FALL 2013 RAPTOR MIGRATION STUDIES AT CHELAN RIDGE, WASHINGTON

A Collaborative Effort between:

HAWK WATCH INTERNATIONAL
Conserving Raptors and Our Shared Environment

Salt Lake City, Utah

and the

FOREST SERVICE
U S
DEPARTMENT OF AGRICULTURE

Okanogan and Wenatchee National Forests
Winthrop, Washington

SUMMARY OF 2013 FALL RAPTOR MIGRATION AT CHELAN RIDGE, WASHINGTON

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INTRODUCTION

The Chelan Ridge Raptor Migration Project in north-central Washington is an ongoing effort to monitor long-term regional trends in raptor populations using the north Cascades migratory flyway (Smith et al. 2008a). 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 beginning in 1998. The Falcon Research Group (FRG), in cooperation with HWI and OWNF, initiated a trapping and banding program at the site in 1999. HWI and OWNF took over coordinating the banding program in 2001, and these collaborative efforts have continued since. To date, observers have recorded 19 species of migratory diurnal raptors at the site, with counts ranging between ~1,500–2,900 migrant raptors per season. The 2013 season marked the 16th consecutive, full-season count and the 15th consecutive season of banding at the site. This report summarizes the 2013 fall raptor migration at Chelan Ridge.

The Chelan Ridge station was 1 of 8 long-term, annual migration counts and 1 of 4 migration banding studies operated or co-sponsored by HWI in North America during 2013. The primary objective of these efforts is to track long-term regional population trends of diurnal raptors in western North America and around the Texas Gulf Coast (Hoffman and Smith 2003; Smith et al. 2001, 2008 a, b). HWI partners with Hawk Mountain Sanctuary, the Hawk Migration Association of North America (HMANA), and Bird Studies Canada (BSC) to provide western US data for the Raptor Population Index (RPI), a collaborative standardized effort to monitor raptor migration across North America. Chelan Ridge falls within the Great Basin bird conservation region, the Intermountain West Joint Venture, and the Columbia Plateau Partners in Flight region. Raptors can serve as important biological indicators of ecosystem health (Bildstein 2001) and long-term migration counts can be a cost effective and efficient method for monitoring regional status and trends of multiple raptor species (Zalles and Bildstein 2000).

In addition to long-term counting and banding efforts, HWI conducts and supports other studies to further our knowledge about the biology of migrating raptors. Some of these efforts include: telemetry work to identify species' ranges, migratory routes and connectivity and blood sampling to track changes in raptor health and populations (e.g., Hoffman et al. 2002, Lott and Smith 2006, Goodrich and Smith 2008, DeLong and Hoffman 2004, McBride et al. 2004). During 2012 and 2013, HWI staff collected blood samples from a subset of trapped birds as part of a study to better understand the physiologic and metabolic status of migrating raptors.

Beyond having scientific and conservation value, our migration studies offer unique opportunities for the public to learn about raptors and the natural environment. Providing such opportunities is another important component of the Chelan Ridge Raptor Migration Project and outreach efforts here reach hundreds of people from central Washington and beyond each season.

STUDY SITE

Chelan Ridge is located approximately 21 km north–northwest of the city of Chelan, on the Chelan / Okanogan County border, and is on the border between the Okanogan and the Wenatchee National Forests (48°01'12.8"N, 120°05'38.4"W; Fig. 1). The site is accessed by following Washington State Road 153 about 11 km northwest of Pateros, on to Black Canyon Road (USFS Road 4010) west–southwest until it ends, then on to 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. Mitchell Creek Basin fills the east–west view and is often a common place to first spot raptors. This basin is approximately 3.5 km wide, and on the southern side of the basin is Goff Peak, which is a major landmark. 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. The view further to the east

extends across the Columbia River and Waterville Plateau, while towards the west, a ridgeline (known as Cooper Ridge) extends into the Sawtooth Wilderness. The view to the north into Black Canyon is constrained by a backdrop of dark-green forest of lodgepole (*Pinus contorta*) and Ponderosa pine (*Pinus ponderosa*), and this dark contrast makes spotting migrant raptors difficult. Although the northern view is unobstructed, Black Canyon does have blind spots that are invisible from the lookout where raptors can be lost. Farther north, the view extends across Methow Valley and into the Pasayten Wilderness. To the southeast, migrant raptors often fly through a gap between the lookout and Cooper Mountain. Thus, allowing some migrants to pass the lookout undetected but are later spotted rising on thermals above the horizon near Cooper Mountain. The south view extends across Lake Chelan and into the Wenatchee National Forest.

The lookout's southwestern slope is a cliff face of 70–80 degrees that drops about 65 m into Mitchell Creek Basin. This cliff face creates excellent updrafts on days of moderate to strong south winds, which allow for extremely close looks at migrants as they fly nearby.

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

METHODS

STANDARDIZED COUNTS

Two designated observers, relieved or supplemented by other trained staff and volunteers, conducted standardized daily counts of migrating raptors from a single traditional observation site. Lead observer Elizabeth Errickson had previous experience counting at Cape May in New Jersey but this past season was her first year with HWI. This was Olivia DaRugna's first full season counting migrating raptors (see Appendix A for a complete history of observer participation). Multi-purpose crewmember Carla Jo Ehlinger also routinely assisted with the counts, while other crewmembers, USFS staff, and visitors assisted on occasion as well.

Weather permitting, observations usually began at 0800 H and ended between 1600 and 1700 H 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 H 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 updated through 2013 follows Farmer et al. (2007). In comparing 2013 annual statistics against means and 95% confidence intervals for previous seasons, we consider a count value falling outside the 95% confidence interval for historic site means as deviating significantly from the mean historic count.

TRAPPING AND BANDING

The trappers operated up to two banding stations daily (weather permitting) from late August through late October, generally between 0800 and 1700 H PST. Capture devices included mist nets, dho-gaza 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 quicker.

2013 RESULTS AND DISCUSSION

OBSERVATION EFFORT AND WEATHER SUMMARY

Observers were able to count on 58 of 65 possible days between 23 August and 26 October during the 2013 season, the 1998-2012 long term average is 60 days (Appendix C). During this time observers logged a total of 493 hours counting, the long term seasonal site average is 490 hours. Two of the 58 days had abbreviated counts (<4 hrs) due to weather. Weather varies throughout every season, in 2013 based on hourly recording of conditions it was clear 31% of the time, overcast or foggy 68% of the time, rainy 2% of the time, and snowy 2% of the time.

2013 FLIGHT SUMMARY

Overall Flight:

A total of 1,081 migrating raptors including 16 species were tallied during the 2013 season, this is a significant ($p < 0.05$) decrease of 48% compared to the long-term average (Table 1) and the lowest on record since the count began in 1997 (Appendix C). The composition of the overall flight broke down as follows: 53% accipiters, 24% buteos, 6% falcons, 5% eagles, 3% harriers, 3% vultures, 2% Ospreys, and 5% unknown raptors (Fig. 2). The proportions of buteos and vultures were above historic averages; while the proportion of accipiters, eagles, and harriers in the 2013 flight were all below historic averages (Fig. 2). As per usual, Sharp-shinned Hawks were the most commonly observed species (32% of the total), followed by Cooper's Hawks (16%), Red-tailed Hawks (15%), Golden Eagles (4%), Northern Harriers (3%), Rough-legged Hawks (3%), Merlins (3%), and Turkey Vultures (at 3%). The remaining species each accounted for 2% or less of the total count. Notable for the season were record high counts of Broad-winged Hawks (11) and Bald Eagles (also 11) (Appendix C).

The following sections summarize the 2013 count relative to historic means at the site, and any stastistically significant ($p < 0.05$) or near significant ($p < 0.1$) population trends based on first and second order regression analysis. HWI only depicts significant trends for species with a historic average count rate greater than or equal to 10 individuals per 100 hours. The rationale is that trends for counts below this threshold likely do not contain biologically useful information on regional populations—species with counts this low likely have a very dispersed migration, migrate along a different primary route, or large portions of the population that are resident. We do include count information in the reports, as

occurrences of rarer species are of interest to both managers and the general public, and could represent the beginning of meaningful long-term changes.

