

**FALL 2005 RAPTOR MIGRATION STUDIES
AT CHELAN RIDGE, WASHINGTON**



**HawkWatch International, Inc.
Salt Lake City, Utah**



**Okanogan and Wenatchee National Forests
Winthrop, Washington**

March 2006

**FALL 2005 RAPTOR MIGRATION STUDIES AT
CHELAN RIDGE, WASHINGTON**

Report prepared by:

Jeff P. Smith and Mike C. Neal

Counts by:

Angela Sjollema, Steve Seibel, and James Waddell

Assisted by Richard Hendrick and Dan Russell

Banding by:

Ben Vang-Johnson, Christy Hand, and Aran Meyer

Assisted by Jim Watson, Devon Batley, and other staff and volunteers

On-site Education by:

Devon Batley

Assisted by Tannis Thorlakson

Project Cooperators:

HawkWatch International, Inc.

Principal Investigator: Dr. Jeff P. Smith

1800 South West Temple, Suite 226, Salt Lake City, UT 84115

(801) 484-6808

Okanogan and Wenatchee National Forests, Methow Valley Ranger District

Principal Investigator: Kent Woodruff

24 Chewuch Road, Winthrop, WA 98862

(509) 996-4002

March 2006

TABLE OF CONTENTS

List of Tables	iii
List of Figures	iii
Introduction.....	1
Study Site.....	1
Methods	2
Standardized Counts.....	2
Trapping and Banding.....	3
Results and Discussion	3
Weather	3
Observation Effort.....	4
Flight Summary and Trends.....	4
Population Trends.....	4
Age Ratios as Indicators of Regional Productivity.....	6
Seasonal Timing	6
Resident Raptors	6
Trapping Effort.....	6
Trapping and Banding Results	7
Encounters with Previously Banded Birds.....	7
Identifying Migrant Origins through Stable Isotope Analyses	8
Visitor Participation and Public Outreach	8
Acknowledgements.....	8
Literature Cited.....	9
Tables.....	10
Figures	17
Appendix A. History of official observer participation in the Chelan Ridge Raptor Migration Project.....	25
Appendix B. Common and scientific names, species codes, and regularly applied age, sex, and color-morph classifications for all diurnal raptor species observed during fall migration at Chelan Ridge, WA.	26
Appendix C. Daily observation effort, visitor disturbance ratings, weather records, and flight summaries for the Chelan Ridge Raptor Migration Project: 2005.....	27
Appendix D. Daily observation effort and fall raptor migration counts by species at Chelan Ridge, WA: 2005.....	30
Appendix E. Annual observation effort and fall raptor migration counts by species at Chelan Ridge, WA: 1997–2005.....	31
Appendix F. Daily capture totals of migrating raptors at Chelan Ridge, WA: 2005.	32
Appendix G. Annual trapping effort and capture totals by species for migrating raptors at Chelan Ridge, WA: 1999–2005.	34

LIST OF TABLES

Table 1.	Fall counts and adjusted passage rates (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) by species for migrating raptors at Chelan Ridge, WA: 1998–2004 versus 2005.	10
Table 2.	Fall counts by age class and immature : adult ratios for selected species of migrating raptors at Chelan Ridge, WA: 1998–2004 versus 2005.	11
Table 3.	First and last observed, bulk-passage, and median-passage dates by species for migrating raptors at Chelan Ridge, WA in 2005, with a comparison of 2005 and 1998–2004 average median passage dates.	12
Table 4.	Median passage dates by age for selected species of migrating raptors at Chelan Ridge, WA: 1998–2004 versus 2005.	13
Table 5.	Fall capture totals, rates, and successes by species for migrating raptors at Chelan Ridge, WA: 1999–2004 versus 2005.	14
Table 6.	Fall capture totals by sex and age (HY = hatching year; AHY = after hatching year), female : male capture ratios, and immature : adult capture ratios for selected species of migrating raptors at Chelan Ridge, WA: 2001–2004 versus 2005.	15
Table 7.	Foreign encounters of raptors banded at the Chelan Ridge Raptor Migration Project: 2000–2005.	16

LIST OF FIGURES

Figure 1.	Location of the Chelan Ridge Raptor Migration Project count and banding sites in north-central Washington.	17
Figure 2.	Fall raptor migration flight composition by major species groups at Chelan Ridge, WA: 1998–2004 versus 2005.	18
Figure 3.	Adjusted fall-migration passage rates at Chelan Ridge, WA for Turkey Vultures, Ospreys, and Northern Harriers: 1998–2005. Dashed lines indicate significant linear or quadratic regressions.	19
Figure 4.	Adjusted fall-migration passage rates at Chelan Ridge, WA for Sharp-shinned Hawks, Cooper’s Hawks, and Northern Goshawks: 1998–2005. Dashed lines indicate significant linear or quadratic regressions.	20
Figure 5.	Adjusted fall-migration passage rates at Chelan Ridge, WA for Broad-winged, Swainson’s, Red-tailed, and Rough-legged Hawks: 1998–2005. Dashed lines indicate significant linear or quadratic regressions.	21
Figure 6.	Adjusted fall-migration passage rates at Chelan Ridge, WA for Golden and Bald Eagles: 1998–2005. Dashed lines indicate significant linear or quadratic regressions.	22
Figure 7.	Adjusted fall-migration passage rates at Chelan Ridge, WA for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons: 1998–2005. Dashed lines indicate significant linear or quadratic regressions.	23
Figure 8.	Combined-species passage volume by five-day periods for migrating raptors at Chelan Ridge, WA: 1998–2004 versus 2005.	24

INTRODUCTION

The Chelan Ridge Raptor Migration Project in north-central Washington is an ongoing effort to monitor long-term trends in populations of raptors using this north Cascades migratory flyway. HawkWatch International (HWI), in partnership with the Okanogan and Wenatchee National Forests (OWNF), initiated standardized counts of the autumn raptor migration through this region in 1997, with full-season counts commencing in 1998. In cooperation with HWI and OWNF, the Falcon Research Group (FRG) initiated a trapping and banding program at the site in 1999 and 2000. HWI took over coordinating the banding program in 2001. To date, HWI observers have recorded 18 species of migratory diurnal raptors at the site, with counts ranging between ~1,500–2,900 migrants per season. The 2005 season marked the 8th consecutive, full-season count and the 7th consecutive season of banding at the site. This report summarizes the 2005 count and banding results.

The Chelan project was 1 of 13 long-term, annual migration counts and 1 of 5 migration-banding studies conducted or co-sponsored by HWI in North America during 2005. The primary objective of these efforts is to track long-term population trends of diurnal raptors in western North America and around the Gulf Coast region (Inzunza et al. 2000, Smith and Hoffman 2000, Smith et al. 2001, Hoffman et al. 2002, Hoffman and Smith 2003). Raptors serve as important biological indicators of ecosystem health (Bildstein 2001) and long-term migration counts are one of the most cost effective and efficient methods for monitoring the regional status and trends of multiple raptor species (Zalles and Bildstein 2000).

The intensive counting and banding operations, along with related research activities such as satellite tracking of migrants, also provide valuable information about breeding and wintering distributions, migratory routes and timing, migratory behavior, population demographics, mortality factors and longevity, morphometric variation, molt timing and sequences, and health assessments (Hoffman et al. 2002). This information helps us understand the life histories, ecology, status, and conservation needs of raptor populations in North America. In addition, these migration studies offer unique opportunities for the public to learn about raptors and the natural environment, and providing such opportunities is another important component of the missions of HWI and OWNF. Accordingly, besides ensuring efficient local coordination of the overall project, OWNF personnel and volunteers, working in tandem with the seasonal observers, banders, and on-site educator, play a critical role in coordinating educational opportunities at the site.

STUDY SITE

Chelan Ridge is located approximately 21 km 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; Figure 1). The study site is accessed by following Washington State Road 153 about 11 km northwest of Pateros, then Black Canyon Road (USFS Road 4010) west–southwest until it ends, then Cooper Mountain Road (USFS Road 8020) southeast for another 5.4 km.

The Chelan Ridge count site sits at an elevation of 1,729 m 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 into the Mitchell Creek Basin. This cliff face creates excellent updrafts on days of moderate to strong 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 cannot 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 are later seen rising above the horizon on thermals near Cooper Mountain.

Two trapping and banding stations were located approximately 1 and 2.25 km southeast of the count site (Figure 1). The North station was located on the northwest flank of Cooper Mountain in the same area used by the FRG crew in 1999 and by HWI since 2001. The South station was located in a saddle on the southwest flanks of Cooper Mountain in an area used regularly since 2001.

Because the stations were located sufficiently “downstream” of the count site, the trapping operations did not affect the behavior of migrants in ways that might have produced a biased count.

METHODS

STANDARDIZED COUNTS

Two official or designated observers, relieved or supplemented by the on-site educator and other trained staff and volunteers, conducted standardized daily counts of migrating raptors from a single traditional observation site. This was official, full-season observer Angela Sjollemas first season of migration counting (see Appendix A for a complete history of observer participation). Official observer James Waddell, also with no prior seasons of migration counting experience, received pre-season training and worked during the first month of the season. Former HWI observer Steve Siebel, with four at least partial seasons of prior migration counting experience, then took over for the rest of the season. Long-time project affiliates and former full-time Chelan observers Richard Hendrick and Dan Russell ably assisted them on a regular basis. Other USFS and HWI staff and crewmembers, as well as visitors, also periodically assisted with the counts.

Weather permitting, observations usually began between 0700 and 0800 hrs and ended between 1500 and 1600 hrs Pacific Standard Time (PST). Data gathering and recording followed standardized protocols used at all HWI migration sites (Hoffman and Smith 2003). The observers routinely recorded the following data:

1. Species, age, sex, and color morph of each migrant raptor, whenever possible and applicable (Appendix B lists common and scientific names for all species, information about the applicability of age, sex, and color morph distinctions, and two-letter codes used to identify species in some tables and figures).
2. Hour of passage for each migrant; e.g., the 1000–1059 hrs PST.
3. Wind speed and direction, air temperature, percent cloud cover, predominant cloud type(s), presence or of precipitation, visibility, and an assessment of thermal-lift conditions, recorded for each hour of observation on the half hour.
4. Predominant direction, altitude, and distance from the lookout of the flight during each hour.

5. Total minutes observed and the mean number of observers present during each hour (included designated observers plus volunteers/visitors who actively contributed to the count [active scanning, pointing out birds, recording data, etc.] for more than 10 minutes in a given hour), recorded on the hour.
6. A subjective visitor-disturbance rating for each hour, recorded on the hour.
7. Daily start and end times for each official observer.

Calculation of “adjusted” (to standardize sampling periods and adjust for incompletely identified birds) passage rates (migrants counted per 100 hours of observation) and analysis of trends follows Hoffman and Smith (2003). In comparing 2005 annual statistics against means and 95% confidence intervals for previous seasons, we equate significance with a 2005 value falling outside the bounds of the confidence interval for the associated mean.

TRAPPING AND BANDING

Weather permitting the trappers operated the two traditional banding stations daily from late August through mid-October, generally between 0900–1700 hrs PST. Capture devices included mist nets, dhogaza nets, and remotely triggered bow nets. Trappers lured migrating raptors into the capture stations from camouflaged blinds using live, non-native avian lures attached to lines manipulated from the blinds. Unless already banded, all captured birds were fitted with a uniquely numbered USGS Biological Resources Division aluminum leg band. Data gathering and recording followed standardized protocols used at all HWI migration-banding sites (Hoffman et al. 2002). All birds were released within 45 minutes, usually much quicker.

RESULTS AND DISCUSSION

WEATHER

The project was shut down on 25 October, two days earlier than hoped for, for logistical reasons related to expectations of heavy snowfall (see Appendix C for daily weather records). Inclement weather entirely precluded only one other day of observation during the 2005 season, which is fewer than the 1998–2004 average of 3 days; however, three others were reduced to ≤ 4 hours of observation, which is slightly higher than average (2 days). Moreover, the season saw a record-high 13% of the active observation days with predominantly mostly cloudy to overcast skies and some rain or snow (average 6%), the overall proportion of active observation days during which some rain or snow occurred was above average (20 vs. 12%), and days when fair skies predominated were less frequent than usual (39 vs. 50%). Unlike in 2002 and 2003, especially, when the prevalence of visibility reducing fog and especially haze (mostly from wildfire smoke) was well above average, the proportion of such days in 2005 was well below average (12 vs. 39%). Moreover, the average east and west visibility ratings were record highs (86 km E, 78 km W vs. 1998–2004 averages of 47 km)

In 2005, light winds (< 12 kph) prevailed on 55% of the active observation days, moderate winds on 44%, and strong winds (≥ 29 kph) on 2% of the days (1998–2004 averages: 70%, 28%, and 2%). In terms of wind directions, 2005 was similar to 2004 in that steady S–SW winds prevailed more often than usual (61% of the active days). Such winds are usually the most common, but before 2004 (75%), the range of prevalence varied from 21–53%. Patterns such as variable NW–NE, N–E, and SW–SE were correspondingly more common then, especially from 1999–2003.

The temperature during active observation periods averaged 15.2°C (the average of daily values, which in turn were averages of hourly readings), ranging from 5.0–31.1°C. The overall range is the highest yet

recorded and the average nearly matches the record high (15.3°C) posted in 2004. In 2005, thermal-lift ratings nearly matched the 1998–2004 averages of 61% poor-to-fair and 39% good-to-excellent.

