FALL 1999 RAPTOR MIGRATION STUDY AT
BONNEY BUTTE, OREGON

Prepared by:

Mark Vekasy & Jeff P. Smith

Counts conducted by:

Nikos Vulgares & Susan Vulgares

Banding conducted by:

Richard Gerhardt, Graham Frye, Carole Hallett & Perry Cabot

On-site education by:

Stacey Hollenberger

Sponsors:

USDA Forest Service, Mt. Hood National Forest, Hood River Ranger District
Mt. Hood, Oregon

Oregon Department of Fish and Wildlife, High Desert Regional Office
Bend, Oregon

National Fish and Wildlife Foundation, Washington, D.C.

Coordinated by:

HawkWatch International
1800 South West Temple, Suite 226, Salt Lake City, UT 84115
(801) 484-6808

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EXECUTIVE SUMMARY

During fall 1999, HawkWatch International (HWI) conducted the sixth consecutive season of standardized raptor migration counts and fifth consecutive season of raptor banding at Bonney Butte in the Cascade Mountains of northern Oregon. The Bonney Butte studies compliment other HWI season-long, fall counts and banding operations in Washington, Montana, Nevada, Utah, Arizona, New Mexico, Texas, Florida, and Vera Cruz, Mexico. The primary objective of HWI migration studies is to document long-term trends in populations of diurnal migratory raptors throughout western North America. Raptors are good biological indicators of ecosystem status. Evaluations of raptor population trends are critical to understanding population dynamics on a broad scale and are relevant to the conservation of avian species faced with human alterations to landscapes and climate.

In 1999, two primary observers counted raptors from a traditional lookout atop Bonney Butte during 416.00 hours of observation on 63 days between 27 August and 28 October. Observations began 5 days earlier than during the previous 3 years, but also ended 2–6 days earlier. Observations were scheduled to conclude on 31 October, but were mostly precluded by inclement weather after 25 October and entirely after 28 October. Compared to previous years, 1999 featured a typical proportion of days hampered by inclement weather (21%), but a greater than usual concentration of foul weather late in the season. Otherwise the weather was relatively cool but mild (little cloudiness, precipitation or high winds, but cool temperatures), and included proportionately more days with south to southwesterly and north to northeasterly winds, and fewer days with westerly winds. In the end, the numbers of observation hours and days totaled 38% and 35% higher than average, respectively.

The combined-species count totaled 4,133 raptors of 18 species, for an annual passage rate of 993.5 raptors per 100 hours of observation. These values are 65% and 19% higher than average and both are record highs for the project; however, only the difference in counts is statistically significant. Accipiters were the most common species group (53% of total count), followed by buteos (26%), vultures (8%), eagles (6%), falcons (3%), ospreys (2%), harriers (1%), and unknown raptors (<1%). Counts were at least slightly above average for all species except Swainson's Hawk, and matched or exceeded previous record highs for Turkey Vulture, Osprey, Sharp-shinned Hawk, Red-shouldered Hawk, Broad-winged Hawk, Red-tailed Hawk, Golden Eagle, Bald Eagle, and Peregrine Falcon. Most notably, Broad-winged Hawks made a return after being absent from the last year's count, with a total count that exceeded the previous high by 2400%! Passage rates paint a slightly different picture, however, with rates exceeding 20% for only 10 species and following below average for 5 species. An increase in observation hours tends to raise counts but lower calculated passage rates, because the extra effort usually increases proportional representation of periods with low flight activity. This was the case in 1999, as the extra effort occurred early in the season and during early and late hours of observation, all periods of relatively low flight volume. However, for most species the magnitude of increase in counts was much higher than expected from a 35% increase in effort, particularly given that the increased effort was applied primarily during periods of low activity. Moreover, the fact that both counts and passage rates were higher than average for all but 5 species clearly indicated that real increases in flight volume (or possibly detectability) occurred for most species. Cooper's Hawk was the only regularly seen species that showed an average count and below average passage rate, suggesting a decrease in flight volume.

While the local area experienced generally typical weather throughout the season, the Pacific Northwest region as a whole experienced dryer than normal conditions from late summer through the migration season. Dry conditions and attendant reductions in prey productivity may have forced greater southward movement among partially migratory species such as Red-tailed Hawks and/or forced more migrants to concentrate along the relatively mesic, montane areas of the Cascades. However, age-specific data also suggest that for several species a very productive 1998 breeding season translated to high adult recruitment in 1999 and that juvenile recruitment also was high for several species in 1999 at least in some areas.

Inconsistencies in timing and count results among HWI's three Cascade Mountains monitoring sites suggest that there is considerable, relatively localized, annual variation in flight dynamics and flight paths in the region. The likely reason for this complexity is that the Cascades lie along a transition zone between two major regional flyways: the Pacific Coast and Intermountain flyways.

The trappers captured 143 raptors of 9 species during 142.75 hours on 22 days between 5 September and 22 October. Effort totaled 36–39% fewer trapping days than in 1997 and 1998, but only 12% fewer than the 1995–1998 average, and the number of station hours is very similar to the long-term average of 143.44 hours. Although the capture total is much lower than during 1997 and 1998, it is the third highest capture total for the project and the total capture rate of 100 birds per 100 station hours is nearly equal to the 1995–1998 average. Typical for the site, Sharp-shinned Hawks (57%), Red-tailed Hawks (25%), and Cooper's Hawks (10%) were the three most commonly captured species. Most species showed average or below average capture totals because of the low effort; exceptions included the first ever American Kestrel, second ever Rough-legged Hawk, and a capture total for Red-tailed Hawks that was 50% above average. The total capture success of 4% of "trappable" raptors (excludes Turkey Vultures, Ospreys, and distant raptors not identified to genus) is 24% lower but not significantly different than average. No significant differences in immature : adult capture ratios occurred among 6 species with sufficient comparative data; however, an 81% reduction in the capture age ratio for Red-tailed Hawks was conspicuous despite the lack of statistical significance due to high annual variation.

Since banding began in 1995, 8 raptors banded at Bonney Butte have subsequently been encountered elsewhere ("foreign encounters") and two raptors banded elsewhere have been recaptured at Bonney Butte ("foreign recaptures"). Four new foreign encounters occurred in 1999: 2 immature Red-tailed Hawks banded in 1999 (recovery location not known at this time); a male Sharp-shinned Hawk banded as an adult in 1997 and killed by a car in San Francisco, CA; and a female Cooper's Hawk banded as a hatch-year bird in 1998 captured and released in good health by biologists working at San Simeon State Park in southern California. Thus far, 4 of 8 encounters with full details known indicate a migratory pathway along the Pacific Coast or through the Coast Ranges of California.

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INTRODUCTION

The Bonney Butte raptor migration study in north-central Oregon is an ongoing effort to monitor long-term trends in populations of raptors using this Cascade Mountains migratory flyway. HawkWatch International (HWI)—and its organizational precursors—has been monitoring raptor migrations through primarily western North America since the late 1970s. During fall 1999, HWI coordinated 12 other fall migration counts in New Mexico, Arizona, Nevada, Utah, Montana, Washington, Texas, Florida, and Veracruz, Mexico. Banding operations occurred at 5 of these sites. Bonney Butte is a relatively recent addition to HWI's network of raptor migration monitoring sites. Following exploratory counts in 1993, the first full-season count occurred in 1994 with a single observer. HWI then instituted a standardized, two-observer count system and annual banding program in 1995. The 1999 season marked the sixth consecutive annual count and fifth consecutive banding effort at the site. HWI expanded the banding program to a full-season, daily effort in 1997 and 1998, but scaled back to a part-time operation in 1999 due to personnel constraints.

The primary objective of HWI migration studies is to track long-term trends in the abundance and distribution of migratory diurnal raptors throughout 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, also represent one of the most cost-effective and efficient methods 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 et al. in review).

HWI's banding operations also provide valuable information about breeding and wintering distributions, migratory routes, mortality factors and longevity, morphometric variation, molt sequences and timing, and health assessments. Documenting population sources and delineating flyways is important for ensuring accurate interpretation of detected population trends. Other studies enabled by both count and banding operations enhance our understanding of species' life histories, migration ecology, and raptor conservation needs. In addition to the scientific value, HWI is also 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. Since 1996, the Bonney Butte field crew has included an on-site educator responsible for conducting environmental education programs at the site and facilitating interactions between visitors and the field biologists.

In this report, we summarize fall 1999 count and banding results from Bonney Butte. We present and discuss data on seasonal timing, daily flight rhythms, and the species, age, sex, and color morph composition of the flight. In addition, where appropriate we compare statistics for the 1999 season with those from previous seasons.

STUDY SITE

Bonney Butte is located approximately 9.5 km ESE of Government Camp, on the east side of the White River drainage within the Mt. Hood National Forest, Hood River County, Oregon (45°16.08' N, 121°59.72' W; Fig. 1). The butte is the southern terminus of Surveyor's Ridge, which originates near Hood River, Oregon south of the Columbia River Gorge. The ridge extends southward for approximately

50 km and ends southeast of Mt. Hood. The central Oregon shrubsteppe region lies immediately to the east.

Several other ridges to the north funnel migrants past the Bonney Butte lookout. Bennett Ridge and Surveyor's Ridge form a "Y" junction 2 km north of Bonney Butte. Bluegrass Ridge parallels Surveyor's Ridge to the west and terminates pointing into the Y. Barlow Ridge lies 2 km west of Bonney Butte, and Frog Lake Butte is immediately south of Barlow. Two long north-south ridges lie to the east of Bonney Butte. Boulder Ridge is 4 km due east, and the lower, closer "Meadow" ridge is 1.5 km due east. Migrants have been seen using all of these ridges, depending on weather conditions.

Bonney Butte is a mostly bald knoll with a summit elevation of 1,754 m. The south and west slopes are steep, dropping approximately 725 m to the White River, whereas the east slope drops only 65 m to Bonney Meadows. The area within a 5-km radius of Bonney Butte is forested, except for Bonney Meadows and several clearcut tracts. Mountain Hemlock (*Tsuga spp.*), true firs (*Abies spp.*), and pines (*Pinus spp.*) are common in the surrounding forests. Several huckleberry species (*Vaccinium spp.*) also commonly occur in the area.

METHODS

COUNTS

Two official or designated observers conducted standardized daily counts of migrating raptors from a single, traditional observation site between 27 August and 28 October 1999. Counting occurred every day unless precluded by inclement weather. Observations typically began between 0800–0900 hrs and ended near 1700 hrs Pacific Standard Time (PST). Stop times were extended when evening flight activity was heavy. Official observers Nikos Vulgares and Sue Vulgares had 3 and 0 full-seasons, respectively, of previous experience counting migratory raptors (see Appendix A for a complete history of observer participation). However, Sue served as on-site educator during the fall 1998 season at Bonney Butte while Nick was an observer, and thereby gained significant observation experience. Visitors occasionally assisted with spotting migrants (see Smith and Hoffman [in review] for a discussion of visitor effects).

The observers routinely recorded the following data:

1. Species, age, sex, and color morph of each migrant raptor, whenever possible and applicable (Appendix B lists common and scientific names for all species, information about the applicability of age, sex, and color morph distinctions, and two-letter codes used to identify species in some tables and figures).
2. Hour of passage for each migrant; e.g., the 1000 hr PST.
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 any person that actively assisted with scanning and locating raptors for more than 10 minutes in a given hour) and visitors (all other guests) present during each hour.
6. Daily start and stop times for each observer.

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

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. The observers recorded as northbound migrants all raptors seen heading north past the lookout that did not appear to stop or change direction while in view. We assume that northbound birds were dispersing juveniles or non-migratory adults searching for more productive wintering grounds in the local region (i.e., within 100 km of their usual territory).

For purposes of examining long-term variation in annual counts, it is often recommended that count data be standardized for sampling period and adjusted for daily variation in observation effort because seasonal and daily duration of observation effort can greatly affect count statistics (Hussell 1985, Kerlinger 1989, Bednarz et al. 1990b). For purposes of this report, we converted counts to passage rates (typically raptors/100 hours of observation) to adjust for daily variation in sampling effort, and present both raw counts and passage rates for comparison. In this report, we compare results from the 1999 season to means for previous seasons and examine trends in annual passage rates. In comparing 1999 annual statistics against means and 95% confidence intervals for previous seasons, we equate significance with a 1999 value falling outside the bounds of the confidence interval for the associated mean.