Vultures, Osprey, and Harriers (Fig. 3a):

In 2013 both total and standardized counts for each of these species were low compared to historic averages, and in the case of Osprey and Northern Harriers, counts were the lowest on record. Despite going from an above average count in 2012 to a below average one in 2013, the long-term trend for Turkey Vultures at Chelan Ridge is a slow, near-significant ($p<0.1$) increase (Fig. 3a, $r^2 = 0.183$, p-value = 0.098). Osprey counts were below historic averages for the second consecutive year and regression analysis shows a significant long-term decline in Osprey counted per 100 observation hours at Chelan Ridge ($r^2 = 0.28$, $p=0.03$). Similarly, Northern Harrier counts were below the average historic count for the third year running and the long-term trend for this species is also a decline ($r^2= 0.38$, $p = 0.01$).

Accipiters (Fig. 3b):

For the third straight year Sharp-shinned Hawks and Cooper's Hawks were counted in below average numbers, notable because these two species historically comprise 49% of the annual fall raptor count. The Sharp-shinned Hawk count in 2013 was the lowest in the the history of the Chelan Ridge count and is part of a significant long-term decline for this species ($r^2 = 0.37$, $p = 0.01$). While still significantly below the historic average for the site, Cooper's Hawk counts have increased for last two years after hitting a record low in 2011 and trend analysis of long-term counts indicates the species is stable (no significant trend). Northern Goshawk counts were also significantly lower than average in 2013, but the long-term counts are also stable.

Buteoine Hawks (Fig. 3c):

Red-tailed Hawk counts were significantly lower than historic averages for the third straight year and the long-term trend at Chelan Ridge is one of slow decline ($r^2 = 0.29$, $p = 0.03$). Rough-legged Hawk numbers returned to mean historic levels in 2013 after record high counts in 2012. It was an average year for Swainson's Hawks and 2013 saw a Chelan Ridge record for number of Broad-winged Hawks (11) counted.

Eagles (Fig.3d):

Bald Eagle numbers were above average in 2013 after being above average in 2012. The 2013 Golden Eagle count was lower than historic average, and the long-term declining trend for this species continues ($r^2 = 0.29$, $p = 0.032$); and is mostly explained by significant declines in adults ($r^2 = 0.36$, $p = 0.014$).

Falcons (Fig. 3e):

American Kestrel counts continue to decline at Chelan Ridge ($r^2 = 0.58$, $p = 0.001$), similar to other sites in the west and across its range. Based on findings from Chelan Ridge and other regional monitoring sites across North America HWI scientists, along with many other North American researchers and Citizen Scientists are partnering to understand these declines locally and at the continental scale under the umbrella of the American Kestrel Partnership (http://kestrel.peregrinefund.org/). The season's passage rates for the other three falcons were also below average but the long-term population trends for those species are stable.

TRAPPING EFFORT

Trapping occurred on 56 of 60 days between 24 August and 22 October, with efforts totaling 660.69 station hours split between two stations (Appendix D). We normally try to end the season on 26 October but an approaching winter storm led the crew to end efforts five days early. Despite this the number of trapping days was above average, but the total station hours were slightly below the long-term mean (Appendix D). The overall capture totals and rate were significantly below average (Table 2), which may reflect the low numbers of raptors that passed through the site during the 2013 season (cf. Appendix C).

A total of 450 raptors of ten species were captured and banded, which is well below the historic average (Appendix D). Red-tailed Hawk and Peregrine Falcon captures were higher than historic averages; Rough-legged Hawks and American Kestrels capture totals were consistent with historic averages; all other species capture totals were below average (Table 2).

BLOOD SAMPLING FOR PHYSIOLOGY STUDY

For the second straight year, banding crews sampled blood from 8 species as part of a pilot study investigating the physiologic status of raptors migrating through Chelan Ridge. The goal of the study is to explore whether birds migrating through the area are using stored energy reserves or that from recently consumed food. In 2013 crews drew blood samples from 223 birds making for 442 samples when combined with the 2012 effort (Table 3). Samples will be analyzed at the University of Nevada Reno by Chris Vennum.

ENCOUNTERS WITH PREVIOUSLY BANDED BIRDS

To date 94 birds banded at Chelan Ridge have been recovered and reported to the Bird Banding Laboratory (Fig. 4). During 2013, we received notification of five Chelan Ridge band recoveries: two Sharp-shinned Hawks, one Merlin, and two Red-tailed Hawks (Fig. 4, Table 4). All the birds, except for the second adult female Sharp-shinned (Band # 1593-61328), were found dead of unknown causes (Table 4), which is relatively common, but the referenced bird died due to colliding into a stationary object, different from wires. This bird was recovered approximately 30 km from where it was banded, near Twisp, Washington almost six years later (Table 4). Since it was recovered on 29 April, during spring migration, we don't know if it was migrating or if it was a local bird that established year-round residency. Many raptors that fly over the Chelan Ridge site will migrate south and utilize two different flyways; the the Pacific Coast and Intermountain (Hoffman et al. 2002). Although there is some overlap, especially near the trapping station, all of these birds were recovered within the Pacific Coast Flyway (cf. Hoffman et al. 2002).

For the third straight year, there were no "foreign recaptures" (birds banded elsewhere) at Chelan Ridge (Appendix D).

VISITOR PARTICIPATION AND PUBLIC OUTREACH

A total of 157 individuals visited the site during the season outside of any organized event. Organized events included the Chelan Ridge Hawk Migration Festival, which took place on 14 September. This year's festival saw approximately 150 participants take advantage of opportunities in Pateros, WA and at the migration station (86 people) to see raptors in the hand prior to their release after being banded, and learn about raptor migration ecology and what counting and banding efforts can tell us about the status of regional raptor populations and the health of the landscapes they use. The festival was sponsored by Methow Valley Ranger District of the US Forest Service, North Central Washington Audubon Society, and HawkWatch International. Team Naturaleza, a group that engages Latino communities in outdoor

activities and educational events brought 25 members to Chelan Ridge this year. Ecology and wildlife classes from Central Washington University, Washington State University, and the North Cascades Institute visited the site to learn about field techniques and more. Visiting biologists included Iliana Arellano, from Mexico, and Benjamin Limle, from the McKenzie River Ranger District in Oregon. Throughout the season most visitors came from the surrounding Washington communities, but others came from Oregon, Hawaii, Illinois, Texas, and Florida.

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Community and logistical support was also provided by Richard Hendrick, who has been with us helping with the count, banding, and other chores since we started in 1997, Brad Martin and his wife Norma for their continuous supply of lure birds through the years, long time biologist Jim Watson of the Washington Department of Fish and Wildlife for his encouragement and help of our research and monitoring efforts.

Finally, enormous thanks to all of the members our 2013 field crew: Elizabeth Errickson, Olivia DaRugna, and Carla Jo Ehlinger, Helen Davis, and Chris Vennum; plus new and veteran volunteers who made their first trip or returned to visit and help with this seasons efforts: Leah Rensel, Tabitha Bergevin-Krumme, Kelsey Navarre, Alysa Adams, Richard Hendrick, and Shawn Hyland. Without your skill, dedication, and willingness to brave the elements over the course of a long field season these efforts would not be possible.

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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: 1998–2012 versus 2013.

