

FALL 2016 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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BONNEY BUTTE HAWKWATCH, HOOD RIVER CO., OREGON**

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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 trapping and banding 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 2016 season marked the 23rd consecutive year of counting and the 21st season of banding efforts. This report summarizes the 2016 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 the fall 2016 (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 observers conducted standardized daily counts of migrating raptors from late August through late October. Observations start between 0800–0900 hrs and end 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 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 2016 counts against means and 95% confidence intervals for previous seasons, we consider a count value falling outside the 95% confidence interval of the historic site means as significantly different. 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 lure migrating raptors into the capture stations from camouflaged blinds using live, non-native avian lures attached to lines manipulated from the blinds. Unless already banded, we fit all captured birds with a uniquely numbered USGS Biological Resources Division aluminum leg band and release them within 45 minutes of capture. Data collection followed standardized protocols used at all HWI migration-banding sites (Hoffman et al. 2002).

2016 RESULTS AND DISCUSSION

OBSERVATION EFFORT AND WEATHER SUMMARY

Bonney Butte HawkWatch's standard season runs 27 August – 31 October; in 2016 observers were able to count on 43 of 66 possible days during this period for a total of 358 hours (Appendix C). We counted 8 fewer days than average. Weather prohibited counting on 20 days with an additional day suspended with <4 hrs of observation due to weather. Weather varies throughout every season, in 2016 based on hourly recording of conditions during observation hours it was clear xx% of the time; partly cloudy xx% of the time; mostly cloudy xx% of the time; overcast and/or foggy xx% of the time; hazy xx% of the time; and raining or snowing less than x% of the time.

2016 FLIGHT SUMMARY

Overall Flight:

Observers counted 2,927 migrating raptors of 15 species in 2016, an average year based on the long-term site average (Table 1).

The flight consisted of 53.8% accipiters, 12% buteos, 20.4 % vultures, 4.8 % falcons, 5.5% eagles, 2.3% Ospreys, 0.4% harriers, and 0.1% unknown raptors. The relative proportions of buteos and harriers in this year's flight were very low compared to site averages; while proportions of eagles, falcons, and vultures surpassed site averages (Fig. 3). Sharp-shinned Hawks were the most common species (39% of the total), followed by Turkey Vultures (20%), Cooper's Hawks (12%), Red-tailed Hawks (12%), Merlins (4%), Bald Eagles (3%), Ospreys (2%), and Golden Eagles (2%). The remaining species each accounted for 1% or less of the total count (Table 1).

The following sections summarize the 2016 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 818 raptors counted per 100 hours of observation at the Bonney Butte HawkWatch in 2016 was consistent with the site average of 766 raptors/100 hrs from 1994-2015. The 2016 season marks the second year in a row that our overall passage rate (Birds/100 hrs) has not been below 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, low for Northern Harriers and high for Turkey Vultures compared to site averages (Table 1). The 596 Turkey Vultures counted is a site record, the 12 Northern Harriers counted is an all-time low for the Bonney Butte HawkWatch. Based on regression analysis of passage rates, regional Harrier populations are declining (slope = -0.3, $r^2 = 0.27$, $p=0.016$). Turkey Vulture are increasing (slope= 2.79, $r^2 = 0.23$, $p=0.02$), 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 and passage rates for Sharp-shinned Hawks, Cooper's Hawks, and Northern Goshawks did not differ from long-term site averages (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 376 total buteos in 2016, the lowest total ever counted for this group at the Bonney Butte HawkWatch. This is driven by a record low Red-tailed Hawk count (344), a species with declining regional populations in the region based on regression analysis of annual fall passage rates (slope= -3.9, $r^2 = 0.28$, $p=0.009$).

Eagles (Fig.3d):

For the fifth consecutive year observers counted below average numbers of Golden Eagle. Despite 2016 passage rates for the species not differing from the site average, Golden Eagle passage rates continue to decline over time at this site (slope = -0.8, $r^2 = 0.38$, $p = 0.002$). Efforts elsewhere document similar declines across North America and targeted research efforts are underway, including some by HWI, to further understand Golden Eagle, ecology, movements and demographics. Bald Eagle count was above average and the effort adjusted passage rate of 23.2 birds/100hr is a site record. Regional populations of Bald Eagles are stable based on regression of Bonney Butte annual passage rates (no significant trend).

