FALL 2016 RAPTOR MIGRATION ANNUAL REPORT:

CHELAN RIDGE HAWKWATCH, WASHINGTON

A Partnership Between

HawkWatch International

Okanogan-Wenatchee National Forest

SUMMARY OF 2016 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 annually 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 2016 season marked the 19th consecutive, full-season count and the 18th straight season of banding at the site. This report summarizes the 2016 fall raptor migration at Chelan Ridge.

The Chelan Ridge station was 1 of 8 long-term, annual fall migration counts and 1 of 4 migration banding studies operated or co-sponsored by HWI in North America during 2015 (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).

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-degree 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 migrating raptors can be missed, or even 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.

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 recorded on the hour for the preceding hour's count.
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 2016 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. We use linear and quadratic regression on effort-adjusted annual passage rates (raptors/100hrs) to identify long-term trends in migrating raptors.

TRAPPING AND BANDING

Crewmembers 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, we fit all captured birds 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). We released all birds within 45 minutes of capture.

2016 RESULTS AND DISCUSSION

OBSERVATION EFFORT AND WEATHER SUMMARY

Observers counted on 51 of 57 possible days between 24 August and 19 October during the 2016 season, which was 7 days below the 1998-2015 long-term average of 58 days, and spent a total of 418 hours counting, in line with the long-term site average of 479 hrs (Appendix C). Based on hourly recording of conditions throughout the season, it was clear 15% of the time (far below the site average of 42% of the time being clear); partly cloudy 38% of the time; mostly cloudy 21% of the time; and overcast 26% of the time. Observers experienced foggy conditions 6% of the time and rain or snow 5% of the time.

2016 FLIGHT SUMMARY

Overall Flight:

We counted 1,374 migrating raptors of 16 species, a statistically significant ($p < 0.05$) 29% below the long-term site average (Table 1), and the fourth lowest total on record over the life of the count (Appendix C). Notables for the 2016 season included record high seasonal counts for Bald Eagles (18), and an all-time low count for Osprey.

The composition of the overall flight broke down as follows: 56% accipiters, 17% buteos, 6% falcons, 8% eagles, 6% harriers, 4% vultures, 1% Ospreys, and 2% unknown raptors. The proportions of eagles, vultures, and harriers were above historic averages; while the proportion of buteos and Osprey were below historic averages (Fig. 3). Sharp-shinned Hawks were the most commonly observed species (36% of the total), followed by Cooper's Hawks (14%), Red-tailed Hawks (11%), Turkey Vultures (4%), Northern Harriers (6%), Golden Eagles (6%), Merlins (3%), and the remaining species each accounted for 2% or less of the total count.

The following sections summarize the 2016 count relative to historic means at the site, and any statistically significant ($\alpha = 0.05$) population trends based on first and second order regression analysis of effort adjusted passage rates. HWI only reports 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 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 since the early years of the count, but seems to have stabilized in recent years (2011 on) at a new and comparably low level ($F = 9.4$, $r^2 = 0.54$, $p = 0.007$).

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

We counted above average Turkey Vultures, below average Ospreys, and average numbers of Northern Harriers in 2016 compared to past seasons. Regression results indicate that regional populations of Northern Harriers declined between 1998 and 2009, but have stabilized since 2010 ($F = 6.5$, $r^2 = 0.45$, $p = 0.02$). Turkey Vulture passage rate was above average and populations are increasing based on fall migration counts (slope = 0.56, $r^2 = 0.42$, p-value = 0.003). Both the Osprey total count and passage rate in 2016 were the lowest ever documented at Chelan Ridge.

Accipiters (Fig. 5b):

The total Accipiter count was below historic average in 2016 (Table 1). We documented below average passage rates for Sharp-shinned Hawk for the sixth straight fall and regression analysis indicates significant declines (slope= -5.5, $r^2 = 0.43$, $p=0.002$). Passage rates for Goshawks were lower than historic averages for the fourth consecutive season while Cooper's Hawks rates were average. Cooper's hawk passage rates remain stable across the years (no significant trend over time). Northern Goshawks passage rates do not meet the 10 birds/100 hour average threshold for trend analysis.

Buteoine Hawks (Fig. 5c):

We counted the third lowest total number of Buteos in the history of the Chelan Ridge count this year (Table 1). We documented average numbers and passage rates of Rough-legged Hawks and Swainson's Hawks; and above average Broad-winged Hawks in 2016 compared to historical values (Table 1). Both the count and passage rate for Red-tailed Hawks were significantly below average for the sixth consecutive season (Table 1, Fig 5c), and regional populations either continue to decline (slope = -2.07, $r^2 = 0.39$, $p = 0.004$), or are shifting migratory behavior (Paprocki et al 2017), based on fall migration counts.

Eagles (Fig.5d):

For the first time since 2012 we recorded Golden Eagle count and passage rates that didn't differ from historical averages at Chelan Ridge (Table 1);despite this relatively 'good' year, regression analysis of migration counts suggests a continued decline in regional Golden Eagle populations (slope = -0.69, $r^2 = 0.32$, $p = 0.012$). The 18 Bald Eagles counted in 2016 was an all-time season high for Chelan Ridge and passage rates were also above average for the third straight year (Table 1).

Falcons (Fig. 5e):

American Kestrel counts and passage rates in 2016 were low compared to site average for the sixth consecutive season and regional Kestrel populations continue to decline based on fall migration rates (slope = -0.84, $r^2 = 0.54$, $p < 0.001$). Based on findings from Chelan Ridge and other migration monitoring sites across North America, HWI scientists along with many other North American researchers and Citizen

Scientists are collaborating to understand these declines both locally (www.hawkwatch.org/kestrels) and at the continental scale under the umbrella of the American Kestrel Partnership (http://kestrel.peregrinefund.org/). The crew counted Merlins and Peregrine Falcons in average numbers in 2016. The Prairie Falcon count was below average and the passage rate was in line with site historic averages.

TRAPPING EFFORT

Trapping occurred on 40 of 47 days between 27 August and 12 October, with efforts totaling 366 hours split between two stations (Appendix D). We normally try to end the season on 26 October but an approaching winter storm led to a shut down on 12 October. Due to an early finish, the number of trapping days was below average and total station hours were over 250 hours below site average (Appendix D).

A total of 339 raptors of nine species were captured and banded in 2016, significantly below the site average of 527 birds (Table 2). The 2016 overall capture rate was lower than 2015 but still above the historic site average, suggesting that the relative efficiency of trapping is being maintained (Table 2). Total captures were low for all species, likely due to the short season. Captures of one Rough-legged Hawk and two Golden Eagles were highlights in 2016. We captured most species below rates consistent with historical site averages. No capture rates exceeded historical averages in 2016.

RECAPTURES

For the first time in 6 years, we had a foreign recapture (recapture of a bird originally banded elsewhere). The bird was a second-year Red-tailed Hawk, originally banded as a hatch-year bird in Portland, Oregon on 15 September, 2015. There were no other recaptures (recapture of a bird originally banded at Chelan ridge) (Appendix D).

FOREIGN ENCOUNTERS WITH PREVIOUSLY BANDED BIRDS FROM CHELAN RIDGE

To date, 123 birds banded at Chelan Ridge have been encountered (recaptured/recovered) and reported to the USGS Bird Banding Laboratory (Fig. 6). In 2016, 8 birds originally banded at Chelan Ridge from 2009-2016 were reported to the BBL, which then passed the information to HWI (Table 3). Three reports were recoveries of Red-tailed Hawks (2 dead and 1 in unknown condition). Two individuals were banded as hatch-year birds while the other was an after second-year bird. Two encounters occurred in Oregon, and 1 in Washington. There were also 5 encounters with Sharp-shinned Hawks, 4 banded as hatch-year birds and one as an after-second-year bird, from 2014-2016. Of the hatch-year birds, 2 were recovered in California, 1 in British Columbia, Canada, and one had no information provided. The after-second-year bird was recaptured at our Bonney Butte migration site. The causes of the other three Sharp-shinned encounters included: a mortality along a highway; a capture by-hand; 1 recovery along a highway, and a window collision (the bird was taken to a wildlife rehabilitation center).

