FALL 2015 RAPTOR MIGRATION ANNUAL REPORT:
CHELAN RIDGE HAWKWATCH, WASHINGTON

A Partnership Between

HawkWatch International

Okanogan-Wenatchee National Forest

SUMMARY OF 2015 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 2015 season marked the 18th consecutive, full-season count and the 17th straight season of banding at the site. This report summarizes the 2015 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 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° 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.
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 2015 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

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, 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 are released within 45 minutes of capture.

2015 RESULTS AND DISCUSSION

OBSERVATION EFFORT AND WEATHER SUMMARY

Observers counted on 41 of 42 possible days between 11 September and 22 October during the 2015 season, which was 16 days below the 1998-2014 long term average, and spent a total of 334 hours counting, also far below the long-term average of 465 hrs (Appendix C). The beginning of the season was considerably shortened due to local wildfires thus raw count numbers are generally lower than historical totals and observers experienced hazy conditions 51% of the time. Based on hourly recording of conditions throughout the season, it was clear 45% of the time; partly cloudy 21% of the time; mostly cloudy 13% of the time; and overcast 20% of the time. Additionally, observers experienced foggy conditions 7% of the time and rain or snow 3% of the time.

2015 FLIGHT SUMMARY

Overall Flight:

A total of 1,192 migrating raptors of 16 species were tallied, a statistically significant ($p < 0.05$) decrease of 39% compared to the long-term site average (Table 1), and the second lowest total on record (Appendix C). Highlights of the 2015 season included record high seasonal counts for Broad-winged Hawks (16), Bald Eagles (16), and Turkey Vultures (81) and a new single day record for Broad-winged Hawks (10).

The composition of the overall flight broke down as follows: 51% accipiters, 20% buteos, 6% falcons, 7% eagles, 6% harriers, 7% vultures, 2% Ospreys, and 3% unknown raptors. The proportions of vultures, ospreys, and harriers were above historic averages; while the proportion of accipiters were below historic averages (Fig. 3). Sharp-shinned Hawks were the most commonly observed species (31% of the total), followed by Cooper's Hawks (15%), Red-tailed Hawks (11%), Turkey Vultures (7%), Northern Harriers (6%), Golden Eagles (5%), Merlins (3%), Rough-legged hawks (3%), Ospreys (2%), and The remaining species each accounted for 2% or less of the total count.

The following sections summarize the 2015 count relative to historic means at the site, and any statistically significant ($p < 0.05$) 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 = -14.03, $r^2 = 0.5$, p=0.002).

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

Counts in 2015 were above historic averages for Turkey Vultures and below average for Ospreys and Northern Harriers. This season marked the fifth consecutive year of below average counts for Northern Harriers and regression results indicate declining regional populations (slope = -0.88, r^2= 0.31, p = 0.017). Turkey Vulture passage rates were higher than all historical seasons and populations are increasing based on fall migration counts (slope = 0.55, $r^2 = 0.37$, p-value = 0.008).

Accipiters (Fig. 5b):

Accipiter counts were below historic averages for all species in 2015 (Table 1). Sharp-shinned Hawk passage rates were below average for the fifth straight fall and regression analysis indicates significant declines (slope= -5.8, $r^2 = 0.42$, p=0.004). Passage rates for Goshawks were lower than historic averages for the third consecutive season while Cooper's Hawks rates were slightly above the historic 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 2015 was low compared to the site average (Table 1). Both the count and passage rate for Red-tailed Hawks were significantly below average for the fifth consecutive season (Table 1, Fig 5c), and regional populations continue to decline (slope = -2.055, $r^2 = 0.34$, p = 0.01) based on fall migration counts.

Rough-legged Hawk count totals were average while Swainson's Hawks and Broad-winged Hawks were above average. Passage rates were above average for Rough-legged Hawks, Swainson's Hawks, and Broad-winged Hawks (Table 1).

Eagles (Fig.5d):

For the fourth time in five 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 = -0.79, $r^2 = 0.36$, p = 0.008). Bald Eagle counts and passage rates were high compared to site averages for the third straight year (Table 1).

Falcons (Fig. 5e):

American Kestrel counts and passage rates in 2015 were low compared to site average for the fifth consecutive season and regional Kestrel populations continue to decline based on fall migration rates (slope

= -0.92, $r^2 = 0.56$, $p < 0.001$). 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 collaborating to understand these declines both locally (www.hawkwatch.org/ourwork/kestrels) and at the continental scale under the umbrella of the American Kestrel Partnership (http://kestrel.peregrinefund.org/). Merlin counts were average but passage rates were slightly higher than the average. Peregrine Falcon and Prairie Falcon counts and passage rates were in line with site historic averages.

TRAPPING EFFORT

Trapping occurred on 44 of 46 days between 6 September and 20 October, with efforts totaling 370.4 hours split between two stations (Appendix D). Trapping normally begins during the final week in August but we started 10 days late due to local fire activity. We normally try to end the season on 26 October but an approaching winter storm led to a shut down on 22 October. Due to a late start and 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 362 raptors of eleven species were captured and banded in 2015, significantly below the site average of 597 birds (Table 2). The 2015 overall capture rate was lower than 2014 but still above the historic site average, suggesting that the relative efficiency of trapping is being maintained (Table 2). Total captures were low for most species due to the short season, although Northern Harrier, Merlin, Prairie Falcon, and Peregrine Falcon totals were at or above site averages. The second largest number of Rough-legged Hawk (8) in Chelan's history were captured and the highest number since 2009. We captured most species at rates consistent with historical site averages but Northern Harrier, Rough-legged Hawk, and Merlin rates were above site average. All other species capture totals were consistent with site averages. Both Rough-legged Hawk and Merlin set site records for capture rate / 100 station hours.

RECAPTURES

One adult female Cooper's Hawk, originally banded in 2013 at Chelan Ridge, was recaptured at the site in 2015. For the fifth straight year, there were no "foreign recaptures" (recaptures of birds banded elsewhere) at Chelan Ridge (Appendix D).

FOREIGN ENCOUNTERS WITH PREVIOUSLY BANDED BIRDS

To date 107 birds banded at Chelan Ridge have been recaptured/recovered and reported to the USGS Bird Banding Laboratory (Fig. 6). In 2015, seven birds originally banded at Chelan Ridge from 2010-2015 were reported to the BBL, which then passed the information to HWI. Six reports were recoveries of dead Red-tailed Hawks (Fig. 6, Table 3). Two individuals were banded as after-hatch-year birds while the others were hatch-year when banded. Three recoveries occurred in Oregon, two in California, one in Washington, and one in British Columbia, Canada. The cause of mortality was not reported for any of the recoveries. The seventh report was of a male Golden Eagle banded as a hatch-year in 2012. This recovery is of interest because the bird was killed by a wind-turbine at the Altamont Wind Farm in California.

VISITOR PARTICIPATION AND PUBLIC OUTREACH

Fire related road closures resulted in low visitation this year at the Chelan Ridge HawkWatch. The Chelan Ridge Hawk Migration Festival, still occurred but events were moved to Base Camp in Mazama because of fire impacts in and around Pateros. Dave Oleyar gave a migration talk and raptor ID workshop and co-led a field trip along with Kent Woodruff to Slate Peak to count migrating raptors. Kent Woodruff was presented with the HawkWatch International Lifetime Achievement Award for his many years of service and friendship to the projects, crews, and partnership. 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.