Falcons (Fig. 3e):

We observed above average counts and passage rates for Peregrine Falcons and Merlins at Bonney Butte in 2016. Prairie Falcon count and passage rate were below average, as were those for the American Kestrel—tying or setting a site low, respectively (Table 1). Despite traditionally low passage rates (below the 10 per 100 hr threshold), it is worth noting that Kestrel passage rate at Bonney Butte is declining annually (slope = -0.3, $r^2 = 0.59$, $p < 0.001$) because similar trends are 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 41 days (totaling 266.2 hours) between 27 August and 28 October and captured 212 raptors of eight different species. Due to poor weather, the crew was forced to shut down operations for a week near the end of the migration season. The number of hours trapped was low 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. Capture totals were low for most species due to the shortened season except for Northern Harrier (3), Golden Eagle (1), Prairie Falcon (1), and Merlin (6). Capture rates were below average for Cooper's Hawk, Sharp-shinned Hawk, Red-tailed Hawk, and American Kestrel.

Season highlights included 3 Northern Harrier's, 6 Merlin's and a previously banded Golden Eagle.

RECAPTURES

There were no "in-house" (Bonney Butte banded birds) recaptures and two "foreign recaptures" (recapture of a bird banded elsewhere) at the site in 2016. The female Golden Eagle was a second-year bird, banded as a nestling in Oregon in 2015. The second foreign recapture was a male after-hatch-year Sharp-shinned Hawk, originally banded at Chelan Ridge in 2015 as an adult.

FOREIGN ENCOUNTERS WITH PREVIOUSLY BANDED BIRDS

To date 103 birds banded at Bonney Butte have been recaptured/recovered and reported to the USGS Bird Banding Laboratory (BBL) (Fig. 6). During 2016, four birds banded at Bonney Butte were reported to the BBL, which then passed the information to HWI. These recoveries included two Red-tailed Hawks, one Cooper's Hawk, and a Bald Eagle (Fig. 6, Table 3). One Red-tailed Hawk (after-hatch-year – 2012) was recovered in Hazelton, British Columbia after being struck by a vehicle and the other (hatch-year 2015) was found dead in Longview, Washington. The Cooper's Hawk (after-second-year female – 2010) was found dead in Bend, Oregon. The Bald Eagle, (hatch-year - 2009) was found dead in Merrill, Oregon. This is the first HawkWatch International banded Bald Eagle to have been encountered after its initial banding.

VISITOR PARTICIPATION AND PUBLIC OUTREACH

Approximately xx individuals visited the site during the 2016 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.

2016 FALL MIGRATION ACROSS HWI'S NETWORK

HawkWatch International and partners operated 8 fall count sites in 2016 (Fig. 1). During the 4,451 hours of standardized observation, we counted 713,979 migrating birds of prey. The power and utility of HWI's network of fall count sites, and long-term monitoring in general, lies in that it allows identification of patterns in regional raptor populations, both over time at a single site and also network-wide. Declines in counts or passage rates for a species or group of species at the regional level can highlight the need for more focused research or management attention at local scales, while increases may indicate the success of management and conservation efforts. While each site in HWI's network varied in terms of individual species or group counts, notable network-wide patterns in 2016 included (Table 4):

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

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elements over the course of a long field season these efforts would not be possible. Local volunteers have also greatly assisted the project for several years now and we want to give special thanks them as well: Adam Baz, Dwight Porter, Mark Lundgren, Tom Jordan, Mary Coolidge, Aurora Gerhardt, Nathan Gerhardt, and Craig Plummer.

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Table 1. Historic fall raptor migration counts (mean±95% CI), counts from fall 2016, and site records at Bonney Butte, OR.

