FALL 2015 RAPTOR MIGRATION ANNUAL REPORT: BONNEY BUTTE HAWKWATCH, HOOD RIVER CO.,OREGON

HawkWatch International, Inc.
Salt Lake City, Utah

Mt. Hood National Forest

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INTRODUCTION

The Bonney Butte HawkWatch in the northern Cascade Mountains of Oregon is an ongoing effort to monitor long-term regional population trends of diurnal raptors that migrate through the Cascade Mountains portion of the Pacific Coast Flyway (Hoffman et al. 2002, Smith et al. 2008a). HawkWatch International (HWI) initiated standardized counts of the autumn raptor migration at Bonney Butte in 1994, and began a trapping and banding program at the site in 1995. To date, HWI observers have recorded 18 species of migratory raptors at the site, with counts typically ranging between 2,000 and 4,000 migrants per season. The 2015 season marked the 22st consecutive year of counting and the 20th season of banding efforts. This report summarizes the 2015 fall raptor migration season.

The Bonney Butte HawkWatch was 1 of 8 long-term, annual migration counts and 1 of 4 migration banding studies conducted or co-sponsored by HWI 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 Gulf Coast region in Texas (Hoffman and Smith 2003; Smith et al. 2001, 2008a, b). Raptors can serve as important biological indicators of ecosystem health (Bildstein 2001) and long-term migration counts are one of the most cost effective and efficient methods for monitoring the regional status and trends of multiple raptor species (Zalles and Bildstein 2000, Bildstein et al. 2008).

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 Bonney Butte HawkWatch and outreach efforts here reach hundreds of people from the Portland area, western Oregon and beyond each season.

STUDY SITE

Bonney Butte is located approximately 9.5 km ESE of Government Camp, on the east side of the White River drainage within the Mt. Hood National Forest, Hood River County, Oregon (45°15'46.8" N, 121°35'31.2" W; elevation 1,754 m; Fig. 1). The butte is the southern terminus of Surveyor's Ridge, which originates near Hood River, Oregon south of the Columbia River Gorge. The ridge extends southward for approximately 50 km and ends southeast of Mt. Hood. The observation site is located on the highest point of the butte. The trapping station is located approximately 500 m north on a separate knoll and is slightly higher in elevation in relation to the observation site. The intervening space is largely forested and the central Oregon shrub-steppe region lies immediately to the east.

METHODS

STANDARDIZED COUNTS

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 was used on effort-adjusted annual passage rates (raptors/100hrs) to identify long-term trends in migrating raptors.

TRAPPING AND BANDING

Similar to the counts, trapping and banding efforts began late August and continued through late October at a single banding station, generally between 0900–1700 hrs PST (see Appendix F for daily trapping records). Capture devices included mist 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

Bonney Butte HawkWatch's standard season runs 27 August – 31 October; in 2015 observers were able to count on 45 of 66 possible days during this period for a total of 365.7 hours (Appendix C). The number of count days this season was about 6 days below the site long-term (1994-2014) average of 51 days and the total hours counted for the season was nearly 21 hours below the long-term average (Appendix C). Lower than average count effort can mainly be attributed to a temporary suspension of one week (6 – 13 October) during the middle of the season due to a nearby wildfire. Weather prohibited counting on 13 days with an additional 2 days suspended with <4 hrs of observation due to weather. Weather varies throughout every season, in 2015 based on hourly recording of conditions during observation hours it was clear 38% of the time; partly cloudy 28% of the time; mostly cloudy 14% of the

time; overcast and/or foggy 22% of the time; hazy 27% of the time; and raining or snowing less than 1% of the time.

2015 FLIGHT SUMMARY

Overall Flight:

A total of 2,704 migrating raptors of 17 species were counted in 2015, an average year based on the long-term site average (Table 1).

The flight consisted of 46.3% accipiters, 23.1% buteos, 18.3% vultures, 3.7% falcons, 5.0% eagles, 2.5% Ospreys, 0.9% harriers, and 0.3% unknown raptors. The relative proportions of buteos, eagles, harriers, and Ospreys surpassed historic averages; while accipiters, falcons, and vultures were lower than average (Fig. 3). Sharp-shinned Hawks were the most common species (33% of the total), followed by Cooper's Hawks (19%), Red-tailed Hawks (17%), Turkey Vultures (13%), Merlins (3%), Ospreys (2%), Northern Goshawks (2%), Golden Eagles (2%), and Bald Eagles (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 first and second order regression analysis. HWI only depicts significant trends for species with a historic average count rate greater than or equal to 10 individuals per 100 hours. The rationale is that trends for counts below this point likely do not contain biologically useful information on regional populations—species with counts this low likely have a dispersed migration, another primary migration 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 739 raptors counted per 100 hours of observation at the Bonney Butte HawkWatch in 2015 was consistent with the site average of 767 raptors/100 hrs from 1994-2014. The 2015 season marks the first time our raptor/100 hrs total has not been low relative to site average since 2012. The fall flight at Bonney Butte has been stable over the history of the site (no significant trend over time).

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

Both seasonal counts and effort-adjusted passage rates (raptors/100 hrs) were average this year for Osprey and Northern Harriers (Table 1). Seasonal counts and effort-adjusted passage rates were both high compared to historical averages for Turkey Vultures. Based on regression analysis of passage rates, regional Harrier populations are declining (slope = -0.3, $r^2 = 0.27$, p=0.016). Turkey Vulture and Osprey numbers have been stable over the 22 years that HWI has been monitoring migration at Bonney Butte (no significant statistical trend).

Accipiters (Fig. 3b):

Seasonal counts for Cooper's Hawks, Sharp-shinned Hawks and Northern Goshawks were below average. Effort-adjusted passage rates were below average for Northern Goshawks and Cooper's Hawks while passage rates of Sharp-shinned hawks were average (Table 1). The long-term regional population trends for all three species are stable based on regression of yearly passage rates (no significant trends).

Buteoine Hawks (Fig. 3c):

We counted 624 total buteos in 2015, an increase of 201 from 2014. Red-tailed Hawk populations in the region are declining based on regression analysis of annual fall passage rates (slope= -3.8, $r^2 = 0.24$, p=0.02).

Eagles (Fig.3d):

Golden Eagle counts have been below average for the past four consecutive seasons. However, this past season's Bald Eagle count was above average and the highest it has been since 2011. Golden Eagle passage rates continue to decline over time at this site (slope = -0.9, $r^2 = 0.39$, $p = 0.002$). Similar declines have been documented across North America and targeted research efforts are underway, including some by HWI, to further understand Golden Eagle, ecology, movements and demographics. Regional populations of Bald Eagles are stable based on regression of Bonney Butte annual passage rates (no significant trend).

Falcons (Fig. 3e):

It was an average or above average year counts and passage rates for Prairie and Peregrine Falcons at Bonney Butte, respectively. Yearly counts and passage rates Merlins were also above average while American Kestrels were below average for the third straight year (Table 1). Despite traditionally low passage rates (below the 10 per 100 hr threshold), it is worth noting that Kestrel rates at Bonney Butte have been declining annually (slope= -0.3, $r^2 = 0.57$, $p<0.001$) because similar trends have been seen for this species across the HWI network and at other count sites. In response to these declines, HWI, along with many other North American researchers and Citizen Scientists are working to understand Kestrel declines both locally (www.hawkwatch.org/kestrels) and at the continental scale and have partnered under the umbrella of the American Kestrel Partnership (http://kestrel.peregrinefund.org/).

TRAPPING EFFORT

Crews trapped for 42 days (totaling 306.5 hours) between 27 August and 25 October and captured 260 raptors of nine different species. Due to local fires the crew was forced to shut down operations for a week during the middle of the migration season. The number of hours trapped was high compared to historic annual site average (Appendix D), the number of birds caught was below average, and the overall capture rate (birds captured/100hrs trapping (Table 2), was also low. All capture totals and rates were at or below historical averages with Sharp-shinned Hawk and Red-tailed Hawk having the lowest totals and rates of all captured species.

Season highlights included a Northern Harrier (hatch-year female), two Golden Eagles (both hatch-year males), two Prairie Falcons (hatch-year male and female), and a Peregrine Falcon (hatch-year male).

