FALL 1999 RAPTOR MIGRATION STUDIES IN THE GOSHUTE MOUNTAINS OF NORTHEASTERN NEVADA

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EXECUTIVE SUMMARY

This report summarizes the 17th consecutive standardized, season-long count of migrant raptors and 20th consecutive season of raptor banding conducted in the Goshute Mountains of Nevada during 1999 by HawkWatch International (HWI) and its organizational precursors. The Goshute Mountains form a 100-km ridge that runs north–south along the Utah–Nevada border just west of the Great Salt Lake Desert. The Goshute flyway is one of the largest known concentration points for migrant raptors in the western United States and Canada.

The 1999 observers counted 22,467 migrant raptors of 17 species during 748.08 observation hours on 82 days between 15 August and 5 November. This is the second highest combined-species count for the site, with record high counts for Northern Harrier, Red-tailed Hawk, Rough-legged Hawk, Golden Eagle, and Bald Eagle, and near-record high counts for Sharp-shinned Hawk, Broad-winged Hawk, and Ferruginous Hawk. No new species were seen in 1999, and the Red-shouldered Hawk was the only species absent that had been seen in previous years. The adjusted (for variation in observer numbers and standardized for seasonal sampling period) combined-species count of 19,172 and adjusted passage rate of 3,720 raptors/100 hrs are both significantly higher than average. High counts this season did not appear to be the result of high productivity, but may reflect the effects of unusual weather or high observer experience.

High passage rates extend increasing trends for Turkey Vulture, Broad-winged Hawk, Osprey, Merlin, and Peregrine Falcon, and establish increasing trends for Northern Harrier, Sharp-shinned Hawk, Cooper's Hawk, Swainson's Hawk, Ferruginous Hawk, American Kestrel, and Prairie Falcon. Northern Goshawks, Red-tailed Hawks, Golden Eagles and Bald Eagles are the only commonly observed species showing no trends in the Goshutes. It is also noteworthy that Sharp-shinned and Cooper's Hawk numbers have shown nearly identical fluctuations on an annual basis, increasing or decreasing each year by as much as 50% since 1991. This phenomenon remains unexplained. High Rough-legged Hawk numbers this season appear to be the result of an irruptive flight. These differ from goshawk irruptive flights (Mueller et al. 1977) by being non-cyclic, usually occurring during severe fall/winters or prey population crashes. Severe weather did not appear to be a factor this season. In fact, mild weather may have contributed to delayed migration, especially for late-season migrants such as eagles and rough-legs, but also for red-tails and harriers.

The trappers captured 1,535 raptors of 9 species during 70 days between 21 August and 3 November. The combined-species capture total and capture success of 7% are both significantly lower than average (55% and 65%, respectively) due primarily to reduced trapping effort. In contrast, the 1999 capture rate of 163.6 birds/100 station hrs is nearly identical to the 1992–1998 mean. Species-specific capture rates were significantly higher than average for Golden Eagle and Merlin, significantly lower the average for Northern Harrier and Broad-winged Hawk, and not significantly different from average for all other species. In addition, capture success was significantly lower than average only for 6 species, rating average for the remaining 6 species. The 1999 results raise the total number of captures since project inception to 41,914 birds of 13 species, including 58 recaptures of Goshute-banded birds and 22 foreign recaptures.

More than 1,000 people visited the project site in 1999 to learn about the research project and raptor conservation needs, and to experience raptors and the migration phenomenon first hand.

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INTRODUCTION

HawkWatch International (HWI)—and its organizational precursors—has been monitoring raptor migrations through primarily western North America since the late 1970s. During 1999, HWI coordinated or assisted with 16 fall and spring migration counts in New Mexico, Arizona, Utah, Nevada, Montana, Oregon, Washington, Texas, Florida, and Veracruz, Mexico (Smith and Hoffman 2000). Banding programs occurred at seven of these sites. The primary objective of HWI migration studies is to track long-term trends in the abundance and distribution of migratory diurnal raptors, emphasizing western North America. Raptors feed atop food pyramids, inhabit most ecosystems, occupy large home ranges, and are sensitive to environmental contamination and other human disturbances. Therefore, they serve as important biological indicators of ecosystem health (Cade et al. 1988; Bednarz et al. 1990a; Bildstein and Zalles 1995). For example, long-term migration counts in the eastern United States documented declines in several raptor species and helped us understand the deleterious effects of organochlorine pesticides (Spofford 1969, Mueller et al. 1988, Bednarz et al. 1990b). Migration counts, in particular, may also 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 and Zalles 1995, Bildstein et al. 1995, Dunn and Hussell 1995, Dixon et al. 1998, Smith and Hoffman 2000). HWI's banding operations compliment the count studies by providing valuable information about breeding and wintering distributions, migratory routes, mortality factors and longevity, morphometric variation, molt sequences and timing, and health assessments. Besides the scientific value, HWI also is dedicated to providing opportunities for the public to learn about the ecology and conservation needs of raptors through personal exposure to raptor migrations and scientific research.

One of HWI's premier long-term monitoring projects occurs during autumn migration in the Goshute Mountains of northeastern Nevada (Figs. 1 and 2). The 1999 season marked the 20th consecutive season of banding and 17th consecutive season-long count of migrating raptors at this site. The geographic location and physiographic characteristics of the Goshute observation site (Fig. 1) make it an ideal spot for monitoring the autumn raptor migration through the region. The relatively inhospitable Great Salt Lake Desert lies immediately east of the Goshute range and represents a formidable barrier to most migrating raptors, providing neither prey, roosting habitat, nor strong updrafts that provide lift. Instead, migrating raptors moving south from breeding grounds north of the desert tend to funnel to the west (and east) and therefore concentrate along the Goshute range where steep slopes and forest habitat provide favorable migration conditions. Moreover, the Goshute Mountains lie at the southern tip of a large funnel that is fed by the Black Pine, Raft River, Grouse Creek, Pilot, and Toana Mountains. These ranges act as "leading lines"(Mueller and Berger 1967) that guide raptors toward the Goshute range from the north and northeast. These conditions are responsible for the Goshute flyway attracting one of the largest known concentrations of migrant raptors in western North America.

In this report, we summarize the 1999 count and banding results from the Goshute monitoring site. We present and discuss data on seasonal timing, daily flight rhythms, the species, age, sex and color morph composition of the flight, capture efficiency, body condition of captured birds, and encounters with previously banded birds. In addition, where appropriate we compare statistics for the 1999 season with long-term means and annual trends for previous seasons.

STUDY SITE

The Goshute Mountains form a 100-km ridge that runs north–south along the Utah–Nevada border (Fig. 1). The study site is located in the Goshute Wilderness Study Area approximately 40 km southwest of Wendover, Nevada, on land administered by the Elko District of the Bureau of Land Management (40° 25.417' N, 114° 16.276' W). The site is reached via a primitive trail that ascends Christmas Tree Canyon from the east. The main observation post is located at an elevation of 2,743 m (8,999 ft) near the south end of the ridge (Fig. 2). The location provides an expansive 360° view of the surrounding landscape, with visibility extending to the Ruby Mountains 100 km to the west and to the Cedar Mountains 120 km to the east. A second observation post (Observation Post 2; Fig. 2) is located 100 m north of the main observation post and is used during east winds when birds often pass below eye-level along the east side of the ridge. In 1999, three banding stations were located 250–600 m to the north and east of the main observation post (Fig. 2).

North station (established mid-season in 1989 and modified slightly in 1998) is located directly on top of the ridge at 2,700 m elevation and is the first station southbound migrants encounter. The station is about 600 m north-northwest of the primary observation point. North station lies in a 50 m x 40 m natural clearing covered by forbs and perennial grasses. The site is bordered by trees and shrubs to the south and steep, mostly rocky slopes to the north, east, and west. The station is equipped with 1 pigeon lure pole and 2 associated bow nets; 2 dove lures, each situated behind a dho-gaza with a bow-net backup; 2 sparrow lure poles, 1 situated behind a dho-gaza with a bow-net backup and 1 situated behind a mist net with a bow-net backup; 1 surge bow; and 2 14-m (10-cm mesh) mist nets on the southern and western borders of the station. The large 2.5 x 3.5 m blind is divided into trapping and processing areas separated by a canvas door.

West station (established in 1980, modified slightly in 1995) is located about 500 m south of North station and 250 m North of the primary observation point at 2,720 m elevation. The station is located in a 25 m x 10 m natural clearing slightly below the crest on the western flank of the ridge. The site is bordered by a near-vertical, rocky slope to the northwest, sparsely distributed trees and shrubs to the west and east, and denser forest cover to the south. The station is equipped with 1 pigeon lure and bow net; 2 dove lures and bow nets, 1 situated behind a dho-gaza; 1 sparrow lure and bow net; and 2 14-m mist nets. A separate processing blind sits 15 m east and upslope from the trapping blind, and a visitor's observation blind sits 25 m east and upslope of the banding station.

Meadow station (established in 1987, modified in 1996 and 1998) is located about 350 m east of the primary observation post at 2,620 m elevation on the east flank of the ridge. The station sits in the northeast corner of a large (about 0.75 sq km), natural, sagebrush–bunchgrass meadow that slopes gently to the southeast. Trees border the station to the east. The station is equipped with 1 pigeon lure and bow net; 2 dove lures and bow nets, 1 situated behind a dho-gaza; 1 sparrow lure and bow net situated behind a dho-gaza, 1 surge bow, and 2 20-m mist nets running north–south between the sparrow and east-side dove pole. Trapping and processing occur in the same blind.

The Goshute Mountains are typical of the Great Basin region: dry, sparsely forested, and rocky. Pinyon pine (*Pinus monophylla*) and Utah juniper (*Juniperus osteosperma*) dominate lower slopes. White fir (*Abies concolor*), limber pine (*Pinus flexilis*), and bristlecone pine (*Pinus aristata*) dominate the overstory along the crest and on north-facing slopes. Mountain mahogany (*Cercocarpus montanus*) is a prominent shrub, especially on exposed portions of the ridge.

COUNT METHODS

COUNT TECHNIQUES

Two official or designated observers conducted standardized daily counts of migrating raptors from traditional observation sites between 15 August and 5 November 1999. The observers used the main observation post during all or most of 41 days, observation post 2 during all or most of 20 days, and both posts for substantial portions of the remaining 21 days. Before fall 1999, primary observers Jerry Liguori and Aaron Barna had 17 and 5 seasons, respectively, of previous experience counting migratory raptors (see Appendix A for a complete history of observer participation). Visitors also frequently assisted with spotting migrants (see Smith and Hoffman [in review] for a discussion of visitor effects, and see Appendix B for daily observer and visitor participation rates). Weather permitting, observations usually began between 0800 and 0900 hrs Mountain Standard Time (MST) and ended near sunset, usually between 1800 and 1900 hrs.

The observers routinely recorded the following data:

1. Species, age, sex, and color morph of each migrant raptor, whenever possible and applicable (Appendix C 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 mean number of observers (official observers plus visitors who actively scanned for migrants for more than 10 minutes in a given hour) and visitors (all other guests) present during each hour.
6. Daily start and end times for each official observer.

The observers used high quality 7–10x binoculars and a 20–60x spotting scope to assist in spotting and identifying birds. Clark and Wheeler (1987), Dunne et al. (1988), and Wheeler and Clark (1995) served as primary identification references. Assessments of wind speed, cloud type, cloud cover, and flight altitude followed guidelines published by the Hawk Migration Association of North America (HMANA). Assessments of thermal lift conditions as poor, fair, good, or excellent involved subjective evaluations of solar intensity, wind speed, and migrant behavior.

Two of three banding stations were located north of the observation lookout. The observers added raptors captured at these stations to the total count at the end of each day. Had they not been previously intercepted, most raptors captured at these stations would have passed observation and been counted by the observers. The observers and banders maintained close radio contact to eliminate duplicate counts. Each time they released a newly banded raptor, the banders notified the observers to avoid counting the bird as it passed. Birds captured at banding stations south of the observation lookout were added to the counts only if they were a particularly uncommon species that the observers definitely missed.

DATA ANALYSIS

For purposes of examining long-term variation in annual counts, we manipulated the count data to standardize sampling periods and adjust for daily variation in observation effort and observer numbers. The seasonal and daily duration of observation effort can greatly affect count statistics (Hussell 1985, Kerlinger 1989, Bednarz et al. 1990b), and both have varied in the Goshutes during the course of the study, particularly during the first several years of observations. To standardize seasonal sampling effort, we defined a consistent annual sample period following conventions proposed by Bednarz and Kerlinger (1989) and Bednarz et al. (1990b). Specifically, we converted counts to passage rates on a daily basis (raptors/100 hours of observation) to adjust for daily variation in sampling effort, summed daily rates by Julian date across all years, and defined standardized passage periods for each species by eliminating approximately 2.5% from each extreme of the cumulative passage-rate distributions. Because entire count days must be either included or excluded, the defined sample period for a given species included between 95–100% of the detected number of migrants. For some species, the sample periods defined in this way encompassed dates earlier or later than periods of continuous observations. In these cases, we further restricted the adjusted sample periods to between mean starting and ending dates of continuous observations for 1983–1999: 15 August – 2 November. The final standardized sample periods for each species are shown in Table 1.

Smith and Hoffman (in review) recently demonstrated that passage rates documented at this site through 1997 increased significantly when the daily-average number of observers increased to 2 or more (observers included official, designated counters plus guests that actively participated for more than 10 minutes in a given hour). Before 1987, a single official observer conducted all counts. From 1987 to 1990, a second observer participated during the peak month of activity. Thereafter, a system of two official observers throughout the season became standard. Guest observers have participated in the counts throughout the study. Smith and Hoffman (in review) provided correction factors to adjust daily counts to standardize for a 2-observer system. We applied the recommended correction factors before examining patterns in the data.

After standardizing sample periods and adjusting daily counts for observer numbers, we 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.

Smith et al. (in review) recently completed a comprehensive analysis of long-term trends in counts from four HWI migration sites, including the Goshutes. We do not repeat the results of these analyses in detail here, but we do cite specific results to provide context for consideration of 1999 observations. For the Goshutes, the analyses involved linear regressions examining trends in annual passage rates between 1983 and 1999. In this context, we refer to results as highly statistically significant ($P \leq 0.01$), significant ($0.01 < P \leq 0.05$), marginally significant ($0.05 < P \leq 0.10$), or not significant ($P > 0.10$).

We also compare 1999 annual statistics (i.e., passage rates, passage dates, age ratios, sex ratios, and color-morph ratios) against means and 95% confidence intervals for previous seasons. Here, we equate significance with a 1999 value falling outside of the 95% confidence interval for the associated mean. Most comparisons of age, sex, and color morph statistics are limited to 1999 versus means for 1992–1998, because older data are not yet computerized.

TRAPPING AND BANDING METHODS

CAPTURE AND PROCESSING TECHNIQUES

The 1999 banding crews operated 1 to 3 trapping stations from 21 August through 3 November, which is a typical period for the site. Rotating crews of 1–3 trappers and processors operated each station depending on experience levels, characteristics of the station, and the flight volume. Stations were generally operated from 0900–1700 hrs Mountain Standard Time (MST).

Capture devices used at the Goshute site in 1999 included mist nets, remotely triggered bow nets (Meng 1963, Austing 1964), and dho-gaza nets (Clark 1971). Trappers lured migrating raptors into the capture stations from camouflaged blinds using live, non-native Rock Doves (*Columba livia*; hereafter called pigeons), Ringed Turtle-doves (*Streptopelia risoria*), and House Sparrows (*Passer domesticus*) attached to lure lines manipulated from the blinds. European Starlings (*Sturnus vulgaris*) were used only at the start of the season. The pigeons, manipulated with lure lines that ran to the tops of tall poles (3–4 m high), served as primary lures. Other species were used secondarily to secure smaller raptors such as Sharp-shinned Hawks and American Kestrels. After being quickly extracted from the capture nets, birds were held for processing in a quiet, shaded blind in ventilated tin cans of appropriate size.

Processors identified, aged, sexed, measured, banded, and released each migrant usually within 15 minutes, but within a maximum of 45 minutes from the time of capture. Unless already banded, all birds were fitted with a uniquely numbered USGS Biological Resources Division aluminum leg band. Processors identified species, subspecies, sexes, and ages using morphological characteristics described in the U.S. Bird Banding Laboratory manual, Clark and Wheeler (1987), Wheeler and Clark (1995), and Hoffman et al. (1990). Standard morphometric data recorded for each bird when time allowed included tarsus width and length, hallux length, standard tail length, culmen length, unflattened wing chord, and mass. Processors also recorded wing span for all harriers, eagles, large falcons, and adult buteos ("gourmet" birds). Standard tail length was measured by inserting a thin ruler between the central rectrices to the base of the body and measuring to the tip of the longest rectrix. All other measurements were taken using standard instruments and techniques. Wing and tail measurements were recorded with appropriate rulers to the nearest 1 mm. All other linear measurements were taken with calipers to the nearest 0.1 mm. Mass was taken to the nearest 1g using a digital laboratory scale. Other data taken where appropriate included: color morph and subspecies; eye color; a subjective assessment of the amount of food in the esophagus (crop), rated as empty, ¼, ½, ¾, or full; progress and sequence of molt (primaries, secondaries, tail, rump, and body); notes on presence of ectoparasites; two subjective assessments of body condition, "keel muscle mass" and "wing-pit fat" (similar to measurements described by Geller and Temple [1983]), rated from 0–2 and 0–3, respectively; and notes about old injuries, deformities, or other odd occurrences.

During busy times, processors discontinued several measurements to reduce holding time for captured birds according to the following protocols:

NORMAL CIRCUMSTANCES

For every bird, record all relevant information and measurements requested on the processing sheet, except that only "gourmet" birds (e.g., eagles, most buteos, and large falcons) have wingspan done.

CODE YELLOW—BUSY BUT NOT OVERWHELMING

Record complete measurements for all gourmet birds and for every fifth bird of each sex for other species.

Otherwise:

1. Minimum requirements (see below).
2. Mass
3. Tarsus length
4. Health measurements, wing-pit fat, keel, crop, and parasites

CODE RED - MINIMUM REQUIREMENTS (a.k.a. ring and fling)

Done at the discretion of the blind leader when conditions are extremely busy or the birds' safety dictates.

1. Properly affix band.
2. Determine and record age of bird.
3. Record a complete set of measurements and information for all gourmet birds.

4. For all other birds, record bird #, band #, trap time, trap type, species, subspecies, color morph, release time, bander name, wing chord, and percentages of rump and body molt (in common practice mass also is frequently recorded).