2015 FALL MIGRATION ACROSS HWI'S NETWORK

HawkWatch International and partners operated 8 fall count sites in 2015(Fig. 1). During the 4,252 hours of standardized observation we counted 700,457 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 2015 included (Table 2):

- Above average or average counts at 6 of 8 sites
    - Exceptions were Chelan Ridge and Manzano Mountain sites which had significantly low counts.
- Below average Golden Eagle counts at 6 of 8 sites—only above average count was at Commissary Ridge, WY
- Below historic average American Kestrel counts at 6 of 9 sites
- Significantly low counts of all accipiter species at both Pacific Northwest sites

- Significantly high Turkey Vulture counts at 5 of 7 sites where counted (record set at 3 sites: Chelan Ridge, Goshute Mountains, and Corpus Christi-where 170,976 were counted!)
- Above average or average Broad-winged Hawk numbers at all sites with record numbers at 3 sites (Chelan Ridge, Goshute Mountains, and Yaki Point).

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 were provided by Richard Hendrick, who has been with us helping with the count, banding, and other chores since we started in 1997; by Brad Martin and his wife Norma who supply lure birds annually, and long-time Chelan Ridge partner and friend, Jim Watson of WDFW who has provided encouragement and support over the years.

We especially want to thank our 2015 field crew: Kelsey Navarre, Jessica Taylor, Tucker Davidson, Secca Roettenbacher, and TC Walker; plus new and veteran volunteers who made their first trip or returned to visit and help with this season's efforts. 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 2015, and site records at Chelan Ridge, WA.

		1998-2014					All-time Historic Records	
	Species	**Mean Count ± 95 % CI**			**2015**	**% Change**	**Season**	**Daily**
	Turkey Vulture	39.3	±	7.2	81	106.1	81 (2015)	25 (2014)
	Osprey	38.2	±	6.2	28	-26.7	71 (2000)	10 (2x including 14)
	Northern Harrier	96.6	±	18.4	73	-24.5	167 (1999)	21 (1998)
Accipiters								
	Sharp-shinned Hawk	744.5	±	103.0	367	-50.7	1050 (2000)	84 (2000)
	Cooper's Hawk	223.4	±	30.7	179	-19.9	363 (2007)	32 (2009)
	Northern Goshawk	28.9	±	5.9	15	-48.1	50 (1999)	7 (2x)
	Unidentified accipiter	100.8	±	29.2	41	-59.3	248 (1999)	
	TOTAL ACCIPITERS	1097.6	±	143.6	602	-45.2	1462 (1999)	
Buteos								
	Red-shouldered Hawk	0.1	±	0.1	0	-100.0	1 (2011)	1 (2011)
	Broad-winged Hawk	5.7	±	1.3	16	180.4	16 (2015)	10 (2015)
	Swainson's Hawk	8.4	±	14.0	14	67.6	43 (2014)	13 (2003)
	Red-tailed Hawk	283.3	±	48.6	139	-50.9	450 (1999)	33 (2006)
	Ferruginous Hawk	0.1	±	0.1	0	-100.0	1 (2000)	1 (2000)
	Rough-legged Hawk	32.7	±	12.2	35	7.0	117 (2012)	39 (2012)
	Unidentified buteo	51.2	±	17.4	30	-41.4	148 (1999)	
	TOTAL BUTEOS	381.4	±	59.5	234	-38.6	664 (1999)	
Eagles								
	Golden Eagle	106.5	±	18.5	60	-43.7	174 (2000)	18 (2000)
	Bald Eagle	7.4	±	2.4	16	115.9	16 (2015)	4 (2000)
	Unknown eagles	1.8	±	1.6	1	-45.2	12 (2003)	
	TOTAL EAGLES	115.8	±	19.0	77	-33.5	194 (2000)	
Falcons								
	American Kestrel	48.1	±	13.0	16	-66.7	107 (1998)	13 (1998)
	Merlin	38.9	±	5.3	34	-12.6	63 (2010)	9 (1998)
	Prairie Falcon	8.3	±	2.2	7	-15.6	19 (2003)	3 (2x)
	Peregrine Falcon	8.4	±	2.4	7	-16.8	20 (2006)	3 (3x)
	Unidentified falcon	5.9	±	1.8	2	-66.0	16 (2009)	
	TOTAL FALCONS	109.5	±	16.7	66	-39.7	180 (1998)	
	Unidentified Raptor	86.6	±	30.8	31	-64.2	218 (1999)	
	GRAND TOTAL	**1965.1**	**±**	**243.2**	**1192**	**-39.3**	**2881 (1999)**	**187 (2009)**

Table 2. Capture totals and rates for fall migrating raptors at Chelan Ridge, WA: 2001-2014 versus 2015.

	Capture Totals			Capture Rate[1]		
	2001-2014[2]	2015	Seasonal Record	2001-2014[2]	2015	Seasonal Record
Northern Harrier	14.0 ± 4.0	17	29	2.1 ± 0.7	4.6	5.6
Sharp-shinned Hawk	395.4 ± 42.9	228	556	60.3 ± 7.1	61.6	76.8
Cooper's Hawk	106.8 ± 13.4	53	140	16.2 ± 2.1	14.3	21.6
Northern Goshawk	13.6 ± 3.4	8	29	2.0 ± 0.4	2.2	3.5
Broad-winged Hawk	0.1 ± 0.1	0	1	0.0 ± 0.0	0.0	0.2
Red-tailed Hawk	27.5 ± 5.0	17	50	4.3 ± 0.9	4.6	6.7
Rough-legged Hawk	2.7 ± 1.3	8	9	0.4 ± 0.2	2.2	2.2
Golden Eagle	3.1 ± 1.0	1	6	0.5 ± 0.2	0.3	1.0
American Kestrel	7.0 ± 2.2	3	17	1.0 ± 0.3	0.8	2.1
Merlin	23.1 ± 4.9	24	49	3.5 ± 0.7	6.5	6.5
Prairie Falcon	2.4 ± 0.8	2	5	0.3 ± 0.1	0.5	0.6
Peregrine Falcon	1.8 ± 0.6	1	4	0.3 ± 0.1	0.3	0.6
All Species	597.4 ± 63.8	362	814	91.0 ± 10.4	97.7	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: 2015.

Band #	Species[1]	Sex	Banding Date	Banding Age[2]	Encounter Location	Encounter Date	Distance (KM)[3]	Status
0629-29195	GOEA	M	9-Oct-12	HY	Livermore, California	16-Mar-15	1089	Found dead - Wind turbine collision
1957-05431	RTHA	U	13-Sep-13	HY	Hermiston, Oregon	24-Mar-15	239	Found dead - Unknown cause
1957-05434	RTHA	U	26-Sep-13	HY	Hermiston, Oregon	24-Mar-15	239	Found dead - Unknown cause
1687-27296	RTHA	U	12-Sep-10	HY	Raymond, Washington	20-Oct-15	282	Found dead - Unknown cause
1687-27002	RTHA	U	23-Sep-13	AHY	Vernon, British Columbia, Canada	23-Nov-15	250	Found dead - Unknown cause
1957-05451	RTHA	U	1-Oct-15	HY	Brookings, Oregon	27-Nov-15	696	Found dead - Unknown cause
1177-06054	RTHA	U	7-Oct-11	AHY	Fresno, California	13-Dec-15	1190	Found dead - Unknown cause

[1] SSHA = Sharp-shinned Hawk; GOEA = Golden Eagle.