TRAPPING AND BANDING

The trappers operated a single station 2–3 days per week from 5 September through 24 October 1999, generally between 0900–1700 hrs PST. Two to four volunteers staffed the blind each day. Capture devices included mist nets and remotely triggered bow nets (Meng 1963, Austing 1964). 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. A pigeon manipulated with a lure line that ran to the top of a tall pole (3–4 m high) served as the primary lure. Other species were used secondarily to secure smaller raptors such as Sharp-shinned Hawks. The trapping array included a central bow net equipped with the main pigeon lure, a triangle of 9 m mist nets to the east of the trapping blind with top-line rigged dove and sparrow lures within, and an 18 m mist net along the west side of the trapping arena. After being quickly extracted from the capture nets, captured raptors were held for processing in a quiet, shaded area of the 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 1 hour from the time of capture. All banding and measuring occurred in the trapping blind. 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 USGS Bird Banding Laboratory (BBL) manual, Clark and Wheeler (1987), Wheeler and Clark (1995), and Hoffman et al. (1990). Morphometric data recorded for each bird included tarsus width and length, hallux length, standard tail length, culmen length, unflattened wing chord, mass, and occasionally wing span. 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 1 g using a digital laboratory scale. When necessary, processors discontinued several measurements to reduce holding time for captured birds. Other data taken where appropriate included: color morph; eye color; a subjective assessment of the amount of food in the esophagus (crop), rated as empty, ¼, ½, ¾, or full; an estimate of the percentage of unmolted feathers on the back and rump; the extent of primary, secondary and rectrix molt; presence or absence of ectoparasites; a subjective rating of keel condition (amount of muscle carried on the keel) evaluated on an integer scale from 0 to 2; a subjective rating of wing-pit fat evaluated on an integer scale from 0–2 (keel and wing-pit assessments are similar to those described by Geller and Temple 1983); and notes about old injuries, deformities, or other odd occurrences.

RESULTS

WEATHER SUMMARY

In 1999, inclement weather effectively precluded 5 days of observation (≤1 hr counting) before 25 October, resulted in the same outcome each day from 25 and 28 October, and ultimately resulted in complete closure of the season 3 days earlier than scheduled (see Appendix C for daily weather records). In addition, rain, snow or fog limited observations to less than 5 hrs on 2 additional days. Thus, in 1999 inclement weather limited observations on 14 of 66 (21%) scheduled observation days. This is similar to the situation during the last three years (19–33% of scheduled days affected). In 1999, clear or at most hazy skies predominated on 57% of the active observation days; partly cloudy skies 13%; overcast skies 13%; and heavy fog, rain, or snow on 17%. This compares to values of 50%, 19%, 15%, and 15% in 1998. For the past 3 years, flight activity was more concentrated during periods of fair weather (85%, 84% and 87% of all flight activity in 1997, 1998 and 1999, respectively) than expected based on availability (62%, 69% and 70% of observation days). Wind direction in 1999 was unusual compared to the previous two seasons. In 1998, westerly winds predominated on 50% of the active observation days; easterly winds 27%; south or southwesterly winds 6%; and variable winds 17%. This compares to values of 42%, 35%, 5%, and 19% in 1997. However, in 1999 south to southwest (44%) and north to northeast (35%) winds predominated, with only 10% of days having west to northwest winds. Remaining days had east to southeast (6%) or variable winds (5%). In 1999, 83% of the observation days featured primarily light or calm winds (≤5 kph) and 14% moderate winds (6–19 kph), typical percentages for this site. Average daily temperatures in 1999 ranged from -6.0 to 23.8°C. Excluding days with limited weather observations, the average temperature was 12.3°C and much cooler (8–9°C) than the previous 2 years. Visibility to the east and west averaged 96 km and 94 km, respectively, in 1999.

In summary, compared to previous years, 1999 featured a typical proportion of days hampered by inclement weather (21%), but a greater than usual concentration of foul weather late in the season. Otherwise the weather was relatively cool but mild (little cloudiness, precipitation or high winds, but cool temperatures), and included proportionately more days with south to southwesterly and north to northeasterly winds, and fewer days with westerly winds.

OBSERVATION EFFORT

Observations occurred during 416.00 hours on 63 days in 1999. These values are 38% and 35% higher than average, respectively (Table 1). Observations began 5 days earlier than during the previous 3 years, but also ended 2–6 days earlier (see Appendix D for summaries of observation effort and counts by species for each year of the project).

FLIGHT SUMMARY

The observers counted 4,133 migrant raptors of 18 species during 416.00 observation hours on 63 days between 27 August and 28 October (Table 1; see Appendix E for 1999 daily count records). The count yields a combined-species annual passage rate of 993.5 raptors/100 hrs. The count and passage rate are 65% and 19% higher than average, respectively, and both are record highs for the project; however, only the count increase is significant (Table 1, Fig. 2). Accipiters were the most common species group (53% of total count), followed by buteos (26%), vultures (8%), eagles (6%), falcons (3%), Ospreys (2%), harriers (2%), and unknown raptors (1%; Fig. 3). Species comprising more than 5% of the total count included Sharp-shinned Hawk (40%), Red-tailed Hawk (17%), Turkey Vulture (8%), and Cooper's Hawk (8%). Counts were more than 20% above average for all species except Cooper's and Swainson's Hawks. Moreover, counts matched or exceeded previous record highs for Turkey Vulture, Osprey, Sharp-shinned Hawk, Red-shouldered Hawk, Broad-winged Hawk, Red-tailed Hawk, Golden Eagle, Bald Eagle, and Peregrine Falcon. Most notably, Broad-winged Hawks made a return after being absent from the last year's count, with a total count that exceeded the previous high by 2400%! Passage rates paint a slightly different picture, however, with rates exceeding 20% for only 10 species and following below average for 5 species. Distinct long-term trends in passage rates generally are not yet discernible from these relatively short-term datasets.

Only 2 of 9 species with sufficient age-specific data show immature : adult ratios that differ significantly from averages for previous seasons (Golden and Bald Eagle; Table 3). Lower than average age ratios for Bald Eagle, Northern Harrier, and Sharp-shinned Hawk resulted from above average adult counts, whereas counts were above average for both adult and immature Golden Eagles and Red-tailed Hawks.

The 1999 combined-species daily flight rhythm is similar to the average pattern, except for showing a significantly higher peak during the 1200 hr (Fig. 4). The combined-species median passage date (date by which 50% of the flight had passed) of 1 October is only 1 day later than average (Table 4). Similarly, the seasonal activity pattern is similar to the average pattern (Fig. 5) except for showing a higher than average mid-season peak and very low late-season activity due to the poor weather. Only 4 of 11 species with sufficient comparative data show median passage dates that differ significantly from average (2 early, 2 late; Table 4). For American Kestrels, the earlier than average start date clearly contributed to the early median passage date. Age-specific median dates show additional variation (Table 5). Only Red-tailed Hawk and Bald Eagle show no significant age-specific differences. All other species with sufficient data show mixed results for adults and immatures, and no distinct interspecific patterns are evident.

TRAPPING EFFORT

In 1999, the trappers worked on 22 days between 5 September and 22 October, which is 36–39% fewer days than in 1997 and 1998, but only 12% fewer than the 1995–1998 average (Table 2). Generally favorable weather on trapping days resulted in a similar number of station hours (142.75 hrs) compared to the long-term average (143.44 hrs).

TRAPPING SUMMARY

The trappers captured 143 raptors of 9 species (Table 2 and see Appendix F for 1999 daily trapping records). Although this total is much lower than during 1997 and 1998, it is the third highest capture total for the project (Table 2). Typical for the site, Sharp-shinned Hawks (57%), Red-tailed Hawks (25%), and Cooper's Hawks (10%) were the three most commonly captured species. Most species show average or below average capture totals; exceptions include the first ever American Kestrel, second ever Rough-legged Hawk, and a capture total for Red-tailed Hawks that is 50% above average. The total capture rate of 100 birds per 100 station hours is nearly equal to the 1995–1998 average (Table 6). The total capture success of 4% of "trappable" raptors (excludes Turkey Vultures, Ospreys, and distant raptors not identified to genus) is 24% lower but not significantly different than average (Table 7).

No significant differences in immature : adult capture ratios occurred among 6 species with sufficient comparative data; however, an 81% reduction in the capture age ratio for Red-tailed Hawks is conspicuous despite the lack of statistical significance due to high annual variation (Table 9).

SPECIES ACCOUNTS

The observers counted 349 **Turkey Vultures** on 28 days between 27 August and 10 October (Tables 1 and 4, Appendix E). This count is the highest on record for the project (Appendix D). The annual count and passage rate of 83.9 raptors/100 hrs are both significantly higher than average (95% and 39%, respectively; Table 1). Until this season, passage rates had declined each year since 1995 (Fig. 6). The median passage date of 24 September is 2 days later but not significantly different than average (Table 4); however, a late shift is evident in the seasonal activity pattern (Fig. 7).

The observers counted 74 **Ospreys** on 31 days between 2 September and 24 October (Tables 1 and 4, Appendix E). This count is the highest on record for the project (Appendix D). The count is significantly higher than average (41%), whereas the annual passage rate of 17.8 raptors/100 hrs equals the long-term mean (Table 1). Although Osprey counts have increased each year of the project, passage rates have remained relatively stable since 1995 (Fig. 6). The median passage date of 21 September is significantly later (4 days) than average (Table 4). A clear late shift in timing is not evident in comparing the 1999 and average seasonal activity patterns; however, the 1999 pattern is distinct in showing a bimodal distribution (Fig. 7).

The observers counted 49 **Northern Harriers** on 26 days between 7 September and 24 October (Tables 1 and 4, Appendix E). This is the second highest count for the project, following last year's record high count of 56 (Appendix D). The count and annual passage rate of 11.8 raptors/100 hrs are 42% and 7% higher than average, respectively, but only the count difference is significant (Table 1). A possible increasing trend is evident in passage rates for this species (Fig. 6). The count included 2% adult females, 20% adult males, 29% "brown" birds (indistinguishable adult females and immature birds), 39% immatures, and 10% birds of unknown sex and age. The immature : adult ratio of 1.73 is 72% lower than average, but the difference is not significant due to high annual variation (Table 3). Moreover, the low ratio is due to an increase in abundance of adults, not a decline in immature. The 1999 median passage date for the species of 4 October is 7 days later than average, but the difference is not significant (Table 4). Nonetheless, although the seasonal activity patterns are irregular, a distinct late shift in activity during 1999 is evident, with higher than average activity during 4 of 5 five-day periods between 1 and 25 October (Fig. 7). Age-specific dates show that adults were 5 days earlier than average, whereas immatures were 10 days late; however, the difference is significant only for immatures (Table 5).

The trappers captured 1 **Northern Harrier** on 3 October (Table 2, Appendix F). The bird was an after hatch-year (AHY) female and only the fourth individual of this species ever captured at the site. The 1999 capture rate of 0.7 raptors/100 station hrs and capture success of 2.0% are both higher but not significantly different than average (Tables 6 and 7). The bird appeared to be in good health, with an average keel-muscle mass and at least some wing-pit fat (Table 11).

The observers counted 1,660 **Sharp-shinned Hawks** on 49 days between 27 August and 24 October (Tables 1 and 4, Appendix E). Both the count and annual passage rate of 399 raptors/100 hrs are significantly higher than average (77% and 29% respectively; Table 1) and are record highs for the site; however, no distinct long-term trend in passage rates is evident (Fig. 8). The count included 26% adults, 14% immatures, and 60% birds of unknown age. The immature : adult ratio of 0.52 is 29% lower than average, but the difference is not significant (Table 3). The low ratio is due to high abundance of adults, not low abundance of immatures. However, a significantly higher than average proportion of unknown-age birds may confound the comparison (Table 3). The median passage date for the species of 3 October is 2 days earlier than average, but the difference is not significant (Table 4) and the seasonal activity pattern is similar to the average pattern (Fig. 9). However, age-specific comparisons showed that adults were significantly earlier than average (7 days), whereas immatures showed average timing (Table 5).

The trappers captured 82 **Sharp-shinned Hawks** between 5 September and 24 October (Table 2, Appendix F). The capture rate of 57.4 raptors/100 station hrs and capture success of 4.6% are 9% and 39% lower than average, respectively, but neither difference is significant (Tables 6 and 7). Note also that the 1999 capture success value is much lower than in 1997 and 1998 when trapping effort was much higher, but is also considerably lower than in 1996 when trapping effort was similar (Tables 2 and 7). The immature : adult capture ratio of 2.2 is 22% higher but not significantly different than average (Tables 8 and 9). Note also that the capture and count age ratios are strikingly different. The female : male ratio of 1.6 is 23% higher but also is not significantly different than average (Tables 8 and 9). Sex and age-specific median capture dates show an atypical pattern, with both adult and immature males uncharacteristically preceding their respective counterparts (Table 10). This is the result of both age classes of males being earlier than average and both age classes of females being later than average. For adults, sex-specific median capture dates are 6–12 days later than the median passage date for adults, and for immatures sex-specific median capture dates are 12 days later for females but 2 days earlier for males (Tables 5 and 10). Compared to previous years, in 1999 it was slightly more common for Sharp-shinned Hawks to have empty or nearly empty crops, normal rather than heavy keels, and lower wing-pit fat ratings (Table 11).

