FALL 2014 RAPTOR MIGRATION REPORT

CHELAN RIDGE, WASHINGTON

A Partnership between:

HAWK WATCH INTERNATIONAL
Conserving Raptors and Our Shared Environment

Salt Lake City, Utah

and the

FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE

Okanogan and Wenatchee National Forests

Winthrop, Washington

SUMMARY OF 2014 FALL RAPTOR MIGRATION AT CHELAN RIDGE, WASHINGTON

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INTRODUCTION

The Chelan Ridge HawkWatch 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 efforts have continued anually 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 2014 season marked the 17th consecutive, full-season count and the 16th straight season of banding at the site. This report summarizes the 2014 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 2014 (Fig. 1). 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). 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, as well as blood sampling to track changes in raptor health (e.g., Hoffman et al. 2002, Lott and Smith 2006, Goodrich and Smith 2008, DeLong and Hoffman 2004, McBride et al. 2004). As a recent example, 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 moving through Chelan Ridge. HWI bander Chris Vennum oversaw this effort and is currently analyzing samples at the University of Nevada, Reno; results will be reported as they become available.

Beyond having scientific and conservation value, each site in HWI's migration network offers unique opportunities for the public to learn about raptors and the natural environment. Providing such opportunities is another important component of the Chelan Ridge HawkWatch 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. 2). 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 missed or 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--allowing some migrants to pass the lookout undetected but they are often 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. 2). 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 observers, relieved or supplemented by other trained staff and volunteers, conduct standardized daily counts of migrating raptors from the observation site. Lead observer Angela Woodside previously participated in fall migration counts at Chestnut Ridge, in New York, and at Hayden Valley in Yellowstone National Park, but this past season was her first year with HWI. For Jessica Taylor, this was her first full season counting migrating raptors (see Appendix A for a complete history of observer participation). Multi-purpose crewmember Leah Rensel, who volunteered on occasion last season, also routinely assisted with the counts. Other crewmembers, USFS staff, and visitors assisted occasionally as well.

Weather permitting; observations usually begin at 0800 H and end between 1600 and 1700 H Pacific Standard Time (PST). Data collection follows standardized protocols used at all HWI migration sites (Hoffman and Smith 2003). Observers routinely record 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 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.

In comparing 2014 counts against means and 95% confidence intervals for previous seasons, we consider a count value falling outside the 95% confidence interval of the historic site means as significantly different. Linear and quadratic regression was used on effort-adjusted annual passage rates (raptors/100hrs) to identify long-term trends in migrating raptors.

TRAPPING AND BANDING

The trappers operated 1-2 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 collection followed standardized protocols used at all HWI migration-banding sites (Hoffman et al. 2002). All birds were released within 45 minutes, usually quicker.

2014 RESULTS AND DISCUSSION

OBSERVATION EFFORT AND WEATHER SUMMARY

Observers counted on 54 of 65 possible days between 23 August and 26 October during the 2014 season, which was five days below the 1998-2013 long term average, and spent a total of 448 hours counting, also below average (Appendix C). Two of the 54 days had abbreviated counts (<4 hrs) due to weather. Based on hourly recording of conditions throughout the season, it was clear 36% of the time, overcast or foggy 64% of the time, and rainy 4% of the time.

2014 FLIGHT SUMMARY

Overall Flight:

A total of 1,384 migrating raptors of 16 species were tallied, a significant ($p < 0.05$) decrease of 31% compared to the long-term site average (Table 1), and the third lowest total on record (Appendix C). Highlights of the 2014 season included record high seasonal counts for Broad-winged Hawks (12) and Swainson's Hawks (43) and single day records for Broad-winged Hawks (five counted on 21 September) and Turkey Vultures (25 counted on 27 September). September 21 was the second biggest day in site history with 169 birds counted.

The composition of the overall flight broke down as follows: 57% accipiters, 15% buteos, 7% falcons, 6% eagles, 5% harriers, 4% vultures, 3% Ospreys, and 3% unknown raptors. The proportions of buteos and eagles were above historic averages; while the proportion of accipiters, falcons, vultures, harriers, and Opreys were all below historic averages (Fig. 3). Sharp-shinned Hawks were the most commonly observed species (38% of the total), followed by Cooper's Hawks (14%), Red-tailed Hawks (9%), Golden Eagles (5%), Northern Harriers (5%), Turkey Vultures (4%), Ospreys (3%), Swainson's Hawks (3%), and Merlins (3%). The remaining species each accounted for 2% or less of the total count.

The following sections summarize the 2014 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 of effort adjusted passage rates. HWI only depicts significant trends for species with a historic mean passage 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.

Total Flight (Fig.4):

Total number of raptors counted per 100 hours of observation at Chelan Ridge has decreased significantly over time (slope = -15.7, r^2 = 0.5, p=0.002).

Vultures, Osprey, and Harriers (Fig. 5a):

Counts in 2014 were above historic averages for Turkey Vultures, comparable to historic average for Ospreys, and below average for Northern Harriers –the fourth consecutive year of below average counts for this species. Harrier passage rates (raptors/100 hrs) are declining over time at Chelan Ridge (slope = -1.15, r^2= 0.37, p = 0.01). Regional Turkey Vulture populations are increasing based on fall migration counts (slope = 0.375, r^2 = 0.27, p-value = 0.03).

Accipiters (Fig. 5b):

Accipiter counts were below historic averages for all species in 2014 (Table 1). Sharp-shinned Hawk passage rates were below average for the fourth straight fall and regression analysis indicates significant declines (slope= -6.38, r^2 = 0.36, p=0.01). Passage rates for Goshawks were lower than historic averages in 2014 while Cooper's Hawks rates were in line with the site average. Trend analyses indicate that passage rates of both species have been stable over time (no statistically significant trend).

Buteoine Hawks (Fig. 5c):

The total number of Buteos counted during 2014 was low compared to the site average (Table 1). Both the count and passage rate for Red-tailed Hawks were significantly below average (Table 1, Fig 5c), and regional populations continue to decline (slope = -2.055, r^2 = 0.27, p = 0.03) based on fall migration counts. Rough-legged Hawk counts were also below site historic average. Conversely, Broad-winged Hawks and Swainson's Hawks were counted in record numbers in 2014, 12 and 43 respectively (Table 1).

Eagles (Fig.5d):

For the third time in four years Golden Eagle counts and passage rates were below average (Table 1) and regression analysis of migration counts suggests a continued decline in regional Golden Eagle populations (slope = -0.89, r^2 = 0.31, p = 0.02). Bald Eagle counts and passage rates were high compared to site averages for the second straight year (Table 1).

Falcons (Fig. 5e):

American Kestrel counts and passage rates in 2014 were low compared to site average and regional Kestrel populations continue to decline based on fall migration rates (slope = -1.22, r^2 = 0.59, p = 0.0003). 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/). Merlin, Peregrine Falcon, and Prairie Falcon counts and passage rates were in line with site historic averages.

TRAPPING EFFORT

Trapping occurred on 56 of 60 days between 24 August and 19 October, with efforts totaling 502.38 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 on 19 October, a week early. The number of trapping days was above average, but the total station hours were slightly below site average (Appendix D).

A total of 530 raptors of ten species were captured and banded in 2014, significantly below the site average of 603 birds (Table 2). The 2014 overall capture rate high compared to the historic site average, suggesting that the relative efficiency of trapping is being maintained (Table 2). Total captures were low for Northern Harrier, Cooper's Hawk, Northern Goshawk, Rogh-legged Hawk, American Kestrel, Prairie Falcon, and Peregrine Falcon. All other species capture totals were in line with site averages.