Data Analysis

We used estimates of percent capture success to gauge the overall effectiveness of the banding project, which we calculated as follows: number of birds captured / number of birds counted by the official observation team * 100. To assess overall combined-species capture success we calculated the index excluding Ospreys, Turkey Vultures, Swainson's Hawks, Rough-legged Hawks, Ferruginous Hawks, and unknown raptors from the count totals. Swainson's Hawks are rarely captured and counts vary widely from year to year, which confounds comparisons of annual capture success. Raptors that cannot be identified to genus usually are too far away to be considered trappable. The remaining species have never or rarely been captured at a HWI banding site. To calculate capture success for individual species, we first adjusted the count totals according to the following protocols:

1. We assumed that all unidentified accipiters were Sharp-shinned or Cooper's Hawks, and allocated unknowns in proportion to the relative abundance of birds identified to these species.
2. We allocated unknown buteos and falcons across all species seen in given year in proportion to the relative abundance of birds identified to species.
3. We assumed that all unknown eagles were Golden Eagles.
4. We did not adjust for unknown raptors; i.e., birds that were not identified to genus.

We calculated estimates of capture rate (captures / 100 station hours) to provide an index of capture activity adjusted for variation in effort, which we use to identify annual, seasonal, and daily patterns in capture activity. This index is roughly comparable to passage rate statistics calculated from observation data. Estimates of capture rate and success are affected by weather patterns (especially wind speed and direction), station layout, availability of appropriate lure birds, trapper experience, overall passage rates, and trapping effort. To avoid bias associated with variation in trapping effort, we generally limited calculations of long-term means for comparisons with current capture statistics to the period 1992–1998. This constrains comparisons to years in which at least five stations were operated full-time. To augment information about migratory timing derived from the count data, we calculated sex–age specific median capture dates (the date by which 50% of the season's total captures occurred) for selected species. We limited these calculations to instances where species or sex–age specific annual capture totals equaled or exceeded 5 birds, and limited calculations of 1992–1998 means to instance where we could derive annual estimates for at least 3 of the 5 years.

In comparing 1999 statistics with long-term means, we equate a significant difference with the 1999 value falling outside a 95% confidence interval for the long-term mean.

We present data for three types of encounters with previously banded birds. Recaptures involve birds that were originally banded and later recaptured during a subsequent season at the Goshute site. Foreign recaptures involve birds that were originally banded elsewhere and were later recaptured at the Goshute site. Foreign encounters involve birds that were originally banded at the Goshute site and were later recaptured or otherwise recovered elsewhere. Herein we report only encounters from 1999 and early 2000. Jewell and Smith (1998) presented a project-wide summary of encounter information through winter 1998.

RESULTS

WEATHER

Weather was generally mild for most of the 1999 season, with only one light snowfall during the season and very little storm activity. Most weather fronts were weak and only brought overcast skies with little or no rainfall. No full observation days were missed due to weather, and only 3 days had observations limited to <5 hrs due to thunderstorms. One day was missed due to severe smoke from wildfires. Average daily temperatures remained above 10°C for most of the season, with a range from –3.5°C to 23.3°C. Thermal lift (a subjective rating) was fair to poor on 87% of all days, despite numerous clear days with light to moderate winds. Strong winds (>20 kph) prevailed on 24% of observation days and were generally associated with smaller flights than moderate to light wind days with similar weather (<20 kph). Southwest winds predominated at the site (33% of observation days) this season, and have typically been associated with peak flights. An additional 21% of days had southwest winds for at least a portion of the day. Following predominance of southwest winds, northeast (20% of days) and variable wind days (16%) were the next most common. Of 20 days with flights above 40 raptors/hr, 70% had southwest winds occurring for at least a portion of the day, 50% had northeast winds, 30% had west winds, and 20% had east winds, with all other wind types occurring on <5% of days.

OBSERVATION EFFORT

This season's 82 of 83 possible observation days and 748.08 observation hours are both significantly higher (6.5% and 14%, respectively) than the 1977–1998 averages (Table 2). The 1999 average daily rate of 2.7 observers/hr (includes official and guest observers; value is mean of daily values, which are in turn means of hourly values) is 4% lower but not significantly different than the 1990–1998 mean of 2.8 ± 95% CI of 0.33 observers/hr. This means that for the analysis of trends in annual passage rates, the raw counts were adjusted downward an average amount to standardize the results for a two-observer count system.

MIGRATION SUMMARY

The observers counted 22,467 migrant raptors of 17 species during 748.08 observation hours on 82 days between 15 August and 5 November (see Appendix D for 1999 daily unadjusted count records and Appendix E for unadjusted count summaries by species for each year of the project). This is the second highest combined-species count for the site, with record high counts for Northern Harrier, Red-tailed Hawk, Rough-legged Hawk, Golden Eagle, and Bald Eagle (Appendix E). In addition, counts reached near-record highs for Sharp-shinned Hawk, Broad-winged Hawk, and Ferruginous Hawk. No new species were seen in 1999. The Red-shouldered Hawk was the only species absent in 1999 that had been seen in previous years, the last sighting being in 1996.

The combined-species adjusted count of 19,172 and adjusted passage rate of 3,720 raptors/100 hrs are both significantly higher than average (39% and 24%, respectively; Table 2, Fig. 3). Based on adjusted numbers, the flight was composed of 59% accipiters, 21% buteos, 15% falcons, and 5% other species. Proportions of accipiters and buteos were very close to average, whereas the proportion of falcons was slightly above average and the proportion of unidentified raptors was slightly below average (Fig.4). The most common species was the Sharp-shinned Hawk (36% of the total unadjusted count), followed by Red-tailed Hawk (23%), Cooper's Hawk (18%), American Kestrel (13%), Northern Harrier (1.6%), Turkey Vulture (1.6%), Golden Eagle (1.6%), and Swainson's Hawk (1.5%). All other species comprised less than 1% of the total count.

Immature : adult ratios are nearly double the average for 3 species, but only half the average for 2 others (Table 3). No significant differences in age ratios are apparent for the remaining 5 species with sufficient age-classified counts. However, for 8 of these 10 species, significantly lower or higher than average percentages of unknown-age birds may confound the age-ratio comparisons (Table 3).

Compared to the average pattern, migration activity occurred earlier in the day during 1999, with higher than average activity from 0700–1000 hrs and lower than average activity from 1400–1800 hrs (Fig. 5). This is the second year in a row this atypical pattern has applied. The combined-species median passage date of 27 September is significantly later than average (5 days; Table 4). This late shift is readily apparent in comparing the 1999 and average seasonal activity patterns (Fig. 6). At the species level, median passage dates are significantly different than average for 10 species, being later than average for 9 species and earlier for one (Table 4). Age-specific median dates are generally later than average for adults, and within the bounds of 95% confidence intervals for immatures (Table 5). Numbers remained strong through the end of the observation season for typical late-season migrants such as Northern Goshawks, Rough-legged Hawks, and Golden and Bald Eagles, as well as for Northern Harriers and Red-tailed Hawks (see below).

TRAPPING EFFORT

The crews operated at least one banding station on 72 of 75 days between 21 August and 3 November. Extremely mild fall weather allowed the trapping to continue roughly 10 days longer than usual. Trapping stations were all opened by 31 August, with West blind opening on 21 August, North blind on 23 August, and Meadow blind last. The Meadow blind is generally only used on days with east winds, so the late opening date is expected. Meadow was closed by 24 October, West by 2 November, and North by 3 November. Crew size was reduced from previous seasons', leading to a reduced number of trapping blinds (3 compared to the usual 5) and an overall reduction in trapping effort. The number of trapping station days (131 days) was lower than average (193 days) and the number of station hours was significantly reduced, with only 938 hours in 1999 compared to an average of 1247 hours. The total station hours in 1999 are less than half of the total for 7 of the previous 8 seasons.

TRAPPING SUMMARY

The 1999 combined-species capture total of 1,535 birds and capture success of 7.1% are both significantly lower than average (55% and 65%, respectively); however, the 1999 capture rate of 163.6 birds/100 station hrs is nearly identical to the 1992–1998 mean (Table 6, Fig. 7). Species-specific capture rates are significantly higher than average for Golden Eagle and Merlin, significantly lower the average for Northern Harrier and Broad-winged Hawk, and not significantly different from average for all other species (Table 6). In addition, capture success was significantly lower than average only for 6 species, rating average for the remaining 6 species. The 1999 results raise the total number of captures since project inception to 41,914 birds of 13 species, including 58 recaptures of Goshute-banded birds and 22 foreign recaptures (see Appendix G for annual summaries of trapping effort and capture results by species for each year of the project). No new species were captured in 1999. Species captured previously but not in 1999 include Northern Harrier, Broad-winged Hawk, Swainson's Hawk, and Bald Eagle. Sharp-shinned Hawks accounted for 59% of the capture total, Cooper's Hawks 29%, American Kestrels 6%, Red-tailed Hawks 3%, Northern Goshawk 1%, and Merlin 1%. Each of the remaining 3 species accounted for less than 1% of the total.

On a daily basis, capture totals typically rose rapidly from 0800 hrs until reaching a peak during the 1000 hour, then declined gradually through the remainder of the day (Fig. 8). Capture rates remained nearly constant throughout the day, but this rate is misleading due to unequal effort during the season. On a seasonal basis, the combined-species capture rate varied significantly from the usual pattern. Capture totals through the second week of September were significantly lower than average, rose to above average during the third week, dropped to below average by the end of the month, then rose to above average for most of October (Fig. 9). The greatest percentage of captures occurred during the 5-day period from 1–5 October, after which capture totals gradually declined.

SPECIES ACCOUNTS

The observers counted 349 **Turkey Vultures** on 30 days between 4 September and 22 October (Tables 2 and 4, Appendix E). The adjusted count of 267 birds and adjusted passage rate of 73 raptors/100 hrs are 2% higher and 4% lower than average, respectively, but neither difference is significant (Table 2). The 1983–1999 regression indicated a highly significant increasing trend, despite the lower than average 1999 passage rate (Fig. 10). The median passage date of 26 September is significantly later than average (5 days; Table 4), which comparison of the seasonal activity patterns clearly illustrates (Fig. 11).

The observers counted 110 **Ospreys** on 37 days between 22 August and 31 October (Tables 2 and 4, Appendix E). The adjusted count of 96 birds and adjusted passage rate of 23 raptors/100 hrs are both significantly higher than average (29% and 24%, respectively; Table 2). The 1983–1999 regression indicated a highly significant increasing trend, despite the 1999 passage rate being lower than during the previous two seasons (Fig. 10). The median passage date of 19 September is significantly later than average (6 days; Table 4). The seasonal activity pattern shows higher than average activity for the end of August, but activity drops below average for the first half of September and shows an unusually high peak during 21–25 September (Fig. 11).

The observers counted 356 **Northern Harriers** on 72 days between 15 August and 5 November (Tables 2 and 4, Appendix E), which is a record high count for the site. The adjusted count of 290 birds and adjusted passage rate of 44 raptors/100 hrs are both significantly higher than average (86% and 69%, respectively; Table 2). The 1983–1999 regression indicated a significant quadratic trend in annual passage rates, with rates remaining relatively steady through 1993, then increasing at an accelerating rate since 1994 (Fig. 10). Based on adjusted numbers, the 1998 flight consisted of 35% adults, 36% immatures, and 30% unidentifiable birds (indistinguishable brown immatures or adult females, and birds of unknown age and sex). The adjusted immature : adult ratio of 1.03 is 23% lower than average, but the difference is not significant (Table 3). Moreover, counts for both adults and immatures are higher than average. The median passage date for the species of 10 October is significantly later than average (16 days; Table 4). Age-specific dates confirm the same pattern for both adults (17 days late) and immatures (15 days late), and conform to the typical pattern of immatures preceding adults (Table 5). The species-level seasonal activity pattern clearly illustrates the late shift in activity, with mostly below average activity through much of September and mostly above average activity after mid-October (Fig. 11).

The trappers did not capture any **Northern Harriers** in 1999, which is a significant deviation from the long-term average of 7 birds per season (Table 6).

The observers counted 8,094 **Sharp-shinned Hawks** on 75 days between 18 August and 5 November (Tables 2 and 4, Appendix E). The adjusted count of 7,232 birds and adjusted passage rate of 1,393 raptors/100 hrs are both significantly higher than average (61% and 40%, respectively; Table 2). The 1983–1999 regression indicated a significant increasing trend in passage rates and the 1999 rate also continues a pattern of pronounced annual fluctuation since 1991 (Fig. 12). Based on adjusted numbers, the flight consisted of 31% adults, 27% immatures, and 42% birds of unknown age. The adjusted immature : adult ratio of 0.87 is 33% lower than average, which is a marginally significant difference (Table 3). We caution, however, that a significantly higher than average proportion of unknown-age birds may confound this comparison (Table 3). In addition, the immature count is actually near average, with the low ratio a result of a higher adult count rather than a low immature count. The median passage date for the species of 4 October is 12 days later than average (Table 4). Age-specific median dates also show a pattern of late arrival, but suggest that immatures were only 1 day later than average and adults were only 4 days later than average (the latter a significant difference; Table 5). The age-specific dates do conform to the typical pattern of immatures preceding adults. Late passage activity is reflected in the seasonal activity pattern as two late peaks in activity during mid-October (Fig. 13).

The trappers captured 899 **Sharp-shinned Hawks** on 62 days between 25 August and 3 November (Tables 6 and 7). The 1999 capture total, which includes 2 recaptures, is significantly lower than average (55%; Table 6). The capture rate of 95.8 birds/100 station hrs nearly matches the long-term average, whereas the capture success of 11% is significantly lower than average (69%; Table 6). The 1999 captures included 28% adult females, 23% adult males, 22% immature females, and 27% immature males, which is a higher than average proportion of immature birds (Table 8). Median capture dates for adult males and females are both significantly earlier than average, whereas dates for immature males and females are average (Table 9). As is typical for the site, age-specific median capture dates indicate that immatures preceded adults within sexes, and females preceded males within age classes (Table 9). The distributions of ratings for wing-pit fat and crop fullness are about average; however, the proportion of birds with good keel musculature is above average (Table 10).

The observers counted 4,109 **Cooper's Hawks** on 75 days between 15 August and 3 November (Tables 2 and 4, Appendix E). The adjusted count of 3,861 birds and adjusted passage rate of 818 raptors/100 hrs are 22% and 9% higher than average, respectively, but neither differences is significant (Table 2). The 1983–1999 regression indicated a significant increasing trend. The 1999 passage rate extends this pattern and, similar to Sharp-shinned Hawks, continues a pattern of pronounced annual fluctuation since 1991 (Fig. 12). Based on adjusted numbers, the flight consisted of 32% adults, 21% immatures, and 47% birds of unknown age. The adjusted immature : adult ratio of 0.63 is 32% lower than average, but the difference is not significant (Table 3). The median passage date for the species of 23 September is only 2 days later than average (Table 4); however, age-specific median dates indicate average timing for immatures (1 day late) but significantly later than average passage of adults (8 days; Table 5). The seasonal activity pattern is similar to the average pattern, but shows lower than average activity early in September and slightly higher than average activity during 21–35 September and 1–5 October (Fig. 13).

The trappers captured 441 **Cooper's Hawks** on 51 days between 21 August and 27 October (Tables 6 and 7). The 1999 capture total, which includes 2 recaptures and 1 foreign recapture, is significantly lower than average (54%; Table 6). The capture rate of 47.0 birds/100 station hrs is 24% higher than average, whereas the capture success of 11% is significantly lower than average (51%; Table 6). The captures included 37% adult females, 28% adult males, 17% immature females, and 18% immature males, which is a higher than average proportion of immatures and a lower than average proportion of females (Table 8). Median capture dates indicate significantly earlier than average timing for adult males and females of both ages (all 7 days early), but significantly later than average timing of immature males (11 days; Table 9). As is typical for the site, median capture dates indicate that immature males preceded adult males, and adult females preceded adult males; however, late passage of immature females rendered them atypically later than all other sex–age groups. Similar to the pattern shown for Sharp-shinned Hawks, the distributions of ratings for wing-pit fat and crop fullness are about average, but the proportion of birds with good keel musculature is above average (Table 10).

The observers counted 103 **Northern Goshawks** on 56 days between 20 August and 5 November (Tables 2 and 4, Appendix E). The adjusted count of 96 birds and adjusted passage rate of 14 raptors/100 hrs are both significantly lower than average (24% and 34% lower, respectively; Table 2). The 1983–1999 regression indicated no significant trends (Fig. 12). Based on adjusted numbers, the flight consisted of 24% adults, 66% immatures, and 11% birds of unknown age. The adjusted immature : adult ratio of 2.74 is 31% higher than average, but the difference is not significant (Table 3). A significantly lower than average proportion of unknown-age birds may confound this comparison (Table 3). The median passage date for the species of 2 October is 5 days earlier than average and the difference is marginally significant (Table 4). However, age-specific dates show that immatures were significantly earlier (8 days) than average, but adults were slightly late (3 days; Table 5). The species-level seasonal activity pattern shows variation from the norm, but no distinct early or late shift is apparent (Fig. 13).

The trappers captured 21 **Northern Goshawks** on 18 days between 24 August and 4 November (Tables 6 and 7)). The capture total and capture success of 20% are both significantly lower than average (51% and 23%, respectively), whereas the 1999 capture rate of 2.2 birds/100 station hrs is 10% higher than average (not a significant difference; Table 6). The captures included 5% adult females, 10% adult males, 57% immature females, and 29% immature males, which is a lower than average proportion of immatures and a higher than average proportion of females (Table 8). The 1999 median capture dates for immature birds of both sexes are near average, and as usual, immature females preceded immature males (Table 9). Too few adults were captured to calculate meaningful median capture dates. Body condition indices indicate higher than average proportions of birds with full crops and good keel musculature, but fewer birds with wing-pit fat (Table 10). Two of the HY female goshawks captured this season were outfitted with backpack satellite transmitters (see www.hawkwatch.org for current tracking results).

The observers counted 59 **Broad-winged Hawks** on 17 days between 9 September and 4 October (Tables 2 and 4, Appendix E). The adjusted count of 52 birds and adjusted passage rate of 18 raptors/100 hrs are 53% and 43% higher than average, respectively, but neither difference is significant due to high annual variability. The 1983–1999 regression indicated a highly significant increasing trend (Fig. 14). Based on adjusted numbers, the 1998 flight consisted of 46% adults, 15% immatures, and 38% birds of unknown age. The adjusted immature : adult ratio of 0.34 is significantly lower than average (53%; Table 3). No dark morph birds were seen this season (Table 11). The 1999 species-level and age-specific median passage dates all fall within the bounds of 95% confidence intervals for the respective means (Tables 4 and 5). The seasonal activity pattern also is similar to the average pattern, except for showing an unusually high concentration of activity just before the typical peak period of 21–25 September and a lower than usual activity level after the peak (Fig. 15). No Broad-winged Hawks were captured this season (see Table 6 for previous capture rates).