[2] HY = hatch year; AHY = after hatch year.

[3] Straight-line distance from banding location.

Table 4. Summary of the 2015 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 count. *In 2015 HWI*

	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 2015							
Species	**365.7**	**338.8**	**399.1**	**532.5**	**679.8**	**568.3**	**553.4**	**814.8**
Black Vulture								186
Turkey Vulture	494	*81*	5	90	*1102*		292	*170976*
Osprey	67	28	*22*	39	162	*75*	30	194
Northern Harrier	24	73	141	*64*	239	55	51	169
Crested Caracara								4
Common Black Hawk								0
Harris' Hawk								2
Accipiters								
Sharp-shinned Hawk	964	367	*655*	1321	6769	2209	1420	1914
Cooper's Hawk	226	179	306	526	4418	1538	469	1094
Northern Goshawk	19	15	38	48	100	3	3	0
Unidentified accipiter	44	41	94	71	43	*728*	39	69
TOTAL ACCIPITERS	1253	602	*1093*	1966	11330	*4478*	1931	3077
Buteos								
Red-shouldered Hawk	1	0	0	0	0	0	0	23
Broad-winged Hawk	4	*16*	29	30	*336*	*47*	18	472276
Short-tailed Hawk								2
Swainson's Hawk	1	14	2	202	*2856*	138	388	2941
White-tailed Hawk								43
Zone-tailed Hawk							1	13
Red-tailed Hawk	614	139	*382*	1070	*6988*	*1723*	384	68
Ferruginous Hawk	0	0	6	3	21	8	2	4
Rough-legged Hawk	1	35	*96*	11	11	0	0	0
Unidentified buteo	3	30	29	47	15	68	16	9
TOTAL BUTEOS	624	234	*544*	1363	*10227*	*1984*	809	475379
Eagles								
Golden Eagle	56	60	1134	*359*	170	1	43	2
Bald Eagle	78	*16*	81	169	15	11	1	14
Unknown eagles	1	1	2	9	0	0	1	0
TOTAL EAGLES	135	77	1217	537	185	12	45	16
Falcons								
American Kestrel	8	16	*180*	189	1881	595	267	1171
Merlin	69	34	*36*	19	73	10	37	*117*
Prairie Falcon	4	7	6	11	37	6	5	4
Peregrine Falcon	12	7	21	8	45	9	23	146
Aplomado Falcon								0
Unidentified falcon	7	2	7	11	1	17	3	11
TOTAL FALCONS	100	66	*250*	238	2037	637	335	1449
Kites								
Hook-billed Kite								0
Swallow-tailed Kite								89
White-tailed Kite								5
Mississippi Kite								8506
Unidentified Kites								0
TOTAL KITES								8600
Unidentified Raptor	7	31	9	12	0	49	7	137
GRAND TOTAL	2704	1192	3281	4309	25282	*7290*	3500	660189

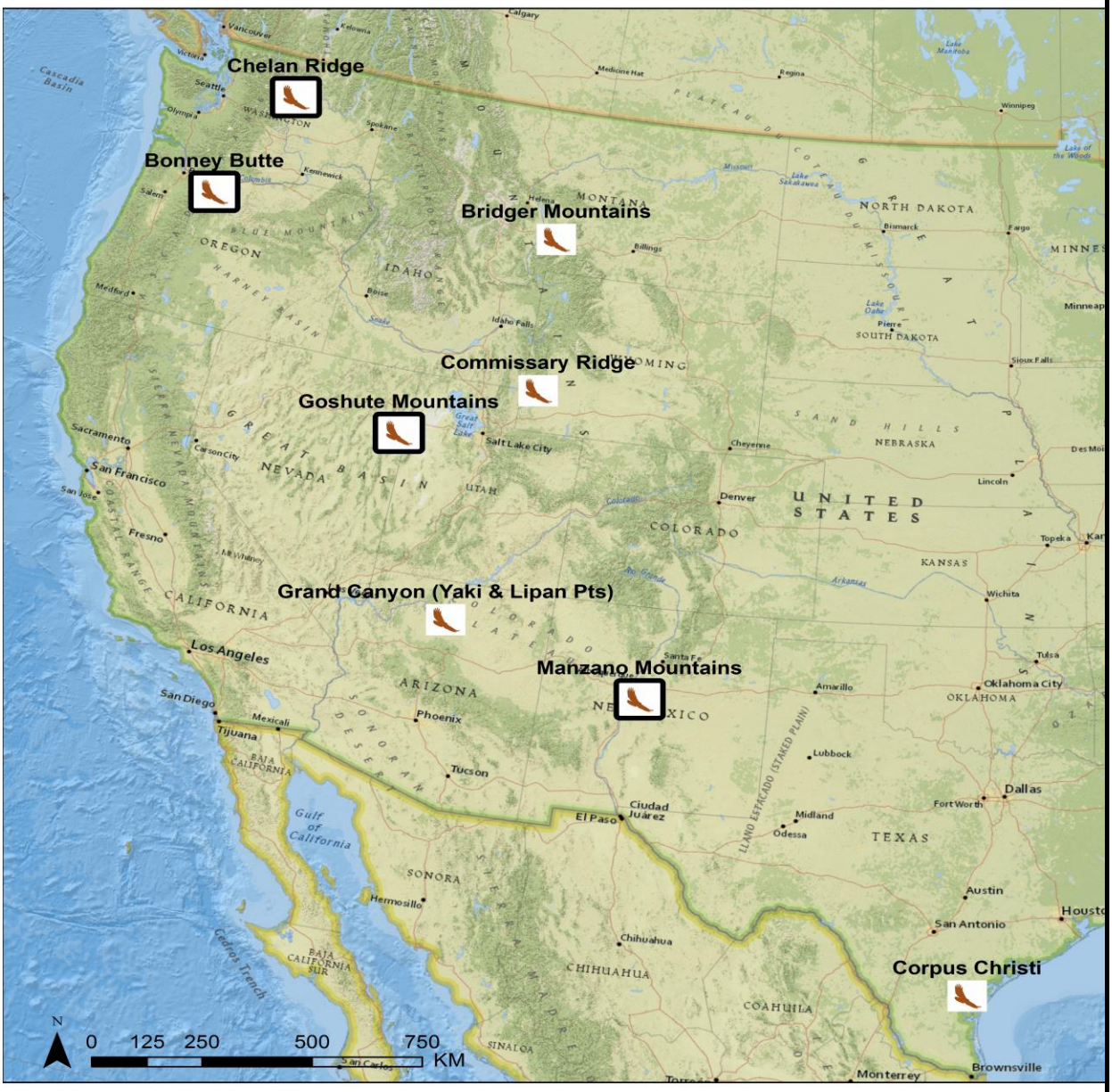
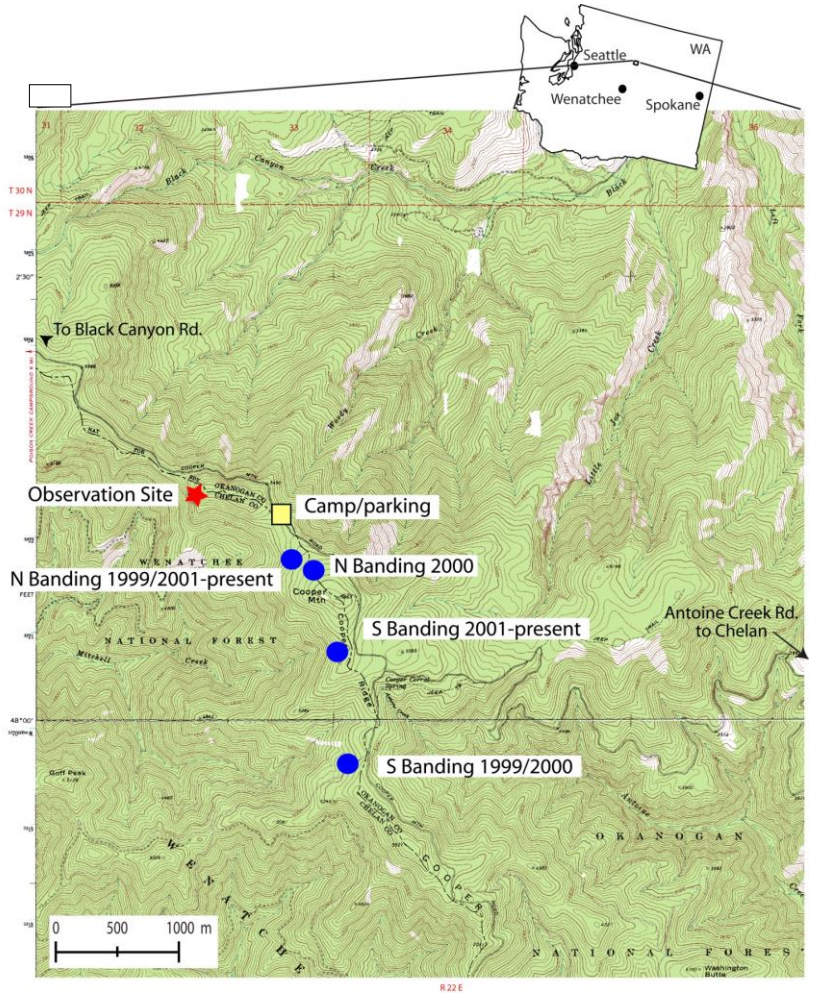