RECAPTURES

There were no in-house (HWI banded birds) recaptures and one "foreign recapture" (recapture of bird banded elsewhere) at the site in 2015. The individual was a hatch-year Red-tailed Hawk that was banded the day prior at Portland International Airport.

FOREIGN ENCOUNTERS WITH PREVIOUSLY BANDED BIRDS

To date 102 birds banded at Bonney Butte have been recaptured/recovered and reported to the USGS Bird Banding Laboratory (Fig. 6). During 2015, four birds banded at Bonney Butte were reported to the BBL, which then passed the information to HWI. These recoveries included two Sharp-shinned Hawks and two Merlins (Fig. 6, Table 3). One Merlin (after-hatch-year male – 2015) died in California after striking an object other than a wire or tower in flight and the other (hatch-year female 2014) was shot in Zacatecas, Mexico. One Sharp-shinned Hawk (after-hatch-year female – 2014) was found dead in Oregon and the other (hatch-year female-2015) was recaptured and released in California. All four of the birds encountered in 2015 were originally banded at Bonney Butte in 2014 or 2015.

VISITOR PARTICIPATION AND PUBLIC OUTREACH

Approximately 310 individuals visited the site during the 2015 season. The largest attendance in a single day was September 26th, with 49 visitors. Visitors to the site get to see raptors in flight and in hand prior to release post- banding, learn to identify raptors in flight and also about raptor migration ecology and what banding and counting efforts can tell us about regional raptor populations and the health of the landscapes they use. They also learn about the ecosystems found around the Bonney Butte HawkWatch and are introduced to/reminded about leave no trace outdoor ethics. Most visitors were from Oregon and Washington, but the crew also met visitors from Arizona, Florida, and the United Kingdom.

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 8 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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Table 1. Historic fall raptor migration counts (mean±95% CI), counts from fall 2015, and site records at Bonney Butte, OR.

		1994-2014					All-time Historic Records	
	Species	**Mean Count ± 95 % CI**			**2015**	**% Change**	**Season**	**Daily**
	Turkey Vulture	346.8	±	66.7	494	42.5	790 (2012)	174 (2011)
	Osprey	68.6	±	9.8	67	-2.3	121 (2012)	22 (2000)
	Northern Harrier	27.3	±	5.3	24	-12.0	56 (1998)	12 (1998)
Accipiters								
	Sharp-shinned Hawk	1128.5	±	132.7	964	-14.6	1790 (2004)	215 (2012)
	Cooper's Hawk	349.3	±	38.1	226	-35.3	485 (2004)	67 (2011)
	Northern Goshawk	27.9	±	5.2	19	-31.8	53 (2014)	9 (2014)
	Unidentified accipiter	80.7	±	17.6	44	-45.5	160 (2008)	
	TOTAL ACCIPITERS	1586.3	±	160.7	1253	-21.0	2337 (2004)	
Buteos								
	Red-shouldered Hawk	1.2	±	0.7	1	-16.0	7 (2004)	2 (2004)
	Broad-winged Hawk	6.2	±	6.9	4	-35.9	75 (1999)	65 (1999)
	Swainson's Hawk	0.8	±	0.5	1	23.5	4 (2010)	3 (2010)
	Red-tailed Hawk	560.8	±	65.3	614	9.5	932 (1999)	99 (2011)
	Ferruginous Hawk	0.3	±	0.2	0	-100	1 (2013)	1 (7x)
	Rough-legged Hawk	12.0	±	3.5	1	-91.7	30 (2000)	9 (2012)
	Unidentified buteo	26.4	±	7.6	3	-88.6	58 (1999)	
	TOTAL BUTEOS	607.8	±	72.1	624	2.7	1090 (1999)	
Eagles								
	Golden Eagle	82.9	±	13.2	56	-32.5	176 (1999)	23 (1997)
	Bald Eagle	50.8	±	6.1	78	53.5	93 (2011)	23 (2011)
	Unknown eagles	3.4	±	1.1	1	-70.6	9 (1997)	
	TOTAL EAGLES	136.8	±	14.9	135	-1.3	231 (1999)	
Falcons								
	American Kestrel	18.5	±	3.3	8	-56.8	35 (1997)	5 (2x)
	Merlin	73.8	±	10.3	69	-6.5	114 (2011)	28 (2011)
	Prairie Falcon	4.8	±	1.1	4	-16.8	10 (1998)	2 (10x)
	Peregrine Falcon	8.6	±	2.3	12	39.2	21 (2011)	4 (2011)
	Unidentified falcon	4.1	±	1.8	7	70.9	18 (2005)	
	TOTAL FALCONS	109.9	±	11.3	100	-9.0	148 (1997)	
	Unidentified Raptor	20.9	±	8.7	7	-66.4	90 (1997)	
	GRAND TOTAL	2904.2	±	278.9	2704	-6.9	4133 (1999)	425 (2011)

Table 2. Capture totals and rates for fall migrating raptors at Bonney Butte, OR: 1996–2014 versus 2015.

	Capture Totals			Capture Rate[1]		
	1996-2014[2]	2015	Seasonal Record	1996-2014[2]	2015	Seasonal Record
Northern Harrier	1.8 ± 0.9	1	7	0.6 ± 0.3	0.3	2.0
Sharp-shinned Hawk	188.9 ± 32.2	147	337	67.1 ± 7.0	48.0	93.7
Cooper's Hawk	63.4 ± 12.2	57	101	21.8 ± 2.9	18.6	38.1
Northern Goshawk	8.8 ± 2.5	10	21	3.2 ± 0.9	3.3	8.0
Red-shouldered Hawk	0.2 ± 0.2	0	1	0.0 ± 0.0	0.0	0.3
Broad-winged hawk	0.2 ± 0.2	0	1	0.1 ± 0.1	0.0	0.4
Red-tailed Hawk	51.0 ± 11.6	34	108	18.1 ± 3.2	11.1	30.2
Rough-legged Hawk	0.4 ± 0.2	0	1	0.1 ± 0.1	0.0	0.7
Golden Eagle	1.7 ± 0.6	2	6	0.6 ± 0.2	0.7	1.7
Bald Eagle	0.2 ± 0.2	0	2	0.0 ± 0.1	0.0	0.6
American Kestrel	0.6 ± 0.3	0	2	0.3 ± 0.2	0.0	1.4
Merlin	6.4 ± 1.7	6	13	2.2 ± 0.5	2.0	5.5
Prairie Falcon	1.4 ± 0.6	2	4	0.5 ± 0.2	0.7	1.7
Peregrine Falcon	0.5 ± 0.5	1	4	0.2 ± 0.1	0.3	1.2
All Species	325.5 ± 53.6	260	522	114.9 ± 11.2	84.8	167.4

[1] Captures / 100 station hours.
[2] Mean of annual values ± 95 % confidence interval

Table 3. Foreign encounters with raptors originally banded at the Bonney Butte HawkWatch in Oregon: 2015.

Band #	Species[1]	Sex	Banding Date	Banding Age[2]	Encounter Location	Encounter Date	Distance (KM)	Status
1084-11426	MERL	F	19-Sep-14	HY	Valparaíso, Zacatecas, Mexico	23-Jan-15	2862	Found dead - Shot
1833-07824	SSHA	F	12-Oct-14	AHY	Madras, Oregon	13-Apr-15	91	Found dead - Unknown cause
1613-17759	MERL	M	15-Sep-15	AHY	Hollister, California	19-Nov-15	879	Found dead - Struck object other than wire or tower in flight
1833-07896	SSHA	F	25-Sep-15	HY	Sausalito, California	23-Nov-15	779	Captured - Released during banding operations

[1] Species: MERL = Merlin; SSHA = Sharp-shinned Hawk.

[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).