VISITOR PARTICIPATION AND PUBLIC OUTREACH

The North Cascades Institute brought two groups to Chelan Ridge, and a wildlife class from Washington State University visited to learn about field techniques and more. There was no Chelan Ridge Migration Festival in 2016, but it will return in 2017. Visitors from various Audubon Chapters from around

Washington visited the site to watch hawks and learn about one of the premier raptor migration study sites in the northwest.

2016 Fall Migration Across HWI's Network

HawkWatch International and partners operated 8 fall count sites in 2016 (Fig. 1). During the 4,451 hours of standardized observation, we counted 713,979 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 2016 included (Table 4):

- Below average Kestrel numbers at 5 of 8 sites (no sites w/ above average counts).
- Below average counts for Prairie Falcons and Osprey at 5 of 8 sites.
- Above average Merlin counts at 5 of 8 sites, only exception was Manzanos with a count below average (this site had second lowest overall (all raptors) count in 32-yr history)
- Above average counts at Bridger, Commissary, and Grand Canyon for second year in a row overall and for most species.
- Below average counts for Red-tailed Hawks at 4 of 8 sites, including a record low at Corpus Christi; above average counts at 3 sites.
- Record highs for:
    - Golden Eagles at Commissary (only network site w above average Golden Eagle count)
    - All falcons except Kestrels and Northern Harriers at the Grand Canyon
    - Bald Eagles at Chelan Ridge
    - Mississippi Kites at Corpus Christi (shattered previous record of 27,285)

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Hendrick, who has helped from the start; and long-time Chelan Ridge partner and friend, Jim Watson of WDFW who has provided encouragement and help over the many years of these efforts.

We especially want to thank our 2016 field crew: Jessica Taylor, Tucker Davidson, TC Walker, Jessica Buskirk, and Dwight Jones; plus new and veteran volunteers who made their first trip or returned to visit and help with this year's efforts. Without your pioneering spirits, 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 2016, and site records at Chelan Ridge, WA.

		1998-2015				All-time Historic Records	
	Species	**Mean Count ± 95 % CI**		**2016**	**% Change**	**Season**	**Daily**
	Turkey Vulture	41.6 ± 8.2		62	49.0	81 (2015)	25 (2014)
	Osprey	37.6 ± 6.0		16	-57.5	71 (2000)	10 (2x)
	Northern Harrier	95.3 ± 17.6		82	-14.0	167 (1999)	21 (1998)
Accipiters							
	Sharp-shinned Hawk	723.5 ± 105.4		490	-32.3	1050 (2000)	84 (2000)
	Cooper's Hawk	220.9 ± 29.4		196	-11.3	363 (2007)	32 (2009)
	Northern Goshawk	28.1 ± 5.7		13	-53.8	50 (1999)	7 (2x)
	Unidentified accipiter	97.5 ± 28.3		74	-24.1	248 (1999)	
	TOTAL ACCIPITERS	1070.1 ± 145.7		773	-27.8	1462 (1999)	
Buteos							
	Red-shouldered Hawk	0.1 ± 0.1		0	-100.0	1 (2011)	1 (2011)
	Broad-winged Hawk	6.3 ± 1.7		8	27.4	16 (2015)	10 (2015)
	Swainson's Hawk	8.7 ± 14.0		6	-30.8	43 (2014)	13 (2003)
	Red-tailed Hawk	275.3 ± 48.5		151	-45.1	450 (1999)	33 (2006)
	Ferruginous Hawk	0.1 ± 0.1		0	-100.0	1 (2000)	1(2000)
	Rough-legged Hawk	32.8 ± 11.5		28	-14.7	117 (2012)	39 (2012)
	Unidentified buteo	50.1 ± 16.6		35	-30.1	148 (1999)	
	TOTAL BUTEOS	373.2 ± 58.4		228	-38.9	664 (1999)	
Eagles							
	Golden Eagle	103.9 ± 18.2		87	-16.3	174 (2000)	18 (2000)
	Bald Eagle	7.9 ± 2.4		18	128.2	18 (2016)	5(2016)
	Unknown eagles	1.8 ± 1.5		0	-100.0	12 (2003)	
	TOTAL EAGLES	113.6 ± 18.4		105	-7.6	194 (2000)	
Falcons							
	American Kestrel	46.3 ± 12.7		26	-43.8	107 (1998)	13 (1998)
	Merlin	38.6 ± 5.0		34	-11.9	63 (2010)	9 (1998)
	Prairie Falcon	8.2 ± 2.0		6	-27.0	19 (2003)	3 (2x)
	Peregrine Falcon	8.3 ± 2.3		9	8.0	20 (2006)	3 (3x)
	Unidentified falcon	5.7 ± 1.7		2	-64.7	16 (2009)	
	TOTAL FALCONS	107.1 ± 16.5		77	-28.1	180 (1998)	
	Unidentified Raptor	83.5 ± 29.7		30	-64.1	218 (1999)	
	GRAND TOTAL	1922.111 ± 244.3		1374	-28.5	2881 (1999)	187 (2009)

Table 2. Capture totals and rates for fall migrating raptors at Chelan Ridge, WA: 2001-2015 versus 2016.

	Capture Totals			Capture Rate[1]		
	2001-2015[2]	2016	Seasonal Record	2001-2015[2]	2016	Seasonal Record
Northern Harrier	14.2 ± 3.8	9	29	2.3 ± 0.7	2.5	5.6
Sharp-shinned Hawk	384.3 ± 45.5	238	556	60.4 ± 6.6	65.1	76.8
Cooper's Hawk	103.2 ± 14.3	57	140	16.1 ± 2.0	15.6	21.6
Northern Goshawk	13.3 ± 3.3	3	29	2.0 ± 0.4	0.8	3.5
Broad-winged Hawk	0.1 ± 0.1	0	1	0.0 ± 0.0	0.0	0.2
Red-tailed Hawk	26.8 ± 4.9	13	50	4.3 ± 0.8	3.6	6.7
Rough-legged Hawk	3.1 ± 1.4	1	9	0.5 ± 0.3	0.3	2.2
Golden Eagle	3.0 ± 1.0	2	6	0.5 ± 0.2	0.5	1.0
American Kestrel	6.7 ± 2.2	0	17	1.0 ± 0.2	0.0	2.1
Merlin	23.2 ± 4.6	15	49	3.7 ± 0.8	4.1	6.5
Prairie Falcon	2.3 ± 0.8	0	5	0.4 ± 0.1	0.0	0.6
Peregrine Falcon	1.7 ± 0.6	1	4	0.3 ± 0.1	0.3	0.6
All Species	581.7 ± 66.9	339	814	91.5 ± 9.7	92.7	120.8

[1] Captures / 100 station hours.

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

Table 3. Foreign encounters with raptors originally banded at the Chelan Ridge HawkWatch in Washington: 2016.