The observers counted 334 **Swainson's Hawks** on 37 days between 27 August and 18 October (Tables 2 and 4, Appendix E). The adjusted count of 269 birds and adjusted passage rate of 70 raptors/100 hrs are both significantly higher than average (63% and 54%, respectively; Table 2). The 1983–1999 regression indicated a significant increasing trend, despite high annual variability (Fig. 14). Based on unadjusted numbers, the 1999 flight consisted of 48% light-morph birds, 18% dark morphs, and 34% birds of unknown color morph. The unadjusted light : dark morph ratio of 2.7 is significantly lower than average (36%; Table 11). The median passage date for the species of 30 September is significantly later than average (13 days; Table 4). This is clearly illustrated by the seasonal activity pattern, which shows a significant late peak in early October that represents nearly 50% of the total flight (Fig. 15). No Swainson's Hawks were captured this season (see Table 6 for previous capture rates).

The observers counted 5,183 **Red-tailed Hawks** on 82 days between 15 August and 5 November (Tables 2 and 4, Appendix E). The adjusted count of 3,605 birds and annual passage rate of 565 raptors/100 hrs are both significantly higher than average (39% and 23%, respectively; Table 2). The 1983–1999 regression indicated no trend (Fig. 16). Based on adjusted numbers, the 1999 flight consisted of 59% adults, 26% immatures, and 15% birds of unknown age. The adjusted immature : adult ratio of 0.45 is 22% higher than average, but the difference is not significant (Table 3). In fact, counts of both immatures and adults are significantly higher than average. Based on unadjusted numbers, the flight consisted of 82% light morphs, 8% dark morphs, and 11% birds of unknown color morph. The light : dark ratio of 10.8 is significantly higher than average (83% higher; Table 11). We caution, however, that significantly lower than average proportions of unknown-age and unknown-morph birds may confound both the age-ratio and morph-ratio comparisons for several species (Tables 3 and 11). The median passage date for the species of 12 October is significantly later than average (9 days; Table 4), with the same pattern shown for both adults and immatures (6 and 13 days late, respectively; Table 5). The seasonal activity pattern is not radically different from the average, but does show several periods of lower than average activity from late August through mid-September, and activity was generally higher than average after mid-October and may have remained significant after the close of the season (Fig. 17).

The trappers captured 49 **Red-tailed Hawks** on 36 days between 23 August and 4 November (Tables 6 and 7). The capture total and capture success of 0.9% are both significantly lower than average (45% and 64%, respectively; Table 6), whereas the capture rate of 5.2 birds/100 station hrs is 24% higher but not significantly different than average (Table 6). The captures included 12% adults and 88% immatures, which are average proportions (Table 8). For both age classes, the percentage of birds with empty crops was similar to 1994–1998 means, but the percentages of birds with above average keel musculature and wing-pit fat increased substantially in 1999 (Tables 10). Three of the adult red-tails received satellite backpack transmitters this season (see www.hawkwatch.org for current tracking results).

The observers counted 25 **Ferruginous Hawks** on 21 days between 7 September and 2 November (Tables 2 and 4, Appendix E). The adjusted count of 21 birds and adjusted passage rate of 3.5 raptors/100 hrs are both significantly higher than average (42% and 29%, respectively; Table 2). The 1983–1999 linear regression indicated a significant increasing trend, but further analyses revealed a significant quadratic trend, which suggests that the increasing trend is gradually diminishing (Fig. 16). Based on adjusted numbers, the 1999 flight consisted of 48% adults, 33% immatures, and 18% birds of unknown age. The adjusted immature : adult ratio of 0.74 is 53% lower than average, but the difference is not significant due to high annual variability (Table 3). Based on unadjusted numbers, the 1998 flight consisted of 76% light morphs, 12% dark morphs, and 12% birds of unknown color morph. The light : dark ratio of 6.3 is significantly higher than average (Table 11). We caution, however, that much lower than average proportions of unknown-age and unknown-morph birds probably confound both the age-ratio and morph-ratio comparisons (Tables 3 and 11). The 1999 median passage date for the species of 9 October is significantly later than average (13 days; Table 4), which examination of the seasonal activity pattern clearly illustrates (Fig. 17). Too few adults were counted in previous years to calculate a long-term average median date; however, the 1999 date of 19 October is 12 days later than in 1998. For immatures, the 1999 date of 27 September is 8 days earlier than average (Table 5), but the average is based on data for only three previous years and is highly skewed by a very late date in 1993. The 1999 median date for immatures is only 1 day later than in 1998.

The observers counted 50 **Rough-legged Hawks** on 22 days between 10 October and 4 November (Tables 2 and 4, Appendix E). The adjusted count of 45 birds and adjusted passage rate of 6.9 raptors/100 hrs are both significantly higher than average (276% and 225%, respectively; Table 2). Statistical analysis of population trends for this species is of marginal value because of low annual counts and potentially incomplete seasonal coverage of this late-season migrant. Moreover, annual passage rates currently show no distinct trend (Fig. 16). Based on unadjusted numbers, the 1999 flight consisted of 92% light morphs and 4% dark morphs. The light : dark morph ratio of 23.0 is 489% higher than average (Table 11). The 1999 median passage date for the species of 21 October is only 1 day earlier than average (Table 4); however, the seasonal activity pattern shows higher than usual activity in mid-October and early November, but lower than average activity during late October (Fig. 17).

The observers counted 348 **Golden Eagles** on 67 days between 17 August and 5 November (Tables 2 and 4, Appendix E). The adjusted count of 297 birds and adjusted passage rate of 44 raptors/100 hrs are 17% and 1% higher than average, respectively, with the count difference significant (Table 2). The 1983–1999 regression indicated no trend in annual passage rates (Fig. 18). Based on adjusted numbers, the 1999 flight consisted of 20% adults, 65% immatures and subadults, and 15% birds of unknown age. The adjusted immature/subadult : adult ratio of 3.32 is significantly higher than average (75%; Table 3), but the lower than average number of unknown birds makes the age ratio suspect. The median passage date of 14 October is significantly later than average (7 days; Table 4), and age-specific dates confirmed late passage of both adults (9 days late) and immatures/subadults (4 days late; Table 5). Late passage is clearly reflected in the seasonal activity pattern as mostly lower than average flight volume from late August through mid-September and mostly above average activity after mid-October (Fig. 19). Relatively high activity in early November also suggests that significant activity may have continued after the count ended.

The trappers captured 8 **Golden Eagles** on 7 days between 2 and 22 October (Tables 6 and 7). The capture total, capture rate of 0.9 birds/100 station hrs, and capture success of 2.3% are 60%, 350%, and 35% higher than average, respectively, with the differences in capture totals and rates significant (Table 6). The captures included 2 hatch-year females, 5 hatch-year males, and 1 second-year female, the latter being only the eighth after-hatch-year bird ever caught at the site (Table 8). The birds captured this season averaged slightly thinner keel muscles than is typical for the site, but wing-pit fat ratings were slightly above average (Table 10). Two of these eagles received satellite backpack transmitters (see www.hawkwatch.org for current tracking results).

The observers counted 31 **Bald Eagles** on 19 days between 11 September and 5 November (Tables 2 and 4, Appendix E). The adjusted count of 24 birds and adjusted passage rate of 4.3 raptors/100 hrs are both significantly higher than average (103% and 65%, respectively; Table 2). The 1983–1999 regression indicated no trend (Fig. 18); however, it is important to note that HWI migration counts may not be a reliable indicator of Bald Eagle population trends because monitoring covers only the early portion of the species' migration, which typically extends through November and into early December. Small annual counts also limit the statistical power of the analyses. Based on unadjusted numbers, the 1999 flight consisted of 29% adults, 67% immatures and subadults, and 4% unknown-age birds. The unadjusted immature/subadult : adult ratio of 2.29 is significantly higher than average (154%; Table 3). The median passage date for the species of 21 October matches the long-term average (Table 4). The seasonal activity pattern is roughly similar to the average pattern; however, activity was much higher than average during the last five-day period of the season (Fig. 19). Moreover, age-specific dates indicate that adults were significantly earlier than average (4 days) while immatures were 1 day later than average (Table 5).

The observers counted 2,974 **American Kestrels** on 71 days between 15 August and 5 November (Tables 2 and 4, Appendix E). The adjusted count of 2,699 birds and adjusted passage rate of 585 raptors/100 hrs are both significantly higher than average (56% and 50%; Table 2). The 1983–1999 regression indicated a highly significant increasing trend (Fig. 20). The 1999 median passage date of 20 September is significantly later than average (5 days; Table 4), which is reflected in the seasonal activity pattern as lower than average activity in early September and higher than average activity in late September and early October (Fig. 21).

The trappers captured 97 **American Kestrels** on 31 days between 29 August and 27 October (Tables 6 and 7). The capture total, capture rate of 10.3 birds/100 station hrs, and capture success of 3.3% are 64%, 18%, and 69% lower than average, respectively, but only the capture total and success differences are significant (Table 6). The captures included 2% adult females, 12% adult males, 26% immature females, and 44% immature males, which is a significant decrease in the proportion of adult females, but an average immature : adult ratio (Table 8). Not enough adults were captured to calculate meaningful median capture dates, but the median date for immature males was significantly earlier than average (17 days), while the date for immature females was the same as average (Table 9). The distributions of various keel muscle and wing-pit fat ratings were about average; however, more birds were captured with partial crops than usual (Table 10).

The observers counted 74 **Merlins** on 39 days between 20 August and 5 November (Tables 2 and 4, Appendix E). The adjusted count of 68 birds and adjusted passage rate of 11.9 raptors/100 hrs are both significantly higher than average (82% and 58%, respectively; Table 2). The 1983–1999 regression indicated a highly significant increasing trend (Fig. 20). The 1999 median passage date for the species of 4 October is significantly later than average (4 days; Table 4); however, the seasonal activity pattern shows higher than average activity in both mid-September and after mid-October (Fig. 21).

The trappers captured 16 **Merlins** on 14 days between 14 September and 1 November (Tables 6 and 7). The capture total matches the long-term average, whereas the capture rate of 1.7 birds/100 station hrs is significantly higher than average (143%) and the capture success of 22% is 17% lower but not significantly different than average (Table 6). The 1999 captures included 6% adult females, 31% adult males, 31% immature females, and 31% immature males. This represents significant decreases in the female : male and immature : adult ratios (Table 8). Proportionately fewer birds were captured with full crops in 1999, but more had at least a partial crop (Table 10). The distribution of keel muscle ratings was skewed toward the high side, but the distribution of wing-pit fat ratings was mostly skewed toward the low side (10).

The observers counted 33 **Prairie Falcons** on 24 days between 15 August and 5 November (Tables 2 and 4, Appendix E). The adjusted annual count of 31 birds and adjusted passage rate of 4.8 raptors/100 hrs are both nearly equal to average (4% higher and 5% lower, respectively; Table 2). The 1983–1999 regression indicated a significant increasing trend (Fig. 20). The 1999 median passage date of 18 September is significantly later than average (6 days; Table 4). The seasonal activity pattern is highly variable, but the 1999 pattern does show a higher than average concentration of activity during mid-September (Fig. 22).

The trappers captured 3 **Prairie Falcons** on 3 days between 6 and 19 September (Tables 6 and 7). The 1999 capture total is 57% lower than average, but the difference is only marginally significant (Table 6). The capture rate of 0.3 birds/100 station hrs is equal to average (Table 6). The capture success of 9% is 42% lower than average, but the difference is not significant (Table 6). All three captures were immature males (Table 8). Adults are rarely captured at the site.

The observers counted 15 **Peregrine Falcons** on 12 days between 23 August and 18 October (Tables 2 and 4, Appendix E). The adjusted count of 15 birds and adjusted passage rate of 2.5 raptors/100 hrs are both significantly higher than average (72% and 60%, respectively; Table 2). The 1983–1999 regression indicated a highly significant increasing trend (Fig. 20). Based on adjusted numbers, the 1999 flight consisted of 40% adults, 53% immatures, and 7% birds of unknown age. The adjusted immature : adult ratio of 1.33 is significantly higher than average (105%), but the low percentage of unknown-age birds may confound the comparison (Table 3). The 1999 median passage date for the species of 27 September is 3 days later than average, but the difference is not significant (Table 4). Nevertheless, the seasonal activity pattern shows higher than average activity 5–10 days later than the average seasonal peak in mid-September (Fig. 22).

The trappers captured 1 immature male **Peregrine Falcon** on 22 September (Tables 6 and 7). This is an average total for the site, as are the capture rate of 0.1 birds/100 station hrs and capture success of 7% (Table 6).

In addition to identified migrants, the observers recorded 220 migrants that they could not identify to species, which accounts for <1% of the unadjusted total count (Fig. 4). This group included 132 unidentified accipiters, 24 unidentified buteos, 7 unidentified falcon, and 57 unidentified raptors (Appendix E). Based on adjusted counts and passage rates, the 1999 values for these classes are significantly lower than average, except for unidentified falcons (Table 2).

Resident and Northbound Raptors

Migrant raptors tend to have a direct flight pattern. Therefore, the observers typically classified all birds seen perching, hunting, or performing territorial displays as residents and excluded them from the count. This season, residents included 2 adult and 2 fledgling Northern Goshawks, 2 adult Cooper's Hawks, 2 adult light-morph and 3 immature light-morph Red-tailed Hawks, 2 adult and 1 immature Golden Eagles, and several local American Kestrels.

Typically, the observers record as northbound migrants all raptors seen heading north past the Goshute lookouts that do not appear to stop or change direction while in view. We assume that many northbound birds are dispersing juveniles or non-migratory adults that were searching for more productive wintering grounds in the local region (i.e., within 100 km of their usual territory). Only 6 northbound migrants were recorded this season: 2 Northern Harriers, 2 Northern Goshawks, 1 Bald Eagle, and 1 Golden Eagle.

Encounters With Previously Banded Birds

Recaptures

The 1999 captures included 4 recaptures of birds originally banded in the Goshutes (Table 12), which brings the total number of Goshute recaptures since 1980 to 58 birds, all accipiters. The 1999 recaptures included 2 Sharp-shinned Hawks, both females originally banded as hatch-year (HY) birds during the 1998 season, and 2 Cooper's Hawks, 1 male banded as a HY during the 1998 season and 1 female banded as a second-year (SY) bird in 1995. All birds originally banded as HY birds were recaptured as adults 1–19 days later in the season, which is consistent with typical trends in age-specific median capture dates.

Foreign Recaptures

The 1999 captures included 2 recaptures of birds originally banded elsewhere (Table 12). The SY female Cooper's Hawk was banded as a HY bird in 1998 at Squaw Peak, UT, and the HY female Northern Goshawk was banded at the nest in 1999 in the Independence Mountains of Nevada. Thus far, the Goshute trappers have recaptured 22 raptors that were originally banded elsewhere, with original banding locations in Utah (1), New Mexico (1), Nevada (3), Idaho (11), Oregon (1), Washington (1), California (1), Montana (1), Alaska (1), and the Yukon Territory (1).

Foreign Encounters

Nineteen raptors originally banded in the Goshutes were encountered elsewhere in 1999 and winter/spring 2000, bringing the total foreign encounters since 1980 to 220 birds (Table 13). With the exception of a male Cooper's Hawk caught by hand and released in Nuevo Vallarta, Mexico, all other foreign encounters involved dead birds. Six mortalities involved collisions with stationary objects, 1 involved a collision with a car, 1 bird was shot, and 10 birds were found dead of unknown causes.

Site Visitation

One of HWI's objectives is to educate the public about the ecology of raptors and their roles in ecosystems. In 1999, HWI welcomed over 1,000 visitors to the Goshute site, including sixth graders from throughout Elko County, Nevada, as well as several other school groups. The average daily visitation rate was approximately 0.9 visitors per hour (Appendix B). Greg Ryder and Aimee Weldon were the on-site educators at the Goshute site in 1999, with primary responsibility for public outreach. The educators greeted visitors, helped answer questions about raptor identification, ecology and conservation issues, gave many visitors the opportunity to see live hawks in hand after banding, and generally facilitated interactions between visitors and the field crews.

DISCUSSION

WEATHER

Weather strongly influences raptor movements (Mueller 1973). In eastern North America, large flights of raptors usually occur after the passage of a cold front (Allen et al. 1996). Strong weather fronts tend to create multi-day decreases in the flight, with many birds waiting out frontal passage, or racing ahead of fronts. Strong winds, a decrease in temperature, and clouds usually co-occur with the passage of a front, creating poor flying conditions for raptors. Twelve of the 20 days with the highest passage rates this season occurred during successive weak frontal systems. These 12 peak days were nearly successive and occurred during the typical peak flight period, indicating that the weak weather systems had only a small influence on flight dynamics.

Southwest and west winds typically predominate in the Goshute Mountains and produce the highest migration counts. This year was true to form, with southwest winds on 54% of observation days resulting in 70% of peak flights. However, peak flights were also common on northeast winds, with some of the highest flights occurring with winds from this direction. The previous year, 5 of 10 days with the highest passage rates featured easterly winds and 5 featured westerly winds (Lanzone 1999). East winds on those days produced 100.8 birds/hour, west winds 100.2 birds/hour, demonstrating that peak flights can occur under a variety of wind directions.

DAILY FLIGHT RHYTHM

The 1999 combined-species daily flight rhythm was very similar to the average pattern, although there were a number of slight but significant differences. Flight activity was higher than normal for every hour before 1100 hrs, and lower than normal for every hour after 1300 hrs. Fall migration activity of accipiters typically peaks in the morning (Mueller 1973) and this season's high morning activity may be due in part to above average accipiter counts. However, buteo counts also were generally higher than average counts, and higher morning activity may be a reflection of mild, clear weather and thermal development earlier in the day.

SEASONAL TIMING

Flight activity was generally lower than average through August and the first 2 weeks of September. The peak flight was 5 to 10 days later than average, marked by significantly higher than average activity in late September following a period of unstable weather. Lower than average counts for the end of September occurred during mostly clear weather, and may have been a result of numbers dropping after the large flights associated with the passage of multiple weak frontal systems. Flights through October were generally above average, and may be the result of mild weather delaying migration. Nearly every species showed later than average peak flights.