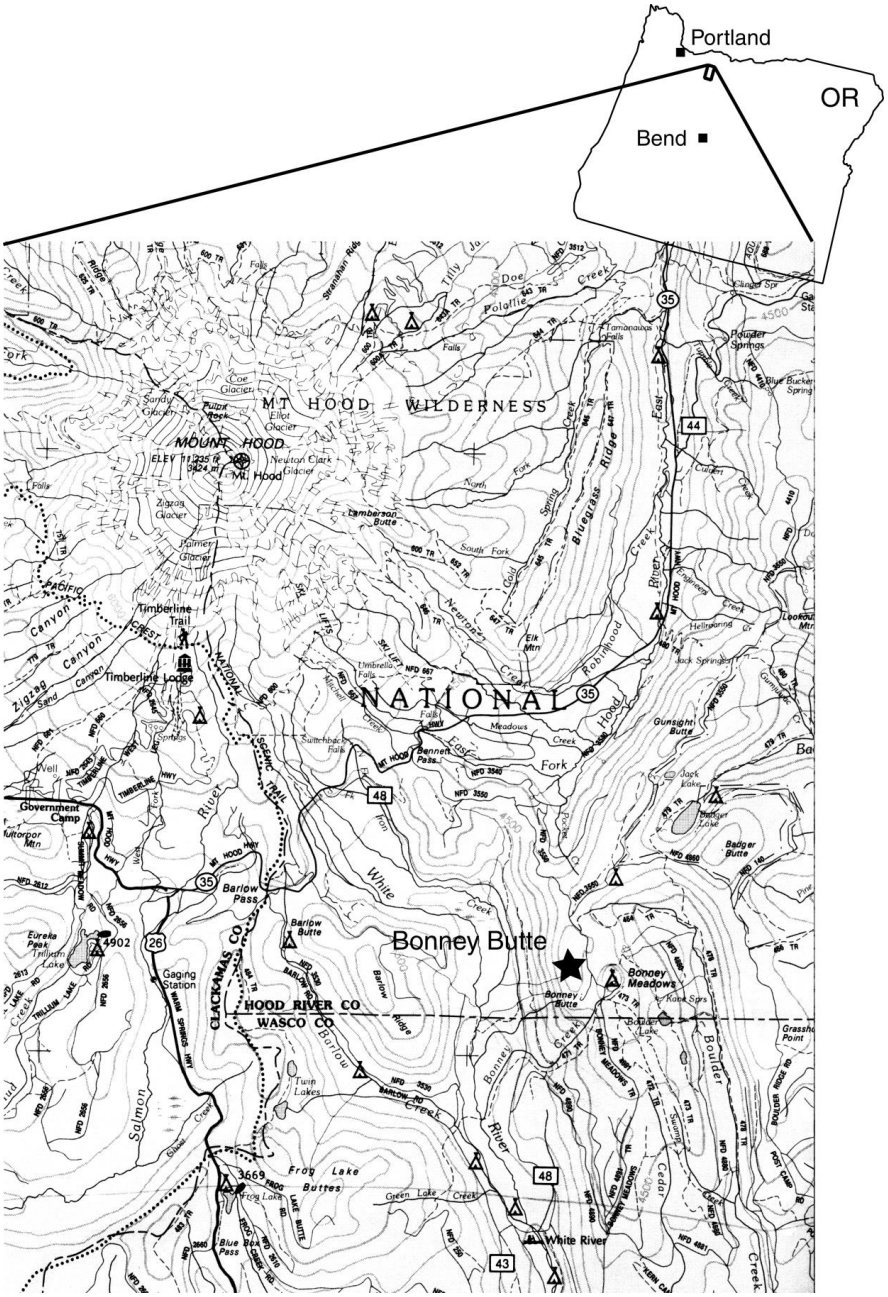

Figure 2. Location of the Bonney Butte HawkWatch near Mt. Hood, Oregon.

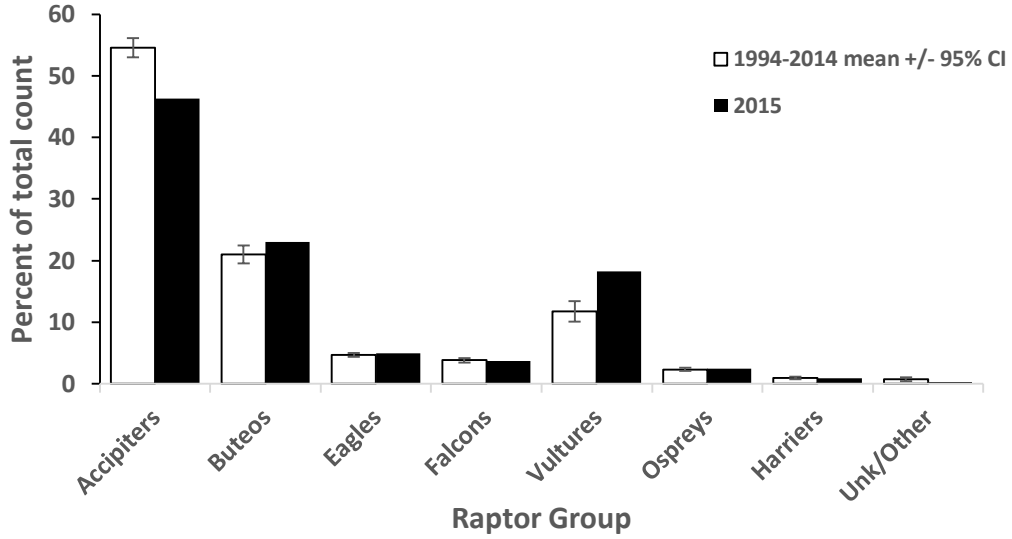

Figure 3. Fall raptor migration flight composition by major species groups at Bonney Butte, Oregon: 1994–2014 versus 2015.

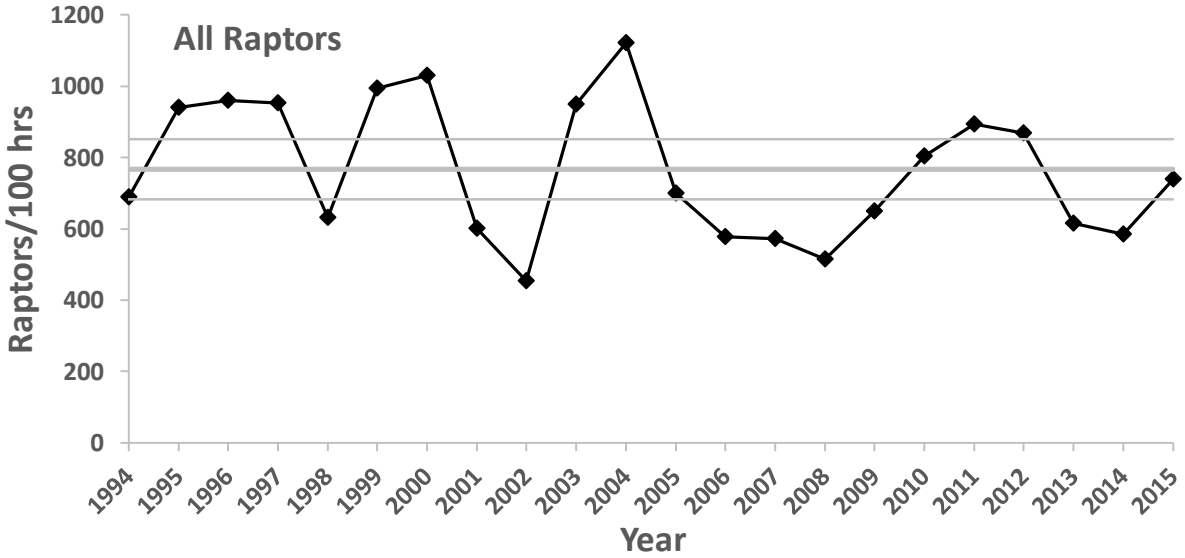

Figure 4. Fall migration passage rates at Bonney Butte, OR for all migrating raptors: 1994-2015. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2014) at Bonney Butte.

