.81	0	clr, haze	22.2	ssw-sw	20.4	28.52	1	31	22	2	2.9
23-Oct	8.00	1.80	0	ovc-pc, haze	13.4	sw-nw	12.8	28.47	2.5	14	16	2	4.4
24-Oct	8.00	1.89	0	mc-ovc, PM haze	14.0	w-nw	6.7	28.46	4	42	41	2	1.4
25-Oct	7.75	1.79	0	clr, PM haze	13.1	ne-ene, wnw-nnw	3.9	28.65	3	40	37	T1	2.7
26-Oct	7.50	2.35	0	pc, PM haze	16.6	nw-ne	6.7	28.72	3	42	27	2	0.3
27-Oct	6.70	1.90	0	ovc, PM haze	29.4	sw-wnw	8.8	28.47	4	34	40	1	0.3
28-Oct	8.00	1.93	0	ovc-pc/haze	24.6	sw-nw	8.7	28.26	4	28	35	2	2.8
29-Oct	3.80	1.60	0	ovc, snow	29.4	w-nw	6.6	27.79	4	8	10	3	0.8
30-Oct	0.00			snow									
31-Oct	0.00			snow									

[1] Average of hourly records.

[2] Median hourly visitor-disturbance rating (subjective assessment by observers): 0 = none, 1 = low, 2 = moderate, 3 = high.

[3] Predominant sky condition during day: clr = clear (0-15% cloud cover); pc = partly cloudy (16-50% cover); mc = mostly cloudy (51-75% cover); ovc = overcast (76-100% cover); ts = 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: 2003.

