FALL 1999 RAPTOR MIGRATION STUDY AT CHELAN RIDGE, WASHINGTON

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EXECUTIVE SUMMARY

During fall 1999, HawkWatch International (HWI) conducted the second standardized, full-season raptor migration count at Chelan Ridge in the eastern Cascade Mountains of north-central Washington. This effort follows an exploratory, 29-day count conducted in fall 1997, which confirmed that the migratory flight through this area was substantial enough to warrant continued monitoring. Each year since 1993, HWI has monitored the raptor migration through the eastern Cascades at Diamond Head, Washington about 86 km (54 mi) south and slightly west of Chelan Ridge. The two sites probably lie along the same flyway, but day-by-day comparisons for 1997 and 1998 showed Chelan Ridge yielding about 30% more detections than Diamond Head. This probably reflects a combination of poorer visibility at Diamond Head and higher actual flight volume at Chelan Ridge. For these and other reasons, HWI is pursuing further development of the Chelan Ridge study in cooperation with the Okanogan National Forest (ONF) as a possible alternative to the Diamond Head count. In addition, a new collaborator, The Falcon Research Group (FRG), joined the project in 1999 to implement a complimentary banding program at the site.

Two trained observers, assisted by ONF biologists and several local volunteers, counted 2,881 raptors of 16 species during 504.33 hours on 61 days between 27 August and 27 October 1999. The observers recorded 15% more observation days and 32% more observation hours in 1999 than in 1998, primarily because we extended the season by 6 days. Compared to 1998, 1999 averaged colder and featured higher proportions of days with moderate/strong and northerly winds, a similar proportion of days affected by snow and rain, and a lower proportion of days with moderate to strong thermals.

The flight was composed of 51% accipiters, 23% buteos, 5% falcons, 6% harriers, 5% eagles, 2% Ospreys, 1% vultures, and 8% unknown raptors. Compared to 1998, the 1999 values reflect significant increases in proportions of buteos and eagles, and significant decreases in proportions of accipiters and falcons. The count yields a combined-species annual passage rate of 571.2 raptors per 100 hours of observation. The count and passage rate are 21% higher and 8% lower, respectively, than the 1998 values. The increase in observation hours contributed to the high count, but the same factor probably contributed to the low passage rate due to inclusion of more hours of observation during periods of low activity. Species whose counts and passage rates increased substantially in 1999 compared to 1998 include Osprey, Northern Goshawk, Swainson's Hawk, Red-tailed Hawk, Rough-legged Hawk, Golden and Bald Eagles, and Peregrine Falcons. Species whose counts and passage rates decreased in 1999 compared to 1998 include Turkey Vulture, Sharp-shinned Hawk, Cooper's Hawk, Broad-winged Hawk, American Kestrel, Merlin, and Prairie Falcon. Count and passage rate results for Northern Harrier were mixed.

The 1998 and 1999 average daily activity patterns were similar, except for showing a slight shift toward earlier activity in 1999. This may reflect low afternoon thermal activity and a consequent shift toward earlier migrations of soaring species. The combined-species seasonal activity pattern showed a relative decline in activity from late August through 10 September and a relative increase in activity during October. Among 14 species with sufficient data for comparisons, 11 species showed median passage dates that were 1–14 days later than in 1998 and 3 species showed 1999 dates that were 1–4 days earlier than in 1998. The prevalence of later median passage dates compared to 1998 reflects in part the extended season. Diamond Head also showed generally later than average dates in 1999; however, results from Bonney Butte in northern Oregon showed no consistent patterns of species-specific timing.

The most conspicuous possible pattern in differences between 1998 and 1999 counts and passage rates concerned the fact that counts were down for the two smallest accipiters, the smallest buteo, and the two smallest falcons, whereas counts were way up for most larger species. Data from Diamond Head and Bonney Butte showed a relatively high degree of consistency with these results. The pattern suggests that some form of visibility bias may have applied, possibly related to variation in weather conditions.

Moderate/strong and northerly winds were more prevalent in 1999 than in 1998 at Chelan. Such conditions tend to concentrate migrants along ridgelines, and high counts of large soaring migrants may be particularly indicative of this effect. However, strong tail winds may increase the pace of migration to a point where the smaller, faster moving species become more difficult rather than easier to detect. It may also be noteworthy that the group of reduced-count species included most of the small-avian prey specialists, perhaps indicating that regional weather patterns had a highly variable effect on the productivity of different classes of prey and their respective predators. Age-specific data shed additional light on this possibility with age ratios indicating low productivity for Sharp-shinned and Cooper's Hawks but high productivity Red-tailed Hawks. Concerning prey ecology, it may be equally noteworthy that the group of high-count species included Northern Goshawks, Rough-legged Hawks, and Golden and Bald Eagles. Each of these species' breeding ranges extends well into the boreal latitudes and the extent of their southward migrations varies in relation to prey conditions on breeding grounds. Highly elevated counts of these species may be indicative of poor prey conditions at northern latitudes and "irruptive" movements by these partially migratory raptors. Again, however, data from Diamond Head and Bonney Butte were only partially consistent with the Chelan data. Thus, both the timing results and count and passage rate data suggest that there may be considerable, relatively local variation in flyway dynamics in the Cascade region. One possible reason for this may be that these sites lie within a transition zone between two major flyways.

The FRG crew captured 220 raptors of 8 species during 388 hours on 47 of 50 days between 28 August and 16 October. Sharp-shinned Hawks comprised 63% of the total captures, Cooper's Hawks 19%, Northern Goshawks 6%, Red-tailed Hawks 5%, Merlins 3%, Northern Harriers 2%, American Kestrels 1%, and Prairie Falcons <1%. The overall combined-species capture rate was 5.7 raptors per 10 hours of trapping effort. The overall combined-species capture success was 8.5% of "trappable" raptors. Species-specific capture rates were generally comparable to those at HWI's Bonney Butte site in Oregon. The first trapping effort at Chelan Ridge was clearly successful and productive.

Visitation to the observation site average 0.7 visitors/hour or 411 total person-hours. These values are 17% and 66% higher, respectively, than in 1998. Besides the scientific value of banding 220 raptors, the new trapping effort also enabled more effective public outreach by providing opportunities for the public to view raptors in the hand. In 2000, HWI will endeavor to add a full-time educator to the field crew to further enhance the projects educational efforts.

The 1999 observation season extended for 3 more days at Chelan than at Diamond Head, and observation hours totaled 28% higher at Chelan. However, the Chelan count yielded more than double the number of birds and a 59% higher passage rate. These differences are much greater than the 37% difference in 1998 and the 30% difference in 1997. The only exceptions to the rule of higher counts at Chelan shown for all three years of comparative counts are for Turkey Vultures (76–80% lower at Chelan) and Cooper's Hawks (3–41% lower at Chelan). Reasons for these apparent anomalies are unclear. Regardless, for 2 of 3 years, the differences between the two sites in counts of Cooper's Hawks were minimal (3–6%) and overall variability in comparative counts of this species has been lower at Chelan. The latter is important for improving the statistical power of trend analyses. Thus, except for perhaps Turkey Vultures, a clear pattern of superiority at Chelan is emerging. Moreover, now that a successful cooperative venture has been established to incorporate banding by the Falcon Research Group and develop a strong, jointly administered education program, the project at Chelan Ridge has definitely taken on a high degree of importance for allocation of continued effort.

ACKNOWLEDGEMENTS

This project is a cooperative effort between HWI, ONF, and FRG. The National Fish and Wildlife Foundation and The Mountaineers Foundation provided funding for this year's count effort, and we are very grateful for their sponsorship.

Numerous individuals were critical to successful promotion and implementation of this season's effort. We are especially grateful for the enthusiasm and contributions of Kent Woodruff, wildlife biologist and local project coordinator for the ONF Methow Valley Ranger District, and his colleague ONF Wildlife Biologist Sarah Haggerty. Dan Harrington did a great job as lead observer and all are especially grateful for Richard Hendrick's participation as an observer. Richard stepped in at the last minute to replace a secondary observer that bailed on us at the last minute. He also dedicated a great deal of effort to improving trails and informative signs at the site, and to providing snacks for other volunteers and visitors. ONF biologists Sarah Haggerty and Kent Woodruff also played important roles as a substitute observers for Dan and Richard on their days off. We are also thankful for ONF staff at the Winthrop Visitor Center and Twisp Office—especially Debbie Conde, Pat Tourangeau, Tommy Days, Spirit Joseph, Kristen Hoppe, and Karen Dahl–who prepared informative public displays about the project, including daily reports of count and banding results, and generally provided strong PR support to the public. Lastly, we thank Bud Anderson and a group of about 25 volunteers affiliated with the Falcon Research Group for their efforts to run the banding program, provide educational opportunities for visitors to see birds in the hand, assist the observers, and generally provide good company during the project. In particular, we greatly appreciate Pat Little's effort to prepare a panoramic display of the observation landscape, complete with identified landmarks, which was of great help to the observers. We look forward to many more years of productive collaboration with FRG and ONF.

Lastly, all of us at HWI, ONF, and FRG would like to dedicate this report to the late Debbie Conde. Debbie's efforts to maintain daily contact with the observers and share jokes and words of encouragement were greatly appreciated and will be missed in subsequent seasons. Debbie was killed in a car wreck during a snowstorm that closed the project on 26 October 1999.