ENCOUNTERS WITH PREVIOUSLY BANDED BIRDS

To date 100 birds banded at Chelan Ridge have been recaptured/recovered and reported to the USGS Bird Banding Laboratory (Fig. 6). During 2014, six birds banded at Chelan Ridge were reported to the BBL, which then passed the information to HWI; these recoveries included two Sharp-shinned Hawks, a Cooper's Hawk, and three Red-tailed Hawks (Fig. 6, Table 3). Four of the six birds were found dead. One was a hatch year Sharp-shinned Hawk banded in October at Chelan Ridge and found dead in Las Cruces, NM in December—2081 km away. This bird is notable because many raptors that pass over Chelan Ridge 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, except for this one were recovered within the Pacific Coast Flyway. The two live (and released) recoveries included a 3+ year old Sharp-shinned Hawk found in and released from a building in Baja Mexico, and a first year Red-Tailed Hawk captured and released near Scotts Mill, Oregon.

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

VISITOR PARTICIPATION AND PUBLIC OUTREACH

A total of 201 individuals visited the site and signed the log during the season, and approximately 4% of those visited the site more than once. The average length of stay was a little under five hours, but approximately 20% of those who visited stayed overnight or for entire weekends. Organized events included the Chelan Ridge Hawk Migration Festival, which took place on 13 September, and included 70 participants of all ages. HWI friend and renowned raptor ID expert and author Jerry Liguori visited the festival and provided interpretation and ID tricks and tips at the HawkWatch during the festival. Jerry also gave a raptor ID workshop in Pateros to a large group (100+) of visitors and budding raptor enthusiasts. The festival was sponsored by Methow Valley Ranger District of the US Forest Service, the City of Pateros, North Central Washington Audubon Society, and HawkWatch International. The North Cascades Institute brought two groups to the site (24 people total), and a wildlife class from Washington State University (25 people) visited to learn about field techniques and more. Throughout the season most visitors came from the surrounding Washington communities, but others came from California, Texas, Florida, and Canada.

2014 FALL MIGRATION ACROSS HWI'S NETWORK

HawkWatch International and partners operated 9 fall count sites in 2014 (Fig. 1). During the 4,884.4 hours of standardized observation we counted 504,905 migrating birds of prey. The power and utility of

HWI's network of fall count sites, and long-term monitoring in general, lies in that it allows identification of patterns in regional raptor populations, both over time at a single site and also network-wide. Declines in counts or passage rates for a species or group of species at the regional level can highlight the need for more focused research or management attention at local scales, while increases may indicate the success of management and conservation efforts. While each site in HWI's network varied in terms of individual species or group counts, notable network-wide patterns in 2014 included (Table 4):

- Below average counts for the fall flight at 4 of 9 sites
    - Both Pacific Northwest sites, Commissary Ridge, and Corpus Christi
- Low or average Golden Eagle counts at all network sites--no increases at any site
- Below historic average American Kestrel counts at 6 of 9 sites
- Low Northern Harrier counts at 8 of 9 network sites
- Above average Peregrine Falcon counts at 6 of 9 sites and average counts at the other 3
- Above average Broad-winged Hawk numbers at 6 western sites and below average Broad-winged numbers at Corpus Christi – does this signify a change in the migration pathways for this species?

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.

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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, and long time Chelan Ridge partner and friend, biologist Jim Watson of the Washington Department of Fish and Wildlife for his encouragement and support of our research and monitoring efforts over the years.

We especially want to thank our 2014 field crew: Kelsey Navarre, Angela Woodside, Jessica Taylor, Monika Lapinski, Carly Melchers, and Leah Rensel; plus new and veteran volunteers who made their first trip or returned to visit and help with this season's efforts: Krista Little, Tabitha Bergevin-Krumme, 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. Historic fall raptor migration counts (mean±95% CI), counts from fall 2014, and site records at Chelan Ridge, WA.

		1998-2013			All-time Historic Records	
	Species	**Mean Count ± 95 % CI**	**2014**	**% Change**	**Season**	**Daily**
	Turkey Vulture	38 ± 7	55	44	70 (2009)	25 (2014)
	Osprey	38 ± 7	41	8	71 (2000)	10 (2x including 14)
	Northern Harrier	98 ± 19	75	-23	167 (1999)	21 (1998)
Accipiters						
	Sharp-shinned Hawk	759 ± 106	520	-31	1050 (2000)	84 (2000)
	Cooper's Hawk	226 ± 32	190	-16	363 (2007)	32 (2009)
	Northern Goshawk	29 ± 6	21	-29	50 (1999)	7 (2x)
	Unidentified accipiter	103 ± 31	64	-38	248 (1999)	
	TOTAL ACCIPITERS	1117 ± 148	795	-29	1462 (1999)	
Buteos						
	Red-shouldered Hawk	1 ±			1 (2011)	1 (2011)
	Broad-winged Hawk	5 ± 1	12	126	12 (2014)	5 (2014)
	Swainson's Hawk	7 ± 2	43	552	43 (2014)	13 (2003)
	Red-tailed Hawk	294 ± 47	119	-59	450 (1999)	33 (2006)
	Ferruginous Hawk	±			1 (2000)	1(2000)
	Rough-legged Hawk	34 ± 12	5	-85	117 (2012)	39 (2012)
	Unidentified buteo	53 ± 18	22	-59	148 (1999)	
	TOTAL BUTEOS	393 ± 59	201	-49	664 (1999)	
Eagles						
	Golden Eagle	109 ± 19	67	-39	174 (2000)	18 (2000)
	Bald Eagle	7 ± 2	14	1000	15 (2011)	4 (2000)
	Unknown eagles	4 ± 2	0	0	12 (2003)	
	TOTAL EAGLES	118 ± 20	81	-31	194 (2000)	
Falcons						
	American Kestrel	50 ± 13	24	-52	107 (1998)	13 (1998)
	Merlin	39 ± 6	42	9	63 (2010)	9 (1998)
	Prairie Falcon	8 ± 2	8	-4	19 (2003)	3 (2x)
	Peregrine Falcon	8 ± 3	10	20	20 (2006)	3 (3x)
	Unidentified falcon	6 ± 2	7	20	16 (2009)	
	TOTAL FALCONS	111 ± 18	91	-18	180 (1998)	
	Unidentified Raptor	89 ± 32	45	-50	218 (1999)	
	GRAND TOTAL	**2001 ± 248**	**1384**	-31	**2881 (1999)**	**187 (2009)**

Table 2. Capture totals and rates for fall migrating raptors at Chelan Ridge, WA: 2001–2013 versus 2014.

	Capture Totals		Capture Rate[1]	
	2001–2013[2]	2014	2001–2013[2]	2014
Northern Harrier	14 ± 4.3	9	2.2 ± 0.72	1.8
Sharp-shinned Hawk	397 ± 46.4	386	59.0 ± 7.25	76.8
Cooper's Hawk	110 ± 13.2	70	16.4 ± 2.23	13.9
Northern Goshawk	14 ± 3.4	4	2.1 ± 0.42	0.8
Broad-winged Hawk	0 ± 0.2	0	0.0 ± 0.02	0.0
Red-tailed Hawk	27 ± 5.4	29	4.2 ± 0.91	5.8
Rough-legged Hawk	2.6 ± 1.40	1	0.4 ± 0.21	0.2
Golden Eagle	3 ± 1.1	2	0.5 ± 0.19	0.4
American Kestrel	7.3 ± 2.33	3	1.0 ± 0.27	0.6
Merlin	23 ± 5.3	25	3.4 ± 0.72	5.0
Prairie Falcon	2 ± 0.9	1	0.3 ± 0.11	0.2
Peregrine Falcon	1.9 ± 0.6	0	0.3 ± 0.10	0.0
All species	603 ± 68.2	530	89.8 ± 11.03	105.5

[1] Captures / 100 station hours.