		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
22-Aug	4.16	2	0	1	1	1	0	0	0	0	0	3	13	1	0	0	0	0	5	0	0	0	0	0	0	0	27	6.5
23-Aug	7.50	1	0	5	1	4	0	0	0	0	0	5	9	0	0	0	1	0	12	0	0	1	0	0	0	1	40	5.3
24-Aug	7.50	0	0	2	1	0	0	0	0	0	0	2	5	0	0	0	3	0	4	0	1	0	0	0	0	0	18	2.4
25-Aug	7.80	0	0	2	0	4	0	2	0	0	0	0	9	0	0	2	0	0	2	0	0	0	0	0	0	0	21	2.7
26-Aug	8.00	1	0	1	0	1	0	0	0	0	0	2	7	0	0	1	1	0	0	0	0	0	0	0	0	0	14	1.8
27-Aug	8.00	0	1	1	0	0	0	0	0	0	0	0	8	0	0	0	3	0	2	0	0	1	0	0	0	1	17	2.1
28-Aug	7.75	1	0	1	1	1	0	1	0	0	0	2	7	0	0	0	3	0	2	0	0	0	0	0	0	0	19	2.5
29-Aug	1.33	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
30-Aug	7.91	0	0	1	0	2	0	0	0	0	0	0	4	0	0	0	1	0	1	0	0	0	0	0	0	0	9	1.1
31-Aug	8.00	0	0	3	0	3	0	1	0	0	0	2	11	0	0	0	2	0	2	0	0	1	0	0	0	0	25	3.1
01-Sep	8.00	0	0	3	2	1	0	1	0	0	0	2	6	0	0	0	0	0	0	0	0	0	0	0	0	0	15	1.9
02-Sep	8.00	4	0	4	3	3	0	0	0	0	0	4	16	0	0	1	0	0	1	0	2	1	0	0	0	1	40	5.0
03-Sep	8.00	1	0	2	1	0	0	0	0	0	0	1	4	0	0	4	0	0	3	0	0	1	0	1	0	0	18	2.3
04-Sep	8.00	1	0	1	0	1	0	1	0	0	0	2	10	0	0	1	1	0	1	0	1	0	0	0	0	0	20	2.5
05-Sep	8.00	0	0	6	1	5	0	1	1	0	0	2	6	0	0	1	0	0	2	1	0	0	0	0	0	0	26	3.3
06-Sep	8.00	0	0	4	12	3	0	0	0	0	0	1	10	1	0	1	1	0	6	1	0	0	0	0	0	0	40	5.0
07-Sep	9.00	3	0	4	6	5	0	1	0	0	0	1	8	0	0	1	3	0	11	0	0	0	0	0	0	0	43	4.8
08-Sep	8.00	0	0	2	1	6	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	11	1.4
09-Sep	6.40	0	0	3	1	0	0	0	0	0	0	0	8	0	0	1	1	0	2	0	0	0	0	0	0	0	16	2.5
10-Sep	0.00																											
11-Sep	7.00	0	0	5	8	3	0	1	0	0	0	1	15	0	0	0	2	0	3	0	1	0	0	0	0	0	39	5.6
12-Sep	7.00	0	0	3	2	1	0	1	0	0	0	3	3	0	0	2	2	0	5	0	1	1	0	0	0	0	24	3.4
13-Sep	8.50	0	1	18	25	37	0	0	0	4	0	1	26	0	0	5	4	0	30	0	0	0	0	0	0	9	160	18.8
14-Sep	8.00	0	1	11	12	10	0	2	0	0	0	1	16	0	0	1	7	0	5	0	1	2	0	0	0	0	69	8.6
15-Sep	8.00	0	0	1	6	3	0	1	0	0	0	0	12	0	0	0	2	0	1	0	0	0	0	0	0	0	26	3.3
16-Sep	8.00	0	0	0	4	1	0	2	0	0	0	0	7	0	0	0	3	0	3	0	1	0	0	0	0	0	21	2.6
17-Sep	0.00																											
18-Sep	8.16	0	1	9	16	9	1	2	0	0	0	0	21	0	0	3	5	0	14	0	0	0	0	0	0	1	82	10.0
19-Sep	8.00	0	1	6	20	11	0	1	0	0	0	0	15	0	0	0	2	0	14	1	0	2	0	0	0	0	73	9.1
20-Sep	7.92	0	1	11	12	24	1	9	0	0	0	4	19	0	0	1	4	0	39	0	3	0	0	0	0	1	129	16.3
21-Sep	8.50	0	2	11	26	15	1	9	0	0	0	0	25	0	0	0	2	0	49	1	2	1	0	0	0	0	144	16.9
22-Sep	7.75	0	1	17	33	10	1	1	0	0	0	1	16	0	0	0	2	0	10	0	0	2	0	0	0	0	94	12.1
23-Sep	7.00	0	1	6	25	12	0	1	0	0	0	0	17	0	0	0	3	0	18	0	0	0	0	0	0	0	83	11.9
24-Sep	8.25	0	0	30	31	18	0	4	0	0	0	2	30	4	0	0	3	0	23	1	0	0	0	0	0	2	148	17.9
25-Sep	7.50	0	1	19	44	25	0	0	0	0	0	31	38	0	0	1	4	0	47	0	2	1	0	0	0	0	213	28.4
26-Sep	8.75	0	0	11	64	24	3	1	0	0	1	0	28	0	0	5	2	1	18	1	1	0	0	0	0	6	166	19.0
27-Sep	8.25	0	1	22	62	46	0	10	0	0	0	6	33	1	0	2	3	0	13	0	1	0	0	0	0	1	201	24.4
28-Sep	8.25	0	0	12	25	17	0	1	0	0	0	9	12	0	0	0	6	0	15	0	0	0	0	0	0	0	97	11.8
29-Sep	8.00	0	0	14	50	22	4	1	0	0	0	2	28	0	0	0	3	0	36	1	1	0	0	0	1	1	164	20.5
30-Sep	8.00	0	1	13	41	24	1	4	0	0	0	7	25	1	0	1	2	0	34	1	0	1	0	0	0	2	158	19.8