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INTRODUCTION

During fall 1999, associates of HawkWatch International (HWI) conducted the second consecutive standardized, full-season fall raptor migration count at Chelan Ridge in the eastern Cascade Mountains of Washington. HWI is developing the Chelan Ridge raptor migration count in cooperation with the Okanogan National Forest, and in 1999 a new cooperator, The Falcon Research Group, was added to the venture to institute a migrant banding program. Each year since 1993, HWI has monitored the raptor migration through the eastern Cascades at Diamond Head, Washington about 86 km (54 mi) south and slightly west of Chelan Ridge. Limited visibility complicates this count, however, and HWI has begun to develop the Chelan project as a possible alternative. The Chelan Ridge and Diamond Head sites probably lie along the same flyway. Day-by-day comparisons of HWI counts from 1997 and 1998 revealed that Chelan Ridge yielded on average about 30% more detections than Diamond Head (Prosser and DeSorbo 1998, Smith 1999). This probably reflects a combination of poorer visibility at Diamond Head and higher actual flight volume at Chelan Ridge.

Affiliates of HWI and its organizational precursors have been monitoring raptor migrations through western North America since the late 1970s. During fall 1999, HWI coordinated 12 other fall migration counts in Texas, New Mexico, Arizona, Utah, Nevada, Montana, Washington, Oregon, Florida, and Veracruz, Mexico. The primary objective of HWI migration studies is to track long-term trends in the abundance and distribution of migratory diurnal raptors throughout primarily western North America. Additional objectives include the following:

1) Document seasonal flight patterns and determine the species, age, and sex composition of migrating raptors.
2) Evaluate how weather affects the visible migratory flights.
3) Compare data collected at multiple sites to elucidate common patterns and regional complexities.
4) Educate the public about the conservation needs of raptor species, their ecological roles in healthy ecosystems, and their value as biological indicators.

Raptors feed atop food pyramids, inhabit most ecosystems, occupy large home ranges, and are sensitive to environmental contamination and other human disturbances. Therefore, they serve as important biological indicators of ecosystem health (Cade et al. 1988; Bednarz et al. 1990a; Bildstein and Zalles 1995). For example, long-term migration counts in the eastern United States documented declines in several raptor species and helped us understand the deleterious effects of organochlorine pesticides (Spofford 1969, Mueller et al. 1988, Bednarz et al. 1990b). Migration counts, in particular, may also represent the most cost-effective and efficient method for monitoring the regional status and trends of multiple raptor species (Bednarz and Kerlinger 1989, Titus et al. 1989, Bildstein and Zalles 1995, Bildstein et al. 1995, Dunn and Hussell 1995, Dixon et al. 1998, Smith et al. in review). 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.

In this report, I summarize observations made at the Chelan Ridge site during fall 1999, discussing aspects of seasonal timing, daily flight rhythms, and the species, sex, age, and color-morph composition of the flight. Where appropriate, I also compare statistics for the 1999 and primarily 1998 seasons and compare 1999 counts from Chelan Ridge and Diamond Head.

STUDY SITE

Chelan Ridge is located approximately 21 km (13 mi) north–northwest of the village of Chelan on the Chelan County / Okanogan County and Okanogan National Forest / Wenatchee National Forest borders (48°01'12.8"N, 120°05'38.4"W; Fig. 1). The site is located just east of U.S. Forest Service (USFS) Road 8020 (also known as Cooper Mountain Road) approximately 5.4 km (3.4 mi) southeast of the intersection of USFS Roads 8020 and 4010 (also known as Black Canyon Road). Black Canyon Road heads west–southwest from Washington State Road 153 just south of Methow and about 11 km (7 mi) northwest of Pateros.

The Chelan Ridge lookout sits at an elevation of 1,729 m (5675 ft) and provides a 360° view of the surrounding landscape. The view to the south extends across Lake Chelan and into the Wenatchee National Forest. The view to the west follows the ridgeline (known as Cooper Ridge) and extends into the Sawtooth Wilderness. The view to the north extends across the Methow Valley and into the Pasayten Wilderness. The view to the east extends across the Columbia River and the Waterville Plateau. The lookout's southwestern slope is a cliff face with a 70–80° slope that drops about 65 m (200 ft) into the Mitchell Creek Basin. This cliff face creates excellent updrafts on days of medium to high south winds. On such days, migrants using the updrafts fly extremely close to the observation point. There are also unobstructed views of the regions to the south (the basin) and west where thermals frequently form. Mitchell Creek Basin fills the east–west view and is a common place to spot raptors. This basin is approximately 3.5 km wide, with Goff Peak the major landmark on the southern side of the basin. In 1970, a major forest fire cleared Mitchell Creek Basin and today it is filled with snags, lots of exposed rocks, and young, regenerating vegetation consisting mainly of Scouler willow (*Salix scouleri*), big basin sagebrush (*Artemisia tridentata*), and some lodgepole pine (*Pinus contorta*). Many migrants enter Mitchell Creek Basin through a gap in the ridge between the observation point and a similar high point further up the ridge. Looking north into Black Canyon it is difficult to spot migrants against the dark-green backdrop lodgepole and Ponderosa pine (*Pinus ponderosa*) forest. Although the view of the northern horizon is unobstructed, one can not see all of Black Canyon from the lookout. To the southeast, migrant raptors often fly through another gap between the lookout and Cooper Mountain. Some migrants pass the lookout undetected but later can be seen rising above the horizon on thermals near Cooper Mountain.

METHODS

Two primary observers, assisted by several local volunteers, shared responsibility for conducting two-person, daily counts of migrant raptors at the Chelan Ridge site from 27 August to 27 October. Primary observer Dan Harrington had previously conducted an extensive series of exploratory raptor migration counts for HWI in Colorado, and received additional training at HWI's Goshute Mountains project site before the 1999 season. Primary observer Richard Hendrick had 1 previous full season of counting experience at Chelan Ridge. Other knowledgeable local volunteers and Okanogan National Forest biologists Sarah Haggerty and Kent Woodruff also assisted with count, including substituting for the primary observers on their days off. Smith and Hoffman (in review) discuss visitor effects on counts at four other long-term HWI sites. Weather permitting, the observers usually began counts between 0800 and 0900 hrs and ended by 1600 hrs Mountain Standard Time (MST). The observers routinely recorded the following data:

1. Species, age, sex, and color morph of each migrant raptor, whenever possible and applicable (Appendix A lists common and scientific names for all species, information about the applicability of

age, sex, and color morph distinctions, and two-letter codes used to identify species in some tables and figures).

2. Hour of passage for each migrant; e.g., the 1000–1059 hrs MST.
3. Wind speed and direction, air temperature, percent cloud cover, predominant cloud type(s), precipitation, visibility, and an assessment of thermal lift conditions, recorded for each hour of observation on the half hour.
4. Predominant direction, altitude, and distance from the lookout of the flight during each hour.
5. Total minutes observed and mean number of observers (official observers plus visitors who actively scanned for migrants for more than 10 minutes in a given hour) and visitors (all other guests) present during each hour.
6. Daily start and end times for each active 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.

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 100–200 km of their usual territory). A similar rationale is applied to occasionally recording as migrants birds that are traveling to the west or east.

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, I converted counts to passage rates on a daily basis (raptors/100 hours of observation) to adjust for daily variation in sampling effort, and present both raw counts and passage rates for comparison.

Although in some cases I present data from 1997–1999 for comparison, I generally limit multi-year comparisons to 1998 versus 1999 to avoid biases caused by the limited duration of the 1997 season.

RESULTS

WEATHER

Clear to partly cloudy skies and light to moderate winds (≤28 kph) predominated on 59% and 56% of the observation days in 1998 and 1999, respectively (see Appendix B for 1999 daily weather records). However, moderate winds prevailed on 25% of such days in 1999 versus 2% in 1998, and strong winds occurred on 12% of the observation days in 1999 versus none in 1998. Rain and/or snow occurred on 10% of the active observation days in 1999 versus 8% in 1998; however, inclement weather precluded observations entirely on only 1 day in 1999 versus 3 days in 1998. In 1999, southwesterly winds

predominated on 36% of the observation days and occurred during significant portions of another 46% of the observation days. In 1998, the comparative values were 53% and 34%. Otherwise, the most prominent difference in wind directions between the two seasons was that in 1999 northerly winds predominated on 13% of the observation days and occurred during significant portions of another 30% of the observation days, whereas the comparative values for 1998 were 4% and 17%. In 1999, thermal lift conditions were rated as good on 23% of the observation days and fair or poor on 77% of days, whereas in 1998 thermal conditions were rated as good or excellent on 53% of days and fair or poor on 47% of days. In 1999, daily average temperatures ranged from –4.0 to 26.2°C, with a season average of 8.1°C, which is 5 degrees colder than in 1998. In summary, compared to 1998, 1999 averaged colder and featured higher proportions of days with moderate/strong and northerly winds, a similar proportion of days affected by snow and rain, and a lower proportion of days with moderate to strong thermals.

MIGRATION SUMMARY

The observers counted 2,881 raptors of 16 species during 504.33 hours on 61 days between 27 August and 27 October (Table 1; see Appendix C for 1999 daily count records). The flight was composed of 51% accipiters, 23% buteos, 5% falcons, 6% harriers, 5% eagles, 2% Ospreys, 1% vultures, and 8% unknown raptors (Fig. 2). Compared to 1998, the 1999 values reflect significant increases in the proportional representation of buteos and eagles, and significant decreases in representation of accipiters and falcons. No new species were seen and no species seen in previous years were not seen in 1999. The count yields a combined-species annual passage rate of 571.2 raptors per 100 hours of observation (Table 1). The count and passage rate are 21% higher and 8% lower, respectively, than the 1998 values. The observers recorded 15% more observation days and 32% more observation hours in 1999 than in 1998, primarily because we extended the season end to 27 October. The increase in observation hours undoubtedly contributed to the 21% increase in the overall count. Note, however, that the same factor probably contributed to the 8% reduction in the combined-species passage rate due to inclusion of more hours of observation during periods of low activity. Species whose counts and passage rates increased substantially in 1999 compared to 1998 include Osprey, Northern Goshawk, Swainson's Hawk, Red-tailed Hawk, Rough-legged Hawk, Golden and Bald Eagles, and Peregrine Falcons. Species whose counts and passage rates decreased in 1999 compared to 1998 include Turkey Vulture, Sharp-shinned Hawk, Cooper's Hawk, Broad-winged Hawk, American Kestrel, Merlin, and Prairie Falcon. Count and passage rate results for Northern Harrier were mixed, suggesting that passage volume was similar in 1998 and 1999.