In summary, although inclement weather deterred our 2005 observers at an average level, the season featured much unsettled weather. Temperature readings extended a steady warming trend since 1999, but mostly cloudy to overcast skies and rainy/snowy weather also were more prevalent than usual. Smoke and haze were much less of a problem than in 2002 and 2003, dropping back to near pre-2002 levels. Wind speeds shifted slightly in favor of moderate as opposed to light winds compared to the average pattern, while much like last year, steady S–SW winds prevailed much more frequently than usual. The combination of warmer weather but stronger winds may have offset one another to result in thermal lift ratings that matched the long-term average.

OBSERVATION EFFORT

Observations occurred on 62 of 65 possible days between the scheduled observation period of 24 August through 27 October. The number of observation days and hours (502.50) were a non-significant 4% and 5% higher than the 1998–2004 averages of $59 \pm 95\%$ CI of 3.4 days and 477.15 ± 35.84 hours. The 2005 average of 1.9 observers per hour (including official and guest observers; value is mean of daily values, which are in turn means of hourly values) matched the 1998–2004 average of 1.9 ± 0.09 observers/hour.

FLIGHT SUMMARY AND TRENDS

The observers counted 1,826 migrating raptors of 16 species during the 2005 season (Table 1; see Appendix D for daily count records), which is a non-significant 16% lower than the 1998–2004 average (see Appendix E for annual count summaries). The flight consisted of 57% accipiters, 16% buteos, 7% eagles, 7% falcons, 6% harriers, 3% vultures, 1% Ospreys, and 2% unknown or other raptors (Figure 2). The proportions of buteos and Ospreys were significantly below average, whereas the proportions of vultures and harriers were significantly above average. The most common species seen in 2005 were the Sharp-shinned Hawk (40% of the total count), Cooper's Hawk (13%), Red-tailed Hawk (13%), Golden Eagle (7%), and Northern Harrier (6%). All other species each comprised less than 5% of the total count.

The count of Turkey Vultures rose to a record high of 58 birds, whereas the Northern Goshawk count fell to a record low of 13 birds (Appendix E). Adjusted passage rates were significantly above average only for Turkey Vultures and Merlins in 2005, whereas passage rates were significantly below average for four species: Osprey, Northern Goshawk, Red-tailed Hawk, and Swainson's Hawk (Table 1).

Population Trends

Eight years of full-season data is still too short a duration to attach much significance to documented trends; nevertheless, comparisons across species and with data from other longer-term monitoring projects in the West are instructive. Regression analyses of trends in adjusted passage rates between 1998 and 2005 indicated marginally ($P \leq 0.10$) to highly significant ($P \leq 0.01$) linear declining trends for Northern Harriers (Figure 3), Sharp-shinned Hawks (Figure 4), Broad-winged Hawks (Figure 5), and American Kestrels (Figure 7). In addition, following two years of increasing passage rates in 1999 and 2000, Ospreys have shown a steep declining pattern thereafter, which resulted in a marginally significant, hill-shaped quadratic trend (Figure 3). Marginally significant quadratic trends were also indicated for Cooper's Hawks and Merlins, but in these cases trough-shaped patterns tracking declines through 2003 followed by rebounds in the last two years (Figure 4). Though not resulting in a significant regression at this point due to a spike in activity in 2004, Northern Goshawks also have generally shown a declining trajectory since 1998 (Figure 4). Similarly, though the 1998 passage rate for Red-tailed Hawks was relatively low, passage rates for this species have shown a fairly steady decline since 1999 (Figure 5).

The only species that have shown distinct increasing trajectories since 1998 are Turkey Vultures, Golden Eagles (primarily adults), and Peregrine Falcons (Figures 3, 6, and 7), though regression analyses revealed significant patterns only for Turkey Vultures ($P = 0.07$) and adult Golden Eagles ($P = 0.02$).

Across HWI's network of western migration-monitoring sites, declining patterns have been common since widespread and prolonged drought began plaguing much of the interior West after 1998 (Hoffman and Smith 2003). In particular, overall counts have been very low for the past four years in the heart of the drought-stricken Great Basin at HWI's monitoring site in the Goshute Mountains of northeastern Nevada (Smith and Neal 2006a), and the count in the Grand Canyon of Arizona farther south along the same flyway plummeted to record lows in 2004 and again in 2005 (Smith and Neal 2006b). Several species have shown declining trends since 1999 at Chelan Ridge as well, but substantially lower overall counts kicked in a year later compared to the Goshute Mountains. Whether or not these are related patterns is unclear at present. Like the central Great Basin, the eastern Cascades region where Chelan Ridge lies has been hit hard by regional drought. A relatively high proportion of the migrants that pass through Chelan Ridge probably originate in areas that lie northwest of the primary drought region, however, whereas the Goshute Mountains normally draw from a much greater expanse of naturally xeric Great Basin habitat. The direct impact of the drought may have hit most quickly populations in the already xeric northern Great Basin and therefore affected the Goshute counts sooner. The drought has also become more severe in the northeastern Cascades in the last two years, whereas moisture levels finally rebounded in the northern Great Basin in 2004 and especially 2005.

We have now recorded three instances of migrants being caught at both Chelan Ridge and at HWI's Bonney Butte migration site farther south in the Cascades of northern Oregon, and several of HWI's satellite-tracked raptors have passed near both sites. Thus, we know that the two sites are connected for many migrants that move within the Pacific Coast Flyway and generally winter in California. In this light, it is particularly noteworthy that counts and passage rates at the two sites over the past several years have followed highly divergent patterns. Counts were high at Chelan but low at Bonney Butte in 2002 (see Smith and Neal 2006c), then counts jumped to record highs at Bonney Butte in 2003 and 2004 while counts dropped to record lows at Chelan, and finally the overall count rose again by 25% at Chelan in 2005 but dropped by 28% at Bonney Butte in 2005.

One possible explanation for these divergent patterns concerns regional flight-line shifts. After three years of severe drought, counts in the Goshute Mountains in the heart of the Great Basin plummeted in 2002 from ~20,000 to ~12,000 migrants per season (Smith and Neal 2006a), coincident with near-record high counts commencing at Bonney Butte in 2003 and 2004 at the same time that counts at Chelan Ridge remained at low levels. We suspected that a logical diversion path for migrants moving south through eastern Washington and northern Idaho to use to avoid the parched Great Basin would be to veer west through the Blue and Wallowa Mountains and over to the Cascades with Mt. Hood as a navigation target. This would result in those migrants intersecting the Cascades just north of Bonney Butte, and might explain the high counts at Bonney Butte despite low counts farther north in the Washington Cascades. Counts at Idaho Bird Observatory's site near Boise have also remained high in the last few years (G. Kaltenecker personal communication) while the counts dropped in the Goshutes several hundred kilometers farther south, again suggesting the possibility that some migrants have been diverting west out of Idaho before passing down through the heart of the Great Basin. Winter/spring moisture levels finally began to rebound in the northern Great Basin in 2004 and especially 2005, whereas drought conditions intensified during 2004 and remained fairly severe through early winter 2005 in the northern Cascades before conditions rebounded to above-average snowpack by spring 2006. It is therefore possible that the 2005 drop in the Bonney Butte count signaled a shift in activity back towards the Great Basin. However, although the count at Boise Ridge was well-above average again in 2005, no corresponding increase occurred at the Goshutes, so it appears we will need to await additional years of data to clarify our understanding of regional dynamics.

Age Ratios as Indicators of Regional Productivity

Six of nine species for which comparisons of immature : adult ratios were possible showed lower than average ratios in 2005, with the differences significant for Northern Goshawks, Red-tailed Hawks, and Golden Eagles (Table 2). Age ratios for Peregrine Falcons and Bald Eagles were significantly above average, but low overall counts preclude attaching much significance to these comparisons. The Cooper's Hawk also showed a significantly above-average age ratio in 2005, with the count of immature birds well above average. This suggests that, although the overall count and passage rate for this species were only slightly above average, it was probably a relatively productive year for Cooper's Hawks in the northern Pacific Northwest in 2005. Conversely, for all species that showed below average age ratios in 2005, lower than average counts of young birds contributed, suggesting that for these species low productivity likely contributed to the continued average to below average counts for these species.

Seasonal Timing

The combined-species median passage date of 18 September was a significant 6 days earlier than the 1998–2004 average (Table 3). Similar to 2003 and 2004, the seasonal distribution of activity in 2005 was atypical compared to previous years in showing a bimodal pattern, with proportionately higher than usual activity during the 16–20 September and 6–10 October five-day periods, but significantly below-average activity in between (Figure 8). The low mid-September activity corresponded to the only multi-day rain and snow event of the season, which occurred from 29 September to 3 October.

At the species level, Northern Goshawks, Red-tailed Hawks, and Golden Eagles showed significantly later than average median passage dates in 2005, whereas Turkey Vultures, Osprey, Northern Harriers, Sharp-shinned Hawks, Broad-winged Hawks, and American Kestrels all showed significantly earlier than average timing in 2005. Most other species showed median passage dates that were within two days of average. Age-specific data revealed three noteworthy clarifications: 1) the indicator of late species-level passage for Red-tailed Hawks primarily reflected late passage of adults; 2) the species-level indication of average timing for Cooper's Hawks was not reflected in the age-specific data for adults, which showed significantly late timing; and 3) the indicator of late species-level passage for Golden Eagles primarily reflected late passage of non-adults (Table 4).

RESIDENT RAPTORS

During the first two weeks of the season, one resident Sharp-shinned Hawk and at least one Cooper's Hawk were regularly seen around the project site. Sightings of an apparently local Peregrine Falcon were noted during the first week of observations, as it “stooped” the owl decoy. A family of light-morph Red-tailed Hawks, including one immature bird and a pair of adults, also were resident in the area, with the young bird gone by early October but at least one adult still present when the project shut down in late October. A territorial pair of Golden Eagles was seen regularly, with their activity concentrated several drainages to the southwest of the observation point. One pair of adult American Kestrels frequented the area through mid-September.

This is a fairly typical resident assemblage for the site, except that local Turkey Vultures, Northern Harriers, and Prairie Falcons have frequented the area in past years

TRAPPING EFFORT

Trapping occurred on 56 of 59 days between 25 August and 22 October, with effort totaling 828.19 station hours (see Appendix F for daily trapping records). The number of trapping days and station hours was comparable to 2002 and 2003, but significantly higher than other years (see Appendix G for annual trapping summaries).

TRAPPING AND BANDING RESULTS

The 2005 capture total of 623 newly banded birds of 10 species was the second highest total since HWI took over the banding program in 2001, 18% higher than the 2001–2004 average and 46% higher than the overall 1999–2004 average for the site (Table 5, Appendix G). Based on 1999–2004 averages, capture totals were above average for six species, significantly so for Northern Harriers, Cooper's Hawks, Rough-legged Hawks, and Merlins, with totals reaching new record highs for the latter three species. In contrast, capture totals were below average for five species, significantly so for Red-tailed Hawks and Prairie Falcons. The 2005 effort raised the total number of diurnal raptors captured at the site to 3,186 (Appendix G). The species captured most frequently in 2005 were the Sharp-shinned Hawk (65% of captures), Cooper's Hawk (19%), Merlin (4%), Red-tailed Hawk (4%), and Northern Goshawk (3%); all other species each comprised <2% of the total (Table 5). It was also a distinct pleasure for the crew to incidentally capture a Northern Pygmy Owl, the first of this species ever caught at the site.

Capture rates (birds captured per 100 station hours) reflected the same pattern as capture totals, whereas capture success—a better measure of the efficiency of our trappers—was significantly above average for Northern Goshawks and Red-tailed Hawks, at least slightly above average for five other species, and did not fall significantly below average for any species (Table 5). These statistics indicate that the trapping crew was efficient, and that low capture totals for Northern Goshawks and Red-tailed Hawks were definitely due to low passage volume.

Compared to the counts, banding at this site yields unique and substantial sex–age specific data only for the three accipiters and American Kestrels (Table 2). For Sharp-shinned Hawks and Northern Goshawks, both the count and banding data indicated significantly below average immature : adult ratios (19 and 26% below average for sharp-shins and 98 and 38% below average for goshawks). Further, the three times greater proportional drop in the count age ratio for goshawks compared to the capture-based age ratio suggests that immature goshawks were both much less common and more susceptible to capture than usual (i.e., hungrier than usual). For Cooper's Hawks, the count indicated a 118% above average age ratio, whereas the banding data indicated a 31% below average ratio. This suggests that immature Cooper's Hawks were relatively more abundant than usual and substantially less susceptible to capture than usual compared to adults. The capture data also uniquely indicated a 76% above-average female : male ratio for Northern Goshawks, whereas the capture-based sex ratios for Sharp-shinned and Cooper's Hawks were near average (Table 2).

The banding data uniquely indicated a 51% below average age ratio for American Kestrels (Table 2), as well as a 71% below-average sex ratio, suggesting that male kestrels may have been more susceptible than usual to capture in 2005. The capture total for kestrels was too low in 2005 to attach much significance to these statistics, however.