Figure 1. Locations of fall HawkWatch sites operated by HWI and partners (symbols with borders represent sites that conducted banding in 2015).



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).

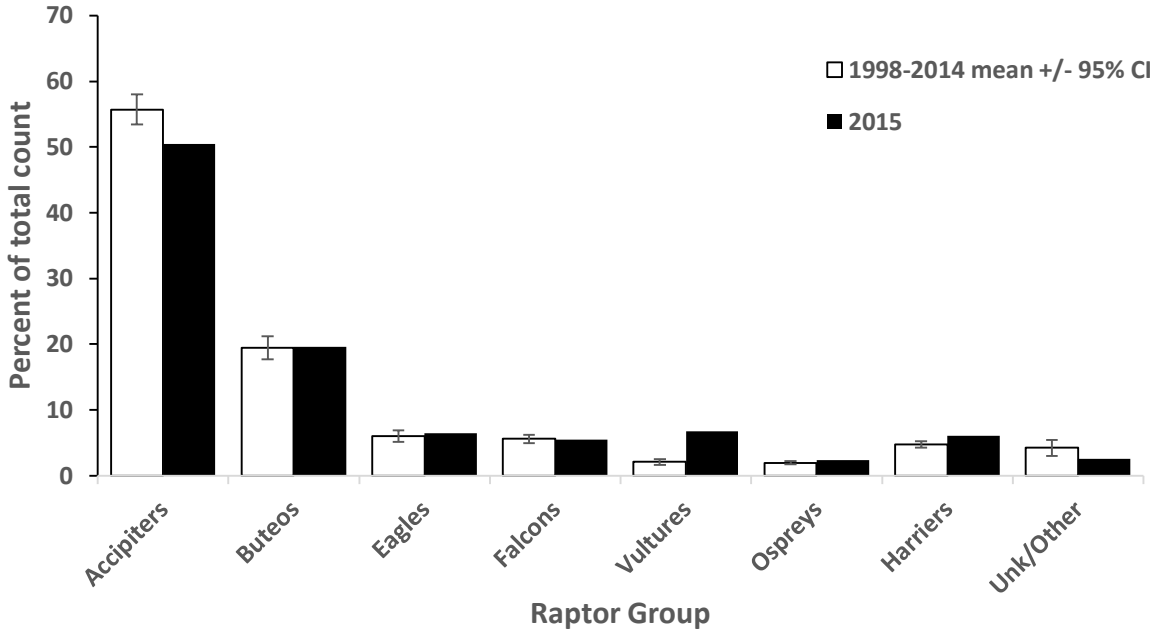


Figure 3. Fall raptor migration flight composition by major species groups at Chelan Ridge, WA: 1998–2014 versus 2015.

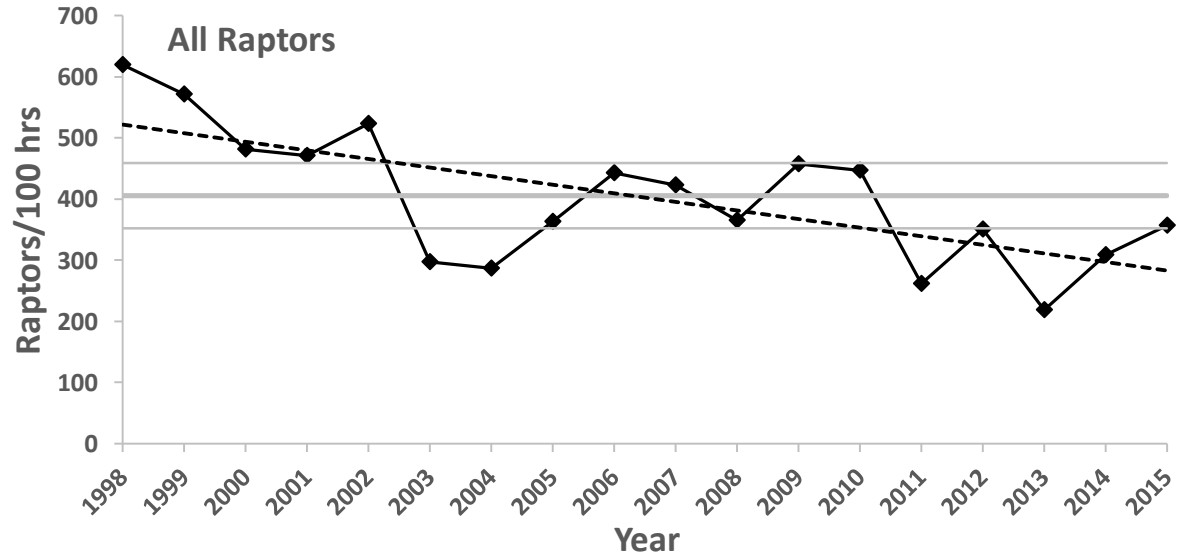


Figure 4. Fall migration passage rates at Chelan Ridge, WA for all migrating raptors: 1998-2015. Dashed line indicates trend for significant ($p < 0.05$) linear regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2014) at Chelan Ridge.

