SPRING 2002 RAPTOR MIGRATION STUDY NEAR JORDANELLE RESERVOIR IN NORTHERN UTAH

HawkWatch International, Inc., Salt Lake City, Utah

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INTRODUCTION

The Jordanelle Raptor Migration Project, located in the Wasatch Mountains of north-central Utah near Jordanelle Reservoir, is an ongoing effort to monitor long-term trends in populations of raptors using the Rocky Mountain migratory flyway (Smith and Hoffman 2000, Hoffman et al. 2002). HawkWatch International (HWI) initiated standardized counts of the spring raptor migration through this region in 1997, and conducted exploratory trapping and banding in the area for three years. To date, HWI observers have recorded 18 species of migratory raptors at the site, with counts typically ranging between 4,000 and 5,000 migrants per season. The 2002 season marked the sixth consecutive count at the site. This report summarizes the results of that effort. No trapping and banding occurred in 2002.

The Jordanelle project was 1 of 16 migration counts (13 fall, 3 spring) conducted or co-sponsored by HWI in North America during 2002. 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 (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).

The intensive counting and banding operations also provide valuable information about breeding and wintering distributions, migratory routes, migratory behavior, population demographics, mortality factors and longevity, morphometric variation, molt sequences and timing, and health assessments. This information enables us to better understand the life histories, ecology, status, and conservation needs of raptor populations in North America. In addition, these migration studies offer unique opportunities for the public to learn about raptors and the natural environment, and providing such opportunities is another important component of HWI's mission.

STUDY SITE

The Jordanelle lookout is located in the eastern foothills of the Wasatch Mountains (40°35'32" N, 111°26'30" W), with the Wasatch crest about 5 km to the west and the Uinta Mountains 15 km to the east. The study site is 10 km north of Heber City, 1.5 km southwest of Jordanelle Reservoir, and 22 km southeast of Park City. The observation site sits atop a small knoll at an elevation of 2,045 m and is reached via a 2.5-km trail that begins along the west side of State Highway 40 and ascends about 200 m (Figure 1). HWI conducted banding programs at this site in 1998 and 1999 at a location about 200 m due west of the observation site at a similar elevation; however, because these efforts were only marginally productive, no banding occurred in 2000. In 2001, limited trapping occurred late in the season at a new exploratory site 1.3 km northwest of and about 225 m higher than the observation point. This site showed promise; however, resource limitations precluded any trapping in 2002 and HWI's Science Committee (including selected staff, Board members, and outside scientists) subsequently decided to abandon trapping as an objective at this site.

Gambel's oak (*Quercus gambelli*), Rocky Mountain maple (*Acer glabrum*), mountain mahogany (*Cercocarpus montanus*), and big sagebrush (*Artemisia tridentata*) are the predominant woody plant species along the foothills of the Wasatch Mountains. Quaking Aspen (*Populus tremuloides*), Douglas-fir (*Psuedotsuga menziesii*), and White Fir (*Abies concolor*) predominate at higher elevations.

The Jordanelle flyway differs from most other HWI sites in that most birds funnel through the foothills of the Wasatch Mountains, not along the top of a ridgeline. Early in the season when snow covers the entire landscape, U.S. Highway 40, which runs north-south just east of the lookout, provides raptors with the only available thermal lift. After the snow has melted in the valley, migrants concentrate along the eastern foothills, avoiding higher elevation snow cover to the west. Heber Valley, an area dominated by agriculture and several riparian areas, also provides ideal hunting and overnight roosting habitat for migratory raptors.

METHODS

Two official or designated observers conducted standardized daily counts of migrating raptors from a single traditional observation site between 25 February and 19 May 2002. Before spring 2002, primary observers Sue Bruner and John Minturn had no previous experience counting migratory raptors, but both received on-site training by HWI staff (see Appendix A for a complete history of observer participation). Visitors also occasionally assisted with spotting migrants. Weather permitting, observations usually began between 0800 and 0900 hrs Mountain Standard Time (MST) and ended between 1700 and 1800 hrs.

The observers routinely recorded the following data:

1. Species, age, sex, and color morph of each migrant raptor, whenever possible and applicable (Appendix B lists common and scientific names for all species, information about the applicability of age, sex, and color-morph distinctions, and two-letter codes used to identify species in some tables and figures).
2. Hour of passage for each migrant; e.g., the 1000–1059 hrs MST.
3. Wind speed and direction, air temperature, percent cloud cover, predominant cloud type(s), precipitation, visibility, and an assessment of thermal lift conditions, recorded for each hour of observation on the half hour.
4. Predominant direction, altitude, and distance from the lookout of the flight during each hour.
5. Total minutes observed and the mean number of observers present during each hour (included designated observers plus volunteers/visitors who actively contributed to the count [active scanning, pointing out birds, recording data, etc.] for more than 10 minutes in a given hour), recorded on the hour.
6. A subjective visitor-disturbance rating (none, low, moderate, high) for each hour, recorded on the hour.
7. Daily start and end times for each official observer.

The observers used high quality 7–10x binoculars to assist in spotting and identifying birds. Clark and Wheeler (1987), Dunne et al. (1988), Wheeler and Clark (1995), and Clark (2001) served as primary identification references. Assessments of wind speed, cloud type, cloud cover, and flight altitude followed guidelines provided 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, we also know from band-return studies and recent telemetry work that species such as Golden Eagles, Prairie Falcons and Ferruginous Hawks frequently "migrate" in non-standard directions to take advantage of favored post-breeding and wintering grounds (Steenhof et al. 1984, personal communication; Watson and Pierce 2000; HWI unpublished data).

The observers commonly identified distant or otherwise poorly observed migrants only to genus or other common non-specific groupings (e.g., unidentified eagle, which includes two genera, *Aquila* and *Haliaeetus*). Beginning in fall 2001, HWI adopted a new standard for recording information about incompletely identified accipiters and falcons (see Appendix B), which should improve the accuracy of classifying incompletely identified birds for analysis of population trends. Whenever possible, all HWI observers now seek to classify any accipiters or falcons for which a species identification is not certain as small or large, using the simpler classifications of "unknown accipiter" or "unknown falcon" only as a last resort. For falcons, identification debates usually center on distinguishing kestrels and Merlins or Prairie and Peregrine Falcons, and the small and large size classes distinguish which debate applied. For the accipiters, most debates concern distinguishing Sharp-shinned and Cooper's Hawks, and designation of the small size class confirms this. Occasionally, however, an observer struggles with distinguishing a large female Cooper's Hawk from a Northern Goshawk, and designation of the large size class confirms this and enables a more informed adjustment of the data before conducting trend analyses.

For purposes of examining long-term variation in annual counts, I calculated annual passage rates (total raptors counted / total hours of observation for a given year * 100 = raptors/100 hrs) for each species. Using passage rates rather than counts as the index of interest avoids potential biases caused by variation in sampling effort due to inclement weather and other unforeseeable events (Bednarz et al. 1990).

I generally limit the analyses in this report to comparing 2002 annual statistics against means ± 95% confidence intervals (CI) for previous seasons, in which case I equate significance with a 2002 value falling outside of the CI for the associated mean.

RESULTS

WEATHER SUMMARY

The 2002 season featured a high proportion of days where inclement weather (mostly heavy snow) entirely precluded observations (20% versus the 1997–2001 average of 10), and weather severely hampered activities (<4 hours of observations) on another 7% of the observation days (see Appendix C for daily weather summaries). Otherwise, fair skies prevailed on 31% of the active observation days, unsettled or transitional weather on 34%, and mostly cloudy to overcast skies on 35% (compared to averages of 35%, 30%, and 35%, respectively). Moreover, fog/haze or scattered rain/snow were relatively uncommon on days when otherwise fair skies or transitional weather prevailed (2% of all days versus an average of 24%). In terms of wind conditions, the season featured near-average arrays of predominant wind speeds (67% light [<12 kph], 33% moderate [12–29 kph], and 0% high, compared to averages of 68%, 28%, and 3%) and directions (23% primarily NW–NE, 1% NE–SE, 28% E–S, 7% SE–SW, 15% S–SW, 17% a combination of NW–NE and SE–SW, 1% a combination of SE–S and SW–NW, and 7% highly variable). The temperature during active observation periods averaged 11.6°C (the average of daily values, which in turn were averages of hourly readings), ranging from -1.1–24.2°C, which is the second warmest average but a similar range as the average pattern. Fifty three percent of the

active observation days received a median (of hourly ratings) thermal-lift rating of fair to poor and 47% good to excellent, compared to the 1997–2001 averages of 66% and 34%.

In summary, although heavy snow curtailed observations on a relatively high proportion of days, during periods when observations occurred the weather conditions were generally within the range of variation seen during the past five seasons. Exceptions included a relatively low prevalence of fog/haze and scattered rain/snow on days with otherwise fair to transitional skies, and slightly stronger thermal ratings.