ENCOUNTERS WITH PREVIOUSLY BANDED BIRDS

Since banding began at Chelan Ridge in 1999, 14 foreign encounters with Chelan-banded birds have been recorded (Table 7). Four new encounters occurred in 2005, two involving birds that were captured at other research sites. The first bird encountered in 2005 was a male Northern Goshawk that was found dead of unknown causes 113 km from Chelan Ridge near Tonasket, WA. The next bird was a female Sharp-shinned Hawk that was injured after colliding with a window while chasing passerines near a bird feeder. This third-year bird was released from rehabilitation and was described as healthy, although a bit obese from its time at the feeders! The next bird was a second-year, female Sharp-shinned Hawk, encountered as a next-season foreign recapture at HWI's Goshute Mountains migration site in northeastern Nevada (Smith and Neal 2006). This is the first such exchange documented between the Chelan and Goshute sites, and is the first Chelan bird to be encountered that far east besides a Golden Eagle that HWI tracked via satellite from the site to southeast New Mexico (see

<http://www.hawkwatch.org/satelliteprogram.php>). The last bird encountered in 2005 was female hatch-year Cooper's Hawk, which was a same-season exchange between Chelan Ridge and Golden Gate Raptor Observatory's migration research site 951 km south in the Marin Headlands of central California. Thus is the second exchange of banded birds recorded between these two sites.

IDENTIFYING MIGRANT ORIGINS THROUGH STABLE ISOTOPE ANALYSES

In 2005, HWI continued to collect feather samples from a variety of species to support on-going stable-isotope research, which seeks to use analyses of hydrogen stable-isotope ratios to identify the approximate natal origins of migrants monitored across HWI's migration project network (e.g., Meehan et al. 2001, Lott et al. 2003, Lott and Smith in press).

VISITOR PARTICIPATION AND PUBLIC OUTREACH

The 2005 visitor logs recorded 120 individuals, mostly from surrounding Washington communities as far away as Seattle. Most visitors came between 18 and 28 September, with 23 September being the day of highest visitor volume. Organized group visitation included the East Lake Audubon Society, Twisp Community School, The River Academy in Wenatchee, and a family of home schooled children.

In 2005, 515 hourly assessments by the observers of visitor disturbance resulted in the following ratings: 92% none, 7% low, 2% moderate, and 0% high. This low level of disturbance testifies to the advantages of having a full-time educator and other dedicated volunteers available to ensure enjoyable and informative visits for all guests without unnecessarily distracting the observers from their primary task of documenting the migration.

ACKNOWLEDGEMENTS

Financial and logistical support for this project in 2005 was provided by Okanogan and Wenatchee National Forests, the Washington Department of Fish and Wildlife (WDFW), the Walbridge Fund, the Kittitas and Vancouver Audubon Societies, and HWI private donors and members. Numerous individuals were essential in helping us achieve successful promotion and implementation of this season's effort. Richard Hendrick once again provided invaluable support with project set-up, lure birds, firewood, food, and supplementing the observation crew. His eyes are important to this project. Brad Martin gets the prize for longevity and consistency of his support in providing pigeons that allow the trapping aspect to proceed. Tannis Thorlakson continued her dedication to the project and has nearly completed her internship requirements. Forest Service Visitor Services staff, including Tommy Days, Pat Tourangeau, Kathy Corrigan, and Sharon Cathcart, covered many bases, especially answering radio calls from the ridge each day, maintaining the tally board, interacting with visitors anxious to see the site, and especially presenting an interesting and informative visitor center display. Jim and Jesse Watson are conscientious helpers each year and this year was no exception. We greatly appreciate the connection to the WDFW that Jim and Area Wildlife Biologist Scott Fitkin provide. Rena Rex again kept the Chelan District involved with our efforts. The USFS staff and line support from District Biologist John Rohrer, District Ranger John Newcom, Forest Biologists Bob Naney and Bill Gaines, and Sarah Madsen, Elaine Rybak, and Robert Alvarado from the Regional Office was especially appreciated. It was also a pleasure to have a visit from USFS Regional Avian Program Coordinator Barb Bresson, who released the first-ever Northern Pygmy Owl captured at the project site.

LITERATURE CITED

- Bildstein, K. L. 2001. Why migratory birds of prey make great biological indicators. Pages 169–179 in K. L. Bildstein and D. Klem (Editors). *Hawkwatching in the Americas*. Hawk Migration Association of North America, North Wales, Pennsylvania, USA.
- Hoffman, S. W., and J. P. Smith. 2003. Population trends of migratory raptors in western North America, 1977–2001. *Condor* 105:397–419.
- Hoffman, S. W., J. P. Smith, and T. D. Meehan. 2002. Breeding grounds, winter ranges, and migratory routes of raptors in the Mountain West. *Journal of Raptor Research* 36:97–110.
- Inzunza, E. R., S. W. Hoffman, L. J. Goodrich, and R. Tingay. 2000. Conservation strategies for the world's largest known raptor migration flyway: Veracruz the River of Raptors. Pages 591–596 in R. D. Chancellor and B.-U. Meyburg, editors. *Raptors at risk*. World Working Group on Birds of Prey and Owls, Berlin, Germany, and Hancock House Publishers, British Columbia and Washington.
- Kerlinger, P. 1989. *Flight strategies of migrating hawks*. University of Chicago Press, Chicago, Illinois. 375 pp.
- Meehan, T. D., C. A. Lott, Z. D. Sharp, R. B. Smith, R. N. Rosenfield, A. C. Stewart, and R. K. Murphy. 2001. Using hydrogen isotope geochemistry to estimate the natal latitudes of immature Cooper's Hawks migrating through the Florida Keys. *Condor* 103:11–20.
- Lott, C. A., T. D. Meehan, and J. A. Heath. 2003. Estimating the latitudinal origins of migratory raptors using hydrogen and sulfur stable isotopes in feathers: influence of marine prey base. *Oecologia* 134: 505-510.
- Lott, C. A., and J. P. Smith. In press. A GIS approach to estimating the origins of migratory raptors in North America using hydrogen stable isotope ratios in feathers. *The Auk*.
- Smith, J. P., and M. C. Neal. 2006a. Fall 2005 raptor migration studies in the Goshute Mountains of northeastern Nevada. HawkWatch International, Inc., Salt Lake City, Utah. 41 pp.
- Smith, J. P., and M. C. Neal. 2006b. Fall 2005 raptor migration studies in the Grand Canyon of Arizona. HawkWatch International, Inc., Salt Lake City, Utah. 32 pp.
- Smith, J. P., and M. C. Neal. 2005c. Fall 2005 raptor migration studies at Bonney Butte, Oregon. HawkWatch International, Inc., Salt Lake City, Utah. 33 pp.
- Smith, J. P., J. Simon, S. W. Hoffman, and C. Riley. 2001. New full-season autumn hawkwatches in coastal Texas. Pages 67–91 in K. L. Bildstein and D. Klem, editors. *Hawkwatching in the Americas*. Hawk Migration Association of North America, North Wales, Pennsylvania, USA.
- Smith, J. P., and S. W. Hoffman. 2000. The value of extensive raptor migration monitoring in western North America. Pages 597–615 in R. D. Chancellor and B.-U. Meyburg, editors. *Raptors at risk*. World Working Group on Birds of Prey and Owls, Berlin, Germany, and Hancock House Publishers, British Columbia, Canada, and Washington, USA.
- Zalles, J. I., and K. L. Bildstein (Editors). 2000. *Raptor watch: a global directory of raptor migration sites*. BirdLife Conservation Series No. 9. BirdLife International, Cambridge, United Kingdom, and Hawk Mountain Sanctuary Association, Kempton, Pennsylvania, USA.

Table 1. Fall counts and adjusted passage rates (truncated to standardized annual sampling periods and adjusted for incompletely identified birds) by species for migrating raptors at Chelan Ridge, WA: 1998–2004 versus 2005.

SPECIES	COUNTS			RAPTORS/100 HOURS		
	1998–2004 ¹	2005	% Change	1998–2004 ¹	2005	% Change
Turkey Vulture	27 ± 7.3	58	+113	8.1 ± 2.54	18.5	+126
Osprey	45 ± 12.1	25	-44	12.7 ± 3.68	6.8	-46
Northern Harrier	113 ± 32.2	113	0	26.3 ± 7.97	25.0	-5
White-tailed Kite	0 ± 0.3	0	-100	–	–	–
Sharp-shinned Hawk	805 ± 186.6	730	-9	218.4 ± 58.80	178.4	-18
Cooper's Hawk	209 ± 27.5	228	+9	60.3 ± 10.52	61.5	+2
Northern Goshawk	30 ± 9.5	13	-57	6.8 ± 1.95	2.7	-60
Unknown small accipiter ²	56 ± 43.4	48	-14	–	–	–
Unknown large accipiter ²	8 ± 7.0	6	-27	–	–	–
Unknown accipiter	95 ± 74.8	9	-90	–	–	–
TOTAL ACCIPITERS	1176 ± 247.3	1034	-12	–	–	–
Broad-winged Hawk	5 ± 1.7	6	+14	3.4 ± 1.35	3.4	0
Swainson's Hawk	8 ± 4.7	2	-74	2.6 ± 1.66	0.6	-77
Red-tailed Hawk	312 ± 67.7	233	-25	81.7 ± 17.08	51.5	-37
Ferruginous Hawk	0 ± 0.3	0	-100	0.2 ± 0.31	0.0	-100
Rough-legged Hawk	29 ± 13.1	22	-24	14.8 ± 4.98	10.9	-26
Unidentified buteo	75 ± 31.9	29	-61	–	–	–
TOTAL BUTEOS	429 ± 106.9	292	-32	–	–	–
Golden Eagle	126 ± 27.7	130	+3	28.5 ± 5.77	29.3	+3
Bald Eagle	5 ± 3.8	4	-24	1.2 ± 0.79	0.9	-22
Unidentified eagle	4 ± 3.4	2	-44	–	–	–
TOTAL EAGLES	135 ± 32.0	136	+1	–	–	–
American Kestrel	67 ± 20.6	55	-18	19.4 ± 6.84	13.4	-31
Merlin	36 ± 8.0	53	+48	9.1 ± 2.51	12.5	+38
Prairie Falcon	8 ± 3.8	4	-51	2.2 ± 0.86	1.4	-33
Peregrine Falcon	6 ± 3.5	4	-38	1.6 ± 0.72	1.6	+2
Unknown small falcon ²	5 ± 0.9	1	-81	–	–	–
Unknown large falcon ²	2 ± 0.5	3	+71	–	–	–
Unknown falcon	3 ± 1.9	0	-100	–	–	–
TOTAL FALCONS	124 ± 26.0	120	-3	–	–	–
Unidentified raptor	135 ± 54.8	48	-65	–	–	–
GRAND TOTAL	2184 ± 397.8	1826	-16	–	–	–

¹ Mean ± 95% confidence interval.

² Designations used for the first time in 2001.

Table 2. Fall counts by age class and immature : adult ratios for selected species of migrating raptors at Chelan Ridge, WA: 1998–2004 versus 2005.

	TOTAL AND AGE-CLASSIFIED COUNTS						IMMATURE : ADULT			
	1998–2004 AVERAGE			2005			% UNKNOWN AGE		RATIO	
	TOTAL	IMM	ADULT	TOTAL	IMM	ADULT	1998–2004 ¹	2005	1998–2004 ¹	2005
Northern Harrier	113	40	29	113	24	18	40 ± 7.6	63	1.4 ± 0.41	1.3
Sharp-shinned Hawk	805	405	126	730	398	129	34 ± 8.9	28	3.7 ± 1.89	3.1
Cooper's Hawk	209	94	28	228	135	17	43 ± 9.9	33	3.8 ± 1.94	7.9
Northern Goshawk	30	15	5	13	3	5	38 ± 11.2	38	5.4 ± 3.36	0.6
Broad-winged Hawk	5	2	1	6	1	2	38 ± 21.7	50	1.5 ± 1.00	0.5
Red-tailed Hawk	312	75	140	233	21	127	30 ± 5.6	36	0.6 ± 0.15	0.2
Golden Eagle	126	63	28	130	44	28	27 ± 4.7	45	2.3 ± 0.41	1.6
Bald Eagle	5	1	4	4	1	3	9 ± 13.9	0	0.2 ± 0.28	1.0
Peregrine Falcon	6	1	2	4	3	1	54 ± 22.1	0	1.1 ± 1.29	3.0

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

Table 3. First and last observed, bulk-passage, and median-passage dates by species for migrating raptors at Chelan Ridge, WA in 2005, with a comparison of 2005 and 1998–2004 average median passage dates.