FLIGHT COMPOSITION, PASSAGE RATES, AND LONG-TERM TRENDS

Flight composition was nearly typical for the site, although the proportion of falcons was slightly above average. This was mostly due to high kestrel counts, but above average counts for Merlin and Peregrine Falcon also contributed. For kestrels, capture data indicated an average immature : adult ratio, leaving causes of high kestrel counts unclear. In 1999, 10 of 17 species showed significantly higher than average adjusted counts and passage rates, and only one common species had significantly lower counts and passage rates. The consistently high counts are partly explained by a 15% increase in observation hours resulting from greater daily effort. However, passage rates generally decrease with increasing observation hours due to greater coverage early and late in the day when flight volumes are low. This was not the case in 1999, as passage rate increases where very similar in magnitude to count increases.

With above average passage rates for most species and largely unremarkable age ratios indicating mostly average productivity, high counts would seem to be the result of some common factor, such as weather, influencing migration pathways and raptor detectability. Another important factor to consider is the relatively high experience of this season's two official observers. Universally low proportions of birds not identified to species and age are indicative of advanced confidence and observation skill, which may affect migration counts.

For most species, immature : adult ratios were near average. Exceptions to this were age ratios for Golden Eagles, Bald Eagles and Peregrine Falcons, each having ratios significantly above average. For Golden Eagles, immature counts were above average, but much of the increase in the age ratio was due to lower than average adult numbers. Eagles are often late season migrants, with adults typically later than immatures. Strong flights of Golden Eagles late this season suggest many adults may still have been migrating, making the age ratio suspect. The increase seen for Peregrine Falcon age ratio is also problematic. While immature numbers were twice as high as average, the number of unknown age peregrines was over 80% lower than average. Bald Eagles were the only species with significantly higher than average age ratios that may be the result of higher than average productivity. This was evident in passage rates, as Bald Eagle rates were significantly higher than average, mainly due to high immature counts.

Sharp-shinned Hawks and Broad-winged Hawks both had significantly lower than average age ratios and the Cooper's Hawk age ratio was lower but not quite significant. For Sharp-shinned Hawks, the percentage of unknown age birds was higher than normal, while immature numbers were very close to average. However, much of the decrease in age ratio can be attributed to higher than average adult counts, suggesting good overwinter survival of last years record high immature numbers (Lanzone 1999). Results from trapping support the count results showing the lower than average age ratio, with proportionally nearly twice as many adults captured this year. Although Cooper's Hawks had near record high productivity last year, adult numbers were near average this season, giving no indication of good overwinter survival. The age ratio was much lower, mostly due to lower than average immature numbers. This is also supported by capture results, with proportionally half as many immature Cooper's Hawks captured. Broad-winged Hawk numbers are more difficult to analyze because the high annual variability in counts make the age ratio suspect. However, the number of immature birds was lower than average, suggesting poor reproductive performance this year. Grier (1979) cautioned against using age ratios as sole indicators of reproductive success and population status. Nevertheless, long-term tracking of variation in the relative abundance of age classes on migration through trapping and observational studies may reveal patterns that correlate strongly with regional-scale demographic trends and therefore yield important insight into the status of migratory populations. It is particularly important to consider this possibility in light of the fact that direct, long-term monitoring of the productivity of raptor populations over large areas is often extremely difficult and costly.

The 1999 above-average passage rates continue steadily increasing abundance trends for Turkey Vultures, Broad-winged Hawks, Ospreys, Merlins, and Peregrine Falcons, which mirror similar increasing trends shown by data from other HWI migration sites and other sources (Smith et al. in review). The latter three species were negatively impacted by the use of organochlorine pesticides in the 1950s and 1960s; however, subsequent banning of DDT allowed populations to rebound in many areas (Cade et al. 1988, Henny and Anthony 1989; Sodhi et al. 1993). Increasing availability of artificial nesting platforms and artificial reservoirs also has helped increase the breeding range and nesting densities of Ospreys (Poole 1989, Henny and Kaiser 1995). Captive breeding and release programs have been instrumental in the Peregrine Falcon's recovery (Cade et al. 1988) and removal from the federal list of endangered species (USDI Fish and Wildlife Service 1999). Long-term increases in the number of Turkey Vultures, a species derived from the tropics, may reflect northward range expansion in response to global warming (Kiff 2000). General increases in population density also may be occurring in response to greater availability of carrion on roadways, around domestic livestock operations, and in other human-altered environments (Wilbur 1983). Increased sightings in several western states during the 1980s (Goodrich et al. 1996) and other observations suggest that the Broad-winged Hawk is expanding its breeding range westward into Alberta and British Columbia (Grindrod and Smith in review). This region is a likely source for birds passing through the Intermountain region.

High annual variability reduces statistical power for detecting trends in passage rates of Swainson's Hawks in the Goshutes, as at other HWI sites (e.g., Vekasy and Smith 2000a). Nonetheless, the high 1999 passage rate establishes an increasing trend for the species. Similar patterns apply at three other long-term HWI sites in the Rocky Mountains (Smith et al. in review). At each site, either the background activity level or the magnitude of peaks has increased through the course of each study. Reasons for concern about Swainson's Hawks exist, such as the recent discovery of extensive mortality from exposure to pesticides on wintering grounds in Argentina (Woodbridge et al. 1995) and widespread declines in productivity in Saskatchewan and Alberta (Houston and Schmutz 1995). However, the Swainson's Hawk has adapted successfully to irrigated agricultural habitats in many areas of the West (e.g., Woodbridge et al. 1995) and is currently considered common and stable in most western states (Harlow and Bloom 1989, England et al. 1997). Possible increases at HWI migration sites are consistent with evidence of expanding grassland habitats in many parts of the Intermountain West (e.g., Knick and Dyer 1997). Moreover, indications of the strongest increases at 2 of HWI's 3 Rocky Mountain sites is consistent with Breeding Bird Survey data showing significant increases from 1980–1996 in Montana, Wyoming, and New Mexico (Sauer et al. 1997). It is also important to note, however, that weather and especially wind patterns may strongly influence migration counts of Swainson's Hawks. The species routinely migrates through valleys as well as along ridgelines, with weather patterns often determining flight paths and behavior.

Recent high counts for Northern Harriers, beginning in 1994 and punctuated by record numbers this season, have established an increasing trend for this species in the Goshutes. This trend is not evident at other sites across the West, suggesting our Goshute site may be monitoring a relatively discrete population, such as birds breeding in the Great Basin or adjacent Snake River Plain. Sharp-shinned and Cooper's Hawks are two other examples of species that are now showing increasing trends in the Goshutes but not at other sites across the West. In addition, both species are showing the same, marked annual fluctuation with an increasing trend. While the two species show roughly similar patterns at most sites, the identical pattern in the Goshutes is striking. Reasons for the same annual fluctuation for both species are unknown, and we will need more information on population origins, influences on productivity and weather effects on migration patterns before identifying causes for this pattern.

A number of other species are showing inconsistent trends across the West. American Kestrels are showing increasing trends in the Goshutes and at our spring site in the Sandias, but a decreasing trend in the Wellsvilles (Smith et al. in review). Kestrels are widely distributed, and one might expect to see similar patterns between observation sites, particularly between sites as close as the Goshutes and Wellsvilles. Identifying source populations and migration patterns associated with individual observation sites will help us to determine reasons for inter-site variation. Prairie Falcons are showing increasing trends in the Goshutes and at least one other site, but no trends at other sites. Prairie Falcons have a wide but relatively spotty distribution (Steenhof 1998), and the close proximity of the Goshute site to the dense Prairie Falcon breeding population in the Snake River Canyon may account for some of the variation seen between migration sites. Ferruginous Hawks also are showing an increasing trend in the Goshutes and Wellsvilles, but a decreasing trend in the Manzanos in New Mexico. Again, we need more information concerning source populations and migration patterns before we can fully understand multi-site variation in population trends.

Northern Goshawks are not showing any significant trends at HWI's long-term sites across the West (Smith et al. in review). Like the Swainson's Hawk, high annual variability makes patterns difficult to discern. This season, the Northern Goshawk was the only common species that showed a lower than average passage rate. There is no indication from the age ratio data, derived from either observation or trapping estimates, that suggests poor productivity this season. In fact, observation estimates suggest productivity was normal and adult numbers were decreased. Mild weather may be related to this finding, allowing more adults than usual to stay on winter territories for extended periods. Although this is the third consecutive year with low passage rates, the addition of irruptive flight years complicates the pattern. Low levels from the past three years closely match past low levels and may represent a normal baseline population.

Red-tailed Hawks showed a higher than average passage rate but only an average immature : adult ratio in 1999 in the Goshutes, and show no long-term trend in passage rates. Age-ratios derived from trapping also agree with the average productivity estimate. Only the Wellsville migration count is showing an increasing trend for red-tails, although both Bonney Butte, OR and the Manzanos are showing weak increasing trends (Vekasy and Smith 2000a, 2000b). Moreover, it is generally believed that this species is benefiting from continued, widespread forest clearing, which creates a mosaic of forested and open habitat (Preston and Beane 1993, Smith et al. in review). Why an increasing trend is not shown in the Goshutes is uncertain, but may reflect origins of migrants in areas of the Great Basin and northern Intermountain regions that are dominated by juniper forests and not heavily impacted by logging activity. Hawks in these areas may in fact be detrimentally impacted by fire and grazing practices (Knick and Dyer 1997) and their influence on nest sites and prey populations.

Rough-legged Hawk passage rates were more than three times greater than average in the Goshutes in 1999 and were significantly higher than average in the Bridger Mountains, MT and at Bonney Butte, OR (Neal et al. 2000, Vekasy and Smith 2000b). Without any age-specific data, it is difficult to discern reasons for the high rough-leg count. Rough-legged Hawks are known to undergo irruptive flights similar to Northern Goshawks. Irruptive flights of rough-legs are not well understood (Palmer 1988), but some populations will move south of normal wintering areas in response to lemming and vole population crashes on their northern breeding grounds or heavy snow cover limiting hunting opportunities. Weather was mild across much of the rough-leg's range this season, so we suspect some influence of prey populations on numbers of rough-legs seen migrating this year, either by influencing high productivity or forcing birds south in search of prey.

CAPTURE RESULTS

Estimates of capture rates, capture success, age/sex composition, and condition information derived from the trapping operation supplement data derived from the Goshute observation study and provide greater understanding of long-term population dynamics. Both trapping and observation data suffer from inherent biases, but considered together can provide more reliable indicators of the behavior and population dynamics of migratory species. Factors that may bias capture statistics include variation in distances of flight lines from the ridgetop related to weather patterns (Millsap and Zook 1983), the condition of migrants (Nass 1964; Weatherhead and Ankney 1984), variation in responsiveness to lures across species, sexes, and age classes (Nass 1964), and variation in the experience levels of trapping crews. These factors can act independently or together to confound interpretation of trends generated from trapping data. Major benefits of trapping data include the ability to accurately identify the sexes and ages of species that cannot be reliably distinguished by counters, the ability to assess the health and condition of migrants, and the long-term value of band recovery information.

We also offer speculative conclusions about relationships between fat levels, crop volume, and the overall condition of migrants. The fat assessments recorded by HWI processors are similar to those employed by Geller and Temple (1983) and are intended to provide a long-term perspective on the condition of migrants. In studying migrating Red-tailed Hawks, Geller and Temple (1983) assumed that "individuals with little subcutaneous fat and concave pectoral muscles were in poorer condition, either having failed to obtain adequate food to develop fat and muscle, or having lost fat supplies and muscle mass as a result of subsequent food shortages." However, they and Clark (1985) found no significant relationship between observable subcutaneous fat levels and overall body mass. Otherwise, little information has been published on fat deposition in raptors (Clark 1985). To our knowledge, no published information is available concerning the relationship between observable subcutaneous fat and actual fat content in raptors. For this reason, an HWI affiliate, John DeLong, is currently investigating the topic as part of his graduate work at Utah State University.

Capture totals and success were lower than average for most species this season, which can largely be attributed to the substantial decrease in trapping effort this season. Only 3 blinds were open for the entire season compared to an average of 5 blinds for 7 seasons previous to this year, and station hours were less than half of the average for the same period (Appendix G). The reduction in trapping effort was driven by two factors: (1) interest in moderating the physical impact of our project on the environment of the Goshute Wilderness Study Area, and (2) interest in moderating the overall financial and logistical cost of the project. Despite the lower overall effort, the combined-species capture rate was slightly higher than average indicating that the efficiency of our trapping operations remained high. Capture rates were significantly lower than average for only two species, Northern Harriers and Broad-winged Hawks, which always constitute very small proportions of total captures. Of greater interest are the average to above average capture totals and rates for Merlins and Golden Eagles. Higher than average immature/subadult counts for Golden Eagles may be one reason for increased capture rates this season. Most eagle captures in the Goshutes involve hatch-year birds (Table 8), and the proportion of hatch-year birds captured in 1999 was higher than average. This was not true for Merlins, however, as we caught twice as many adults than usual (Table 8), which produced an immature : adult ratio that was nearly 3 times lower than average. An exceptionally high passage rate and a low capture age ratio suggest that the high count of Merlins probably did not result from high productivity. With mild conditions over much of the Merlins northern breeding range eliminating weather as a factor, reduced prey populations may have forced more adults than usual to migrate further to find suitable wintering areas.

We trapped sufficient numbers of Sharp-shinned Hawks and Cooper's Hawks to determine complete median capture dates by sex and age, and sufficient numbers of Northern Goshawks and American Kestrels to determine median capture dates for immatures of each sex and adults of only one sex. Median capture dates and median passage dates are a confusing mix of timing differences, but they do generally agree concerning the typical patterns of immatures preceding adults within sexes and females preceding males within age classes for each species. Immature female Cooper's Hawks were one exception this season, averaging much later trapping dates than usual and atypically later than all other sex–age classes. Immature male kestrels also were an exception, being trapped on average earlier than immature females. Reasons behind these types of unusual differences are difficult to explain without specific knowledge of the origins of captured birds and effects of local conditions on productivity, prey populations, migration timing, and other variables affecting migration counts and trapping results.

Body condition estimates for most species were above average this season. Sharp-shinned Hawks, Cooper's Hawks, Northern Goshawks, American Kestrels and Merlins all had above average estimates of keel muscle condition, and only kestrels and goshawks had slightly below average estimates for wing-pit fat. Merlins had mixed estimates for wing-pit fat, with greater percentages of birds with no fat and with heavy fat deposits. Golden Eagles had slightly skinnier keels, but wing-pit fat ratings were above slightly average. Taken together, above average condition would suggest lower capture rates and success. Capture success was lower, but with average capture rates, this can be attributed to the decrease in trapping effort and overall capture totals. If increased counts for some species, particularly Merlins, were related to low prey densities on typical wintering areas, there is no evidence from body condition estimates that migrants this season were in poor condition.

ENCOUNTERS WITH PREVIOUSLY BANDED BIRDS

Recaptures of Goshute-banded birds in the Goshutes and exchanges between the Goshute and Boise Ridge projects along the same flyway (9 exchanges since 1994) provide valuable information about fidelity to this Intermountain Flyway. Over the course of the project, both male and female accipiters originally banded in the Goshutes as immatures have subsequently been recaptured as adults, and other birds originally banded as adults also have returned. However, HWI data on foreign encounters confirm that flyway crossovers also occur. For example, a Cooper's Hawk originally banded by HWI during fall migration 1994 in the Manzano Mountains of central New Mexico—which lies along the Rocky Mountain Flyway—was later recaptured during fall migration 1996 at the Goshute site along the Intermountain Flyway. Moreover, the numbers of both recaptures and foreign encounters of Goshute-banded birds are very small compared to the number of birds banded (0.1–0.3% recaptures and 0.3–1.5% foreign encounters for the 3 accipiter species). Therefore, caution is essential in drawing conclusions about flyway fidelity.

Recaptures of Goshute-banded birds this season included 2 Sharp-shinned Hawks and 2 Cooper's Hawks, one of which was originally captured in 1995 as a SY and was recaptured as a 6^{th} year bird this season. No foreign recaptures from the Boise Ridge project occurred this season, but an immature goshawk banded in the Independence Mountains, NV was caught. This is the 5^{th} exchange of goshawks between these two sites, and helps support the theory that many of the juvenile goshawks along this flyway are from relatively local origins. We also had our first exchange with a bird banded at Squaw Peak in Utah, which suggests that some migrants vary among years the pathway they take around the Great Salt Lake complex.

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Table 1. Species-specific standardized sample periods.

SPECIES	SAMPLING PERIOD
Turkey Vulture	29-Aug – 5-Oct
Osprey	25-Aug – 9-Oct
Northern Harrier	18-Aug – 29-Oct
Sharp-shinned Hawk	1-Sep – 23-Oct
Cooper's Hawk	31-Aug – 17-Oct
Northern Goshawk	23-Aug – 3-Nov
Red-shouldered Hawk	4-Sep – 27-Sep
Broad-winged Hawk	10-Sep – 8-Oct
Swainson's Hawk	24-Aug – 4-Oct
Red-tailed Hawk	22-Aug – 29-Oct
Ferruginous Hawk	24-Aug – 26-Oct
Rough-legged Hawk	9-Oct – 3-Nov*
Golden Eagle	21-Aug – 2-Nov
Bald Eagle	18-Sep – 3-Nov*
American Kestrel	23-Aug – 11-Oct
Merlin	2-Sep – 30-Oct
Prairie Falcon	17-Aug – 25-Oct
Peregrine Falcon	20-Aug – 22-Oct

Note: Sample periods include approximately 95% of the cumulative, study-wide count rate for a given species unless noted with an * next to the ending date, in which case the sample period is further constrained to between mean starting and ending dates of continuous observations.

Table 2. Adjusted annual counts and passage rates by species: 1983–1998 versus 1999.