OBSERVATION EFFORT

The observers worked on 70 of 84 possible days between 25 February and 19 May 2002. The number of observation days and hours (488.75) were 8% and 4% higher, respectively, than the 1997–2001 averages of 65 ± 95% CI of 2.1 days and 468.31 ± 95% CI of 26.18 hours. The increased effort resulted partly from extending the season by a week to increase late-season coverage. The 2002 average of 1.7 observers per hour (including official and guest observers; value is mean of daily values, which are in turn means of hourly values) was a significant 15% lower than the 1997–2001 average of 2.0 ± 95% CI of 0.08 observers/hr.

MIGRATION SUMMARY

The observers counted 2,209 migrants of 17 species during the 2002 season (Table 1, and see Appendix D for daily count records). The combined-species count and annual passage rate of 452 raptors/100 hours of observation were 47% and 50% lower than average, respectively, with both differences highly significant (Table 1). The flight was composed of 44% vultures, 25% buteos, 9% accipiters, 8% eagles, 2% falcons, 2% Ospreys, 1% harriers, and 9% unknown raptors. This composition differs significantly from the average pattern, including significantly below average proportions of accipiters, buteos, falcons, Ospreys, and harriers, and significantly above average proportions of vultures and unknown raptors (Figure 2). As usual, Turkey Vultures and Red-tailed Hawks were the most abundant species, followed by Bald Eagles, Cooper's Hawks, Sharp-shinned Hawks, Ospreys, Golden Eagles, and American Kestrels (Table 1). With the exception of Red-shouldered Hawk (seen for the first time this year), the Northern Goshawk was the only species that showed a higher than average count and passage rate in 2002, with both differences significant. All other commonly observed species showed counts and passage rates that were more than 20% below average, with the differences significant for all species except Turkey Vulture and Rough-legged Hawk. Extending the season by another week and stronger thermals (which tends to disperse the flight) may have contributed to lower than average passage rates; however, the almost universally and substantially low counts and passage rates confirm that overall flight volume was truly much lower than average this season.

Six years of data are generally insufficient to warrant close attention to long-term trends. In this case, however, the similarities between trends at Jordanelle and those shown at several other long-term HWI sites in the interior West are marked and therefore deserve attention. Specifically, at Jordanelle most species have shown distinct downturns since at least 1998 or 1999 (Figures 3–8), which matches the general pattern shown at other sites. We believe that the consistency of downturns across species and sites reflects the negative effects of the prolonged and widespread drought and extensive wildfires that have plagued much of the interior West since 1997/1998 (Hoffman and Smith in review).

All nine species with relevant age-specific data showed immature : adult ratios that were more than 20% below average in 2002, with the differences significant for Sharp-shinned and Cooper's Hawks, Northern Goshawks, and Bald Eagles (Table 2). Moreover, for all species except Ferruginous Hawks, the lower age-ratios reflected low abundance of second-year birds. These data again suggest that the drought reduced productivity and survival.

The combined-species median passage date (date by which 50% of the total migration had passed) of 7 April was an insignificant two days later than average (Table 3); however, the seasonal activity pattern shows that relative flight volume was generally below average during the first three weeks of March and more concentrated than usual between late March and mid-April (Figure 9). The low activity pattern in early March largely reflects poor weather, with an above-average proportion (~33%) of potential observation days in March entirely or severely precluded by heavy snow (Appendix C). Species-level median passage dates confirmed that 13 of 15 species for which comparisons were possible showed later than average timing in 2002, with the differences significant for 7 species (Turkey Vulture, Northern Harrier, Red-tailed Hawk, Rough-legged Hawk, Golden and Bald Eagles, and American Kestrels). Extending the season another week may have contributed to the late dates for a few species (i.e., Turkey Vulture, Northern Harrier, and Sharp-shinned Hawk); however, most species did not occur in sufficient numbers beyond April for this effect to have occurred. Only Ospreys and Swainson's Hawks showed earlier than average timing in 2002, but neither difference was significant. Age-specific data also consistently indicated late timing (Table 4).

Only three species (Turkey Vultures, Sharp-shinned Hawks, and Red-tailed Hawks) were recorded as migrants during the last week of observations this season. Moreover, the proportions of these species' total flight volume that occurred during this time ranged from only 0.7 to 3.4%, and only 2.1% of the combined-species total flight volume occurred then. In contrast, during the first week of observations, the combined-species flight volume amounted to a similar 1.6% of the season total, but a substantial 15% of the eagle flight occurred then. Thus, although only one year of data is a limited sample, in terms of comparative efficiency it appears that monitoring this migration after 12 May is unlikely to be productive enough to warrant the expense of maintaining the count.

RESIDENT RAPTORS

Typical for the site, local Northern Harriers appeared in the area by late March and by at least mid-April a pair appeared to have established a territory in a typical locale south of the observation site. The first local Osprey was noted on 7 April and a bird sighted on 15 April appeared to be carrying nest material as it headed south toward the Provo River. At least 8–10 local Turkey Vultures began patrolling the west ridge beginning in early April.

No Northern Goshawks were confirmed as locals this season. The first apparently local Cooper's Hawk was recorded on 6 April and from mid-April on at least one immature and one or more adult birds were seen regularly along the west ridge near the observation site. The first local Sharp-shinned Hawk was recorded on 14 April. A pair of adults was seen on 22 April chasing one another towards Coyote Ridge, and single adult was seen again on 13 May. One local immature bird was recorded on 12 May.

The first confirmed local Red-tailed Hawks (one immature and one adult) were recorded on 18 March. Subsequently, it appeared that at least two pairs of adults (3 light-morphs and 1 dark-morph) resided in the area throughout the season and at least one light-morph immature bird was seen on several other occasions. One possible local Ferruginous Hawk was recorded on 6 May along the western ridge.

Until mid-March, several adult and subadult Bald Eagles were routinely seen making foraging excursions around Jordanelle Reservoir and along the Provo River, with two additional sightings in April. Local Golden Eagles were present throughout the season. As is typical, it appeared that at least two breeding pairs established territories in the area, one on Coyote Ridge to the east and one on the main ridge to the west. At least two subadult birds (2-4 years old) were recorded as locals early in the season, but positive confirmation of their continued presence was not obtained after late March.

The first apparently local American Kestrel was recorded on 22 March heading south from Jordanelle Reservoir; however, the next sighting did not occur until two males were seen on 25 April, which is

more-typical timing for their arrival as locals. The first evidence of a possible pair in the area was recorded on 30 April along the western ridge, and a male was seen regularly thereafter hunting in the area around the site. No other local falcons were recorded.

SITE VISITATION

Beginning in fall 2001, HWI adopted a new approach to quantifying the influence of visitors on counts at all of its project sites. Encouraging visitation and achieving positive public education and outreach are important goals for all HWI projects; however, during migration counts, visitors can represent a distraction for the official observers that may compromise the integrity of the count. Tolerating a certain level of distraction in the interest of positive outreach is a tradeoff that we gladly accept as part of our operations; however, because the distraction potential fluctuates considerably through time, it is important that the data we record include a means of quantifying the distraction potential through statistical modeling. Previously, at each site we had the observers estimate the number of visitors present during each hour of active counts. Two primary problems confounded use of this system for quantifying the visitor-distraction factor.

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

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

In 2002 at the Jordanelle site, 498 hourly assessments of visitor disturbance resulted in the following ratings: 97% none, 2% low, 1% moderate, and <1% high.

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Table 1. Annual counts and passage rates by species at the Jordanelle Raptor Migration Project site in northern Utah: 1997–2001 versus 2002.

	Raptor Count			Raptors / 100 hours		
Species	1997–2001[1]	2002	% Change	1997–2001[1]	2002	% Change
Turkey Vulture	1249 ± 253.1	961	-23	266 ± 47.8	197	-26
Osprey	148 ± 30.5	54	-64	32 ± 7.9	11	-66
Northern Harrier	84 ± 25.4	31	-63	18 ± 5.7	6	-65
Sharp-shinned Hawk	261 ± 53.2	61	-77	56 ± 14.0	13	-78
Cooper's Hawk	311 ± 142.4	65	-79	68 ± 33.7	13	-80
Northern Goshawk	4 ± 0.7	6	+58	0.8 ± 0.2	1.2	+50
Unknown small accipiter[3]	–	4	–	–	0.8	–
Unknown large accipiter[3]	–	1	–	–	0.2	–
Unknown accipiter	93 ± 36.8	72	–	20 ± 8.5	15	–
Total accipiters	669 ± 219.5	209	-69	145 ± 53.7	43	-71
Red-shouldered Hawk	0 ± 0.0	1	–	0.0 ± 0.0	0.2	–
Broad-winged Hawk	4 ± 2.1	1	-76	0.9 ± 0.5	0.2	-78
Swainson's Hawk	89 ± 17.2	22	-75	19 ± 4.4	5	-76
Red-tailed Hawk	1146 ± 294.9	444	-61	244 ± 59.9	91	-63
Ferruginous Hawk	9 ± 2.7	5	-42	1.8 ± 0.6	1.0	-45
Rough-legged Hawk	8 ± 8.4	6	-29	1.8 ± 1.9	1.2	-33
Unidentified buteo	48 ± 17.2	65	+37	10 ± 3.2	13	+32
Total buteos	1304 ± 307.7	544	-58	278 ± 62.7	111	-60
Golden Eagle	127 ± 67.1	53	-58	27 ± 14.2	11	-60
Bald Eagle	255 ± 72.8	86	-66	55 ± 16.6	18	-68
Unidentified eagle	21 ± 12.3	31	+46	4.5 ± 2.5	6.3	+42
Total eagles	403 ± 136.4	170	-58	86 ± 29.9	35	-60
American Kestrel	213 ± 60.9	41	-81	46 ± 14.6	8	-82
Merlin	9 ± 5.1	0	-100	1.9 ± 1.2	0.0	-100
Prairie Falcon	10 ± 6.4	2	-80	2.1 ± 1.4	0.4	-81
Peregrine Falcon	8 ± 3.8	1	-88	1.7 ± 0.8	0.2	-88
Unknown small falcon[3]	–	0	–	–	0.0	–
Unknown large falcon[3]	–	0	–	–	0.0	–
Unknown falcon	11 ± 6.7	8	-26	2.3 ± 1.5	1.6	-30
Total falcons	250 ± 63.4	52	-79	54 ± 15.5	11	-80
Unidentified Raptor	96 ± 43.5	189	+97	21 ± 9.6	39	+89
All Species	4202 ± 772.8	2209	-47	900 ± 174.4	452	-50