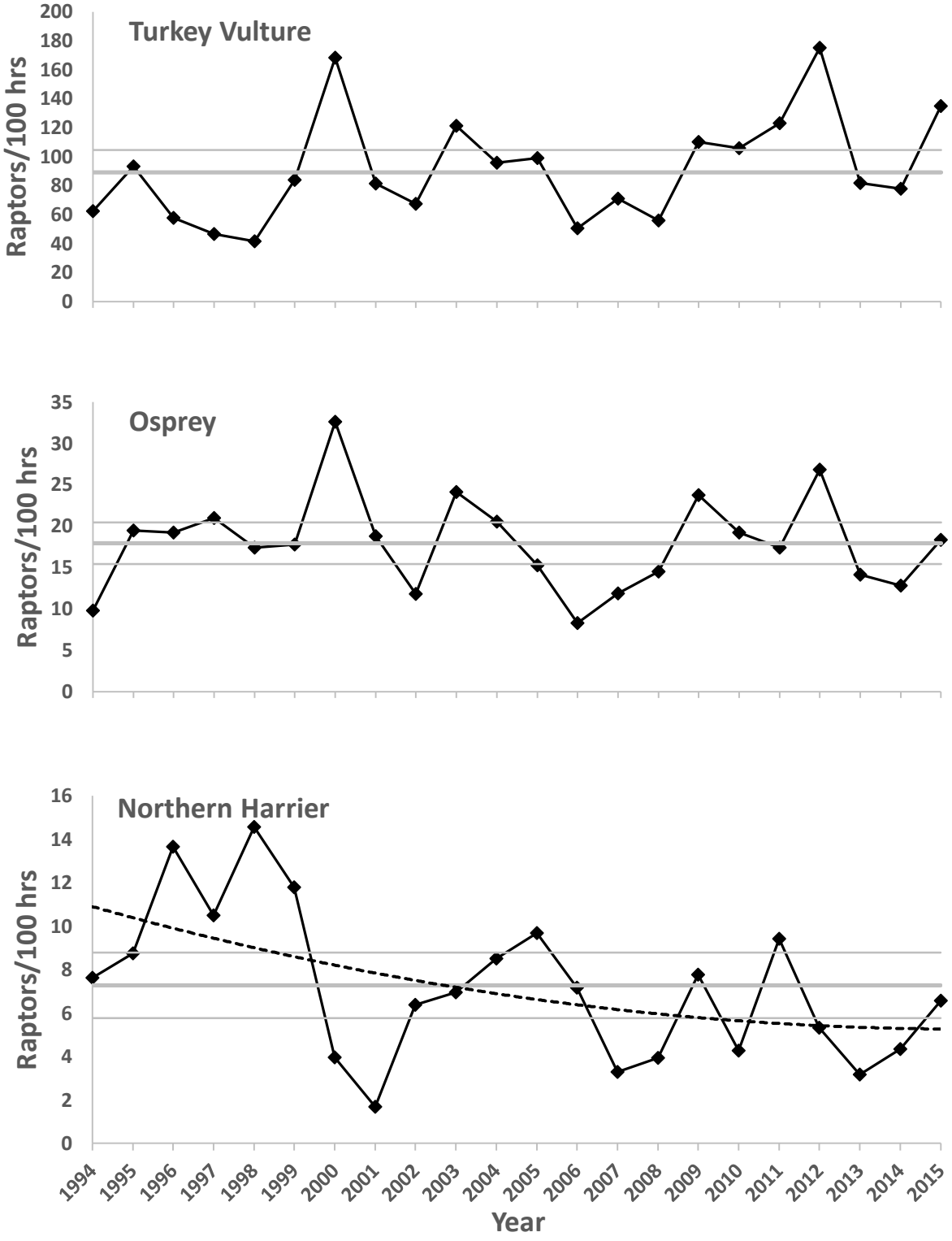

Figure 5a. Fall-migration passage rates at Bonney Butte, OR for Turkey Vultures, Ospreys, and Northern Harriers: 1994–2015. Dashed lines indicate trends for significant ($p < 0.05$) linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1994-2014).

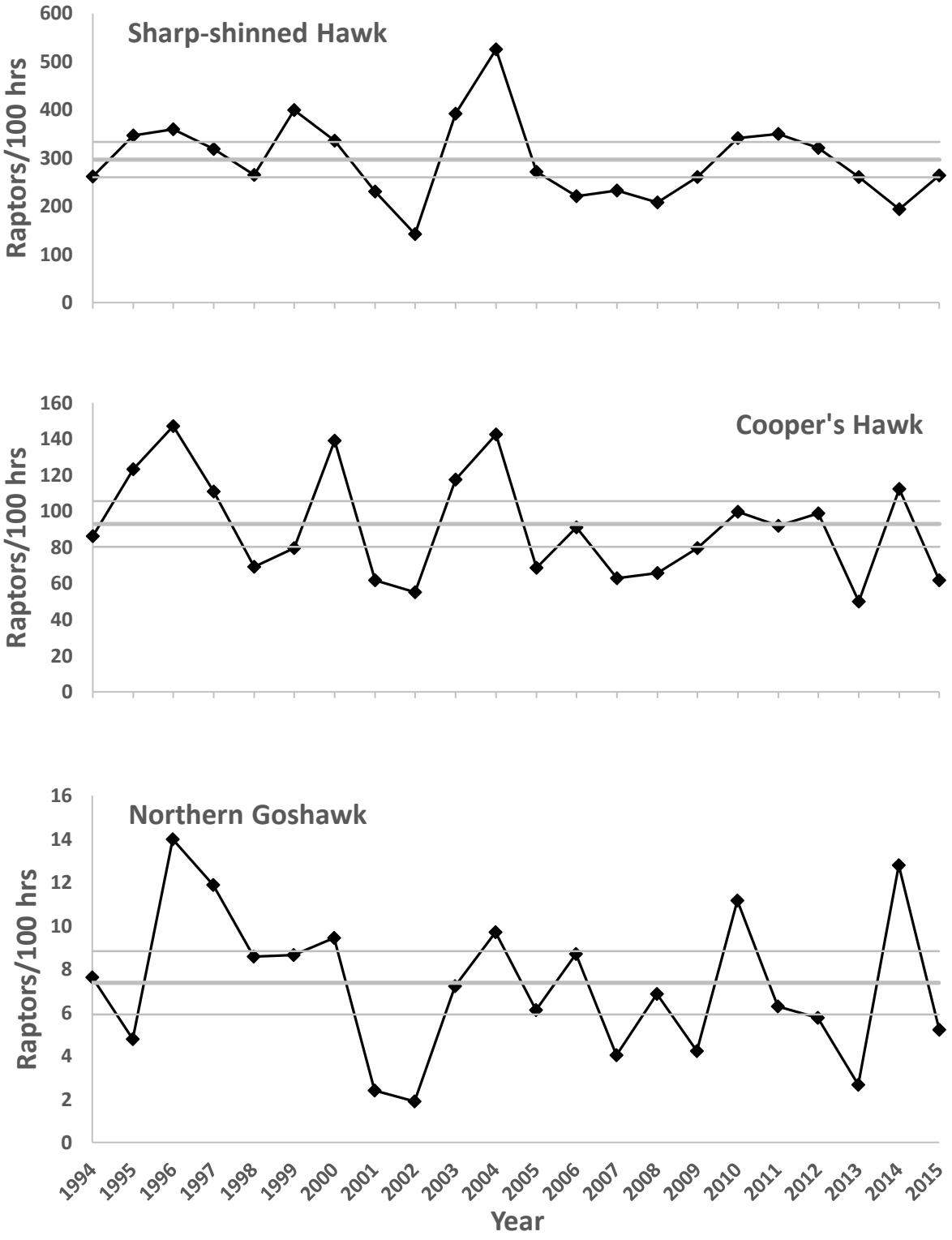

Figure 5b. Fall-migration passage rates at Bonney Butte, OR for the three North American accipiter species: 1994–2015. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1994-2014).