	1983-1998[1]	1999	% Change			
Start Date	15 Aug ± 0.7	15 Aug				
End Date	2 Nov ± 2.9	5 Nov				
Observation Days	77 ± 3.0	82	+6.5			
Observations Hours	650.06 ± 35.98	748.08	+15			
	COUNTS			RAPTORS/100 HOURS		
SPECIES	1983-1998[1]	1999	% Change	1983-1998[1]	1999	% Change
Turkey Vulture	262 ± 71.7	267	+2	76 ± 17.6	73	-4
Osprey	75 ± 18.7	96	+29	18 ± 3.9	23	+24
Northern Harrier	156 ± 26.3	290	+86	26 ± 3.7	44	+69
Sharp-shinned Hawk	4496 ± 936.2	7232	+61	992 ± 172.9	1393	+40
Cooper's Hawk	3163 ± 748.4	3861	+22	747 ± 148.2	818	+9
Northern Goshawk	126 ± 25.2	96	-24	22 ± 4.2	14	-34
Unidentified accipiter	398 ± 92.1	126	-68	97 ± 22.0	27	-72
TOTAL ACCIPITERS	8184 ± 1640.1	11316	38	1858 ± 304.5	2253	21
Red-shouldered Hawk	0.3 ± 0.27	0	-100	0.1 ± 0.05	0	-100
Broad-winged Hawk	34 ± 21.2	52	+53	13 ± 6.9	18	+43
Swainson's Hawk	165 ± 56.2	269	+63	45 ± 15.9	70	+54
Red-tailed Hawk	2588 ± 295.5	3605	+39	458 ± 47.3	565	+23
Ferruginous Hawk	15 ± 3.1	21	+42	2.7 ± 0.55	3.5	+29
Rough-legged Hawk	11.8 ± 2.85	44.5	+276	2.1 ± 0.53	6.9	+225
Unidentified buteo	79 ± 27.8	20	-75	14 ± 5.3	3	-78
TOTAL BUTEOS	2894 ± 342.8	4011	39	535 ± 60.5	666	24
Golden Eagle	253 ± 19.2	297	+17	43 ± 3.6	44	+1
Bald Eagle	12 ± 3.0	24	+103	2.6 ± 0.63	4.3	+65
Unidentified eagle	1 ± 0.7	0	-100	0.2 ± 0.12	0.0	-100
TOTAL EAGLES	266 ± 20.9	321	21	46 ± 3.9	48	4
American Kestrel	1732 ± 381.2	2699	+56	390 ± 75.0	585	+50
Merlin	37 ± 15.0	68	+82	7.5 ± 2.97	11.9	+58
Prairie Falcon	30 ± 6.8	31	+4	5.0 ± 1.04	4.8	-5
Peregrine Falcon	9 ± 4.3	15	+72	1.6 ± 0.74	2.5	+60
Unidentified falcon	7 ± 1.8	6	-12	1.4 ± 0.39	1.0	-27
TOTAL FALCONS	1815 ± 400.0	2818	55	406 ± 78.2	605	49
Unidentified raptor	138 ± 62.3	52	-62	30 ± 15.0	9.1	-69
GRAND TOTAL	13789 ± 2327.1	19172	39	2995 ± 422.5	3718	24

[1] Mean ± 95% confidence interval.

Table 3. Adjusted counts by age class and immature : adult ratios for selected species: 1992–1998 versus 1999.

	Total and Age-classified Counts						% Unknown Age		Immature : Adult Ratio	
	1992–1998 Average			1999						
	Total	Imm	Adult	Total	Imm	Adult	1992–1998[1]	1999	1992–1998[1]	1999
Northern Harrier	199	65	51	290	104	101	43 ± 17.3	30	1.34 ± 0.417	1.03
Sharp-shinned Hawk	5456	2133	1591	7232	1960	2258	32 ± 5.8	42	1.30 ± 0.423	0.87
Cooper's Hawk	4179	1101	1118	3861	793	1249	47 ± 6.2	47	0.92 ± 0.474	0.63
Northern Goshawk[2]	126	61	39	96	63	23	21 ± 5.6	11	2.10 ± 0.800	2.74
Broad-winged Hawk	50	14	19	52	8	24	37 ± 11.1	38	0.73 ± 0.261	0.34
Red-tailed Hawk	2793	576	1498	3605	949	2127	25 ± 7.1	15	0.37 ± 0.082	0.45
Ferruginous Hawk	16	4	3	21	7	10	57 ± 13.1	18	1.59 ± 1.060	0.74
Golden Eagle[2]	253	123	78	297	194	58	20 ± 4.2	15	1.90 ± 0.495	3.32
Bald Eagle[3]	13	6	7	24	16	7	4 ± 5.2	7	0.96 ± 0.474	2.44
Peregrine Falcon	15	4	6	15	8	6	41 ± 19.4	7	0.65 ± 0.596	1.33

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

[2] Long-term averages based on data for 1983–1998.

[3] Based on unadjusted counts (see text for details).

Table 4. First and last observed, bulk-passage, and median-passage dates by species for 1999, with a comparison of 1999 and 1983–1998 average median passage dates.

	1999				1983–1998
Species	First Observed	Last Observed	Bulk Passage Dates[1]	Median Passage Date[2]	Median Passage Date[2, 3]
Turkey Vulture	4-Sep	22-Oct	18-Sep – 3-Oct	26-Sep	21-Sep ± 2.2
Osprey	22-Aug	31-Oct	31-Aug – 27-Sep	19-Sep	13-Sep ± 1.7
Northern Harrier	15-Aug	5-Nov	31-Aug – 27-Oct	10-Oct	24-Sep ± 3.4
Sharp-shinned Hawk	18-Aug	5-Nov	12-Sep – 21-Oct	4-Oct	24-Sep ± 2.3
Cooper's Hawk	15-Aug	3-Nov	12-Sep – 10-Oct	23-Sep	21-Sep ± 1.7
Northern Goshawk	20-Aug	5-Nov	6-Sep – 30-Oct	2-Oct	7-Oct ± 4.2
Broad-winged Hawk	9-Sep	4-Oct	16-Sep – 2-Oct	21-Sep	23-Sep ± 2.1
Swainson's Hawk	27-Aug	18-Oct	17-Sep – 5-Oct	30-Sep	17-Sep ± 3.5
Red-tailed Hawk	15-Aug	5-Nov	10-Sep – 30-Oct	12-Oct	3-Oct ± 3.0
Ferruginous Hawk	7-Sep	2-Nov	14-Sep – 25-Oct	9-Oct	26-Sep ± 2.3
Rough-legged Hawk	10-Oct	4-Nov	14-Oct – 1-Nov	21-Oct	22-Oct ± 2.1
Golden Eagle	17-Aug	5-Nov	15-Sep – 29-Oct	14-Oct	7-Oct ± 2.0
Bald Eagle	11-Sep	5-Nov	26-Sep – 4-Nov	21-Oct	21-Oct ± 4.9
American Kestrel	15-Aug	5-Nov	6-Sep – 9-Oct	20-Sep	15-Sep ± 2.0
Merlin	20-Aug	5-Nov	14-Sep – 23-Oct	4-Oct	1-Oct ± 2.9
Prairie Falcon	15-Aug	5-Nov	23-Aug – 1-Oct	18-Sep	12-Sep ± 3.4
Peregrine Falcon	23-Aug	18-Oct	28-Aug – 9-Oct	27-Sep	24-Sep ± 4.5
Total	15-Aug	5-Nov	9-Sep – 21-Oct	27-Sep	22-Sep ± 1.8

[1] Dates between which the central 80% of the flight passed the lookout (based on adjusted counts).

[2] Date by which 50% of the flight had passed the lookout (based on adjusted counts).

[3] Mean ± 95% confidence interval in days; calculated using only data for years when counts ≥5 birds.

Table 5. Median passage dates by age for selected species: 1992–1998 versus 1999 (based on adjusted counts).

	Adult		Immature / subadult	
Species	1992–1998[1]	1999	1992–1998[1]	1999
Northern Harrier	27-Sep ± 7.8	14-Oct	15-Sep ± 10.9	30-Sep
Sharp-shinned Hawk	6-Oct ± 2.5	10-Oct	15-Sep ± 2.6	16-Sep
Cooper's Hawk	24-Sep ± 3.3	2-Oct	17-Sep ± 2.4	18-Sep
Northern Goshawk	13-Oct ± 5.2	16-Oct	2-Oct ± 4.3	24-Sep
Broad-winged Hawk	23-Sep ± 3.5	22-Sep	24-Sep ± 6.1	20-Sep
Red-tailed Hawk	8-Oct ± 2.2	14-Oct	13-Sep ± 4.4	26-Sep
Ferruginous Hawk	–	19-Oct	5-Oct ± 20.8	27-Sep
Golden Eagle	11-Oct ± 3.3	20-Oct	6-Oct ± 3.5	10-Oct
Bald Eagle	25-Oct ± 2.5	21-Oct	24-Oct ± 6.4	23-Oct
Peregrine Falcon	30-Sep ± 2.4	27-Sep	22-Sep ± 7.9	24-Sep

Note: Median passage dates are dates by which 50% of the flight (based on adjusted counts) had passed the lookout; calculated only for species and years with counts ≥5 birds.

[1] Mean ± 95% confidence interval in days; calculated only for species with ≥3 years of counts ≥ 5 birds, except for Peregrine Falcons with suitable comparative data available only for 1996 and 1997.

Table 6. Capture totals, rates, and successes: 1992–1998 versus 1999.

	Capture Total		Capture Rate[1]		Capture Success (%)[2]	
Species	1992–1998[3]	1999	1992–1998[3]	1999	1992–1998[3]	1999
Northern Harrier	7 ± 4.4	0	0.3 ± 0.20	0.0	3.0 ± 1.83	0.0
Sharp-shinned Hawk	2015 ± 271.1	899	96.2 ± 14.53	95.8	35.1 ± 6.38	11.0
Cooper's Hawk	964 ± 216.3	441	45.9 ± 9.88	47.0	21.5 ± 4.96	10.6
Northern Goshawk	43 ± 23.7	21	2.0 ± 1.02	2.2	26.5 ± 6.33	20.4
Broad-winged Hawk	1 ± 0.9	0	0.05 ± 0.038	0.0	2.5 ± 2.43	0.0
Swainson's Hawk	0.4 ± 0.58	0	0.02 ± 0.029	0.0	0.2 ± 0.33	0.0
Red-tailed Hawk	89 ± 25.3	49	4.2 ± 0.98	5.2	2.5 ± 0.33	0.9
Golden Eagle	5 ± 2.2	8	0.2 ± 0.10	0.9	1.7 ± 0.62	2.3
American Kestrel	266 ± 60.0	97	12.5 ± 2.47	10.3	10.8 ± 2.99	3.3
Merlin	16 ± 4.7	16	0.7 ± 0.22	1.7	26.1 ± 7.35	21.6
Prairie Falcon	7 ± 3.7	3	0.3 ± 0.18	0.3	15.8 ± 7.78	9.1
Peregrine Falcon	1 ± 1.0	1	0.05 ± 0.050	0.1	7.2 ± 6.91	6.7
All Species	3414 ± 508.0	1535	162.6 ± 23.73	163.6	20.0 ± 3.45	7.1

[1] Captures / 100 station hours.

[2] Number of birds captured / number of birds observed (see text for details).

[3] Mean of annual values ± 95% confidence interval.

Table 7. Effort and capture results by station: 1999.

	NORTH			WEST			MEADOW		
Start date	23-Aug			21-Aug			31-Aug		
End date	3-Nov			2-Nov			24-Oct		
Trapping days	68			49			14		
Station hours	532.14			331.63			74.7		
	NUMBER	%	BIRDS / 100 HRS	NUMBER	%	BIRDS / 100 HRS	NUMBER	%	BIRDS / 100 HRS
Northern Harrier	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Sharp-shinned Hawk	559	55.1	105.0	312	67.4	94.1	28	49.1	37.5
Cooper's Hawk	320	31.5	60.1	106	22.9	32.0	15	26.3	20.1
Northern Goshawk	16	1.6	3.0	3	0.6	0.9	2	3.5	2.7
Broad-winged Hawk	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Swainson's Hawk	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Red-tailed Hawk	33	3.3	6.2	13	2.8	3.9	3	5.3	4.0
Golden Eagle	2	0.2	0.4	5	1.1	1.5	1	1.8	1.3
American Kestrel	69	6.8	13.0	21	4.5	6.3	7	12.3	9.4
Merlin	13	1.3	2.4	2	0.4	0.6	1	1.8	1.3
Prairie Falcon	2	0.2	0.4	1	0.2	0.3	0	0.0	0.0
Peregrine Falcon	1	0.1	0.2	0	0.0	0.0	0	0.0	0.0
All Species	1015		190.7	463		139.6	57		76.3

Table 8. Capture totals by sex and age for selected species: 1992–1998 versus 1999.

		Female			Male			Unknown		Female : Male	Immature : Adult
		AHY	HY	Unk.	AHY	HY	Unk.	AHY	HY	Ratio	Ratio
Sharp-shinned Hawk	1992–1998	340	632	–	281	761	–	–	–	0.94	2.30
	1999	253	193	–	209	244	–	–	–	0.98	0.95
Cooper's Hawk	1992–1998	312	254	–	166	233	–	–	–	1.43	1.05
	1999	163	76	–	122	80	–	–	–	1.18	0.55
Northern Goshawk	1992–1998	8	15	–	3	18	–	–	–	1.09	8.91
	1999	1	12	–	2	6	–	–	–	1.63	6.00
Red-tailed Hawk	1992–1998	–	–	–	–	–	–	11	78	–	9.01
	1999	–	–	–	–	–	–	6	43	–	7.17
Golden Eagle	1992–1998	0.3	2.1	–	0.7	2.0	–	–	–	0.84	3.57
	1999	1	2	–	0	5	–	–	–	0.60	7.00
American Kestrel	1992–1998	7	100	28	31	99	1	–	–	1.07	7.30
	1999	2	25	11	12	43	4	–	–	0.64	4.86
Merlin	1992–1998	2	8	–	1	5	–	–	–	2.62	6.13
	1999	1	5	–	5	5	–	–	–	0.60	1.67
Prairie Falcon	1992–1998	0	2	–	0	5	–	–	–	–	7.14
	1999	0	0	–	0	3	–	–	–	–	>3.00
Peregrine Falcon	1992–1998	0.3	0.3	–	0.1	0.3	–	–	–	–	0.75
	1999	0	0	–	0	1	–	–	–	–	>1.00

Table 9. Median capture dates for selected species by sex–age classes: 1992–1998 versus 1999.

		ADULT		IMMATURE	
SPECIES	SEX	1992–1998[1]	1999	1992–1998[1]	1999
Sharp-shinned Hawk	Female	29-Sep ± 1.0	21-Sep	10-Sep ± 1.3	10-Sep
	Male	5-Oct ± 1.8	29-Sep	14-Sep ± 1.9	12-Sep
Cooper's Hawk	Female	20-Sep ± 2.5	13-Sep	14-Sep ± 2.9	25-Sep
	Male	25-Sep ± 2.6	18-Sep	20-Sep ± 2.7	13-Sep
Northern Goshawk	Female	14-Oct ± 12.2	–	13-Sep ± 7.7	19-Sep
	Male	–	–	1-Oct ± 4.8	28-Sep
American Kestrel	Female	–	–	2-Sep ± 2.6	2-Sep
	Male	15-Sep ± 32.6	–	11-Sep ± 5.1	25-Aug

Note: Median capture dates are dates by which 50% of the annual total was captured; computed based only on data for years when species-specific annual capture totals equaled or exceeded 5 birds.

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

Table 10. Measures of body condition for selected species: 1994–1998 versus 1999.

		Crop[1]					Keel[2]			Wing-pit Fat[3]			
		Empty	1/4	1/2	3/4	Full	0	1	2	0	1	2	3
Sharp-shinned Hawk	1994-1998	61.4	14.2	12.3	5.3	6.8	6.9	74.9	18.2	9.5	56.9	27.1	6.5
	1999	63.7	14.1	8.1	5.1	8.9	1.0	69.0	30.1	8.6	57.9	29.8	3.7
Cooper's Hawk	1994-1998	72.7	7.9	7.7	5.1	6.6	21.6	68.4	10.1	12.3	51.9	26.5	9.3
	1999	75.4	9.1	7.8	4.9	2.8	4.9	74.5	20.6	17.8	51.8	21.9	8.5
Northern Goshawk	1994-1998	88.3	5.7	4.8	1.2	0.0	17.3	73.4	9.2	9.8	54.9	32.2	3.1
	1999	85.7	4.8	0.0	4.8	4.8	4.8	76.2	19.0	19.0	47.6	28.6	4.8
Red-tailed Hawk	1994-1998	92.2	2.6	1.5	1.5	2.2	24.6	68.0	7.3	35.8	49.1	13.9	1.2
	1999	95.8	0.0	2.1	2.1	0.0	2.1	66.7	31.3	31.3	43.8	16.7	8.3
Golden Eagle	1994-1998	94.3	5.7	0.0	0.0	0.0	19.4	61.8	18.8	39.4	40.9	15.7	4.0
	1999	100.0	0.0	0.0	0.0	0.0	25.0	62.5	12.5	37.5	37.5	25.0	0.0
American Kestrel	1994-1998	97.3	1.9	0.3	0.0	0.4	15.8	68.8	15.4	15.2	46.8	31.4	6.6
	1999	88.9	10.0	1.1	0.0	0.0	2.2	76.7	21.1	20.2	52.8	23.6	3.4
Merlin	1994-1998	79.6	9.9	6.2	1.7	2.7	12.5	76.5	11.0	4.0	42.9	51.2	1.9
	1999	68.8	18.8	6.3	6.3	0.0	6.3	68.8	25.0	12.5	43.8	37.5	6.3
Prairie Falcon	1994-1998	97.1	2.9	0.0	0.0	0.0	35.9	50.5	13.6	29.9	53.0	17.1	0.0
	1999	100.0	0.0	0.0	0.0	0.0	33.3	66.7	0.0	0.0	0.0	100.0	0.0
Peregrine Falcon	1994-1998	58.3	33.3	8.3	0.0	0.0	33.3	50.0	16.7	66.7	16.7	16.7	0.0
	1999	100.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0

[1] Subjective assessment of the degree to which the crop (esophagus) is filled with food. Values are percentages of birds in each category.

[2] Subjective assessment of muscle mass along keel: 0 = skinny, 1 = normal, 2 = heavy. Values are percentages of birds in each category.

[3] Subjective assessment of fat storage in wing-pit area: 0 = none, 1 = light, 2 = moderate; 3 = heavy. Values are percentages of birds in each category.

Table 11. Morph-specific counts and light : dark morph ratios (based on unadjusted counts) for selected buteos: 1992–1998 versus 1999.

	Total and Morph-classified Counts						% Unknown Morph		Light : Dark Ratio	
	1992–1998 Average			1999						
	Total	Light	Dark	Total	Light	Dark	1992–1998[1]	1999	1992–1998[1]	1999
Broad-winged Hawk	51	39	2	59	41	0	33 ± 12.9	31	19.8 ± 5.91	≥41
Swainson's Hawk	292	148	33	334	160	59	39 ± 8.5	34	4.2 ± 0.81	2.7
Red-tailed Hawk	3399	2086	339	5183	4226	391	28 ± 5.4	11	6.4 ± 0.95	10.8
Ferruginous Hawk	19	9	2	25	19	3	39 ± 10.2	12	3.2 ± 0.74	6.3
Rough-legged Hawk	12	4	1	50	46	2	52 ± 15.2	4	3.9 ± 1.68	23.0

[1] Mean ± 95% confidence interval. For morph ratios, note that long-term mean light : dark ratios are averages of annual ratios and may differ from values obtained by dividing average numbers of light and dark morphs. Discrepancies in the two values reflect high annual variability in the observed morph ratio.