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

Table 3. Foreign encounters of raptors banded at the Chelan Ridge HawkWatch in 2014.

Band #	Species[1]	Sex	Banding Date	Banding Age[2]	Encounter Location	Encounter Date	Encounter Age[2]	Distance (km)	Status
1573 – 38089	SS	F	16-Sep-11	SY	Tijuana, Baja California, Mexico	19-Dec-14	ATY	1440	Captured in Bldng – released
1783 – 91046	SS	F	02-Oct-14	HY	Las Cruces, NM	14-Dec-14	HY	2081	Found dead – unknown cause
1005 – 24330	CH	F	25-Aug-09	ASY	Brewster, WA	22-Sep-14	ATY	48	Found dead – unknown cause
1177 – 52194	RT	U	08-Sep-13	HY	Neskowin, OR	17-Jan-14	AHY	502	Found dead – recovery unknown
1957 – 05457	RT	U	04-Oct-13	HY	Scotts Mills, OR	01-Jan-14	AHY	398	Captured and released – not from banding operation
1687 – 24359	RT	U	04-Sep-13	ASY	Chelan, WA	27-May-14	ASY	20	Found dead – recovery unknown

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

Table 4. Summary of the 2014 fall flight of migrating raptors across HWI's monitoring network. Values are counts ; green indicates a count significantly higher (outside the 95% confidence interval) than the historic site average, red indicates a count significantly lower than average, and black indicates a count that does not differ from the site average.

	Bonney Butte, OR	Chelan Ridge, WA	Bridger Mtn, MT	Commissary Ridge, WY	Goshute Mts, NV	Yaki Pt, AZ	Lipan Pt, AZ	Manzano Mts, NM	Corpus Christi, TX
	Hours Counted in 2014								
Species	414.5	448.3	392.7	491.3	690	605.6	518.1	505.1	818.8
Black Vulture									228
Turkey Vulture	322	55	8	31	661	*	*	343	57128
Osprey	53	41	6	6	125	58	45	38	211
Northern Harrier	18	75	112	6	145	31	35	42	171
Crested Caracara									1
Common Black Hawk									0
Harris' Hawk									4
Accipiters									
Sharp-shinned Hawk	802	520	422	600	6141	1806	1572	1304	2101
Cooper's Hawk	465	190	203	148	3986	862	599	770	821
Northern Goshawk	53	21	59	4	152	4	2	11	0
Unidentified accipiter	41	64	66	49	42	342	281	51	105
TOTAL ACCIPITERS	1361	795	750	801	10321	3014	2454	2136	3027
Buteos									
Red-shouldered Hawk	2				0				15
Broad-winged Hawk	1	12	22	0	203	28	23	17	370575
Short-tailed Hawk									0
Swainson's Hawk	0	43	2	16	509	59	54	2279	8035
White-tailed Hawk									23
Zone-tailed Hawk									5
Red-tailed Hawk	415	119	239	530	5095	1262	1687	696	159
Ferruginous Hawk	0		8	3	32	12	2	7	6
Rough-legged Hawk	1	5	84	3	19	0		3	0
Unidentified buteo	6	22	37	73	16	28	28	7	22
TOTAL BUTEOS	425	201	392	625	5874	1389	1794	3009	378766
Eagles									
Golden Eagle	59	67	1222	136	230	2	16	103	1
Bald Eagle	38	14	106	108	16	12	7	6	15
Unknown eagles	5	0	11	22	0	0	0	0	0
TOTAL EAGLES	102	81	1339	266	246	14	23	109	16
Falcons									
American Kestrel	10	24	138	64	1730	474	440	200	1016
Merlin	80	42	28	4	110	16	12	37	98
Prairie Falcon	7	8	13	9	43	7	0	17	8
Peregrine Falcon	17	10	23	16	33	18	11	59	237
Aplomado Falcon									0
Unidentified falcon	7	7	7	10	0	5	4	2	8
TOTAL FALCONS	121	91	209	103	1916	520	467	315	1367
Kites									
Hook-billed Kite									0
Swallow-tailed Kite									59
White-tailed Kite									4
Mississippi Kite					1				20032
Unidentified Kites									0
TOTAL KITES									20095
Unidentified Raptor	21	45	63	28	0	19	38	0	157
GRAND TOTAL	2423	1384	2879	1866	19288	5045	4856	5993	461171