The observers counted 331 **Cooper's Hawks** on 48 days between 27 August and 24 October (Tables 1 and 4, Appendix E). The count and annual passage rate of 79.6 raptors/100 hrs are 4% higher and 26% lower than average, respectively, but neither difference is significant (Table 1) and no distinct long-term trend in passage rates is evident (Fig. 8). The count included 17% adults, 19% immatures, and 64% birds of unknown age. The immature : adult ratio of 1.14 is 43% lower than average, but the difference is not significant due to high annual variability (Table 3). Moreover, a significantly higher than average proportion of unknown-age birds may confound the comparison. The 1999 median passage date for the species of 29 September is significantly later than average (5 days; Table 4). The 1999 seasonal activity pattern differs from the average pattern in showing low activity during the 21–25 September period and relatively high activity during mid-October (Fig. 9). Age-specific comparisons of median passage dates show that adults were significantly later than average (4 days), whereas immatures were significantly earlier than average (6 days; Table 5).

The trappers captured 14 **Cooper's Hawks** between 10 September and 24 October (Table 2, Appendix F). This is the lowest total for the project other than during the first year when none were captured. The capture rate of 9.8 raptors/100 station hrs and capture success of 3.9% are 24% and 7% lower than average, respectively, but neither difference is significant (Tables 6 and 7). Note also that the 1999 capture success value is much lower than in 1997 and 1998 when trapping effort was much higher, but is only slightly lower than in 1996 when trapping effort was similar (Tables 2 and 7). The immature : adult capture ratio of 1.3 is 28% lower than average, but the difference is not significant (Tables 8 and 9). Unlike for Sharp-shinned Hawks, the capture and count age ratios are similar. The female : male capture ratio of 1.8 is significantly lower than average (25%; Tables 8 and 9). Sex-age specific comparisons of median capture dates are possible only for immature females, which were 4 days earlier but not significantly different than average (Table 10). This pattern is similar to that shown by the count data. Cooper's Hawks captured in 1999 showed slightly poorer body condition than in previous years (Table 11).

The observers counted 36 **Northern Goshawks** on 23 days between 2 September and 23 October (Tables 1 and 4, Appendix E). The count and annual passage rate of 8.7 raptors/100 hrs are 25% higher and 8% lower than average, respectively, but neither difference is significant (Table 1). The 1999 count is the second highest on record for the site (Appendix D); however, no distinct long-term trend in passage rates is evident (Fig. 8). The count included 25% adults, 56% immatures, and 19% birds of unknown age. The immature : adult ratio of 2.22 is 13% lower than average, but the difference is not significant and a significantly lower than average proportion of unknown-age birds may confound the comparison (Table 3). The 1999 median passage date for the species of 28 September is 5 days earlier than average, but the difference is not significant (Table 4). The 1999 seasonal activity pattern differs from the average pattern in showing a very high peak in activity during 1–5 October and relatively low activity during the preceding and succeeding 5-day periods (Fig. 9). No comparison of adult median passage dates is possible due to low counts of aged birds in previous years; however, immatures were 7 days earlier than average in 1999 (not a significant difference; Table 5).

The trappers captured 3 **Northern Goshawks** between 17 September and 24 October (Table 2, Appendix F). The capture rate of 2.1 raptors/100 station hrs and capture success of 7.7% are 34% and 46% lower than average, respectively, but only the difference in capture success is significant (Tables 6 and 7). Note also that there is no clear pattern of difference in capture success relative to variation in trapping effort (Tables 2 and 7). The captures were all hatch-year males, which yields a near-average immature : adult capture ratio (although technically inestimable) but a low female : male ratio (Tables 8 and 9). None of the birds had food in their crops, but all three had average keel muscles and some wing-pit fat (Table 11).

The observers counted 2 **Red-shouldered Hawks** on 21and 27 September (Tables 1 and 4, Appendix E). These are the third and fourth individuals of this species recorded as migrants during the project, and this is the first time two birds were seen in the same season (Appendix D). The observers identified 1 bird as immature (Table 3).

The observers counted 75 **Broad-winged Hawks** on 7 days between 20 September and 15 October (Tables 1 and 4, Appendix E). Previously, this species had been seen in only 3 of 5 years and the previous high count was only 3 birds (Appendix D). The 1999 tally included a group of 65 seen on 29 September (Appendix D). The annual passage rate of 18.0 raptors/100 hrs is more than 4000% higher than average (Table 1, Fig. 10). The tally included 4 light-morph adults, 1 light-morph immature, 2 unknown-age dark morphs, 1 unknown-age light morph, and two adults of unknown color morph (Table 3). The median passage date for the species was 29 September (Table 4), which is later than all previous activity at the site (Fig. 11).

The observers counted 1 **Swainson's Hawk** on 14 October (Tables 1 and 4, Appendix E). This is only the sixth migrant ever recorded at the site (Appendix D).

The observers counted 932 **Red-tailed Hawks** on 51 days between 27 August and 24 October (Tables 1 and 4, Appendix E). This is a record high count for the site (Appendix D). The count and annual passage rate of 224 raptors/100 hrs are both significantly higher than average (71% and 22%, respectively; Table 1); however, no distinct long-term trend in passage rates is evident (Fig. 10).. The count included 56% adults, 28% immatures, and 16% birds of unknown age. The immature : adult ratio of 0.49 is 22% lower than average, but the difference is not significant and counts of both adults and immatures are higher than average (Table 3). The median passage date for the species of 29 September is only 1 day later than average (Table 4) and the 1999 and average seasonal activity patterns are roughly similar (Fig. 11). Age-specific comparisons showed similar patterns (Table 5).

The trappers captured 36 **Red-tailed Hawks** between 5 September and 24 October (Table 2, Appendix F). The capture rate of 25.2 raptors/100 station hrs and capture success of 3.7% are 105% and 37% higher than average, respectively, but only the difference in capture rates is significant (Tables 6 and 7). Note also that the 1999 capture success value is much lower than in 1997 and 1998 when trapping effort was much higher, but is considerably higher than in 1996 when trapping effort was similar (Table 7). The immature : adult capture ratio of 1.8 is 81% lower than average, but the difference is not significant due to high annual variation (Table 9). Moreover, the capture age ratio is more than three times as high as the count age ratio. Age specific median capture dates suggest that both adults and immatures were earlier than average and show the typical pattern of immatures preceding adults (Table 10); however, only the date for immatures is similar to the relevant median passage date. Compared to previous years, the 1999 birds showed average body condition (Table 11).

The observers counted 1 unknown age and color morph **Ferruginous Hawk** on 13 September (Tables 1 and 4, Appendix E). This was only the fourth individual ever seen at the site (Appendix D).

The observers counted 21 **Rough-legged Hawks** on 11 days between 4 and 23 October (Tables 1 and 4, Appendix E). This is a record high count for the site (Appendix D). The count and annual passage rate of 5.0 raptors/100 hrs are 67% and 22% higher than average, respectively, but only the count difference is significant (Table 1) and no distinct long-term trend in passage rates is evident (Fig. 10).. The median passage date for the species of 18 October is significantly earlier than average (5 days; Table 4), which is clearly reflected in the seasonal activity pattern (Fig. 11).

The trappers captured 1 immature male **Rough-legged Hawk** on 20 October (Table 2). This is only the second individual of this species ever captured at the site (Appendix F).

The observers counted 176 **Golden Eagles** on 37 days between 28 August and 24 October (Tables 1 and 4, Appendix E). The count and annual passage rate of 42.3 raptors/100 hrs are both significantly higher than average (105% and 49%, respectively; Table 1) and represent record highs for the site (Appendix D); however, no distinct long-term trend in passage rates is evident (Fig. 12). The count consisted of 21% adults, 52% immatures/subadults, and 27% birds of unknown age. The immature/subadult : adult ratio of 2.46 is significantly higher than average (58%), due primarily to an increase in immature/subadult birds; however, a significantly higher than average proportion of unknown-age birds may confound the comparison (Table 3). The 1999 median passage date for the species of 11 October matches the average (Table 4); however, adults were significantly later than average (3 days), whereas immatures/subadults were significantly earlier than average (5 days; Table 5). The seasonal activity pattern shows two significantly higher than average activity peaks in October that correspond to these dates (Fig. 13).

The trappers captured 2 hatch-year male **Golden Eagles** on 13 October (Table 2). The 1999 capture rate of 1.4 raptors/100 station hrs and capture success of 1.1% are 40% higher and 48% lower than average, respectively, but neither difference is significant (Tables 6 and 7). Note also that there is no clear pattern of difference in capture success relative to variation in trapping effort (Tables 2 and 7). Neither bird had food in its crop or much wing-pit fat, but both had average keel muscles (Table 11).

The observers counted 53 **Bald Eagles** on 28 days between 4 September and 23 October (Tables 1 and 4, Appendix E). This is a record high count for the site (Appendix D). The count and annual passage rate of 12.7 raptors/100 hrs are 41% and 2% higher than average, respectively, but only the count difference is significant (Table 1) and no distinct long-term trend in passage rates is evident (Fig. 12). The count included 85% adults, 11% immatures/subadults, and 4% birds of unknown age. The immature/subadult : adult ratio of 0.13 is significantly lower than average (55%) due to high abundance of adults (Table 3). The median passage date for the species of 3 October is 2 days earlier but not significantly different than average (Table 4). Age-specific dates also show no significant differences; however, adults were 3 days earlier than average, whereas immatures/subadults were 6 days late (Table 5). The 1999 seasonal activity pattern is similar to the average pattern through September, but shows irregular variation from the norm in October (Fig. 13).

The observers counted 30 **American Kestrels** on 20 days between 27 August and 19 October (Tables 1 and 4, Appendix E). The count and annual passage rate of 7.2 raptors/100 hrs are 23% higher and 10% lower than average, respectively, but neither difference is significant (Table 1). The median passage date for the species of 11 September is significantly earlier than average (10 days; Table 4), which is reflected in the seasonal activity pattern (Fig. 15).

The trappers captured 1 immature female **American Kestrel** on 10 October (Table 2), which is the first individual of this species ever captured at the site (Appendix F).

The observers counted 83 **Merlins** on 32 days between 11 September and 23 October (Tables 1 and 4, Appendix E). The count and annual passage rate of 20.0 raptors/100 hrs are 33% higher and 3% lower than average, respectively, but neither difference is significant (Table 1). The 1999 median passage date of 10 October is 1 day later than average, but the difference is not significant (Table 4) and the seasonal activity pattern is similar to the average pattern (Fig. 15).

The trappers captured 3 **Merlins** between 19 September and 20 October (Table 2). The capture rate of 2.1 raptors/100 station hrs and capture success of 3.6% are both near average (Tables 6 and 7). Note also that there is no clear pattern of difference in capture success relative to variation in trapping effort (Tables 2 and 7). The immature : adult ratio of 2.0 is 33% lower than average, but the difference is not significant. The female : male ratio of 0.8 is significantly lower than average (50%; Tables 8 and 9). Compared to previous years, the body condition of the 1999 birds appears average (Table 11).

The observers counted 8 **Prairie Falcons** on 7 days between 10 September and 22 October (Tables 1 and 4, Appendix E). The count and annual passage rate of 1.9 raptors/100 hrs are 67% and 29% higher than average, respectively, but only the count difference is marginally significant (Table 1). The median passage date of 21 September is 2 days earlier than average, but the difference is not significant (Table 4) and no distinct pattern of difference is evident in comparing seasonal activity patterns (Fig. 15).

The observers counted 5 **Peregrine Falcons** on 5 days between 11 September and 15 October (Tables 1 and 4, Appendix E). The count and annual passage rate of 1.2 raptors/100 hrs are 92% and 40% higher than average, respectively, but only the count difference is significant (Table 1). The median passage date for the species was 29 September, but too few individuals were counted in previous years to enable a meaningful comparison (Table 4). The distribution of activity in 1999 falls within the temporal range seen in previous years (Fig. 15).

In addition to identified migrants, the observers recorded 247 migrants that could not be identified to species, which accounted for 6% of the total count. This group included 155 unidentified accipiters, 58 unidentified buteos, 2 unidentified eagles, and 32 unidentified raptors (Table 1).

NORTHBOUND AND RESIDENT RAPTORS

In 1999, the observers classified 8 birds as northbound migrants: 3 Ospreys, 3 Bald Eagles, 1 Golden Eagle, and 1 unidentified eagle. Northbound Golden and Bald Eagles were recorded in 2 of the previous 3 years.

Resident birds recorded in 1999 included a pair of Red-tailed Hawks, possibly associated with one immature bird, a few early season Turkey Vultures, and an early season immature Sharp-shinned Hawk.

ENCOUNTERS WITH PREVIOUSLY BANDED RAPTORS

Since banding began in 1995, 8 raptors banded at Bonney Butte have subsequently been encountered elsewhere ("foreign encounters") and two raptors banded elsewhere have been recaptured at Bonney Butte ("foreign recaptures"; Table 12). Four new foreign encounters occurred in 1999. Two recent encounters involved immature Red-tailed Hawks banded this season, but we have not yet received detailed reports from the BBL as to the cause and location of the encounters. An adult, male Sharp-shinned Hawk banded on 24 October 1997 was found dead, probably from a car collision, on 13 March 1999 in San Francisco, CA (approx. 687 km S). A hatch-year, female Cooper's Hawk banded on 20

September 1998 was captured in a mist net and released in good health by biologists working at San Simeon State Park in southern California (approx. 872 km SSW) on 24 September 1999. Thus far, 4 of 8 encounters with full details known indicate a migratory pathway along the Pacific Coast or through the Coast Ranges of California.

