FALL 2015 RAPTOR MIGRATION ANNUAL REPORT: COMMISSARY RIDGE HAWKWATCH, SW WYOMING

HawkWatch International, Inc.

Salt Lake City, Utah

May 2016

FALL 2015 RAPTOR MIGRATION ANNUAL REPORT: COMMISSARY RIDGE HAWKWATCH, SW WYOMING

Report prepared by:

Dave Oleyar, Jesse Watson, and Neil Paprocki

Counts conducted by:

Thomas Cooney, Caleb, Hansen, and Ben Sweet

Project coordinated by:

HawkWatch International, Inc.

Principal Investigator: Dr. Dave Oleyar

2240 South 900 East, Salt Lake City, UT 84106

(801) 484-6808, ext. 109 doleyar@hawkwatch.org

May 2016

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The Commissary Ridge HawkWatch in southwest Wyoming is an ongoing effort to monitor long-term regional population trends of diurnal raptors that migrate along the Rocky Mountain Flyway (Hoffman et al. 2002). HawkWatch International (HWI) initiated standardized counts at Commissary Ridge, prior to this no long-term raptor migration counts occurred in Wyoming. To date HWI observers have recorded 17 species of migratory raptors at the site, with counts typically ranging between 3,000 and 4,300 migrants per season. The 2015 season marks the 14th consecutive season of counting at Commissary Ridge.

The Commissary Ridge HawkWatch was 1 of 8 long-term, annual raptor migration counts conducted or co-sponsored by HWI in North America during 2015 (Fig. 1). The primary objective of these efforts is to track long-term population trends of diurnal raptors in western North America and around the Texas Gulf Coast region (Hoffman et al. 2002, Hoffman and Smith 2003, Smith et al. 2008a, b). Raptors can serve as important biological indicators of ecosystem health (Bildstein 2001) and long-term migration counts can be a very cost effective and efficient method for monitoring the regional status and trends of multiple raptor species (Zalles and Bildstein 2000, Bildstein et al. 2008).

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 Commissary Ridge HawkWatch and outreach efforts here reach people from western Wyoming, eastern Utah, northwestern Colorado, and beyond each season.

STUDY SITE

The study site is located atop the southern end of Commissary Ridge on the southwestern tip of South Fork Mountain about 37 km north of Kemmerer, Wyoming, on land managed by the Bureau of Land Management, Kemmerer Field Office (Fig. 2). The site is accessed from Hwy 233 just northeast of Lake Viva Naughton, and is located on the western edge of a broad ridgetop overlooking the Ham's Fork River Valley and Lake Viva Naughton to the west (42°01'29"N 110°35'22"W; T24 R116 S28 SESW; elevation ~2,700 m). The location provides an unobstructed 360° view of the surrounding landscape. The ridgetop and immediate landscape consists of rocky substrates and low growing desert shrubs and grasses, with scattered stands of mixed-conifer and aspen in sheltered pockets and ravines.

METHODS

STANDARDIZED COUNT

Weather permitting; two designated observers conducted standardized daily counts of migrating raptors from late August through late October. Observations typically began between 0800–0900 hrs and ended near 1700 hrs Pacific Standard Time (PST). Visitors occasionally assisted with the count.

Data collection followed standardized protocols used at all HWI migration sites (Hoffman and Smith 2003). The observers routinely recorded the following data:

1. Species, age, sex, and color morph of each migrant raptor, whenever possible and applicable (Appendix B lists common and scientific names for all species, information about the applicability of age, sex, and color morph distinctions, and two-letter codes used to identify species in tables and figures).
2. Hour of passage for each migrant; e.g., the 1000–1059 hrs PST.
3. Wind speed and direction, air temperature, percent cloud cover, predominant cloud type(s), presence of precipitation, visibility, and an assessment of thermal-lift conditions were 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 were run on effort-adjusted annual passage rates (raptors/100hrs) to identify long-term trends in migrating raptors.

2015 RESULTS AND DISCUSSION

OBSERVATION EFFORT AND WEATHER SUMMARY

The Commissary Ridge HawkWatch standard season runs 27 August—5 November but in 2015 the season ended 4 days early on 1 Nov; observers counted during all of the 65 possible days during this period for a total of 532.5 hours (Appendix C), however weather led to shortened counts (<4hrs) on four days. The number of count days this season was 3 days above the long-term average (2002-2014) and total observation hours were nearly 50 above the long-term average (Appendix C). Weather varies throughout every season, in 2015 based on hourly recording of conditions during observation it was clear 32% of the time; partly cloudy 20% of the time; mostly cloudy 23% of the time; overcast 23% of the time; and raining or snowing 8% of the time.

2015 FLIGHT SUMMARY

Overall Flight:

A total of 4,309 migrating raptors representing 17 species were counted in 2015, a significant (alpha =0.05) 22% increase compared to the site long term average (Table 1) and nearly 45% more individuals than 2014. was a site record count for Golden Eagles (349).

The fight consisted of 45.6% accipiters, 31.6% buteos, 12.5% eagles, 5.5% falcons, 2.1% vultures, 1.5% Northern Harriers, and 0.9 % Ospreys. The relative proportions of accipiters, buteos, vultures, and ospreys was consistent with those from historic counts; while falcons up less of the flight than they typically do and harriers made up more of the count than they have historically (Fig. 3). Sharp-shinned Hawks were the most abundant species (31% of the total), followed by Red-tailed Hawks (25%), Cooper's Hawks (12%), Golden Eagles (8%), Swainson's Hawks (5%), Bald Eagles (4%), American Kestrels (4%), and Turkey Vultures (2%). The remaining species each accounted for 1% or less of the total count (Table 1).