Table 12. Recaptures of previously banded birds in the Goshute Mountains during 1999.

Species	Sex	Band #	Banding Site	Banding Date	Banding Age	Recapture Date	Recapture Age	Distance (km)
RECAPTURES								
Cooper's Hawk	M	0804 – 04205	Goshute Mts., NV	10/9/98	HY	10-Oct-99	SY	–
Cooper's Hawk	F	0745 – 96261	Goshute Mts., NV	9/28/95	SY	15-Oct-99	6th yr	–
Sharp-shinned Hawk	F	1523 – 72148	Goshute Mts., NV	9/5/98	HY	12-Sep-99	SY	–
Sharp-shinned Hawk	F	1523 – 72116	Goshute Mts., NV	9/2/98	HY	23-Sep-99	SY	–
FOREIGN RECAPTURES								
Cooper's Hawk	F	0745 – 17741	Squaw Peak, UT	9/23/98	HY	18-Sep-99	SY	294
Northern Goshawk	F	1807 – 70441	Independence Mts., NV	6/21/99	L	13-Sep-99	HY	206

Table 13. Foreign encounters during 1999 and winter 2000 with birds banded in the Goshute Mountains.

Species	Sex	Band #	Banding date	Banding age	Encounter Date	Encounter Age	Encounter Location	Distance (km)	Status
CH	M	1204 – 56397	14-Sep-98	HY	13-Apr-99	SY	Alamos, Sonora, MX	1348.56	window kill
SS	F	1523 – 72490	15-Sep-98	HY	12-May-99	SY	Philipsburg, MT, USA	541.89	found dead
SS	F	1523 – 72146	05-Sep-98	HY	14-May-99	SY	Clearwater, BC, CAN	1203.10	collision kill
SS	F	1523 – 72486	15-Sep-98	SY	17-May-99	TY	Deer Lodge, MT, USA	563.66	window kill
SS	F	2003 – 65036	16-Sep-94	HY	06-Jun-99	6^{th} yr	Tulameen, BC, CAN	1089.79	found dead
RT	U	1177 – 06656	06-Sep-99	HY	Sep-99	HY	Albion, ID, USA	217.71	collision/died later
SS	F	2003 – 93197	06-Oct-96	SY	15-Sep-99	5^{th} yr	Spokin Lake, BC, CAN	1428.49	collision kill
SS	M	0952 – 87879	11-Sep-96	HY	11-Oct-99	4^{th} yr	Sierra Vista, AZ, USA	915.72	found dead
CH	F	1005 – 01701	21-Sep-99	HY	Dec-99	HY	Gaudalajara, Jalisco, MX	2462.32	found dead
CH	M	1204 – 56477	03-Oct-97	AHY	22-Dec-99	$\geq 4^{th}$ yr	Nuevo Vallarta, Nayarit, MX	1960.41	captured/released
CH	F	1705 – 40461	19-Sep-98	HY	20-Jan-00	TY	Brewster, WA, USA	927.06	car kill
SS	F	1523 – 88727	20-Sep-99	HY	23-Jan-00	SY	Artesia, NM, USA	1255.24	found dead
SS	F	2003 – 76077	30-Sep-96	AHY	02-Mar-00	$\geq 6^{th}$ yr	Yuma, AZ, USA	888.24	found dead
CH	F	1705 – 28583	18-Aug-97	ASY	14-Mar-00	$\geq 5^{th}$ yr	Tecoman, Colima, MX	2640.83	shot
RT	U	1177 – 02004	24-Sep-98	HY	22-Mar-00	TY	Payson, UT, USA	241.33	found dead
SS	F	1523 – 51120	06-Oct-97	ASY	05-May-00	$\geq 5^{th}$ yr	Rutland, BC, CAN	1087.56	found dead
CH	F	0745 – 61912	02-Oct-98	SY	05-May-00	4^{th} yr	Sandpoint, ID, USA	878.12	found dead
RT	U	1177 – 06606	09-Oct-99	HY	14-May-00	SY	Carmangay, AB, CAN	1080.28	found dead
SS	F	1523 – 88990	18-Sep-99	HY	21-May-00	SY	Silverdale, WA, USA	1013.30	collision kill

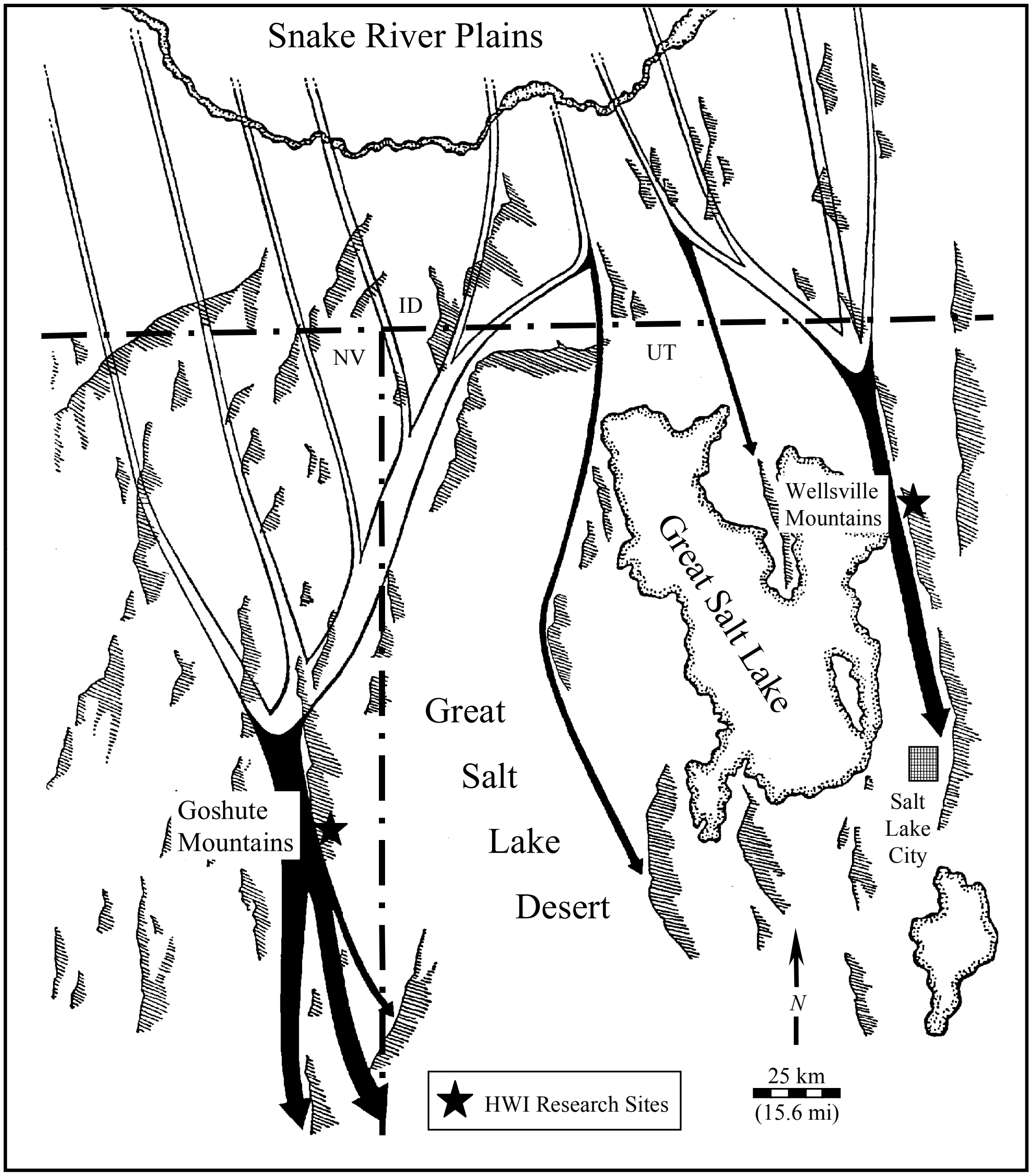

Figure 1. Map showing location of the Goshute Mountains in relation to regional raptor flyways.

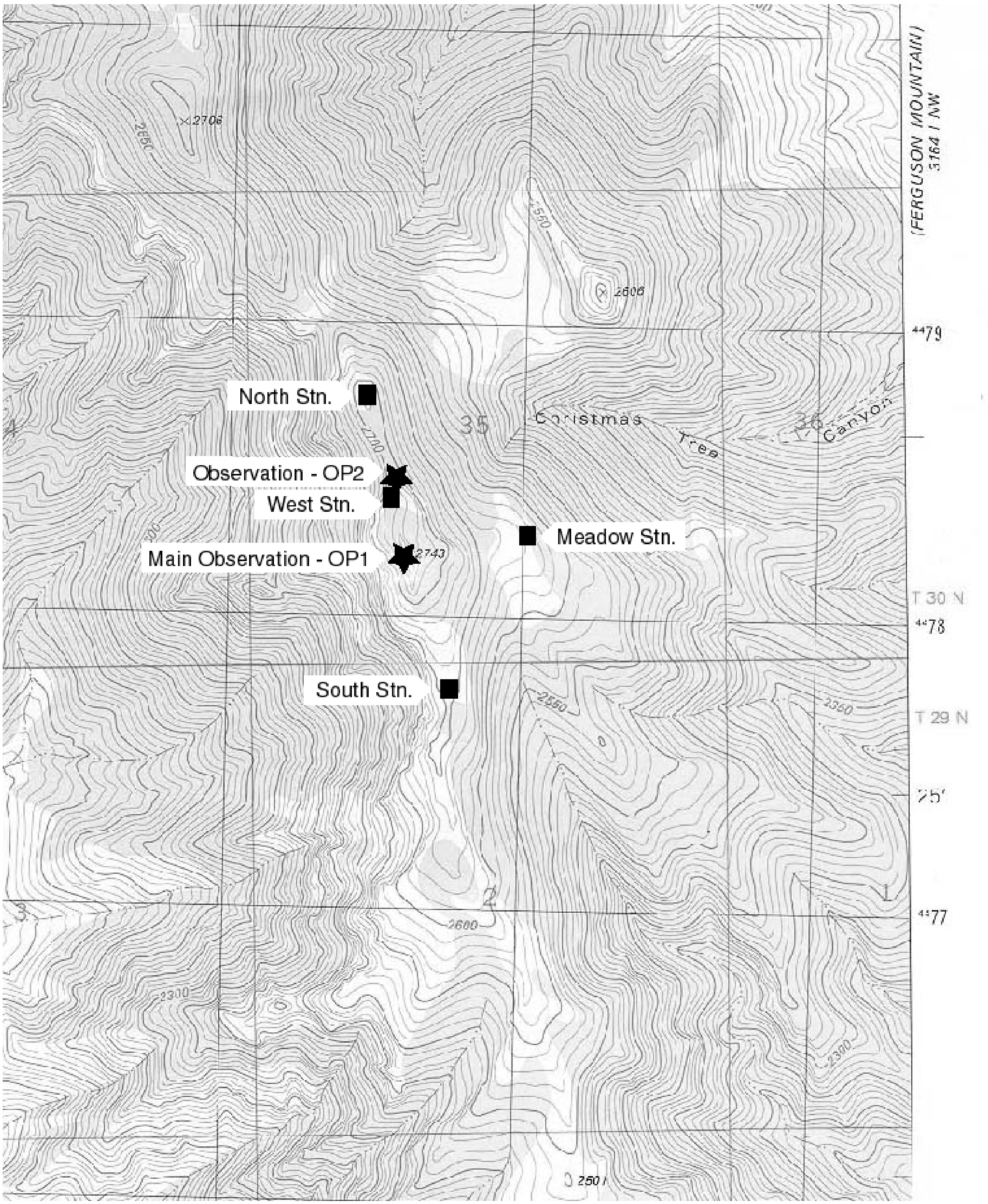

Figure 2. Topographic map of the Goshute Mountains showing locations of the primary and secondary observation posts and banding stations.

Figure 3. Combined-species, adjusted annual passage rates: 1983–1999.

Figure 4. Flight composition by major species groups: 1983–1998 versus 1999.

Figure 5. Combined-species daily flight rhythm: 1983–1998 versus 1999.

Figure 6. Combined-species passage volume by 5-day periods: 1983–1998 versus 1999.

Figure 7. Combined-species capture rate: 1992–1999.

Figure 8. Combined-species annual capture totals by hourly periods of the day: 1999.

Figure 9. Combined-species capture rates by five-day periods: 1999.

Figure 10. Adjusted annual passage rates for Turkey Vultures, Ospreys, and Northern Harriers: 1983–1999.

Figure 11. Passage volume by 5-day periods for Turkey Vultures, Ospreys, and Northern Harriers: 1983–1998 versus 1999.

Figure 12. Adjusted annual passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks: 1983–1999.

Figure 13. Passage volume by 5-day periods for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks: 1983–1998 versus 1999.

Figure 14. Adjusted annual passage rates for Broad-winged and Swainson's Hawks: 1983–1999.

Figure 15. Passage volume by 5-day periods for Broad-winged and Swainson's Hawks: 1983–1998 versus 1999.

Figure 16. Adjusted annual passage rates for Red-tailed Hawks, Ferruginous Hawks, and Rough-legged Hawks: 1983–1999.

Figure 17. Passage volume by 5-day periods for Red-tailed Hawks, Ferruginous Hawks, and Rough-legged Hawks: 1983–1998 versus 1999.

Figure 18. Adjusted annual passage rates for Golden Eagles and Bald Eagles: 1983–1999.

Figure 19. Passage volume by 5-day periods for Golden and Bald Eagles: 1983–1998 versus 1999.

Figure 20. Adjusted annual passage rates for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons: 1983–1999.

Figure 21. Passage volume by 5-day periods for American Kestrels and Merlins: 1983–1998 versus 1999.

Figure 22. Passage volume by 5-day periods for Prairie Falcons and Peregrine Falcons: 1983–1998 versus 1999.

Appendix A. History of observer participation.

1983: Single observer throughout. David Sherman (0)[1].

1984: Single observer throughout and an occasional scribe. Three principal observers: Jim Daly (0), Jeff Smith (0), and Fred Tilly (14).

1985: Single observer throughout with an occasional scribe. Two principal observers: Jim Daly (1) and Fred Tilly (15).

1986: Single observer with an occasional scribe. Principal observer: John Lower (0).

1987: Single observer throughout, two observers during the peak month. Two principal observers: Victor Fazio (2) and Fred Tilly (16).

1988: Single observer throughout, two observers during the peak month, with a scribe throughout. Two principal observers: Brian Mongi (2) and Fred Tilly (17).

1989: Single observer throughout, two observers during the peak month, with a scribe throughout. Brian Mongi (3) and Fred Tilly (19).

1990: Two observers throughout with two teams of two for a comparison count during the peak month. Four principal observers: John Martin (1), LisaBeth Daly (2), Fred Tilly (21), and Cathy Tilly (1).

1991: Two observers throughout except 30 October - 5 November, with a scribe throughout. Principal observers: Steve Engel (1) and Dale Payne (0).

1992: Two observers throughout, three observers during the peak month, with a scribe throughout. Three principal observers: Steve Engel (2), Maureen O'Mara (0), and Fred Tilly (24).

1993: Two observers throughout with a scribe throughout. Principal observers: Emily Teachout (1) and Jeff Maurer (0).

1994: Two observers throughout, three observers during the peak month, with a scribe throughout. Principal observers: Steve Engel (3), Jeff Maurer (1), and Fred Tilly (27).

1995: Two observers throughout with a scribe through 17 October. Principal observers: Robert Clemens (3) and Susan Salafsky (2).

1996: Two observer throughout except 27 October- 4 November, three observers for the peak month with a scribe until 27 October. Principal observers: Fred Tilly (29), Cathy Tilly (4), Robert Clemens (4), and Aaron Barna (1).

1997: Two observers throughout with a scribe from 10 September - 15 October. Principal observers: Jessie Jewell (9) and Neils Maumenee (2).

1998: Two observers throughout. Principal observers: Jerry Liguori (14) and Mike Lanzone (0).

1999: Two observers throughout. Principal observers: Jerry Liguori (15) and Aaron Barna (4).

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[1] Numbers in parentheses indicate the number of years of previous experience conducting season-long migratory raptor counts.

Appendix B. Daily observation effort, weather, and flight summaries: 1999.