Robust comparisons of 1998 and 1999 age ratios were possible for 7 species (Table 2). These comparisons revealed 26–80% reductions in immature : adult ratios for Northern Harrier, Sharp-shinned Hawk, Cooper's Hawk, Northern Goshawk, and Red-tailed Hawk; a 8% increase for Golden Eagle; and no change for Bald Eagle. Sex-specific data revealed a 26% reduction in the female : male ratio for adult Northern Harriers and a 36% increase in the female : male ratio for American Kestrels (Table 3).

The 1998 and 1999 average daily activity patterns are similar, except for showing a slight shift toward earlier activity in 1999 (Fig. 3).

The 1999 combined-species bulk passage dates (dates between which the central 80% of the flight passed) of 9 September to 14 October (Table 4) reflect about an 8-day late shift compared to 1998. The 1999 combined-species median passage date (date by which 50% of the total flight had passed) of 23 September is only 3 days later than in 1998. Nevertheless, the combined-species seasonal activity pattern clearly shows a relative decline in activity from late August through 10 September and a relative increase in activity during October (Fig. 4). Among 14 species with sufficient data for comparisons, 11 species show median passage dates that are 1–14 days later than in 1998 and 3 species show 1999 dates that are 1–4 days earlier than in 1998 (Table 4). No comparison was possible for Bald Eagle or Peregrine Falcon because of low counts in 1998.

Age and sex-specific median passage dates reveal greater complexity for 7 species with sufficient data for comparisons. Data for Northern Harriers reveal that all age and sex groups were earlier than in 1998, but adults and especially adult females were particularly early (Tables 5 and 6). Although the species-level data indicate late (8 days) passage of Sharp-shinned Hawks (Table 4), age-specific data suggest that adults were 1 day earlier in 1999, whereas immatures were 2 days late (Table 5). This discrepancy suggests that the proportion of aged birds varied through the season, and therefore that the age-specific data may not be entirely accurate. Age-specific dates for Cooper's Hawks indicate that adults were 9 days earlier than in 1998, whereas immatures were 4 days late. Sex-specific data for American Kestrels indicate that males were 2 days earlier than in 1998, whereas females were 6 days late (Table 6). For Red-tailed Hawks and Golden Eagles, the age-specific data do not diverge significantly from the species-level indicators.

SPECIES ACCOUNTS

The observers counted 21 **Turkey Vultures** on 15 days between 3 and 30 September (Tables 1 and 4, Appendix C). The count and annual passage rate of 4.2 raptors/100 hrs are 28% and 45% lower, respectively than in 1998 (Table 1). The median passage date of 12 September is 5 days later than in 1998 (Table 4), which is reflected in the seasonal activity pattern as a complete lack of activity during late August (Fig. 5).

The observers counted 47 **Ospreys** on 23 days between 29 August and 15 October (Tables 1 and 4, Appendix C). The count and annual passage rate of 9.3 raptors/100 hrs are 96% and 49% higher than in 1998 (Table 1). The median passage date of 18 September is 4 days earlier than in 1998 (Table 4). This is somewhat misleading, however, in that 1998 showed a bimodal seasonal activity pattern with peaks during 11–15 and 26–30 September, whereas 1999 showed closer to a unimodal pattern with a single, broad peak during 16–25 September (Fig. 5).

The observers counted 167 **Northern Harriers** on 47 days between 27 August and 24 October (Tables 1 and 4, Appendix C). This was the 4th most common species, comprising 6% of the total count. The count and annual passage rate of 33.1 raptors/100 are 10% higher and 17% lower, respectively, than in 1998 (Table 1). The count included 35 (21%) adult males, 16 (10%) adult females, 58 (35%) immatures, 20 (12%) "brown" birds (either adult females or immature birds), and 38 (23%) birds of unknown age or sex. The immature : adult ratio of 1.1 is 27% lower than in 1998 (Table 2). Similarly, the female : male ratio for adults of 0.46 is 26% lower than in 1998 (Table 3). The median passage date for the species of 18 September is 4 days earlier than in 1998 (Table 4); however, age and sex-specific dates show variation from 5–12 days early, with adults and especially adult females particularly early (Tables 5 and 6). These circumstances created an atypical pattern of adults preceding immatures in 1999. The 1998 and 1999 species-level seasonal activity patterns are similar, except for showing a shift in peak activity from 21–30 September in 1998 to 11–20 September in 1999 (Fig. 5).

The observers counted 932 **Sharp-shinned Hawks** on 57 days between 27 August and 26 October (Tables 1 and 4, Appendix C). This was by far the most common species, comprising 32% of the total count. The count and annual passage rate of 184.8 raptors/100 hrs are 2% and 25% lower, respectively, than in 1998 (Table 1). The count included 195 (21%) adults, 351 (38%) immatures, and 386 (41%) birds of unknown age. The immature : adult ratio of 1.8 is 80% lower than in 1998; however, a much higher percentage of unknown-age birds in 1999 may confound this comparison (Table 2). The median passage date for the species of 26 September is 8 days later than in 1998 (Table 4), a shift that is clearly illustrated by comparing the seasonal activity patterns (Fig. 6). Age-specific median dates suggest a different pattern, with adults 1 day earlier than in 1998 and immatures 2 days late (Table 5). However, the mismatch of species-level and age-specific dates suggests that the proportion of aged birds did not remain consistent through the season, and therefore the age-specific data should be considered with

caution. Regardless, timing data for both 1998 and 1999 show the typical pattern of immatures preceding adults. The observers recorded 3 migrant sharp-shins as heading west.

The observers counted 232 **Cooper's Hawks** on 48 days between 27 August and 26 October (Tables 1 and 4, Appendix C). This was the 3rd most common species, comprising 8% of the total flight. The count and annual passage rate of 46.0 raptors/100 hrs are 6% and 29% lower than in 1998 (Table 1). The count included 36 (16%) adults, 65 (28%) immatures, and 131 (56%) birds of unknown age. The immature : adult ratio of 1.8 is 70% lower than in 1998; however, a much higher percentage of unknown-age birds in 1999 may confound this comparison (Table 2). The median passage date for the species of 17 September is 3 days later than in 1998 (Table 4), which is illustrated by a shift in activity from late-August / early September in 1998 to mid-to-late September in 1999 (Fig. 6). Age-specific median dates revealed greater complexity in showing that adults were 9 days earlier than in 1998, whereas immatures were 4 days late (Table 5). Regardless, timing data for both 1998 and 1999 show the typical pattern of immatures preceding adults. The observers recorded 1 migrant Cooper's Hawk as heading west.

The observers counted 50 **Northern Goshawks** on 32 days between 8 September and 25 October (Tables 1 and 4, Appendix C). The count and annual passage rate of 9.9 raptors/100 hrs are 56% and 19% higher than in 1998 (Table 1). The count included 10 (20%) adults, 23 (46%) immatures, and 17 (34%) birds of unknown age. The immature : adult ratio of 2.3 is approximately 84% lower than the technically inestimable 1998 ratio (Table 2). The median passage date for the species of 30 September is 14 days later than in 1998 (Table 4), which the seasonal activity patterns clearly illustrate (Fig. 6). No comparison of median dates for adults was possible because of the absence of identified adults in 1998, but dates for immatures confirmed late passage (9 days) in 1999, and the 1999 median date for adults was 3 days later than for immatures (Table 5). The observers recorded 4 migrant goshawks as heading west.

The observers counted 5 **Broad-winged Hawks** on 4 days between 11 and 17 September (Tables 1 and 4, Appendix C). The count and annual passage rate of 1.0 raptors/100 hrs are 29% and 46% lower, respectively, than in 1998 (Table 1). The count included 0 adults, 3 (60%) immatures, and 2 (40%) birds of unknown age (Table 2). Two of the birds were light-morphs, but the observers were unable to confirm the color morph of the other three (Table 7). The 1998 median passage date for the species of 15 September is 1 day earlier than 1998 (Table 4) and the seasonal activity patterns are similar (Fig. 7).

The observers counted 17 **Swainson's Hawks** on 9 days between 28 August and 30 September (Tables 1 and 4, Appendix C). The count and annual passage rate of 3.4 raptors/100 hrs are 113% and 61% higher than in 1998 (Table 1). The count included 3 light morphs, 7 dark morphs, and 7 birds of unknown color morph. The light : dark morph ratio of 0.4 is 93% lower than in 1998 (Table 7). The median passage date of 17 September is 10 days later than in 1998 (Table 4), which the seasonal activity patterns clearly illustrate (Fig. 7).