	COUNTS			RAPTORS/100 HOURS		
SPECIES	1998–2012[1]	2013	% Change	1998–2012[1]	2013	% Change
Turkey Vulture	39 ± 7.8	28	-28	8.3 ± 1.61	5.7	-32
Osprey	39 ± 6.6	20	-49	9.8 ± 1.78	4.7	-53
Northern Harrier	102 ± 18.7	33	-68	23.9 ± 4.63	6.9	-71
White-tailed Kite	0 ± 0.1	0	-100	–	–	
Sharp-shinned Hawk	786 ± 97.5	350	-55	205.2 ± 29.11	88.4	-57
Cooper's Hawk	229 ± 33.8	169	-26	63.7 ± 8.94	46.5	-27
Northern Goshawk	31 ± 6.1	12	-61	7.0 ± 1.29	2.8	-60
Unknown small accipiter[2]	50 ± 19.3	14	-72	–	–	
Unknown large accipiter[2]	9 ± 3.1	7	-21	–	–	
Unknown accipiter	60 ± 38.8	20	-67	–	–	
TOTAL ACCIPITERS	1234 ± 230.0	572	-54	–	–	
Red-shouldered Hawk	0 ± 0.1	0	-100	–	–	
Broad-winged Hawk	5 ± 0.9	11	+123	2.5 ± 0.60	9.4	+274
Swainson's Hawk	6 ± 2.5	5	-20	2.2 ± 0.96	2.7	+24
Red-tailed Hawk	302 ± 46.8	161	-47	74.1 ± 11.10	43.4	-41
Ferruginous Hawk	0 ± 0.1	0	-100	0.1 ± 0.16	0.0	-100
Rough-legged Hawk	35 ± 13.3	28	-20	21.9 ± 10.20	17.0	-22
Unidentified buteo	53 ± 19.4	57	+8	–	–	
TOTAL BUTEOS	426 ± 79.3	262	-39	–	–	
Golden Eagle	113 ± 18.3	45	-60	24.7 ± 3.86	10.2	-59
Bald Eagle	7 ± 2.5	11	+63	1.5 ± 0.54	2.4	+61
Unidentified eagle	2 ± 1.8	0	-100	–	–	
TOTAL EAGLES	130 ± 22.5	56	-57	–	–	
American Kestrel	52 ± 13.6	17	-67	14.1 ± 4.17	3.8	-73
Merlin	39 ± 5.8	28	-29	9.5 ± 1.65	6.6	-31
Prairie Falcon	9 ± 2.4	5	-41	2.1 ± 0.51	0.7	-69
Peregrine Falcon	8 ± 2.8	6	-29	2.1 ± 0.60	1.4	-35
Unknown small falcon[2]	3 ± 1.5	2	-41	–	–	
Unknown large falcon[2]	2 ± 0.8	0	-100	–	–	
Unknown falcon	2 ± 1.1	1	-44	–	–	
TOTAL FALCONS	123 ± 27.2	59	-52	–	–	
Unidentified raptor	92 ± 34.1	51	-44	–	–	
GRAND TOTAL	2063 ± 231.4	1081	-48	–	–	

[1] Mean ± 95% confidence interval.

[2] Designations used for the first time in 2001.

Table 2. Capture totals, rates, and success by species for fall migrating raptors at Chelan Ridge, WA: 2001–2012 versus 2013.

	Capture Totals		Capture Rate[1]		Capture Success[2]	
	2001–2012[3]	2013	2001–2012[3]	2013	2001–2012[3]	2013
Northern Harrier	15 ± 4.5	8	2.2 ± 0.77	0.7	16.0 ± 3.2	43.6
Sharp-shinned Hawk	406 ± 46.5	287	60.3 ± 7.38	25.9	52.7 ± 6.7	106.7
Cooper's Hawk	112 ± 13.4	81	16.7 ± 2.31	7.3	46.5 ± 7.4	58.7
Northern Goshawk	15 ± 3.6	11	2.1 ± 0.45	1.0	51.8 ± 10.7	119.9
Broad-winged Hawk	0 ± 0.2	0	0.0 ± 0.03	0.0	1.4 ± 2.7	0.5
Red-tailed Hawk	27 ± 5.8	33	4.1 ± 0.98	3.0	8.4 ± 1.7	13.3
Rough-legged Hawk	2.7 ± 1.51	2	0.4 ± 0.23	0.2	7.9 ± 4.1	7.3
Golden Eagle	4 ± 1.0	0	0.5 ± 0.18	0.0	3.6 ± 1.5	7.2
American Kestrel	7.3 ± 2.53	7	1.0 ± 0.29	0.6	18.2 ± 6.7	40.6
Merlin	24 ± 5.6	16	3.5 ± 0.77	1.4	59.4 ± 14.4	76.7
Prairie Falcon	3 ± 0.9	2	0.4 ± 0.12	0.2	27.0 ± 12.1	49.2
Peregrine Falcon	1.8 ± 0.6	3	0.3 ± 0.11	0.3	21.9 ± 9.9	32.1
All species	616 ± 68.9	450	91.6 ± 11.35	40.6	35.1 ± 3.6	61.4

[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.

Table 3. Blood sampling effort by species and year for 2012 and 2013 at Chelan Ridge, WA.

Species	2012	2013	Total
Sharp-shinned Hawk	153	135	288
Cooper's Hawk	46	34	80
Northern Goshawk		9	9
Red-tailed Hawk	10	27	37
Rough-legged Hawk		2	2
American Kestrel	1	5	6
Merlin	9	7	16
Northern Harrier		4	4

Table 4. Foreign encounters of raptors banded at the Chelan Ridge Raptor Migration Project from records obtained in 2013.

Band #	Species[1]	Sex	Banding Date	Banding Age[2]	Encounter Location	Encounter Date	Encounter Age[2]	Distance (km)	Status
1623 – 23915	SS	F	30-Aug-12	HY	Snelling, CA	04-Jan-13	AHY	947	Found dead – unknown cause
1593 – 61328	SS	F	09-Sep-07	HY	Twisp, WA	29-Apr-13	ATY	30	Found dead – collision
1623 – 24536	ML	M	18-Sep-12	HY	Laguna Beach, CA	25-Feb-13	AHY	1335	Found dead – unknown cause
1807 – 81474	RT	U	02-Sep-07	HY	Birds Landing, CA	28-Dec-13	ATY	908	Found dead – unknown cause
1807 – 93857	RT	U	30-Sep-12	HY	Sausalito, CA	24-Mar-13	AHY	951	Found dead – unknown cause

[1] CH = Cooper's Hawk; SS = Sharp-shinned Hawk; RT = Red-tailed Hawk.