VISITOR ATTENDANCE

In 1999, the daily number of observers averaged 2.0 (average of daily values, which in turn were averages of hourly records) and the daily average number of visitors was 1.7 visitors per hour of observation. The comparative averages for previous seasons are 2.3 ± 95% CI of 0.69 observers and 1.8 ± 95% CI of 0.88 visitors/hr. Visitor hours (including guest observers and other visitors) totaled 729 in 1999, which is slightly but not significantly lower than the average for the previous 4 years (793 ± 95% CI of 488.7). A reduction in banding activity compared to 1997 and 1998 contributed to the low visitation rate.

DISCUSSION

WEATHER

The high prevalence of fair weather (70% of observation days) in 1999 may have stimulated high migratory activity. Alternatively, actual migratory volume may have been average, but the increase in fair weather may have increased the detectable portion of activity. However, the weather was generally fairer than average in 1998, as well, but counts were not particularly high. While the local area experienced generally typical weather throughout the season, the Pacific Northwest region as a whole experienced dryer than normal conditions from late summer through the migration season (National Climatic Data Center, NOAA web-site). Dry conditions and attendant reductions in prey productivity may have forced greater southward movement among partially migratory species such as Red-tailed Hawks and/or forced more migrants to concentrate along the relatively mesic, montane areas of the Cascades. Counts were also generally high at HWI's Chelan Ridge site in the Washington Cascades (Smith 2000a); however, this was not the case at HWI's Diamond Head site in the Washington Cascades (Smith 2000b).

SEASONAL TIMING

Many factors may affect the seasonal timing of migrations, including direct weather effects on flight timing, indirect weather effects through impacts on prey populations, and natural prey cycles. Few significant differences in comparing 1999 and average median passage dates and seasonal activity patterns suggests that the influence of such factors was limited in 1999. For example, 2 avian-prey specialists, the Sharp-shinned Hawk and Merlin, were 2 days earlier and 1 day later than average, respectively, and 2 small mammalian-prey specialists, the Red-tailed Hawk and Rough-legged Hawk, were 1 day later and 5 days earlier than average, respectively. However, the consistency of results across multiple sites for Rough-legged Hawks is noteworthy. Three other HWI sites with annual counts of 10 or more rough-legs showed earlier than average passage dates and record high counts for the species in 1999 (Neal et al. 2000, Smith 2000a, Vekasy and Smith 2000a). The consistency of these data may indicate an irruptive migration. Such irruptive events are usually triggered by crashes in small mammal populations on the species' tundra breeding grounds or low prey availability and unfavorable weather at typical wintering sites (Palmer 1988). Weather conditions were generally dry and mild during the migration season across most of the Pacific Northwest. Thus, it is unlikely that direct weather effects contributed to the high rough-leg numbers and early passage dates. However, indirect effects may have occurred through effects on prey populations, perhaps forcing rough-legs away from traditional wintering areas to find better foraging conditions.

Within the Cascades flyway, the timing results at Bonney Butte differ markedly from those at HWI's Chelan Ridge and Diamond Head sites in the Washington Cascades. At both Washington sites, most species showed later median passage dates in 1999 than in 1998 (Smith 2000a, b), whereas at Bonney Butte a mixed pattern was evident but earlier passage dates in 1999 were most common. It is possible that this discrepancy is due to the change in seasonal duration of Bonney Butte monitoring in 1999, in particular the fact that inclement weather largely precluded observations after 25 October. Had observations continued as planned for another week, more later than average median dates may have emerged. Otherwise, the discrepancy in results for the three sites suggests that there may be considerable, relatively local variation in flyway dynamics in the Cascades region. This may reflect the fact that these sites lie along a transition zone between two major regional flyways: the Pacific Coast and Intermountain flyways (Smith and Hoffman 2000).

FLIGHT COMPOSITION, PASSAGE RATES AND LONG-TERM TRENDS

An increase in observation hours tends to raise counts but lower calculated passage rates, because the extra effort usually increases proportional representation of periods with low flight activity. This was the case in 1999, as the extra effort occurred early in the season and during early and late hours of observation, all periods of relatively low flight volume. However, for most species the magnitude of increase in counts was much higher than expected from a 35% increase in effort, particularly given that the increased effort was applied primarily during periods of low activity. Moreover, although consistently lesser increases in passage rates than counts does indicate the effects of increased effort, the fact that both counts and passage rates were higher than average for all but 5 species clearly indicates that real increases in flight volume (or possibly detectability) occurred. Most notably, record high counts of Red-tail Hawks, Golden Eagles, Sharp-shinned Hawks, Broad-winged Hawks, and Turkey Vultures were responsible for nearly 90% of the overall count increase, and each of these species also showed higher than average passage rates (although not quite significant for Red-tailed Hawk). Other regularly seen species that showed high counts and at least slightly above average passage rates, a combination that most likely reflects increased flight volume, include Osprey, Northern Harrier, Rough-legged Hawk, Bald Eagle, Prairie Falcon, and Peregrine Falcon. In contrast, regularly seen species that showed moderately higher than average counts but below average passage rates, most likely indicating average flight volume, include Northern Goshawk, American Kestrel, and Merlin. Cooper's Hawk is the only regularly seen species that showed an average count and below average passage rate, suggesting a decrease in flight volume. Red-shouldered, Swainson's and Ferruginous Hawks are all too uncommon to emphasize patterns for these species.

Count and passage rate data from 1999 at HWI's Chelan Ridge and Diamond Head sites in the eastern Cascades of Washington do not consistently mirror the patterns seen at Bonney Butte. Buteo and eagle numbers were generally high at Chelan Ridge, but counts of the small accipiters, small falcons, and Broad-winged Hawks were all down (Smith 2000a). At Diamond Head, counts were down for the small accipiters and falcons and up for Red-tailed and Rough-legged Hawks, but were down for eagles (Smith 2000b). Only a single Broad-winged Hawk has ever been seen at Diamond Head, so no comparison is possible for this species. In general, thus far there appears to be slightly more consistency in results from the two Washington sites than between Bonney Butte and either of the Washington sites. We know that at least some birds fly past both the Diamond Head and Bonney Butte sites, because the same Sharp-shinned Hawk was captured at both sites (HWI and The Falcon Research Group, unpublished data). However, Bonney Butte lies slightly west of the Cascade crest, more within the Pacific Flyway, whereas the two Washington sites lie east of the crest, more within the transition zone between the Pacific Coast and Intermountain flyways. For this reason, the Washington sites may attract a more diverse mix of birds.

Because they are gregarious species that depend heavily on thermals during migration, annual variation in counts of Broad-wing Hawks and Turkey Vultures can be significant if regional weather patterns vary and cause flight lines to shift. However, data from several long-term migration monitoring sites and other sources indicate that both species are increasing in abundance across a broad area of the West (Kiff 2000, Smith et al. in review). This is therefore another possible explanation for high counts of these species at Bonney Butte this season. However, a decreasing trend had been evident for Turkey Vultures at Bonney Butte before this season's record high count, which suggests that shifting flight lines may affect counts at this site more than at other sites.

At Bonney Butte, Osprey counts have increased each year of the project but passage rates have remained relatively stable since 1995; however, the combination of count and passage rate data, considered in the context of increased observation effort, suggested that actual flight volume probably did increase in 1999. Migration counts from several sites as well as other sources of data clearly indicate that Ospreys are increasing over a broad area of the country (Smith et al. in review). Osprey populations suffered heavily during the DDT era, but since then populations have rebounded strongly due to a combination of DDT being banned and the species' ability to adapt to exploiting artificial nesting platforms and reservoirs (Henny and Anthony 1989, Poole 1989, Henny and Kaiser 1995).

Northern Harrier counts and passage rates were above average at most HWI count sites in the interior West during 1998 because of very high abundance of immature birds. High recruitment of young adults into the population would be expected to lower 1999 age ratios if juvenile recruitment remained average. This was the case at Bonney Butte and Chelan Ridge (Smith 2000a), but not at Diamond Head where abundance of adults was average and abundance of immatures was low (Smith 2000b). Similar mixed results occurred at 5 other HWI sites in the interior West, with only 3 sites showing high abundance of adults (Vekasy and Smith 2000a, b, d) and 4 sites showing high abundance of immature birds (Vekasy and Smith 2000a, b, c, d). The pattern in the Bridger Mountains (Neal et al. 2000) was similar to that shown at Diamond Head. Prolonged drought over much of the southwestern U.S. and northern Mexico due to a La Niña weather pattern may have resulted in high mortality among young birds over the 1998/99 winter in some areas. It appeared that this may have contributed to low abundance of adults during spring and fall 1999 in New Mexico (Smith 2000c, Vekasy and Smith 2000b); however, high adult abundance during fall 1999 most everywhere else suggests that harrier survivorship during winter 1998/99 was overall moderate to high. In addition, average to high abundance of immature harriers during fall 1999 at 6 of HWI's 8 sites in the western U.S. indicates that the very productive 1998 breeding season was followed by at least a moderately productive breeding season in 1999.

One of the few consistent patterns across the three Cascade sites involves Cooper's Hawks (Smith 2000a, b), which was the only species to show average to below average counts and passage rates at all three sites. A similar pattern was shown at several other HWI sites in the interior West, along with low immature : adult ratios due to low abundance of immature birds (Vekasy and Smith 2000a, b; Neal et al. 2000); however, the opposite was true at southern sites in New Mexico (Vekasy and Smith 2000c) and Arizona (Vekasy and Smith 2000d). This suggests that productivity for this species was low at northern latitudes, but higher in the southern Rocky Mountains and southern Great Basin.

Age-specific data from Bonney Butte suggest that Red-tailed Hawks experienced both high productivity (high immature counts) and high adult recruitment (high adult counts) in 1999 and that this is the reason for the high counts. Similar results applied at most HWI sites in 1999. Although the pattern was less clear in the Pacific Northwest, Red-tailed Hawks were one of several species that showed widespread high counts in 1998 due to high juvenile recruitment (e.g., Lanzone 1999, Neal 1999, Rossman 1999, Tidhar and Peacock 1999). It therefore appears that high juvenile recruitment in 1998 resulted in high adult recruitment in 1999 for this species, and that juvenile recruitment was again high in 1999. Statistically significant long-term increasing trends generally are not yet evident in HWI's migration data (Smith et al. in review), but widespread high counts in 1998 and 1999 have added an upward inflection to trends at most sites. Red-tailed Hawks benefit from forest clearing that creates a mosaic of wooded and open country (Preston and Beane 1993).

Prairie Falcon counts and passage rates were average to above average at Bonney Butte and most of HWI's interior sites, but were significantly lower than average at Diamond Head and Chelan Ridge. Reasons for the inconsistent results in the Pacific Northwest are uncertain, but may relate to the fact that the Cascades lie along the western edge of the species' breeding range (Steenhof 1998). Long-term increasing trends are shown for Prairie Falcons at HWI's Goshute Mountains, NV and Manzano Mountains, NM sites (Smith et al. in review), and high counts in both 1998 and 1999 suggest this possibility at Bonney Butte (Appendix D). However, no distinct trends are shown at most other HWI sites (Smith et al. in review, Neal et al. 2000, Smith 2000b, Vekasy and Smith 2000d). In contrast, average to high counts of Peregrine Falcons were widespread in 1999 and strong increasing trends are shown at most HWI sites. Peregrine Falcons were negatively impacted by heavy use of organochlorine pesticides in the 1950s and 1960s; however, subsequent banning of DDT for agricultural use allowed populations to rebound in many areas (Cade et al. 1988). Captive breeding and release programs also have been instrumental in the Peregrine Falcon's recovery (Cade et al. 1988) and removal from the Endangered Species list (USDI Fish and Wildlife Service 1999).

Capture Timing, Rates, Success and Composition

Comparisons of 1999 and 1995–1998 mean capture rates mirror comparisons of 1999 and 1994–1998 mean passage rates for 7 of 10 relevant species. Exceptions include Sharp-shinned Hawk (record high passage rate but average capture rate), American Kestrel (slightly below average passage rate but first ever capture), and Prairie Falcon (high passage rate but low capture rate). The number of American Kestrel and Prairie Falcon captures is too low to warrant paying attention to variation in capture rates; however, the discrepancy in count and capture results for Sharp-shinned Hawks is noteworthy. This result may simply reflect the effects of lower trapping effort in 1999 compared to 1997 and 1998. The 1999 capture rate is similar to the rate achieved in 1996 when effort was similar and the second highest count on record occurred. In contrast, the 1999 rate is much lower than in 1997 and 1998 when effort was much higher. Similar to the effect on passage rates of increasing observation hours, one might expect a significant increase in trapping hours to result in a low capture rate. However, in this case the low trapping effort was due to reducing effort from daily to weekends only. This means that there were many days during peak flight periods when trapping did not occur. Thus, unlike the situation with the change in observation effort, the reduction in trapping effort reduced coverage of high as well as low activity periods.