Band #	Species[1]	Sex	Banding Date	Banding Age[2]	Encounter Location	Encounter Date	Distance (KM)[3]	Status
1687-27288	RTHA	U	17-Oct-09	HY	Moses Lake, Washington	20-Jul-16	128.6	Unknown
1687-24357	RTHA	U	1-Sep-13	HY	Ashland, Oregon	24-Jan-16	645.7	Found dead - Unknown cause
1687-27005	RTHA	U	4-Oct-13	ASY	Medford, Oregon	28-Apr-16	629.2	Found dead - Unknown cause
1783-91270	SSHA	F	15-Sep-14	HY	UNK	21-Dec-16	UNK	Hit Window - Taken to Rehab
1352-58598	SSHA	M	13-Oct-15	ASY	Bonney Butte, Oregon	23-Oct-16	309.4	Recaptured - Released
1783-90681	SSHA	F	15-Oct-15	HY	Osoyoos, British Columbia	17-Apr-16	115.8	Found dead - Unknown cause
1613-04975	SSHA	F	9-Sep-16	HY	Paso Robles, California	24-Oct-16	1296.4	Alive - Caught by hand
1833-41906	SSHA	F	10-Sep-16	HY	Calipatria, California	29-Sep-16	1592.1	Found dead on higway

[1] SSHA = Sharp-shinned Hawk; RTHA = Red-tailed Hawk.

[2] HY = hatch year; ASY = after second year.

[3] Straight-line distance from banding location.

Table 4. Summary of the 2016 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. Asterisks denote a record high or low count. *In 2016 HWI monitored fall migration for 4,451.7 hrs and counted 713,979 birds.*

	Bonney Butte, OR	Chelan Ridge, WA	Bridger Mtn, MT	Commissary Ridge, WY	Goshute Mts, NV	Yaki Pt, AZ	Manzano Mts, NM	Corpus Christi, TX
	Hours Counted in 2016							
Species	**366**	**421**	**381.8**	***573.8***	**698.5**	**600.8**	**553.5**	**856.3**
Black Vulture								140
Turkey Vulture	596	63	14	59	370		214	45293
Osprey	66	*16*	13	22	54	70	22	187
Northern Harrier	12	82	44	52	211	*68*	30	158
Crested Caracara								5
Common Black Hawk								0
Harris' Hawk								5
Accipiters								
Sharp-shinned Hawk	1146	490	616	1487	3204	1667	892	2159
Cooper's Hawk	362	196	198	536	1960	1255	466	824
Northern Goshawk	24	13	62	45	27	10	9	0
Unidentified accipiter	43	74	60	66	656	377	94	64
TOTAL ACCIPITERS	1575	773	936	2134	5847	3309	1461	3047
Buteos								
Red-shouldered Hawk	0	0		0	*3*	0	0	15
Broad-winged Hawk	4	8	31	25	91	37	8	594222
Short-tailed Hawk								0
Swainson's Hawk	0	6	4	96	180	59	149	2255
White-tailed Hawk								22
Zone-tailed Hawk							3	7
Red-tailed Hawk	344	151	212	1183	3128	1510	421	*44*
Ferruginous Hawk	0	0	3	8	9	10	5	2
Rough-legged Hawk	3	28	77	11	20	0	0	0
Unidentified buteo	25	35	16	37	102	60	22	24
TOTAL BUTEOS	376	228	343	1360	3533	1676	608	596591
Eagles								
Golden Eagle	66	87	1434	*476*	139	4	95	0
Bald Eagle	83	*18*	78	230	10	8	2	9
Unknown eagles	*11*	0	1	11	5	1	0	0
TOTAL EAGLES	160	105	1513	*717*	154	13	97	9
Falcons								
American Kestrel	9	26	88	167	893	496	237	810
Merlin	108	34	33	31	42	*22*	17	83
Prairie Falcon	2	6	14	5	11	*11*	13	7
Peregrine Falcon	17	9	30	13	26	*19*	35	224
Aplomado Falcon								0
Unidentified falcon	4	2	4	2	*43*	*33*	9	10
TOTAL FALCONS	140	77	169	218	1015	581	311	1134
Kites								
Hook-billed Kite								0
Swallow-tailed Kite								152
White-tailed Kite								13
Mississippi Kite								*35219*
Unidentified Kites								0
TOTAL KITES								*35384*
Unidentified Raptor	2	30	34	18	185	*71*	6	172
GRAND TOTAL	**2927**	**1374**	**3066**	**4580**	**11369**	**5788**	**2749**	**682126**

Figure 1. Locations of fall HawkWatch sites operated by HWI and partners (symbols with borders represent sites that conducted banding in 2016).

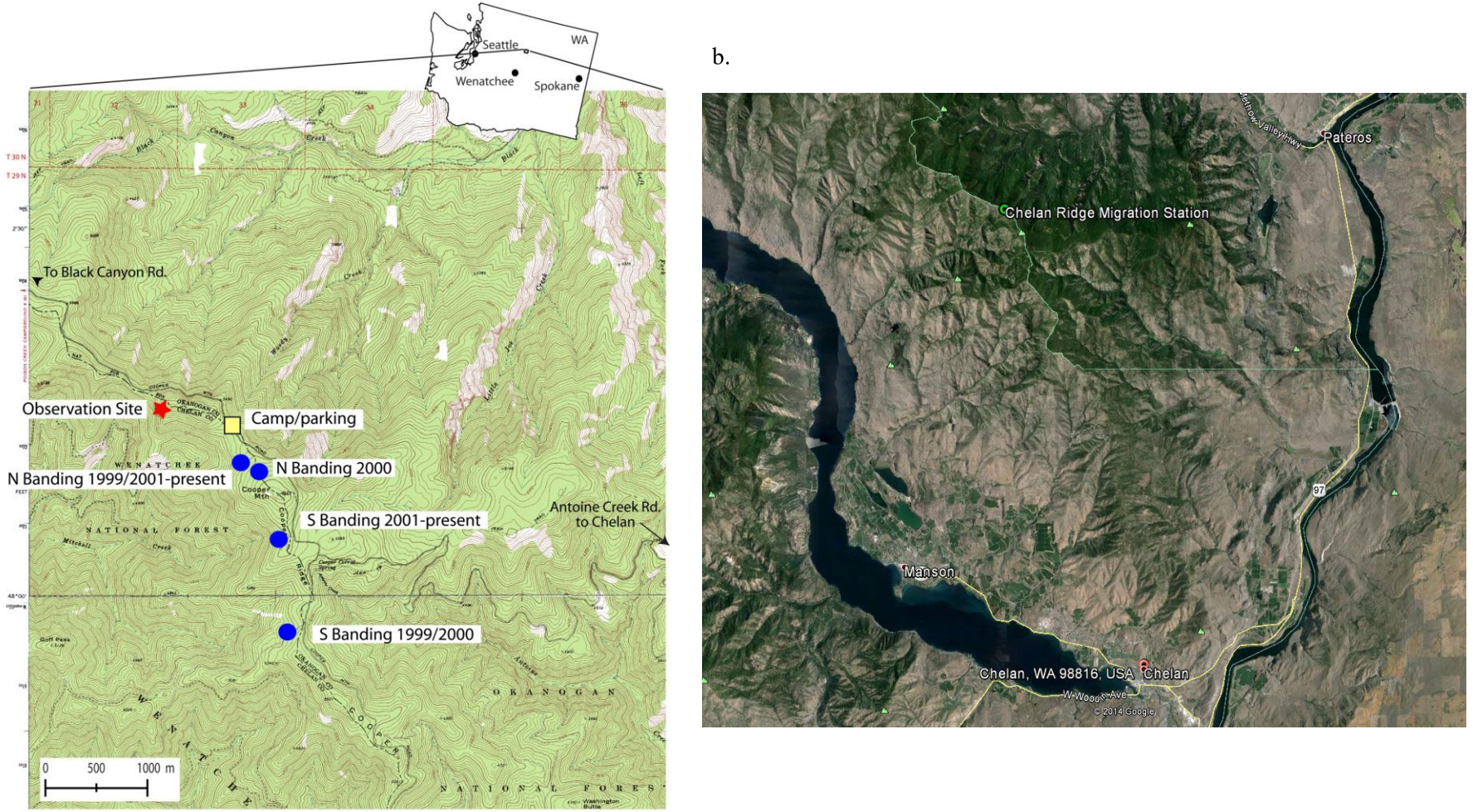

Figure 2. a. Location of the Chelan Ridge HawkWatch counting and banding sites in north-central Washington, USA. b. Location of Chelan Ridge HawkWatch relative to Chelan and Pateros, WA (GoogleEarth View).