[1] Mean ± 95% confidence interval.

Table 2. Annual raptor migration counts by age classes and second-year (SY) : after-second-year (ASY) age ratios for selected species at the Jordanelle Raptor Migration Project site in northern Utah: 1997–2001 versus 2002.

	Total and Age-classified Counts									
	1997–2001 Average			2002			% Unknown Age		SY : ASY Ratio	
	ALL	SY	ASY	ALL	SY	ASY	1997–2001[1]	2002	1997–2001[1]	2002
Northern Harrier	84	12	33	31	2	9	49 ± 13.7	65	0.29 ± 0.259	0.22
Sharp-shinned Hawk	261	15	78	61	2	28	65 ± 3.7	51	0.20 ± 0.071	0.07
Cooper's Hawk	311	12	98	65	2	30	66 ± 6.2	51	0.13 ± 0.048	0.07
Northern Goshawk	4	1	<1	6	0	4	65 ± 36.7	33	1.33 ± 0.653	0.00
Broad-winged Hawk	4	<1	3	1	0	1	18 ± 22.9	0	0.27 ± 0.381	0.00
Red-tailed Hawk	1146	36	845	444	9	377	23 ± 1.3	13	0.05 ± 0.024	0.02
Ferruginous Hawk	9	1	2	5	1	3	59 ± 18.6	20	0.57 ± 0.728	0.33
Golden Eagle	127	42	42	53	15	18	33 ± 14.0	38	1.63 ± 1.079	0.83
Bald Eagle	255	86	136	86	26	47	12 ± 4.2	15	0.69 ± 0.169	0.07
Peregrine Falcon	8	2	3	1	0	0	26 ± 23.9	100	0.71 ± 0.714	–

[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 migrating raptors at the Jordanelle Raptor Migration Project site in northern Utah in 2002, with a comparison of 2002 and 1997–2001 average median passage dates.

	2002				1997–2001
Species	First Observed	Last Observed	Bulk Passage Dates[1]	Median Passage Date[2]	Median Passage Date[2]
Turkey Vulture	21-Mar	19-May	30-Mar – 6-May	11-Apr	7-Apr ± 2.9
Osprey	30-Mar	5-May	4-Apr – 25-Apr	13-Apr	15-Apr ± 2.1
Northern Harrier	22-Mar	12-May	28-Mar – 10-May	13-Apr	7-Apr ± 2.9
Sharp-shinned Hawk	22-Mar	19-May	4-Apr – 6-May	20-Apr	16-Apr ± 5.7
Cooper's Hawk	20-Mar	8-May	6-Apr – 29-Apr	17-Apr	16-Apr ± 3.4
Northern Goshawk	22-Mar	5-May	22-Mar – 5-May	22-Apr	16-Apr [3]
Red-shouldered Hawk	2-Apr	2-Apr	–	–	–
Broad-winged Hawk	4-Apr	4-Apr	–	–	27-Apr ± 2.0
Swainson's Hawk	30-Mar	9-May	3-Apr – 25-Apr	17-Apr	19-Apr ± 2.2
Red-tailed Hawk	25-Feb	16-May	19-Mar – 24-Apr	29-Mar	23-Mar ± 2.9
Ferruginous Hawk	21-Mar	18-Apr	21-Mar – 18-Apr	31-Mar	28-Mar ± 10.7
Rough-legged Hawk	19-Mar	26-Apr	19-Mar – 26-Apr	27-Mar	17-Mar ± 0.7
Golden Eagle	27-Feb	5-May	3-Mar – 13-Apr	27-Mar	17-Mar ± 2.3
Bald Eagle	25-Feb	24-Apr	25-Feb – 6-Apr	21-Mar	15-Mar ± 2.4
American Kestrel	4-Apr	5-May	6-Apr – 30-Apr	22-Apr	17-Apr ± 3.6
Merlin	–	–	–	–	11-Apr ± 6.3
Prairie Falcon	26-Feb	30-Apr	–	–	2-Apr ± 1.7
Peregrine Falcon	5-Apr	5-Apr	–	–	9-Apr ± 11.9
All species	25-Feb	19-May	22-Mar – 3-May	7-Apr	5-Apr ± 2.9

[1] Dates between which the central 80% of the flight passed; calculated only for species whose annual count equaled or exceeded 5 birds (see Table 1 for sample sizes).

[2] Date by which 50% of the flight passed; calculated based only on annual counts ≥5 birds. Values for 1997–2001 are means ± 95% confidence interval and unless otherwise indicated are calculated only for species with annual counts ≥5 birds for ≥3 years.

[3] For 1998 only.

Table 4. Median passage dates by age classes for selected species of migrating raptors at the Jordanelle Raptor Migration Project site in northern Utah: 1997–2001 versus 2002.

	ASY ADULT		SY IMMATURE	
SPECIES	1997–2001[1]	2002	1997–2001[1]	2002
Northern Harrier	1-Apr ± 6.0	13-Apr	12-Apr ± 10.5	–
Sharp-shinned Hawk	14-Apr ± 3.2	23-Apr	22-Apr ± 8.9	–
Cooper's Hawk	14-Apr ± 1.7	21-Apr	23-Apr ± 10.9	–
Red-tailed Hawk	22-Mar ± 3.4	29-Mar	15-Apr ± 2.0	20-Apr
Golden Eagle	13-Mar ± 3.3	29-Mar	23-Mar ± 7.1	27-Mar
Bald Eagle	14-Mar ± 1.8	21-Mar	18-Mar ± 2.9	27-Mar

Note: Median passage dates are dates by which 50% of the flight had passed the lookout; values were calculated based only on counts of ≥5 birds per year.

[1] Mean ± 95% confidence interval in days; unless otherwise indicated, values were calculated only for species with ≥3 years of counts ≥5 birds per year.