Date	Obs. Hours	Obsrvr / Hour	Visitor / Hour	Predominant Weather[1]	Wind Speed[2]	Wind Direction	Temp (°C)[3]	Thermal Lift[4]	Visibility E / W (km)	Flight Distance[5]	Birds / Hour
15-Aug	7.17	2.0	1.0	clr	1	var, ne	22.9	2	101 / 91	2	5.4
16-Aug	7.08	2.0	0.5	clr	1	sw, var	24.3	2	109 / 93	2	1.4
17-Aug	7.00	2.0	0.8	clr-mc	2	sw, ene	24.7	2	120 / 94	2	3.1
18-Aug	9.00	4.7	0.0	mc-ovc	1	sw, var, ne	23.0	3	115 / 96	2	4.1
19-Aug	7.00	5.7	0.0	pc-ovc	2	wsw, var	20.1	3	99 / 95	1	2.6
20-Aug	3.75	7.0	0.0	clr-ovc/ts	2	sw, ne	23.6	1	96 / 86	2	9.9
21-Aug	9.50	4.0	0.2	clr-ovc	2	w, ne	21.1	2	97 / 99	2	3.2
22-Aug	8.50	2.8	0.1	clr-ovc	2	ne	23.3	3	106 / 95	2	14.6
23-Aug	9.50	1.9	0.0	clr-pc	2	s-sw, ne	22.8	3	103 / 100	2	7.9
24-Aug	7.50	1.8	0.9	pc-ovc, haze AM, ts PM	1	nne-ne	21.8	3	82 / 88	2	3.2
25-Aug	4.50	2.8	0.0	clr-ovc, haze	1	sw-nw	18.1	3	71 / 62	2	2.9
26-Aug	0.00										
27-Aug	4.50	1.9	0.0	pc-ovc, ts PM	4	sw	17.9	4	102 / 77	2	3.6
28-Aug	8.50	2.9	0.0	mc-ovc, brief ts	2	sw-wsw	17.7	3	96 / 83	2	5.6
29-Aug	9.83	2.5	0.4	clr	1	sw-wsw, ne	19.6	2	88 / 90	2	9.0
30-Aug	7.50	3.2	0.0	pc-ovc, ts late AM	6	sw-wsw	15.7	4	75 / 54	3	3.2
31-Aug	8.50	3.0	0.0	clr, haze AM	2	ne	9.3	4	57 / 56	2	6.1
1-Sep	8.00	2.5	0.0	clr/haze, ovc/rain	1	var, sw-nw	11.1	3	59 / 69	2	5.3
2-Sep	9.00	3.3	0.0	ovc, rain PM	2	ne, sw	10.5	4	70 / 75	2	10.2
3-Sep	9.00	3.2	0.0	pc-ovc	4	sw	9.2	4	93 / 96	3	8.4
4-Sep	8.75	2.1	0.0	clr	2	ne-e	10.4	3	100 / 100	1	1.7
5-Sep	8.50	2.7	0.0	clr	1	sw	16.6	3	100 / 100	2	12.6
6-Sep	10.75	3.0	0.2	clr	5	w	15.5	4	71 / 73	2	27.6
7-Sep	9.25	3.6	0.0	clr	2	w, e	13.8	3	72 / 72	2	31.0
8-Sep	9.75	2.2	0.0	clr	1	var, sw, e	15.7	2	66 / 66	2	26.9
9-Sep	9.50	2.7	0.2	pc-ovc	2	sw, e, sw	16.5	3	97 / 97	2	20.5
10-Sep	8.75	2.8	0.0	ovc, haze AM	2	wsw, ne-e	14.8	4	55 / 53	3	17.7
11-Sep	10.25	2.9	8.4	clr	1	ne, e	13.5	3	88 / 88	2	48.5
12-Sep	10.00	2.4	1.7	clr	2	sw, e	14.5	2	100 / 100	3	47.3
13-Sep	8.50	3.1	0.0	clr-ovc/ts	3	sw, var	16.1	4	108 / 91	2	45.5
14-Sep	9.50	2.9	0.0	ovc-pc	2	ne	13.2	4	100 / 100	3	24.0
15-Sep	10.00	3.0	0.0	clr	3	e-ene	15.4	3	100 / 100	3	50.8
16-Sep	10.50	3.0	0.0	pc-ovc	2	sw, e-ene	14.3	3	100 / 100	3	40.8
17-Sep	9.00	3.2	0.2	pc-ovc/ts	2	w, var	13.2	3	106 / 90	3	30.9
18-Sep	10.50	2.0	6.8	pc-ovc, brief rain	2	ne, w-wsw	14.8	4	103 / 95	2	47.7
19-Sep	8.00	2.7	4.9	ovc, scat rain	3	w	12.0	4	77 / 90	2	87.9
20-Sep	9.00	3.0	0.8	clr-mc, rain PM	2	sw, ne	10.7	3	95 / 86	2	48.0
21-Sep	10.00	2.3	3.3	clr-mc	1	sw-w, ne	14.4	3	102 / 92	3	45.8
22-Sep	11.00	1.9	4.8	mc-ovc	3	sw, ne	13.1	3	100 / 100	3	67.5
23-Sep	9.50	2.6	0.2	clr-ovc, rain PM	1	ne	13.8	2	100 / 95	3	91.7
24-Sep	11.00	2.0	6.3	mc	5	w	14.5	4	88 / 100	3	76.8
25-Sep	11.00	1.8	0.0	clr	7	sw-wsw	14.6	4	88 / 100	3	31.6
26-Sep	10.50	2.5	1.0	clr-mc	4	sw-w	9.2	4	103 / 94	2	34.5
27-Sep	11.00	3.5	0.3	clr	4	sw-w	2.6	4	109 / 100	2	37.1
28-Sep	9.50	4.0	2.0	clr	2	ne-ene, wsw	0.1	4	105 / 100	2	13.4
29-Sep	11.50	2.5	2.4	clr-pc	4	sw	9.1	3	100 / 100	3	13.2
30-Sep	10.00	2.5	1.8	dust/haze	3	wsw	11.0	3	38 / 33	2	46.4
1-Oct	10.50	2.9	0.9	ovc-pc, haze AM	3	sw, e-ene	11.4	3	75 / 80	3	35.4
2-Oct	11.00	1.9	0.2	clr	4	sw-w	10.4	4	100 / 100	3	33.4
3-Oct	10.00	3.8	1.6	clr, haze AM	1	ssw-w, ne	8.9	3	106 / 92	3	86.7
4-Oct	9.50	4.2	1.3	clr/haze	2	sw, se	12.4	4	67 / 67	2	47.7

Appendix B. continued

DATE	OBS. HOURS	OBSRVR / HOUR	VISITOR / HOUR	PREDOMINANT WEATHER[1]	WIND SPEED[2]	WIND DIRECTION	TEMP (°C)[3]	THERMAL LIFT[4]	VISIBILITY E / W (KM)	FLIGHT DISTANCE[5]	BIRDS / HOUR
5-Oct	10.00	2.4	0.0	clr-mc, haze AM	3	sw-wsw	13.3	4	86 / 84	2	91.4
6-Oct	6.75	2.0	0.3	ovc, ts PM	3	sw	7.5	4	80 / 71	2	6.5
7-Oct	8.00	2.2	0.0	clr	1	var	4.2	3	89 / 88	2	3.5
8-Oct	10.50	3.9	0.8	clr	1	ene, var	7.0	3	100 / 100	3	40.6
9-Oct	11.00	2.0	8.3	clr	4	wnw, sw	13.5	4	100 / 100	3	51.7
10-Oct	10.75	1.9	3.8	clr	3	sw	15.1	4	100 / 100	2	98.3
11-Oct	10.75	2.8	0.0	clr	5	w	13.1	4	100 / 100	3	57.8
12-Oct	10.50	2.8	0.0	pc-mc	2	sw-nw	14.7	3	93 / 90	3	34.4
13-Oct	10.75	2.8	0.8	clr	4	sw	11.9	4	50 / 90	2	48.8
14-Oct	10.50	2.3	0.0	clr-ovc	4	wsw-w	12.5	4	93 / 98	2	37.7
15-Oct	10.50	2.8	1.8	clr	4	sw-wsw	5.5	4	100 / 97	3	26.7
16-Oct	9.50	3.0	2.6	clr	2	nne-ene	-3.5	4	107 / 97	3	17.9
17-Oct	9.50	2.3	0.6	clr-pc	2	ne, sw-w	2.7	4	105 / 98	2	19.1
18-Oct	10.50	2.1	0.0	clr-ovc	2	nw	6.1	3	100 / 100	3	19.0
19-Oct	10.00	2.9	0.0	clr-pc	1	var, sw	4.5	3	103 / 97	2	34.7
20-Oct	9.50	3.0	0.0	clr	1	var, sw	8.5	3	115 / 98	3	27.8
21-Oct	8.50	3.8	0.0	clr	1	ne	10.8	3	110 / 100	3	25.9
22-Oct	8.50	2.0	0.0	clr	1	ne	7.4	4	90 / 100	3	14.9
23-Oct	9.50	2.9	4.1	mc-ovc	3	w	10.8	3	110 / 100	2	16.9
24-Oct	9.00	2.6	0.0	clr-mc	1	sw	11.3	3	100 / 100	3	14.0
25-Oct	9.50	2.0	0.0	clr-pc	1	w-sw	10.1	2	100 / 100	3	39.6
26-Oct	9.00	2.0	0.0	clr-pc	2	sw	12.9	3	100 / 100	2	41.2
27-Oct	9.00	2.9	0.0	clr-ovc, haze AM	2	sw	8.5	4	63 / 97	2	27.4
28-Oct	6.50	2.4	0.0	mc-ovc	6	sw	5.7	4	51 / 35	3	13.1
29-Oct	8.25	3.0	0.0	clr	1	var, sw	-1.4	3	100 / 120	2	4.4
30-Oct	8.50	2.0	0.0	clr	5	w		4	100 / 100	3	15.8
31-Oct	9.00	2.0	0.0	clr	3	sw	10.6	4	100 / 100	2	10.7
1-Nov	7.50	2.0	0.8	clr	1	ne	3.2	2	100 / 100	3	18.8
2-Nov	9.50	1.5	0.0	clr	4	sw	4.9	4	100 / 100	2	5.3
3-Nov	8.00	2.3	0.1	pc-ovc	3	sw	9.7	4	100 / 100	2	6.1
4-Nov	8.50	2.0	0.0	clr	5	sw	7.6	4	100 / 100	2	23.8
5-Nov	8.50	2.0	0.0	clr	4	sw	10.1	4	100 / 100	2	24.2

[1] Predominant weather codes: clr = clear, ovc = overcast; mc = mostly cloudy; pc = partly cloudy; ts = thundershowers.

[2] Average wind speeds: 0 = <1 kph; 1 = 1–5 kph; 2 = 6–11 kph; 3 = 12–19 kph; 4 = 20–28 kph; 5 = 29–38 kph; 6 = 39–49 kph; 7 = 50–61 kph.

[3] Average of hourly readings.

[4] Average thermal lift conditions: 1 = excellent – sunny and little or no wind; 2 = good – sunny and light to moderate winds; 3 = fair – sunny but windy; 4 = poor – cloudy and windy.

[5] Average flight distances: 1 = close – birds identifiable with naked eye; 2 = moderate – birds easily seen with naked eye but binoculars required for identification; 3 = far – binoculars required for sighting and identification; 4 = distant - birds seen only as small dots in binoculars.

Appendix C. Common and scientific names, species codes, and regularly applied age, sex, and color-morph classifications for all raptor species observed during migration in the Goshute Mountains.

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 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	A 2 1 I/S U[4]	U	NA
Bald Eagle	*Haliaeetus leucocephalus*	BE	A 3 2 1 I/S 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	M U	NA
Prairie Falcon	*Falco mexicanus*	PR	U	U	NA
Peregrine Falcon	*Falco peregrinus*	PG	U	U	NA
Unknown falcon	*Falco* spp.	UF	U	U	NA
Unknown raptor	Falconiformes	UU	U	U	NA

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

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

[3] Color morph classification codes: D = dark or rufous, L = light, U – unknown, NA = not applicable.

[4] Golden Eagle age codes: A = adult - no white in wings or tail; 2 = plumage class 2 - no white patch in wings, obvious white in tail; 1 = plumage class 1- white wing patch visible below, small wing patch may be visible above, bold white in tail; I/S = unknown age immature or subadult - obvious white in tail, wings not adequately observed

[5] Bald Eagle age codes: A = adult - completely white head and tail; 3 = plumage class 3 -head mostly white, with osprey-like dark eyeline; 2 = plumage class 2 - dark head, light belly, and/or upside-down white triangle on back; 1 = plumage class 1 - dark head, breast, and belly; I/S = unknown age immature or subadult - dark or mottled head, other plumage features not adequately observed.

Appendix D. Daily records of unadjusted raptor counts: 1999.

Date	Hours	TV	OS	NH	SS	CH	NG	UA	BW	SW	RT	FH	RL	UB	GE	BE	AK	ML	PR	PG	UF	UU	Total	Birds/hr
15-Aug	7.17	0	0	1	0	2	0	0	0	0	25	0	0	1	0	0	9	0	1	0	0	0	39	5.4
16-Aug	7.08	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	2	0	0	0	0	0	10	1.4
17-Aug	7.00	0	0	0	0	1	0	0	0	0	16	0	0	0	2	0	3	0	0	0	0	0	22	3.1
18-Aug	9.00	0	0	3	1	1	0	0	0	0	22	0	0	0	1	0	8	0	1	0	0	0	37	4.1
19-Aug	7.00	0	0	0	1	0	0	0	0	0	14	0	0	0	1	0	2	0	0	0	0	0	18	2.6
20-Aug	3.75	0	0	2	0	1	1	0	0	0	19	0	0	0	2	0	11	1	0	0	0	0	37	9.9
21-Aug	9.50	0	0	7	0	1	0	0	0	0	17	0	0	0	2	0	3	0	0	0	0	0	30	3.2
22-Aug	8.50	0	1	7	2	4	1	0	0	0	65	0	0	0	3	0	38	0	2	0	0	1	124	14.6
23-Aug	9.50	0	0	8	2	2	0	0	0	0	37	0	0	0	0	0	22	1	1	1	0	1	75	7.9
24-Aug	7.50	0	0	0	2	3	2	0	0	0	2	0	0	0	0	0	12	1	1	0	0	1	24	3.2
25-Aug	4.50	0	0	0	3	3	0	0	0	0	4	0	0	0	0	0	3	0	0	0	0	0	13	2.9
26-Aug	0.00																							
27-Aug	4.50	0	0	1	0	3	0	0	0	1	10	0	0	0	0	0	0	0	1	0	0	0	16	3.6
28-Aug	8.50	0	3	0	6	6	1	0	0	0	21	0	0	0	1	0	9	0	0	1	0	0	48	5.6
29-Aug	9.83	0	4	4	1	3	1	0	0	1	26	0	0	0	2	0	46	0	0	0	0	0	88	9.0
30-Aug	7.50	0	2	1	0	2	0	0	0	2	11	0	0	0	0	0	5	0	0	0	1	0	24	3.2
31-Aug	8.50	0	3	3	4	10	1	1	0	0	9	0	0	0	1	0	20	0	0	0	0	0	52	6.1
1-Sep	8.00	0	2	2	7	6	0	0	0	0	15	0	0	0	0	0	10	0	0	0	0	0	42	5.3
2-Sep	9.00	0	0	0	9	21	0	1	0	1	35	0	0	0	1	0	24	0	0	0	0	0	92	10.2
3-Sep	9.00	0	0	4	24	9	1	0	0	0	28	0	0	0	0	0	9	0	1	0	0	0	76	8.4
4-Sep	8.75	1	0	1	6	1	0	0	0	0	3	0	0	0	0	0	3	0	0	0	0	0	15	1.7
5-Sep	8.50	0	1	2	37	14	1	2	0	0	14	0	0	0	2	0	34	0	0	0	0	0	107	12.6
6-Sep	10.75	0	3	4	44	16	1	0	0	2	41	0	0	0	0	0	177	3	4	0	0	2	297	27.6
7-Sep	9.25	2	2	2	67	30	1	0	0	4	34	1	0	1	4	0	139	0	0	0	0	0	287	31.0
8-Sep	9.75	1	3	1	94	51	2	0	0	1	27	0	0	0	2	0	80	0	0	0	0	0	262	26.9
9-Sep	9.50	0	2	2	95	52	1	1	1	1	13	0	0	0	2	0	24	0	1	0	0	0	195	20.5
10-Sep	8.75	0	1	2	80	23	2	1	0	2	19	0	0	1	0	0	23	0	0	0	0	1	155	17.7
11-Sep	10.25	5	6	7	188	57	3	2	0	5	71	0	0	1	2	1	145	0	1	0	1	2	497	48.5
12-Sep	10.00	0	4	2	195	105	0	4	0	1	74	0	0	0	3	0	83	1	1	0	0	0	473	47.3
13-Sep	8.50	0	1	3	185	120	1	1	1	1	30	1	0	0	0	0	43	0	0	0	0	0	387	45.5
14-Sep	9.50	0	2	2	70	63	0	1	1	1	54	1	0	0	3	0	27	2	1	0	0	0	228	24.0
15-Sep	10.00	3	1	5	209	148	4	7	1	2	53	0	0	0	3	0	70	0	0	0	0	2	508	50.8
16-Sep	10.50	3	4	5	159	114	3	5	5	0	62	0	0	1	1	0	60	2	0	1	0	3	428	40.8
17-Sep	9.00	11	3	0	78	68	1	0	1	12	43	0	0	2	4	0	53	0	0	0	1	1	278	30.9
18-Sep	10.50	9	4	5	215	147	1	0	5	3	24	0	0	0	2	0	80	3	2	0	0	1	501	47.7
19-Sep	8.00	10	6	4	235	160	2	8	2	13	41	0	0	0	2	0	211	5	1	0	0	3	703	87.9
20-Sep	9.00	0	8	3	150	124	0	9	11	16	70	0	0	2	1	0	34	2	0	0	0	2	432	48.0
21-Sep	10.00	10	7	1	157	131	2	10	3	4	65	0	0	2	2	0	62	0	2	0	0	0	458	45.8
22-Sep	11.00	28	10	9	176	336	1	11	9	12	98	1	0	1	6	0	41	1	0	2	0	1	743	67.5
23-Sep	9.50	33	6	8	306	302	2	5	7	10	83	1	0	0	1	0	101	1	1	0	1	3	871	91.7
24-Sep	11.00	2	2	5	257	236	4	4	4	11	44	0	0	0	7	1	259	5	0	1	0	3	845	76.8
25-Sep	11.00	13	2	4	71	63	3	2	0	4	26	0	0	0	7	0	147	1	3	1	0	1	348	31.6
26-Sep	10.50	94	0	7	32	40	0	3	0	26	122	0	0	3	1	1	31	0	0	0	0	2	362	34.5
27-Sep	11.00	33	7	2	66	86	0	6	0	16	159	2	0	0	1	0	24	2	0	2	0	2	408	37.1