Changes in capture success may reflect changes in 6 factors: (1) passage rates, (2) proportions of immature birds, (3) physical condition of birds (hunger levels, fat storage), (4) weather conditions, (5) trapping station design or trapper skill, and (6) trapping effort. For this season, because of the significant decline in trapping effort relative to 1997 and 1998, it is most instructive to compare annual values rather than 1999 versus 1995–1999 means. Increases in capture success relative to 1997 and 1998 are not expected because of low trapping effort in 1999, and for all commonly captured species no such anomalies occurred. If we then compare the 1999 values with those from 1996 when trapping effort was similar, we see declines among all commonly trapped species except Red-tailed Hawks. Such declines are expected given higher counts and passage rates in 1999. The anomalous increase in capture success for Red-tailed Hawks does not appear to reflect a higher prevalence of immature birds among those captured, because the 1999 immature : adult capture ratio was three times lower than in 1996. Similarly, the trapping station setup and trapper skill levels did not change appreciably. What did change is the average crop levels and body condition of the red-tails captured. In 1999, 83% of the captured red-tails had empty crops, whereas in 1996 only 43% had empty crops. Similarly, in 1999, 97% of the captured red-tails had keel ratings below 2, whereas in 1996 only 71% had average or thin keels. The only result that is inconsistent with the hypothesis that the 1999 birds were hungrier than in 1996 is slightly higher average wing-pit fat ratings in 1999. It is also possible that the noted changes in temperatures and wind patterns somehow may have resulted in greater susceptibility of capture for red-tails.

Robust comparisons of immature : adult ratios derived from count and capture results are possible only for the three accipiters and Red-tailed Hawks. However, patterns of difference between 1999 and average ratios are consistent only for Cooper's and Red-tailed Hawks, and capture age ratios are consistently higher than count age ratios. Reasons for the former differences are unclear, whereas higher capture age ratios are expected because immature birds are more susceptible to capture than adults.

Robust sex and age-specific comparisons of seasonal timing data derived from count and capture results are possible only for Sharp-shinned and Red-tailed Hawks. For Sharp-shinned Hawks, 3 of 4 sex-age specific median capture dates are substantially later than the relevant age-specific median passage dates. Moreover, although median capture dates for adult and immature males are consistent with age-specific median passage dates in showing earlier than average activity in 1999, median capture dates for both age classes of females indicate late rather than early activity. For immature Red-tailed Hawks, median capture and passage dates are in general agreement. For adults, however, the 1999 median passage date matches the long-term average, whereas the 1999 median capture date is much earlier than in 1997 (the only year for which comparative data are available) and is 8 days earlier than the median passage date. Reasons for these discrepancies are uncertain; however, median capture dates may have been affected by reduced trapping effort and, more generally, lower capture totals are expected to yield less reliable indicators of timing than counts.

ENCOUNTERS WITH PREVIOUSLY BANDED RAPTORS

Thus far, the Bonney Butte foreign encounter and recapture data confirm that the site is part of the Pacific Coast flyway. Based on extensive band return data from Golden Gate Raptor Observatory, this flyway extends from southwestern British Columbia to northern Mexico primarily between the Cascade and Sierra Nevada ranges and the Pacific Coast (e.g., Scheuermann 1996).

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Table 1. Annual counts and passage rates by species: 1994–1998 versus 1999.

	1994–1998[1]	1999	% CHANGE	1994–1998[1]	1999	% CHANGE
Start date	1-Sep ± 1.1	27-Aug				
End date	29-Oct ± 3.2	28-Oct				
Observation days	45.6 ± 4.4	63	+38			
Observation hours	307.25 ± 44.820	416.00	+35			
SPECIES	COUNT			RAPTORS / 100 HOURS		
Turkey Vulture	179 ± 35.2	349	+95	60.3 ± 17.81	83.9	+39
Osprey	53 ± 11.6	74	+41	17.4 ± 3.89	17.8	+2
Northern Harrier	34 ± 12.0	49	+42	11.0 ± 2.64	11.8	+7
Sharp-shinned Hawk	938 ± 70.2	1660	+77	310.3 ± 39.88	399.0	+29
Cooper's Hawk	319 ± 53.0	331	+4	107.1 ± 26.93	79.6	-26
Northern Goshawk	29 ± 9.5	36	+25	9.4 ± 3.18	8.7	-8
Unidentified accipiter	87 ± 41.4	155	+79	29.0 ± 14.52	37.3	+29
TOTAL ACCIPITERS	1372 ± 131.0	2182	+59	455.7 ± 74.51	524.5	+15
Red-shouldered Hawk	0.4 ± 0.48	2	+400	0.1 ± 0.15	0.5	+295
Broad-winged Hawk	1.0 ± 1.07	75	+7400	0.4 ± 0.43	18.0	+4778
Swainson's Hawk	1.0 ± 0.88	1	0	0.3 ± 0.27	0.2	-23
Red-tailed Hawk	546 ± 83.7	932	+71	184.0 ± 44.69	224.0	+22
Ferruginous Hawk	0.6 ± 0.48	1	+67	0.2 ± 0.15	0.2	+31
Rough-legged Hawk	13 ± 5.1	21	+67	4.1 ± 1.77	5.0	+22
Unidentified buteo	35 ± 9.9	58	+66	11.8 ± 4.02	13.9	+18
TOTAL BUTEOS	597 ± 89.7	1090	+83	200.9 ± 48.28	262.0	+30
Golden Eagle	86 ± 13.8	176	+105	28.5 ± 5.81	42.3	+49
Bald Eagle	38 ± 3.7	53	+41	12.5 ± 2.31	12.7	+2
Unidentified eagle	3.8 ± 2.73	2	-47	1.2 ± 0.96	0.5	-61
TOTAL EAGLES	127 ± 12.8	231	+82	42.2 ± 6.97	55.5	+31
American Kestrel	24 ± 6.5	30	+23	8.0 ± 2.29	7.2	-10
Merlin	63 ± 24.5	83	+33	20.6 ± 8.33	20.0	-3
Prairie Falcon	4.8 ± 3.12	8	+67	1.5 ± 0.82	1.9	+29
Peregrine Falcon	2.6 ± 1.82	5	+92	0.9 ± 0.67	1.2	+40
Unidentified falcon	4.0 ± 2.06	0	-100	1.3 ± 0.59	0.0	-100
TOTAL FALCONS	98 ± 29.6	126	+28	32.3 ± 10.02	30.3	-6
Unidentified Raptor	45 ± 22.8	32	-29	15.2 ± 8.31	7.7	-49
ALL SPECIES	2506 ± 193.0	4133	+65	835.0 ± 141.24	993.5	+19

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

Table 2. Annual trapping effort and capture totals by species: 1995–1999.

	1995	1996	1997	1998	1999	AVERAGE
First trapping day	7-Oct	18-Sep	31-Aug	6-Sep	5-Sep	
Last trapping day	28-Oct	10-Oct	1-Nov	30-Oct	24-Oct	
Number of stations	1	1	1	1	1	1
Station days	10	21	39	34	22	25
Station hours	44.50	127.20	202.80	199.95	142.75	143.44
SPECIES			NUMBER OF CAPTURES			
Northern Harrier	0	1	0	2	1	0.8
Sharp-shinned Hawk	18	80	139	163	82	96
Cooper's Hawk	0	20	29	43	14	21
Northern Goshawk	1	7	7	3	3	4
Red-tailed Hawk	2	14	39	29	36	24
Rough-legged Hawk	0	0	1	0	1	0.4
Golden Eagle	0	3	2	1	2	2
American Kestrel	0	0	0	0	1	0
Merlin	1	2	5	11	3	4
Prairie Falcon	0	0	1	4	0	1
All species	22	127	223	256	143	154
Recaptures	0	0	0	0	0	0
Foreign Recaptures	0	0	1	1	0	0.4
Foreign Encounters	1	0	1	2	5	1.6

Table 3. Counts by age class and immature : adult ratios for selected species: 1994–1998 versus 1999.

	Total and Age-classified Counts						% Unknown Age		Immature : Adult Ratio	
	1994–1998 Average			1999						
	Total	Imm.	Adult	Total	Imm.	Adult	1994–1998[1]	1999	1994–1998[1]	1999
Northern Harrier	34	19	4	49	19	11	25 ± 10.6	10	6.25 ± 5.116	1.73
Sharp-shinned Hawk	937	228	329	1660	228	436	41 ± 7.7	60	0.73 ± 0.330	0.52
Cooper's Hawk	319	102	75	331	64	56	44 ± 6.0	64	1.99 ± 1.880	1.14
Northern Goshawk	29	11	6	36	20	9	40 ± 18.3	19	2.56 ± 1.472	2.22
Red-shouldered Hawk	0.4	0.4	0.0	2	1	0	0 ± 0.0	50	≥1	≥1
Broad-winged Hawk	1.0	0.6	0.4	75	1	6	0 ± 0.0	91	1.00 ± 1.132	0.17
Red-tailed Hawk	546	155	276	932	260	526	21 ± 4.5	16	0.63 ± 0.260	0.49
Ferruginous Hawk	0.6	0.2	0.0	1	0	0	67 ± 65.3	100	≥1	–
Golden Eagle	86	41	28	176	91	37	18 ± 5.2	27	1.56 ± 0.424	2.46
Bald Eagle	38	7	26	53	6	45	11 ± 9.8	4	0.29 ± 0.152	0.13
Peregrine Falcon	2.4	0.4	1.0	5	2	2	33 ± 23.1	20	0.50 ± 0.566	1.00

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

Table 4. First and last observation, bulk passage, and median passage dates by species for 1999, with a comparison of median passage dates for 1999 versus 1994–1998 means.

	1999				1994–1998
SPECIES	FIRST OBSERVED	LAST OBSERVED	BULK PASSAGE DATES[1]	MEDIAN PASSAGE DATE[2]	MEDIAN PASSAGE DATE[3]
Turkey Vulture	27-Aug	10-Oct	16-Sep – 2-Oct	24-Sep	22-Sep ± 2.1
Osprey	2-Sep	24-Oct	6-Sep – 1-Oct	21-Sep	17-Sep ± 2.1
Northern Harrier	7-Sep	24-Oct	18-Sep – 21-Oct	4-Oct	27-Sep ± 7.9
Sharp-shinned Hawk	27-Aug	24-Oct	20-Sep – 17-Oct	3-Oct	5-Oct ± 3.3
Cooper's Hawk	27-Aug	24-Oct	12-Sep – 17-Oct	29-Sep	25-Sep ± 3.5
Northern Goshawk	2-Sep	23-Oct	11-Sep – 17-Oct	28-Sep	3-Oct ± 6.4
Red-shouldered Hawk	21-Sep	27-Sep	–	–	–
Broad-winged Hawk	20-Sep	15-Oct	29-Sep 1-Oct	29-Sep	–
Swainson's Hawk	14-Oct	14-Oct	–	–	–
Red-tailed Hawk	27-Aug	24-Oct	10-Sep – 15-Oct	29-Sep	28-Sep ± 3.8
Ferruginous Hawk	13-Sep	13-Sep	–	–	–
Rough-legged Hawk	4-Oct	23-Oct	10-Oct – 23-Oct	18-Oct	23-Oct ± 1.8
Golden Eagle	28-Aug	24-Oct	27-Sep – 18-Oct	11-Oct	11-Oct ± 3.6
Bald Eagle	4-Sep	23-Oct	19-Sep – 20-Oct	3-Oct	5-Oct ± 5.3
American Kestrel	27-Aug	19-Oct	27-Aug – 10-Oct	11-Sep	21-Sep ± 2.3
Merlin	11-Sep	23-Oct	19-Sep – 19-Oct	10-Oct	9-Oct ± 4.0
Prairie Falcon	10-Sep	22-Oct	10-Sep – 22-Oct	21-Sep	23-Sep ± 8.6
Peregrine Falcon	11-Sep	15-Oct	11-Sep – 15-Oct	29-Sep	–
All species	2-Sep	24-Oct	15-Sep – 17-Oct	1-Oct	30-Sep ± 2.2

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

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

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

Table 5. Median passage dates by age for selected species: 1994–1998 versus 1999.

	Adult		Immature	
Species	1994–1998[1]	1999	1994–1998[1]	1999
Northern Harrier	9-Oct ± 8.8	4-Oct	23-Sep ± 2.4	3-Oct
Sharp-shinned Hawk	11-Oct ± 3.1	4-Oct	22-Sep ± 3.1	21-Sep
Cooper’s Hawk	30-Sep ± 3.8	4-Oct	20-Sep ± 2.4	14-Sep
Northern Goshawk	–	15-Oct	28-Sep ± 9.5	21-Sep
Red-tailed Hawk	2-Oct ± 5.1	2-Oct	22-Sep ± 3.8	20-Sep
Golden Eagle	11-Oct ± 1.6	14-Oct	9-Oct ± 4.8	4-Oct
Bald Eagle	6-Oct ± 7.1	3-Oct	8-Oct ± 6.1	14-Oct

Note: Median passage dates are dates by which 50% of species/age-specific flights had passed; values are based only on annual counts ≥5 birds.