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

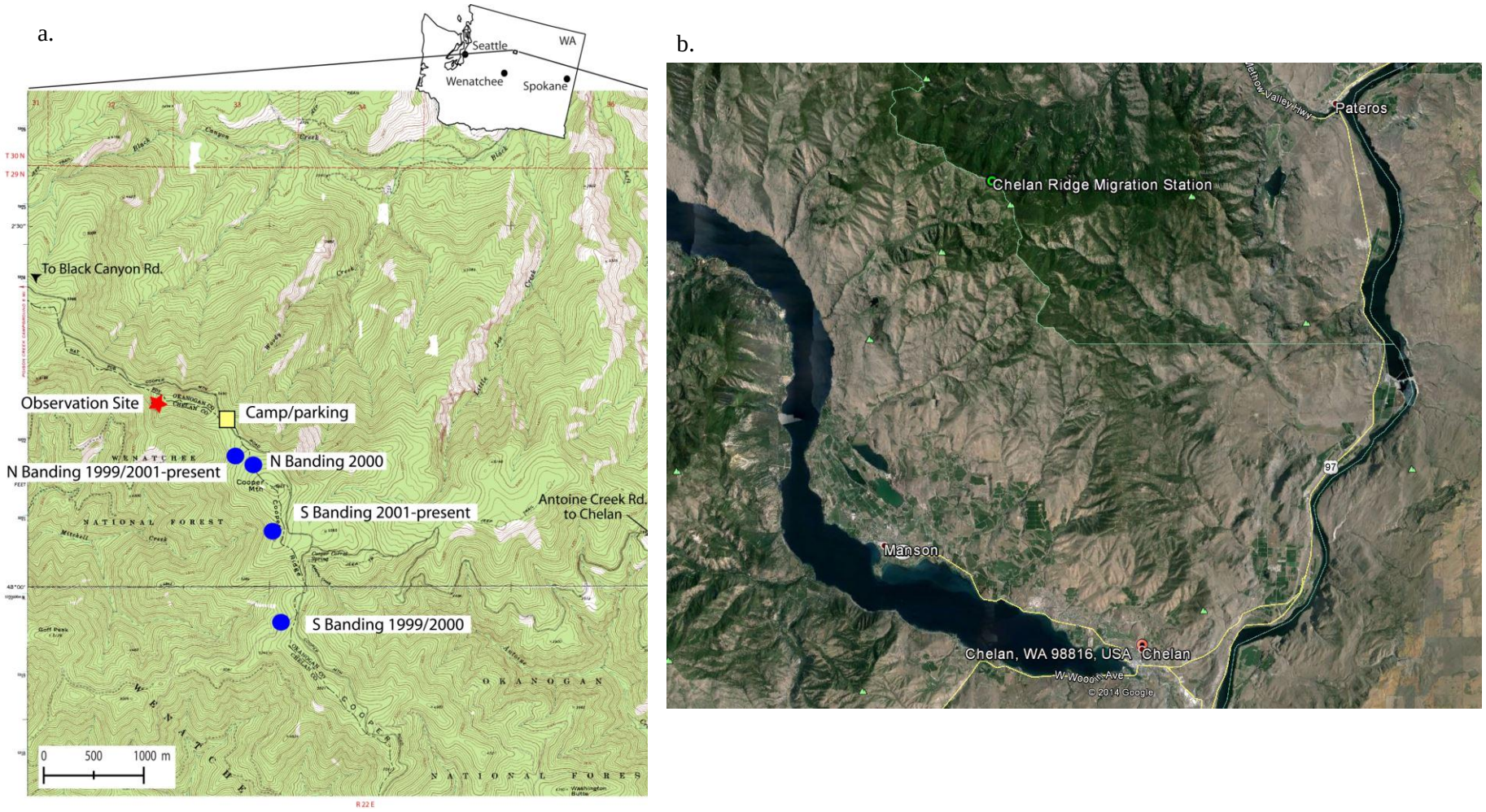

Figure 1. a. Location of the Chelan Ridge Raptor Migration Project count and banding sites in north-central Washington. b. Location of Chelan Ridge Migration Station relative to Chelan and Pateros, WA (GoogleEarth View).

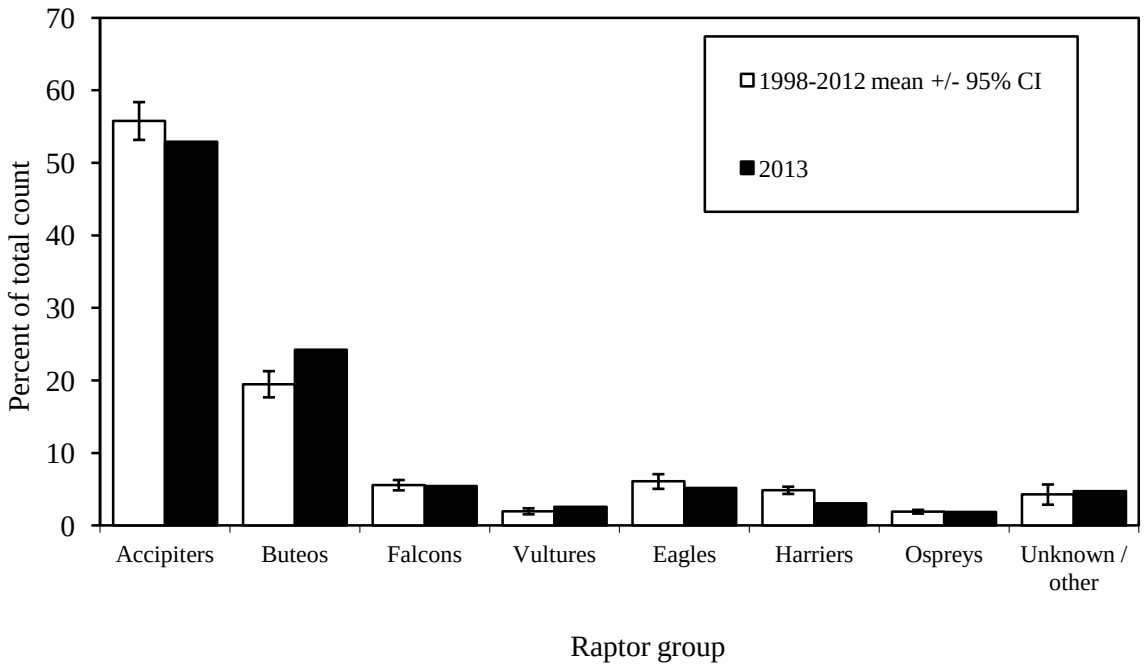

Figure 2. Fall raptor migration flight composition by major species groups at Chelan Ridge, WA: 1998–2012 versus 2013.

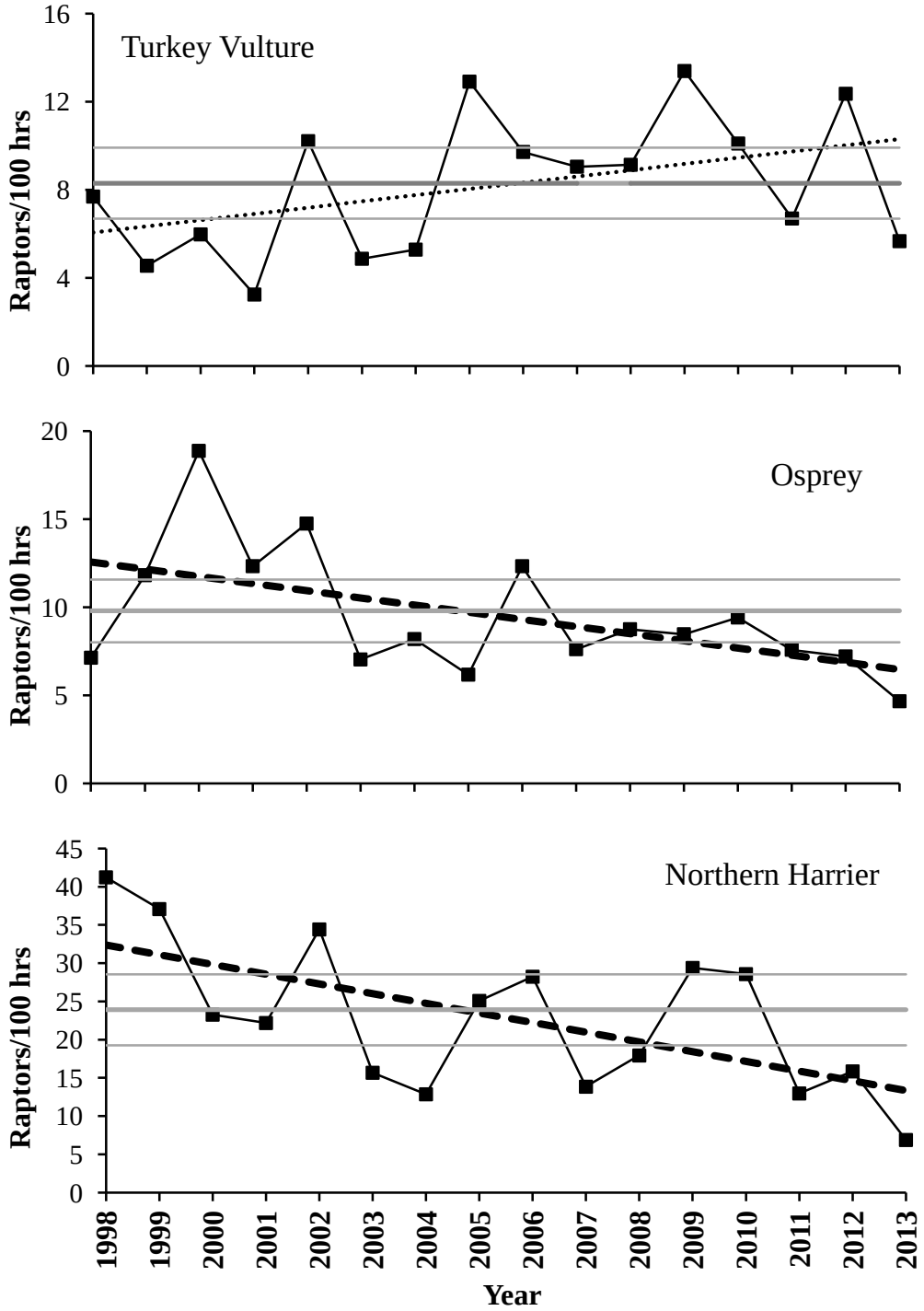

Figure 3a. Adjusted fall-migration passage rates at Chelan Ridge, WA for Turkey Vultures, Ospreys, and Northern Harriers: 1998–2013. Dashed lines indicate trends for significant ($p < 0.05$) linear or quadratic regressions and dotted lines represent near significant trends ($p < 0.1$). Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2012) at Chelan Ridge.