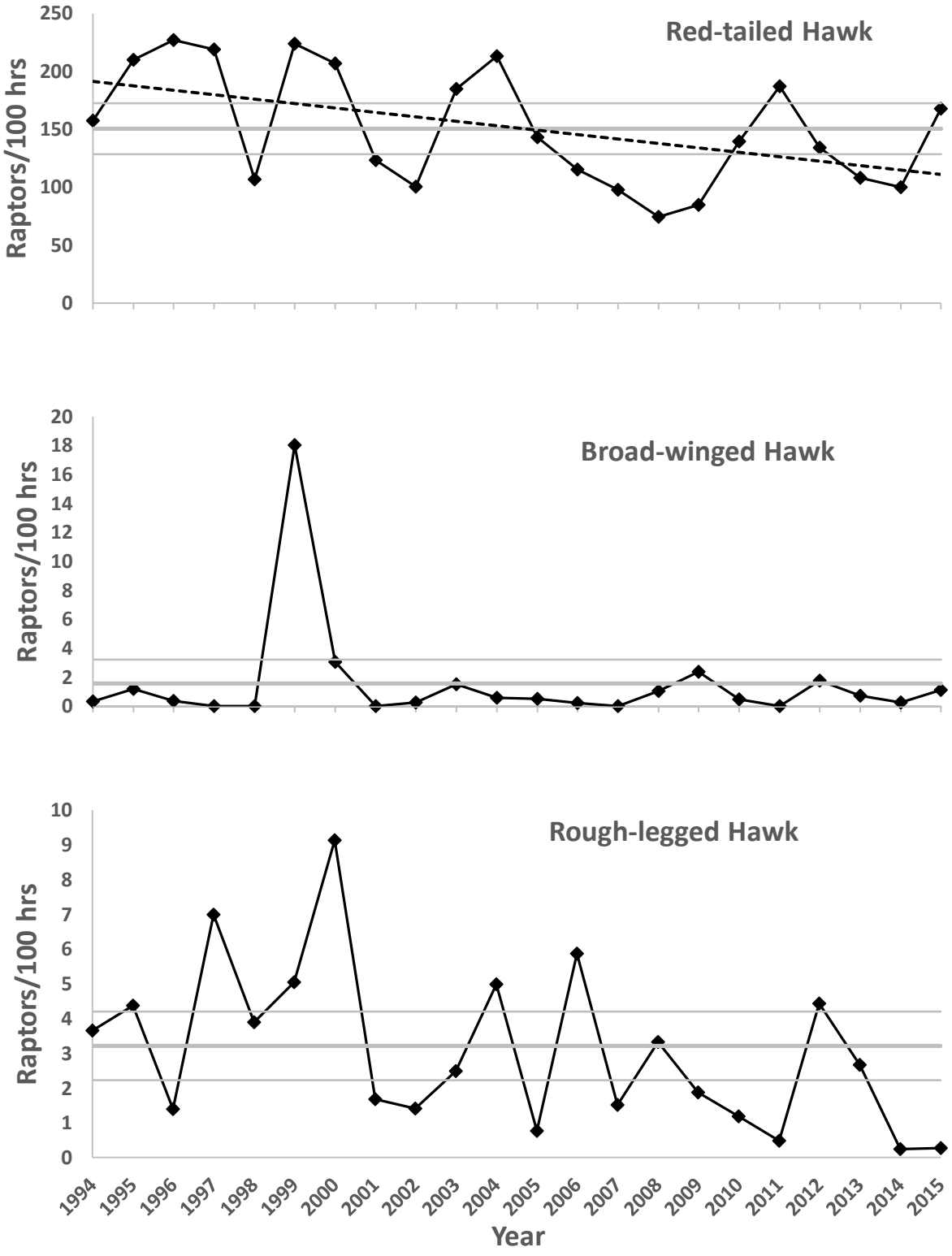

Figure 5c. Fall-migration buteo passage rates at Bonney Butte, OR: 1994–2015. Dashed lines indicate significant ($p < 0.05$) population trends based on linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1994-2014).

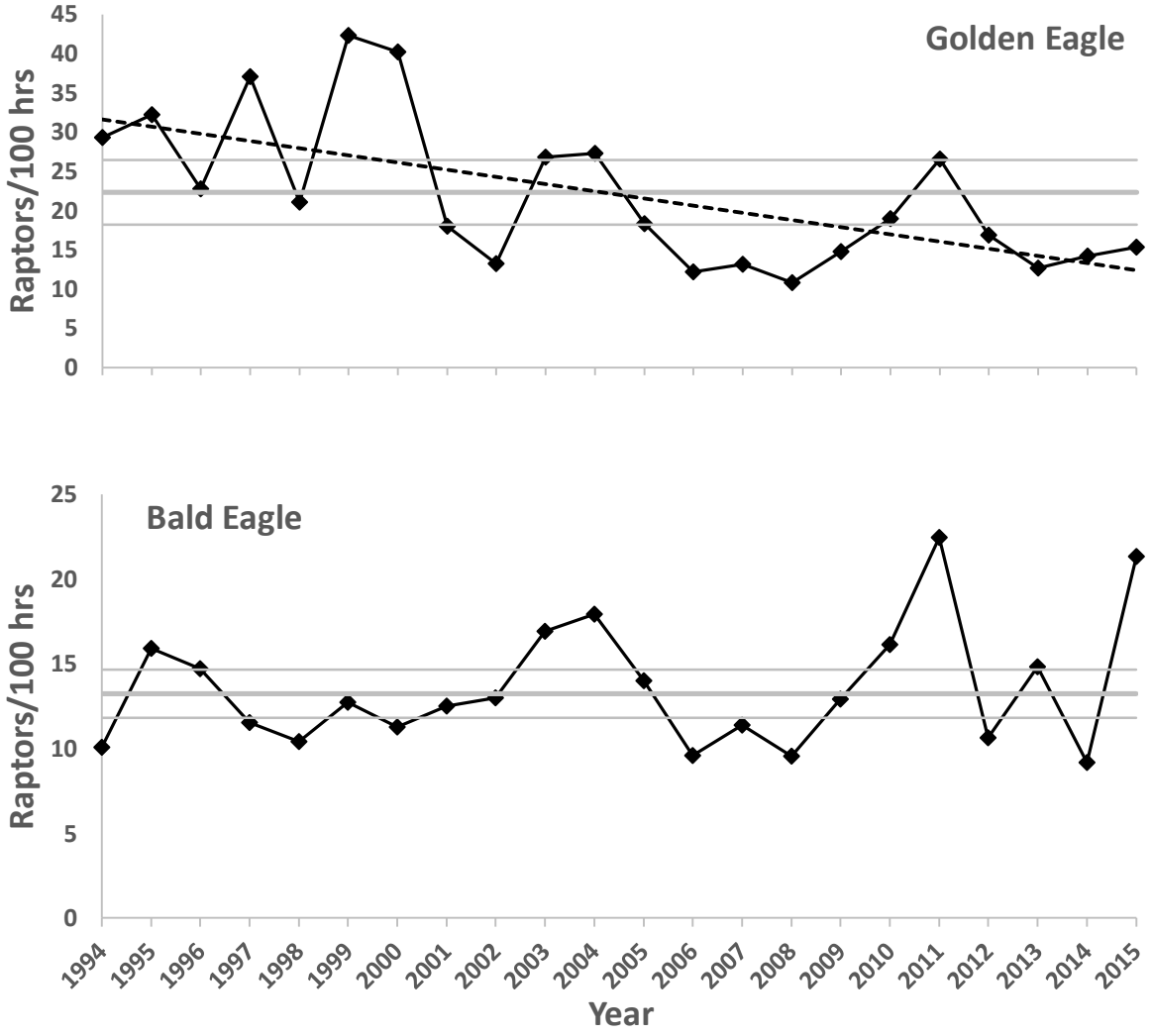

Figure 5d. Eagle passage rates for the fall migration at Bonney Butte, OR: 1994–2015. Dashed lines indicate trends for significant ($p < 0.05$) linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1994-2014).