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

Table 6. Annual capture rates (captures / 100 station hours) by species: 1995–1999.

Species	1995	1996	1997	1998	1995–1998 Mean ± 95% CI	1999
Northern Harrier	0.0	0.8	0.0	1.0	0.4 ± 0.51	0.7
Sharp-shinned Hawk	40.4	62.9	68.5	81.5	63.4 ± 16.80	57.4
Cooper's Hawk	0.0	15.7	14.3	21.5	12.9 ± 8.95	9.8
Northern Goshawk	2.2	5.5	3.5	1.5	3.2 ± 1.71	2.1
Red-tailed Hawk	4.5	11.0	19.2	14.5	12.3 ± 6.08	25.2
Rough-legged Hawk	0.0	0.0	0.5	0.0	0.1 ± 0.24	0.7
Golden Eagle	0.0	2.4	1.0	0.5	1.0 ± 0.99	1.4
American Kestrel	0.0	0.0	0.0	0.0	0.0 ± 0.00	0.7
Merlin	2.2	1.6	2.5	5.5	2.9 ± 1.71	2.1
Prairie Falcon	0.0	0.0	0.5	2.0	0.6 ± 0.93	0.0
All species	49.4	99.8	110.0	128.0	96.8 ± 33.00	100.2

Table 7. Annual percent capture success (# captured / # observed * 100) by species: 1995–1999.

Species	1995	1996	1997	1998	1995–1998 mean ± 95% CI	1999
Northern Harrier	0.0	2.6	0.0	3.6	0.9 ± 1.68	2.0
Sharp-shinned Hawk	2.0	7.4	13.6	14.9	7.6 ± 6.57	4.6
Cooper's Hawk	0.0	4.5	8.1	15.0	4.2 ± 4.62	3.9
Northern Goshawk	7.7	16.7	18.4	8.6	14.3 ± 6.51	7.7
Red-shouldered Hawk	–	–	0.0	0.0	0.0 ± 0.00	0.0
Broad-winged Hawk	0.0	0.0	–	–	0.0 ± 0.00	0.0
Swainson’s Hawk	–	0.0	0.0	0.0	0.0 ± 0.00	0.0
Red-tailed Hawk	0.4	2.0	5.8	6.6	2.7 ± 3.13	3.7
Ferruginous Hawk	–	–	0.0	0.0	0.0 ± 0.00	0.0
Rough-legged Hawk	0.0	0.0	4.5	0.0	1.5 ± 2.97	4.5
Golden Eagle	0.0	4.5	1.8	1.2	2.1 ± 2.59	1.1
Bald Eagle	0.0	0.0	0.0	0.0	0.0 ± 0.00	0.0
American Kestrel	0.0	0.0	0.0	0.0	0.0 ± 0.00	3.3
Merlin	2.0	4.3	4.7	13.6	3.6 ± 1.67	3.6
Prairie Falcon	0.0	–	20.0	40.0	10.0 ± 19.60	0.0
Peregrine Falcon	0.0	–	0.0	0.0	0.0 ± 0.00	0.0
Total	1.1	5.1	9.1	11.8	5.1 ± 4.55	3.9

Table 8. Capture totals by sex and age for selected species: 1995–1998 versus 1999.

	1995–1998 average capture total						1999 capture total					
	Female		Male		Unknown		Female		Male		Unknown	
	HY[1]	AHY	HY	AHY	HY	AHY	HY	AHY	HY	AHY	HY	AHY
Northern Harrier	0.5	0.0	0.3	0.0	–	–	0	1	0	0	0	0
Sharp-shinned Hawk	37	21	30	13	–	–	37	14	19	12	0	0
Cooper's Hawk	9	8	6	1	–	–	5	4	3	2	0	0
Northern Goshawk	1.3	0.8	1.8	0.8	–	–	0	0	3	0	0	0
Red-tailed Hawk	–	–	–	–	18	3	0	0	0	0	23	13
Rough-legged Hawk	–	–	–	–	0.3	0	0	0	1	0	0	0
Golden Eagle	0.3	0.0	0.3	0.0	1	0	0	0	2	0	0	0
American Kestrel	0	0	0	0	0	0	1	0	0	0	0	0
Merlin	2.3	0.3	2.0	0.3	–	–	1	0	1	1	0	0
Prairie Falcon	0.5	0.0	0.8	0.0	–	–	0	0	0	0	0	0

[1] HY = hatch-year or immature; AHY = after hatch-year or adult

Table 9. Capture age and sex ratios for selected species: 1995–1997 versus 1999.

	I : A Ratio		F : M Ratio	
	1995–1998[1]	1999	1995–1998[1]	1999
Sharp-shinned Hawk	1.8 ± 1.46	2.2	1.3 ± 0.36	1.6
Cooper's Hawk	1.8 ± 0.81	1.3	2.4 ± 0.21	1.8
Northern Goshawk	2.6 ± 2.95	≥3	0.8 ± 0.56	0.0
Red-tailed Hawk	9.7 ± 12.06	1.8	–	–
Merlin	3.1 ± 1.89	2.0	1.1 ± 0.28	0.5

[1] Mean ± 95% CI (confidence interval).

Table 10. Median capture dates for selected species by sex and age: 1997–1999

Species	Sex	Age	1995–1998[1]	1999
Sharp-shinned Hawk	female	immature	27-Sep ± 4.6	3-Oct
	female	adult	7-Oct ± 6.0	13-Oct
	male	immature	28-Sep ± 3.6	19-Sep
	male	adult	14-Oct ± 6.6	10-Oct
Cooper’s Hawk	female	immature	22-Sep ± 6.4	18-Sep
	female	adult	3-Oct ± 11.8	–
	male	immature	24-Sep ± 4.9	–
	male	adult	–	–
Red-tailed Hawk	unknown	immature	23-Sep ± 5.2	19-Sep
	unknown	adult	19-Oct [2]	24-Sep

Note: Median capture date is the date by which 50% of total captures occurred; calculated only for species-sex-age classes with annual capture totals ≥5 birds.

[1] Mean ± 95% CI (confidence interval).

[2] Based on data from 1997 only.

Table 11. Measures of body condition (% of captured raptors in category) by species and year: 1995–1998 averages versus 1999.

		Crop[1]					Keel[2]			Wing-pit Fat[3]			
Species	Year	0	1/4	1/2	3/4	1	0	1	2	0	1	2	3
Northern	1995–98	75	0	0	0	25	0	100	0	50	50	0	0
Harrier	1999	100	0	0	0	0	0	100	0	0	100	0	0
Sharp-shinned	1995–98	49	27	11	7	6	2	67	31	15	53	21	12
Hawk	1999	61	24	10	4	1	0	99	1	6	70	11	13
Cooper's	1995–98	53	17	15	9	6	14	75	10	32	49	11	8
Hawk	1999	64	36	0	0	0	21	79	0	14	71	14	0
Northern	1995–98	63	26	0	4	7	24	76	0	19	77	4	0
Goshawk	1999	100	0	0	0	0	0	100	0	0	67	33	0
Red-tailed	1995–98	78	9	8	3	2	23	69	8	63	36	1	0
Hawk	1999	83	14	3	0	0	0	97	3	17	81	3	0
Rough-legged	1995–98	100	0	0	0	0	0	100	0	100	0	0	0
Hawk	1999	100	0	0	0	0	0	100	0	100	0	0	0
Golden	1995–98	100	0	0	0	0	17	50	33	67	33	0	0
Eagle	1999	100	0	0	0	0	0	100	0	50	50	0	0
American	1995–98	–	–	–	–	–	–	–	–	–	–	–	–
Kestrel	1999	100	0	0	0	0	0	100	0	0	100	0	0
Merlin	1995–98	88	7	5	0	0	15	78	7	19	47	9	25
	1999	67	33	0	0	0	0	100	0	0	100	0	0
Prairie	1995–98	25	63	0	13	0	25	75	0	50	50	0	0
Falcon	1999	–	–	–	–	–	–	–	–	–	–	–	–

[1] Degree to which crop (esophagus) is filled with food.

[2] Assessment of muscle mass along keel, with 0 = skinny, 1 = normal, and 2 = heavy.

[3] Assessment of fat storage in wing-pit area: 0 = none, 1 = light, 2 = moderate, 3 = heavy.

Table 12. Foreign recaptures and foreign encounters associated with the Bonney Butte Raptor Migration Study.

Date banded	Species	Age	Sex	Banding site	Recovery date	Recovery location	Distance (km)	Disposition
28-Oct-95	SS	HY	F	Bonney Butte, OR	15-Dec-95	Drew, OR	272.96	found dead, unknown cause
02-Sep-97	SS	HY	F	Diamond Head, WA	06-Sep-97	Bonney Butte, OR	189.12	captured and released
29-Sep-97	SS	HY	F	Bonney Butte, OR	19-Oct-97	Madras, OR	66.17	window kill
19-Sep-97	RT	HY	U	Bonney Butte, OR	26-Jan-98	Walnut Creek, CA	690.37	injured and euthanized
16-Oct-97	SS	HY	F	Bonney Butte, OR	14-Feb-98	Central Point, OR	310.37	found dead, unknown cause
24-Sep-93	SS	HY	F	Marin Headlands, CA	13-Sep-98	Bonney Butte, OR	681.32	captured and released
24-Oct-97	SS	AHY	M	Bonney Butte, OR	13-Mar-99	San Francisco, CA	737.48	killed by car
20-Sep-98	CH	HY	F	Bonney Butte, OR	24-Sep-99	San Simeon, CA	872.40	captured and released
24-Sep-99	RT	HY	U	Bonney Butte, OR	Winter 1999	unknown	unknown	waiting for full BBL report
29-Sep-99	RT	HY	U	Bonney Butte, OR	Winter 1999	unknown	unknown	waiting for full BBL report

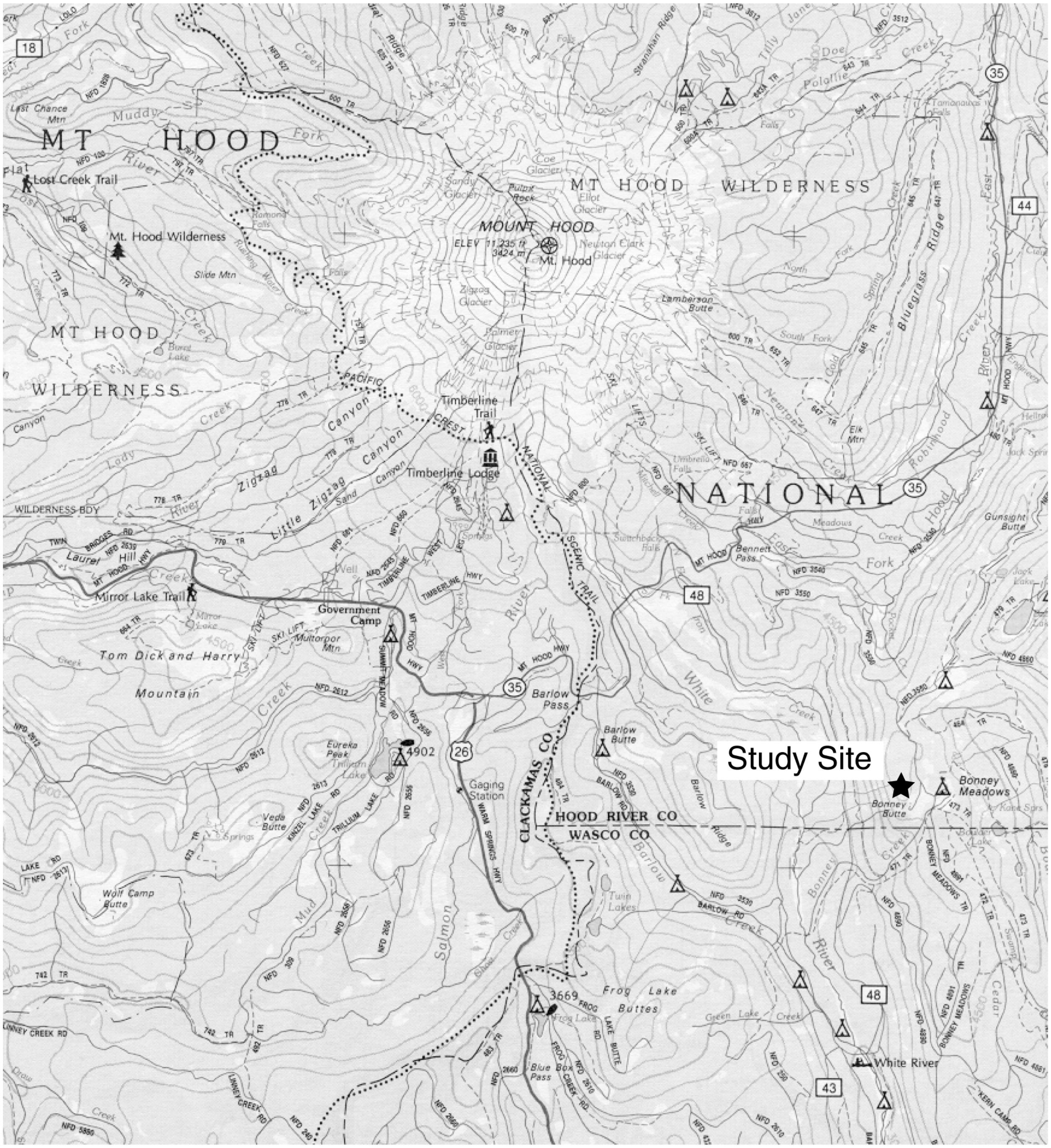

Figure 1. Location of Bonney Butte study site near Mt. Hood, Oregon.