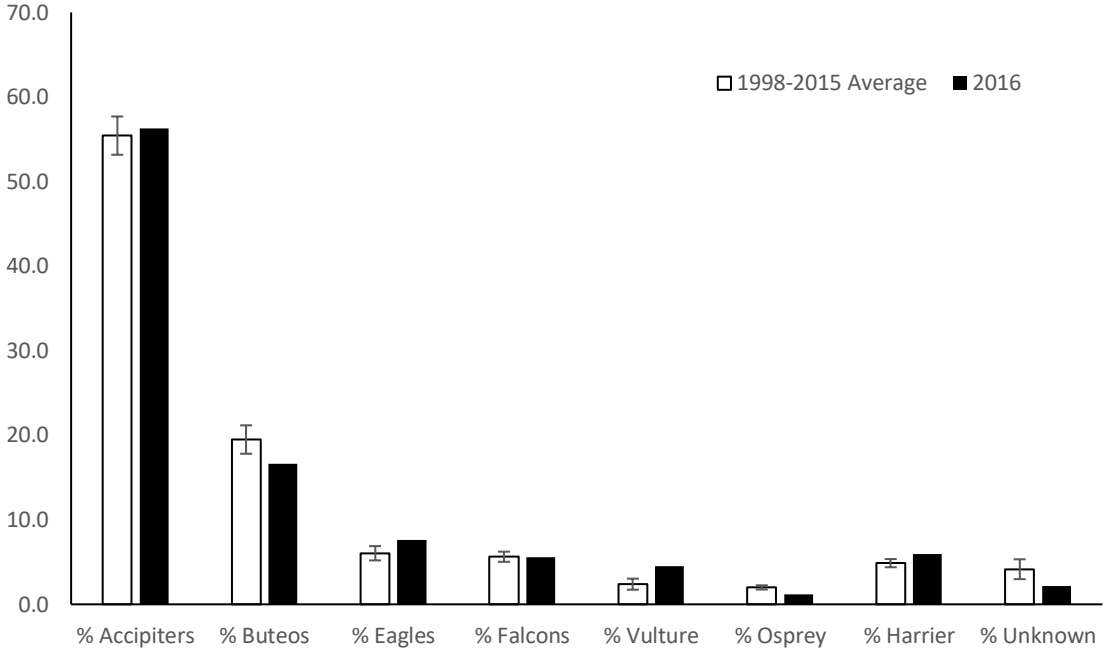

Figure 3. Fall raptor migration flight composition by major species groups at Chelan Ridge, WA: 1998–2015 versus 2016.

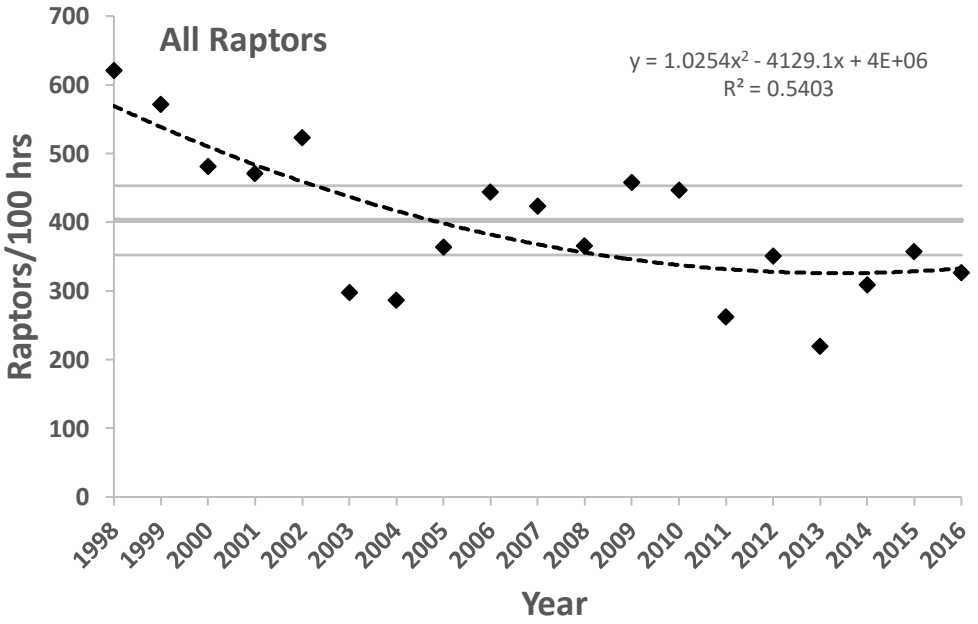

Figure 4. Fall migration passage rates at Chelan Ridge, WA for all migrating raptors: 1998-2016. Dashed line indicates trend for significant ($p < 0.05$) linear regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2015) at Chelan Ridge.