The observers counted 450 **Red-tailed Hawks** on 55 days between 27 August and 26 October (Tables 1 and 4, Appendix C). This was the 2nd most common species, comprising 16% of the total flight. The count and annual passage rate of 89.2 raptors/100 hrs are 147% and 88% higher, respectively, than in 1998 (Table 1). The count included 207 (46%) adults, 112 (25%) immatures, and 131 (29%) birds of unknown age. The immature : adult ratio of 0.5 is 50% lower than in 1998 (Table 2). The count included 270 (60%) light morphs, 44 (10%) dark morphs, and 136 (30%) birds of unknown color morph. The light : dark morph ratio of 6.1 is 40% lower than in 1998 (Table 7). The observers classified 4 of the dark morph birds as Harlan's race (*B. j. harlani*). The median passage date for the species of 22 September is 1 day later than in 1998 (Table 4), and the seasonal activity patterns are roughly similar (Fig. 8). Age-specific median passage dates show that adults were 3 days later than in 1998, whereas immatures were 1 day early, and that the typical pattern of immatures preceding adults was maintained (Table 5). The observers recorded 8 migrant red-tails as heading in directions other than south: 6 north or northwest and 2 west.

The observers counted 44 **Rough-legged Hawks** on 15 days between 2 and 26 October (Tables 1 and 4, Appendix C). The count and annual passage rate of 8.7 raptors/100 hrs are 238% and 157% higher, respectively, than in 1998 (Table 1). The count included 22 (50%) light morphs, 2 (5%) dark morphs, and 20 (45%) birds of unknown color morph. The light : dark morph ratio of 11.0 is more than 10 times higher than in 1998 (Table 7). The median passage date of 19 October is 9 days later than in 1998 (Table 4), which is clearly reflected by a relative dearth of birds in late September and early October in 1999 (Fig. 8). However, extension of the season by 6 days definitely contributed to the late shift in median dates for this late-season migrant.

The observers counted 141 **Golden Eagles** on 43 days between 29 August and 26 October (Tables 1 and 4, Appendix C). This was the 5th most common species, comprising 5% of the total count. The count and annual passage rate of 28.0 raptors/100 hrs are 156% and 9% higher, respectively, than 1998 (Table 1). The count included 31 (22%) adults, 86 (61%) immatures and subadults, and 24 (17%) birds of unknown age. The immature/subadult : adult ratio of 2.8 is 8% higher than in 1998 (Table 2). The median passage date for the species of 4 October is 4 days later than in 1998 (Table 4), which the seasonal activity patterns illustrate (Fig. 9). However, extension of the season by 6 days definitely contributed to the late shift in median dates for this mid-to-late-season migrant. Age-specific median passage dates showed that passage of adults was slightly more delayed (5 days) than passage of immatures and subadults (2 days; Table 5). The observers recorded 1 migrant Golden Eagle as heading west.

The observers counted 7 adult **Bald Eagles** on 6 days between 26 September and 24 October (Tables 1 and 4, Appendix C). The count and annual passage rate of 1.4 raptors/100 hrs are 250% and 166% higher, respectively, than in 1998 (Table 1). The absence of immature and subadult birds is consistent with observations of 2 adults in both 1997 and 1998. The median passage date in 1999 was 15 October (Table 4). No comparison of median dates with previous years is possible because of low counts; however, the timing of passage for the two birds seen in 1998 falls within the range of 1999 observations (Fig. 9). Note also that 2 of the 7 birds seen in 1999 occurred after the 1998 closing date.

The observers counted 89 **American Kestrels** on 33 days between 27 August and 22 October (Tables 1 and 4, Appendix C). The count and annual passage rate of 17.6 raptors/100 hrs are 17% and 37% lower than in 1998 (Table 1). The count included 39 (44%) males, 28 (31%) females, and 22 (25%) birds of unknown sex. The female : male ratio of 0.72 is 36% higher than in 1998 (Table 3). The median passage date for the species of 19 September is 5 days later than in 1998 (Table 4); however, sex-specific dates indicate that females were 6 days later than in 1998, whereas males were 2 days early (Table 6). The 1999 seasonal activity pattern for the species differs from the 1998 pattern in showing low activity in late August and several periods of relatively high activity after mid-September (Fig. 10). The observers recorded 1 migrant kestrel as northbound.

The observers counted 36 **Merlins** on 24 days between 3 September and 19 October (Tables 1 and 4, Appendix C). The count and annual passage rate of 7.1 raptors/100 hrs are 35% and 50% lower than in 1998 (Table 1). The observers were unable to obtain reliable age-sex data for any birds in 1999, but tentatively identify 1 bird as a Black Merlin (*F. c. suckleyi*). The median passage date for the species of 27 September is 6 days later than in 1998 (Table 4), which the seasonal activity patterns clearly illustrate (Fig. 10).

The observers counted 7 **Prairie Falcons** on 6 days between 8 September and 10 October (Tables 1 and 4, Appendix C). The count and annual passage rate of 1.4 raptors/100 hrs are 30% and 47% lower, respectively, than in 1998 (Table 1). The median passage date for the species of 15 September is 10 days later than in 1998 (Table 4), which the seasonal activity patterns clearly illustrate (Fig. 11). The observers recorded 1 migrant Prairie Falcon as westbound.

The observers counted 9 **Peregrine Falcons** on 9 days between 16 September and 24 October (Tables 1 and 4, Appendix C). The count and annual passage rate of 1.8 raptors/100 hrs are 350% and 242% higher than 1998 (Table 1). The median passage date for the species was 29 September (Table 4). The count in 1998 was too small to calculate a comparable date; however, both 1998 birds passed through much earlier than any of the 1999 birds (Fig. 11). The observers recorded 2 migrant peregrines as westbound.

Besides birds identified to species, the observers tallied 248 unidentified accipiters, 148 unidentified buteos, 7 unidentified eagles, 6 unidentified falcons, and 218 unidentified raptors (Table 1). These values are 1% to approximately 700% higher than in 1998 for accipiters, buteos, eagles, and unknown raptors, and match the 1998 value for falcons.

Resident and Northbound Raptors

Raptors classified as northbound migrants and added to the 1999 count totals included 6 Red-tailed Hawks and 1 American Kestrel. Raptors classified as westbound migrants and added to the 1999 count totals included 3 Sharp-shinned Hawks, 1 Cooper's Hawk, 4 Northern Goshawks, 2 Red-tailed Hawks, 1 Golden Eagle, 1 Prairie Falcon, and 2 Peregrine Falcons. It is possible that some of these birds were local residents mistaken for migrants.

The observers recorded 10 species of raptors as residents during the 1999 season. At least 2 local Turkey Vultures appeared in early September, but not thereafter. One adult male Northern Harrier displayed resident behavior on 18 October. At least 2 immature Sharp-shinned Hawks regularly appeared in the area through the third week of September, but not thereafter. At least 1 adult female Sharp-shinned Hawk appeared periodically from mid September through at least early October. At least 1 adult male, 1 second-year, and 1 first-year Cooper's Hawks appeared on several occasions from late August through mid-September, and then single adults appeared twice in mid-October. Single adult Northern Goshawks displayed resident behavior twice in early and late September. At least 2 adult and 1 immature Red-tailed Hawks regularly appeared in the area up until mid-October, most often around Cooper Mountain. At least 2 adult and 2 plumage-class 1 Golden Eagles periodically appeared throughout the season. Two adult Bald Eagles appeared around a nearby lake on 17 October acting like locals, and then moved off to the northwest. At least 3 male and 2 female American Kestrels appeared regularly through the third week of September, but not thereafter. Lastly, single Peregrine Falcons (1 confirmed adult) appeared in the area acting like locals on two occasions in late August and early September.

Comparison of Chelan Ridge and Diamond Head Counts

The 1999 observation season extended for 3 more days at Chelan than at Diamond Head, and observation hours totaled 28% higher at Chelan (Table 8). However, the Chelan count yielded more than double the number of birds and a 59% higher passage rate. These differences are much greater than the 37% difference in 1998 and the 30% difference in 1997 (Prosser and DeSorbo 1998, Smith 1999). The only exceptions to the rule of higher counts at Chelan shown for all three years of comparative counts are for Turkey Vultures (76–80% lower at Chelan) and Cooper's Hawks (3–41% lower at Chelan).

Banding Results

Herein, I provide a brief summary of the results of FRG's trapping efforts this season. More detailed information can be obtained directly from FRG (moreinfo@frg.org). The FRG crew captured 220 raptors of 8 species during 388 hours on 47 of 50 days between 28 August and 16 October (Table 9). Sharp-shinned Hawks comprised 63% of the total captures, Cooper's Hawks 19%, Northern Goshawks 6%, Red-tailed Hawks 5%, Merlins 3%, Northern Harriers 2%, American Kestrels 1%, and Prairie Falcons <1%. The overall combined-species capture rate was 5.7 raptors per 10 hours of trapping effort, with

species-specific rates ranging from <0.1 captures / 10 hrs for Prairie Falcon to 3.6 captures / 10 hrs for Sharp-shinned Hawk (Table 9). The overall combined-species capture success was 8.5% of "trappable" raptors (number of raptors captured / number of raptors counted excluding Turkey Vultures, Ospreys, and unidentified raptors that were too distant to be considered trappable * 100), with species-specific values ranging from 2.4% for Northern Harrier and Red-tailed Hawk to 28.0% for Northern Goshawk (Table 9).

VISITOR PARTICIPATION

Visitation to the observation site average 0.7 visitors/hour or 411 total person-hours. These values are 17% and 66% higher, respectively, than in 1998. Addition of a banding program contributed greatly to the increase in visitation.