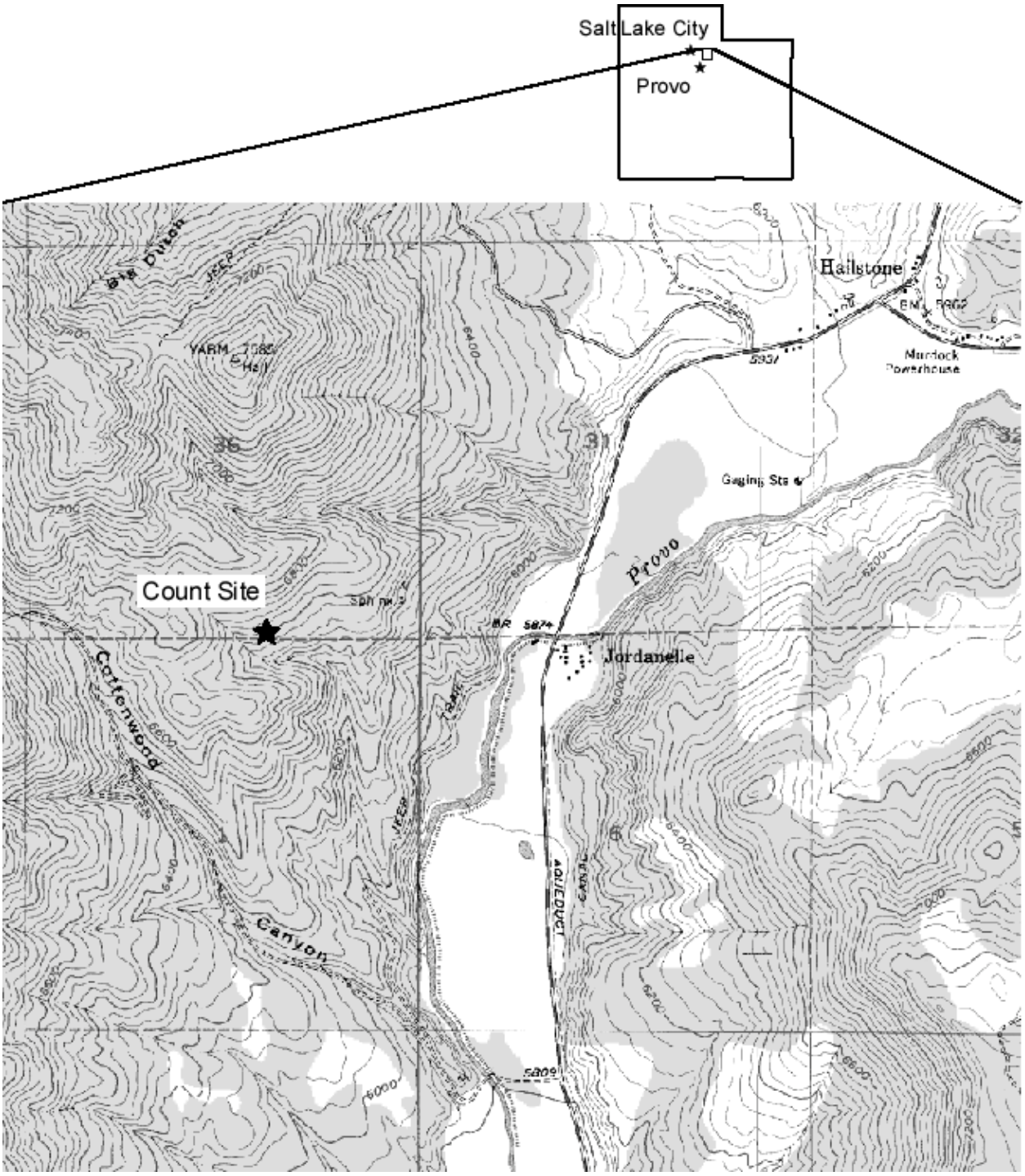

Figure 1. Location of Jordanelle Raptor Migration Project study site in north-central Utah, just north of Heber City. This map is based on a 1955 topographic map (the latest available for the area). It does not show Jordanelle Reservoir, which begins where the town of Jordanelle used to be and runs north and east beyond the boundaries of the map. It also does not depict the new route for the highway, which now runs west of the Provo River and the reservoir.

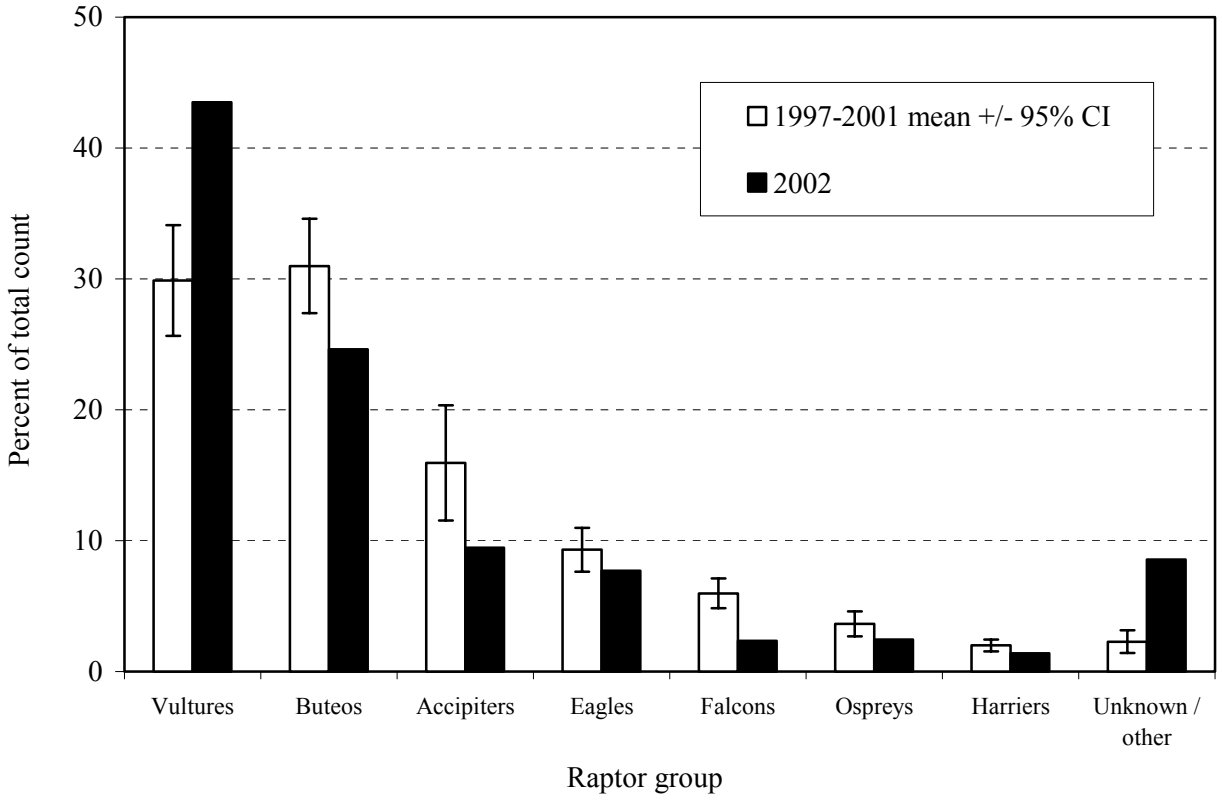

Figure 2. Spring raptor-migration flight composition by major species groups at the Jordanelle Raptor Migration Project site in northern Utah: 1997–2001 versus 2002.

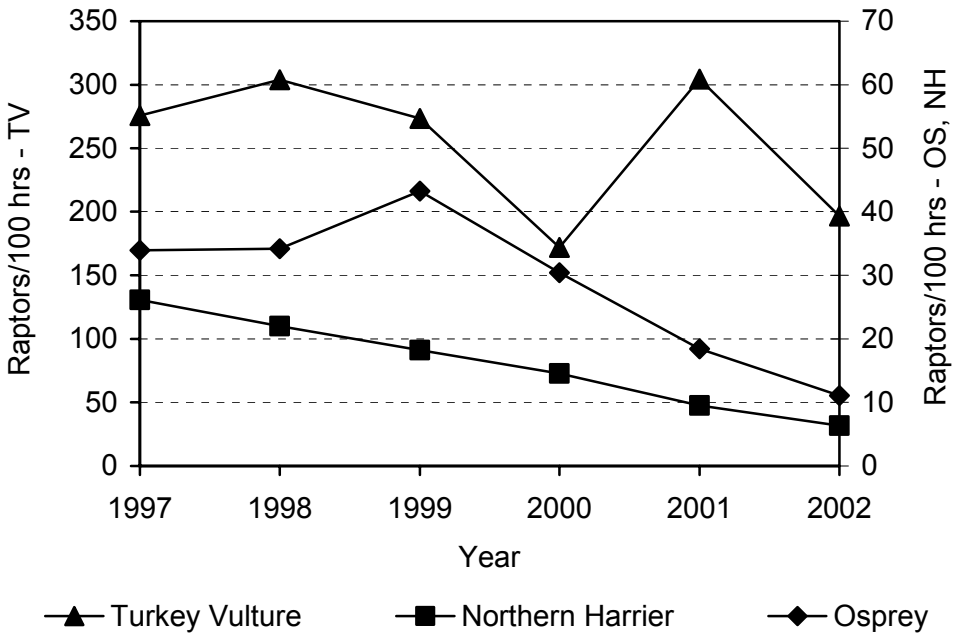

Figure 3. Trends in fall-migration passage rates for Turkey Vultures, Ospreys, and Northern Harriers at the Jordanelle Raptor Migration Project in northern Utah: 1997–2002.

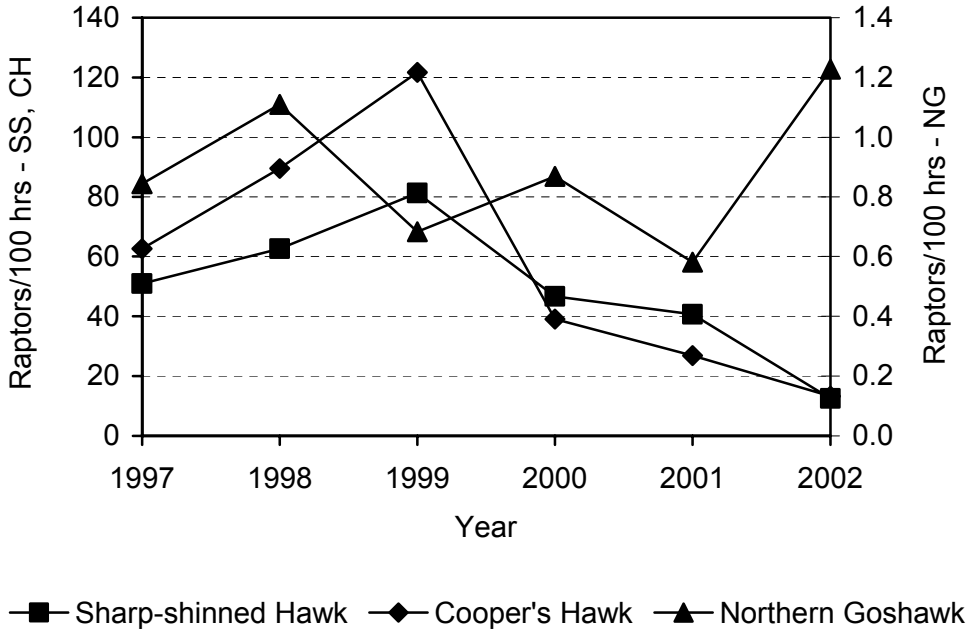

Figure 4. Trends in fall-migration passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks at the Jordanelle Raptor Migration Project in northern Utah: 1997–2002.