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 analyses of first and/or second order regression. HWI only depicts significant trends for species with a historic average count rate greater than or equal to 10 individuals per 100 hours. The rationale is that trends for counts below this threshold likely do not contain biologically useful information on regional populations—species with counts this low likely have a very dispersed migration, migrate along a different primary route, or large portions of the population that are resident. We do include count information in the reports, as occurrences of rarer species are of interest to both managers and the general public, and could represent the beginning of meaningful long-term changes.

Total Flight (Fig.4):

The 809 raptors counted per 100 hours of observation at the Commissary Ridge HawkWatch in 2015 was near the historic average of 748 raptors/100 hrs and was the highest rate since the 2010 season (Appendix C).

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

Seasonal counts and effort-adjusted passage rates for Turkey Vultures and Ospreys were average while Northern Harrier counts set a new seasonal record (64) (Table 1). All three species are stable based on regression analysis of passage rates (no significant trend).

Accipiters (Fig. 5b):

Total counts were high for all three accipiter species (Table 1). Passage rates were average for both Cooper's Hawks and Northern Goshawks and above average for above average for Sharp-shinned Hawks. Long-term regional population trends for these species are stable (no significant trend based on regression analysis).

Buteoine Hawks (Fig. 5c):

Total counts and passage rates for Swainson's Hawks, Rough-legged Hawks, and Red-tailed Hawks were similar to historic averages (Appendix C). The Broad-winged Hawk count and rate were above average while the Ferruginous Hawk count and rate was below average. Regional populations remain stable (no significant trend based on regression analysis).

Eagles (Fig.5d):

The 2015 Golden Eagle count set a new record (359) which is worth noting because 2014 tied the record for the lowest count at Commissary Ridge (Table 1). The passage rate for Golden Eagles was also above the historical average. The count and passage rate for Bald Eagles was consistent with the historic average. Analyses of long-term passage rates indicate that regional populations of both eagle species remain stable (no significant trend based on regression analysis).

Falcons (Fig. 5e):

Peregrine Falcon count and passage rate were below average in 2015, while those for Prairie Falcons were similar to site average. The Merlin and American Kestrel counts and passage rates were consistent with historic averages. Regional populations of Kestrels are declining based on fall migration passage rates (slope = -4.7, $r^2 = 0.69$, $p < 0.001$). Similar declines have been documented for Kestrels across the HWI network and at other count sites. In response, HWI, along with many other North American researchers and Citizen Scientists are working to understand American Kestrel declines both locally (www.hawkwatch.org/our-work/kestrels) and at the continental scale and have partnered under the umbrella of the American Kestrel Partnership (http://kestrel.peregrinefund.org/).

Site Visitation and Public Outreach

Commissary Ridge is a remote migration site located in rural Wyoming. In 2015, the site was officially visited by 5 individuals from Wyoming and Utah who learned about raptor migration from our crew. The crew also continued to make good local acquaintances by visiting with hunters, ranchers, herdsman, and other locals from nearby Kemmerer, WY.

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.

ACKNOWLEDGMENTS

We'd like to thanks the Bureau of Land Management – Kemmerer Field Office for providing their encouragement and essential logistical support for our crew. We also want to thank the Kemmerer Recreation Center for also providing our staff local encouragement, camaraderie, and sometimes logistical support as well. Finally, many thanks to our fearless field crew: Thomas Cooney, Caleb Hansen, and Ben Sweet —without all of your dedication, good spirits, grit, and willingness to brave the Wyoming wind and other elements this season would not have been possible.

LITERATURE CITED

Bildstein, K. L. 2001. Why migratory birds of prey make great biological indicators. Pages 169–179 *in* K. L. Bildstein and D. Klem, Jr. (Editors), Hawkwatching in the Americas. Hawk Migration Association of North America, North Wales, Pennsylvania, U.S.A.

Bildstein, K. L., J. P. Smith, E. Ruelas Inzunza, and R. R. Veit (Editors). 2008. State of North America's birds of prey. Series in Ornithology No. 3. Nuttall Ornithological Club, Cambridge, Massachusetts, and American Ornithologists' Union, Washington, DC U.S.A.

Farmer, C. J., and D. J. T. Hussell. 2008. The raptor population index in practice. Pages 165178 *in* K. L. Bildstein, J. P. Smith, E. Ruelas Inzunza, and R. R. Veit (Editors), State of North America's birds of prey. Series in Ornithology No. 3. Nuttall Ornithological Club, Cambridge, Massachusetts, and American Ornithologists' Union, Washington, DC U.S.A.

Hoffman, S. W., and J. P. Smith. 2003. Population trends of migratory raptors in western North America, 1977–2001. Condor 105:397–419.

Hoffman, S. W., J. P. Smith, and T. D. Meehan. 2002. Breeding grounds, winter ranges, and migratory routes of raptors in the Mountain West. Journal of Raptor Research 36:97–110.

Smith, J. P., C. J. Farmer, S. W. Hoffman, G. S. Kaltenecker, K. Z. Woodruff, and P. Sherrington. 2008a. Trends in autumn counts of migratory raptors in western North America. Pages 217–252 *in* K. L. Bildstein, J. P. Smith, E. Ruelas Inzunza, and R. R. Veit (Editors), State of North America's birds of prey. Series in Ornithology No. 3. Nuttall Ornithological Club, Cambridge, Massachusetts, and American Ornithologists' Union, Washington, DC U.S.A.

Smith, J. P., C. J. Farmer, S. W. Hoffman, C. A. Lott, L. J. Goodrich, J. Simon, C. Riley, and E. Ruelas Inzunza. 2008b. Trends in autumn counts of migratory raptors around the Gulf of Mexico, 1995–2005. Pages 253–278 *in* K. L. Bildstein, J. P. Smith, E. Ruelas Inzunza, and R. R. Veit (Editors), State of North America's birds of prey. Series in Ornithology No. 3. Nuttall Ornithological Club, Cambridge, Massachusetts, and American Ornithologists' Union, Washington, DC U.S.A.