1994-2015						All-time Historic Records		
Species	Mean Count ± 95 % CI			2016	% Change	Season	Year	Daily
Turkey Vulture	353.5	±	65.0	596	69	790.0	2012	174 (2011)
Osprey	68.5	±	9.4	66	-4	121	2012	22 (2000)
Northern Harrier	27.1	±	5.1	12	-56	56	1998	12 (1998)
Accipiters								
Sharp-shinned Hawk	1121.0	±	127.4	1146	2	1790	2004	215 (2012)
Cooper’s Hawk	343.7	±	37.9	362	5	485	2004	67 (2011)
Northern Goshawk	27.5	±	5.1	24	-13	53	2014	9 (2014)
Unidentified accipiter	79.0	±	17.1	43	-46	160	2008	
TOTAL ACCIPITERS	1571.2	±	156.1	1575	0	2337	2004	
Buteos								
Red-shouldered Hawk	1.2	±	0.7	0	-100.0	7	2004	2 (2004)
Broad-winged Hawk	6.1	±	6.6	4	-34.8	75	1999	65 (1999)
Swainson’s Hawk	0.8	±	0.5	0	-100.0	4	2010	3 (2010)
Red-tailed Hawk	563.2	±	62.4	344	-38.9	932	1999	99 (2011)
Ferruginous Hawk	0.3	±	0.2	0	-100.0	1	2013	1 (7x)
Rough-legged Hawk	11.5	±	3.5	3	-73.9	30	2000	9 (2012)
Unidentified buteo	25.3	±	7.5	25	-1.3	58	1999	
TOTAL BUTEOS	608.5	±	68.7	376	-38.2	1090	1999	
Eagles								
Golden Eagle	81.7	±	12.8	65	-20	176	1999	23 (1997)
Bald Eagle	52.0	±	6.3	83	59	93	2011	23 (2011)
Unknown eagles	3.4	±	1.1	12	252.9	12	2016	
TOTAL EAGLES	136.7	±	14.2	160	17	231	1999	
Falcons								
American Kestrel	18.0	±	3.3	7	-61	35	1997	5 (2x)
Merlin	73.6	±	9.8	110	49	114	2011	28 (2011)
Prairie Falcon	4.8	±	1.1	2	-58	10	1998	2 (10x)
Peregrine Falcon	8.8	±	2.2	17	94	21	2011	4 (2011)
Unidentified falcon	4.2	±	1.7	4.00	-5	18	2005	
TOTAL FALCONS	109.4	±	10.8	140	28	148	1997	
Unidentified Raptor	20.2	±	8.4	2	-90	90	1997	
Grand Total	2895.1	±	266.5	2927	1	4133	1999	425 (2011)

Table 2. Capture totals and rates for fall migrating raptors at Bonney Butte, OR: 1996–2015 versus 2016.

	Capture Totals				Capture Rate ¹			
	1996-2015 ²		2016	Seasonal Record	1996-2015 ²		2016	Seasonal Record
Northern Harrier	1.8	± 0.9	3	7	0.6	± 0.2	1.1	2.0
Sharp-shinned Hawk	186.8	± 30.8	149	337	66.1	± 6.9	56.0	93.7
Cooper's Hawk	63.1	± 11.5	38	101	21.7	± 2.8	14.3	38.1
Northern Goshawk	8.8	± 2.4	4	21	3.2	± 0.8	1.5	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	50.2	± 11.1	10	108	17.8	± 3.1	3.8	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	1	6	0.6	± 0.2	0.4	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	0.2	± 0.2	0.0	1.4
Merlin	6.4	± 1.6	6	13	2.2	± 0.5	2.3	5.5
Prairie Falcon	1.5	± 0.6	1	4	0.5	± 0.2	0.4	1.7
Peregrine Falcon	0.6	± 0.4	0	4	0.2	± 0.1	0.0	1.2
All Species	322.1	± 51.3	212	522	113.4	± 11.0	79.6	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: 2016.

Band #	Species ¹	Sex	Banding Date	Banding Age ²	Encounter Location	Encounter Date	Distance (KM) ³	Status
1098-00801	BAEA	U	9-Oct-09	HY	Merrill, Oregon	7-Jul-16	338.3	Found dead - Unknown cause
1075-01937	COHA	F	2-Oct-10	ASY	Bend, Oregon	27-Oct-16	127.7	Found dead - Unknown cause
1177-30927	RTHA	U	2-Oct-12	AHY	New Hazleton, British Columbia	9-Aug-16	1148.4	Alive - Caught due to being struck by motor vehicle
1177-31063	RTHA	U	23-Sep-15	HY	Longview, Washington	5-Apr-16	133.8	Found dead - Unknown cause

¹ Species: BAEA = Bald Eagle; COHA = Cooper's Hawk; RTHA = Red-tailed Hawk.

² HY = hatch year; AHY = after hatch year; ASY = after second year.

³ Straight-line distance from banding location.