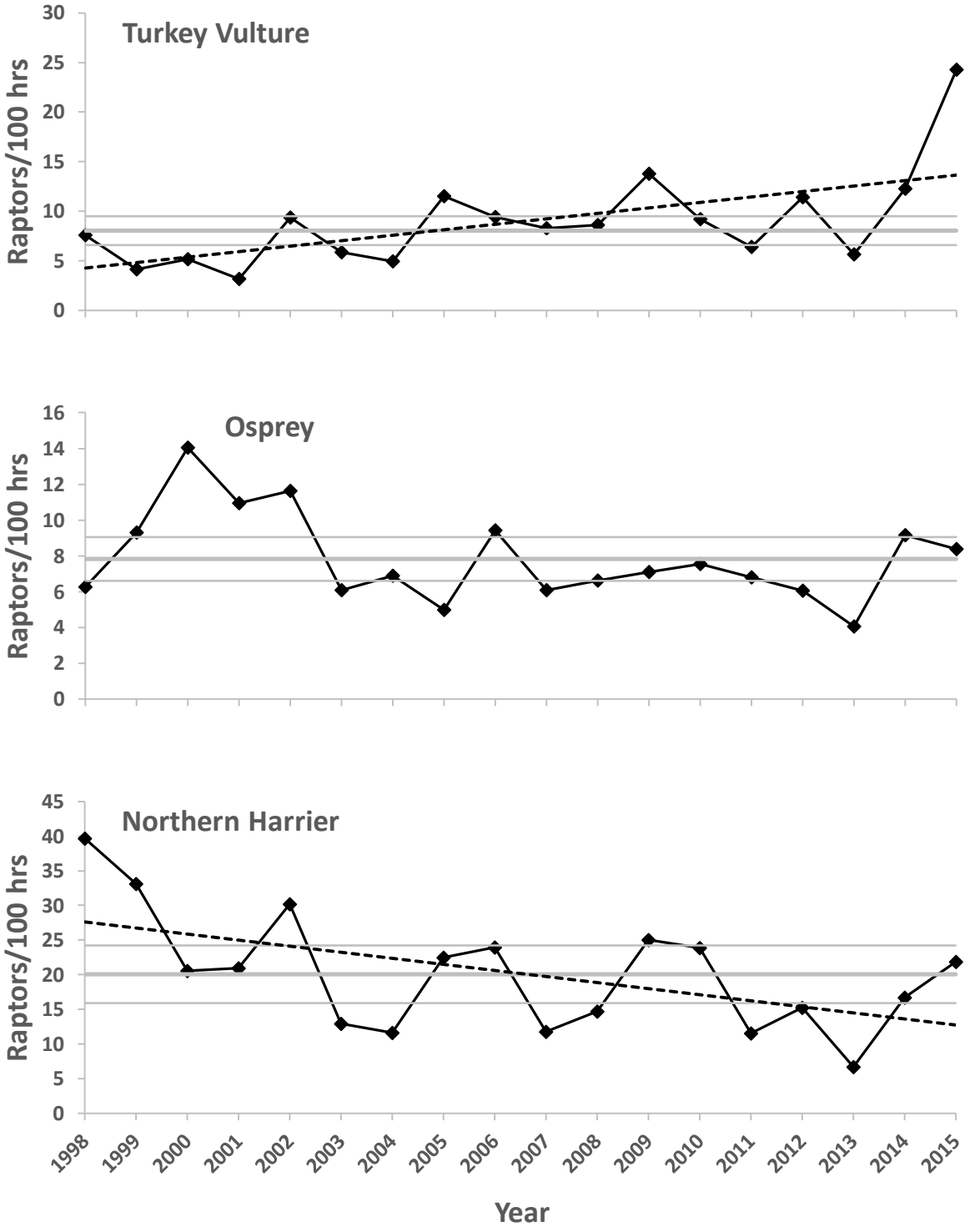


Figure 5a. Fall-migration passage rates at Chelan Ridge, WA for Turkey Vultures, Ospreys, and Northern Harriers: 1998–2015. Dashed lines indicate trends for significant ($p < 0.05$) linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2014) at Chelan Ridge.

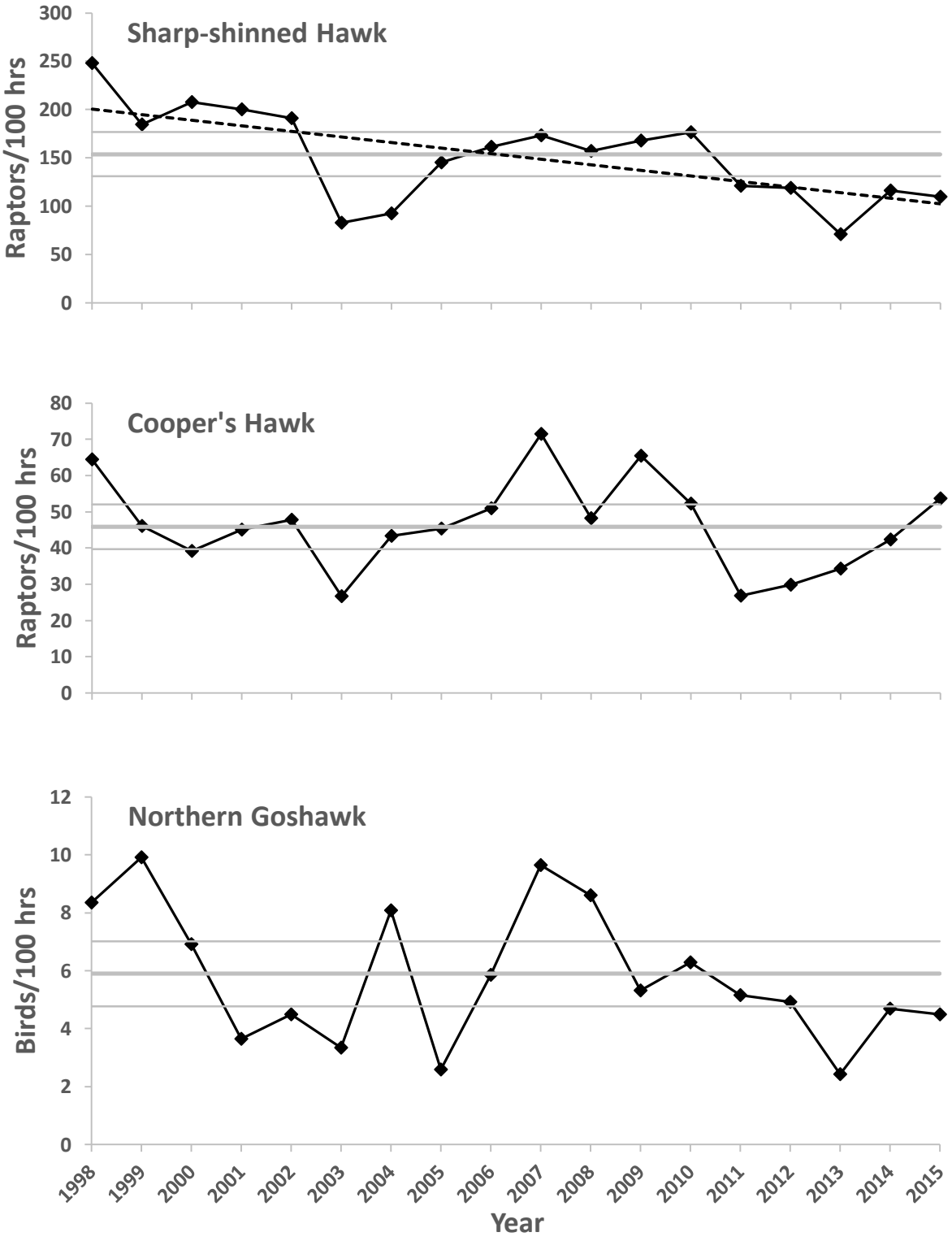


Figure 5b. Fall-migration passage rates at Chelan Ridge, WA for the three North American accipiter species: 1998–2015. Dashed lines indicate trends for significant ($p < 0.05$) linear regression. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2014).