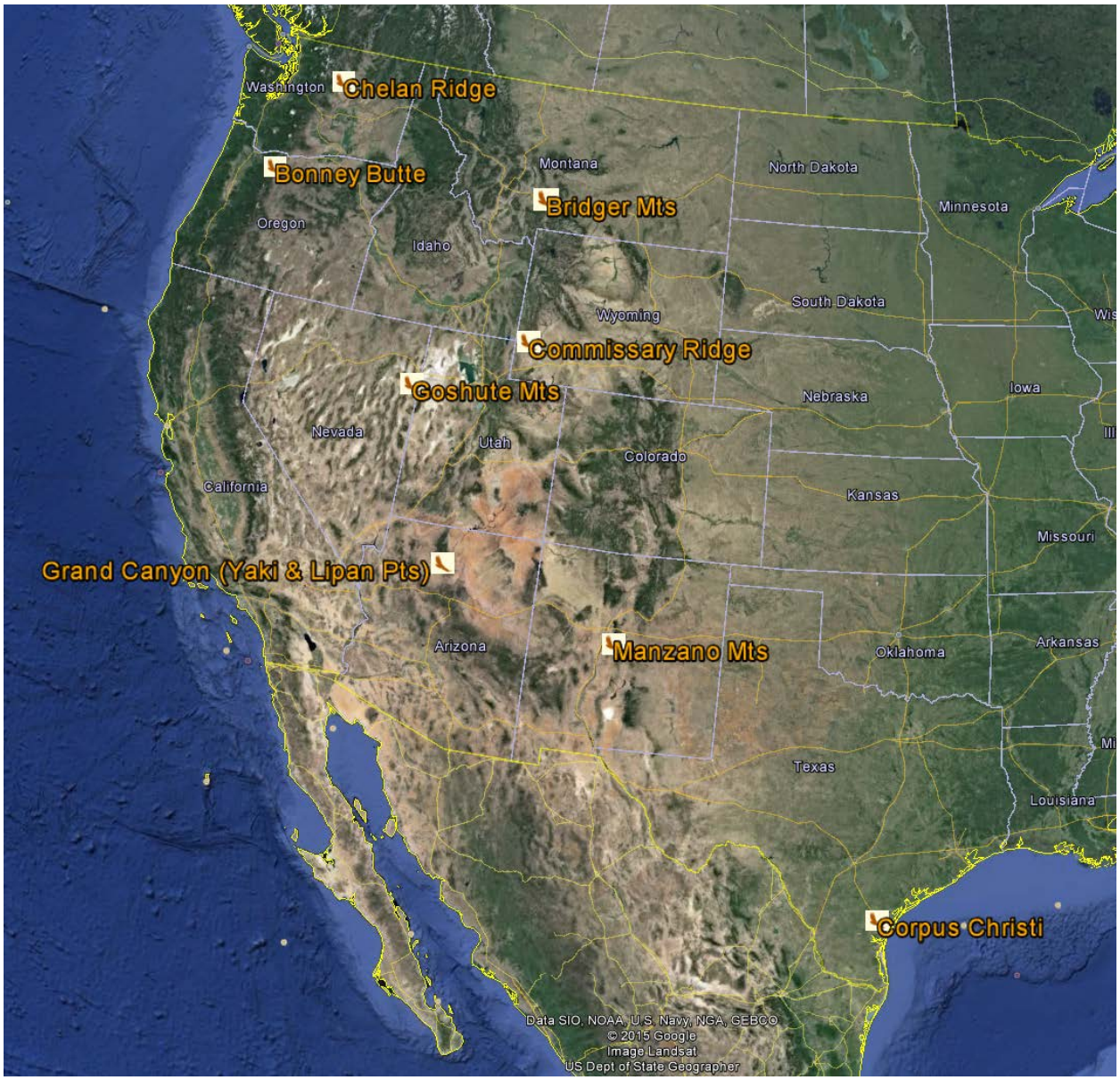
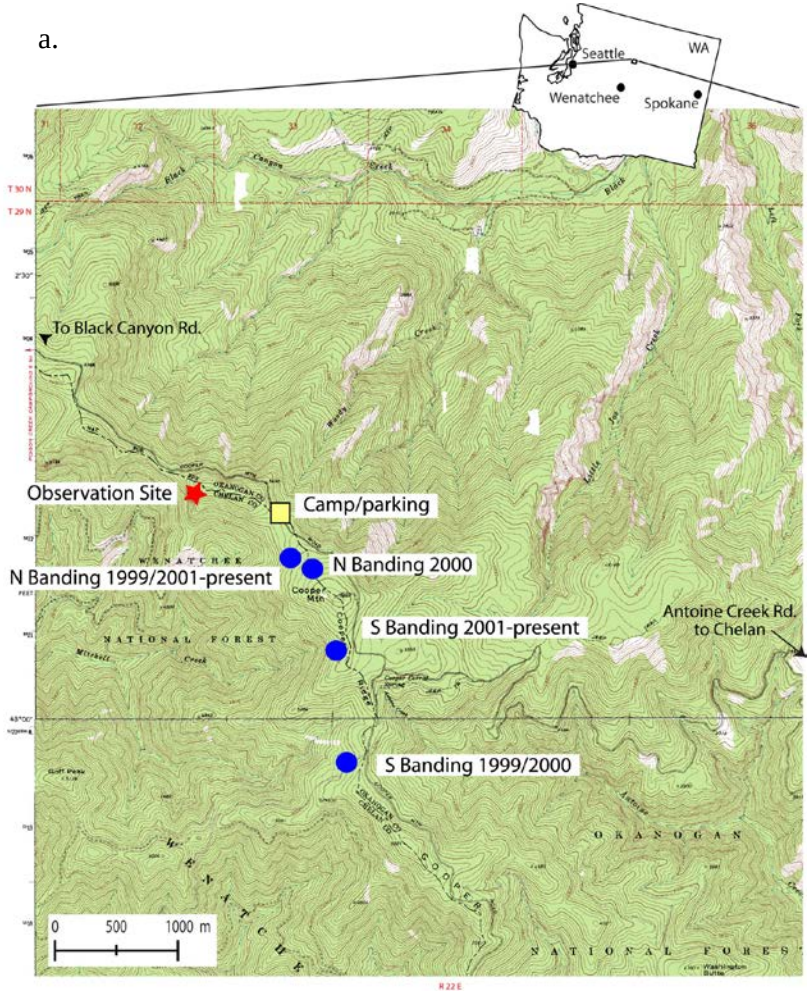


Figure 1. Locations of fall raptor migration count sites operated by HWI and partners.

a.



b.

Figure 2. a. Location of the Chelan Ridge HawkWatch counting and banding sites in north-central Washington, USA. b. Location of Chelan Ridge HawkWatch relative to Chelan and Pateros, WA (GoogleEarth View).

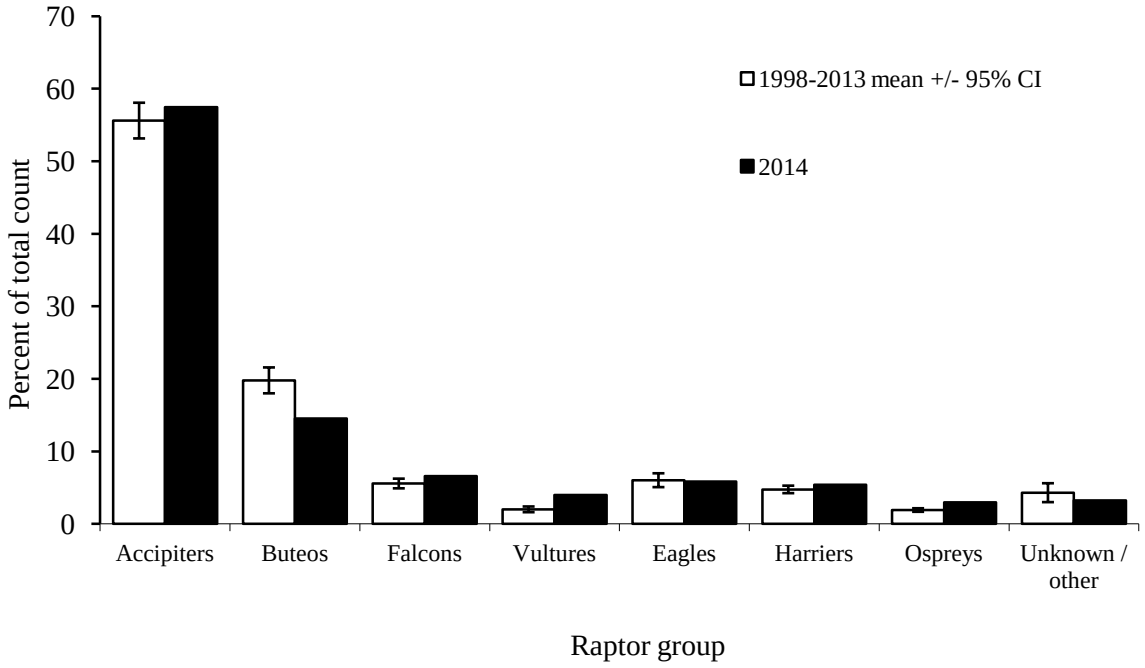


Figure 3. Fall raptor migration flight composition by major species groups at Chelan Ridge, WA: 1998–2013 versus 2014.