SPECIES	2005				1998–2004
	FIRST OBSERVED	LAST OBSERVED	BULK PASSAGE DATES ¹	MEDIAN PASSAGE DATE ²	MEDIAN PASSAGE DATE ^{2,3}
Turkey Vulture	26-Aug	1-Oct	1-Sep – 18-Sep	8-Sep	17-Sep ± 4.5
Osprey	27-Aug	13-Oct	31-Aug – 8-Oct	6-Sep	20-Sep ± 1.1
Northern Harrier	24-Aug	24-Oct	1-Sep – 11-Oct	18-Sep	23-Sep ± 2.0
Sharp-shinned Hawk	24-Aug	25-Oct	3-Sep – 9-Oct	18-Sep	21-Sep ± 2.5
Cooper's Hawk	24-Aug	22-Oct	1-Sep – 4-Oct	17-Sep	18-Sep ± 2.6
Northern Goshawk	26-Aug	21-Oct	2-Sep – 14-Oct	6-Oct	23-Sep ± 5.6
Broad-winged Hawk	7-Sep	15-Sep	7-Sep – 15-Sep	7-Sep	14-Sep ± 1.8
Swainson's Hawk	14-Sep	8-Oct	–	–	14-Sep ± 6.5
Red-tailed Hawk	24-Aug	23-Oct	31-Aug – 15-Oct	27-Sep	24-Sep ± 2.3
Rough-legged Hawk	30-Sep	23-Oct	7-Oct – 21-Oct	16-Oct	15-Oct ± 4.4
Golden Eagle	27-Aug	25-Oct	6-Sep – 22-Oct	6-Oct	03-Oct ± 2.3
Bald Eagle	31-Aug	15-Oct	–	–	15-Oct ± 7.4
American Kestrel	24-Aug	13-Oct	25-Aug – 28-Sep	3-Sep	14-Sep ± 5.4
Merlin	27-Aug	22-Oct	3-Sep – 8-Oct	19-Sep	21-Sep ± 3.7
Prairie Falcon	24-Aug	7-Sep	–	–	19-Sep ± 8.6
Peregrine Falcon	27-Aug	13-Sep	–	–	19-Sep ± 10.8
Total	27-Aug	25-Oct	1-Sep – 11-Oct	18-Sep	23-Sep ± 1.5

¹ Dates between which the central 80% of the flight passed the lookout.

² Date by which 50% of the flight had passed the lookout.

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

Table 4. Median passage dates by age for selected species of migrating raptors at Chelan Ridge, WA: 1998–2004 versus 2005.

SPECIES	ADULT		IMMATURE	
	1998–2004 ¹	2005	1998–2004 ¹	2005
Northern Harrier	22-Sep ± 3.7	21-Sep	23-Sep ± 2.8	18-Sep
Sharp-shinned Hawk	02-Oct ± 1.7	1-Oct	15-Sep ± 2.1	14-Sep
Cooper’s Hawk	25-Sep ± 2.4	4-Oct	13-Sep ± 1.8	14-Sep
Northern Goshawk	09-Oct ± 10.8	6-Oct	23-Sep ± 4.6	–
Red-tailed Hawk	27-Sep ± 2.0	4-Oct	16-Sep ± 4.6	13-Sep
Golden Eagle	06-Oct ± 3.4	4-Oct	02-Oct ± 1.5	11-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 \pm 95% confidence interval in days; values are given only for species with annual counts ≥ 5 birds for ≥ 3 years.

Table 5. Fall capture totals, rates, and successes by species for migrating raptors at Chelan Ridge, WA: 1999–2004 versus 2005.

	CAPTURE TOTALS		CAPTURE RATE ¹		CAPTURE SUCCESS ²	
	1999–2004 ³	2005	1999–2004 ³	2005	1999–2004 ³	2005
Northern Harrier	8 ± 3.3	12	1.3 ± 0.29	1.4	9.1 ± 5.2	7.5
Sharp-shinned Hawk	283 ± 110.0	389	45.8 ± 9.09	47.0	39.1 ± 21.1	38.5
Cooper's Hawk	80 ± 28.7	137	12.8 ± 3.15	16.5	37.9 ± 13.9	35.7
Northern Goshawk	12 ± 2.1	11	2.1 ± 0.83	1.3	47.4 ± 20.8	93.4
Red-tailed Hawk	18 ± 6.1	11	2.9 ± 0.51	1.3	4.3 ± 1.7	6.5
Rough-legged Hawk	0.8 ± 0.60	5	0.1 ± 0.09	0.6	5.8 ± 7.3	6.0
Golden Eagle	2 ± 1.2	2	0.2 ± 0.19	0.2	0.9 ± 0.6	1.2
American Kestrel	7.2 ± 4.79	6	1.2 ± 0.49	0.7	8.5 ± 4.6	12.5
Merlin	14 ± 6.8	49	2.3 ± 0.66	5.9	47.6 ± 29.0	35.6
Prairie Falcon	2 ± 1.2	0	0.4 ± 0.14	0.0	24.4 ± 19.0	33.3
Peregrine Falcon	1.2 ± 1.3	1	0.2 ± 0.19	0.1	14.3 ± 20.9	19.0
All species	427 ± 159.8	623	69.4 ± 13.44	75.2	24.5 ± 11.3	26.9

¹ Captures / 100 station hours.

² Number of birds captured / number of birds observed. The combined-species value was calculated excluding Ospreys, Turkey Vultures, and unknown raptors from the count totals. Species-specific values were calculated after birds identified only to genus were allocated across possible species in proportion to the relative abundance of birds identified to those species.

³ Mean of annual values ± 95% confidence interval; data collected by the Falcon Research Group in 1999 and 2000.

Table 6. Fall capture totals by sex and age (HY = hatching year; AHY = after hatching year), female : male capture ratios, and immature : adult capture ratios for selected species of migrating raptors at Chelan Ridge, WA: 2001–2004 versus 2005.

SPECIES	YEARS	FEMALE		MALE		FEMALE : MALE RATIO	IMM. : ADULT RATIO
		HY	AHY	HY	AHY		
Sharp-shinned Hawk	Avg. 2001–2004	144	48	138	28	1.2 ± 0.18	3.7 ± 0.94
	2005	155	60	133	47	1.2	2.7
Cooper's Hawk	Avg. 2001–2004	36	22	32	9	1.6 ± 0.51	2.2 ± 0.67
	2005	55	27	47	8	1.5	2.9
Northern Goshawk	Avg. 2001–2004	3	1	7	1	0.5 ± 0.22	7.2 ± 4.68
	2005	4	1	6	0	0.8	10.0
American Kestrel	Avg. 2001–2004	1	1	6	1	0.2 ± 0.08	4.1 ± 3.89
	2005	1	0	3	2	0.2	2.0

¹ Mean ± 95% CI.

Table 7. Foreign encounters of raptors banded at the Chelan Ridge Raptor Migration Project: 2000–2005.

BAND #	SPECIES ¹	SEX	BANDING DATE	BANDING AGE ²	ENCOUNTER LOCATION	ENCOUNTER DATE	ENCOUNTER AGE ²	DISTANCE (KM)	STATUS
? – ?	CH	?	16-Sep-00	HY	Edwards AFB, CA	4-Oct-00	HY	583	found dead
1593 – 02001	SS	F	30-Aug-01	HY	Fallon, NV	16-Sep-01	HY	798	hit by car / captive
1293 – 25056	ML	F	13-Sep-01	HY	Bend, OR	25-Sep-01	HY	376	hit by car / euthanized
1593 – 02076	SS	F	02-Oct-01	HY	Bonney Butte, OR	10-Oct-01	HY	288	research recapture
1593 – 02002	SS	F	02-Sep-01	HY	Georgetown, CA	14-Oct-01	HY	831	collision kill
1202 – 22157	SS	M	24-Sep-01	HY	Marin Headlands, CA	26-Oct-01	HY	957	research recapture
1177 – 06406	RT	U	05-Oct-01	ASY	Clinton, BC	21-Oct-02	ATY	312	found dead
1573 – 60662	SS	F	21-Sep-02	HY	Stinson Beach, CA	24-Nov-02	HY	956	found dead
1593 – 02189	SS	F	26-Sep-01	HY	Nampa, ID	06-Dec-03	TY	574	found dead
1483 – 55870	SS	F	13-Sep-04	HY	Bonney Butte, OR	13-Oct-04	HY	288	research recapture
2206 – 55543	NG	M	14-Oct-03	HY	Tonasket, WA	29-Dec-05	TY	113	found dead
1005 – 01200	CH	F	27-Aug-05	HY	Marin Headlands, CA	19-Oct-05	HY	951	research recapture
1573 – 60818	SS	F	04-Oct-04	SY	Prince George, BC	03-Apr-05	TY	598	injured / released
1483 – 55867	SS	F	10-Sep-04	HY	Goshute Mountains, NV	17-Oct-05	SY	948	research recapture

¹ SS = Sharp-shinned Hawk; CH = Cooper's Hawk; ML = Merlin.

² HY = hatch year, SY = second year; TY = third year; AHY = after hatch year; ASY = after second year; ATY = after third year.



Figure 1. Location of the Chelan Ridge Raptor Migration Project count and banding sites in north-central Washington.

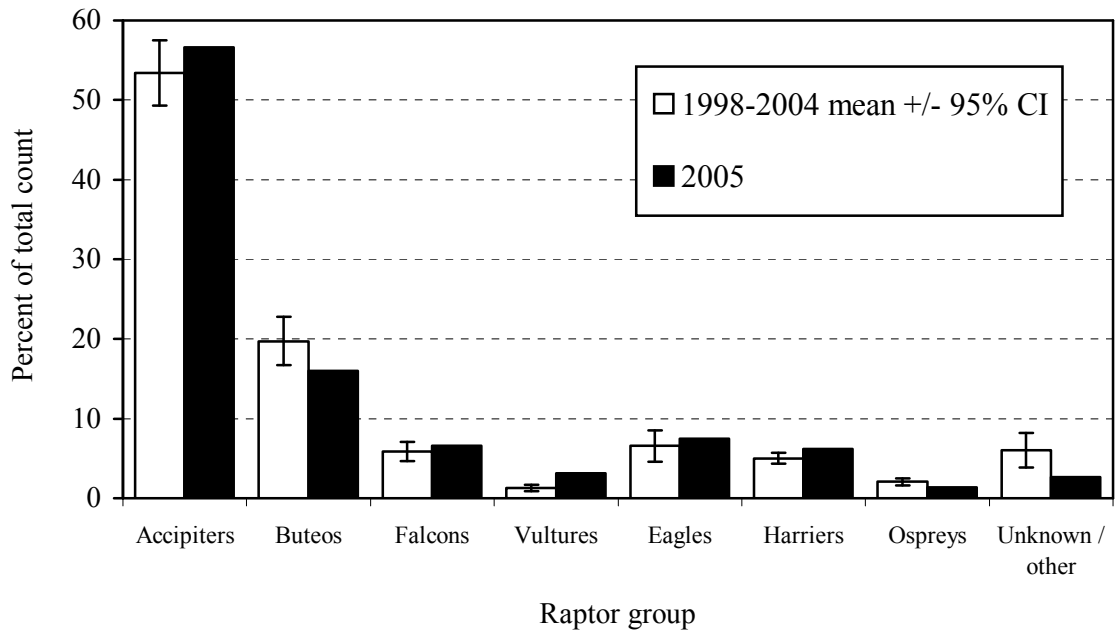


Figure 2. Fall raptor migration flight composition by major species groups at Chelan Ridge, WA: 1998–2004 versus 2005.

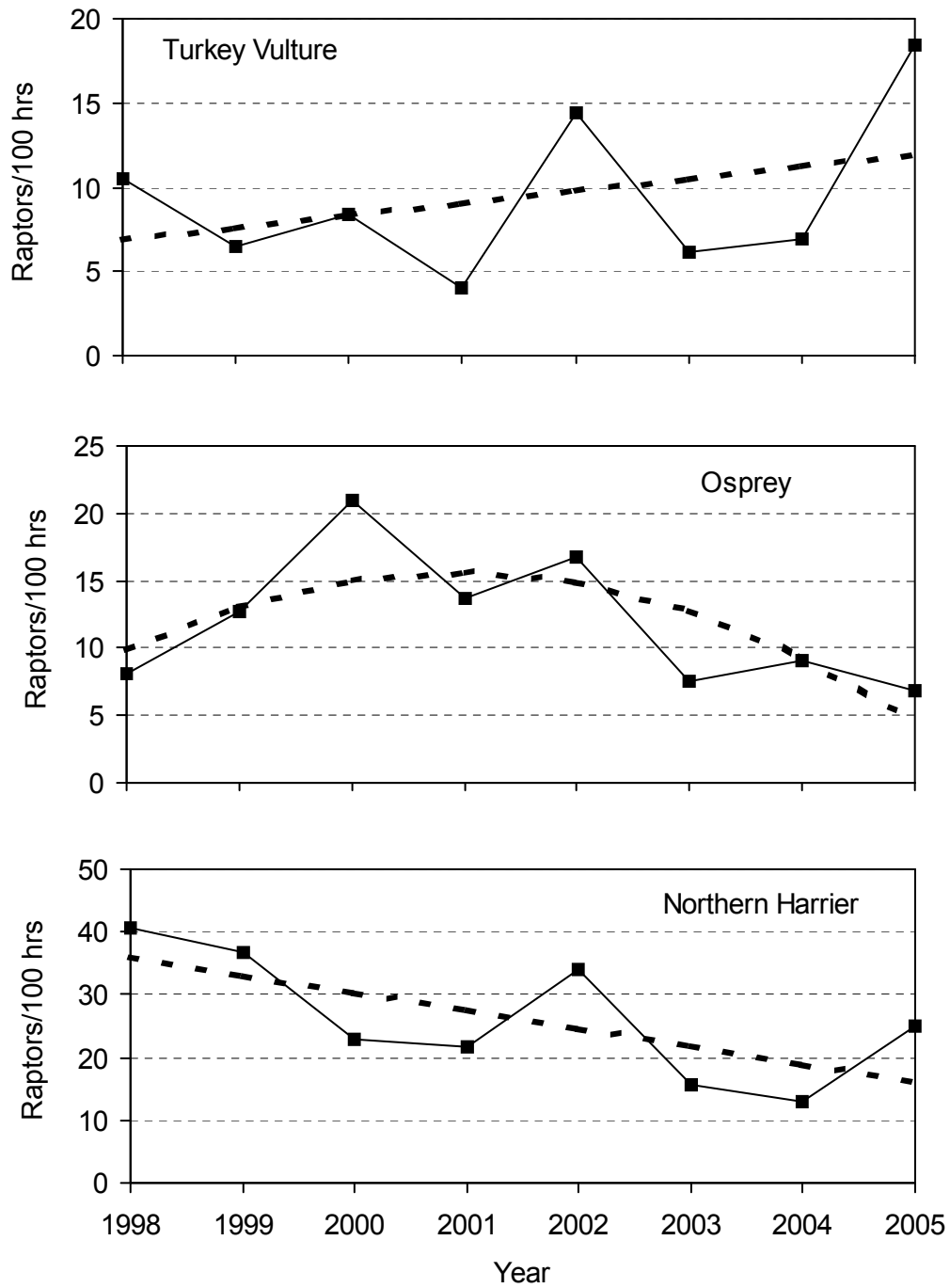


Figure 3. Adjusted fall-migration passage rates at Chelan Ridge, WA for Turkey Vultures, Ospreys, and Northern Harriers: 1998–2005. Dashed lines indicate significant linear or quadratic regressions.