28-Sep	9.50	1	1	0	46	29	2	1	0	7	34	0	0	0	1	0	4	0	0	0	0	1	127	13.4

Appendix D. continued

Date	Hours	TV	OS	NH	SS	CH	NG	UA	BW	SW	RT	FH	RL	UB	GE	BE	AK	ML	PR	PG	UF	UU	Total	Birds/hr
29-Sep	11.50	10	0	1	38	45	1	1	1	5	32	0	0	0	4	0	12	0	1	0	0	1	152	13.2
30-Sep	10.00	31	2	5	142	105	3	3	0	1	67	0	0	0	6	0	90	3	1	1	2	2	464	46.4
1-Oct	10.50	10	0	4	69	59	0	2	0	18	87	1	0	0	7	0	108	2	2	0	0	3	372	35.4
2-Oct	11.00	6	1	2	121	91	1	4	2	15	61	0	0	0	7	0	54	0	0	2	0	0	367	33.4
3-Oct	10.00	4	1	6	296	230	0	8	4	81	186	1	0	3	6	0	36	0	0	0	1	4	867	86.7
4-Oct	9.50	14	0	5	172	141	1	6	1	7	69	1	0	0	3	0	32	1	0	0	0	0	453	47.7
5-Oct	10.00	0	1	13	471	244	4	9	0	39	64	0	0	0	11	0	54	1	0	1	0	2	914	91.4
6-Oct	6.75	1	0	1	19	10	2	0	0	0	3	0	0	0	5	0	2	0	1	0	0	0	44	6.5
7-Oct	8.00	7	0	0	7	2	0	0	0	1	7	0	0	2	0	0	2	0	0	0	0	0	28	3.5
8-Oct	10.50	3	0	3	123	53	1	1	0	6	178	2	0	1	2	0	50	1	0	0	0	2	426	40.6
9-Oct	11.00	0	1	3	336	54	2	0	0	0	76	1	0	0	11	1	79	3	0	1	0	1	569	51.7
10-Oct	10.75	0	1	17	674	204	1	3	0	0	70	0	1	0	14	0	71	1	0	0	0	0	1057	98.3
11-Oct	10.75	1	0	17	417	86	3	2	0	0	39	0	2	0	5	0	46	2	1	0	0	0	621	57.8
12-Oct	10.50	0	0	9	147	37	2	1	0	0	110	1	1	2	3	1	43	3	0	0	0	1	361	34.4
13-Oct	10.75	0	0	7	275	36	0	2	0	0	161	0	1	0	6	1	31	2	1	0	0	2	525	48.8
14-Oct	10.50	0	0	7	199	29	3	0	0	0	103	0	3	0	6	2	41	3	0	0	0	0	396	37.7
15-Oct	10.50	1	0	14	81	12	5	1	0	1	141	1	0	0	9	1	12	1	0	0	0	0	280	26.7
16-Oct	9.50	0	0	5	30	4	2	0	0	0	119	0	4	0	5	0	0	1	0	0	0	0	170	17.9
17-Oct	9.50	0	0	5	43	9	1	2	0	0	107	0	1	0	10	0	0	2	0	0	0	1	181	19.1
18-Oct	10.50	0	0	2	57	6	2	0	0	1	99	1	6	0	20	1	1	3	0	1	0	0	200	19.0
19-Oct	10.00	1	0	8	113	15	0	1	0	0	186	2	5	0	12	0	3	1	0	0	0	0	347	34.7
20-Oct	9.50	0	0	3	112	12	1	0	0	0	117	1	1	0	12	2	1	1	0	0	0	1	264	27.8
21-Oct	8.50	0	1	4	83	1	1	0	0	0	106	2	1	0	16	2	2	1	0	0	0	0	220	25.9
22-Oct	8.50	1	0	7	57	2	0	0	0	0	45	1	2	0	8	0	1	2	0	0	0	1	127	14.9
23-Oct	9.50	0	0	7	95	4	1	0	0	0	39	0	6	0	4	3	0	2	0	0	0	0	161	16.9
24-Oct	9.00	0	0	7	53	1	2	0	0	0	58	0	1	0	2	0	2	0	0	0	0	0	126	14.0
25-Oct	9.50	0	0	7	79	2	1	0	0	0	271	1	0	0	15	0	0	0	0	0	0	0	376	39.6
26-Oct	9.00	0	0	12	186	6	0	0	0	0	150	0	2	0	9	0	2	4	0	0	0	0	371	41.2
27-Oct	9.00	0	0	18	115	8	0	0	0	0	94	0	1	0	7	1	3	0	0	0	0	0	247	27.4
28-Oct	6.50	0	0	2	29	3	2	0	0	0	42	1	0	0	4	1	0	0	0	0	0	1	85	13.1
29-Oct	8.25	0	0	1	7	0	1	0	0	0	17	0	1	0	8	0	0	0	0	0	0	1	36	4.4
30-Oct	8.50	0	0	1	26	0	2	0	0	0	101	0	0	0	4	0	0	0	0	0	0	0	134	15.8
31-Oct	9.00	0	1	4	22	0	1	0	0	0	57	0	4	0	6	1	0	0	0	0	0	0	96	10.7
1-Nov	7.50	0	0	3	8	1	1	0	0	0	117	0	4	1	5	0	0	1	0	0	0	0	141	18.8
2-Nov	9.50	0	0	2	11	1	1	0	0	0	31	1	1	0	0	2	0	0	0	0	0	0	50	5.3
3-Nov	8.00	0	0	4	5	2	3	0	0	0	26	0	1	0	6	1	1	0	0	0	0	0	49	6.1
4-Nov	8.50	0	0	4	51	0	3	0	0	0	128	0	1	0	7	3	3	1	0	0	0	1	202	23.8
5-Nov	8.50	0	0	7	45	0	4	1	0	0	131	0	0	0	10	5	1	1	1	0	0	0	206	24.2
Total	748.08	349	110	356	8094	4109	103	132	59	334	5183	25	50	24	348	31	2974	74	33	15	7	57	22467	30.0

Appendix E. Annual observation effort statistics and fall migration count totals by species: 1983–1999.

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Mean
Start Date	15-Aug	16-Aug	20-Aug	16-Aug	17-Aug	17-Aug	18-Aug	15-Aug	16-Aug	16-Aug	16-Aug	16-Aug	15-Aug	15-Aug	15-Aug	15-Aug	15-Aug	15-Aug
End Date	23-Oct	17-Nov	5-Nov	31-Oct	27-Oct	9-Nov	4-Nov	31-Oct	5-Nov	10-Nov	5-Nov	4-Nov	5-Nov	4-Nov	5-Nov	31-Oct	5-Nov	2-Nov
Observation days	68	83	76	67	66	85	76	78	79	85	80	78	83	74	79	71	82	77
Observation hours	561.08	638.66	654.50	485.00	564.25	734.66	567.50	667.00	707.67	743.42	659.50	709.58	694.92	620.17	673.58	719.50	748.08	655.83
Raptors / 100 hours	1517	1130	1427	1435	1921	1704	2397	2527	1879	2703	1510	3122	2276	3514	2541	3515	3003	2242
Counts by Species																		
Turkey Vulture	92	141	211	131	165	198	200	285	327	473	270	418	289	486	482	732	349	309
Osprey	41	39	40	43	51	54	65	86	62	119	54	130	92	99	187	176	110	85
Northern Harrier	109	105	139	89	120	125	77	161	152	184	116	292	252	255	255	247	356	178
Sharp-shinned Hawk	2021	2067	3177	2233	3537	4405	5404	5275	3702	5927	2838	6835	4752	6773	4677	9598	8094	4783
Cooper's Hawk	1698	1378	1741	1149	2042	3012	3074	3647	2779	5070	2298	5576	3252	5075	3848	6736	4109	3323
Northern Goshawk	105	146	119	65	65	74	80	123	146	259	120	105	150	241	97	99	103	123
Unidentified accipiter	562	362	311	251	710	295	204	374	648	646	348	522	416	464	368	75	132	393
Total Accipiters	4386	3953	5348	3698	6354	7786	8762	9419	7275	11902	5604	13038	8570	12553	8990	16508	12438	8622
Red-shouldered Hawk	0	0	0	1	1	0	0	1	0	0	0	0	0	2	0	0	0	0.3
Broad-winged Hawk	6	13	15	7	30	16	37	35	44	26	27	41	40	27	37	160	59	36
Swainson's Hawk	116	34	78	276	69	43	60	351	108	209	159	244	287	498	143	507	334	207
Red-tailed Hawk	2105	1765	2132	1663	2317	2048	2263	3336	2976	3482	1827	4663	3572	3990	2922	3329	5183	2916
Ferruginous Hawk	3	6	17	5	15	9	23	17	26	19	15	20	29	16	18	16	25	16
Rough-legged Hawk	0	17	17	10	9	23	21	14	3	13	7	17	11	17	10	6	50	14
Unidentified buteo	185	74	65	42	156	44	47	36	147	73	128	110	69	62	77	5	24	79
Total Buteos	2415	1909	2324	2004	2597	2183	2451	3790	3304	3822	2163	5095	4008	4612	3207	4023	5675	3270
Golden Eagle	239	206	230	196	221	154	203	290	324	263	317	338	299	344	329	235	348	267
Bald Eagle	8	10	9	13	7	8	9	19	16	21	26	19	17	6	6	6	31	14
Unidentified eagle	2	0	0	1	0	0	0	2	6	2	1	1	1	1	0	0	0	1
Total Eagles	249	216	239	210	228	162	212	311	346	286	344	358	317	351	335	241	379	281
American Kestrel	731	697	934	708	1099	1844	1669	2634	1564	2982	1234	2461	1964	3199	3394	3169	2974	1956
Merlin	4	14	3	3	17	20	33	25	37	43	19	72	86	71	78	91	74	41
Prairie Falcon	31	16	5	11	15	27	24	26	23	40	26	45	58	44	48	50	33	31
Peregrine Falcon	0	5	1	3	2	8	9	3	5	4	4	7	15	21	29	26	15	9
Unidentified falcon	6	7	2	8	6	7	5	10	11	4	6	9	18	21	7	2	7	8
Total Falcons	772	739	945	733	1139	1906	1740	2698	1640	3073	1289	2594	2141	3356	3556	3338	3103	2045
Unidentified Raptor	446	113	94	53	186	107	96	106	193	228	117	229	149	83	102	25	57	141
Grand Total	8510	7215	9340	6961	10840	12521	13603	16856	13299	20093	9957	22154	15818	21795	17114	25290	22467	14931

Appendix F. Daily trapping effort and captures by station: 1999.

	North		West		Meadow		Total		Captures
Date	Hours	Captures	Hours	Captures	Hours	Captures	Hours	Captures	/ Hour
21-Aug	0.00		2.00	1	0.00		2.00	1	0.5
22-Aug	0.00		2.17	0	0.00		2.17	0	0.0
23-Aug	5.17	2	3.00	0	0.00		8.17	2	0.2
24-Aug	4.83	3	0.00		0.00		4.83	3	0.6
25-Aug	2.00	2	0.00		0.00		2.00	2	1.0
26-Aug	0.00		0.00		0.00		0.00		
27-Aug	0.00		2.75	1	0.00		2.75	1	0.4
28-Aug	5.00	1	7.00	4	0.00		12.00	5	0.4
29-Aug	7.00	5	0.00		0.00		7.00	5	0.7
30-Aug	0.00		0.00		0.00		0.00		
31-Aug	5.50	3	0.00		5.67	2	11.17	5	0.4
1-Sep	6.25	4	1.75	0	0.00		8.00	4	0.5
2-Sep	6.00	7	0.00		0.00		6.00	7	1.2
3-Sep	6.00	2	0.00		0.00		6.00	2	0.3
4-Sep	7.50	4	0.00		0.00		7.50	4	0.5
5-Sep	7.50	10	7.00	6	0.00		14.50	16	1.1
6-Sep	8.00	9	8.50	8	0.00		16.50	17	1.0
7-Sep	8.00	12	0.00		0.00		8.00	12	1.5
8-Sep	8.33	24	0.00		0.00		8.33	24	2.9
9-Sep	8.50	26	0.00		0.00		8.50	26	3.1
10-Sep	7.00	14	0.00		0.00		7.00	14	2.0
11-Sep	9.00	38	0.00		0.00		9.00	38	4.2
12-Sep	8.33	39	0.00		0.00		8.33	39	4.7
13-Sep	7.83	31	0.00		0.00		7.83	31	4.0
14-Sep	6.50	14	0.00		0.00		6.50	14	2.2
15-Sep	8.58	27	0.00		8.00	28	16.58	55	3.3
16-Sep	9.00	37	9.17	13	0.00		18.17	50	2.8
17-Sep	9.00	16	9.00	20	0.00		18.00	36	2.0
18-Sep	9.00	44	4.83	12	2.25	3	16.08	59	3.7
19-Sep	7.58	25	7.50	22	0.00		15.08	47	3.1
20-Sep	8.00	37	8.25	22	0.00		16.25	59	3.6
21-Sep	9.50	36	9.50	14	0.00		19.00	50	2.6
22-Sep	9.00	49	0.00		0.00		9.00	49	5.4
23-Sep	8.50	34	0.00		0.00		8.50	34	4.0
24-Sep	7.75	25	0.00		0.00		7.75	25	3.2
25-Sep	9.83	1	6.50	3	0.00		16.33	4	0.2
26-Sep	9.50	5	2.50	1	0.00		12.00	6	0.5
27-Sep	9.00	15	0.00		0.00		9.00	15	1.7
28-Sep	6.83	6	0.00		6.50	2	13.33	8	0.6
29-Sep	9.25	1	8.83	8	0.00		18.08	9	0.5
30-Sep	6.50	11	8.75	15	0.00		15.25	26	1.7

Appendix F. continued

Date	North		West		Meadow		Total		Captures
	Hours	Captures	Hours	Captures	Hours	Captures	Hours	Captures	/ Hour
1-Oct	6.00	7	8.50	10	0.00		14.50	17	1.2
2-Oct	8.58	9	8.75	17	0.00		17.33	26	1.5
3-Oct	9.00	17	9.25	26	2.00	1	20.25	44	2.2
4-Oct	8.50	36	8.58	20	0.00		17.08	56	3.3
5-Oct	9.00	69	10.00	56	0.00		19.00	125	6.6
6-Oct	6.00	3	6.00	2	0.00		12.00	5	0.4
7-Oct	0.00		0.00		0.00		0.00		
8-Oct	7.75	12	2.50	3	5.00	5	15.25	20	1.3
9-Oct	10.00	11	9.75	12	0.00		19.75	23	1.2
10-Oct	10.00	73	9.75	54	0.00		19.75	127	6.4
11-Oct	9.00	11	8.75	22	0.00		17.75	33	1.9
12-Oct	9.25	9	8.50	3	0.00		17.75	12	0.7
13-Oct	9.00	24	9.00	13	0.00		18.00	37	2.1
14-Oct	9.00	6	9.00	11	0.00		18.00	17	0.9
15-Oct	9.00	5	9.00	2	4.50	3	22.50	10	0.4
16-Oct	8.00	2	3.00	0	7.50	0	18.50	2	0.1
17-Oct	7.50	4	2.50	1	5.50	3	15.50	8	0.5
18-Oct	8.50	5	8.50	4	0.00		17.00	9	0.5
19-Oct	8.50	12	5.75	9	1.33	1	15.58	22	1.4
20-Oct	8.50	13	9.00	5	4.00	2	21.50	20	0.9
21-Oct	7.75	12	0.00		6.75	4	14.50	16	1.1
22-Oct	8.00	8	5.75	0	7.75	2	21.50	10	0.5
23-Oct	8.00	8	8.00	5	0.00		16.00	13	0.8
24-Oct	8.00	2	7.75	4	8.00	1	23.75	7	0.3
25-Oct	8.00	1	8.00	4	0.00		16.00	5	0.3
26-Oct	8.00	16	8.50	24	0.00		16.50	40	2.4
27-Oct	8.00	10	7.00	5	0.00		15.00	15	1.0
28-Oct	0.00		2.00	0	0.00		2.00	0	0.0
29-Oct	7.50	0	7.00	0	0.00		14.50	0	0.0
30-Oct	7.00	6	2.00	0	0.00		9.00	6	0.7
31-Oct	7.50	0	6.50	1	0.00		14.00	1	0.1
1-Nov	8.00	3	7.00	0	0.00		15.00	3	0.2
2-Nov	7.50	0	7.00	0	0.00		14.50	0	0.0
3-Nov	6.75	2	0.00		0.00		6.75	2	0.3
Total	532.17	1015	331.58	463	74.75	57	938.50	1535	113.6

Appendix G. Annual summaries of banding effort and capture totals by species: 1980–1999.

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Mean
Start date	23-Sep	2-Sep	8-Sep	25-Aug	28-Aug							21-Aug	19-Aug	22-Aug	19-Aug	22-Aug	19-Aug	18-Aug	18-Aug	21-Aug	
End date	19-Oct	10-Oct	16-Oct	22-Oct	17-Nov							26-Oct	7-Nov	22-Oct	29-Oct	25-Oct	23-Oct	22-Oct	22-Oct	3-Nov	
Blinds in operation	1	1	2	2	2	2	2	3	3	4	4	4	5	5	5	6	5	5	5	3	
Trapping days	21	37	27	55	69							64	74	59	65	63	61	62	63	72	57
Station days	21	37		66	104							240	296	254	278	312	270	264	233	131	193
Station hours	149.1	227.3	159.0	443.0	621.9	654.0	483.8	833.0	1085.0	1212.0	1454.0	1899.0	2316.0	1971.0	2290.0	2382.0	2061.0	2086.5	1689.7	938.5	1247.8
Captures / 100 stn hrs	84.5	341.0	215.1	228.9	149.1	185.2	127.5	168.2	175.4	195.5	190.2	159.5	166.8	136.0	205.1	120.1	160.7	147.0	202.3	163.6	176.1
SPECIES											Capture Totals										
Northern Harrier	0	2	0	8	3	6	2	4	10	9	4	9	10	4	7	2	1	18	4	0	5
Sharp-shinned Hawk	62	376	186	571	548	705	410	886	1177	1528	1584	1695	2040	1531	2692	1824	2095	1786	2137	899	1237
Cooper's Hawk	36	300	129	306	261	366	164	395	553	652	822	911	1222	825	1478	697	739	772	1014	441	604
Northern Goshawk	6	11	3	32	40	42	5	27	22	29	44	33	105	28	35	27	69	20	20	21	31
Broad-winged Hawk	0	0	0	0	2	0	1	1	1	1	1	2	0	2	1	3	0	0	1	0	1
Swainson's Hawk	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0
Red-tailed Hawk	14	26	14	43	31	51	15	43	37	66	99	93	97	53	158	93	84	68	69	49	60
Golden Eagle	1	1	1	1	5	6	2	4	7	6	10	3	3	2	11	4	7	5	4	8	5
Bald Eagle	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
American Kestrel	7	58	8	51	28	34	17	37	85	61	190	266	368	224	286	194	290	352	149	97	140
Merlin	0	1	1	0	2	0	0	1	5	8	2	9	10	8	21	13	18	26	13	16	8
Prairie Falcon	0	0	0	1	6	1	1	3	6	7	8	7	8	1	7	3	7	17	7	3	5
Peregrine Falcon	0	0	0	0	1	0	0	0	0	3	1	1	0	1	0	1	1	4	0	1	1
All Species	126	775	342	1014	927	1211	617	1401	1903	2370	2765	3029	3863	2681	4697	2861	3311	3068	3418	1535	2096
Recaptures	0	0	0	0	0	0	0	0	0	0	2	4	7	9	10	3	3	7	9	4	3
Foreign Recaptures	0	0	1	0	0	0	0	0	0	2	0	0	1	1	2	1	4	3	5	2	1
Foreign Encounters	0	1	5	3	9	12	5	7	11	12	15	18	14	21	19	16	9	14	10	19	11