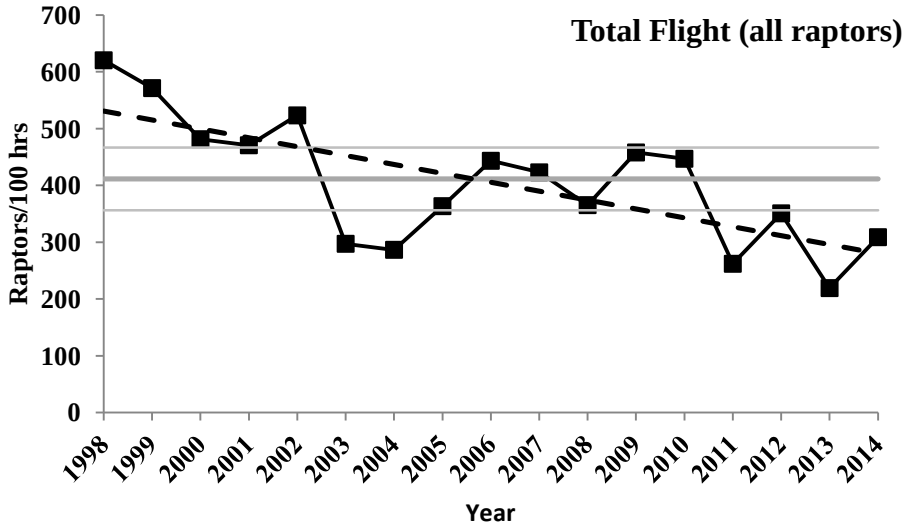


Figure 4. Fall migration passage rates at Chelan Ridge, WA for all migrating raptors: 1998-2014. Dashed line indicates trend for significant ($p < 0.05$) linear regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2013) at Chelan Ridge.

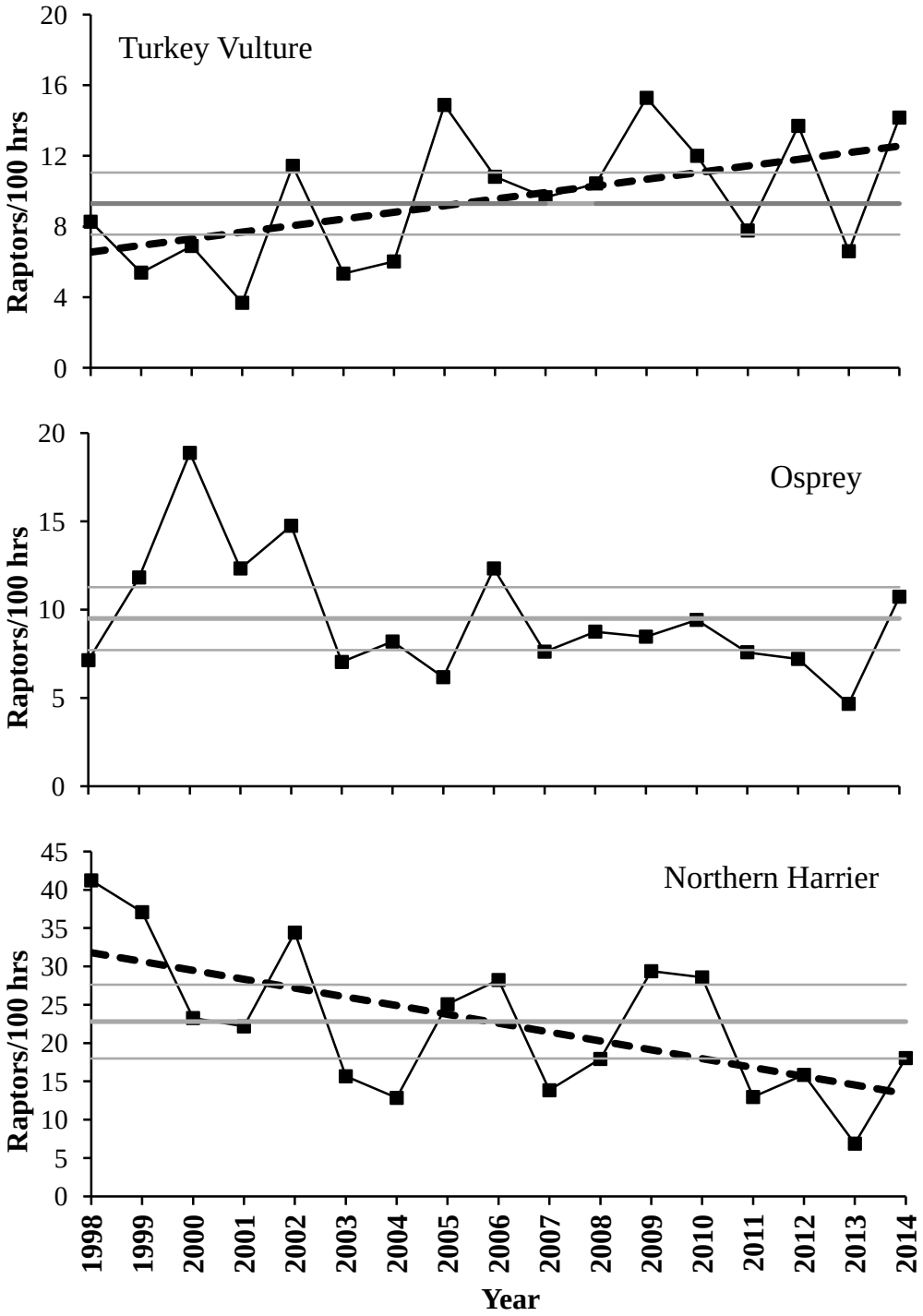


Figure 5a. Fall-migration passage rates at Chelan Ridge, WA for Turkey Vultures, Ospreys, and Northern Harriers: 1998–2014. Dashed lines indicate trends for significant ($p < 0.05$) linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2013) at Chelan Ridge.