Figure 2. Combined-species annual passage rate: 1994–1999.

Figure 3. Flight composition by major species groups: 1994–1998 versus 1999.

Figure 4. Combined-species flight volume by hourly periods: 1994–1998 versus 1999.

Figure 5. Combined-species flight volume by 5-day periods: 1994–1998 versus 1999.

Figure 6. Annual passage rates for Turkey Vultures, Ospreys, and Northern Harriers: 1994–1999.

Figure 7. Flight volume by 5-day periods for Turkey Vultures, Ospreys, and Northern Harriers: 1994–1998 versus 1999.

Figure 8. Annual passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks: 1994–1999.

Figure 9. Flight volume by 5-day periods for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks: 1994–1998 versus 1999.

Figure 10. Annual passage rates for Broad-winged, Red-tailed and Rough-legged Hawks: 1994–1999.

Figure 11. Flight volume by 5-day periods for Broad-winged, Red-tailed and Rough-legged Hawks: 1994–1998 versus 1999.

Figure 12. Annual passage rates for Golden and Bald Eagles: 1994–1999.

Figure 13. Flight volume by 5-day periods for Golden and Bald Eagles: 1994–1998 versus 1999.

Figure 14. Annual passage rates for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons: 1994–1999.

Figure 15. Flight volume by 5-day periods for American Kestrels and Merlins: 1994–1998 versus 1999.

Figure 16. Flight volume by 5-day periods for Prairie and Peregrine Falcons: 1994–1998 versus 1999.

Appendix A. Common and scientific names, species codes, and regularly applied age, sex, and color morph classifications for all raptor species observed during migration at Bonney Butte, Oregon.

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
Swainson'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 U	AM Br U	NA
Prairie Falcon	*Falco mexicanus*	PR	U	U	NA
Peregrine Falcon	*Falco peregrinus*	PG	A I 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 B. A history of observer participation in the Bonney Butte raptor migration project: 1994–1998.

1994: Single observer throughout: David Schuetze (0) and Sean O'Connor (0)[1].

1995: Two observers throughout: David Schuetze (1) and Alison Clark (0).

1996: Two observers throughout: David Schuetze (2) and Alison Clark (1).

1997: Two observers throughout: Rose Jaffe (0) and Sean Donaghy (0).

1998: Two observers throughout: Nikos Vulgares (1) and Jeremy Davit (0).

1999: Two observers throughout: Nikos Vulgares (3) and Sue Vulgares (0).

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

Appendix C. Daily summaries of observation effort, visitation, predominant weather conditions, and raptor passage rates: 1999.

Date	Obs. Hours	Average Observers	Average Visitors	Sky Condition[1]	Wind Speed[3]	Wind Direct	Avg. Temp. (°C)	Avg. Visib. E (km)	Avg. Visib. W (km)	Thermal Lift[2]	Flight Dist.[4]	Raptors / Hour
27-Aug	8.50	2.0	0.2	pc-mc, haze	0	ne, var	23.8	100	100	2	2	1.2
28-Aug	7.25	2.0	0.0	pc-ovc, haze	0	wnw-nw	20.3	100	100	2	3	0.3
29-Aug	1.00	2.0	0.0	fog	1	wnw	11.0	2	0	4	-	0.0
30-Aug	0.50	2.0	0.0	fog/rain/snow	2	w	0.0	0	0	4	-	0.0
31-Aug	0.25	2.0	0.0	fog/rain	1	w	2.0	0	0	4	-	0.0
1-Sep	6.50	2.0	0.0	clr, ovc PM	1	ne-e	9.3	100	100	2	2	0.2
2-Sep	7.00	2.0	0.4	clr-mc	0	ne, w	10.6	100	100	2	3	3.0
3-Sep	8.50	2.0	1.3	clr-pc	0	var	11.7	100	100	2	3	2.0
4-Sep	8.50	2.0	3.8	ovc-pc	0	wsw-nw	13.8	100	100	3	3	0.9
5-Sep	8.50	2.0	1.6	pc, ovc PM	1	sw-nw	14.6	100	100	3	3	2.1
6-Sep	7.25	2.0	0.4	fog/rain AM, ovc-pc	1	sw-wnw	9.2	89	59	3	3	1.4
7-Sep	8.75	2.0	0.0	clr/haze	1	n-ne	10.0	98	95	2	2	1.7
8-Sep	8.50	2.0	0.0	clr/haze	2	ne	13.5	100	100	3	2	5.4
9-Sep	9.25	1.9	0.0	clr/haze	1	sw-nw	12.6	95	94	3	3	7.1
10-Sep	7.50	2.0	0.0	clr/haze	0	wsw-wnw	13.3	100	100	2	3	3.2
11-Sep	8.50	2.0	2.2	clr/haze	2	ene-ne	10.6	100	100	3	3	5.6
12-Sep	8.50	2.0	0.4	clr/haze	1	ene-ne	13.1	100	100	3	3	3.4
13-Sep	8.25	1.9	0.2	clr/haze	1	ne	16.1	100	100	2	3	6.3
14-Sep	7.50	1.8	0.0	clr-pc, haze	0	ese, sw-nw	18.8	100	100	1	3	6.0
15-Sep	8.50	1.7	2.2	clr/haze	0	sw-wsw	16.2	100	100	1	3	5.8
16-Sep	8.75	2.0	0.7	clr/haze	0	sw-wsw	14.4	100	100	1	2	7.2
17-Sep	8.00	2.0	0.3	clr/haze	0	ene-ne	15.8	100	100	2	3	6.3
18-Sep	8.25	2.6	3.2	clr/haze	0	n-ne	16.6	100	100	1	3	9.0
19-Sep	8.50	2.1	3.3	pc/haze	0	n-ne	17.0	100	100	2	2	11.4
20-Sep	8.50	1.8	0.0	clr/haze	0	n-ne	16.3	100	100	1	3	9.6
21-Sep	8.50	1.9	0.0	clr/haze	0	ene-se, wsw-nw	19.5	100	100	1	2	15.8
22-Sep	8.50	1.9	1.1	clr/haze	0	sw-wnw, se	19.4	100	100	1	3	9.6
23-Sep	7.50	1.8	0.0	pc-ovc/rain	1	nw, se	15.3	81	91	3	3	6.5
24-Sep	8.50	1.9	2.7	pc-ovc	1	sw-nw	9.1	100	100	3	3	10.8
25-Sep	0.25	2.0	0.0	fog/rain	3	sw	1.0	0	0	4	-	0.0
26-Sep	7.00	2.0	4.6	mc-ovc/fog	1	wsw-wnw	3.3	71	51	4	3	6.3
27-Sep	8.00	2.0	1.3	clr-pc	0	se, ne	3.2	100	100	3	3	18.6
28-Sep	8.00	2.0	0.0	clr	1	ne-e	6.3	100	100	3	3	23.8
29-Sep	8.50	2.0	2.6	clr-pc	0	sw-wnw	13.0	100	100	2	3	27.4
30-Sep	7.50	2.0	0.8	clr	0	sw-wnw	10.0	100	100	2	3	13.3
1-Oct	8.00	2.9	3.6	clr/haze	0	ne-se	9.3	100	100	2	3	22.6
2-Oct	8.25	3.0	16.7	clr/haze	1	ne-ese	7.3	100	100	3	3	21.8
3-Oct	8.50	3.0	18.4	clr	0	ne-ese, sw	12.8	100	100	2	3	29.9
4-Oct	7.50	2.0	0.0	clr-pc, haze	0	ese-se, nw	13.6	40	32	2	2	24.7
5-Oct	5.50	1.9	0.8	ovc, fog AM	1	w-nw	7.0	89	68	4	2	1.1
6-Oct	4.00	2.0	0.0	ovc/fog/rain	1	ssw-w	6.6	56	39	4	3	3.0

Appendix C. continued

Date	Obs. Hours	Average Observers	Average Visitors	Sky Condition[1]	Wind Speed[3]	Wind Direct	Avg. Temp. (°C)	Avg. Visib. E (km)	Avg. Visib. W (km)	Thermal Lift[2]	Flight Dist.[4]	Raptors / Hour
7-Oct	2.00	1.5	3.0	fog/rain	0	sw	3.3	0	0	4	-	0.0
8-Oct	0.25	2.0	0.0	fog	2	sw	6.5	0	0	4	-	0.0
9-Oct	6.50	2.0	1.4	mc	0	sw-wsw	4.5	100	100	2	3	23.7
10-Oct	8.00	2.9	6.7	pc-mc	1	ne, sw-wnw	5.2	100	100	3	3	28.6
11-Oct	7.50	2.0	2.1	mc-ovc	1	sw-nw	10.2	100	100	4	3	16.8
12-Oct	7.50	1.9	0.6	clr-mc	1	sw-wnw	9.4	100	100	2	3	12.9
13-Oct	6.25	1.9	0.0	clr-ovc/fog	2	sw-wnw	10.1	88	78	3	3	7.8
14-Oct	7.50	2.0	0.8	ovc-pc	1	sw-w	1.2	98	62	4	3	17.6
15-Oct	8.00	3.0	3.5	pc-clr, fog AM	0	sw-nw	1.6	100	95	3	3	11.5
16-Oct	7.50	2.6	1.8	clr	1	ne	1.4	100	100	4	3	15.9
17-Oct	8.00	2.0	4.8	clr	0	var, nw	9.3	100	100	1	3	14.3
18-Oct	8.00	2.0	1.3	clr	3	ne-e	4.8	100	100	4	3	7.8
19-Oct	7.50	1.3	0.0	clr	1	ne-e	7.7	100	100	2	2	6.4
20-Oct	7.00	2.0	1.5	clr/haze	0	ssw-w	11.9	98	100	1	3	8.9
21-Oct	6.50	1.9	0.1	clr/haze	0	se-s	11.5	100	100	1	2	4.0
22-Oct	7.00	1.9	0.6	clr/haze	0	var	11.1	100	98	1	3	5.1
23-Oct	7.50	2.6	4.5	clr-ovc, dust/haze	2	sw-wsw	10.4	77	70	2	3	4.9
24-Oct	7.00	2.4	2.3	mc-ovc	0	sw, var	6.9	100	100	3	3	4.6
25-Oct	0.50	1.0	0.0	ovc/fog/rain	3	sw	6.0	5	20	4	-	0.0
26-Oct	0.50	2.0	0.0	fog/snow	0	sw	-6.0	0	0	4	-	0.0
27-Oct	0.25	2.0	0.0	fog/snow	7	ene	-3.0	0	0	4	-	0.0
28-Oct	0.25	2.0	0.0	fog/snow	5	sw	-1.0	0	0	4	-	0.0

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

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

[3] Average of hourly categorical ratings: 0 = less than 1 km/h; 1 = 1–5 km/h; 2 = 6–11 km/h; 3 = 12–19 km/h; 4 = 20–28 km/h; 5 = 29–38 km/h, etc.

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

Appendix D. Annual summaries of observation effort and raptor counts by species: 1994–1999.