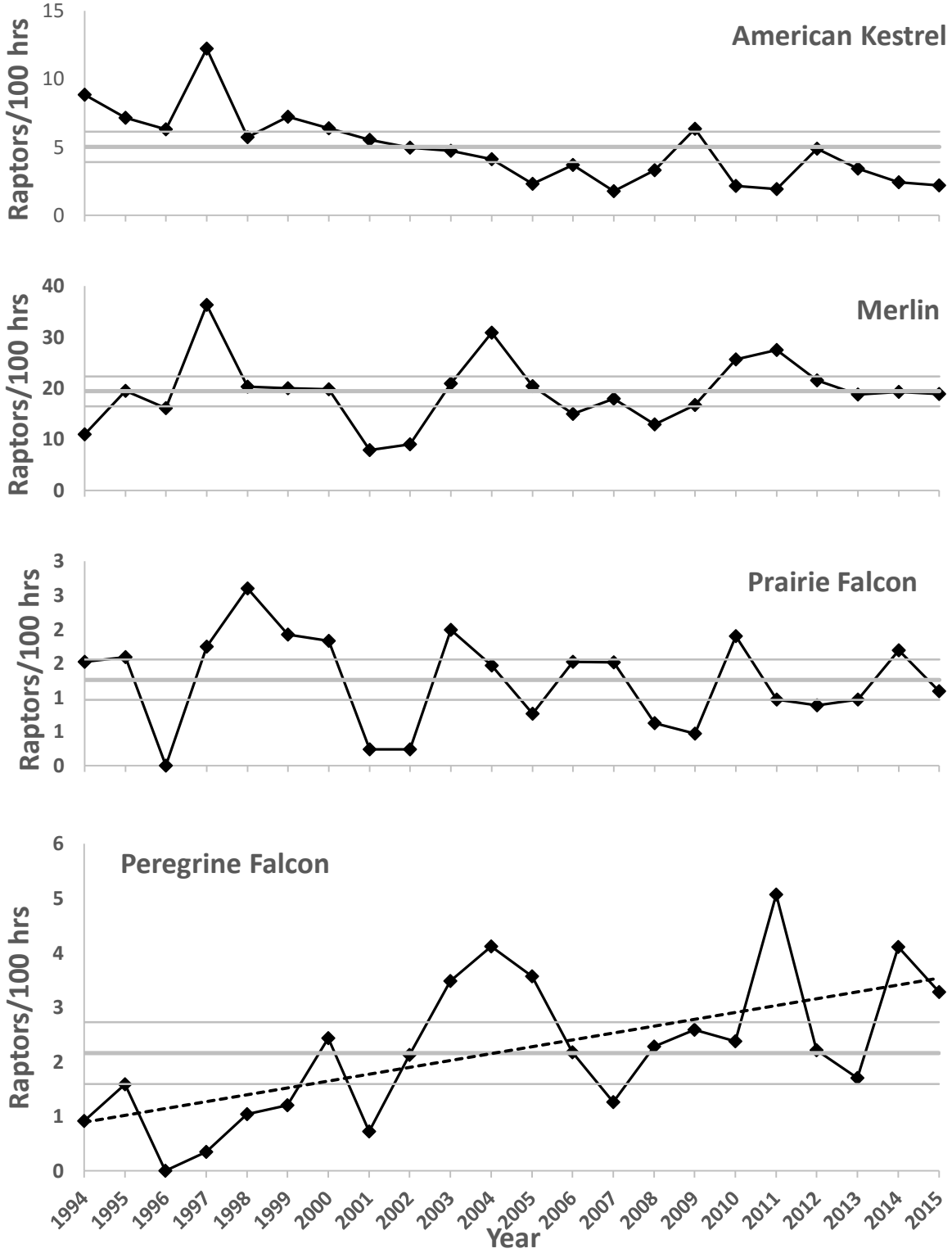

Figure 5e. Fall-migration falcon passage rates at Bonney Butte, OR: 1994–2015. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1994-2014).

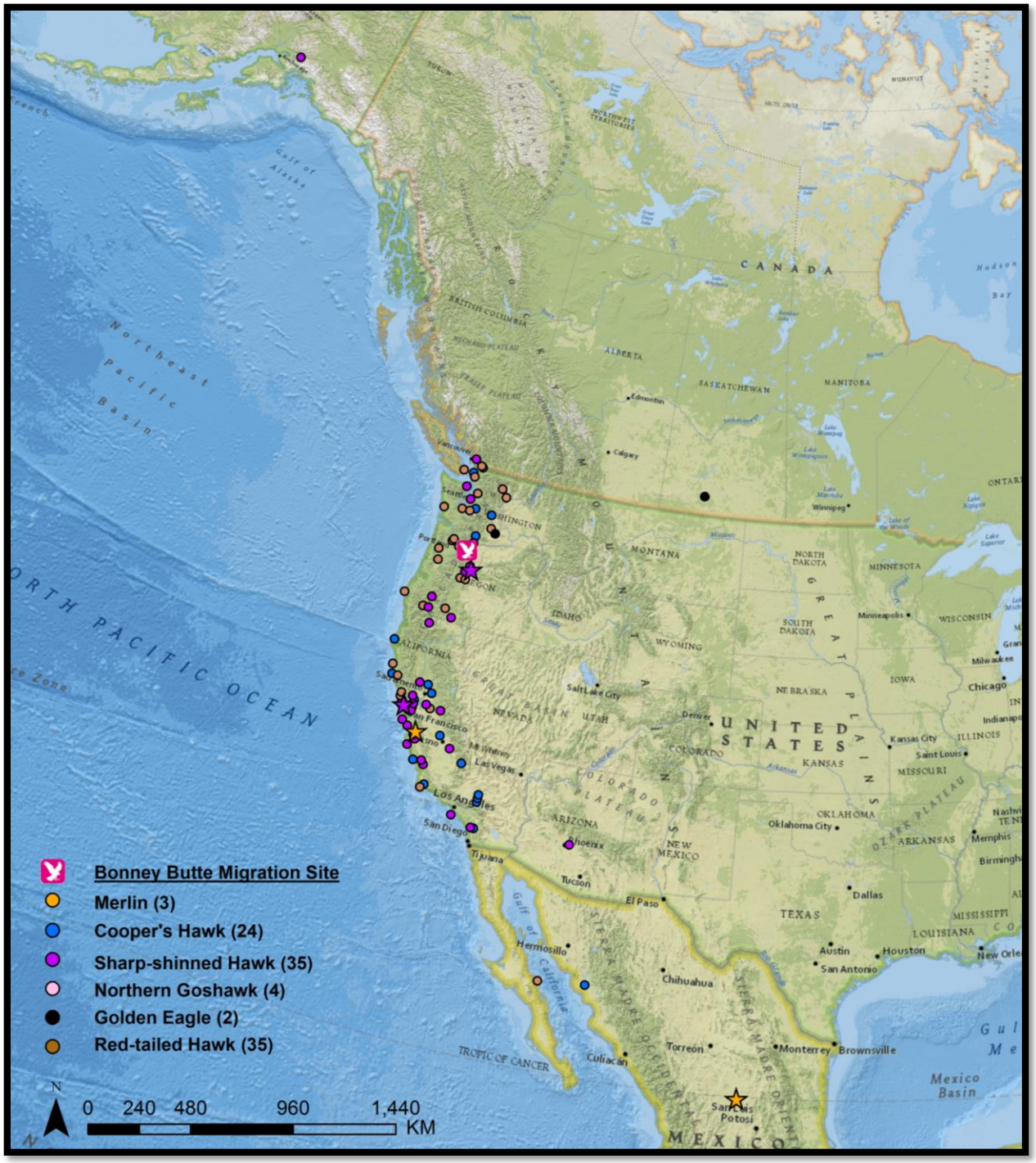

Figure 6. Recovery locations of raptors banded at Bonney Butte, OR. Circles indicate recoveries from 1995-2014, stars indicate 2015 recoveries.

Appendix A. A history of observer participation in the Bonney Butte Raptor Migration Project in northern Oregon.

1994: Single observer throughout: David Schuetze (0) and Sean O'Connor (0)[1].

1995: Two observers throughout: David Schuetze (1) and Alison Clark (0).

1996: Two observers throughout: David Schuetze (2) and Alison Clark (1).

1997: Two observers throughout: Rose Jaffe (0) and Sean Donaghy (0).

1998: Two observers throughout: Nick Vulgares (1) and Jeremy Davit (0).

1999: Two observers throughout: Nick Vulgares (3) and Sue Vulgares (0).

2000: Two observers throughout: Nick Vulgares (5) and Sue Vulgares (2).

2001: Two observers throughout: Alison Cebula Benedict (1) and Eric Hallingstad (0).

2002: Two observers throughout: Eric Hallingstad (1) and Sue Bruner (1).