Zalles, J. I., and K. L. Bildstein (Editors). 2000. Raptor watch: a global directory of raptor migration sites. BirdLife Conservation Series No. 9. BirdLife International, Cambridge, U.K., and Hawk Mountain Sanctuary Association, Kempton, Pennsylvania, U.S.A.

Table 1. Counts and historic records of fall migrating raptors at the Commissary Ridge HawkWatch, in sw Wyoming.

		1994-2013				All-time Historic Records	
	Species	**Mean Count ± 95 % CI**		**2014**	**% Change**	**Season**	**Daily**
	Turkey Vulture	99 ± 28		31	-69	185 (2007)	7 (2013)
	Osprey	34 ± 8		6	-82	59 (2004)	6 (2009)
	Northern Harrier	28 ± 6		6	-79	38 (2009)	5 (2009)
Accipiters							
	Sharp-shinned Hawk	951 ± 233		600	-37	1687 (2005)	25 (2x)
	Cooper's Hawk	422 ± 71		148	-65	669 (2010)	22 (4x)
	Northern Goshawk	35 ± 13		4	-89	89 (2007)	6 (2012)
	Unidentified accipiter	127 ± 45		49	-61	296 (2010)	
	TOTAL ACCIPITERS	1536 ± 313		801	-48	2425 (2010)	
Buteos							
	Red-shouldered Hawk	±					
	Broad-winged Hawk	18 ± 9		0	-100	58 (2010)	5 (2010)
	Swainson's Hawk	187 ± 189		16	-91	1211 (2010)	12 (2009)
	Red-tailed Hawk	958 ± 166		530	-45	1459 (2007)	38 (2007)
	Ferruginous Hawk	7 ± 2		3	-60	15 (2004)	4 (2009)
	Rough-legged Hawk	13 ± 6		3	-77	34 (2008)	6 (2010)
	Unidentified buteo	55 ± 19		73	32	144 (2008)	
	TOTAL BUTEOS	1239 ± 263		625	-50	2246 (2010)	
Eagles							
	Golden Eagle	254 ± 46		136	-46	352 (2002)	18 (2002)
	Bald Eagle	152 ± 47		108	-29	299 (2007)	16 (2008)
	Unknown eagles	15 ± 7		22	43	39 (2012)	
	TOTAL EAGLES	420 ± 93		266	-37	648 (2007)	
Falcons							
	American Kestrel	224 ± 55		64	-71	403 (2004)	21 (2004)
	Merlin	17 ± 6		4	-77	32 (2012)	5 (2004)
	Prairie Falcon	11 ± 3		9	-15	21 (2007)	4 (2x)
	Peregrine Falcon	12 ± 3		16	38	20 (2010)	3 (2x)
	Unidentified falcon	8 ± 3		10	24	16 (2x)	
	TOTAL FALCONS	272 ± 56		103	-62	458 (2004)	
	Unidentified Raptor	43 ± 18		28	-35	102 (2004)	
	GRAND TOTAL	3672 ± 626		1866	-49	5602 (2010)	125 (2013)

Table 2. 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 monitored migration for 4,252 hrs and counted 700,457 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 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).

Figure 2. Location of Commissary Ridge HawkWatch in southwestern Wyoming relative to Kemmerer, WY and other nearby towns.

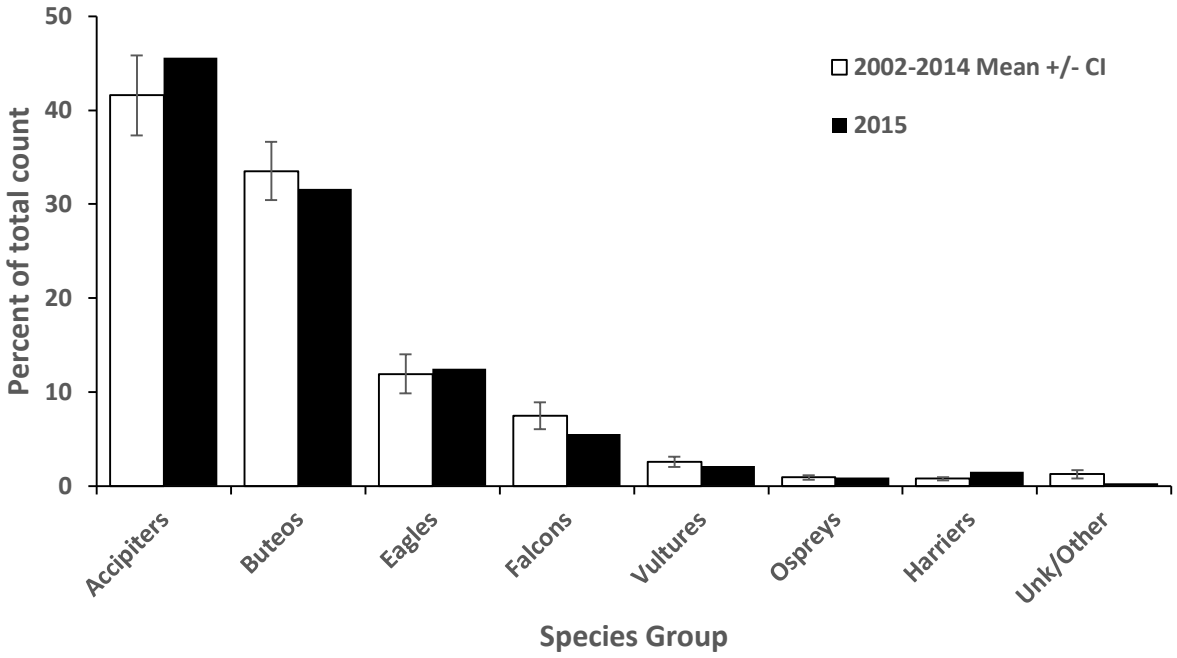

Figure 3. Composition of the fall flight by major raptor species groups of at the Commissary Ridge HawkWatch in SW Wyoming: 2002–2014 average compared to 2015.