DISCUSSION

SEASONAL TIMING

Unlike in 1998, starting the monitoring season on 27 August did not appear to cause us to miss a significant portion of the migration. This is consistent with HWI data from other western sites at similar latitudes. In contrast, extending the season to 27 October clearly resulted in better coverage of late-season migrants such as Rough-legged Hawks and Bald Eagles.

The prevalence of later median passage dates in 1999 than in 1998 reflects in part the extended season. Results from HWI's other sites along the Cascade flyway may help discern whether other influences are at work. In fact, results from Diamond Head frequently showed earlier than average median passage dates in 1998 (Smith and Grindrod 1999a) and mostly later than average dates in 1999 (Smith 2000). However, results from Bonney Butte in northern Oregon showed no consistent patterns of species-specific timing in either year (Smith and Grindrod 1999b, Vekasy and Smith 2000). This suggests that there was either considerable, relatively local variation in flyway dynamics in this region during the past two fall seasons or that the effects of weather on sampling efficiency varied from site to site. We will have to wait for the collection of additional years of data before we can clearly assess the meaning of these timing results.

FLIGHT COMPOSITION AND PASSAGE RATES

Perhaps the most conspicuous possible pattern in differences between 1998 and 1999 counts and passage rates is the fact that counts were down for the two smallest accipiters, the smallest buteo, and the two smallest falcons, whereas counts were way up for most larger species. This pattern suggests that some form of visibility bias may have applied, possibly related to variation in weather conditions. Moderate/strong and northerly winds were more prevalent in 1999 than in 1998. As wind velocity increases, especially if a tail wind is involved, migrants tend to remain closer to ridgelines where most species are then easier to detect. This is because migrants are less reliant on thermals for energy-saving lift (which tends to disperse the migration), but are more reliant on navigational aids (i.e., "leading lines" provided by extensive north–south ranges) to avoid being blown off-course by strong winds. High counts of most large soaring migrants may be particularly indicative of this effect, although the reduced count of Turkey Vultures appears anomalous in this light. Strong winds also may keep the smaller accipiters and falcons nearer the ridgeline, which in theory would make them easier to detect, as well. Alternatively, strong tail winds may increase the pace of migration to a point where the smaller, faster moving species become more difficult rather than easier to detect. A high abundance of relatively conspicuous species might exacerbate this detectability problem.

Again, results from HWI's other sites along the Cascade flyway may help confirm these patterns. Results from Diamond Head are consistent in showing lower than average counts and passage rates for the small accipiters and falcons, but are only partially consistent for the large buteos and eagles (Smith 2000). Only counts of Red-tailed and Rough-legged Hawks were higher than average and counts and passage rates of eagles were down. In contrast, results from Bonney Butte are largely consistent for the lager buteos and eagles, but are only partially consistent for the small accipiters and falcons (Vekasy and Smith 2000). Results are consistent for Cooper's Hawks, but Sharp-shinned Hawks, American Kestrels, and Merlins showed near average instead of low counts and passage rates at Bonney Butte. Thus, in this case, some but not entire consistency is evident.

It may also be noteworthy that the group of reduced-count species includes most of the small-avian prey specialists, perhaps indicating that regional weather patterns had a highly variable effect on the productivity of different classes of prey and their respective predators. Age-specific data shed additional light on this possibility. Counts of adult Sharp-shinned and Cooper's Hawks were relatively high in 1999 at Chelan, but counts of immatures of both species were much lower than in 1998. The high counts of adults may reflect strong recruitment into the adult population after a productive breeding season in 1998 across much of the interior West (e.g., see Lanzone 1999, Neal 1999, Tidhar and Peacock 1999). In contrast, the very low counts of immatures probably indicate that productivity was low in 1999 for these species in the Pacific Northwest. The same pattern of differences applied at Diamond Head, but only partially at Bonney Butte. In contrast to the situation for Sharp-shinned and Cooper's Hawks, counts of both adult and immature Red-tailed Hawks were up at all three sites, suggesting that both adult and immature recruitment was high in 1999 for this species.

Concerning prey ecology, it may be equally noteworthy that the group of high-count species includes Northern Goshawks, Rough-legged Hawks, and Golden and Bald Eagles. Each of these species' breeding ranges extends well into the boreal latitudes and the extent of their southward migrations varies in relation to prey conditions on breeding grounds (e.g., Mueller et al. 1977). Highly elevated counts of these species may be indicative of poor prey conditions at northern latitudes and "irruptive" movements by these partially migratory raptors. For each of these species, results form Chelan Ridge and Bonney Butte are generally consistent. Counts were up for Rough-legged Hawks, for both immature and adult goshawks and Golden Eagles, and for adult but not immature (average) Bald Eagles. The Diamond Head count of Rough-legged Hawks also was up slightly; however, counts were up only for immature goshawks and Golden Eagles, and were down for immature Bald Eagles and only average for adults. Thus, again in this case, some but not entire consistency is evident.

In summary, both the timing results and count and passage rate data suggest that there may be considerable, relatively local variation in flyway dynamics in the Cascade region. One possible reason for this may be that these sites lie within a transition zone between two major flyways: the Pacific Flyway which runs between the Pacific Coast and the Cascade and Sierra Nevada ranges, and the Intermountain Flyway which runs between the Cascade/Sierra Nevada and Rocky Mountain ranges (Smith and Hoffman 2000). For example, band return data from the Golden Gate Raptor Observatory in the Marin Headlands of California clearly show that at least Red-tailed Hawks frequently cross-over the Cascade Mountains from eastern Washington and Oregon and migrate south through coastal California (Scheuermann 1996). However, band return data from HWI's Goshute Mountains site in northeastern Nevada clearly show that other members of the same regional population stay to the east of the Cascade/Sierra Nevada ranges on their southward migrations (Smith and Hoffman 2000, Meehan et al. in preparation).

COMPARISON OF CHELAN RIDGE AND DIAMOND HEAD

For the third year, comparison counts revealed that Chelan Ridge yields considerably more detections of migrant raptors than Diamond Head given similar effort. Moreover, for the second year, the Chelan

count included two more species than the Diamond Head count: Swainson's and Broad-winged Hawks. However, it appears that the pattern of relative abundance may not be consistent across all species. All three years of comparison counts indicated lower detection rates at Chelan Ridge for Turkey Vultures (76–94% lower) and Cooper's Hawks (3–41% lower; Prosser and DeSorbo 1998, Smith 1999). Reasons for this unusual pattern are unclear. Regardless, for 2 of 3 years, the differences between the two sites in counts of Cooper's Hawks were minimal (3–6%) and overall variability in comparative counts of this species has been lower at Chelan (159–232 at Chelan versus 150–417 at Diamond Head). The latter is important for improving the statistical power of trend analyses. Thus, except for perhaps Turkey Vultures, a clear pattern of superiority at Chelan is emerging. Moreover, now that a successful cooperative venture has been established to incorporate banding by the Falcon Research Group and develop a strong, jointly administered education program, the project at Chelan Ridge has definitely taken on a high degree of importance for allocation of continued effort.

BANDING RESULTS

The first trapping effort at Chelan Ridge was clearly successful and productive. Capture rates were generally comparable to those at HWI's Bonney Butte site in Oregon. The only exceptions were that the Bonney Butte effort yielded higher capture rates for Sharp-shinned Hawk (5.7 versus 3.6 raptors / 10 hrs) and Red-tailed Hawk (2.5 versus 0.3 raptors / 10 hrs). The Bonney Butte effort also yielded 2 Golden Eagles and 1 Rough-legged Hawk, but no Prairie Falcons. Besides the scientific value of banding 220 raptors, the trapping effort also enabled more effective public outreach by providing opportunities for the public to view raptors in the hand. In 2000, HWI will endeavor to add a full-time educator to the field crew to further enhance our collective educational efforts.

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Table 1. Summary of observation effort, raptor counts, and passage rates by species at Chelan Ridge: 1997–1999.

	1997	1998	1999	% CHANGE '98 VS '99	1997	1998	1999	% CHANGE '98 VS '99
Start date	5-Sep	27-Aug	27-Aug					
End date	11-Oct	21-Oct	27-Oct					
Observation days	29	53	61	+15				
Observation hours	204.60	382.92	504.33	+32				
SPECIES	COUNT				RAPTORS /100 HRS			
Turkey Vulture	4	29	21	-28	2.0	7.6	4.2	-45
Osprey	41	24	47	+96	20.0	6.3	9.3	+49
Northern Harrier	115	152	167	+10	56.2	39.7	33.1	-17
Sharp-shinned Hawk	311	949	932	-2	152.0	247.8	184.8	-25
Cooper's Hawk	150	247	232	-6	73.3	64.5	46.0	-29
Northern Goshawk	38	32	50	+56	18.6	8.4	9.9	+19
Unidentified accipiter	182	221	248	+12	89.0	57.7	49.2	-15
TOTAL ACCIPITERS	681	1449	1462	+1	332.8	378.4	289.9	-23
Broad-winged Hawk	2	7	5	-29	1.0	1.8	1.0	-46
Swainson's Hawk	0	8	17	+113	0.0	2.1	3.4	+61
Red-tailed Hawk	145	182	450	+147	70.9	47.5	89.2	+88
Rough-legged Hawk	1	13	44	+238	0.5	3.4	8.7	+157
Unidentified buteo	75	58	148	+155	36.7	15.1	29.3	+94
TOTAL BUTEOS	223	268	664	+148	109.0	70.0	131.7	+88
Golden Eagle	105	55	141	+156	51.3	14.4	28.0	+95
Bald Eagle	2	2	7	+250	1.0	0.5	1.4	+166
Unidentified eagle	7	0	7	–	3.4	0.0	1.4	–
TOTAL EAGLES	114	57	155	+172	55.7	14.9	30.7	+106
American Kestrel	24	107	89	-17	11.7	27.9	17.6	-37
Merlin	17	55	36	-35	8.3	14.4	7.1	-50
Prairie Falcon	2	10	7	-30	1.0	2.6	1.4	-47
Peregrine Falcon	5	2	9	+350	2.4	0.5	1.8	+242
Unidentified falcon	10	6	6	0	4.9	1.6	1.2	-24
TOTAL FALCONS	58	180	147	-18	28.3	47.0	29.1	-38
Unidentified raptor	178	216	218	+1	87.0	56.4	43.2	-23
GRAND TOTAL	1414	2375	2881	+21	691.1	620.2	571.2	-8

Table 2. Adjusted counts by age class and immature : adult ratios for selected species at Chelan Ridge: 1998 versus 1999.