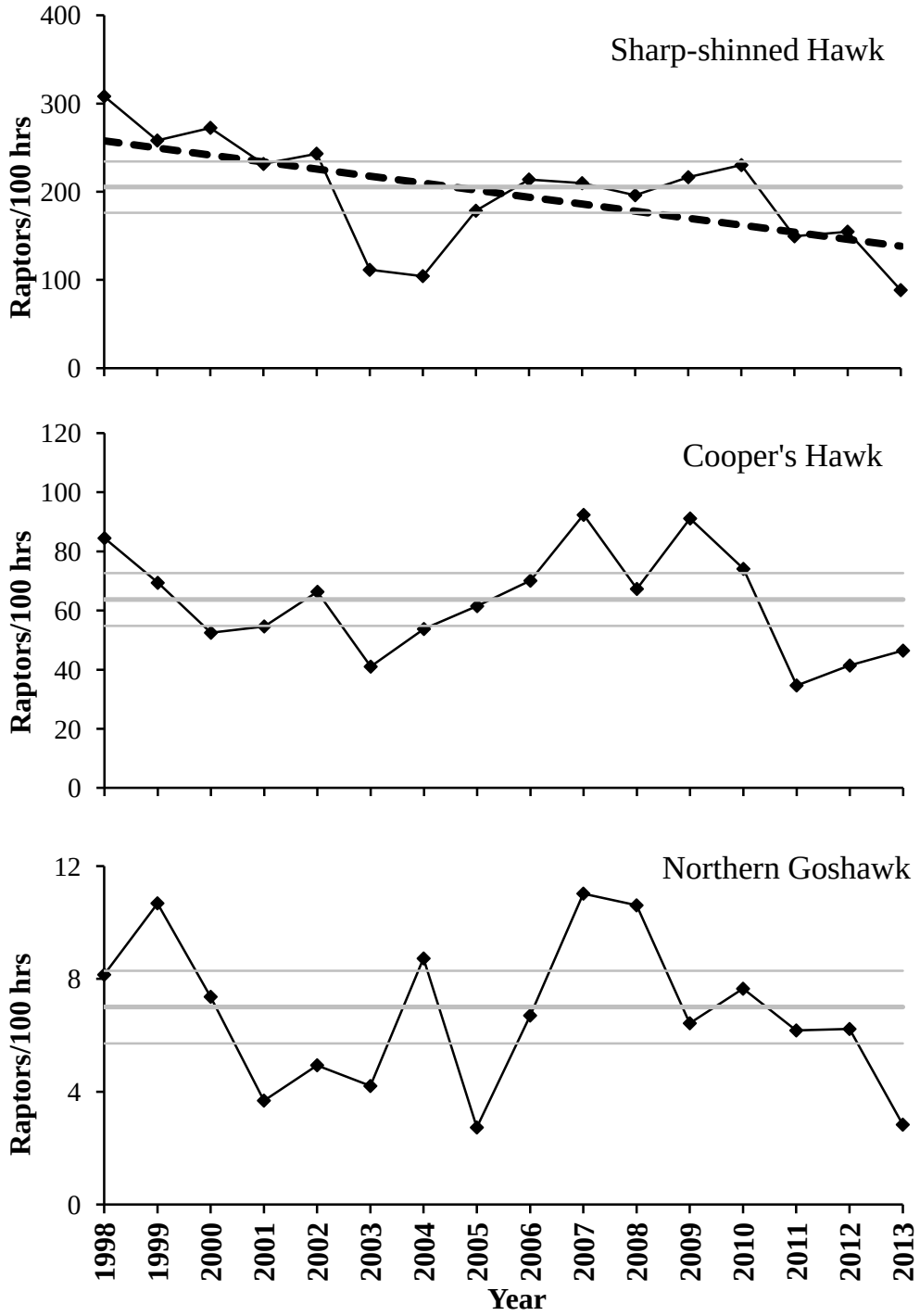

Figure 3b. Adjusted fall-migration passage rates at Chelan Ridge, WA for the three North American accipiter species: 1998–2013. Dashed lines indicate trends for significant ($p < 0.05$) linear regression. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2012).

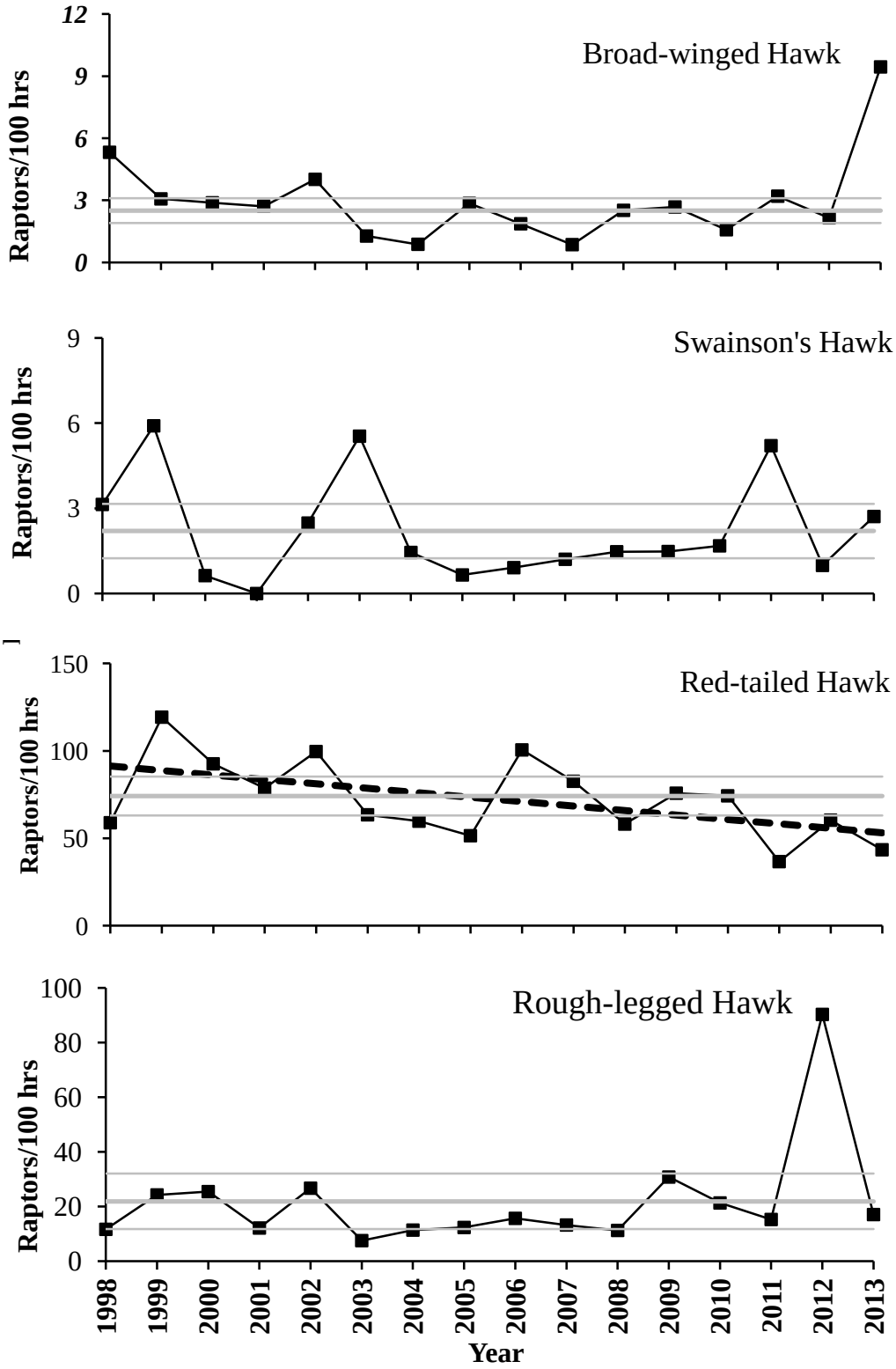

Figure 3c. Adjusted fall-migration buteo passage rates at Chelan Ridge, WA: 1998–2013. Dashed lines indicate significant($p < 0.05$) population trends based on linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2012).