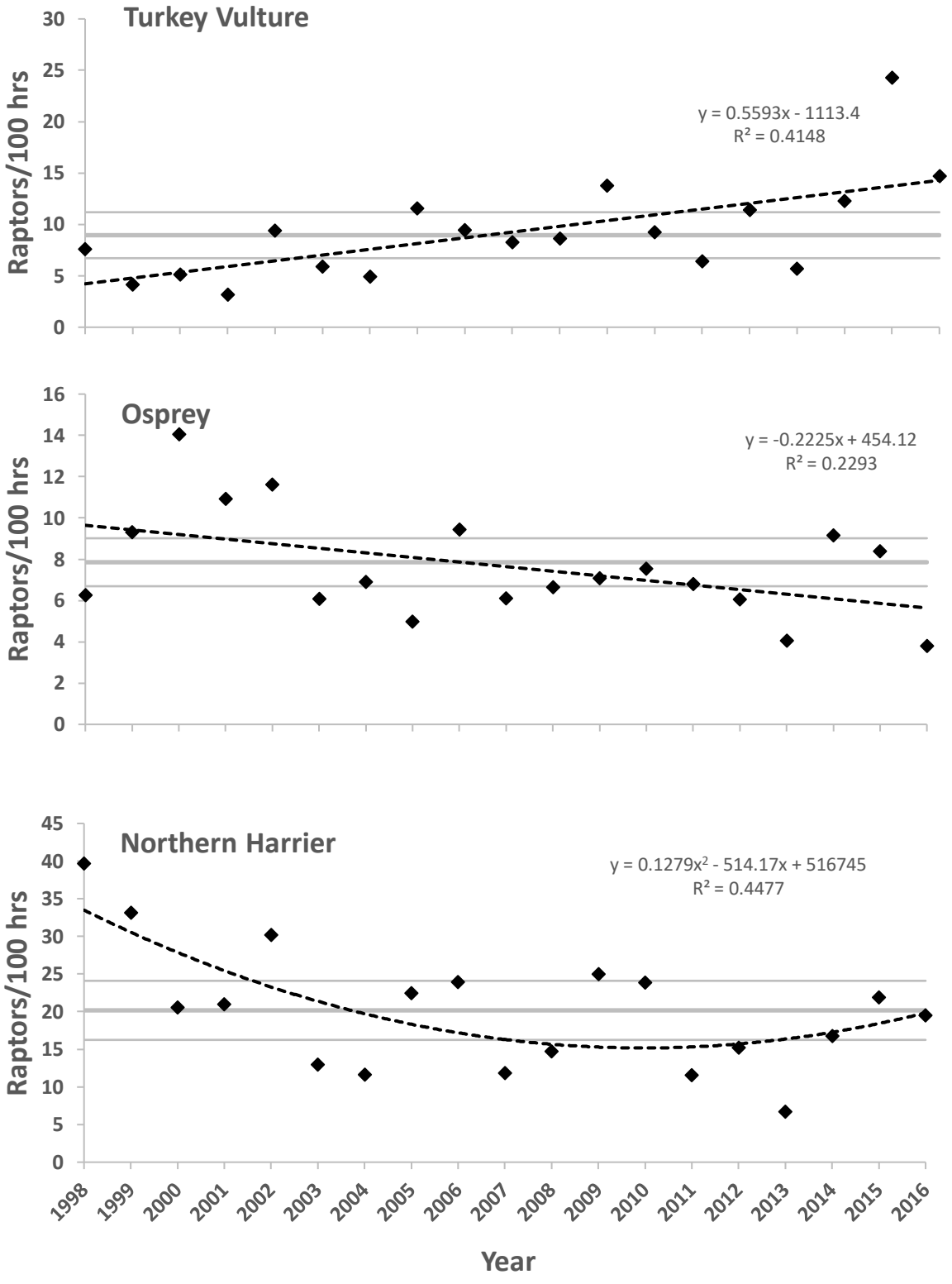

Figure 5a. Fall-migration passage rates at Chelan Ridge, WA for Turkey Vultures, Ospreys, and Northern Harriers: 1998–2016. Dashed lines indicate trends for significant ($p < 0.05$) linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2015) at Chelan Ridge.

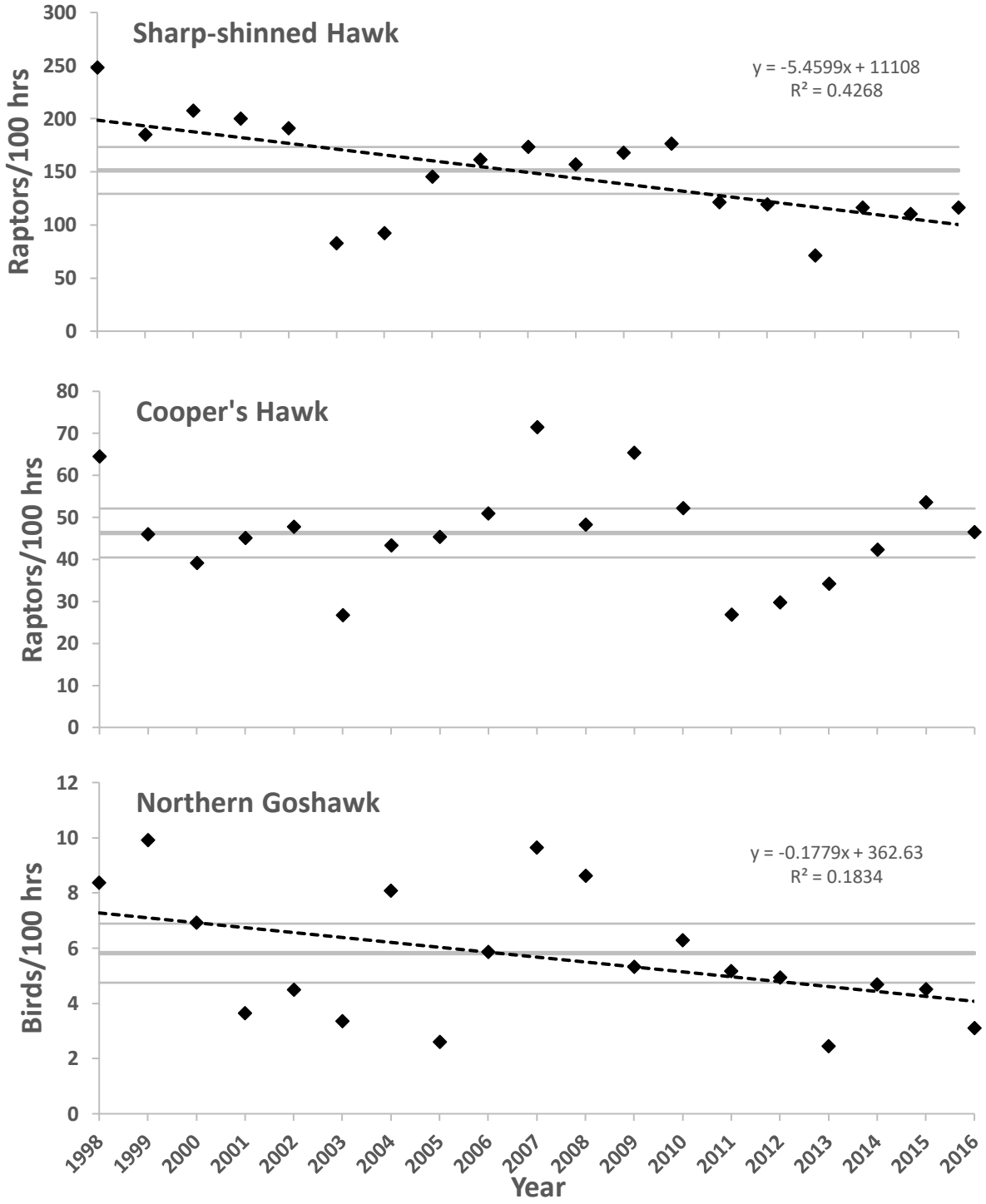

Figure 5b. Fall-migration passage rates at Chelan Ridge, WA for the three North American accipiter species: 1998–2016. Dashed lines indicate trends for significant ($p < 0.05$) linear regression. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2015).