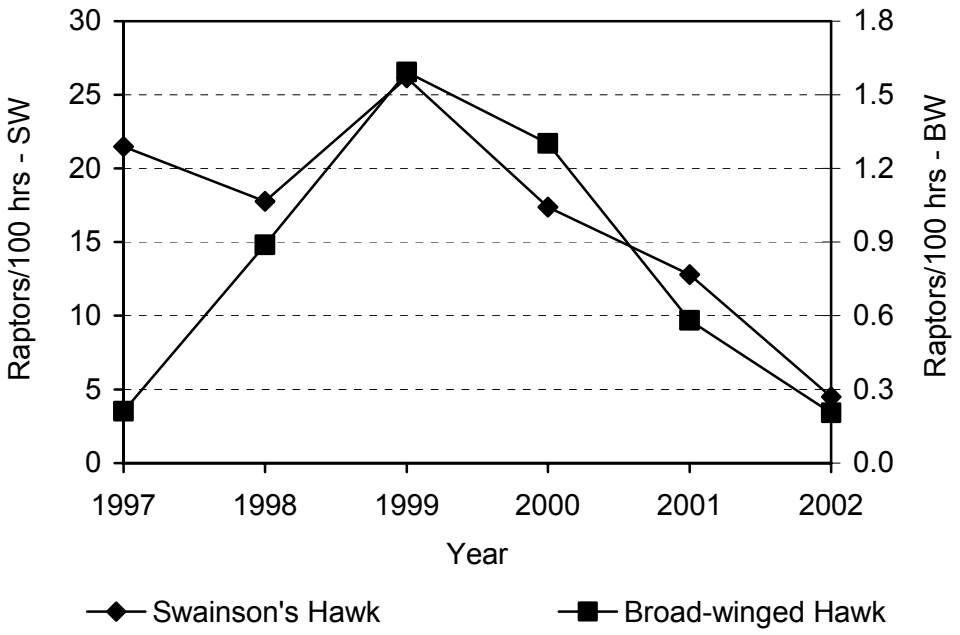

Figure 5. Trends in fall-migration passage rates for Broad-winged and Swainson's Hawks at the Jordanelle Raptor Migration Project in northern Utah: 1997–2002.

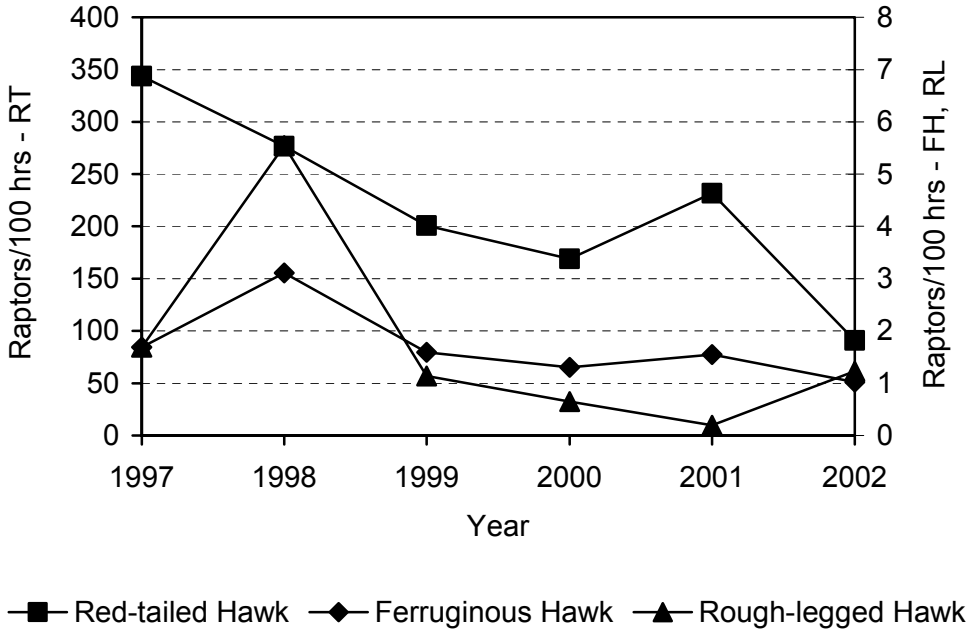

Figure 6. Trends in fall-migration passage rates for Red-tailed, Ferruginous, and Rough-legged Hawks at the Jordanelle Raptor Migration Project in northern Utah: 1997–2002.

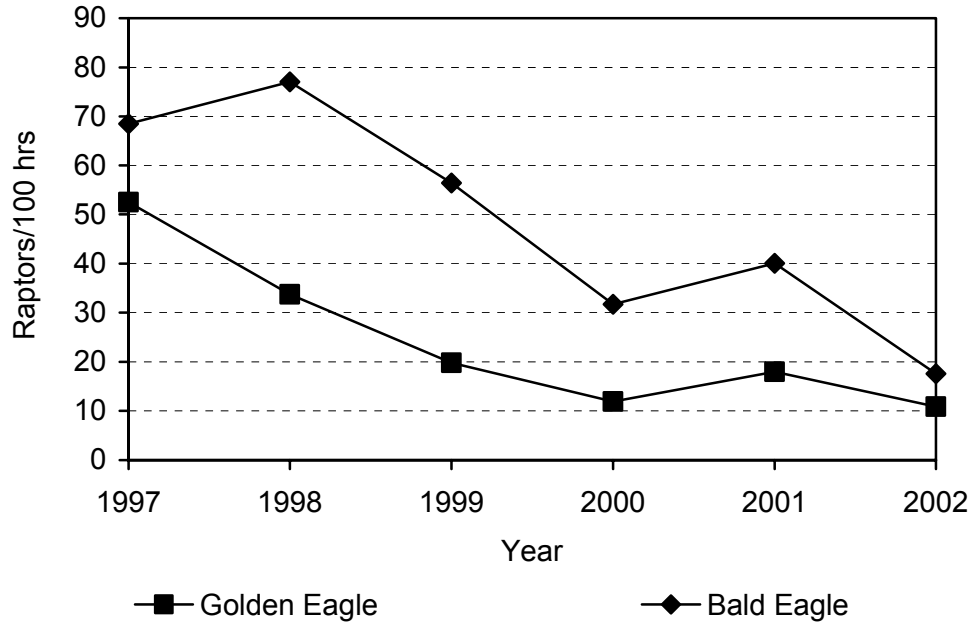

Figure 7. Trends in fall-migration passage rates for Golden and Bald Eagles at the Jordanelle Raptor Migration Project in northern Utah: 1997–2002.

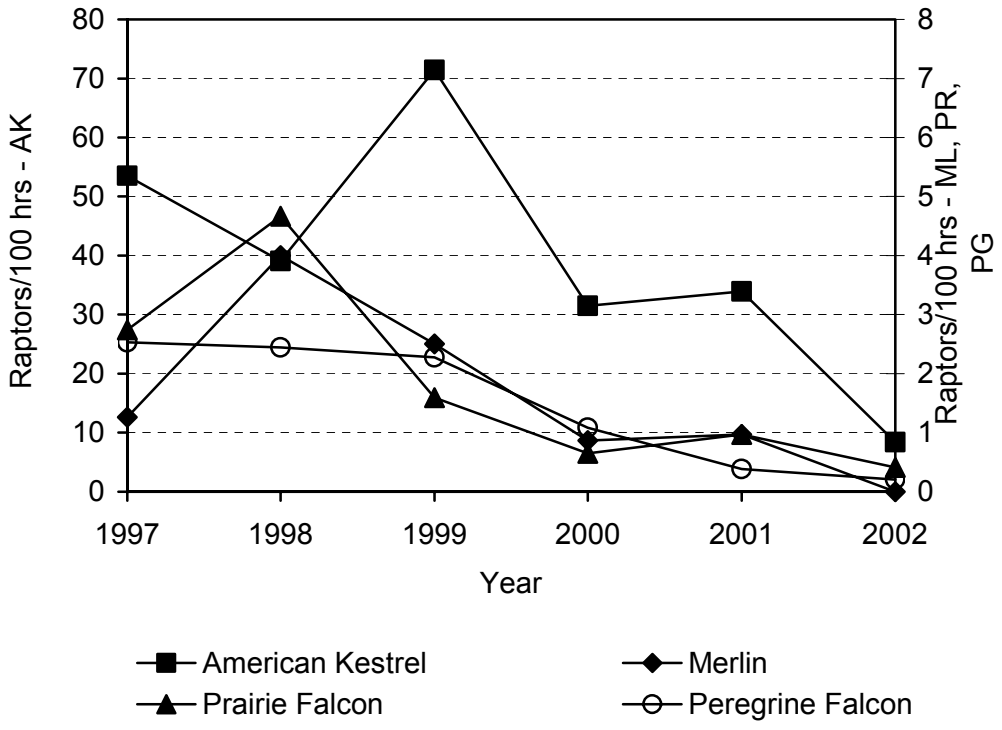

Figure 8. Trends in fall-migration passage rates for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons at the Jordanelle Raptor Migration Project in northern Utah: 1997–2002.