	1994	1995	1996	1997	1998	1999	MEAN
Start date	2-Sep	4-Sep	1-Sep	1-Sep	1-Sep	27-Aug	31-Aug
End date	25-Oct	31-Oct	2-Nov	3-Nov	30-Oct	28-Oct	29-Oct
Observation days	47	38	46	45	52	63	49
Observation hours	327.74	251.51	285.82	286.25	384.91	416.00	325.37
Raptors / 100 hours	688.0	941.5	959.7	953.7	631.8	993.5	835.0
SPECIES				RAPTOR COUNTS			
Turkey Vulture	204	235	165	133	160	349	208
Osprey	32	49	55	60	67	74	56
Northern Harrier	25	22	39	30	56	49	37
Sharp-shinned Hawk	858	873	1027	912	1018	1660	1058
Cooper's Hawk	280	310	420	317	266	331	321
Northern Goshawk	25	12	40	34	33	36	30
Unidentified accipiter	27	67	85	156	99	155	98
TOTAL ACCIPITERS	1190	1262	1572	1419	1416	2182	1507
Red-shouldered Hawk	0	0	0	1	1	2	1
Broad-winged Hawk	1	3	1	0	0	75	13
Swainson's Hawk	0	0	1	2	2	1	1
Red-tailed Hawk	516	528	649	626	411	932	610
Ferruginous Hawk	1	0	0	1	1	1	1
Rough-legged Hawk	12	12	4	20	15	21	14
Unidentified buteo	23	30	40	52	30	58	39
TOTAL BUTEOS	553	573	695	702	460	1090	679
Golden Eagle	96	81	65	106	81	176	101
Bald Eagle	33	40	42	33	40	53	40
Unidentified eagle	3	2	1	9	4	2	4
TOTAL EAGLES	132	123	108	148	125	231	145
American Kestrel	29	18	18	35	22	30	25
Merlin	36	49	46	104	78	83	66
Prairie Falcon	5	4	0	5	10	8	5
Peregrine Falcon	3	5	0	1	4	5	3
Unidentified falcon	8	3	2	3	4	0	3
TOTAL FALCONS	81	79	66	148	118	126	103
Unidentified raptor	38	25	43	90	30	32	43
GRAND TOTAL	2255	2368	2743	2730	2432	4133	2777

Appendix E. Daily raptor counts: 1999.

		Species[1]																								Raptors
Date	Hours	TV	OS	NH	SS	CH	NG	UA	RS	BW	SW	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	UF	UU	Total	/ Hour
27-Aug	8.50	1	0	0	1	1	0	1	0	0	0	2	0	0	0	0	0	0	4	0	0	0	0	0	10	1.2
28-Aug	7.25	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	2	0.3
29-Aug	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
30-Aug	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
31-Aug	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
1-Sep	6.50	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0.2
2-Sep	7.00	1	2	0	5	0	1	1	0	0	0	8	0	0	0	0	0	1	2	0	0	0	0	0	21	3.0
3-Sep	8.50	0	3	0	2	0	0	2	0	0	0	7	0	0	2	0	0	0	1	0	0	0	0	0	17	2.0
4-Sep	8.50	0	1	0	2	2	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	8	0.9
5-Sep	8.50	0	1	0	5	1	0	0	0	0	0	9	0	0	0	0	1	0	1	0	0	0	0	0	18	2.1
6-Sep	7.25	0	1	0	0	1	0	0	0	0	0	7	0	0	0	0	1	0	0	0	0	0	0	0	10	1.4
7-Sep	8.75	0	3	1	4	0	1	0	0	0	0	5	0	0	0	0	0	0	1	0	0	0	0	0	15	1.7
8-Sep	8.50	0	3	1	15	5	0	1	0	0	0	16	0	0	0	1	0	0	4	0	0	0	0	0	46	5.4
9-Sep	9.25	11	6	0	10	9	1	1	0	0	0	27	0	0	0	1	0	0	0	0	0	0	0	0	66	7.1
10-Sep	7.50	0	2	1	0	7	0	0	0	0	0	10	0	0	0	1	0	0	1	0	2	0	0	0	24	3.2
11-Sep	8.50	0	3	0	9	5	1	2	0	0	0	22	0	0	1	1	0	0	2	1	0	1	0	0	48	5.6
12-Sep	8.50	2	2	0	5	3	1	2	0	0	0	11	0	0	0	1	0	0	2	0	0	0	0	0	29	3.4
13-Sep	8.25	7	2	0	12	13	1	0	0	0	0	15	1	0	0	0	0	0	0	1	0	0	0	0	52	6.3
14-Sep	7.50	1	1	0	13	11	0	3	0	0	0	11	0	0	1	1	0	0	0	1	0	0	0	2	45	6.0
15-Sep	8.50	3	1	1	8	5	0	2	0	0	0	20	0	0	0	3	1	0	0	2	1	0	0	2	49	5.8
16-Sep	8.75	20	2	0	11	8	1	0	0	0	0	15	0	0	2	1	1	0	0	0	0	1	0	1	63	7.2
17-Sep	8.00	7	1	0	17	10	2	1	0	0	0	10	0	0	0	0	0	0	0	2	0	0	0	0	50	6.3
18-Sep	8.25	15	1	3	18	8	1	6	0	0	0	15	0	0	0	1	0	0	1	1	0	0	0	4	74	9.0
19-Sep	8.50	21	0	2	25	9	0	11	0	0	0	25	0	0	1	0	1	0	1	1	0	0	0	0	97	11.4
20-Sep	8.50	11	1	1	22	11	2	4	0	3	0	22	0	0	2	0	0	0	0	2	0	0	0	1	82	9.6
21-Sep	8.50	36	2	1	54	9	4	5	1	1	0	17	0	0	1	0	0	0	0	2	1	0	0	0	134	15.8
22-Sep	8.50	9	2	0	27	7	0	9	0	0	0	24	0	0	1	0	0	0	0	0	1	0	0	2	82	9.6
23-Sep	7.50	3	8	1	7	6	1	0	0	0	0	18	0	0	1	1	2	0	0	1	0	0	0	0	49	6.5
24-Sep	8.50	28	2	0	24	3	0	1	0	0	0	29	0	0	0	1	3	0	0	1	0	0	0	0	92	10.8
25-Sep	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
26-Sep	7.00	3	0	0	7	7	0	2	0	0	0	23	0	0	0	1	1	0	0	0	0	0	0	0	44	6.3
27-Sep	8.00	51	5	1	49	7	0	7	1	0	0	19	0	0	3	3	0	0	1	1	0	0	0	1	149	18.6
28-Sep	8.00	36	6	0	82	5	1	6	0	2	0	42	0	0	1	5	1	0	1	1	1	0	0	0	190	23.8
29-Sep	8.50	15	3	3	67	20	0	4	0	65	0	50	0	0	0	2	2	0	0	1	0	1	0	0	233	27.4
30-Sep	7.50	7	2	0	52	7	0	2	0	0	0	25	0	0	0	2	2	0	1	0	0	0	0	0	100	13.3

Appendix E. continued

Date	Hours	Species[1] TV	OS	NH	SS	CH	NG	UA	RS	BW	SW	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	UF	UU	Total	Raptors / Hour
1-Oct	8.00	19	2	2	68	6	1	10	0	1	0	32	0	0	9	19	4	0	1	7	0	0	0	0	181	22.6
2-Oct	8.25	25	3	0	59	4	1	6	0	0	0	58	0	0	5	6	2	0	0	3	0	0	0	8	180	21.8
3-Oct	8.50	3	0	6	175	4	1	7	0	0	0	31	0	0	5	11	6	0	1	3	1	0	0	0	254	29.9
4-Oct	7.50	7	1	2	110	19	7	3	0	2	0	23	0	1	0	6	0	0	1	2	0	0	0	1	185	24.7
5-Oct	5.50	2	0	0	2	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	6	1.1
6-Oct	4.00	0	0	0	9	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	12	3.0
7-Oct	2.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
8-Oct	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
9-Oct	6.50	2	0	1	92	16	0	4	0	0	0	25	0	0	0	10	0	0	0	4	0	0	0	0	154	23.7
10-Oct	8.00	3	0	4	128	11	0	17	0	0	0	38	0	2	4	7	1	1	2	6	0	0	0	5	229	28.6
11-Oct	7.50	0	0	1	96	1	1	4	0	0	0	12	0	0	0	3	1	0	0	6	0	1	0	0	126	16.8
12-Oct	7.50	0	0	0	42	10	0	2	0	0	0	22	0	2	0	12	2	0	1	4	0	0	0	0	97	12.9
13-Oct	6.25	0	0	0	23	1	0	1	0	0	0	8	0	0	1	10	0	0	0	3	0	0	0	2	49	7.8
14-Oct	7.50	0	0	2	31	11	0	2	0	0	1	55	0	2	2	22	2	0	0	2	0	0	0	0	132	17.6
15-Oct	8.00	0	0	2	16	11	3	2	0	1	0	37	0	0	3	14	1	0	0	1	0	1	0	0	92	11.5
16-Oct	7.50	0	1	2	62	12	0	7	0	0	0	12	0	1	1	7	6	0	0	8	0	0	0	0	119	15.9
17-Oct	8.00	0	0	2	65	13	1	3	0	0	0	16	0	2	1	2	3	0	0	5	0	0	0	1	114	14.3
18-Oct	8.00	0	0	2	20	2	1	5	0	0	0	13	0	3	5	8	1	0	0	0	0	0	0	2	62	7.8
19-Oct	7.50	0	0	1	28	2	0	1	0	0	0	8	0	1	1	2	0	0	1	3	0	0	0	0	48	6.4
20-Oct	7.00	0	0	0	31	4	0	4	0	0	0	13	0	2	2	1	2	0	0	3	0	0	0	0	62	8.9
21-Oct	6.50	0	0	2	13	6	0	0	0	0	0	0	0	0	1	1	1	0	0	2	0	0	0	0	26	4.0
22-Oct	7.00	0	0	2	11	5	1	4	0	0	0	4	0	2	1	2	1	0	0	2	1	0	0	0	36	5.1
23-Oct	7.50	0	0	0	15	4	1	0	0	0	0	9	0	3	0	2	2	0	0	1	0	0	0	0	37	4.9
24-Oct	7.00	0	1	2	11	7	0	0	0	0	0	7	0	0	0	4	0	0	0	0	0	0	0	0	32	4.6
25-Oct	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
26-Oct	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
27-Oct	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
28-Oct	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Total	416.00	349	74	49	1660	331	36	155	2	75	1	932	1	21	58	176	53	2	30	83	8	5	0	32.0	4133	9.9

[1] See Appendix A for full names associated with species codes.

Appendix F. Daily raptor capture totals: 1999.

Date	Station Hours	Species[1]											Captures / hour
		NH	SS	CH	NG	RT	RL	GE	AK	ML	PR	Total	
05-Sep	6.50	0	1	0	0	3	0	0	0	0	0	4	0.6
06-Sep	0.00												
07-Sep	0.00												
08-Sep	0.00												
09-Sep	4.25	0	1	0	0	1	0	0	0	0	0	2	0.5
10-Sep	7.00	0	1	2	0	2	0	0	0	0	0	5	0.7
11-Sep	7.42	0	1	0	0	4	0	0	0	0	0	5	0.7
12-Sep	8.00	0	1	0	0	1	0	0	0	0	0	2	0.3
13-Sep	0.00												
14-Sep	0.00												
15-Sep	0.00												
16-Sep	0.00												
17-Sep	6.67	0	9	1	1	3	0	0	0	0	0	14	2.1
18-Sep	7.00	0	3	2	0	2	0	0	0	0	0	7	1.0
19-Sep	7.75	0	4	2	0	3	0	0	0	1	0	10	1.3
20-Sep	0.00												
21-Sep	0.00												
22-Sep	0.00												
23-Sep	0.00												
24-Sep	7.50	0	2	0	0	3	0	0	0	0	0	5	0.7
25-Sep	0.00												
26-Sep	6.00	0	2	0	0	1	0	0	0	0	0	3	0.5
27-Sep	0.00												
28-Sep	0.00												
29-Sep	5.75	0	5	0	0	2	0	0	0	0	0	7	1.2
30-Sep	5.58	0	2	2	0	4	0	0	0	0	0	8	1.4
01-Oct	0.00												
02-Oct	6.00	0	3	1	0	2	0	0	0	0	0	6	1.0
03-Oct	7.25	1	10	1	0	0	0	0	0	1	0	13	1.8
04-Oct	0.00												
05-Oct	0.00												
06-Oct	0.00												
07-Oct	0.00												
08-Oct	0.00												
09-Oct	7.50	0	11	1	0	1	0	0	0	0	0	13	1.7
10-Oct	6.33	0	6	0	0	0	0	0	1	0	0	7	1.1

Appendix F. continued

Date	Station Hours	NH	SS	CH	NG	RT	RL	GE	AK	ML	PR	Total	Captures / hour
		Species[1]											
11-Oct	0.00												
12-Oct	0.00												
13-Oct	4.00	0	2	0	0	2	0	2	0	0	0	6	1.5
14-Oct	0.00												
15-Oct	0.00												
16-Oct	6.75	0	5	0	0	0	0	0	0	0	0	5	0.7
17-Oct	6.25	0	1	0	0	0	0	0	0	0	0	1	0.2
18-Oct	0.00												
19-Oct	0.00												
20-Oct	5.25	0	5	1	0	0	1	0	0	1	0	8	1.5
21-Oct	0.00												
22-Oct	0.00												
23-Oct	7.00	0	5	0	1	1	0	0	0	0	0	7	1.0
24-Oct	7.00	0	2	1	1	1	0	0	0	0	0	5	0.7
Total	142.75	1	82	14	3	36	1	2	1	3	0	143	1.0

[1] See Appendix A for full names associated with species codes.