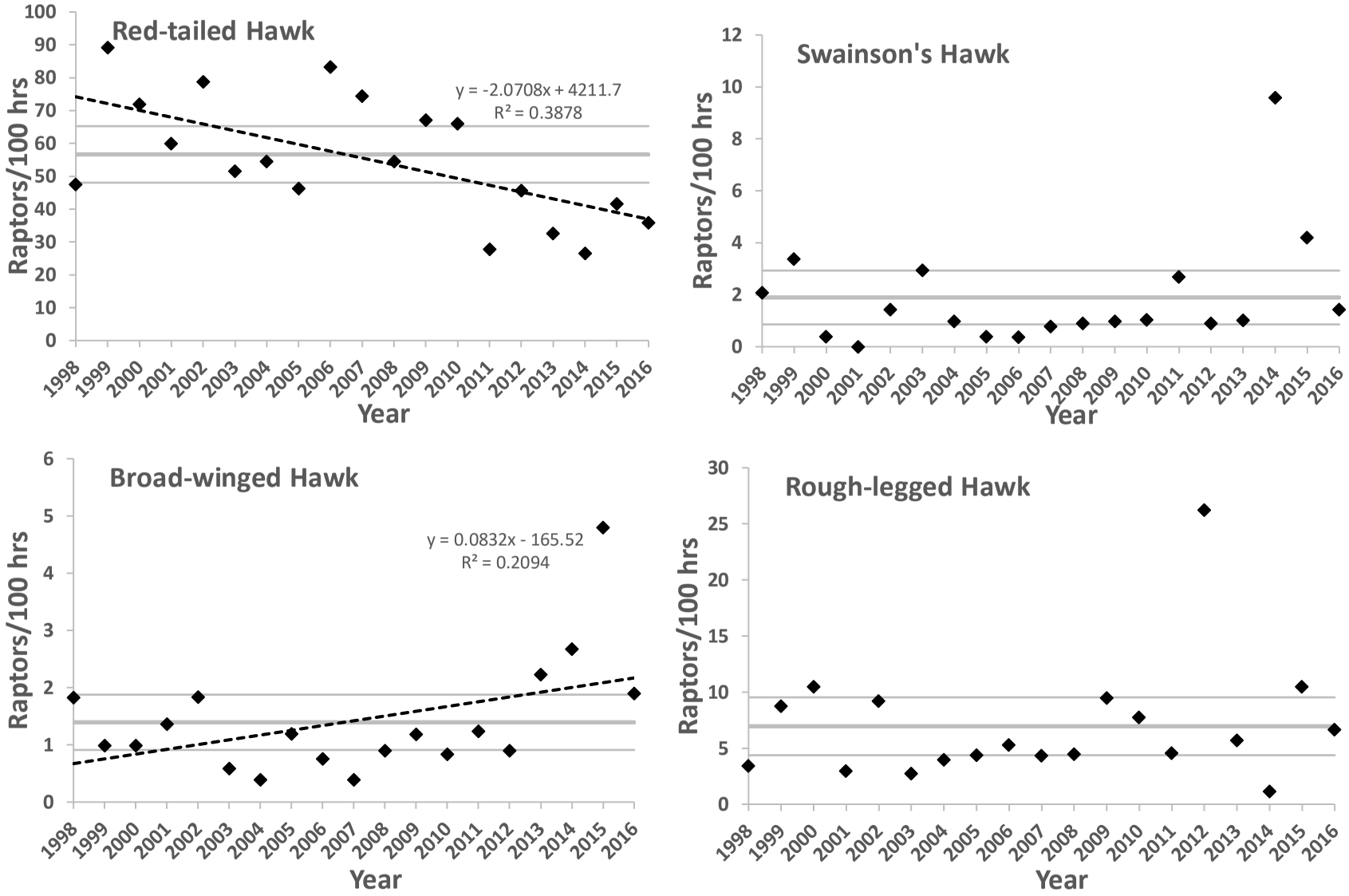

Figure 5c. Fall-migration buteo passage rates at Chelan Ridge, WA: 1998–2016. Dashed lines indicate significant ($p < 0.05$) population trends based on linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2015).

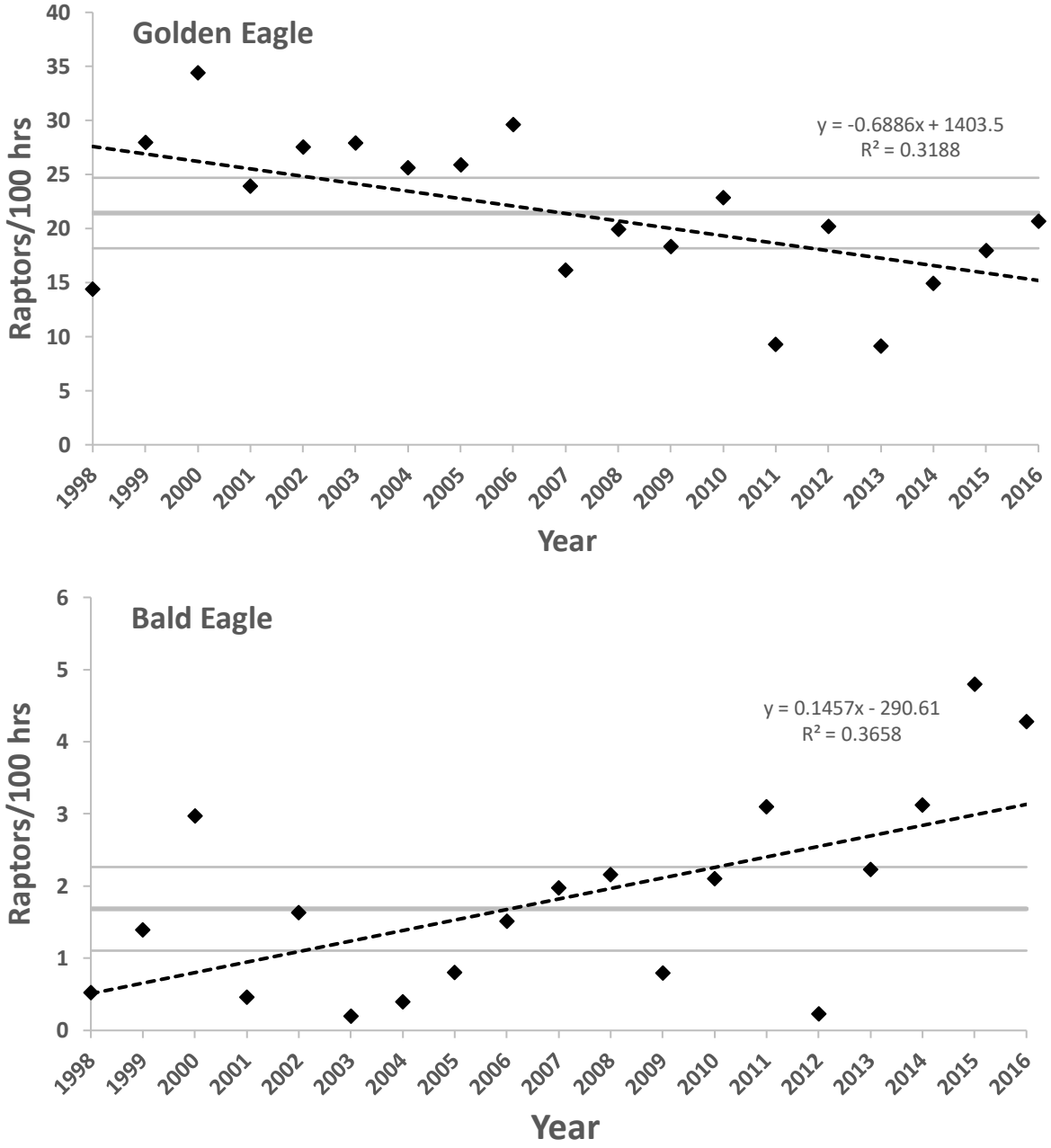

Figure 5d. Eagle passage rates for the fall migration at Chelan Ridge, WA.: 1998–2016. Dashed lines indicate significant ($p < 0.05$) population trends based on linear regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2015).