	Total and Age-classified Counts						Percent Unknown Age		Imm : Adult Ratio	
	1998			1999						
	Total	Imm.	Adult	Total	Imm.	Adult	1998	1999	1998	1999
Northern Harrier	152	52	34	167	58	51	43	35	1.5	1.1
Sharp-shinned Hawk	949	770	84	932	351	195	10	41	9.2	1.8
Cooper's Hawk	247	172	28	232	65	36	19	56	6.1	1.8
Northern Goshawk	32	14	0	50	23	10	56	34	≥14	2.3
Broad-winged Hawk	7	1	0	5	3	0	86	40	≥1	≥3
Red-tailed Hawk	182	76	77	450	112	207	16	29	1.0	0.5
Golden Eagle	55	31	12	141	86	31	22	17	2.6	2.8
Bald Eagle	2	0	2	7	0	7	0	0	0.0	0.0
Peregrine Falcon	2	0	0	9	0	4	100	56	–	0.0

Table 3. Adjusted counts by sex and female : male ratios for selected species at Chelan Ridge: 1998 versus 1999.

	Total and Sex-classified Counts						Percent Unknown Sex		Female : Male Ratio	
	1998			1999						
	Total	Female	Male	Total	Female	Male	1998	1999	1998	1999
Adult										
Northern Harrier	152	13	21	167	16	35	78	69	0.62	0.46
American Kestrel	107	28	53	89	28	39	24	25	0.53	0.72

Table 4. First and last observation, bulk passage, and median passage dates by species at Chelan Ridge in 1999, with a comparison of 1998 and 1999 median passage dates.

	1999				1998
	First Observed	Last Observed	Bulk (80%) Passage Dates[1]	Median Passage Date[2]	Median Passage Date[2]
Turkey Vulture	3-Sep	30-Sep	3-Sep – 27-Sep	12-Sep	7-Sep
Osprey	29-Aug	15-Oct	7-Sep – 28-Sep	18-Sep	22-Sep
Northern Harrier	27-Aug	24-Oct	7-Sep – 7-Oct	18-Sep	22-Sep
Sharp-shinned Hawk	27-Aug	26-Oct	9-Sep – 14-Oct	26-Sep	18-Sep
Cooper's Hawk	27-Aug	26-Oct	3-Sep – 3-Oct	17-Sep	14-Sep
Northern Goshawk	8-Sep	25-Oct	13-Sep – 15-Oct	30-Sep	16-Sep
Broad-winged Hawk	11-Sep	17-Sep	11-Sep – 17-Sep	15-Sep	16-Sep
Swainson's Hawk	28-Aug	30-Sep	4-Sep – 27-Sep	17-Sep	7-Sep
Red-tailed Hawk	27-Aug	26-Oct	3-Sep – 15-Oct	22-Sep	21-Sep
Rough-legged Hawk	2-Oct	26-Oct	14-Oct 25-Oct	19-Oct	10-Oct
Golden Eagle	29-Aug	26-Oct	19-Sep 21-Oct	4-Oct	30-Sep
Bald Eagle	26-Sep	24-Oct	26-Sep – 24-Oct	15-Oct	–
American Kestrel	27-Aug	22-Oct	6-Sep – 3-Oct	19-Sep	14-Sep
Merlin	3-Sep	19-Oct	9-Sep – 15-Oct	27-Sep	21-Sep
Prairie Falcon	8-Sep	10-Oct	8-Sep – 10-Oct	15-Sep	5-Sep
Peregrine Falcon	16-Sep	24-Oct	16-Sep – 24-Oct	29-Sep	–
All Species	27-Aug	26-Oct	9-Sep – 14-Oct	23-Sep	20-Sep

[1] Dates between which the central 80% of the flight passed through; calculated only for species with an annual count ≥5 birds.

[2] Date by which 50% of the flight at passed through; calculated only for species with an annual count ≥5 birds.

Table 5. Median passage dates by age for selected species at Chelan Ridge: 1998 versus 1999.

	ADULT		IMMATURE / SUBADULT	
SPECIES	1998	1999	1998	1999
Northern Harrier	23-Sep	15-Sep	23-Sep	18-Sep
Sharp-shinned Hawk	4-Oct	3-Oct	17-Sep	19-Sep
Cooper's Hawk	1-Oct	22-Sep	10-Sep	14-Sep
Northern Goshawk	–	4-Oct	22-Sep	1-Oct
Red-tailed Hawk	24-Sep	27-Sep	17-Sep	16-Sep
Golden Eagle	1-Oct	6-Oct	30-Sep	2-Oct

[1] Date by which 50% of the flight had passed the lookout; calculated only for cases with counts ≥5 birds.

Table 6. Median passage dates by sex for selected species at Chelan Ridge: 1998.

	MALE		FEMALE	
SPECIES	1998	1999	1998	1999
Adult Northern Harrier	23-Sep	15-Sep	23-Sep	11-Sep
American Kestrel	21-Sep	19-Sep	10-Sep	16-Sep

[1] Date by which 50% of the flight had passed the lookout.

Table 7. Morph-specific counts and light : dark morph ratios for selected buteos at Chelan Ridge: 1998 versus 1999.

	TOTAL AND MORPH-CLASSIFIED COUNTS						% UNKNOWN MORPH		LIGHT : DARK RATIO	
	1998			1999						
	TOTAL	LIGHT	DARK	TOTAL	LIGHT	DARK	1998	1999	1998	1999
Broad-winged Hawk	7	0	0	5	2	0	100	60	–	≥2
Swainson's Hawk	8	6	1	17	3	7	13	41	6.0	0.4
Red-tailed Hawk	182	133	13	450	270	44	20	30	10.2	6.1
Rough-legged Hawk	13	3	4	44	22	2	46	45	0.8	11.0

Table 8. Comparison of observation effort and raptor migration counts and passage rates for 1999 at Chelan Ridge and Diamond Head, WA.

	Diamond Head	Chelan Ridge	% Difference	Diamond Head	Chelan Ridge	% Difference
Start Date	27-Aug	27-Aug				
End Date	24-Oct	27-Oct				
Observation days	57	61	+7			
Observation hours	392.75	504.33	+28			
Species	Counts			Raptors / 100 hours		
Turkey Vulture	107	21	-80	27.2	4.2	-85
Osprey	11	47	+327	2.8	9.3	+233
Northern Harrier	21	167	+695	5.3	33.1	+519
Sharp-shinned Hawk	623	932	+50	158.6	184.8	+17
Cooper's Hawk	238	232	-3	60.6	46.0	-24
Northern Goshawk	16	50	+213	4.1	9.9	+143
Unidentified accipiter	46	248	+439	11.7	49.2	+320
Total accipiters	923	1462	+58	235.0	289.9	+23
Broad-winged Hawk	0	5	–	0.0	1.0	–
Swainson's Hawk	0	17	–	0.0	3.4	–
Red-tailed Hawk	225	450	+100	57.3	89.2	+56
Rough-legged Hawk	2	44	+2100	0.5	8.7	+1613
Unidentified buteo	3	148	+4833	0.8	29.3	+3742
Total buteos	230	664	+189	58.6	131.7	+125
Golden Eagle	46	141	+207	11.7	28.0	+139
Bald Eagle	3	7	+133	0.8	1.4	+82
Unidentified eagles	0	7	–	0.0	1.4	–
Total eagles	49	155	+216	12.5	30.7	+146
American Kestrel	35	89	+154	8.9	17.6	+98
Merlin	20	36	+80	5.1	7.1	+40
Prairie Falcon	1	7	+600	0.3	1.4	+445
Peregrine Falcon	3	9	+200	0.8	1.8	+134
Unidentified falcon	0	6	–	0.0	1.2	–
Total falcons	59	147	+149	15.0	29.1	+94
Unidentified raptor	7	218	+3014	1.8	43.2	+2325
All species	1407	2881	+105	358.2	571.2	+59

Table 9. Falcon Research Group raptor trapping effort and banding totals in 1999 at Chelan Ridge, WA.

Start date	28 August		
End date	16 October		
Trapping days	47		
Trapping hours	388		
SPECIES	CAPTURE TOTALS	CAPTURES / 10 HRS	% CAPTURE SUCCESS[1]
Northern Harrier	4	0.1	2.4
Sharp-shinned Hawk	139	3.6	14.9
Cooper's Hawk	42	1.1	18.1
Northern Goshawk	14	0.4	28.0
Red-tailed Hawk	11	0.3	2.4
American Kestrel	3	0.1	3.4
Merlin	6	0.2	16.7
Prairie Falcon	1	<0.1	14.3
All species	220	5.7	8.5

[1] For individual species, values equal: number of raptors captured / number of raptors counted that were positively identified to species * 100. The "All species" value equals: total number of raptors captured / total number of raptors counted excluding Turkey Vultures, Ospreys, and unidentified raptors that were too distant to be considered trappable * 100.