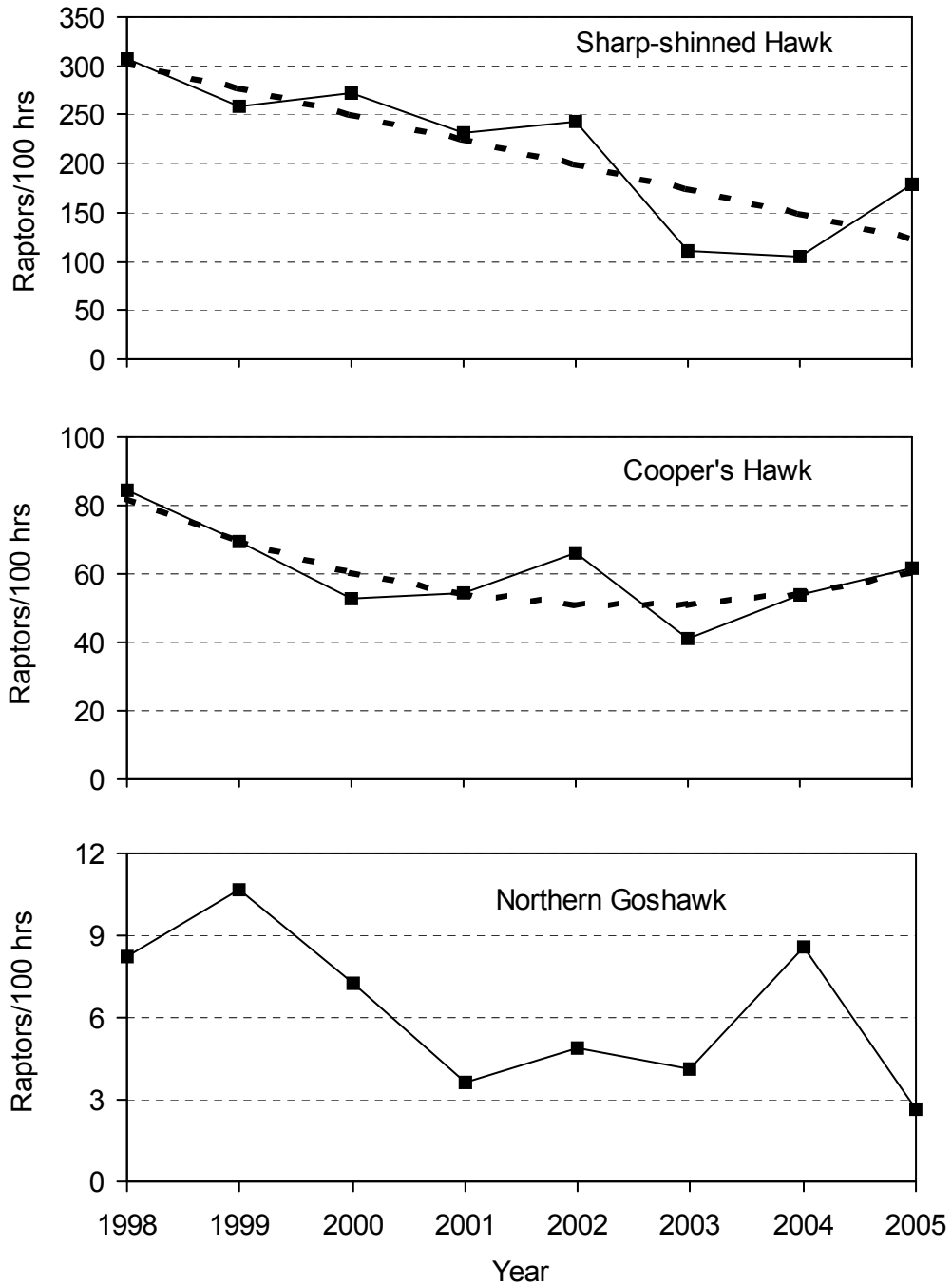


Figure 4. Adjusted fall-migration passage rates at Chelan Ridge, WA for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks: 1998–2005. Dashed lines indicate significant linear or quadratic regressions.

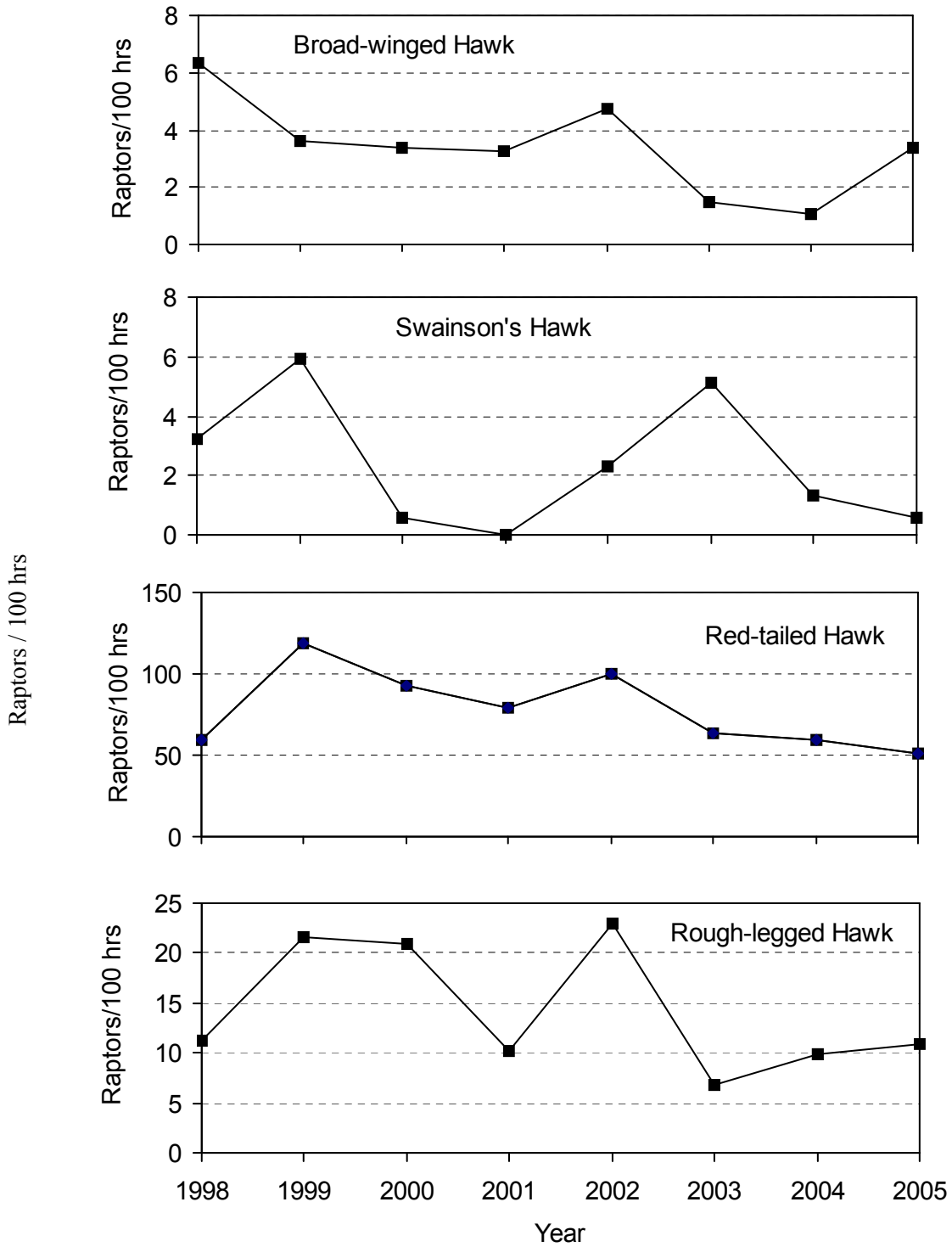


Figure 5. Adjusted fall-migration passage rates at Chelan Ridge, WA for Broad-winged, Swainson's, Red-tailed, and Rough-legged Hawks: 1998–2005. Dashed lines indicate significant linear or quadratic regressions.

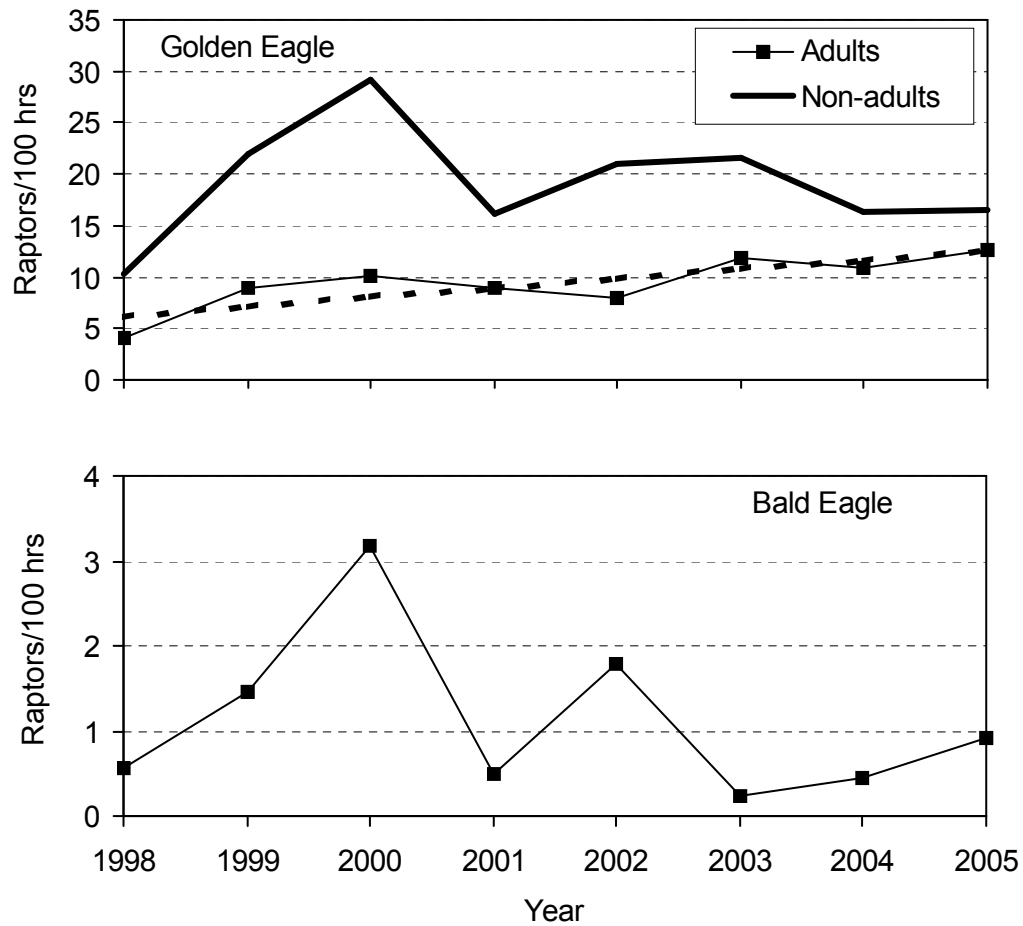


Figure 6. Adjusted fall-migration passage rates at Chelan Ridge, WA for Golden and Bald Eagles: 1998–2005. Dashed lines indicate significant linear or quadratic regressions.