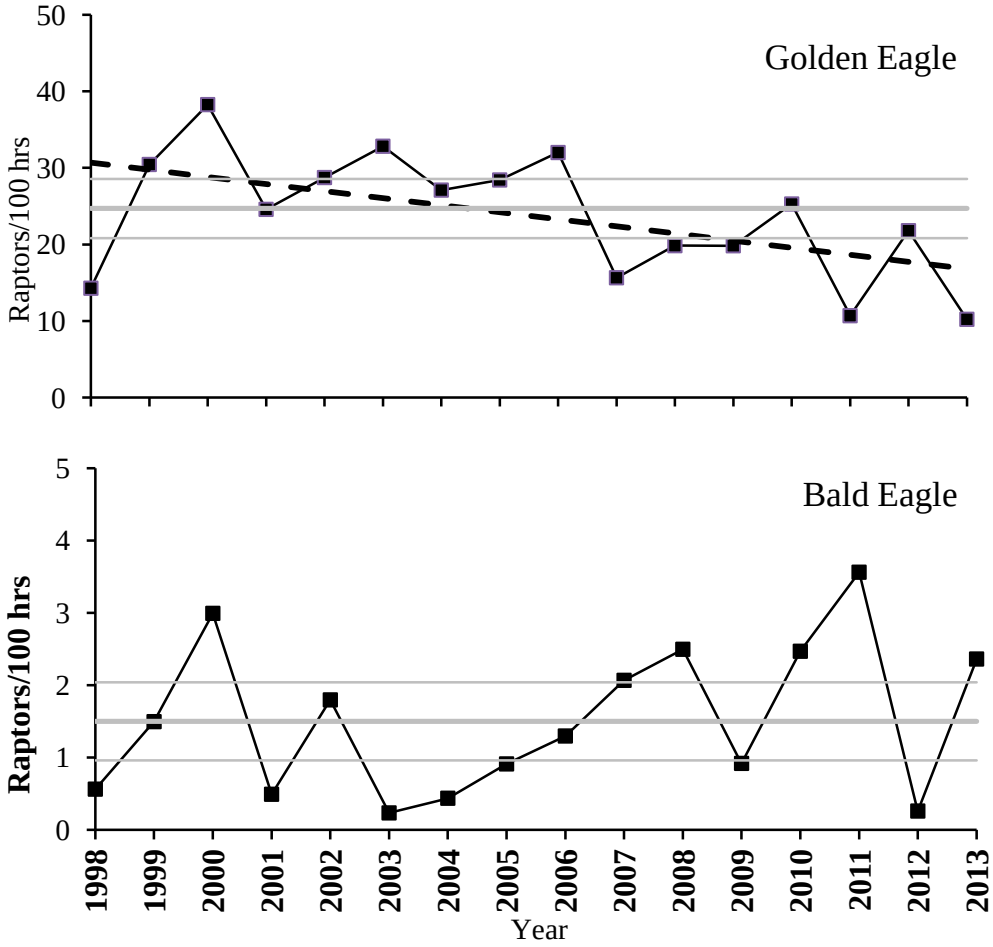

Figure 3d. Adjusted eagle passage rates for the fall migration at Chelan Ridge, WA.: 1998–2013. Dashed lines indicate significant (p< 0.05) population trends based on linear regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2012).

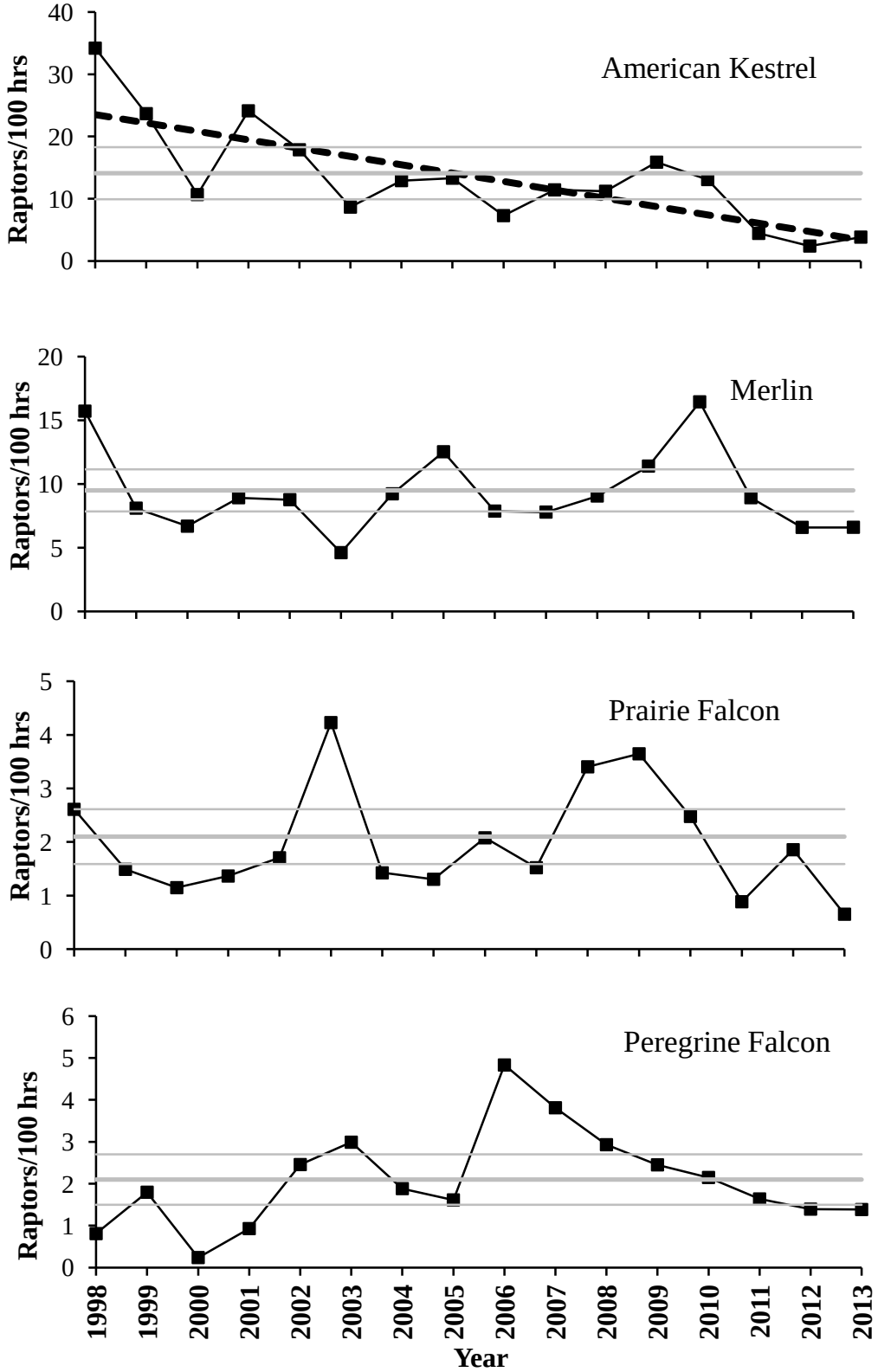

Figure 3e. Adjusted fall-migration falcon passage rates at Chelan Ridge, WA: 1998–2013. Dashed lines indicate significant ($p < 0.05$) population trends based on linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2012).