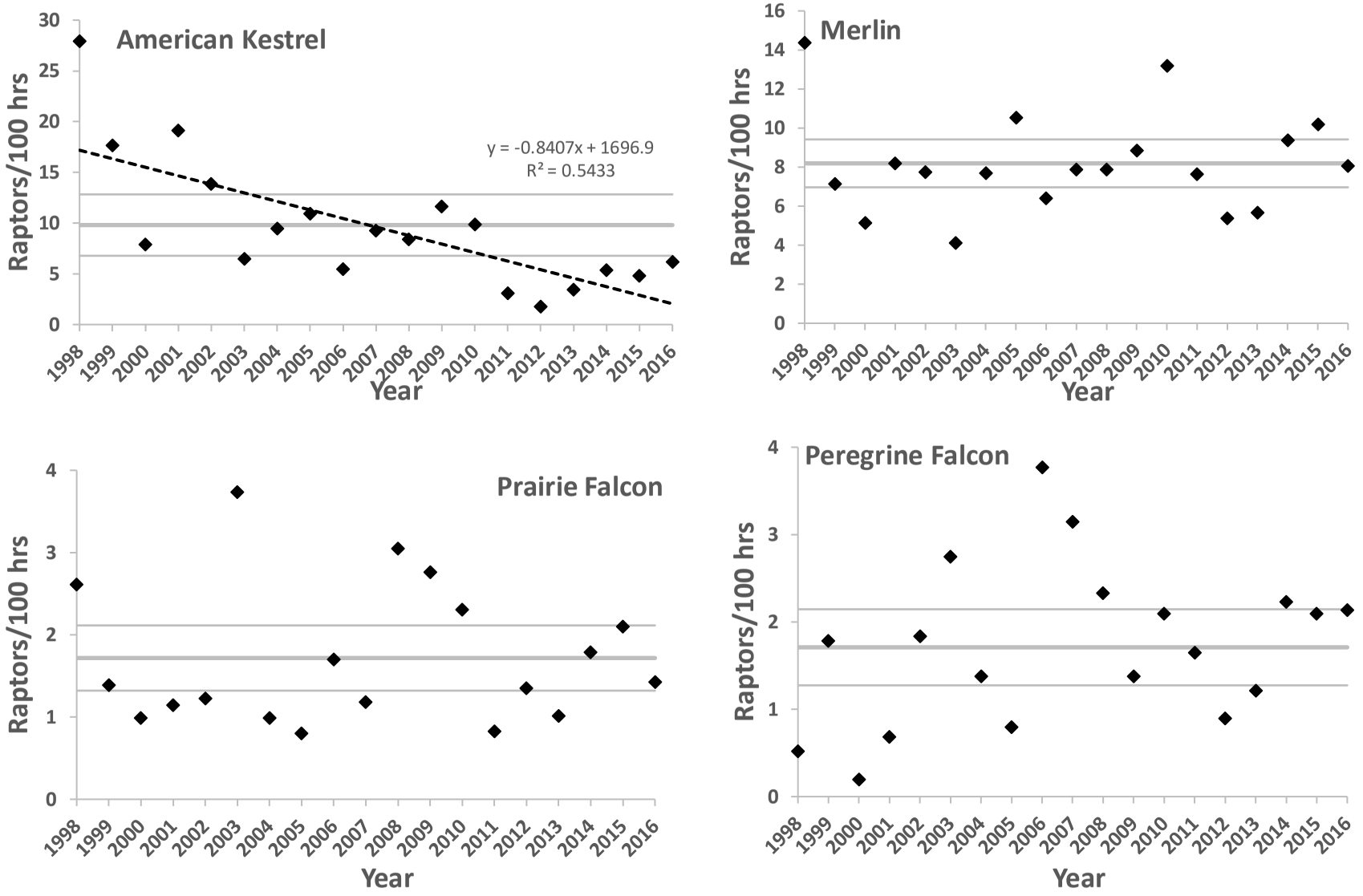

Figure 5e. Fall-migration falcon passage rates at Chelan Ridge, WA: 1998–2016. Dashed lines indicate significant ($p < 0.05$) population trends based on linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2015).

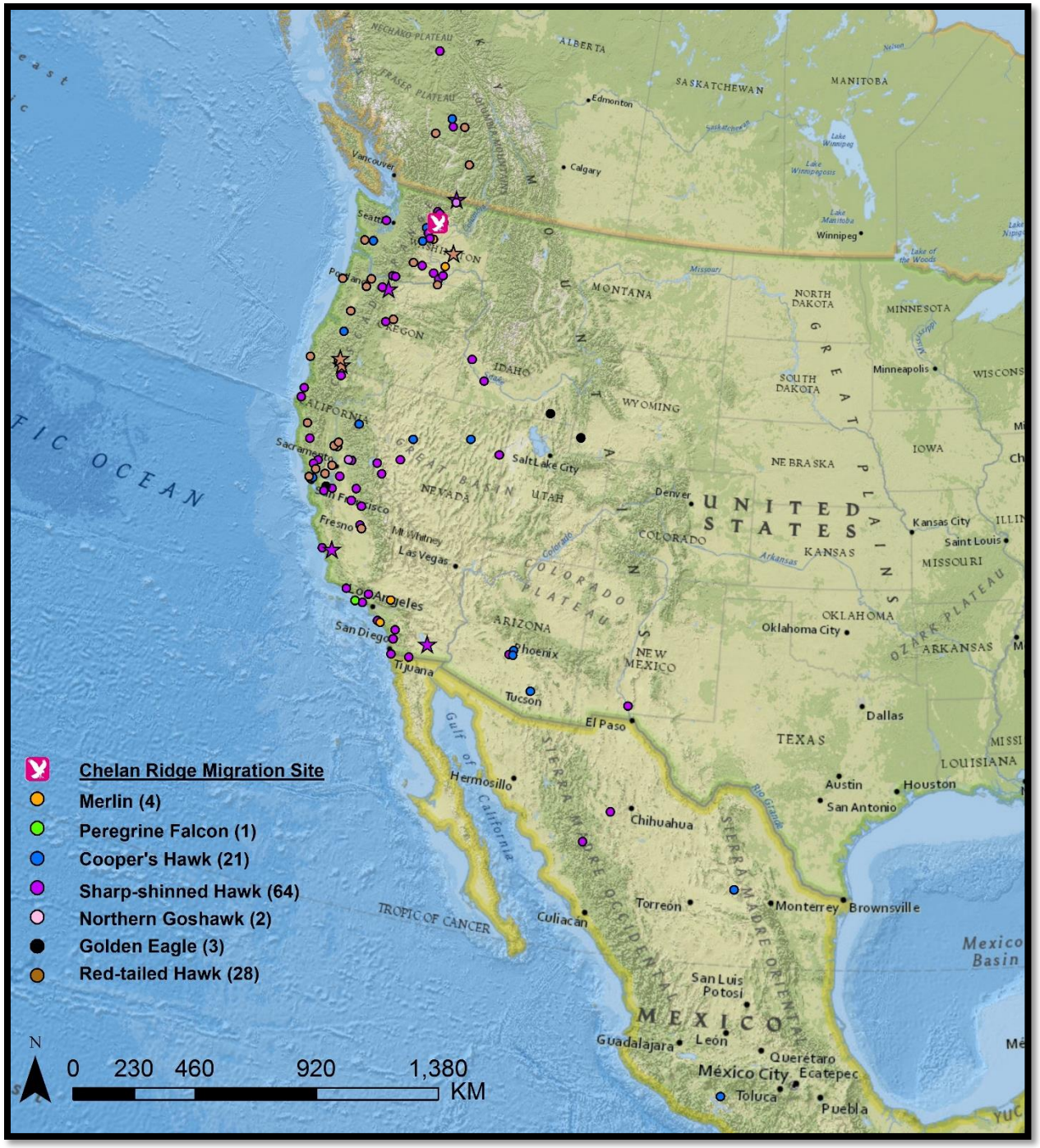

Figure 6. Encounter locations of raptors banded at Chelan Ridge. Circles indicate encounters from 2001-2015, stars indicate 2016 encounters.

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).

2015: Two observers throughout: Jessica Taylor (2), Tucker Davidson (0), Secca Roettenbacher (0), and TC Walker (0)

2016: Two observers throughout: Jessica Taylor (3), Tucker Davidson (1), TC Walker (1), Jessica Buskirk (0), and Dwight Jones (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 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 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: 1997–2016.