Figure 1. Location of Chelan Ridge observation site in north-central Washington.

Figure 2. Composition of raptor flights by species groups: 1998 versus 1999.

Figure 3. Combined-species daily passage volume by hourly periods: 1998 versus 1999.

Figure 4. Combined-species passage volume by 5-day periods: 1998 versus 1999.

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

Figure 6. Passage volume by 5-day periods for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks: 1998 versus 1999.

Figure 7. Passage volume by 5-day periods for Broad-winged and Swainson's Hawks: 1998 versus 1999.

Figure 8. Passage volume by 5-day periods for Red-tailed and Rough-legged Hawks: 1998 versus 1999.

Figure 9. Passage volume by 5-day periods for Golden and Bald Eagles: 1998 versus 1999.

Figure 10. Passage volume by 5-day periods for American Kestrels and Merlins: 1998 versus 1999.

Figure 11. Passage volume by 5-day periods for Prairie Falcons and Peregrine Falcons: 1998 versus 1999.

Appendix A. Common and scientific names and species codes for all raptors observed at the Chelan Ridge site.

COMMON NAME	SCIENTIFIC NAME	SPECIES CODE
Turkey Vulture	*Cathartes aura*	TV
Osprey	*Pandion haliaetus*	OS
Northern Harrier	*Circus cyaneus*	NH
Sharp-shinned Hawk	*Accipiter striatus*	SS
Cooper's Hawk	*Accipiter cooperii*	CH
Northern Goshawk	*Accipiter gentilis*	NG
Unidentified accipiter	*Accipiter* spp.	UA
Broad-winged Hawk	*Buteo platypterus*	BW
Swainson's Hawk	*Buteo swainsoni*	SW
Red-tailed Hawk	*Buteo jamaicensis*	RT
Rough-legged Hawk	*Buteo lagopus*	RL
Unidentified buteo	*Buteo* spp.	UB
Golden Eagle	*Aquila chrysaetos*	GE
Bald Eagle	*Haliaeetus leucocephalus*	BE
Unidentified eagle	*Aquila or Haliaeetus* spp.	UE
American Kestrel	*Falco sparverius*	AK
Merlin	*Falco columbarius*	ML
Prairie Falcon	*Falco mexicanus*	PR
Peregrine Falcon	*Falco peregrinus*	PG
Unidentified falcon	*Falcon* spp.	UF
Unidentified raptor	Falconiformes	UU

Appendix B. Daily records of observation effort, visitor participation, and predominant weather conditions at Chelan Ridge: 1999.

Date	Obs. Hours	Average Number Observers	Average Number Visitors	Sky Condition[1]	Thermal Lift[2]	Wind Speed[3]	Wind Direct.	Avg. Temp. (°C)	Avg. Visib. E (km)	Avg. Visib. W (km)	Flight Dist.[4]	Raptors / Hour
27-Aug	8.33	1.6	0.0	clr	2	2	var, sw	21.9	60	40	2	1.56
28-Aug	8.25	4.4	0.1	clr	3	3	s-sw	24.5	40	60	2	4.00
29-Aug	8.00	5.0	0.9	clr-mc	3	4	s	26.2	60	40	2	2.88
30-Aug	0.00											
31-Aug	7.33	1.0	0.0	clr-pc	3	4	s-sw	7.1	57	37	2	0.41
01-Sep	8.50	2.4	0.0	pc-mc	3	2	n, se-sw	7.9	50	30	2	1.53
02-Sep	8.75	1.9	0.1	clr-pc	3	2	nnw-ne	--	50	30	2	4.57
03-Sep	8.67	3.9	0.0	clr-pc	2	2	n-ne, sw-s	--	40	30	3	4.84
04-Sep	9.75	3.9	0.5	mc-ovc	3	3	s-sw	12.9	33	30	2	3.38
05-Sep	8.00	2.7	0.2	pc-ovc/rain/snow	4	5	ssw-sw	11.6	30	20	2	0.38
06-Sep	8.67	2.2	0.0	pc	3	4	ssw-sw	10.0	47	25	2	2.19
07-Sep	8.75	1.8	0.0	clr	2	2	nw-nne, sw	8.6	60	40	2	2.74
08-Sep	9.50	1.4	3.0	clr	2	2	se-ssw	12.8	37	44	2	3.37
09-Sep	9.50	1.9	0.0	clr	3	4	sse-sw	14.9	34	39	2	7.89
10-Sep	9.25	2.2	0.0	clr	2	2	nne-ne, sw	10.5	40	40	2	5.95
11-Sep	8.50	2.9	0.0	clr	2	3	nnw-nne, sw	8.3	50	40	2	6.59
12-Sep	8.75	2.9	0.7	clr	2	3	nnw-ne	10.6	40	40	2	5.03
13-Sep	9.25	2.9	0.0	clr	2	2	ne, nw	13.6	40	40	2	7.03
14-Sep	9.00	2.8	1.0	clr-pc	3	3	s-sw	12.6	40	40	2	6.56
15-Sep	9.00	3.3	0.0	clr-pc	2	1	s	14.8	30	40	2	9.89
16-Sep	9.25	1.8	0.4	pc-mc	3	2	nne, ssw-w	14.2	18	35	2	10.27
17-Sep	9.00	2.6	0.7	clr	2	3	ne, sw	14.0	24	35	2	13.00
18-Sep	9.00	2.5	3.6	clr	3	3	n-ne	14.7	32	40	2	15.00
19-Sep	10.00	2.6	5.6	clr	2	1	se-sw	12.3	29	40	2	12.30
20-Sep	8.50	2.0	2.9	clr	3	4	s-sw	14.6	30	40	3	6.12
21-Sep	9.00	1.9	0.7	clr	3	4	s-sw	15.2	25	40	2	10.11
22-Sep	9.00	1.9	2.6	clr	3	2	s-sw	14.5	25	40	2	11.00
23-Sep	7.50	1.9	0.3	pc-ovc	4	6	s-sw	12.7	26	36	2	4.53
24-Sep	9.50	1.5	4.0	pc-ovc	3	2	sw	5.2	36	39	2	2.11
25-Sep	5.75	1.9	3.0	pc-mc	4	4	var, sw	2.6	28	27	2	1.22
26-Sep	8.25	2.8	0.1	mc-ovc, snow	4	1	var	2.6	26	22	2	2.91
27-Sep	8.25	2.0	0.6	clr-mc	3	3	nnw-ne	0.9	44	40	2	16.73
28-Sep	8.50	2.2	0.0	clr-mc	4	5	ssw-sw	2.7	36	40	2	8.82
29-Sep	8.50	1.4	1.1	clr	3	1	s-sw	7.2	29	40	2	7.41
30-Sep	9.00	1.8	0.2	clr-pc	3	2	var	5.1	47	40	3	8.22
01-Oct	8.83	1.8	1.2	pc	3	2	n-ne, s-sw	4.4	49	40	2	17.09
02-Oct	9.00	1.9	2.6	clr-mc	3	3	n-ne, sw	2.5	50	40	2	10.78
03-Oct	9.00	1.9	1.9	clr	3	5	s-ssw	5.2	47	40	2	7.67
04-Oct	9.25	1.7	0.9	clr	2	1	nne, s-sw	7.2	47	40	2	4.76
05-Oct	8.50	2.0	0.3	clr-ovc	3	3	s-sw	7.6	25	32	2	6.24
06-Oct	8.50	1.0	1.3	pc-mc	3	1	n, s-sw	6.2	25	35	2	6.24
07-Oct	8.00	2.0	0.0	mc-ovc/rain	4	5	s-sw	6.7	42	32	2	2.75
08-Oct	7.50	2.0	0.8	mc-ovc	4	6	ssw-sw	6.3	47	21	2	1.47
09-Oct	8.50	2.7	1.1	clr-pc	3	3	nne, ssw-sw	2.2	50	40	2	4.24
10-Oct	8.50	1.9	0.0	ovc	4	1	ne, sw	3.1	50	40	2	5.06
11-Oct	6.25	2.0	0.0	ovc, rain/snow PM	4	1	ne, sw	3.5	33	26	2	5.44
12-Oct	5.25	1.0	2.0	mc-ovc	4	2	s-ssw	3.4	8	5	1	1.33
13-Oct	5.75	1.0	0.0	clr	4	6	ssw-sw	7.6	31	35	2	6.78

Appendix B. continued

Date	Obs. Hours	Average Number Observers	Average Number Visitors	Sky Condition[1]	Thermal Lift[2]	Wind Speed[3]	Wind Direct.	Avg. Temp. (°C)	Avg. Visib. E (km)	Avg. Visib. W (km)	Flight Dist.[4]	Raptors / Hour
14-Oct	8.50	1.9	0.0	clr-pc	4	2	var, ssw-sw	2.1	50	34	2	8.24
15-Oct	8.00	1.6	0.0	clr-ovc/snow	4	2	n-ne	-2.0	45	36	2	9.63
16-Oct	8.00	1.9	0.6	clr-pc	4	4	ssw-sw	-1.3	46	40	1	3.88
17-Oct	7.00	1.0	0.0	clr-mc	.4	2	s-w, ne	5.0	45	35	2	1.71
18-Oct	8.00	1.0	0.0	clr	3	4	nw-ne	2.2	50	40	3	1.25
19-Oct	8.25	1.4	0.0	clr	2	1	nw-ne, ssw-sw	5.7	44	40	2	3.52
20-Oct	8.00	1.0	0.0	clr	2	2	s-sw	6.8	32	40	1	0.75
21-Oct	8.00	1.9	0.0	clr	3	2	nw, se-ssw	8.3	31	40	2	1.50
22-Oct	8.00	1.8	0.0	pc	4	4	se-s	8.3	30	38	2	1.38
23-Oct	8.50	2.1	0.0	clr-ovc	4	4	se-s	6.9	30	30	2	1.88
24-Oct	8.50	1.8	0.0	clr-mc	3	1	nw-ne, sw	1.2	50	40	3	5.18
25-Oct	6.50	1.9	0.0	ovc, rain/snow PM	4	5	s-ssw	3.3	43	29	2	0.62
26-Oct	8.00	1.9	0.0	ovc	4	1	nw-ne	0.0	40	39	2	4.00
27-Oct	3.50	1.0	0.0	ovc	4	4	e	-4.0	14	26	--	5.75

[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 C. Daily count records at Chelan Ridge: 1999.