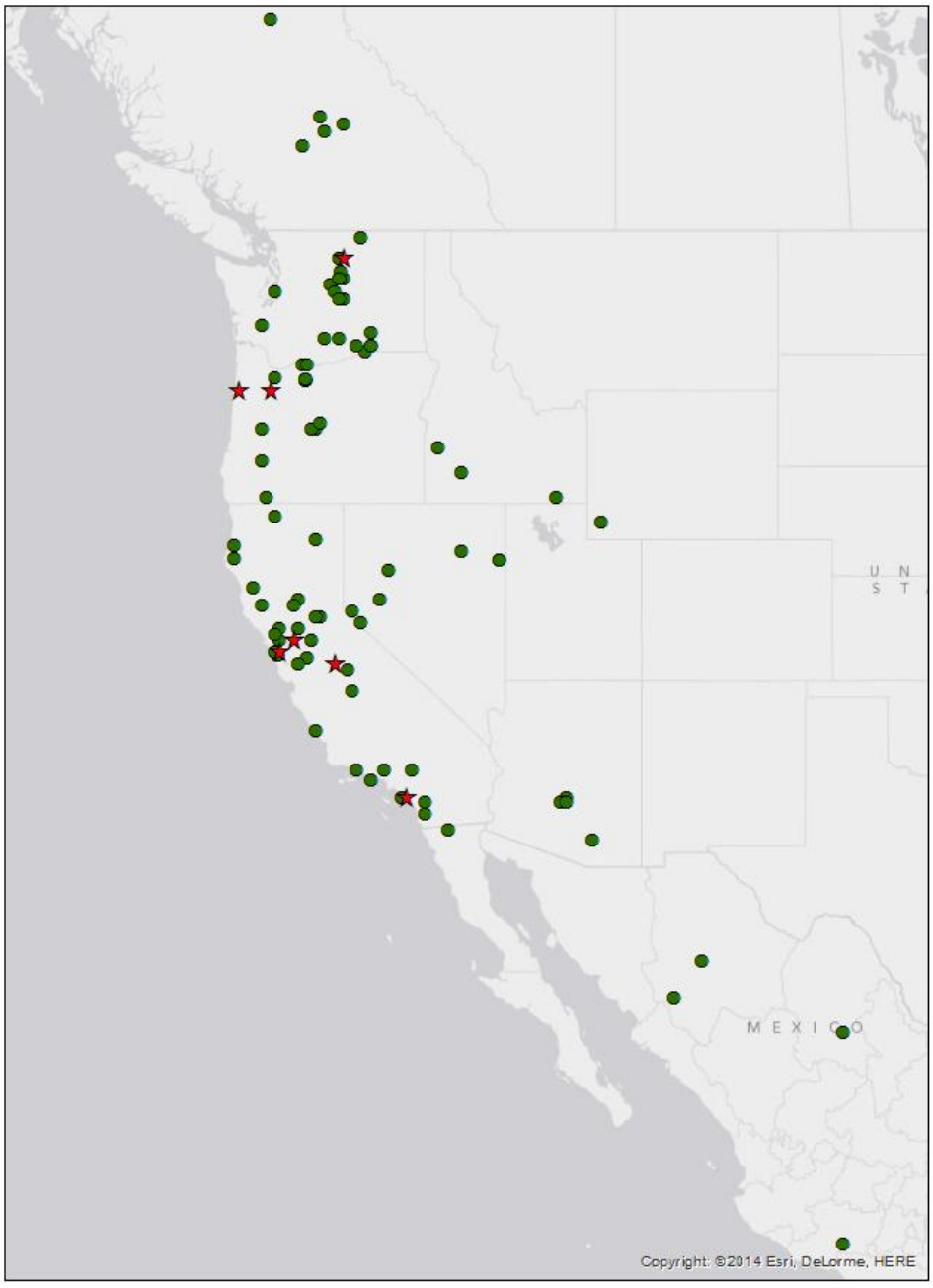

Figure 4. Recovery locations of raptors banded at Chelan Ridge. Circles indicate recoveries from 2001-2012, red stars indicate 2013 and early 2014 (through 1 April 2014) recoveries.

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 Loock (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 Sjollema (0), James Waddell (0; first half), Steve Seibel (3+; second half), and regular substitutes Richard Hendrick (4+) and Dan Russell (2).

2006: Two observers throughout: Angela Sjollema (1), Steve Seibel (4+), with assistance from Aran Meyer (1+), Rob Spaul (2), Devon Batley (1), and Richard Hendrick (4+).

2007: Two observers throughout: Dayna Hawes (1), Shaun Hyland (0), Angela Winter (0), with assistance from Rob Spaul (2+), Ben Vang-Johnson (1+), and Richard Hendrick (4+).

2008: Two observers throughout: Grace Eger (0), Brian Connely (0), Leif Baierl (0), with assistance from Rob Spaul (2+).

2009: Two observers throughout: Brian Connely (1), Craig Waythomas (+), and Marie-Catherine Fournier (+).

2010: Two observers throughout: Brian Connely (2), Craig Waythomas (1+), and Marie-Catherine Fournier (1+).

2011: Two observers throughout: Chadette Pfaff (4), Michael Oliveira (0), and Kathryn Walpole (0).

2012: Two observers throughout: Joshua Collette (0), Kelsey Navarre (0), and Jonathan Roatch (0).

2013: Two observers throughout: Elizabeth Errickson (+), Olivia DaRugna (0), and Carla Jo Ehlinger (0).

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

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

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

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

[4] Golden Eagle age codes: I = Immature: juvenile or first-year bird, bold white wing patch visible below, bold white in tail, no molt; S = Subadult: 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. Annual observation effort and fall raptor migration counts by species at Chelan Ridge, WA: 1997–2013.

	1997	1998	1999	2000	2001	2002	2003	2004	2005
Start Date	5-Sep	27-Aug	27-Aug	27-Aug	27-Aug	25-Aug	23-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
Observation days	29	53	61	67	55	62	59	59	62
Observation hours	204.60	382.92	504.33	505.75	439.00	491.28	509.24	507.50	502.50
Raptors / 100 hours	691.1	620.2	571.2	481.3	470.4	522.1	297.1	286.1	363.4
SPECIES									
Turkey Vulture	4	29	21	26	14	46	30	25	58
Osprey	41	24	47	71	48	57	31	34	25
Northern Harrier	115	152	167	104	91	148	66	59	113
White-tailed Kite	0	0	0	0	0	0	1	0	0
Sharp-shinned Hawk	311	949	932	1,050	878	937	421	468	730
Cooper's Hawk	150	247	232	198	198	234	136	220	228
Northern Goshawk	38	32	50	35	16	22	17	41	13
Unknown small accipiter[1]	–	–	–	–	98	85	40	1	48
Unknown large accipiter[1]	–	–	–	–	0	10	17	6	6
Unknown accipiter	182	221	248	98	0	49	36	10	9
TOTAL ACCIPITERS	681	1,449	1,462	1,381	1,190	1,337	667	746	1,034
Red-shouldered Hawk	0	0	0	0	0	0	0	0	0
Broad-winged Hawk	2	7	5	5	6	9	3	2	6
Swainson's Hawk	0	8	17	2	0	7	15	5	2
Red-tailed Hawk	145	182	450	364	263	386	263	277	233
Ferruginous Hawk	0	0	0	1	0	0	0	0	0
Rough-legged Hawk	1	13	44	53	13	45	14	20	22
Unidentified buteo	75	58	148	97	83	82	39	15	29
TOTAL BUTEOS	223	268	664	522	365	529	334	319	292
Golden Eagle	105	55	141	174	105	135	142	130	130
Bald Eagle	2	2	7	15	2	8	1	2	4
Unidentified eagle	7	0	7	5	1	0	12	0	2
TOTAL EAGLES	114	57	155	194	108	143	155	132	136
American Kestrel	24	107	89	40	84	68	33	48	55
Merlin	17	55	36	26	36	38	21	39	53
Prairie Falcon	2	10	7	5	5	6	19	5	4
Peregrine Falcon	5	2	9	1	3	9	14	7	4
Unknown small falcon[1]	–	–	–	–	6	4	6	5	1
Unknown large falcon[1]	–	–	–	–	1	2	2	2	3
Unknown falcon	10	6	6	2	2	0	0	4	0
TOTAL FALCONS	58	180	147	74	137	127	95	110	120
Unidentified Raptor	178	216	218	62	112	178	134	27	48
GRAND TOTAL	1,414	2,375	2,881	2,434	2,065	2,565	1,513	1,452	1,826