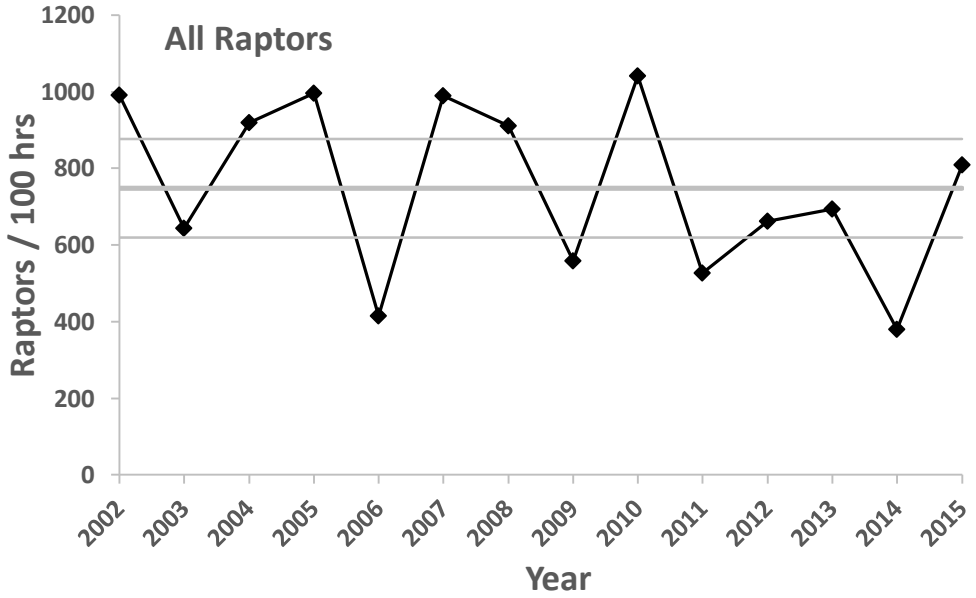

Figure 4. Fall migration passage rates at the Commissary Ridge HawkWatch in SW Wyoming for all migrating raptors: 2002-2015. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1985-2014) at Commissary Ridge.

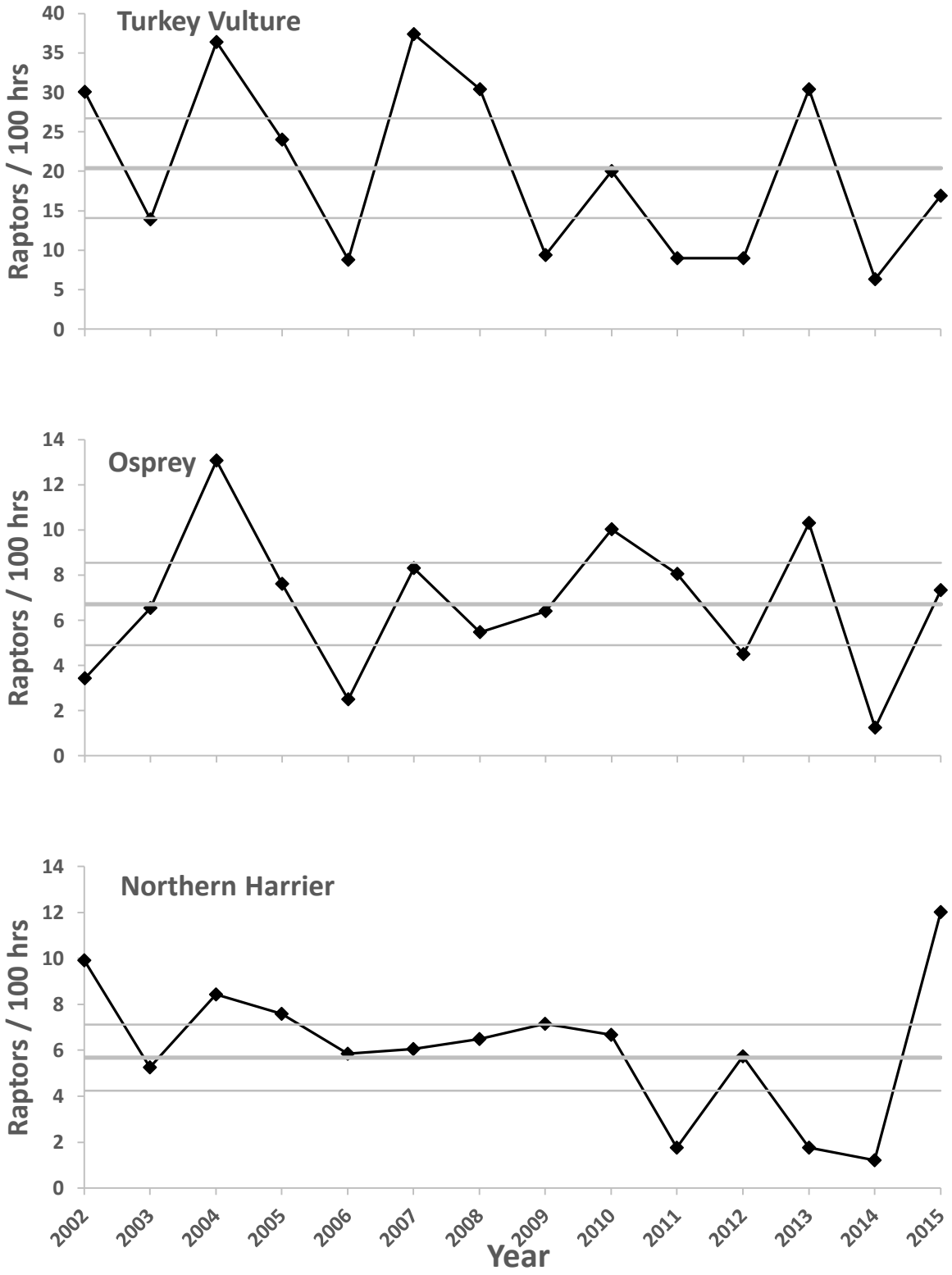

Figure 5a. Fall-migration passage rates a at the Commissary Ridge HawkWatch in SW Wyoming for Turkey Vultures, Ospreys, and Northern Harriers: 2002–2015. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (2002-2014) at Commissary Ridge.