2003: Two observers throughout: David Haines (0) and Lindsay Reynolds (0).

2004: Two observers throughout: David Haines (1) and Amy Scarpignato (+).

2005: Two observers throughout: Sean Wolfe (0) and Jim DeStaebler (0)

2006: Two observers throughout: Justin Feld (0) and Juliet Lamb (0).

2007: Two observers throughout: Mary Coolidge (1) and Sue Bruner (2)

2008: Two observers throughout: Aaron Viducich (1) and James Butch (0)

2009: Two observers throughout: James Butch (2) and Glen McHargue (0)

2010: Two observers throughout: Juliet Lamb (1), Yvan Satge (0), and Andrew Tillinghast (0)

2011: Two observers throughout: Robert Baez (2), Jade Ajani (0), and Adam Baz (0)

2012: Two observers throughout: Frank Mayer (4), Jade Ajani (1), Andrew Rosenberg (0), and Sanders Li Ho (0)

2013: Two observers throughout: Mary Coolidge (2), Jeremy Halka (0), Jade Ajani (2), and Andrew Rosenberg (1)

2014: Two observers throughout: Gaelyn Tso-Jun Ong (1), Allison Beard (0), Dustin Maloney (0)

2015: Two observers throughout: Jeremy Halka (2), Liz Bartholomew (0), Scott Shively (0), and Maddie Ore (0)

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[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 diurnal raptor species observed during fall migration at Bonney Butte, Oregon.

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
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
Red-shouldered Hawk	*Buteo lineatus*	RS	A, I, U	U	NA
Broad-winged Hawk	*Buteo platypterus*	BW	A I U	U	D L U
Swanson's Hawk	*Buteo swainsoni*	SW	U	U	D L U
Red-tailed Hawk	*Buteo jamaicensis*	RT	A I U	U	D L U
Ferruginous Hawk	*Buteo regalis*	FH	A I U	U	D L U
Rough-legged Hawk	*Buteo lagopus*	RL	U	U	D L U
Unknown buteo	*Buteo* spp.	UB	U	U	D L U
Golden Eagle	*Aquila chrysaetos*	GE	I, S, NA, A, U[4]	U	NA
Bald Eagle	*Haliaeetus leucocephalus*	BE	I, S1, S2, NA, A, U[5]	U	NA
Unknown eagle	*Aquila* or *Haliaeetus spp.*	UE	U	U	NA
American Kestrel	*Falco sparverius*	AK	U	M F U	NA
Merlin	*Falco columbarius*	ML	AM Br U	AM Br U	NA
Prairie Falcon	*Falco mexicanus*	PR	U	U	NA
Peregrine Falcon	*Falco peregrinus*	PG	A I U	U	NA
Unknown small falcon	*F. sparverius* or *columbarius*	SF	U	U	NA
Unknown large falcon	*F. mexicanus* or *peregrinus*	LF	U	U	NA
Unknown falcon	*Falco* spp.	UF	U	U	NA
Unknown raptor	Falconiformes	UU	U	U	NA

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

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

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

[4] Golden Eagle age codes: I = Immature: juvenile or first-year bird, bold white wing patch visible below, bold white in tail, no molt; S = Subadult: white wing patch variable or absent, obvious white in tail and molt or tawny bar visible on upper wing; NA = Not adult: unknown age immature/subadult; A = Adult: no white in wings or tail; U = Unknown.

[5] Bald Eagle age codes: I = Immature: juvenile or first-year bird, dark breast and tawny belly; S1 = young Subadult: Basic I and II plumages, light belly, upside-down triangle on back; S2 = older Subadult: Basic III plumage, head mostly white with osprey-like dark eye line and dark band on tail; NA = Not adult: unknown age immature/subadult; A = Adult: includes near adult with dark flecks in head and dark tail tip, and adult with white head and tail; U = Unknown.

Appendix C. Annual observation effort and fall raptor migration counts by species at Bonney Butte, Oregon: 1994–2015.

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Start date	2-Sep	4-Sep	1-Sep	1-Sep	1-Sep	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug
End date	25-Oct	31-Oct	2-Nov	3-Nov	30-Oct	28-Oct	30-Oct	28-Oct	31-Oct	31-Oct
Observation days	47	38	46	45	52	63	48	58	59	51
Observation hours	327.74	251.51	285.82	286.25	384.91	416.00	328.50	415.75	423.67	402.65
Raptors / 100 hours	688.4	939.9	959.7	953.7	631.8	993.5	1029.5	601.1	453.7	948.0
SPECIES	RAPTOR COUNTS									
Turkey Vulture	204	235	165	133	160	349	553	338	286	488
Osprey	32	49	55	60	67	74	107	78	50	97
Northern Harrier	25	22	39	30	56	49	13	7	27	28
Sharp-shinned Hawk	857	871	1027	912	1018	1660	1105	957	600	1578
Cooper's Hawk	282	310	420	317	266	331	456	256	233	473
Northern Goshawk	25	12	40	34	33	36	31	10	8	29
Unknown accipiter	27	67	85	156	99	155	98	84	33	35
TOTAL ACCIPITERS	1191	1260	1572	1419	1416	2182	1690	1307	874	2115
Red-shouldered Hawk	0	0	0	1	1	2	3	0	0	1
Broad-winged Hawk	1	3	1	0	0	75	10	0	1	6
Swainson's Hawk	0	0	1	2	2	1	0	0	0	0
Red-tailed Hawk	516	528	649	626	411	932	680	513	425	744
Ferruginous Hawk	1	0	0	1	1	1	1	0	0	0
Rough-legged Hawk	12	11	4	20	15	21	30	7	6	10
Unidentified buteo	23	30	40	52	30	58	26	29	48	18
TOTAL BUTEOS	553	572	695	702	460	1090	750	549	480	779
Golden Eagle	96	81	65	106	81	176	132	75	56	108
Bald Eagle	33	40	42	33	40	53	37	52	55	68
Unidentified eagle	3	2	1	9	4	2	0	6	7	0
TOTAL EAGLES	132	123	108	148	125	231	169	133	118	176
American Kestrel	29	18	18	35	22	30	21	23	21	19
Merlin	36	49	46	104	78	83	65	33	38	84
Prairie Falcon	5	4	0	5	10	8	6	1	1	8
Peregrine Falcon	3	4	0	1	4	5	8	3	9	14
Unknown falcon	8	3	2	3	4	0	0	7	3	2
TOTAL FALCONS	81	78	66	148	118	126	100	67	72	127
Unidentified raptor	38	25	43	90	30	32	0	20	15	7
GRAND TOTAL	2256	2364	2743	2730	2432	4133	3382	2499	1922	3817

Appendix C. continued

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Start date	27-Aug	27-Aug	28-Aug	27-Aug	28-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug
End date	29-Oct	27-Oct	31-Oct	31-Oct	31-Oct	25-Oct	22-Oct	29-Oct	25-Oct	31-Oct
Observation days	46	49	57	51	60	51	52	55	53	54
Observation hours	341.25	392.92	459.92	397.00	481.83	425.75	421.42	414.33	451.42	412.25
Raptors / 100 hours	1119.7	699.6	577.5	571.5	514.5	649.9	804.4	893.2	869.3	613.9
SPECIES										
Turkey Vulture	326	389	232	281	269	469	446	510	790	337
Osprey	70	60	38	47	70	101	81	72	121	58
Northern Harrier	29	38	33	13	19	33	18	39	24	13
Sharp-shinned Hawk	1790	1067	1015	921	1003	1110	1438	1448	1446	1072
Cooper's Hawk	485	269	418	249	316	339	420	380	446	205
Northern Goshawk	33	24	40	16	33	18	47	26	26	11
Unknown accipiter	29	73	69	74	160	77	47	82	130	73
TOTAL ACCIPITERS	2337	1433	1542	1260	1512	1544	1952	1936	2048	1361
Red-shouldered Hawk	7	0	0	3	3	1	0	0	1	0
Broad-winged Hawk	2	2	1	0	5	10	2	0	8	3
Swainson's Hawk	1	0	0	1	0	0	4	2	3	0
Red-tailed Hawk	725	562	531	388	359	361	588	775	605	444
Ferruginous Hawk	0	1	0	0	0	0	0	0	0	1
Rough-legged Hawk	17	3	27	6	16	8	5	2	20	11
Unidentified buteo	9	4	30	40	16	3	7	5	23	57
TOTAL BUTEOS	761	572	589	438	399	383	606	784	660	516
Golden Eagle	93	72	56	52	52	63	80	110	76	52
Bald Eagle	61	55	44	45	46	55	68	93	48	61
Unidentified eagle	2	1	1	2	8	5	1	3	1	2
TOTAL EAGLES	156	128	101	99	106	123	149	206	125	115
American Kestrel	14	9	17	7	16	27	9	8	22	14
Merlin	105	80	69	71	62	71	108	114	97	77
Prairie Falcon	5	3	7	6	3	2	8	4	4	4
Peregrine Falcon	14	14	10	5	11	11	10	21	10	7
Unknown falcon	1	18	2	9	2	2	0	1	8	4
TOTAL FALCONS	139	124	105	98	94	113	135	148	141	106
Unidentified raptor	3	5	16	33	10	1	3	6	15	25
GRAND TOTAL	3821	2749	2656	2269	2479	2767	2390	3701	3924	2531