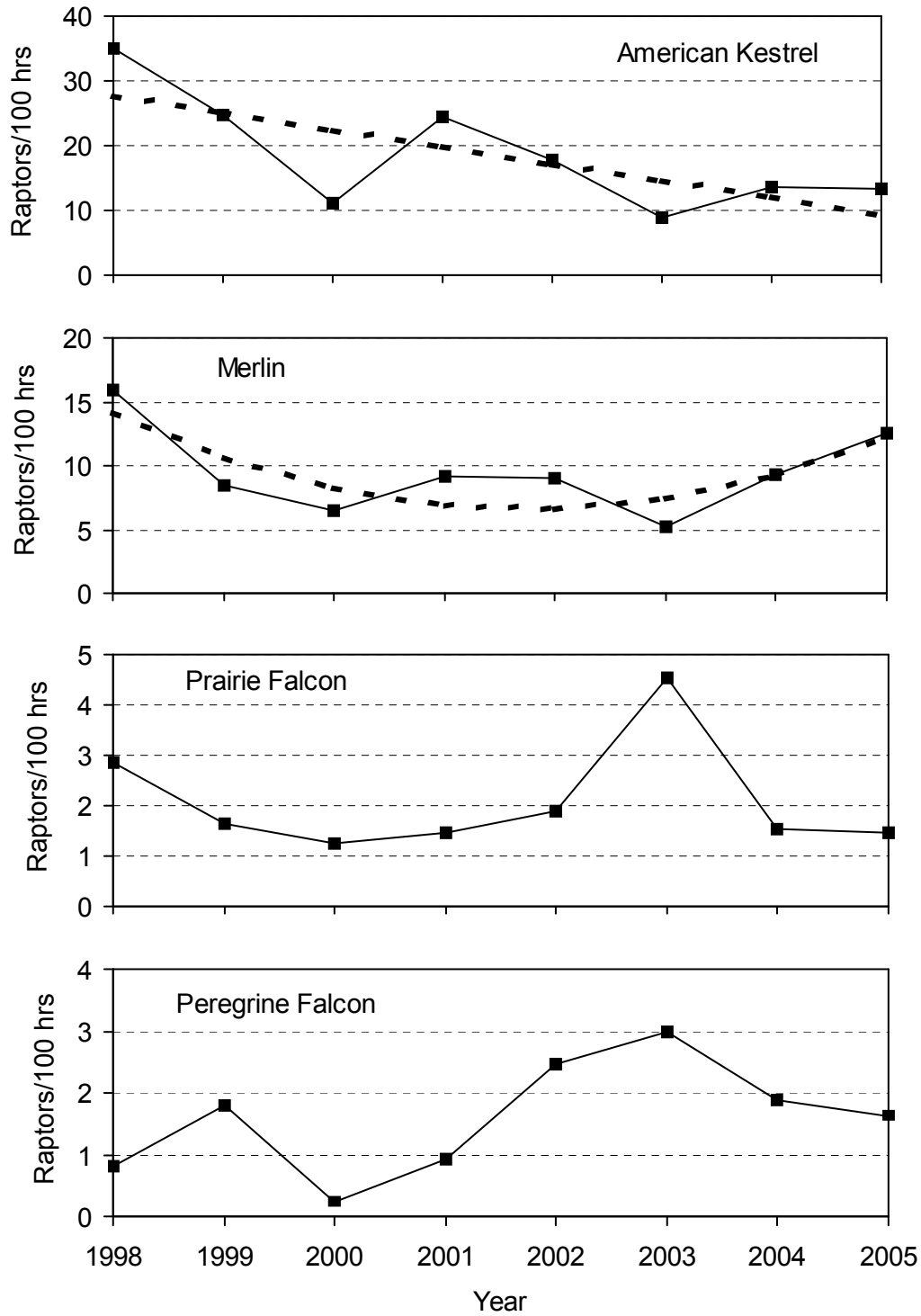


Figure 7. Adjusted fall-migration passage rates at Chelan Ridge, WA for American Kestrels, Merlins, Prairie Falcons, and Peregrine Falcons: 1998–2005. Dashed lines indicate significant linear or quadratic regressions.

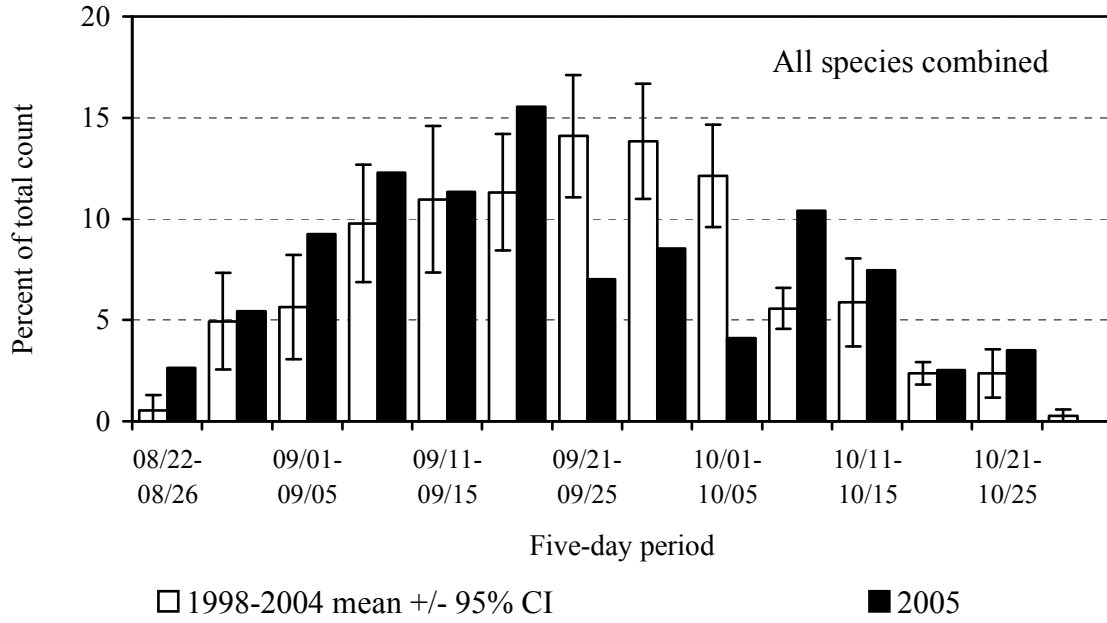


Figure 8. Combined-species passage volume by five-day periods for migrating raptors at Chelan Ridge, WA: 1998–2004 versus 2005.

Appendix A. History of official observer participation in the Chelan Ridge Raptor Migration Project.

1997: Single observer throughout: Dan Rossman (0)

1998: Two observers throughout: Steve Seibel (partial), Susan Crampton (0), Richard Hendrick (0).

1999: Two observers throughout: Dan Harrington (1), Richard Hendrick (1).

2000: Two observers throughout: Dan Harrington (2), Richard Hendrick (2).

2001: Two observers throughout: Richard Hendrick (3; first half of season), Wendy King (0), Don Look (0; primarily second half of season), Dan Harrington (3; training and substitute observer).

2002: Two observers throughout: Mark Leavens (0), Teresa Lorenz (0), Dan Harrington (3+; training and substitute observer), Richard Hendrick (4; regular substitute).

2003: Two observers throughout: Ben Kinkade (~1/2), Blake Mathys (0), Dan Harrington (3+; training and substitute observer), Richard Hendrick (4+; regular substitute).

2004: Two observers throughout: Dan Russell (1), Aran Meyer (0), Richard Hendrick (4+; regular substitute).

2005: Two observers throughout: Angela Sjollega (0), James Waddell (0; first half), Steve Seibel (3+; second half), and regular substitutes Richard Hendrick (4+) and Dan Russell (2).

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

Appendix B. Common and scientific names, species codes, and regularly applied age, sex, and color-morph classifications for all diurnal raptor species observed during fall migration at Chelan Ridge, WA.

COMMON NAME	SCIENTIFIC NAME	SPECIES CODE	AGE ¹	SEX ²	COLOR MORPH ³
Turkey Vulture	<i>Cathartes aura</i>	TV	U	U	NA
Osprey	<i>Pandion haliaetus</i>	OS	U	U	NA
Northern Harrier	<i>Circus cyaneus</i>	NH	AM AF I Br U	AM AF U	NA
White-tailed Kite	<i>Elanus leucurus</i>	WK	A, I, U	U	NA
Sharp-shinned Hawk	<i>Accipiter striatus</i>	SS	A I U	U	NA
Cooper's Hawk	<i>Accipiter cooperii</i>	CH	A I U	U	NA
Northern Goshawk	<i>Accipiter gentilis</i>	NG	A I U	U	NA
Unknown small accipiter	<i>A. striatus</i> or <i>cooperii</i>	SA	U	U	NA
Unknown large accipiter	<i>A. cooperii</i> or <i>gentilis</i>	LA	U	U	NA
Unknown accipiter	<i>Accipiter</i> spp.	UA	U	U	NA
Broad-winged Hawk	<i>Buteo platypterus</i>	BW	A I U	U	D L U
Swanson's Hawk	<i>Buteo swainsoni</i>	SW	U	U	D L U
Red-tailed Hawk	<i>Buteo jamaicensis</i>	RT	A I U	U	D L U
Ferruginous Hawk	<i>Buteo regalis</i>	FH	A I U	U	D L U
Rough-legged Hawk	<i>Buteo lagopus</i>	RL	U	U	D L U
Unknown buteo	<i>Buteo</i> spp.	UB	U	U	D L U
Golden Eagle	<i>Aquila chrysaetos</i>	GE	I, S, NA, A, U ⁴	U	NA
Bald Eagle	<i>Haliaeetus leucocephalus</i>	BE	I, S1, S2, NA, A, U ⁵	U	NA
Unknown eagle	<i>Aquila</i> or <i>Haliaeetus</i> spp.	UE	U	U	NA
American Kestrel	<i>Falco sparverius</i>	AK	U	M F U	NA
Merlin	<i>Falco columbarius</i>	ML	AM Br U	AM Br U	NA
Prairie Falcon	<i>Falco mexicanus</i>	PR	U	U	NA
Peregrine Falcon	<i>Falco peregrinus</i>	PG	A I U	U	NA
Unknown small falcon	<i>F. sparverius</i> or <i>columbarius</i>	SF	U	U	NA
Unknown large falcon	<i>F. mexicanus</i> or <i>peregrinus</i>	LF	U	U	NA
Unknown falcon	<i>Falco</i> spp.	UF	U	U	NA
Unknown raptor	Falconiformes	UU	U	U	NA

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

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

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

⁴ Golden Eagle age codes: I = Immature: juvenile or first-year bird, bold white wing patch visible below, bold white in tail, no molt; S = Subadult: white wing patch variable or absent, obvious white in tail and molt or tawny bar visible on upper wing; NA = Not adult: unknown age immature/subadult; A = Adult: no white in wings or tail; U = Unknown.

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

Appendix C. Daily observation effort, visitor disturbance ratings, weather records, and flight summaries for the Chelan Ridge Raptor Migration Project: 2005.