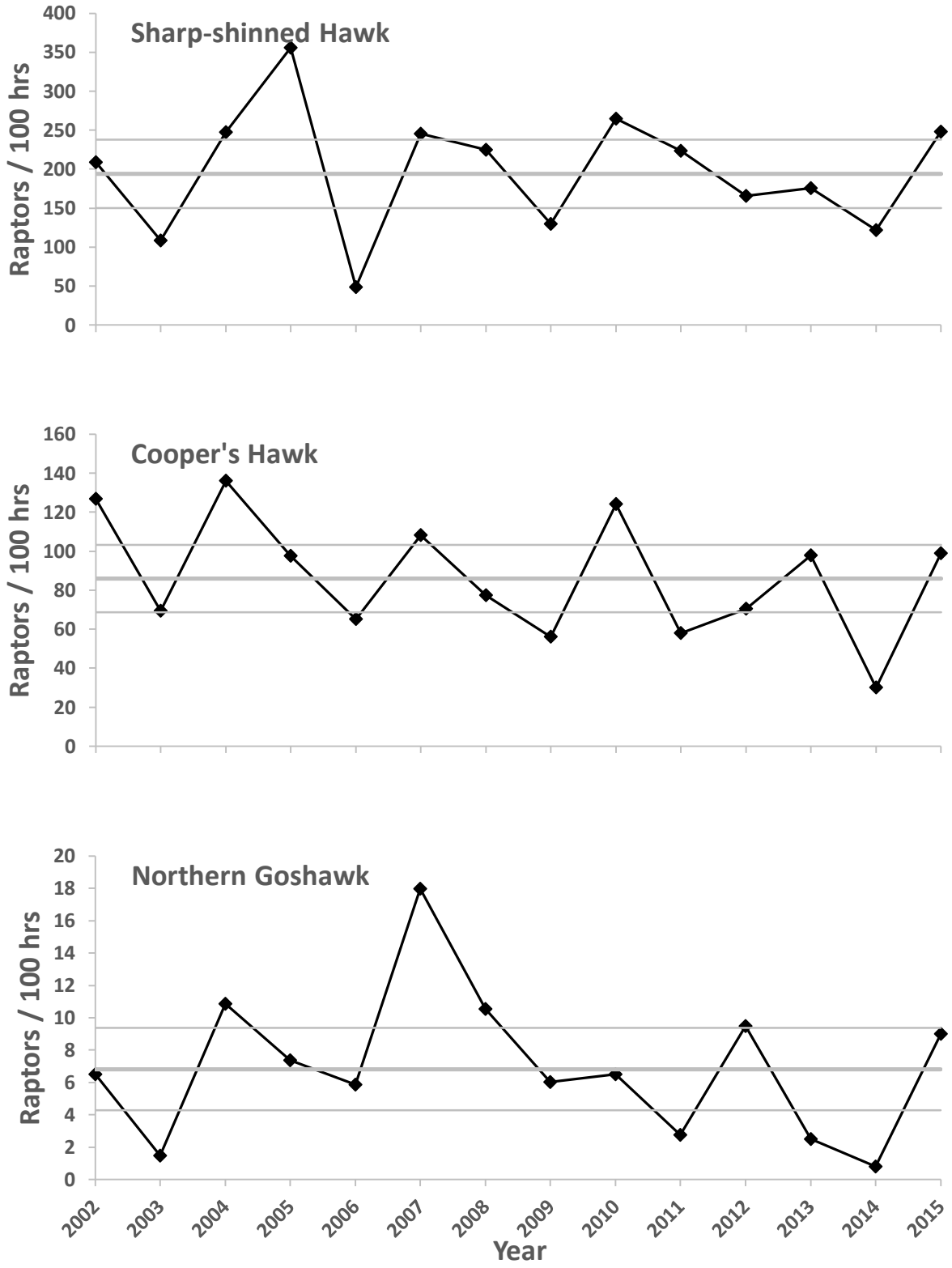

Figure 5b. Fall-migration passage rates at the Commissary Ridge HawkWatch in SW Wyoming for the three North American accipiter species: 2002–2015. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (2002-2014).