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
01-Oct	7.50	0	0	3	10	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	18	2.4
02-Oct	0.00																											
03-Oct	8.00	0	1	2	2	0	2	0	0	0	0	0	10	0	0	0	1	0	2	0	0	0	0	0	0	2	22	2.8
04-Oct	8.00	0	0	13	45	12	1	3	0	1	0	2	22	0	0	0	5	0	23	0	0	1	0	0	0	0	128	16.0
05-Oct	7.75	0	0	20	29	15	2	0	0	0	0	1	14	0	0	0	4	0	11	1	0	0	1	0	0	0	98	12.6
06-Oct	0.00																											
07-Oct	8.25	0	0	7	14	5	1	0	0	0	0	1	14	0	0	0	6	0	6	1	1	0	0	0	0	0	56	6.8
08-Oct	8.00	0	0	9	59	12	1	0	0	1	0	0	9	0	0	0	5	0	15	0	0	0	0	0	0	0	111	13.9
09-Oct	8.00	4	0	7	31	4	0	1	0	0	0	0	11	0	0	0	4	0	14	0	1	0	0	0	0	0	77	9.6
10-Oct	7.50	0	0	5	1	0	2	0	0	0	0	0	21	1	0	0	1	0	1	0	0	0	0	0	0	0	32	4.3
11-Oct	7.50	0	0	7	24	3	2	0	0	0	0	0	12	0	0	0	4	0	2	1	1	0	0	0	0	0	56	7.5
12-Oct	7.75	0	0	7	15	4	1	0	0	0	0	0	19	0	0	0	3	0	3	0	1	0	0	0	0	0	53	6.8
13-Oct	7.00	0	0	6	13	3	0	0	0	0	0	0	14	0	0	0	1	0	1	0	0	0	0	0	0	0	38	5.4
14-Oct	7.95	0	0	1	8	1	0	0	0	0	0	0	9	0	0	0	7	0	0	0	0	0	0	0	0	0	26	3.3
15-Oct	7.90	0	0	2	7	1	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	14	1.8
16-Oct	7.75	0	0	5	6	3	2	0	0	0	0	0	6	0	0	0	6	0	0	0	0	0	0	0	0	0	28	3.6
17-Oct	7.75	0	0	6	10	2	1	0	0	0	0	0	3	1	0	0	3	0	1	0	0	0	0	0	0	0	27	3.5
18-Oct	7.75	0	0	9	10	3	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	24	3.1
19-Oct	7.25	0	0	9	11	1	0	0	0	0	0	0	2	0	0	0	2	0	0	1	0	0	0	0	0	0	26	3.6
20-Oct	8.00	0	0	25	25	8	1	0	0	0	0	0	34	1	0	0	4	0	2	1	0	0	0	0	0	0	101	12.6
21-Oct	8.00	0	0	9	2	4	0	0	0	0	0	1	46	1	0	1	3	0	1	0	0	0	0	0	0	0	68	8.5
22-Oct	8.00	0	0	9	4	3	0	0	0	0	0	0	5	0	0	0	2	0	0	0	0	0	0	0	0	0	23	2.9
23-Oct	8.00	0	0	8	3	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	35	4.4
24-Oct	8.00	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	2	0	0	0	0	0	0	0	0	0	11	1.4
25-Oct	7.75	0	0	3	0	0	1	0	0	0	0	0	16	0	0	0	1	0	0	0	0	0	0	0	0	0	21	2.7
26-Oct	7.50	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.3
27-Oct	6.70	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0.3
28-Oct	8.00	0	0	3	3	1	1	0	0	0	0	0	8	0	0	0	5	0	0	0	1	0	0	0	0	0	22	2.8
29-Oct	3.80	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	3	0.8
30-Oct	0.00																											
31-Oct	0.00																											
Total	495.53	18	14	441	869	440	33	64	1	6	1	102	841	12	0	35	154	1	515	13	23	17	1	1	1	29	3632	7.3

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

Appendix E. Annual observation effort and unadjusted raptor counts by species: 1977–2003.