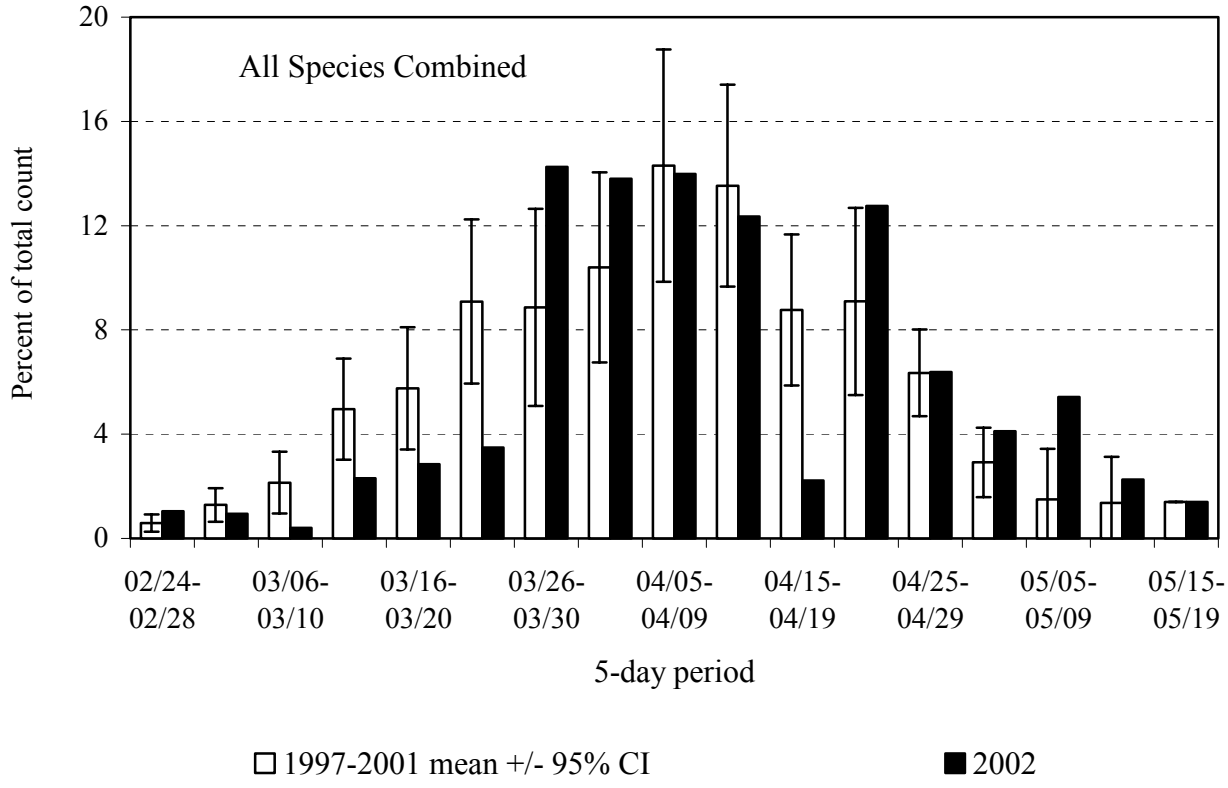

Figure 9. Combined-species, spring-migration passage volume by five-day periods for raptors at the Jordanelle Raptor Migration Project site in northern Utah: 1997–2001 versus 2002.

Appendix A. History of official observer participation in the Jordanelle Raptor Migration Project: 1997–2002.

1997: Two observers throughout: Neils Maumenee (1) and Vicki Garcia (1).

1998: Two observers throughout: Patty Scifres (1), Tricia Miller (2), and Kristin Covert (0).

1999: Two observers throughout: Dan Rossman (2), Kevan Damm (0).

2000: Two observers throughout: Craig Fosdick (2), Susan Michaelson (0).

2001: Two observers throughout: Helena Kokes (0), Kirsten McDonnell (0).

2002: Two observers throughout: Sue Bruner (0), John Minturn (0).

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[1] Numbers in parentheses indicate previous full seasons of observation experience.

Appendix B. Common and scientific names, species codes, and regularly applied age, sex, and color-morph classifications for all diurnal raptor species observed during spring migration at the Jordanelle Raptor Migration Project site in northern Utah.

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
Zone-tailed Hawk	*Buteo albonotus*	ZT	A I U	U	NA
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 or older immature: white wing patch variable or absent, obvious white in tail and molt or tawny bar visible on upper wing; NA = Not adult: unknown age immature/subadult; A = Adult: no white in wings or tail; U = Unknown.

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

Appendix C. Daily observation effort, visitor disturbance ratings, weather records, and flight summaries for the Jordanelle Raptor Migration Project: 2002.

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
25-Feb	4.75	1.5	0	clr	3.3	ne	2.0	29.92	3	100	70	3	2.3
26-Feb	7.75	1.0	0	pc-ovc	2.1	se-s, ne	3.4	29.93	4	100	100	2	0.4
27-Feb	7.50	1.4	0	clr	5.3	nne	3.4	29.73	3	100	88	3	0.4
28-Feb	6.00	1.0	0	mc-ovc	8.2	var	7.3	29.28	4	88	96	3	1.0
1-Mar	0.00			snow									
2-Mar	7.75	1.0	0	clr-ovc	3.3	se, ne	-1.1	29.73	4	100	88	3	1.0
3-Mar	8.00	1.0	0	clr-pc	3.0	se-s	1.3	29.90	3	100	100	3	0.5
4-Mar	8.00	1.0	0	clr-mc	3.0	se-sse	7.8	29.83	3	100	94	3	0.3
5-Mar	8.00	1.0	0	clr-mc	8.1	s	12.5	29.61	3	100	100	3	0.9
6-Mar	7.83	1.0	0	ovc	7.6	s	13.5	29.48	4	100	100	3	0.5
7-Mar	0.00			snow									
8-Mar	0.00			snow									
9-Mar	6.00	1.0	0	clr-pc	8.0	s	8.0	29.86	4	100	100	3	0.5
10-Mar	5.75	3.2	0	mc-ovc	9.0	s	14.2	29.58	4	100	100	2	0.3
11-Mar	8.00	2.0	0	pc-ovc	3.6	nw, ne, nw	10.3	29.82	3	100	88	3	1.5
12-Mar	0.50	2.0	0	ovc, snow	0.0		11.0	29.64	4	90	63	-	0.0
13-Mar	0.00			snow									
14-Mar	0.00			snow									
15-Mar	7.50	2.0	0	clr-pc	5.4	se, ne	5.7	29.42	3	96	99	3	5.2
16-Mar	0.00			snow									
17-Mar	0.00			snow									
18-Mar	6.50	2.0	0	pc-mc, PM snow	7.0	nw	2.3	29.56	4	100	76	3	2.0
19-Mar	8.00	2.0	0	clr-pc	6.6	se-s, ne	8.0	29.78	3	100	99	3	4.3
20-Mar	8.00	1.9	0	clr-pc	8.7	se-s	14.3	29.86	3	100	100	3	2.0
21-Mar	8.00	1.0	0	ovc	6.0	se-s	20.4	29.85	3	100	100	3	3.3
22-Mar	7.00	2.4	0	clr-ovc	11.7	se	15.1	29.82	4	100	100	3	6.7
23-Mar	7.00	1.0	0	ovc	21.7	s-wsw	8.4	29.47	4	70	66	3	0.6
24-Mar	0.00			snow									
25-Mar	1.00	2.0	0	snow	3.5	nw	3.0	29.83	4	83	5	-	0.0
26-Mar	8.00	2.0	0	clr-ovc	7.3	sse	7.8	29.96	2	100	98	3	5.0
27-Mar	8.00	2.0	0	ovc-pc	10.9	se, nw, var	9.8	29.81	3	100	100	4	1.6
28-Mar	8.00	2.5	0	clr-mc	4.6	nw, var	9.0	29.89	2	100	100	3	13.1
29-Mar	8.00	1.0	0	pc-mc	14.6	n-ne	6.0	29.89	3	100	100	3	6.1
30-Mar	8.00	3.3	0	pc	13.0	var	8.0	29.99	3	99	98	3	13.5
31-Mar	8.00	2.1	0	clr-pc, haze	4.3	n-nne/var	9.8	30.00	1	89	86	3	8.0
1-Apr	7.50	2.3	0	clr-pc	7.0	var	12.5	29.85	1	100	96	3	4.9
2-Apr	8.00	2.0	0	clr	10.3	ne/var	9.4	29.86	2	100	100	3	8.9
3-Apr	8.00	2.0	0	clr-pc	10.6	ne, w-nw	11.3	29.86	1	99	95	3	8.3
4-Apr	8.00	2.4	0	clr	7.3	s, ne, sw	14.6	30.00	1	100	100	4	8.4
5-Apr	8.00	1.0	0	pc-ovc	16.6	se-ssw	19.5	29.90	1	100	97	4	6.9
6-Apr	8.00	1.1	0	ovc	7.8	se, n	15.1	29.61	3	100	100	3	12.3
7-Apr	8.00	2.3	0	pc	8.9	wnw-n	9.3	29.69	2	100	100	3	10.1
8-Apr	8.00	2.0	0	ovc-mc	8.1	sse-s/var	9.0	29.87	3	100	100	3	5.6
9-Apr	8.00	1.9	0	ovc	12.9	s-sw	16.4	29.95	3	95	90	3	3.8
10-Apr	5.00	2.0	0	ovc	1.8	nw-n	10.5	29.95	3	100	100	3	5.0
11-Apr	8.00	2.3	0	pc-ovc	5.1	se/var	11.5	30.02	2	100	100	3	4.6
12-Apr	8.00	1.0	0	mc-ovc, scat rain	12.8	s-ssw, nw	15.9	29.98	3	95	100	3	6.5
13-Apr	8.50	1.7	0	clr-ovc	8.6	se-s/var	17.5	30.09	1	98	96	3	6.4
14-Apr	8.00	2.0	0	ovc-pc	12.3	sse-sw	20.6	29.71	3	100	100	3	13.1
15-Apr	5.00	2.0	0	ovc, snow	16.4	ssw-sw	12.0	29.20	4	58	58	3	2.4