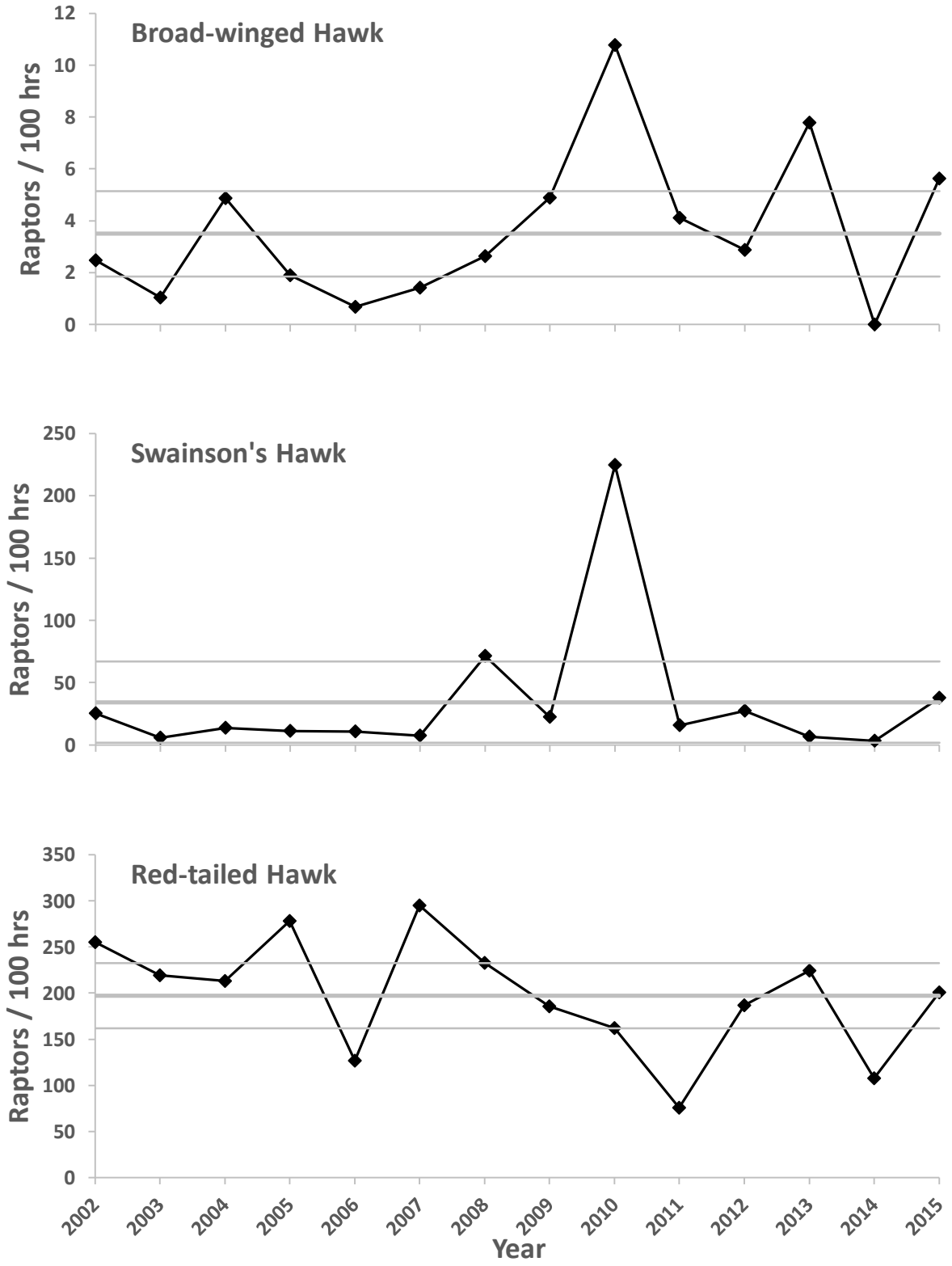

Figure 5c. Fall-migration buteo passage rates at the Commissary Ridge HawkWatch in SW Wyoming: 2002–2015. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (2002-2014).