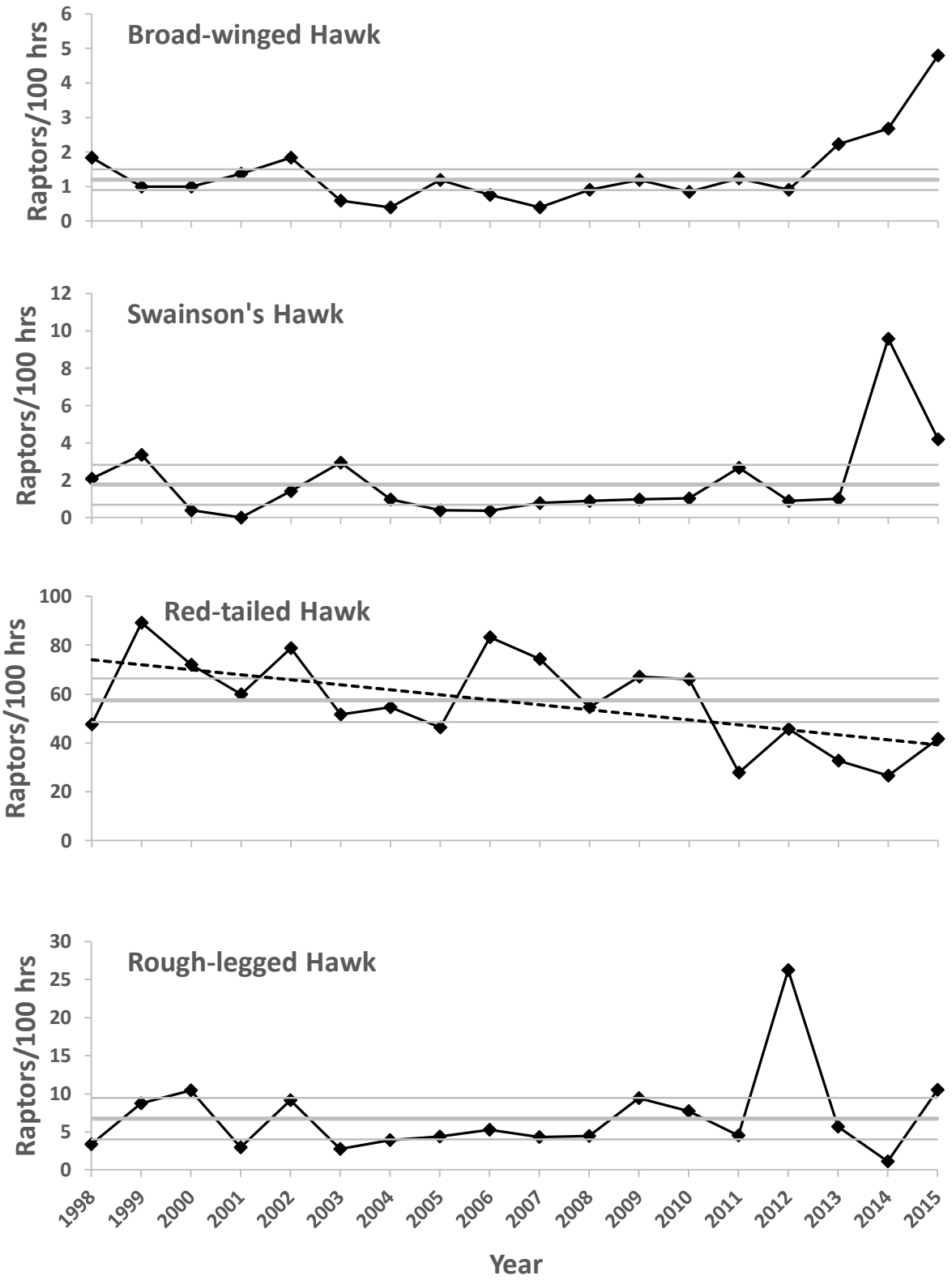


Figure 5c. Fall-migration buteo passage rates at Chelan Ridge, WA: 1998–2015. Dashed lines indicate significant ($p < 0.05$) population trends based on linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2014).