DATE	OBS. HOURS	OBSRVR / HOUR ¹	VISITOR DISTURB ²	PREDOMINANT WEATHER ³	SPEED (KPH) ¹	WIND DIRECTION	TEMP (°C) ¹	PRESS. (IN HG) ¹	THERMAL LIFT ⁴	WEST (KM) ¹	EAST (KM) ¹	FLIGHT DISTANCE ⁵ / HOUR	BIRDS
24-Aug	9.00	2.0	0	clr-pc	6.2	sse-sw, nnw	31.1	30.78	1	100	100	2	2.1
25-Aug	9.00	1.3	0	clr-pc	9.0	s-sw	26.7	30.86	1	98	98	2	1.4
26-Aug	9.00	2.0	2	clr	19.9	s-sw	24.6	30.81	2	92	92	2	1.8
27-Aug	9.00	2.7	0	clr	12.8	s-sw	26.1	30.77	2	100	100	3	3.8
28-Aug	9.17	2.8	0	clr-mc	16.6	s-sw	22.5	30.63	2	100	100	2	3.3
29-Aug	9.00	2.0	0	pc-mc	17.7	s-ssw	17.3	30.58	3	97	94	3	0.7
30-Aug	9.17	2.0	0	clr-mc	9.8	sw	18.8	30.86	3	95	87	1	0.5
31-Aug	9.08	2.0	0	clr	14.3	sw	23.0	30.87	2	100	100	2	2.6
1-Sep	9.00	1.9	1	clr-mc	11.0	s-sw	23.7	30.78	2	99	100	3	4.8
2-Sep	8.50	2.0	0	clr-ovc	18.9	s-sw	23.6	30.63	3	100	100	2	3.1
3-Sep	9.17	2.0	0	pc-ovc	16.8	sw	21.9	30.68	3	100	100	2	5.0
4-Sep	9.00	1.0	0	mc-ovc	11.3	sw	18.9	30.72	3	95	100	2	3.2
5-Sep	9.00	2.0	0	clr-pc	7.5	n, sw	22.6	30.90	1	100	100	3	2.8
6-Sep	7.00	2.0	0	pc	10.2	n, sw	25.2	30.92	2	100	100	3	7.4
7-Sep	9.00	1.9	1	clr-pc	11.0	s-sw	25.6	30.89	1	100	100	3	11.8
8-Sep	9.00	2.0	0	clr-pc	13.2	sse, sw	22.7	30.65	2	100	100	2	6.3
9-Sep	3.75	1.0	0	mc, rain	9.8	nne, sw-w	13.5	30.42	4	93	59	-	0.8
10-Sep	2.42	2.0	0	ovc, scat rain	5.5	nnw	14.0	30.57	4	73	58	2	2.5
11-Sep	6.83	1.9	0	ovc, scat fog/rain	7.4	ssw	10.7	30.70	4	48	13	1	0.4
12-Sep	7.83	2.0	0	mc-ovc, scat rain	6.2	calm-var.	13.7	30.73	4	76	76	2	0.6
13-Sep	8.83	2.0	0	clr-pc	14.0	s-ssw	18.2	30.78	2	100	100	2	4.9
14-Sep	9.00	1.9	0	clr-mc	7.2	calm, s-sw	18.8	30.72	2	100	100	3	12.6
15-Sep	9.00	2.0	0	pc-ovc	4.0	calm, sw	18.3	30.68	3	100	100	3	4.8
16-Sep	5.00	2.0	0	ovc, scat rain	13.7	nnw-nne	11.3	30.63	4	91	76	3	0.8
17-Sep	9.00	2.0	0	pc-mc	7.8	nnw-nne, ssw	16.6	30.76	2	100	99	2	7.6
18-Sep	9.00	3.2	0	clr-mc	14.4	s-sw	18.1	30.76	2	100	100	1	14.4
19-Sep	9.00	2.0	0	clr-pc	15.1	ssw	18.8	30.78	3	100	100	3	5.6
20-Sep	9.00	2.0	0	clr	4.6	ssw	17.6	30.86	1	100	100	2	3.6
21-Sep	9.00	1.8	0	clr	8.0	n, s	14.4	30.88	3	100	100	2	4.2
22-Sep	8.00	1.9	0	clr-ovc	8.0	n, calm, nnw	11.2	30.71	3	100	100	2	2.8
23-Sep	9.00	2.0	0	clr	10.0	nw-n	15.1	30.69	3	100	100	2	2.3
24-Sep	9.00	1.1	0	clr	8.0	nnw-nne, calm	15.9	30.78	1	98	100	3	3.0
25-Sep	7.50	2.4	0	clr	17.8	sw	15.4	30.83	3	100	100	2	2.7
26-Sep	9.00	1.9	0	clr-pc	8.0	s-sw	17.7	30.73	1	100	100	2	5.2
27-Sep	9.00	1.7	0	clr	8.6	n, s, ssw	17.0	30.88	2	100	100	3	4.9
28-Sep	9.00	1.9	0	clr-mc	18.2	s-ssw	16.7	30.91	2	100	100	1	4.9
29-Sep	7.00	2.0	0	ovc, scat rain	37.0	s	14.0	30.51	4	77	53	1	1.6
30-Sep	8.50	1.8	0	ovc, PM rain	26.5	s-ssw	11.3	30.39	4	95	64	2	1.2
1-Oct	9.00	2.0	0	mc-ovc, scat snow	9.3	s-ssw	9.2	30.33	4	96	75	1	2.1
2-Oct	7.50	1.9	0	ovc, PM snow	5.3	calm, ssw	5.0	30.48	4	57	43	2	1.6
3-Oct	0.00			weather day									
4-Oct	8.00	2.2	0	pc-ovc	5.9	ssw, nw	11.0	30.89	4	100	52	3	5.0
5-Oct	4.25	3.0	0	ovc, AM fog	6.8	ssw	5.9	30.36	4	29	6	1	0.9
6-Oct	8.00	1.6	0	ovc, PM rain/fog	14.0	ssw	7.1	29.92	4	62	11	2	2.8
7-Oct	7.50	2.2	0	mc-ovc	11.6	sw	6.9	29.81	4	97	71	2	1.6
8-Oct	9.00	2.0	0	pc-ovc	8.6	ssw	8.5	29.77	3	100	49	3	6.9
9-Oct	8.50	2.2	0	clr-pc	12.8	sse-ssw	7.7	30.13	3	74	90	1	8.8
10-Oct	7.50	1.9	0	mc-ovc, scat fog/rain	20.9	ssw	6.8	30.01	4	41	17	1	2.5
11-Oct	9.00	2.2	0	clr	11.2	n, calm, ssw	13.5	30.09	1	100	100	3	7.2
12-Oct	7.50	2.0	0	clr-ovc, PM rain	17.7	ssw	7.9	30.02	4	31	67	1	1.5
13-Oct	7.00	2.3	0	pc	9.7	ssw	11.4	30.03	1	100	92	3	5.4
14-Oct	6.25	2.2	0	ovc-mc, AM fog	7.9	se-ssw	11.9	29.84	4	58	24	3	1.6

Appendix C. continued

DATE	OBS. HOURS	OBSRVR / HOUR ¹	VISITOR DISTURB ²	PREDOMINANT WEATHER ³	SPEED (KPH) ¹	WIND DIRECTION	TEMP (°C) ¹	PRESS. (IN HG) ¹	THERMAL LIFT ⁴	WEST (KM) ¹	EAST (KM) ¹	FLIGHT DISTANCE ⁵ / HOUR	BIRDS / HOUR
15-Oct	9.00	2.0	0	pc-mc	13.0	s	12.5	29.77	2	100	82	1	1.3
16-Oct	9.00	1.5	0	pc-ovc	16.0	sw	9.5	30.00	3	100	55	2	1.1
17-Oct	9.00	2.0	0	pc-mc	26.6	sw	13.9	29.87	4	100	61	2	0.6
18-Oct	7.50	2.3	0	ovc-mc	11.3	ne, s	10.8	29.93	4	100	47	3	1.2
19-Oct	2.75	1.0	0	ovc/fog	12.8	sw	8.3	29.80	4	0	0	-	0.0
20-Oct	9.00	2.0	0	pc	4.7	sw	8.5	30.11	2	86	98	3	2.4
21-Oct	8.00	2.0	0	pc-mc	12.6	s	10.2	30.23	3	79	36	1	2.8
22-Oct	8.50	1.9	0	clr	15.2	s-sw	11.3	30.05	3	64	89	3	2.8
23-Oct	8.50	1.6	0	mc-pc	11.0	se-ssw	11.1	29.97	4	57	76	3	1.2
24-Oct	8.50	1.5	0	clr	9.6	se-ssw	12.1	30.07	2	44	93	1	0.6
25-Oct	8.00	1.4	0	clr-ovc/haze	15.6	s-ssw	10.8	29.83	4	11	31	2	0.4

¹ Average of hourly records.

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

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

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

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

Appendix D. Daily observation effort and fall raptor migration counts by species at Chelan Ridge, WA: 2005.

DATE	OBS.		SPECIES ¹																							BIRDS				
	HOURS	TV	OS	NH	WK	SS	CH	NG	SA	LA	UA	BW	SW	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	SF	LF	UF	UU	TOTAL	/HOUR
24-Aug	9.00	0	0	1	0	4	1	0	0	0	0	0	0	5	0	0	1	0	0	0	4	0	1	0	0	0	0	2	19	2.1
25-Aug	9.00	0	0	2	0	3	3	0	0	0	0	0	0	1	0	0	0	0	0	0	3	0	0	0	0	0	0	1	13	1.4
26-Aug	9.00	1	0	2	0	2	4	1	0	0	0	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	2	16	1.8
27-Aug	9.00	0	2	0	0	6	4	0	1	0	0	0	0	10	0	0	1	1	0	0	6	1	0	1	0	0	0	1	34	3.8
28-Aug	9.17	2	0	2	0	19	3	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	30	3.3
29-Aug	9.00	0	0	0	0	1	2	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0.7
30-Aug	9.17	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	5	0.5
31-Aug	9.08	0	3	0	0	8	4	0	1	0	0	0	0	2	0	0	0	2	1	0	3	0	0	0	0	0	0	0	24	2.6
1-Sep	9.00	4	1	5	0	12	10	0	2	0	0	0	0	3	0	0	0	1	0	0	2	1	1	0	0	0	0	1	43	4.8
2-Sep	8.50	1	0	0	0	9	5	2	1	0	0	0	0	2	0	0	0	0	0	0	2	1	0	0	0	0	0	3	26	3.1
3-Sep	9.17	6	2	0	0	15	3	0	1	1	0	0	0	4	0	0	1	3	0	0	7	2	0	0	0	0	0	1	46	5.0
4-Sep	9.00	2	0	1	0	17	3	0	1	0	0	0	0	1	0	0	0	0	0	0	2	0	0	1	0	0	0	1	29	3.2
5-Sep	9.00	4	2	3	0	5	1	0	1	0	0	0	0	1	0	0	0	3	0	0	1	2	0	0	0	0	0	2	25	2.8
6-Sep	7.00	2	3	0	0	22	9	0	0	1	0	0	0	5	0	0	0	3	0	0	3	1	0	0	0	0	0	3	52	7.4
7-Sep	9.00	2	1	8	0	50	18	0	3	0	0	3	0	8	0	0	1	3	0	0	4	3	1	0	0	0	0	1	106	11.8
8-Sep	9.00	5	1	2	0	22	11	0	3	0	1	0	0	1	0	0	1	3	0	0	3	2	0	0	0	0	0	2	57	6.3
9-Sep	3.75	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0.8
10-Sep	2.42	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	6	2.5
11-Sep	6.83	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0.4
12-Sep	7.83	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0.6
13-Sep	8.83	2	1	6	0	14	4	1	1	0	0	0	0	2	0	0	1	2	0	0	1	5	0	1	0	0	0	2	43	4.9
14-Sep	9.00	7	0	2	0	68	11	2	3	0	1	2	1	6	0	0	2	2	0	0	1	3	0	0	0	0	0	2	113	12.6
15-Sep	9.00	3	0	2	0	16	8	0	2	1	0	1	0	1	0	0	0	6	0	0	0	2	0	0	0	0	0	1	43	4.8
16-Sep	5.00	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	4	0.8
17-Sep	9.00	4	1	10	0	23	15	0	0	1	0	0	0	6	0	0	1	2	0	0	1	0	0	0	0	0	0	4	68	7.6
18-Sep	9.00	8	1	15	0	60	27	0	0	0	3	0	0	7	0	0	1	3	0	0	0	1	0	0	0	0	0	4	130	14.4
19-Sep	9.00	1	0	2	0	19	9	0	1	1	2	0	0	8	0	0	0	2	0	2	0	2	0	0	0	0	0	1	50	5.6
20-Sep	9.00	0	0	6	0	14	3	0	1	0	0	0	0	4	0	0	0	0	0	0	1	3	0	0	0	0	0	0	32	3.6
21-Sep	9.00	0	1	2	0	16	8	0	0	0	0	0	0	3	0	0	0	3	0	0	1	1	0	0	0	0	0	3	38	4.2
22-Sep	8.00	1	0	3	0	11	3	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	1	22	2.8
23-Sep	9.00	0	0	0	0	7	6	0	0	0	0	0	0	5	0	0	0	2	0	0	1	0	0	0	0	0	0	0	21	2.3

Appendix D. continued

DATE	OBS.		SPECIES ¹																							BIRDS				
	HOURS	TV	OS	NH	WK	SS	CH	NG	SA	LA	UA	BW	SW	RT	FH	RL	UB	GE	BE	UE	AK	ML	PR	PG	SF	LF	UF	UU	TOTAL	/HOUR
24-Sep	9.00	0	0	0	0	10	6	0	3	0	0	0	0	4	0	0	2	0	0	0	1	0	0	0	0	0	0	1	27	3.0
25-Sep	7.50	0	0	2	0	5	3	0	0	0	0	0	0	7	0	0	0	2	0	0	0	1	0	0	0	0	0	0	20	2.7
26-Sep	9.00	0	0	3	0	34	3	0	0	0	1	0	0	2	0	0	0	2	0	0	0	2	0	0	0	0	0	0	47	5.2
27-Sep	9.00	1	1	3	0	9	2	0	2	0	1	0	0	15	0	0	3	1	0	0	0	6	0	0	0	0	0	0	44	4.9
28-Sep	9.00	0	0	6	0	28	4	0	0	0	0	0	0	2	0	0	0	0	0	0	1	3	0	0	0	0	0	0	44	4.9
29-Sep	7.00	0	0	1	0	7	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	11	1.6
30-Sep	8.50	0	0	0	0	6	0	0	0	0	0	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	0	0	10	1.2
1-Oct	9.00	1	0	1	0	12	1	0	0	0	0	0	0	1	0	0	1	2	0	0	0	0	0	0	0	0	0	0	19	2.1
2-Oct	7.50	0	0	0	0	3	0	0	0	0	0	0	0	3	0	1	0	3	0	0	0	2	0	0	0	0	0	0	12	1.6
3-Oct	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Oct	8.00	0	0	1	0	15	8	0	0	0	0	0	0	8	0	0	0	5	0	0	0	1	0	0	0	1	0	1	40	5.0
5-Oct	4.25	0	0	0	0	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0.9	
6-Oct	8.00	0	0	2	0	9	3	1	0	0	0	0	0	2	0	0	0	4	0	0	0	0	0	0	0	0	0	1	22	2.8
7-Oct	7.50	0	0	0	0	5	1	0	2	0	0	0	0	1	0	1	0	2	0	0	0	0	0	0	0	0	0	0	12	1.6
8-Oct	9.00	0	2	1	0	27	3	1	2	0	0	0	1	6	0	3	2	6	0	0	2	2	0	0	1	0	0	3	62	6.9
9-Oct	8.50	0	0	5	0	44	2	0	0	0	0	0	0	19	0	0	0	2	1	0	0	1	0	0	0	0	0	1	75	8.8
10-Oct	7.50	0	0	0	0	12	0	1	0	0	0	0	0	1	0	1	0	4	0	0	0	0	0	0	0	0	0	0	19	2.5
11-Oct	9.00	0	0	3	0	13	6	0	7	1	0	0	0	19	0	0	3	11	1	0	0	0	0	0	0	1	0	0	65	7.2
12-Oct	7.50	0	0	0	0	4	1	0	0	0	0	0	0	4	0	1	0	0	0	0	0	1	0	0	0	0	0	0	11	1.5
13-Oct	7.00	0	1	1	0	3	4	2	4	0	0	0	0	15	0	0	0	5	0	0	2	0	0	0	0	0	0	1	38	5.4
14-Oct	6.25	0	0	0	0	1	0	1	0	0	0	0	0	5	0	0	1	2	0	0	0	0	0	0	0	0	0	0	10	1.6
15-Oct	9.00	0	0	3	0	4	0	0	0	0	0	0	0	1	0	1	0	2	1	0	0	0	0	0	0	0	0	0	12	1.3
16-Oct	9.00	0	0	2	0	2	0	0	1	0	0	0	0	0	0	2	0	3	0	0	0	0	0	0	0	0	0	0	10	1.1
17-Oct	9.00	0	0	0	0	3	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	5	0.6
18-Oct	7.50	0	0	0	0	2	0	0	1	0	0	0	0	1	0	0	0	5	0	0	0	0	0	0	0	0	0	0	9	1.2
19-Oct	2.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
20-Oct	9.00	0	0	2	0	2	1	0	0	0	0	0	0	8	0	6	1	0	0	0	0	1	0	0	0	0	0	1	22	2.4
21-Oct	8.00	0	0	1	0	4	0	1	1	0	0	0	0	6	0	2	1	6	0	0	0	0	0	0	0	0	0	0	22	2.8
22-Oct	8.50	0	0	0	0	7	1	0	1	0	0	0	0	7	0	1	1	5	0	0	0	1	0	0	0	0	0	0	24	2.8
23-Oct	8.50	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	1	6	0	0	0	0	0	0	0	0	0	0	10	1.2
24-Oct	8.50	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	5	0.6	
25-Oct	8.00	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	3	0.4	
Total	486.00	58	25	112	0	729	228	13	48	6	9	6	2	233	0	22	27	126	4	2	55	53	4	4	1	3	0	48	1818	3.7