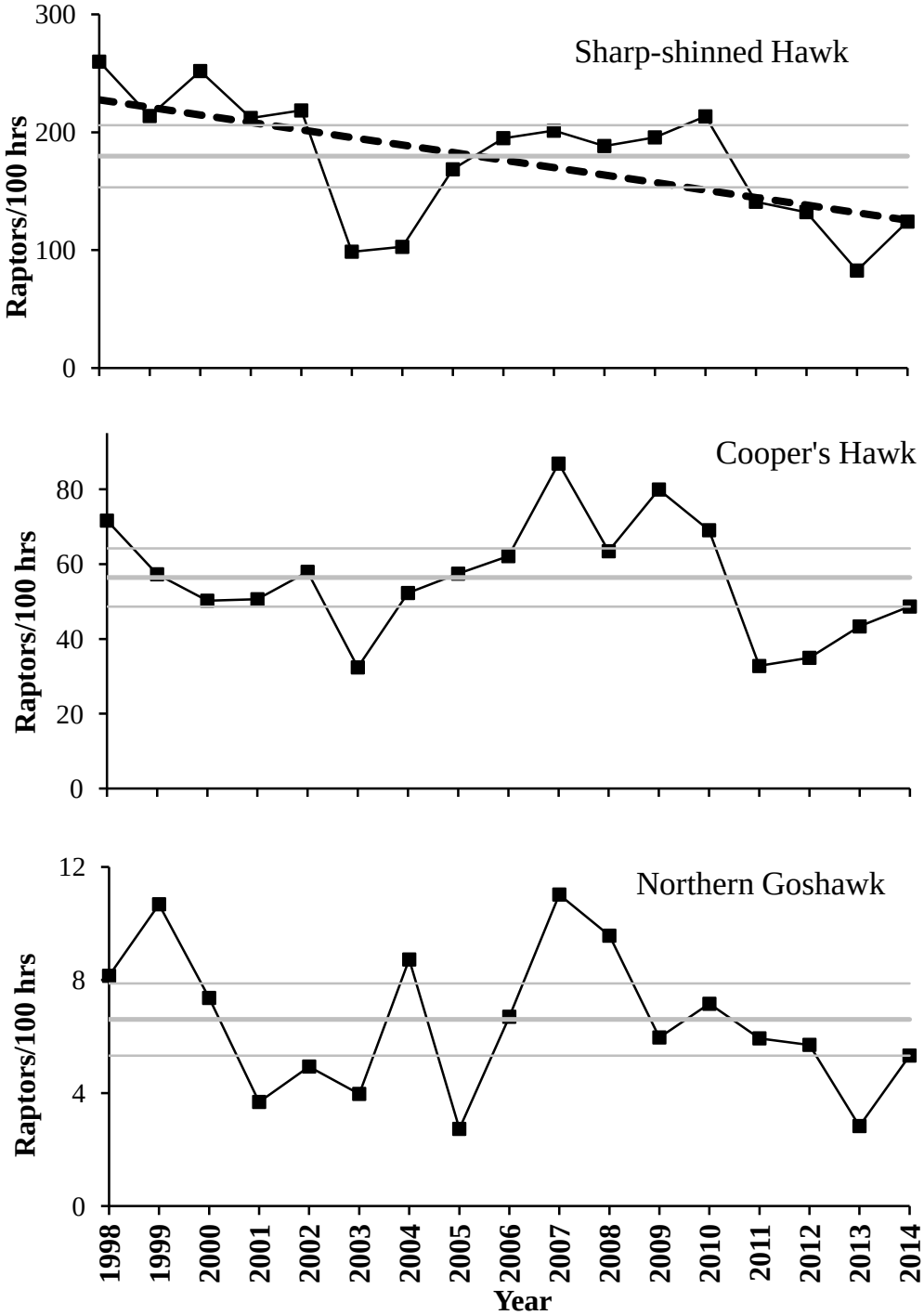


Figure 5b. Fall-migration passage rates at Chelan Ridge, WA for the three North American accipiter species: 1998–2014. Dashed lines indicate trends for significant ($p < 0.05$) linear regression. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2013).

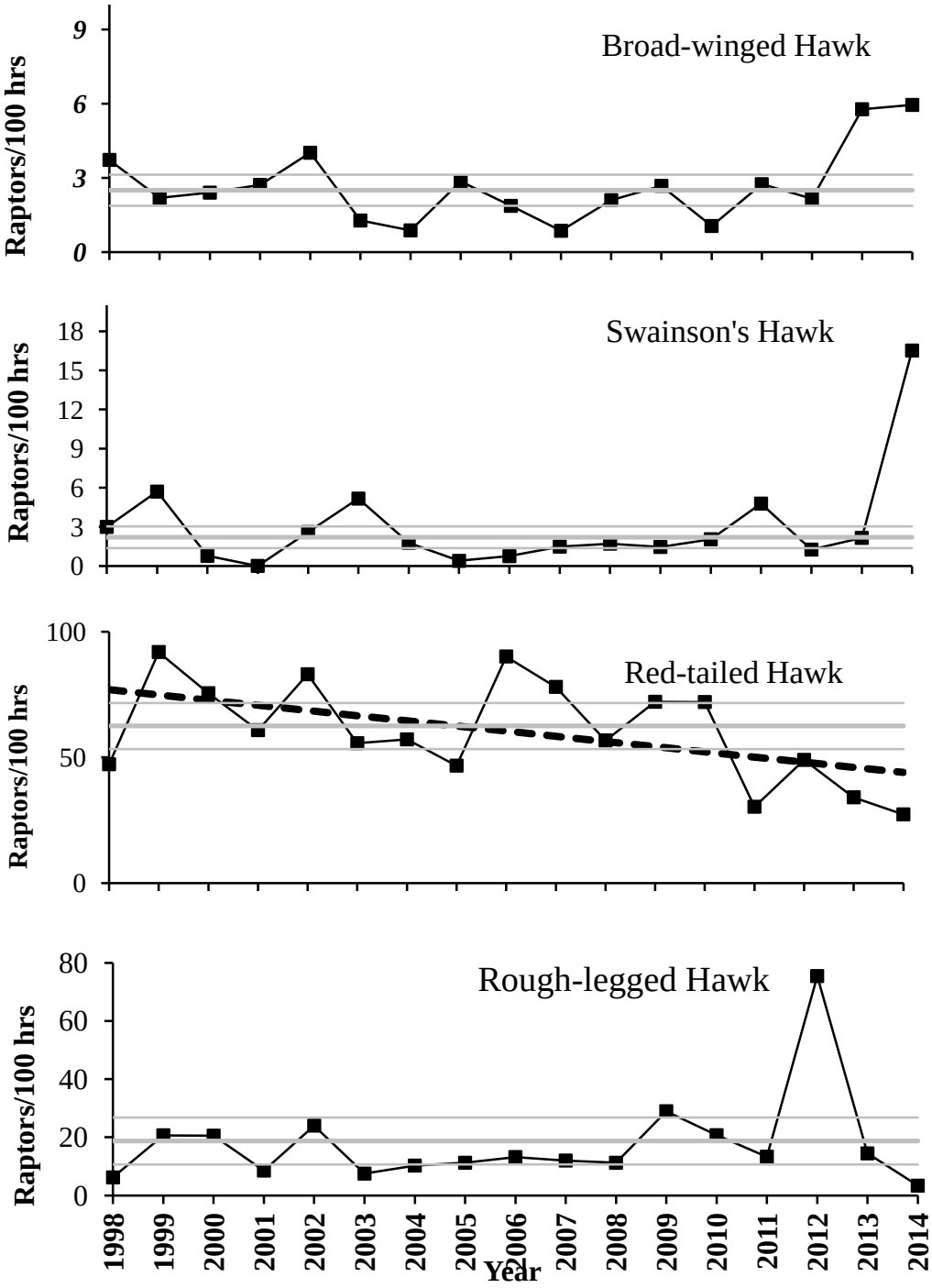


Figure 5c. Fall-migration buteo passage rates at Chelan Ridge, WA: 1998–2014. Dashed lines indicate significant($p < 0.05$) population trends based on linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2013).