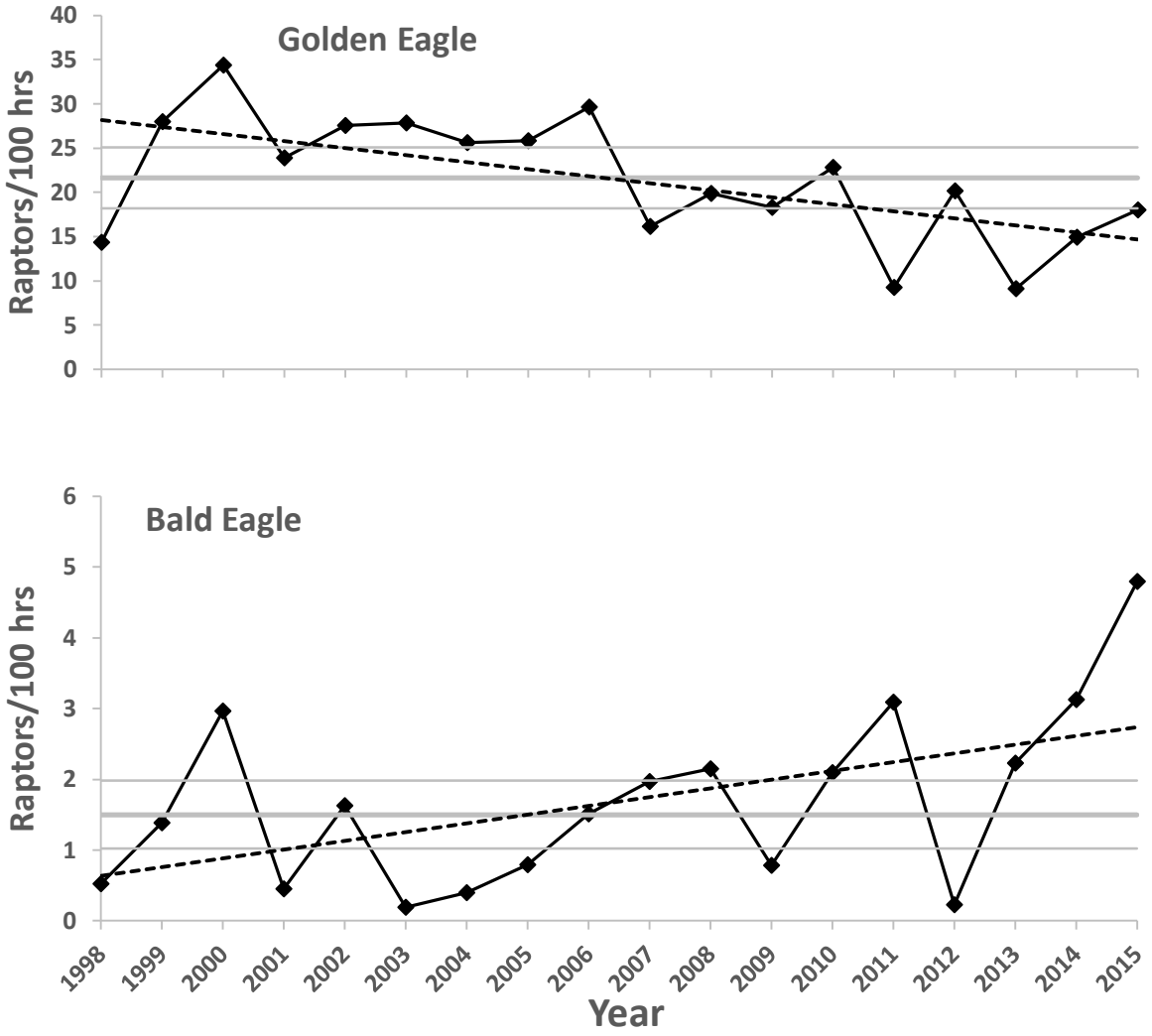


Figure 5d. Eagle passage rates for the fall migration at Chelan Ridge, WA.: 1998–2015. Dashed lines indicate significant ($p < 0.05$) population trends based on linear regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2014).

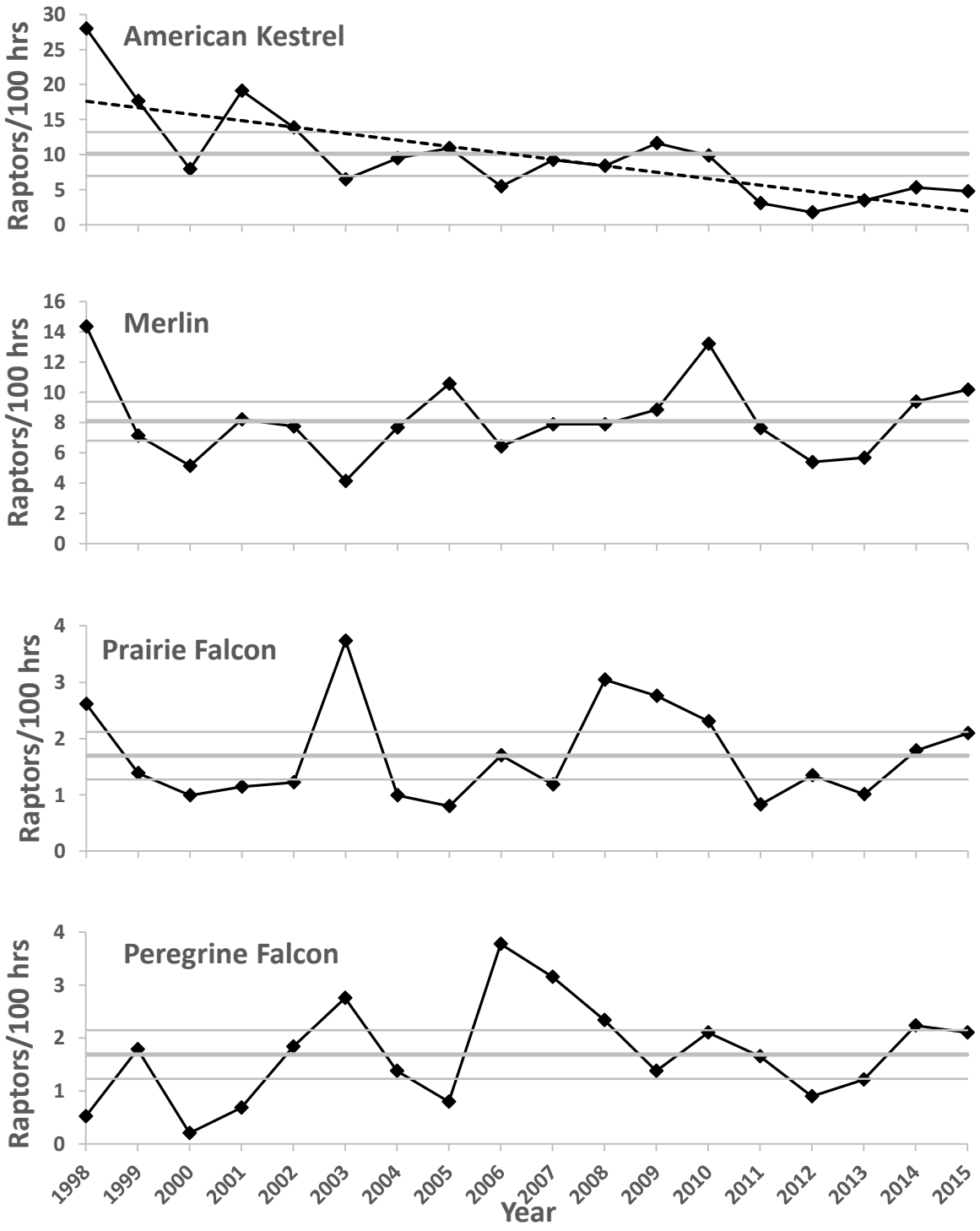


Figure 5e. Fall-migration falcon passage rates at Chelan Ridge, WA: 1998–2015. Dashed lines indicate significant ($p < 0.05$) population trends based on linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2014).