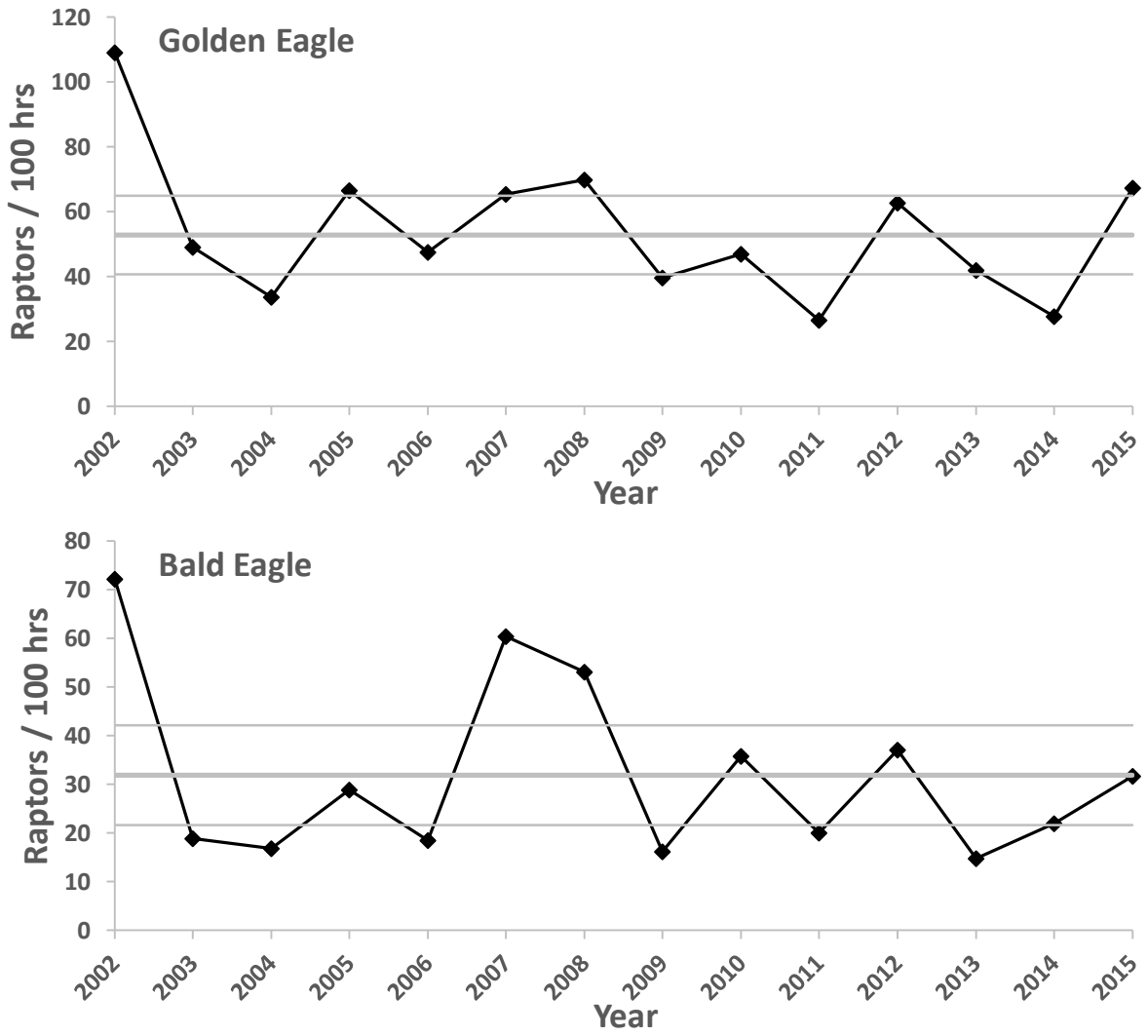

Figure 5d. Eagle passage rates for the fall migration at the Commissary Ridge HawkWatch in SW Wyoming: 2002–2015. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (2002-2014).

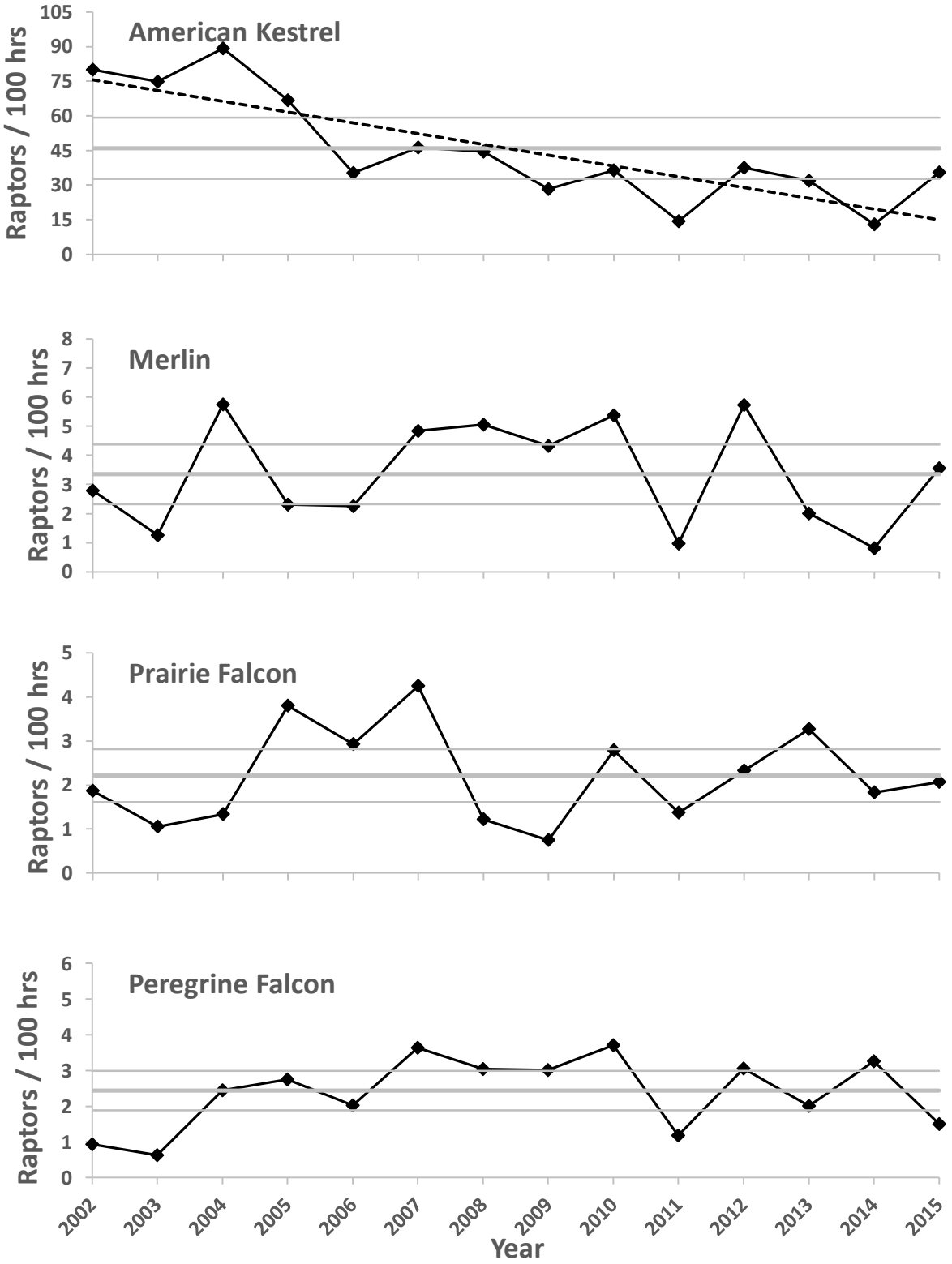

Figure 5e. Fall-migration falcon passage rates at the Commissary Ridge HawkWatch in SW Wyoming: 2002–2015. Dashed lines indicate significant ($p < 0.05$) population trends based on linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (2002-2014).

Appendix A. History of official observer participation at the Commissary HawkWatch in southwestern Wyoming:

2000: Exploratory count, single observer throughout, rotating observers: Mike Neal (3)[1] and Margarite Lomow (0).