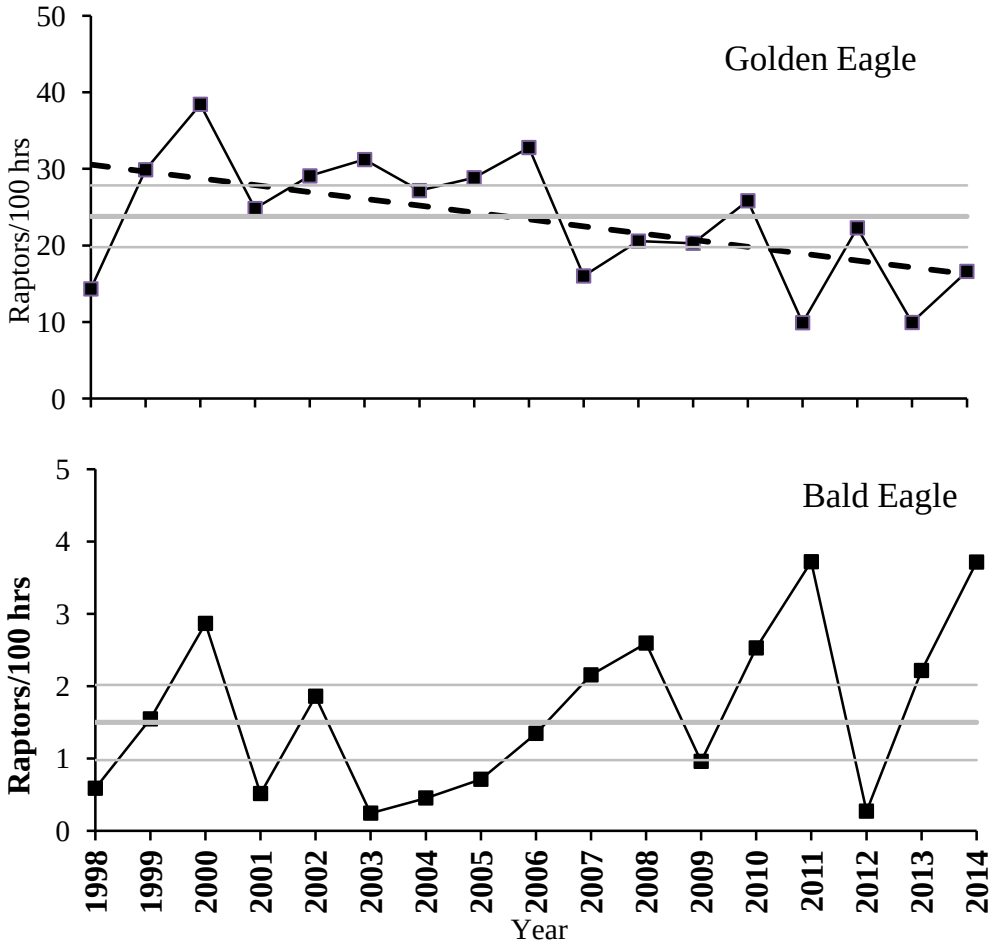


Figure 5d. Eagle passage rates for the fall migration at Chelan Ridge, WA.: 1998–2014. Dashed lines indicate significant (p< 0.05) population trends based on linear regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2013).

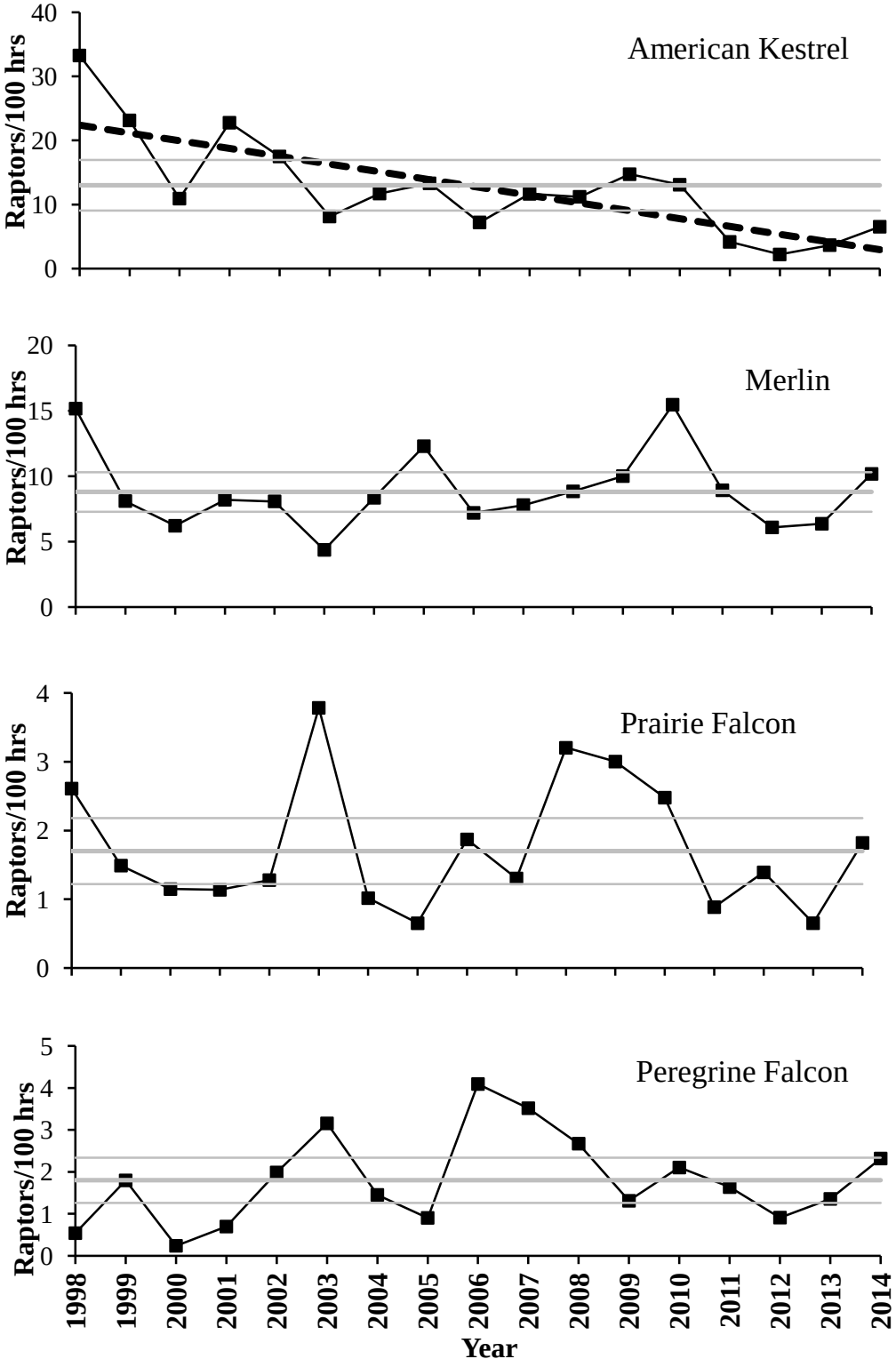


Figure 5e. Fall-migration falcon passage rates at Chelan Ridge, WA: 1998–2014. Dashed lines indicate significant ($p < 0.05$) population trends based on linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2013).