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
16-Apr	0.00			snow									
17-Apr	0.00			snow									
18-Apr	3.50	2.0	0	ovc, snow	3.3	ne-se	6.0	29.77	4	40	35	2	10.6
19-Apr	0.00			snow									
20-Apr	0.00			snow									
21-Apr	8.00	2.4	0	mc, AM snow	4.8	se, ne, sse-s	7.8	29.96	4	84	80	3	9.4
22-Apr	8.00	2.0	0	pc	8.0	ssw, nw	12.0	29.98	1	100	100	3	6.3
23-Apr	8.00	2.0	0	clr-mc	12.3	se, nw	15.4	29.87	1	98	98	3	8.8
24-Apr	8.00	2.5	0	clr-mc	6.1	n-ne, sse-s	11.1	30.14	1	100	100	3	10.9
25-Apr	8.00	2.0	0	mc-ovc	7.0	se	14.0	29.85	2	83	81	3	6.4
26-Apr	8.00	1.0	0	pc-ovc	23.5	s-ssw	16.4	29.46	2	94	96	3	3.9
27-Apr	0.00			heavy rain, low clouds									
28-Apr	4.00	2.0	0	ovc	8.8	se-s	9.2	29.99	4	92	92	3	5.0
29-Apr	8.00	1.8	0	clr	14.6	sse-ssw	15.3	29.84	2	100	100	3	4.9
30-Apr	8.00	2.0	0	clr-pc	15.6	s-ssw	15.6	29.61	2	99	99	3	3.1
1-May	2.50	2.0	0	mc-ovc	16.7	s	10.0	29.59	2	100	100	2	1.2
2-May	8.00	1.9	0	pc-ovc	5.4	ne/var	10.4	29.73	2	96	96	3	4.4
3-May	2.67	1.0	0	ovc, rain	15.0	ne, s-ssw	12.6	29.82	3	84	80	3	3.4
4-May	8.00	1.9	0	pc-mc	12.4	sse-s	15.0	29.96	1	98	98	3	2.4
5-May	7.00	2.0	0	ovc, scat rain	11.6	s-sw	14.4	29.86	3	94	95	2	6.1
6-May	8.00	2.0	0	clr	18.3	s-sw	17.8	29.83	2	100	100	3	4.4
7-May	6.00	2.0	0	mc-ovc, scat rain	13.7	s-ssw	13.2	29.60	2	63	66	3	1.0
8-May	7.00	2.0	0	clr	10.0	nw-nne	5.6	29.93	2	100	100	3	2.6
9-May	8.00	1.9	0	clr-ovc	14.4	sse-sw	12.1	29.82	2	96	94	3	2.3
10-May	5.25	1.0	0	ovc, scat rain	11.8	n	8.6	29.64	3	98	96	3	1.5
11-May	5.00	1.0	0	ovc, rain/snow	7.6	nw	10.2	30.78	3	1	1	3	1.2
12-May	8.00	2.0	0	clr	10.4	nw-n	15.8	30.18	1	100	100	3	2.5
13-May	7.00	2.0	0	clr-pc	12.1	se-s	18.1	30.08	1	99	99	3	1.7
14-May	5.00	2.0	0	pc-mc	12.4	s, w	22.6	29.73	1	96	96	3	0.8
15-May	8.00	1.0	0	clr-mc	14.1	se, sw-wnw	18.5	29.77	1	100	100	3	1.1
16-May	8.00	1.0	0	mc-ovc	9.3	se, nw	14.8	29.91	2	100	100	3	0.9
17-May	8.00	1.0	0	clr-mc	12.5	s-ssw	20.1	29.95	1	100	100	3	1.1
18-May	0.00			no personnel									
19-May	5.00	1.0	0	clr-pc	24.2	s-ssw	24.2	29.82	1	100	100	3	1.2

[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 = thunderstorms.

[4] Median hourly rating concerning prevalence of lift-generating thermals, based on subjective assessments of solar intensity, wind speeds, and migrant behavior: 1 = excellent, 2 = good, 3 = fair, 4 = poor.

[5] Median hourly rating concerning line-of-sight distance of flight from observation site: 1 = close, detection and identification possible with naked eye; 2 = moderate, detection possible with naked eye, but binoculars needed for identification; 3 = far, binoculars needed for both detection and identification; 4 = distant, birds detected and identified only with excellent binoculars or spotting scope and by experienced observers.

Appendix D. Daily observation effort, visitor disturbance ratings, weather records, and flight summaries for the Jordanelle Raptor Migration Project in northern Utah: 2002.

	Obs.	Species[1]																										Birds	
Date	Hours	TV	OS	NH	SS	CH	NG	SA	LA	UA	RS	BW	SW	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	SF	LF	UF	UU	Total	/ Hour
25-Feb	4.75	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	9	1	0	0	0	0	0	0	0	0	11	2.3
26-Feb	7.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	3	0.4
27-Feb	7.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	3	0.4
28-Feb	6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	2	6	1.0
29-Feb	0.00																													
1-Mar	7.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	3	8	1.0
2-Mar	8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	4	0.5
3-Mar	8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	2	0.3
4-Mar	8.00	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	3	1	0	0	0	0	0	0	0	1	7	0.9
5-Mar	7.83	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	1	0	0	0	0	0	0	0	0	4	0.5
6-Mar	0.00																													
7-Mar	0.00																													
8-Mar	6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	3	0.5
9-Mar	5.75	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0.3
10-Mar	8.00	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	3	3	4	0	0	0	0	0	0	0	0	12	1.5
11-Mar	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
12-Mar	0.00																													
13-Mar	0.00																													
14-Mar	7.50	0	0	0	0	0	0	0	0	0	0	0	0	26	0	0	0	1	3	4	0	0	0	0	0	0	0	5	39	5.2
15-Mar	0.00																													
16-Mar	0.00																													
17-Mar	6.50	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	2	0	1	0	0	0	0	0	0	0	0	5	13	2.0
18-Mar	8.00	0	0	0	0	0	0	0	0	0	0	0	0	19	0	1	3	0	4	1	0	0	0	0	0	0	1	5	34	4.3
19-Mar	8.00	0	0	0	0	1	0	0	0	0	0	0	0	9	0	0	1	0	4	0	0	0	0	0	0	0	0	1	16	2.0
20-Mar	8.00	2	0	0	0	0	0	0	0	0	0	0	0	13	1	0	0	0	2	0	0	0	0	0	0	0	1	7	26	3.3
21-Mar	7.00	2	0	1	2	1	1	0	0	0	0	0	0	30	0	1	0	2	7	0	0	0	0	0	0	0	0	0	47	6.7
22-Mar	7.00	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	4	0.6
23-Mar	0.00																													
24-Mar	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
25-Mar	8.00	8	0	0	0	0	0	0	0	1	0	0	0	26	0	0	0	1	0	2	0	0	0	0	0	0	0	2	40	5.0
26-Mar	8.00	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	8	13	1.6
27-Mar	8.00	37	0	3	2	1	0	0	0	0	0	0	0	37	0	1	0	9	6	0	0	0	0	0	0	0	0	9	105	13.1
28-Mar	8.00	22	0	1	0	0	0	1	0	0	0	0	0	10	0	0	0	2	4	0	0	0	0	0	0	0	0	9	49	6.1
29-Mar	8.00	46	1	1	1	0	0	0	0	1	0	0	1	41	1	0	5	3	5	0	0	0	0	0	0	0	0	2	108	13.5
30-Mar	8.00	39	3	1	0	0	0	0	0	2	0	0	0	13	0	0	0	1	1	0	0	0	0	0	0	0	0	4	64	8.0