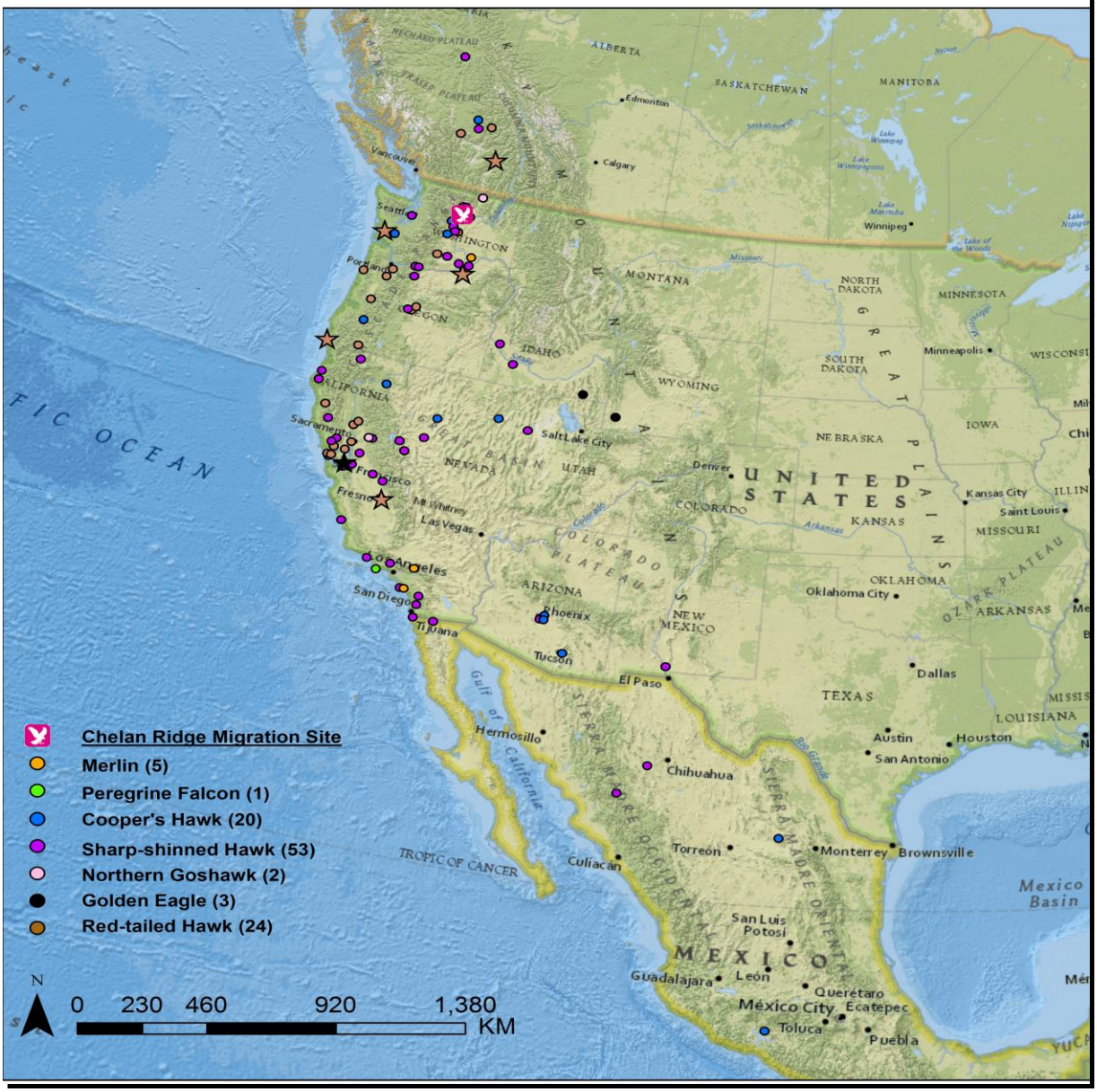


Figure 6. Recovery locations of raptors banded at Chelan Ridge. Circles indicate recoveries from 2001-2014, stars indicate 2015 recoveries.

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).

2015: Two observers throughout: Jessica Taylor (2), Tucker Davidson (0), Secca Roettenbacher (0), and TC Walker(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: 1997–2015.

	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	Mean
Start Date	24-Aug	24-Aug	24-Aug	23-Aug	23-Aug	23-Aug	23-Aug	23-Aug	24-Aug	11-Sep	25-Aug
End Date	26-Oct	27-Oct	27-Oct	25-Oct	23-Oct	25-Oct	18-Oct	24-Oct	21-Oct	22-Oct	23-Oct
Observation days	64	62	64	60	58	58	52	58	54	41	56.9
Observation hours	512	520	557.85	507.74	477.17	484.92	446.22	493.4	448.25	333.8	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	364.0
Species											
Turkey Vulture	50	42	48	70	44	31	51	28	55	81	39.6
Osprey	50	31	37	36	36	33	27	20	41	28	37.7
Northern Harrier	127	60	82	127	114	56	68	33	75	73	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	701.7
Cooper's Hawk	270	363	269	332	249	130	133	169	190	179	217.2
Northern Goshawk	31	49	48	27	30	25	22	12	21	15	28.6
Unknown accipiter	120	56	60	137	92	43	119	41	64	41	101.9
Total Accipiters	1275	1348	1252	1348	1212	785	805	572	795	602	1049.5
Red-shouldered Hawk	0	0	0	0	0	1	0	0	0	0	0.1
Broad-winged Hawk	4	2	5	6	4	6	4	11	12	16	6.1
Swainson's Hawk	2	4	5	5	5	13	4	5	43	14	8.2
Red-tailed Hawk	441	378	304	341	315	135	204	161	119	139	268.4
Ferruginous Hawk	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	31.2
Unidentified Buteo	57	29	10	20	14	40	71	57	22	30	51.4
Total Buteos	532	435	349	420	375	216	400	262	201	234	365.3
Golden Eagle	157	82	111	93	109	45	90	45	67	60	104.0
Bald Eagle	8	10	12	4	10	15	1	11	14	16	7.6
Unidentified eagle	0	0	0	1	0	3	0	0	0	1	2.1
Total Eagles	165	92	123	98	119	63	91	56	81	77	113.6
American Kestrel	29	47	47	59	47	15	8	17	24	16	45.1
Merlin	34	40	44	45	63	37	24	28	42	34	37.5
Prairie Falcon	9	6	17	14	11	4	6	5	8	7	7.9
Peregrine Falcon	20	16	13	7	10	8	4	6	10	7	8.2
Unknown falcon	6	2	3	16	5	1	5	3	7	2	5.9
Total Falcons	98	111	124	141	136	65	47	59	91	66	104.5
Unidentified Raptor	52	30	22	85	96	20	76	51	45	31	88.5
Grand Total	2,349	2,149	2,037	2,325	2,132	1,270	1,565	1,081	1,384	1,192	1895.2

Appendix D. Annual trapping effort and capture totals by species for migrating raptors at Chelan Ridge, WA: 1999–2015.

	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	?	612.8	837.3	803.3	699.6	828.2	797.3	716.1	836.5
Captures/100 stn hrs	56.7	?	85.7	81.0	73.3	50.3	75.2	102.1	94.1	91.3
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

Appendix D. Continued

	2009	2010	2011	2012	2013	2014	2015	Mean	Total
Start date	24-Aug	25-Aug	22-Aug	25-Aug	24-Aug	24-Aug	6-Sep	26-Aug	---
End date	24-Oct	22-Oct	20-Oct	17-Oct	22-Oct	19-Oct	22-Oct	20-Oct	---
Blinds in operation	2	2	2	2	2	2	2	2	---
Trapping days	58	54	52	48	56	53	44	52	884
Station days	80	66	64	59	84	63	49	83	1,251
Station hours	632.8	520.7	496.1	468.6	660.7	502.4	370.4	635.7	10,170.6
Captures/100 stn hrs	104.8	120.8	110.9	111.4	68.1	105.5	97.7	89.3	---
Species	Raptor Captures								
Northern Harrier	24	29	8	8	8	9	17	12.9	220
Sharp-shinned Hawk	417	395	373	350	287	386	228	354.6	6,028
Cooper's Hawk	128	112	96	101	81	70	53	96.2	1,636
Northern Goshawk	10	15	15	6	11	4	8	13.1	223
Broad-winged Hawk	1	0	0	0	0	0	0	0.1	1
Red-tailed Hawk	34	35	26	25	33	29	17	24.8	421
Rough-legged Hawk	9	1	1	3	2	1	8	2.6	44
Golden Eagle	5	5	5	4	0	2	1	2.7	46
American Kestrel	9	3	4	2	7	3	3	6.1	104
Merlin	21	30	19	20	16	25	24	21.1	358
Prairie Falcon	3	1	0	2	2	1	2	2.2	37
Peregrine Falcon	2	3	3	1	3	0	1	1.5	26
All species	663	629	550	522	450	530	362	537.9	9,144
Recaptures[2]	0	7	3	0	0	2	1	1	14
Foreign Recaptures[3]	1	1	0	0	0	0	0	0	7

[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.