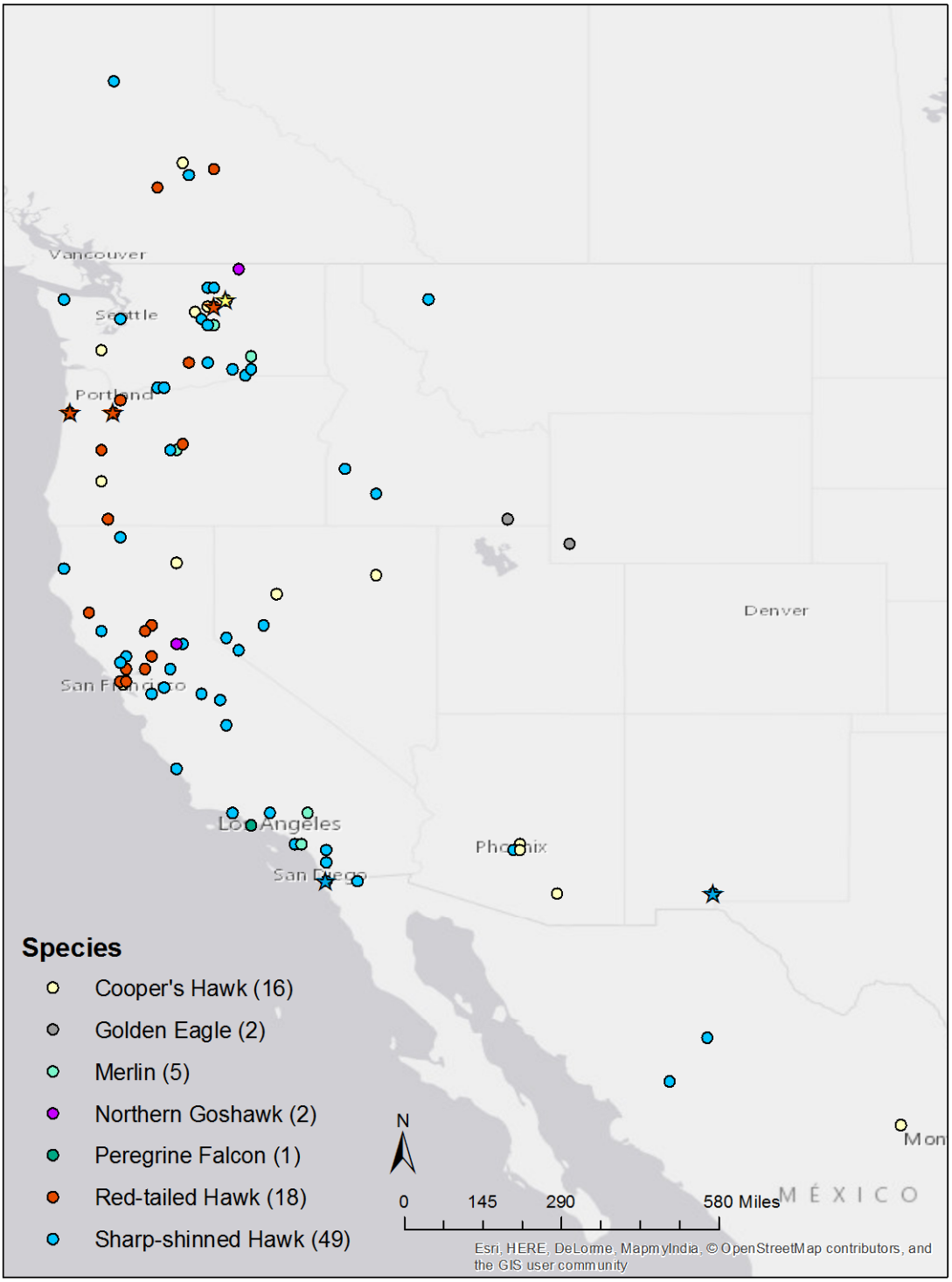


Figure 6. Recovery locations of raptors banded at Chelan Ridge. Circles indicate recoveries from 2001-2013, stars indicate 2014 recoveries.

Appendix A. History of official observer participation at the Chelan Ridge HawkWatch.

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).

2014: Two observers throughout: Angela Woodside (+), Monika Lapinski (0), and Leah Rensel (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	2014	MEAN
Start Date	24-Aug	24-Aug	24-Aug	23-Aug	23-Aug	23-Aug	23-Aug	23-Aug	24-Aug	23-Aug
End Date	26-Oct	27-Oct	27-Oct	25-Oct	23-Oct	25-Oct	18-Oct	24-Oct	21-Oct	24-Oct
Observation days	64	62	64	60	58	58	52	58	54	59
Observation hours	512.00	520.00	557.85	507.74	477.17	484.92	446.22	493.40	448.25	490.47
Raptors / 100 hours	458.8	413.3	365.2	457.9	446.8	261.9	350.7	219.1	308.8	411.3
SPECIES										
Turkey Vulture	50	42	48	70	44	31	51	28	55	38
Osprey	50	31	37	36	36	33	27	20	41	38
Northern Harrier	127	60	82	127	114	56	68	33	75	98
White-tailed Kite	0	0	0	0	0	0	0	0	0	0
Sharp-shinned Hawk	854	880	875	852	841	587	531	350	520	758
Cooper's Hawk	270	363	269	332	249	130	133	169	190	226
Northern Goshawk	31	49	48	27	30	25	22	12	21	29
Unknown small accipiter[1]	97	45	33	87	59	16	88	14	15	47
Unknown large accipiter[1]	11	3	19	12	7	5	11	7	3	9
Unknown accipiter	12	8	8	38	26	22	20	20	46	58
TOTAL ACCIPITERS	1,275	1,348	1,252	1,348	1,212	785	805	572	795	1,192
Red-shouldered Hawk	0	0	0	0	0	1	0	0	0	0
Broad-winged Hawk	4	2	5	6	4	6	4	11	12	5
Swainson's Hawk	2	4	5	5	5	13	4	5	43	6
Red-tailed Hawk	441	378	304	341	315	135	204	161	119	294
Ferruginous Hawk	0	0	0	0	0	0	0	0	0	0
Rough-legged Hawk	28	22	25	48	37	22	117	28	5	34
Unidentified buteo	57	29	10	20	14	40	71	57	22	53
TOTAL BUTEOS	532	435	349	420	375	216	400	262	201	416
Golden Eagle	157	82	111	93	109	45	90	45	67	109
Bald Eagle	8	10	12	4	10	15	1	11	14	7
Unidentified eagle	0	0	0	1	0	3	0	0	0	2
TOTAL EAGLES	165	92	123	98	119	63	91	56	81	125
American Kestrel	29	47	47	59	47	15	8	17	24	50
Merlin	34	40	44	45	63	37	24	28	42	39
Prairie Falcon	9	6	17	14	11	4	6	5	8	8
Peregrine Falcon	20	16	13	7	10	8	4	6	10	8
Unknown small falcon[1]	3	0	2	9	4	0	2	2	3	3
Unknown large falcon[1]	3	1	1	5	0	0	2	0	3	2
Unknown falcon	0	1	0	2	1	1	1	1	1	2
TOTAL FALCONS	98	111	124	141	136	65	47	59	91	119
Unidentified Raptor	52	30	22	85	96	20	76	51	45	89
GRAND TOTAL	2,349	2,149	2,037	2,325	2,132	1,270	1,565	1,081	1,384	2,001

[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: 1999–2014.

	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	2014	MEAN	TOTAL
First trapping day	25-Aug	24-Aug	24-Aug	25-Aug	22-Aug	25-Aug	24-Aug	24-Aug	24-Aug	
Last trapping day	16-Oct	23-Oct	24-Oct	22-Oct	20-Oct	17-Oct	22-Oct	19-Oct	19-Oct	
Number of stations	2	2	2	2	2	2	2	2	2	
Trapping days	51	60	58	54	52	48	56	56	53.8	
Station hours	716.12	836.48	632.76	520.66	496.08	468.55	660.69	502.38	687.54	
Captures / stn. hour	9.4	9.1	10.5	12.1	11.1	11.1	6.8	10.5	9.0	
SPECIES	RAPTOR CAPTURES									
Northern Harrier	12	18	24	29	8	8	8	9	14.4	203
Sharp-shinned Hawk	450	503	419	396	373	350	287	386	396.9	5810
Cooper's Hawk	138	140	128	113	96	101	81	70	109.7	1584
Northern Goshawk	16	29	10	15	15	6	11	4	14.4	215
Broad-winged Hawk	0	0	1	0	0	0	0	0	0.1	1
Red-tailed Hawk	33	22	34	27	26	25	33	29	27.4	404
Rough-legged Hawk	1	2	9	1	1	3	2	1	2.6	36
Golden Eagle	2	5	5	3	5	4	0	2	3.2	45
American Kestrel	3	13	9	8	4	2	7	3	7.3	101
Merlin	15	25	21	30	19	20	16	25	23.0	334
Prairie Falcon	4	5	3	1	0	2	2	1	2.5	35
Peregrine Falcon	1	2	2	3	3	1	3	0	1.9	25
All species	675	764	665	631	550	522	450	530	603.4	8793
Recaptures[2]	1	0	0	7	3	0	0	2	0.8	11
Foreign Recaptures[3]	2	0	1	1	0	0	0	0	0.6	8
Foreign Encounters[4]	12	7	9	9	9	5	5	6	6.6	100

[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.