Appendix D. continued

Date	Obs. Hours	Species[1]																											Birds
		TV	OS	NH	SS	CH	NG	SA	LA	UA	RS	BW	SW	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	SF	LF	UF	UU	Total / Hour
31-Mar	7.50	7	1	0	0	2	0	0	0	1	0	0	0	18	1	0	1	2	0	0	0	0	0	0	0	0	0	4	37	4.9
1-Apr	8.00	35	0	1	1	0	0	0	0	4	1	0	1	13	1	0	2	2	3	2	0	0	0	0	0	0	0	5	71	8.9
2-Apr	8.00	34	0	1	0	0	0	0	0	1	0	0	1	13	0	0	3	1	0	1	0	0	0	0	0	0	0	11	66	8.3
3-Apr	8.00	33	1	0	1	0	0	0	0	0	0	1	0	8	0	0	4	2	5	1	2	0	0	0	0	0	0	9	67	8.4
4-Apr	8.00	16	0	1	1	1	0	1	0	0	0	0	0	24	0	0	0	0	2	1	2	0	0	1	0	0	0	5	55	6.9
5-Apr	8.00	61	3	1	2	2	0	0	1	3	0	0	1	4	0	0	5	3	2	3	1	0	0	0	0	0	0	6	98	12.3
6-Apr	8.00	63	1	0	1	2	0	0	0	0	0	0	0	7	0	0	2	0	0	0	0	0	0	0	0	0	0	5	81	10.1
7-Apr	8.00	35	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	2	1	0	0	0	0	0	0	0	3	45	5.6
8-Apr	8.00	14	0	0	3	1	0	0	0	3	0	0	2	3	0	0	1	1	0	0	0	0	0	0	0	0	0	2	30	3.8
9-Apr	5.00	10	0	0	1	1	0	0	0	4	0	0	0	5	0	0	0	0	0	1	0	0	0	0	0	0	1	2	25	5.0
10-Apr	8.00	14	1	0	4	4	0	0	0	0	0	0	0	4	0	0	2	2	0	1	0	0	0	0	0	0	0	5	37	4.6
11-Apr	8.00	21	3	0	0	1	0	0	0	3	0	0	0	20	0	0	1	0	0	0	0	0	0	0	0	0	0	3	52	6.5
12-Apr	8.50	11	11	1	2	7	0	0	0	1	0	0	1	11	0	0	1	3	1	1	1	0	0	0	0	0	0	2	54	6.4
13-Apr	8.00	40	6	3	4	6	0	0	0	8	0	0	1	11	0	1	11	0	0	1	8	0	0	0	0	0	1	4	105	13.1
14-Apr	5.00	4	0	0	2	1	0	0	0	1	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	12	2.4
15-Apr	0.00																												
16-Apr	0.00																												
17-Apr	3.50	19	3	1	2	2	0	0	0	1	0	0	6	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	37	10.6
18-Apr	0.00																												
19-Apr	0.00																												
20-Apr	8.00	38	1	2	4	5	0	0	0	2	0	0	0	7	0	0	0	1	2	1	1	0	0	0	0	0	2	9	75	9.4
21-Apr	8.00	17	2	2	2	8	1	0	0	2	0	0	3	5	0	0	0	1	2	0	4	0	0	0	0	0	0	1	50	6.3
22-Apr	8.00	36	2	0	2	2	1	0	0	4	0	0	0	6	0	0	6	0	0	1	2	0	0	0	0	0	0	8	70	8.8
23-Apr	8.00	44	7	4	5	4	0	2	0	1	0	0	2	10	0	0	1	0	1	0	4	0	0	0	0	0	0	2	87	10.9
24-Apr	8.00	20	2	1	2	5	1	0	0	5	0	0	2	7	0	0	0	0	0	0	2	0	0	0	0	0	1	3	51	6.4
25-Apr	8.00	21	2	0	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	3	31	3.9
26-Apr	0.00																												
27-Apr	4.00	4	1	0	1	1	0	0	0	5	0	0	0	2	0	0	0	0	0	0	4	0	0	0	0	0	0	2	20	5.0
28-Apr	8.00	14	1	0	2	2	0	0	0	5	0	0	0	5	0	0	0	0	0	0	3	0	0	0	0	0	0	7	39	4.9
29-Apr	8.00	16	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	3	0	1	0	0	0	0	2	25	3.1
30-Apr	2.50	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1.2
1-May	8.00	23	0	0	1	0	0	0	0	5	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	2	35	4.4
2-May	2.67	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	9	3.4
3-May	8.00	8	0	0	1	0	0	0	0	1	0	0	0	6	0	0	1	0	0	0	0	0	0	0	0	0	0	2	19	2.4
4-May	7.00	31	1	0	1	0	1	0	0	0	0	0	0	1	0	0	3	1	0	0	1	0	0	0	0	0	1	2	43	6.1
5-May	8.00	25	0	0	3	3	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	35	4.4

Appendix D. continued

Date	Obs. Hours	Species[1]																											Birds
		TV	OS	NH	SS	CH	NG	SA	LA	UA	RS	BW	SW	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	SF	LF	UF	UU	Total / Hour
6-May	6.00	3	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	1.0
7-May	7.00	9	0	1	0	2	0	0	0	1	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	2	18	2.6
8-May	8.00	14	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	18	2.3
9-May	5.25	6	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	1.5
10-May	5.00	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	1.2
11-May	8.00	12	0	1	0	0	0	0	0	2	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	2	20	2.5
12-May	7.00	11	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	1.7
13-May	5.00	3	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0.8
14-May	8.00	6	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	3	9	1.1
15-May	8.00	3	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	0.9
16-May	8.00	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	9	1.1
17-May	0.00																													
18-May	5.00	4	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	6	1.2
19-May	488.75	961	54	31	61	65	6	4	1	72	1	1	22	444	5	6	65	53	86	31	41	0	2	1	0	0	8	189	2210	4.5
Total	4.75	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	9	1	0	0	0	0	0	0	0	0	11	2.3

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

Appendix E. Annual observation effort and spring raptor migration counts by species (unadjusted data) for the Jordanelle Raptor Migration Project in northern Utah: 1997–2002.

	1997	1998	1999	2000	2001	2002	Mean
Start date	26-Feb	21-Feb	24-Feb	26-Feb	25-Feb	25-Feb	24-Feb
End date	6-May	5-May	2-May	5-May	12-May	19-May	7-May
Observation days	64	64	65	63	69	70	66
Observation hours	474.50	450.42	439.50	460.65	516.48	488.75	471.72
SPECIES							
Turkey Vulture	1309	1369	1202	792	1572	961	1201
Osprey	161	154	190	140	95	54	132
Northern Harrier	124	99	80	67	49	31	75
Sharp-shinned Hawk	242	282	357	215	210	61	228
Cooper's Hawk	297	403	535	180	139	65	270
Northern Goshawk	4	5	3	4	3	6	4
Unknown small accipiter[1]	–	–	–	–	–	4	–
Unknown large accipiter[1]	–	–	–	–	–	1	–
Unknown accipiter	86	156	103	41	78	72	89
TOTAL ACCIPITERS	629	846	998	440	430	209	592
Red-shouldered Hawk	0	0	0	0	0	1	0
Broad-winged Hawk	1	4	7	6	3	1	4
Swainson's Hawk	102	80	115	80	66	22	78
Red-tailed Hawk	1631	1246	882	778	1195	444	1029
Ferruginous Hawk	8	14	7	6	8	5	8
Rough-legged Hawk	8	25	5	3	1	6	8
Unidentified buteo	58	39	45	22	74	65	51
TOTAL BUTEOS	1808	1408	1061	895	1347	544	1177
Golden Eagle	249	152	87	55	93	53	115
Bald Eagle	325	347	248	146	207	86	227
Unidentified eagle	15	31	18	3	39	31	23
TOTAL EAGLES	589	530	353	204	339	170	364
American Kestrel	254	176	314	145	175	41	184
Merlin	6	18	11	4	5	0	7
Prairie Falcon	13	21	7	3	5	2	9
Peregrine Falcon	12	11	10	5	2	1	7
Unknown small falcon[1]	–	–	–	–	–	0	–
Unknown large falcon[1]	–	–	–	–	–	0	–
Unknown falcon	6	24	5	9	10	8	10
TOTAL FALCONS	291	250	347	166	197	52	217
Unidentified raptor	138	153	31	80	77	189	111
Total	5049	4809	4262	2784	4106	2210	3870

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