		Species Codes[1]																					Birds /
Date	Hours	TV	OS	NH	SS	CH	NG	UA	BW	SW	RT	RL	UB	GE	BE	UE	AK	ML	PR	PG	UF	UU	Total	Hour
27-Aug	8.33	0	0	1	5	3	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	13	1.6
28-Aug	8.25	0	0	2	6	1	0	2	0	1	15	0	1	0	0	0	3	0	0	0	0	2	33	4.0
29-Aug	8.00	0	1	1	4	6	0	0	0	0	9	0	0	2	0	0	0	0	0	0	0	0	23	2.9
30-Aug	0.00																							
31-Aug	7.33	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	3	0.4
1-Sep	8.50	0	1	2	3	1	0	0	0	0	3	0	2	1	0	0	0	0	0	0	0	0	13	1.5
2-Sep	8.75	0	0	1	7	7	0	2	0	0	15	0	3	1	0	0	2	0	0	0	0	2	40	4.6
3-Sep	8.67	4	0	5	11	6	0	4	0	0	7	0	1	0	0	0	1	1	0	0	0	2	42	4.8
4-Sep	9.75	0	1	2	13	5	0	2	0	1	5	0	1	1	0	0	0	0	0	0	0	2	33	3.4
5-Sep	8.00	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0.4
6-Sep	8.67	1	1	0	9	2	0	2	0	0	1	0	2	0	0	0	1	0	0	0	0	0	19	2.2
7-Sep	8.75	1	2	4	4	2	0	2	0	0	3	0	1	0	0	0	1	1	0	0	0	3	24	2.7
8-Sep	9.50	1	0	0	14	5	2	2	0	0	1	0	1	0	0	0	2	1	1	0	0	2	32	3.4
9-Sep	9.50	0	2	3	38	10	0	6	0	0	3	0	2	0	0	0	5	1	0	0	0	5	75	7.9
10-Sep	9.25	1	2	4	14	6	1	5	0	0	6	0	5	2	0	0	2	2	0	0	0	5	55	5.9
11-Sep	8.50	1	1	4	13	6	1	4	1	0	11	0	9	0	0	0	0	0	0	0	0	5	56	6.6
12-Sep	8.75	1	0	4	12	4	1	7	0	0	11	0	3	0	0	0	0	0	0	0	0	1	44	5.0
13-Sep	9.25	1	0	9	15	5	2	7	0	0	11	0	5	1	0	0	2	0	1	0	0	6	65	7.0
14-Sep	9.00	0	1	12	12	7	1	0	1	2	14	0	0	1	0	0	3	4	0	0	0	1	59	6.6
15-Sep	9.00	2	4	10	24	14	2	4	2	2	11	0	4	2	0	0	1	1	2	0	0	4	89	9.9
16-Sep	9.25	0	2	8	27	17	0	9	0	0	11	0	2	1	0	0	9	0	0	1	0	8	95	10.3
17-Sep	9.00	1	5	9	31	12	0	13	1	5	14	0	9	0	0	0	7	0	0	0	1	9	117	13.0
18-Sep	9.00	0	2	9	33	17	2	26	0	0	30	0	5	1	0	0	2	1	0	0	0	7	135	15.0
19-Sep	10.00	1	1	8	39	12	2	12	0	3	15	0	3	6	0	0	8	2	1	0	1	9	123	12.3
20-Sep	8.50	1	3	1	15	1	1	13	0	0	3	0	2	4	0	0	1	2	0	0	0	5	52	6.1
21-Sep	9.00	0	5	7	45	4	1	6	0	0	10	0	2	0	0	0	4	1	0	1	0	5	91	10.1
22-Sep	9.00	0	3	5	47	6	1	11	0	1	16	0	4	0	0	0	1	0	0	1	0	3	99	11.0
23-Sep	7.50	0	1	1	12	1	0	5	0	0	6	0	1	1	0	0	0	0	0	0	0	6	34	4.5
24-Sep	9.50	0	2	0	9	2	0	0	0	0	4	0	1	1	0	0	1	0	0	0	0	0	20	2.1
25-Sep	5.75	0	0	0	3	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	1	7	1.2
26-Sep	8.25	0	1	4	4	3	1	4	0	0	2	0	1	0	1	0	1	0	0	0	0	2	24	2.9
27-Sep	8.25	3	0	6	30	13	2	19	0	1	32	0	15	4	0	0	3	1	0	1	0	8	138	16.7

Appendix C. continued

		Species Codes[1]																						Birds /
Date	Hours	TV	OS	NH	SS	CH	NG	UA	BW	SW	RT	RL	UB	GE	BE	UE	AK	ML	PR	PG	UF	UU	Total	Hour
28-Sep	8.50	0	3	4	36	2	2	4	0	0	8	0	2	10	0	0	0	0	0	0	1	3	75	8.8
29-Sep	8.50	0	0	3	26	5	2	3	0	0	6	0	2	3	1	0	7	1	0	1	0	3	63	7.4
30-Sep	9.00	1	0	3	25	4	1	6	0	1	9	0	4	2	0	0	5	2	0	0	0	11	74	8.2
1-Oct	8.83	0	0	7	62	10	3	16	0	0	25	0	2	12	0	0	3	0	0	0	2	9	151	17.1
2-Oct	9.00	0	2	3	31	6	1	9	0	0	17	1	6	8	0	0	2	1	0	1	0	9	97	10.8
3-Oct	9.00	0	0	1	40	4	0	5	0	0	6	0	1	2	0	2	2	1	0	0	0	5	69	7.7
4-Oct	9.25	0	0	2	13	4	3	4	0	0	4	0	1	6	0	0	1	3	1	0	0	2	44	4.8
5-Oct	8.50	0	0	2	21	1	1	1	0	0	4	0	1	11	0	0	3	0	0	0	0	8	53	6.2
6-Oct	8.50	0	0	2	20	3	2	4	0	0	7	0	4	5	1	0	1	1	0	0	0	3	53	6.2
7-Oct	8.00	0	0	1	6	2	2	3	0	0	1	0	2	3	0	0	0	0	0	0	0	2	22	2.8
8-Oct	7.50	0	0	1	3	0	1	0	0	0	2	0	2	1	0	0	0	0	0	0	0	1	11	1.5
9-Oct	8.50	0	0	0	10	2	1	2	0	0	9	0	2	4	0	1	0	0	0	0	1	4	36	4.2
10-Oct	8.50	0	0	1	12	2	1	6	0	0	4	1	3	2	0	0	0	0	1	0	0	10	43	5.1
11-Oct	6.25	0	0	2	16	0	0	3	0	0	3	1	1	4	0	0	0	2	0	0	0	2	34	5.4
12-Oct	5.25	0	0	0	3	1	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	7	1.3
13-Oct	5.75	0	0	0	13	1	0	1	0	0	6	0	4	3	0	1	1	1	0	0	0	8	39	6.8
14-Oct	8.50	0	0	2	27	2	2	1	0	0	12	2	4	5	0	0	1	1	0	1	0	10	70	8.2
15-Oct	8.00	0	1	3	20	1	4	1	0	0	18	9	5	4	1	0	0	3	0	0	0	7	77	9.6
16-Oct	8.00	0	0	1	16	0	1	0	0	0	7	0	1	1	1	0	0	0	0	0	0	3	31	3.9
17-Oct	7.00	0	0	1	6	1	1	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	12	1.7
18-Oct	8.00	0	0	0	5	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	1	10	1.3
19-Oct	8.25	0	0	0	4	0	0	3	0	0	4	10	2	3	0	0	0	1	0	1	0	1	29	3.5
20-Oct	8.00	0	0	1	1	0	0	0	0	0	0	2	1	1	0	0	0	0	0	0	0	0	6	0.8
21-Oct	8.00	0	0	1	1	0	0	1	0	0	2	2	0	4	0	0	0	0	0	0	0	1	12	1.5
22-Oct	8.00	0	0	0	3	0	1	0	0	0	1	3	0	1	0	0	1	0	0	0	0	1	11	1.4
23-Oct	8.50	0	0	2	3	0	0	1	0	0	2	4	0	2	0	0	0	0	0	0	0	2	16	1.9
24-Oct	8.50	0	0	1	4	0	0	2	0	0	10	1	6	10	2	1	0	0	0	1	0	6	44	5.2
25-Oct	6.50	0	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	4	0.6
26-Oct	8.00	0	0	0	6	1	0	3	0	0	9	3	4	1	0	2	0	0	0	0	0	3	32	4.0
27-Oct	3.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Total	504.33	21	47	167	932	232	50	248	5	17	450	44	148	141	7	7	89	36	7	9	6	218	2881	5.7

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