	2014	2015	MEAN
Start date	27-Aug	27-Aug	28-Aug
End date	19-Oct	27-Oct	28-Oct
Observation days	49	45	51.3
Observation hours	417.48	365.7	386.6
Raptors / 100 hours	580.4	739.4	765.1
SPECIES			
Turkey Vulture	322	494	353.5
Osprey	53	67	68.5
Northern Harrier	18	24	27.1
Sharp-shinned Hawk	802	964	1121.0
Cooper's Hawk	465	226	343.7
Northern Goshawk	53	19	27.5
Unknown accipiter	41	44	79.0
TOTAL ACCIPITERS	1361	1598	1586.8
Red-shouldered Hawk	2	1	1.2
Broad-winged Hawk	1	4	6.1
Swainson's Hawk	0	1	0.8
Red-tailed Hawk	415	614	563.2
Ferruginous Hawk	0	0	0.3
Rough-legged Hawk	1	1	11.5
Unidentified buteo	6	3	25.3
TOTAL BUTEOS	425	624	608.5
Golden Eagle	59	56	81.7
Bald Eagle	38	78	52.0
Unidentified eagle	5	1	3.0
TOTAL EAGLES	102	135	136.7
American Kestrel	10	8	18.0
Merlin	80	69	73.6
Prairie Falcon	7	4	4.8
Peregrine Falcon	17	12	8.8
Unknown falcon	7	7	4.2
TOTAL FALCONS	121	100	109.4
Unidentified raptor	21	7	20.2
GRAND TOTAL	2423	2704	2849.6

Appendix D. Annual trapping effort and capture totals by species for migrating raptors at Bonney Butte, Oregon: 1995–2015.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Start date	7-Oct	18-Sep	31-Aug	6-Sep	5-Sep	28-Aug	25-Aug	27-Aug	26-Aug	27-Aug
End date	28-Oct	10-Oct	1-Nov	30-Oct	24-Oct	24-Oct	28-Oct	27-Oct	27-Oct	15-Oct
Blinds in operation	1	1	1	1	1	1	1	1	1	1
Station days	10	21	39	34	22	58	50	55	47	36
Station hours	44.5	127.2	202.8	200.0	142.8	239.8	320.5	357.8	345.4	236.0
Captures/100 stn hrs	40.5	99.1	110.0	125.5	100.2	129.7	102.7	103.7	124.5	167.4
Species					Raptor Captures					
Northern Harrier	0	1	0	2	1	1	0	6	4	2
Sharp-shinned Hawk	14	80	139	163	82	161	171	172	268	219
Cooper's Hawk	0	20	29	39	14	67	74	71	64	90
Northern Goshawk	1	7	7	3	3	8	11	7	12	14
Red-shouldered Hawk	0	0	0	0	0	0	0	0	0	0
Broad-winged hawk	0	0	0	0	0	1	0	0	0	0
Red-tailed Hawk	2	14	39	29	36	66	66	108	73	61
Rough-legged Hawk	0	0	1	0	1	0	1	0	0	0
Golden Eagle	0	2	2	1	2	3	1	0	2	1
Bald Eagle	0	0	0	0	0	0	0	0	0	0
American Kestrel	0	0	0	0	1	0	1	0	0	0
Merlin	1	2	5	11	3	1	4	5	4	4
Prairie Falcon	0	0	1	3	0	1	0	1	3	4
Peregrine Falcon	0	0	0	0	0	2	0	1	0	0
All Species	18	126	223	251	143	311	329	371	430	395
Recaptures[1]	0	0	0	0	0	0	0	0	0	2
Foreign Recaptures[2]	0	0	1	1	0	0	1	0	2	2

Appendix D. Continued

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Start date	27-Aug	27-Aug	27-Aug	28-Aug	27-Aug	27-Aug	1-Sep	27-Aug	27-Aug	27-Aug
End date	27-Oct	28-Oct	30-Oct	30-Oct	25-Oct	21-Oct	26-Sep	25-Oct	30-Oct	19-Oct
Blinds in operation	1	1	1	1	1	1	1	1	1	1
Station days	48	49	45	56	49	38	30	51	49	48
Station hours	342.3	354.3	317.3	406.0	359.5	263.3	139.5	376.3	328.0	335.5
Captures/100 stn hrs	152.5	138.9	105.3	104.9	138.5	134.9	106.1	76.8	70.7	92.1
Species	Raptor Captures									
Northern Harrier	7	2	1	3	3	0	0	1	0	1
Sharp-shinned Hawk	310	259	200	247	337	199	93	168	137	184
Cooper's Hawk	101	88	75	100	98	68	30	72	50	55
Northern Goshawk	12	11	3	16	3	21	2	6	3	18
Red-shouldered Hawk	0	0	1	1	0	0	0	0	0	1
Broad-winged hawk	0	0	0	1	0	0	0	1	0	1
Red-tailed Hawk	67	106	42	45	39	57	19	33	31	38
Rough-legged Hawk	1	1	0	1	0	0	0	1	0	0
Golden Eagle	3	6	0	1	2	1	0	2	2	1
Bald Eagle	1	0	0	0	2	0	0	0	0	0
American Kestrel	0	2	1	1	1	1	2	0	1	1
Merlin	13	12	9	8	12	8	2	5	5	8
Prairie Falcon	3	4	2	1	1	0	0	0	2	1
Peregrine Falcon	4	1	0	1	0	0	0	0	1	0
All Species	522	492	334	426	498	355	148	289	232	309
Recaptures[1]	1	1	0	0	0	0	0	0	0	0
Foreign Recaptures[2]	3	1	1	1	2	1	0	1	0	0

Appendix D. Continued

	2015	Mean*	Total
Start date	27-Aug	29-Aug	---
End date	25-Oct	23-Oct	---
Blinds in operation	1	1.0	---
Station days	42	43.4	877
Station hours	306.5	285.0	5,744.8
Captures/100 stn hrs	84.8	113.4	---
Species			
Northern Harrier	1	1.7	36
Sharp-shinned Hawk	147	178.6	3,750
Cooper's Hawk	57	60.1	1,262
Northern Goshawk	10	8.5	178
Red-shouldered Hawk	0	0.1	3
Broad-winged hawk	0	0.2	4
Red-tailed Hawk	34	47.9	1,005
Rough-legged Hawk	0	0.3	7
Golden Eagle	2	1.6	34
Bald Eagle	0	0.1	3
American Kestrel	0	0.6	12
Merlin	6	6.1	128
Prairie Falcon	2	1.4	29
Peregrine Falcon	1	0.5	11
All Species	260	307.7	6,462
Recaptures[1]	0	0.2	4
Foreign Recaptures[2]	1	0.9	18

[1] Recaptures at Bonney Butte of birds originally banded at Bonney Butte.

[2] Recaptures at Bonney Butte of birds originally banded elsewhere.

* Mean calculations 1996 through 2013, 1995 excluded because of banding effort.