¹ See Appendix B for full names associated with species codes.

Appendix E. Annual observation effort and fall raptor migration counts by species at Chelan Ridge, WA: 1997–2005.

	1997	1998	1999	2000	2001	2002	2003	2004	2005	MEAN
Start Date	5-Sep	27-Aug	27-Aug	27-Aug	27-Aug	25-Aug	23-Aug	24-Aug	24-Aug	24-Aug
End Date	11-Oct	21-Oct	27-Oct	5-Nov	22-Oct	25-Oct	26-Oct	23-Oct	25-Oct	24-Oct
Observation days	29	53	61	67	55	62	59	59	62	60
Observation hours	204.60	382.92	504.33	505.75	439.00	491.28	509.24	507.50	502.50	480.32
Raptors / 100 hours	691.1	620.2	571.2	481.3	470.4	522.1	297.1	286.1	363.4	451.5
SPECIES	RAPTOR COUNTS									
Turkey Vulture	4	29	21	26	14	46	30	25	58	31
Osprey	41	24	47	71	48	57	31	34	25	42
Northern Harrier	115	152	167	104	91	148	66	59	113	113
White-tailed Kite						0	1	0	0	0
Sharp-shinned Hawk	311	949	932	1050	878	937	421	468	730	796
Cooper's Hawk	150	247	232	198	198	234	136	220	228	212
Northern Goshawk	38	32	50	35	16	22	17	41	13	28
Unknown small accipiter ¹					98	85	40	1	48	54
Unknown large accipiter ¹					0	10	17	6	6	8
Unknown accipiter	182	221	248	98	0	49	36	10	9	84
TOTAL ACCIPITERS	681	1449	1462	1381	1190	1337	667	746	1034	1158
Broad-winged Hawk	2	7	5	5	6	9	3	2	6	5
Swainson's Hawk	0	8	17	2	0	7	15	5	2	7
Red-tailed Hawk	145	182	450	364	263	386	263	277	233	302
Ferruginous Hawk	0	0	0	1	0	0	0	0	0	0
Rough-legged Hawk	1	13	44	53	13	45	14	20	22	28
Unidentified buteo	75	58	148	97	83	82	39	15	29	69
TOTAL BUTEOS	223	268	664	522	365	529	334	319	292	412
Golden Eagle	105	55	141	174	105	135	142	130	130	127
Bald Eagle	2	2	7	15	2	8	1	2	4	5
Unidentified eagle	7	0	7	5	1	0	12	0	2	3
TOTAL EAGLES	114	57	155	194	108	143	155	132	136	135
American Kestrel	24	107	89	40	84	68	33	48	55	66
Merlin	17	55	36	26	36	38	21	39	53	38
Prairie Falcon	2	10	7	5	5	6	19	5	4	8
Peregrine Falcon	5	2	9	1	3	9	14	7	4	6
Unknown small falcon ¹					6	4	6	5	1	4
Unknown large falcon ¹					1	2	2	2	3	2
Unknown falcon	10	6	6	2	2	0	0	4	0	3
TOTAL FALCONS	58	180	147	74	137	127	95	110	120	124
Unidentified Raptor	178	216	218	62	112	178	134	27	48	124
GRAND TOTAL	1414	2375	2881	2434	2065	2565	1513	1452	1826	2139

¹ Designations used for the first time in 2001.

Appendix F. Daily capture totals of migrating raptors at Chelan Ridge, WA: 2005.

DATE	STN.	SPECIES ¹											CAPTURES	
	HOURS	NH	SS	CH	NG	RT	RL	GE	AK	ML	PR	PG	TOTAL	/ STN HR
25-Aug	4.10	0	1	1	0	0	0	0	0	0	0	0	2	0.5
26-Aug	8.10	0	3	6	0	2	0	0	0	0	0	0	11	1.4
27-Aug	17.25	0	10	6	0	0	0	0	0	1	0	0	17	1.0
28-Aug	17.00	0	9	4	0	1	0	0	0	0	0	0	14	0.8
29-Aug	16.83	0	2	0	1	0	0	0	0	0	0	0	3	0.2
30-Aug	14.33	0	1	1	0	0	0	0	0	1	0	0	3	0.2
31-Aug	18.25	0	9	4	0	0	0	0	0	0	0	0	13	0.7
1-Sep	18.10	0	3	12	0	0	0	0	1	0	0	0	16	0.9
2-Sep	17.66	0	6	5	0	0	0	0	0	1	0	0	12	0.7
3-Sep	8.25	0	1	7	0	0	0	0	1	0	0	0	9	1.1
4-Sep	14.00	0	13	4	0	0	0	0	0	1	0	0	18	1.3
5-Sep	17.58	0	9	3	0	1	0	0	0	1	0	0	14	0.8
6-Sep	13.50	0	13	5	0	0	0	0	0	1	0	0	19	1.4
7-Sep	18.00	1	22	8	0	0	0	0	2	3	0	0	36	2.0
8-Sep	13.03	0	6	2	0	2	0	0	1	1	0	1	13	1.0
9-Sep	0.00													
10-Sep	5.25	0	1	0	0	0	0	0	0	0	0	0	1	0.2
11-Sep	14.25	0	3	0	0	0	0	0	0	0	0	0	3	0.2
12-Sep	15.80	1	3	1	0	0	0	0	0	1	0	0	6	0.4
13-Sep	17.83	2	13	4	0	0	0	0	0	4	0	0	23	1.3
14-Sep	16.58	0	27	12	0	0	0	0	0	3	0	0	42	2.5
15-Sep	17.92	1	3	4	0	0	0	0	0	4	0	0	12	0.7
16-Sep	9.41	0	1	0	0	0	0	0	0	1	0	0	2	0.2
17-Sep	9.25	1	10	1	0	0	0	0	0	0	0	0	12	1.3
18-Sep	18.00	0	26	9	0	1	0	0	0	6	0	0	42	2.3
19-Sep	17.16	1	14	5	0	0	0	0	0	0	0	0	20	1.2
20-Sep	18.00	0	17	7	1	1	0	0	0	2	0	0	28	1.6
21-Sep	18.00	0	5	2	0	0	0	0	0	0	0	0	7	0.4
22-Sep	17.66	0	12	2	0	0	0	0	0	1	0	0	15	0.8
23-Sep	16.25	0	4	3	0	0	0	0	0	0	0	0	7	0.4
24-Sep	18.30	0	6	1	0	0	0	0	1	1	0	0	9	0.5
25-Sep	17.50	1	8	2	0	0	0	0	0	0	0	0	11	0.6

Appendix F. continued

DATE	STN.	SPECIES ¹											CAPTURES	
	HOURS	NH	SS	CH	NG	RT	RL	GE	AK	ML	PR	PG	TOTAL	/ STN HR
26-Sep	17.25	0	12	4	1	0	0	0	0	2	0	0	19	1.1
27-Sep	16.33	2	12	1	0	0	0	0	0	3	0	0	18	1.1
28-Sep	17.50	1	11	1	1	1	0	0	0	0	0	0	15	0.9
29-Sep	13.75	0	3	1	0	0	0	0	0	0	0	0	4	0.3
30-Sep	16.75	0	5	1	0	0	0	0	0	1	0	0	7	0.4
1-Oct	16.50	0	9	2	0	0	0	0	0	0	0	0	11	0.7
2-Oct	14.50	0	2	1	0	0	0	0	0	0	0	0	3	0.2
3-Oct	0.00													
4-Oct	4.00	0	3	0	0	0	1	0	0	0	0	0	4	1.0
5-Oct	3.00	0	0	0	0	0	0	0	0	0	0	0	0	0.0
6-Oct	14.25	0	8	1	0	0	0	0	0	1	0	0	10	0.7
7-Oct	15.37	0	7	0	0	1	1	0	0	2	0	0	11	0.7
8-Oct	16.25	0	14	0	0	1	1	0	0	0	0	0	16	1.0
9-Oct	16.50	1	18	1	0	0	0	0	0	3	0	0	23	1.4
10-Oct	15.00	0	7	0	1	0	0	0	0	0	0	0	8	0.5
11-Oct	17.00	0	4	2	1	0	0	0	0	0	0	0	7	0.4
12-Oct	15.50	0	4	1	0	0	2	1	0	0	0	0	8	0.5
13-Oct	12.50	0	1	0	1	0	0	1	0	1	0	0	4	0.3
14-Oct	12.00	0	2	0	0	0	0	0	0	0	0	0	2	0.2
15-Oct	16.75	0	0	0	1	0	0	0	0	0	0	0	1	0.1
16-Oct	16.50	0	1	0	0	0	0	0	0	0	0	0	1	0.1
17-Oct	17.20	0	3	0	0	0	0	0	0	1	0	0	4	0.2
18-Oct	15.55	0	0	0	1	0	0	0	0	0	0	0	1	0.1
19-Oct	0.00													
20-Oct	15.85	0	1	0	0	0	0	0	0	1	0	0	2	0.1
21-Oct	14.00	0	5	0	1	0	0	0	0	1	0	0	7	0.5
22-Oct	15.25	0	2	0	1	0	0	0	0	0	0	0	3	0.2
Total	828.19	12	395	137	11	11	5	2	6	49	0	1	629	0.8

¹ See Appendix B for full names associated with species codes.

Appendix G. Annual trapping effort and capture totals by species for migrating raptors at Chelan Ridge, WA: 1999–2005.

	1999 ¹	2000 ¹	2001	2002	2003	2004	2005	MEAN	TOTAL
First trapping day	28-Aug	2-Sep	30-Aug	27-Aug	23-Aug	25-Aug	25-Aug		
Last trapping day	16-Oct	14-Oct	17-Oct	19-Oct	25-Oct	18-Oct	22-Oct		
Number of stations	2	2	2	2	2	2	2	2	
Trapping days	47	42	44	54	56	53	56	50	
Station hours	388	?	612.75	837.25	803.31	699.56	828.19	694.84	
Captures / stn. hour	5.7	?	8.6	8.1	7.3	5.0	7.5	7.0	
SPECIES		RAPTOR CAPTURES							
Northern Harrier	4	3	10	13	11	6	12	8.4	59
Sharp-shinned Hawk	139	125	341	459	394	237	389	298	2084
Cooper's Hawk	42	46	107	127	100	58	137	88	617
Northern Goshawk	14	10	12	13	9	16	11	12	85
Red-tailed Hawk	11	8	22	29	20	16	11	17	117
Rough-legged Hawk	0	1	1	2	1	0	5	1.4	10
Golden Eagle	0	1	2	0	4	2	2	2	11
American Kestrel	3	0	8	10	17	5	6	7	49
Merlin	6	4	17	21	25	10	49	19	132
Prairie Falcon	1	1	3	4	4	1	0	2	14
Peregrine Falcon	0	0	2	0	4	1	1	1	8
All species	220	199	525	678	589	352	623	455	3186
Recaptures ²	0	0	0	0	0	0	0	0	0
Foreign Recaptures ³	0	0	0	1	0	0	0	<1	1
Foreign Encounters ⁴	0	1	5	2	1	1	4	2	14

¹ Data collected by the Falcon Research Group.

² Recaptures at Chelan Ridge of birds originally banded at Chelan Ridge.

³ Recaptures at Chelan Ridge of birds originally banded elsewhere.

⁴ Birds originally banded at Chelan Ridge and subsequently encountered elsewhere.