	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	204.6	382.92	504.33	505.75	439	491.28	509.24	507.5	502.5
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 accipiter	182	221	248	98	98	144	93	17	63
Total Accipiters	681	1449	1462	1381	1190	1337	667	746	1034
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 falcon	10	6	6	2	9	6	8	11	4
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	2015	2016	Mean
Start Date	24-Aug	24-Aug	24-Aug	23-Aug	23-Aug	23-Aug	23-Aug	23-Aug	24-Aug	11-Sep	24-Aug	25-Aug
End Date	26-Oct	27-Oct	27-Oct	25-Oct	23-Oct	25-Oct	18-Oct	24-Oct	21-Oct	22-Oct	19-Oct	23-Oct
Observation days	64	62	64	60	58	58	52	58	54	41	51	56.9
Observation hours	512	520	557.85	507.74	477.17	484.92	446.22	493.4	448.25	333.8	421	478.1
Raptors / 100 hours	458.8	413.3	365.2	457.9	446.8	261.9	350.7	219.1	308.8	357.2	326.4	364.0
Species												
Turkey Vulture	50	42	48	70	44	31	51	28	55	81	62	39.6
Osprey	50	31	37	36	36	33	27	20	41	28	16	37.7
Northern Harrier	127	60	82	127	114	56	68	33	75	73	82	96.3
White-tailed Kite	0	0	0	0	0	0	0	0	0	0		0.1
Sharp-shinned Hawk	854	880	875	852	841	587	531	350	520	367	490	701.7
Cooper's Hawk	270	363	269	332	249	130	133	169	190	179	196	217.2
Northern Goshawk	31	49	48	27	30	25	22	12	21	15	13	28.6
Unknown accipiter	120	56	60	137	92	43	119	41	64	41	74	101.9
Total Accipiters	1275	1348	1252	1348	1212	785	805	572	795	602	773	1049.5
Red-shouldered Hawk	0	0	0	0	0	1	0	0	0	0	0	0.1
Broad-winged Hawk	4	2	5	6	4	6	4	11	12	16	8	6.1
Swainson's Hawk	2	4	5	5	5	13	4	5	43	14	6	8.2
Red-tailed Hawk	441	378	304	341	315	135	204	161	119	139	151	268.4
Ferruginous Hawk	0	0	0	0	0	0	0	0	0	0	0	0.1
Rough-legged Hawk	28	22	25	48	37	22	117	28	5	35	28	31.2
Unidentified Buteo	57	29	10	20	14	40	71	57	22	30	35	51.4
Total Buteos	532	435	349	420	375	216	400	262	201	234	228	365.3
Golden Eagle	157	82	111	93	109	45	90	45	67	60	87	104.0
Bald Eagle	8	10	12	4	10	15	1	11	14	16	18	7.6
Unidentified eagle	0	0	0	1	0	3	0	0	0	1	0	2.1
Total Eagles	165	92	123	98	119	63	91	56	81	77	105	113.6
American Kestrel	29	47	47	59	47	15	8	17	24	16	26	45.1
Merlin	34	40	44	45	63	37	24	28	42	34	34	37.5
Prairie Falcon	9	6	17	14	11	4	6	5	8	7	6	7.9
Peregrine Falcon	20	16	13	7	10	8	4	6	10	7	9	8.2
Unknown falcon	6	2	3	16	5	1	5	3	7	2	2	5.9
Total Falcons	98	111	124	141	136	65	47	59	91	66	77	104.5
Unidentified Raptor	52	30	22	85	96	20	76	51	45	31	30	88.5
Grand Total	2,349	2,149	2,037	2,325	2,132	1,270	1,565	1,081	1,384	1,192	1,374	1895.2

Appendix D. Annual trapping effort and capture totals by species for migrating raptors at Chelan Ridge, WA: 1999–2016.

	1999[1]	2000[1]	2001	2002	2003	2004	2005	2006	2007	2008
Start Date	28-Aug	2-Sep	30-Aug	27-Aug	23-Aug	25-Aug	25-Aug	25-Aug	25-Aug	24-Aug
End Date	16-Oct	14-Oct	17-Oct	19-Oct	25-Oct	18-Oct	22-Oct	22-Oct	16-Oct	23-Oct
Blinds in operation	2	2	2	2	2	2	2	2	2	2
Trapping days	47	42	44	54	56	53	56	56	51	60
Station Days	?	?	87	104	101	93	107	99	90	105
Station hours	388.0	?	644.6	841.3	803.3	699.8	828.2	797.3	717.1	843.5
Captures/100 stn hrs	56.7	?	81.4	80.6	73.3	50.3	75.2	102.1	94.0	90.6
Species					Raptor Captures					
Northern Harrier	4	3	10	13	11	6	12	28	12	18
Sharp-shinned Hawk	139	125	341	459	394	237	389	556	449	503
Cooper's Hawk	42	46	107	127	100	58	137	100	138	140
Northern Goshawk	14	10	12	13	9	16	11	24	16	29
Broad-winged Hawk	0	0	0	0	0	0	0	0	0	0
Red-tailed Hawk	11	8	22	29	20	16	11	50	33	22
Rough-legged Hawk	0	1	1	2	1	0	5	6	1	2
Golden Eagle	0	1	2	0	4	2	2	6	2	5
American Kestrel	3	0	8	10	17	5	6	8	3	13
Merlin	6	4	17	21	25	10	49	31	15	25
Prairie Falcon	1	1	3	4	4	1	0	3	4	5
Peregrine Falcon	0	0	2	0	4	1	1	2	1	2
All species	220	199	525	678	589	352	623	814	674	764
Recaptures[2]	0	0	0	0	0	0	0	0	1	0
Foreign Recaptures[3]	0	0	0	1	0	0	0	2	2	0

[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 (includes birds initially captured at other HWI sites).

Appendix D. Annual trapping effort and capture totals by species for migrating raptors at Chelan Ridge, WA: 1999–2016.

	2009	2010	2011	2012	2013	2014	2015	2016	Mean	Total
Start Date	24-Aug	25-Aug	22-Aug	25-Aug	24-Aug	24-Aug	6-Sep	27-Aug	26-Aug	---
End Date	24-Oct	22-Oct	20-Oct	17-Oct	22-Oct	19-Oct	22-Oct	12-Oct	19-Oct	---
Blinds in operation	2	2	2	2	2	2	2	2	2	---
Trapping days	58	54	52	48	56	53	44	40	51	924
Station Days	80	66	64	59	84	63	49	47	81.1	1298
Station hours	632.8	520.7	519.1	478.1	660.7	502.4	370.4	365.6	624.3	10612.7
Captures/100 stn hrs	104.8	120.8	106.0	109.2	68.1	105.5	97.7	92.7	88.8	---
Species										
Northern Harrier	24	29	8	8	8	9	17	9	12.7	229
Sharp-shinned Hawk	417	395	373	350	287	386	228	238	348.1	6266
Cooper's Hawk	128	112	96	101	81	70	53	57	94.1	1693
Northern Goshawk	10	15	15	6	11	4	8	3	12.6	226
Broad-winged Hawk	1	0	0	0	0	0	0	0	0.1	1
Red-tailed Hawk	34	35	26	25	33	29	17	13	24.1	434
Rough-legged Hawk	9	1	1	3	2	1	8	1	2.5	45
Golden Eagle	5	5	5	4	0	2	1	2	2.7	48
American Kestrel	9	3	4	2	7	3	3	0	5.8	104
Merlin	21	30	19	20	16	25	24	15	20.7	373
Prairie Falcon	3	1	0	2	2	1	2	0	2.1	37
Peregrine Falcon	2	3	3	1	3	0	1	1	1.5	27
All species	663	629	550	522	450	530	362	339	526.8	9483
Recaptures[2]	0	7	3	0	0	2	1	0	1	14
Foreign Recaptures[3]	1	1	0	0	0	0	0	1	0	8

[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 (includes birds initially captured at other HWI sites).