Appendix C. Continued

	2006	2007	2008	2009	2010	2011	2012	2013	MEAN
Start Date	24-Aug	24-Aug	24-Aug	23-Aug	23-Aug	23-Aug	23-Aug	23-Aug	23-Aug
End Date	26-Oct	27-Oct	27-Oct	25-Oct	23-Oct	25-Oct	18-Oct	24-Oct	24-Oct
Observation days	64	62	64	60	58	58	52	58	60
Observation hours	512.00	520.00	557.85	507.74	477.17	484.92	446.22	493.40	490.27
Raptors / 100 hours	458.8	413.3	365.2	457.9	446.8	261.9	350.7	219.1	424.1
SPECIES									
Turkey Vulture	50	42	48	70	44	31	51	28	39
Osprey	50	31	37	36	36	33	27	20	39
Northern Harrier	127	60	82	127	114	56	68	33	102
White-tailed Kite	0	0	0	0	0	0	0	0	0
Sharp-shinned Hawk	854	880	875	852	841	587	531	350	786
Cooper's Hawk	270	363	269	332	249	130	133	169	229
Northern Goshawk	31	49	48	27	30	25	22	12	31
Unknown small accipiter[1]	97	45	33	87	59	16	88	14	50
Unknown large accipiter[1]	11	3	19	12	7	5	11	7	9
Unknown accipiter	12	8	8	38	26	22	20	20	60
TOTAL ACCIPITERS	1,275	1,348	1,252	1,348	1,212	785	805	572	1,234
Red-shouldered Hawk	0	0	0	0	0	1	0	0	0
Broad-winged Hawk	4	2	5	6	4	6	4	11	5
Swainson's Hawk	2	4	5	5	5	13	4	5	6
Red-tailed Hawk	441	378	304	341	315	135	204	161	302
Ferruginous Hawk	0	0	0	0	0	0	0	0	0
Rough-legged Hawk	28	22	25	48	37	22	117	28	35
Unidentified buteo	57	29	10	20	14	40	71	57	53
TOTAL BUTEOS	532	435	349	420	375	216	400	262	426
Golden Eagle	157	82	111	93	109	45	90	45	113
Bald Eagle	8	10	12	4	10	15	1	11	7
Unidentified eagle	0	0	0	1	0	3	0	0	2
TOTAL EAGLES	165	92	123	98	119	63	91	56	130
American Kestrel	29	47	47	59	47	15	8	17	52
Merlin	34	40	44	45	63	37	24	28	39
Prairie Falcon	9	6	17	14	11	4	6	5	9
Peregrine Falcon	20	16	13	7	10	8	4	6	8
Unknown small falcon[1]	3	0	2	9	4	0	2	2	3
Unknown large falcon[1]	3	1	1	5	0	0	2	0	2
Unknown falcon	0	1	0	2	1	1	1	1	2
TOTAL FALCONS	98	111	124	141	136	65	47	59	123
Unidentified Raptor	52	30	22	85	96	20	76	51	92
GRAND TOTAL	2,349	2,149	2,037	2,325	2,132	1,270	1,565	1,081	2,063

[1] Designations used for the first time in 2001.

Appendix D. Annual trapping effort and capture totals by species for migrating raptors at Chelan Ridge, WA: 1999–2013.

	1999[1]	2000[1]	2001	2002	2003	2004	2005	2006
First trapping day	28-Aug	2-Sep	30-Aug	27-Aug	23-Aug	25-Aug	25-Aug	25-Aug
Last trapping day	16-Oct	14-Oct	17-Oct	19-Oct	25-Oct	18-Oct	22-Oct	22-Oct
Number of stations	2	2	2	2	2	2	2	2
Trapping days	47	42	44	54	56	53	56	56
Station hours	388	?	612.8	837.3	803.3	699.6	828.2	797.33
Captures / stn. hour	5.7	?	8.6	8.1	7.3	5.0	7.5	10.2
SPECIES	RAPTOR CAPTURES							
Northern Harrier	4	3	10	13	11	6	12	28
Sharp-shinned Hawk	139	125	341	459	394	237	389	556
Cooper's Hawk	42	46	107	127	100	58	137	100
Northern Goshawk	14	10	12	13	9	16	11	24
Broad-winged Hawk	0	0	0	0	0	0	0	0
Red-tailed Hawk	11	8	22	29	20	16	11	50
Rough-legged Hawk	0	1	1	2	1	0	5	6
Golden Eagle	0	1	2	0	4	2	2	6
American Kestrel	3	0	8	10	17	5	6	8
Merlin	6	4	17	21	25	10	49	31
Prairie Falcon	1	1	3	4	4	1	0	3
Peregrine Falcon	0	0	2	0	4	1	1	2
All species	220	199	525	678	589	352	623	814
Recaptures[2]	0	0	0	0	0	0	0	0
Foreign Recaptures[3]	0	0	0	1	0	0	0	2
Foreign Encounters[4]	0	1	5	2	1	1	4	15

Appendix D. Continued

	2007	2008	2009	2010	2011	2012	2013	MEAN	TOTAL
First trapping day	25-Aug	24-Aug	24-Aug	25-Aug	22-Aug	25-Aug	24-Aug	24-Aug	
Last trapping day	16-Oct	23-Oct	24-Oct	22-Oct	20-Oct	17-Oct	22-Oct	19-Oct	
Number of stations	2	2	2	2	2	2	2	2	
Trapping days	51	60	58	54	52	48	56	53.8	
Station hours	716.12	836.48	632.76	520.66	496.08	468.55	660.69	687.54	
Captures / stn. hour	9.4	9.1	10.5	12.1	11.1	11.1	6.8	9.0	
SPECIES	RAPTOR CAPTURES								
Northern Harrier	12	18	24	29	8	8	8	14.9	194
Sharp-shinned Hawk	450	503	419	396	373	350	287	406.1	5424
Cooper's Hawk	138	140	128	113	96	101	81	112.1	1514
Northern Goshawk	16	29	10	15	15	6	11	14.7	211
Broad-winged Hawk	0	0	1	0	0	0	0	0.1	1
Red-tailed Hawk	33	22	34	27	26	25	33	26.9	375
Rough-legged Hawk	1	2	9	1	1	3	2	2.7	35
Golden Eagle	2	5	5	3	5	4	0	3.5	43
American Kestrel	3	13	9	8	4	2	7	7.3	98
Merlin	15	25	21	30	19	20	16	23.6	309
Prairie Falcon	4	5	3	1	0	2	2	2.5	34
Peregrine Falcon	1	2	2	3	3	1	3	1.8	25
All species	675	764	665	631	550	522	450	616.2	8263
Recaptures[2]	1	0	0	7	3	0	0	0.9	11
Foreign Recaptures[3]	2	0	1	1	0	0	0	0.7	8
Foreign Encounters[4]	12	7	9	9	9	5	5	6.8	87

[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.