	1977	1978	1979	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2003	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	22-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	31-Oct	25-Oct
Observation days	67	41	41	43	47	47	52	59	63	55	49	62	55	58	54	59	49	59	65	54
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	495.53	368.62
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	733.0	1004.9
SPECIES	RAPTOR COUNTS																			
Turkey Vulture	6	7	8	11	11	9	1	39	15	28	16	43	33	47	17	28	20	26	18	20
Osprey	5	8	13	11	17	30	19	34	29	25	44	41	35	39	39	21	28	27	14	25
Northern Harrier	159	200	173	278	185	172	195	430	330	208	363	362	315	171	443	487	198	230	441	281
Sharp-shinned Hawk	618	737	570	793	1093	832	546	997	989	1000	901	1217	928	652	1005	901	790	764	869	853
Cooper's Hawk	457	333	495	362	561	603	260	621	601	596	778	874	701	388	587	577	482	545	440	540
Northern Goshawk	35	32	30	8	15	15	20	18	74	26	16	23	27	17	14	16	24	15	33	24
Unknown small accipiter[1]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	87	64	76
Unknown large accipiter[1]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	2
Unidentified accipiter	86	53	122	64	26	43	47	59	124	44	70	66	73	22	55	20	31	0	6	53
TOTAL ACCIPITERS	1196	1155	1217	1227	1695	1493	873	1695	1788	1666	1765	2180	1729	1079	1661	1514	1327	1413	1413	1478
Broad-winged Hawk	0	0	2	5	1	9	4	10	3	2	5	13	7	3	1	7	1	1	1	4
Swainson's Hawk	19	5	21	44	12	47	188	129	97	91	487	468	419	106	309	155	29	61	102	147
Red-tailed Hawk	311	258	238	409	403	413	286	908	566	621	891	926	876	430	609	1089	509	357	841	576
Ferruginous Hawk	2	0	3	6	11	8	6	16	13	15	23	18	15	8	14	13	2	6	12	10
Rough-legged Hawk	2	0	1	1	4	3	0	1	2	1	2	0	3	6	1	2	3	2	0	2
Unidentified buteo	10	13	21	12	5	5	34	17	38	26	14	24	33	9	19	23	4	19	35	19
TOTAL BUTEOS	344	276	286	477	436	485	518	1081	719	756	1422	1449	1353	562	953	1289	548	446	991	757
Golden Eagle	236	285	237	73	106	119	101	292	423	133	224	163	127	212	154	245	130	122	154	186
Bald Eagle	5	3	3	5	4	0	0	13	10	10	4	3	2	7	0	2	1	0	1	4
TOTAL EAGLES	241	288	240	78	110	119	101	305	433	143	228	166	129	219	154	247	131	122	155	190
American Kestrel	808	970	799	817	862	744	557	1307	1118	888	975	1371	922	524	727	600	660	623	515	831
Merlin	2	3	5	10	11	15	3	21	17	8	11	17	12	8	11	13	20	8	13	11
Prairie Falcon	4	15	11	10	7	11	16	13	17	14	33	18	17	23	13	28	14	16	23	16
Peregrine Falcon	0	0	0	7	5	5	9	10	7	7	6	11	8	9	19	24	13	16	17	9
Unknown small falcon[1]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0	6	1	4
Unknown large falcon[1]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0	6	1	4
Unidentified falcon	0	0	2	2	1	2	4	2	3	3	0	1	1	3	2	6	10	2	1	2
TOTAL FALCONS	814	988	817	846	886	777	589	1353	1162	920	1025	1418	960	567	772	671	717	677	571	870
Unidentified raptors	42	31	57	12	2	16	76	34	10	18	8	8	21	8	30	4	7	15	29	23
GRAND TOTAL	2807	2953	2811	2940	3342	3101	2372	4971	4486	3764	4871	5667	4575	2692	4069	4261	2976	2956	3632	3645

[1] Designations used for the first time in 2001.