2001: Exploratory count, single observer throughout: Mike Neal (4)

2002: Single observer throughout, two observers for peak: Mike Neal (5), Nick Meyer (1), assisted by other trained crew members and staff.

2003: Two observers throughout: Chadette Pfaff (+), Don Higgins (0), Jason Farrell (0), assisted by Mike Neal (6).

2004: Two observers throughout: Mark Vukovich (1), Jennifer Nagy (0), assisted by other trained crew members and staff.

2005: Two observers throughout: Rob Spaul (1), Mary Ann Donnovan (0), assisted by other trained crew members and staff.

2006: Two observers throughout: David Jansen (0), Tiara Westcott (0), assisted by other trained crew members and staff.

2007: Two observers throughout: Tiffany Russell (0), Patty Brundage (0), assisted by other trained crew members and staff.

2008: Two observers throughout: Sue Bruner (4), Sedona Maniak (0), Chase Cammarota (0); assisted by other trained crew members and staff.

2009: Two observers throughout: Andrew Eberly (1), Julia Fromfeld (0), Andrew Grant (+).

2010: Two observers throughout: Robert Baez (1), John Cannon (0), Ben Zyla (0).

2011: Two observers throughout: Lainie LaHaye (1), Mary Raikes (0), Emily Underwood (0).

2012: Two observers throughout: Russell Seeley (2), Rya Rubenthaler (0), Donna Wilhelm (0).

2013: Two observers throughout: Cherin Spencer-Bower (1), Meghan McPherson (0), Bradley Wilkinson (0), and Dan D. Tempest (+).

2014: Two observers throughout: Erik Corredor (0), Philip Kavouriaris (0), and Keelan Dann (0).

2015: Two observers throughout: Thomas Cooney (0), Caleb Hansen (0), and Ben Sweet (0)

---

[1] Numbers in parentheses indicate the number of seasons 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 raptors observed on migration at Commissary Ridge, Wyoming.

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	A I Br U	M F 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	AM 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 raptor counts by species during fall migration at Commissary Ridge, Wyoming: 2002–2015.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Mean
Start date	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug
End date	29-Oct	29-Oct	3-Nov	31-Oct	31-Oct	5-Nov	5-Nov	5-Nov	5-Nov	31-Oct	5-Nov	28-Oct	4-Nov	1-Nov	1-Nov
Observation days	45	63	65	64	56	66	66	64	65	61	68	57	66	65	62.1
Observation hours	322.67	474.85	452.67	478.83	443.58	494.56	493.33	531.82	538.58	510.25	557.83	398.58	491.33	532.5	480.1
Raptors/100 hrs	991	644	917	985	415	990	911	559	1040	526	662	693	380	809	751.6
SPECIES	RAPTOR COUNTS														
Turkey Vulture	97	66	164	114	39	185	150	50	108	46	50	121	31	90	93.6
Osprey	11	31	59	36	11	41	27	34	54	41	25	41	6	39	32.6
Northern Harrier	32	25	38	36	26	30	32	38	36	9	32	7	6	64	29.4
Sharp-shinned Hawk	675	516	1,118	1,687	217	1,214	1,109	690	1425	1,140	924	698	600	1,321	952.4
Cooper's Hawk	409	329	614	462	289	535	382	298	669	296	393	389	148	526	409.9
Northern Goshawk	21	7	49	35	26	89	52	32	35	14	53	10	4	48	33.9
Unknown accipiter	100	146	178	68	51	180	82	124	296	214	50	36	49	71	117.5
TOTAL ACCIPITERS	1,205	998	1,959	2,252	583	2,018	1,625	1,144	2,425	1,664	1,420	1,133	801	1,966	1513.8
Broad-winged Hawk	8	5	22	9	3	7	13	26	58	21	16	31	0	30	17.8
Swainson's Hawk	82	28	62	52	47	36	352	119	1,211	80	153	26	16	202	176.1
Red-tailed Hawk	823	1,042	961	1,319	563	1,459	1,148	987	872	386	1,043	892	530	1,070	935.4
Ferruginous Hawk	6	3	15	8	7	3	7	9	11	5	11	4	3	3	6.8
Rough-legged Hawk	5	5	8	13	5	13	34	7	33	4	24	8	3	11	12.4
Unidentified buteo	17	87	63	42	35	63	144	43	61	44	31	34	73	47	56.0
TOTAL BUTEOS	941	1,170	1,131	1,443	660	1,581	1,698	1,191	2,246	540	1,278	995	625	1,363	1204.4
Golden Eagle	352	233	152	316	211	324	345	211	253	136	350	167	136	359	253.2
Bald Eagle	233	90	76	137	82	299	262	86	193	102	207	59	108	169	150.2
Unidentified eagle	10	7	10	2	6	25	34	0	16	16	39	4	22	9	14.3
TOTAL EAGLES	595	330	238	455	299	648	641	297	462	254	596	230	266	537	417.7
American Kestrel	258	355	403	317	156	229	219	151	196	73	209	127	64	189	210.4
Merlin	9	6	26	11	10	24	25	23	29	5	32	8	4	19	16.5
Prairie Falcon	6	5	6	18	13	21	6	4	15	7	13	13	9	11	10.5
Peregrine Falcon	3	3	11	13	9	18	15	16	20	6	17	8	16	8	11.6
Unknown falcon	2	3	12	4	16	16	15	3	4	7	8	7	10	11	8.4
TOTAL FALCONS	278	372	458	363	204	308	280	197	264	98	279	163	103	238	257.5
Unidentified raptor	38	68	102	19	19	83	39	20	7	32	13	72	28	12	39.4
ALL SPECIES	3,197	3,060	4,149	4,718	1,841	4,894	4,492	2,971	5,602	2,684	3,693	2,762	1,866	4,309	3588.4