Table 4. Summary of the 2016 fall flight of migrating raptors across HWI's monitoring network. Values are counts ; green indicates a count significantly higher (outside the 95% confidence interval) than the historic site average, red indicates a count significantly lower than average, and black indicates a count that does not differ from the site average. Asterisks denote a record high or low count. In 2016 HWI monitored fall migration for 4,451.7 hrs and counted 713,979 birds.

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



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

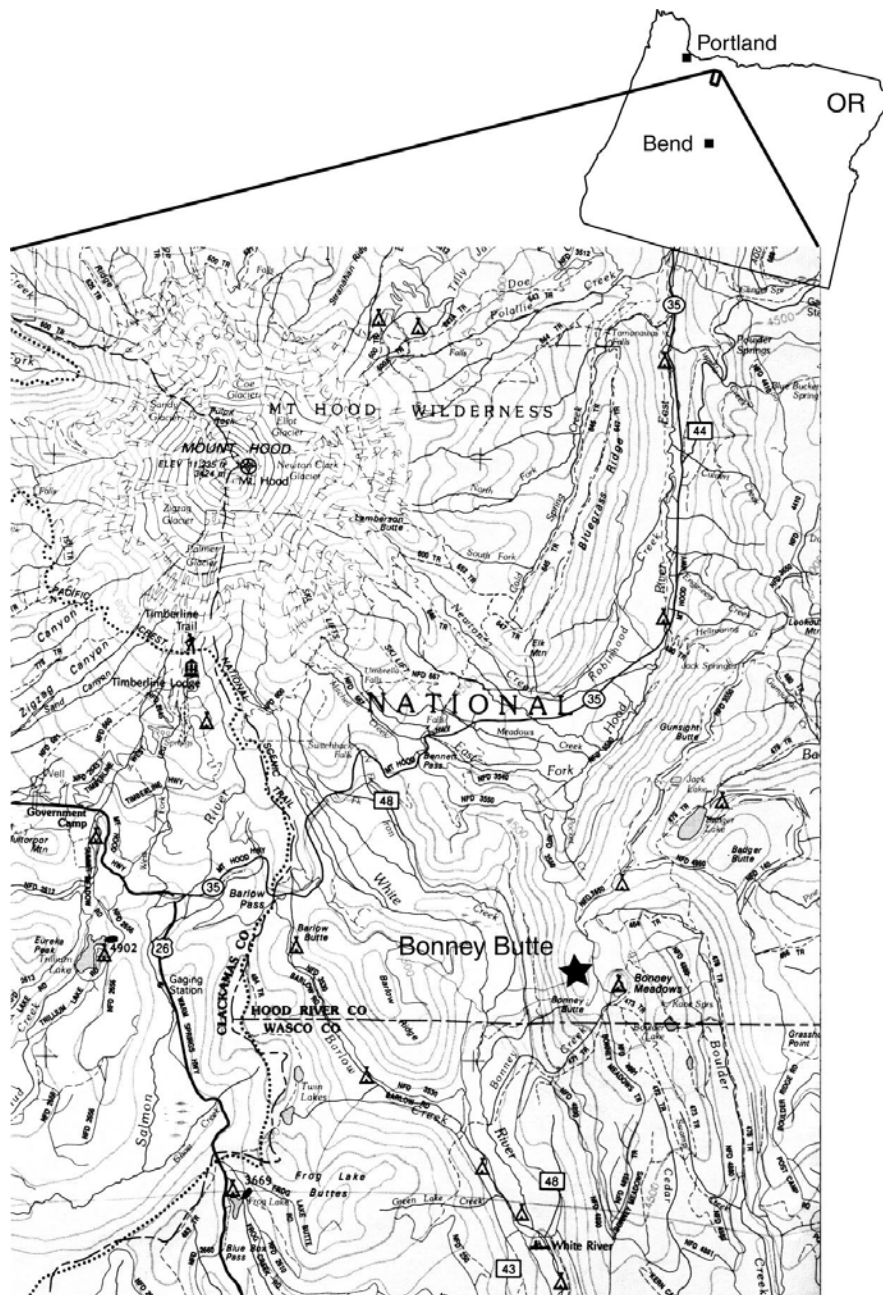


Figure 2. Location of the Bonney Butte HawkWatch near Mt. Hood, Oregon.

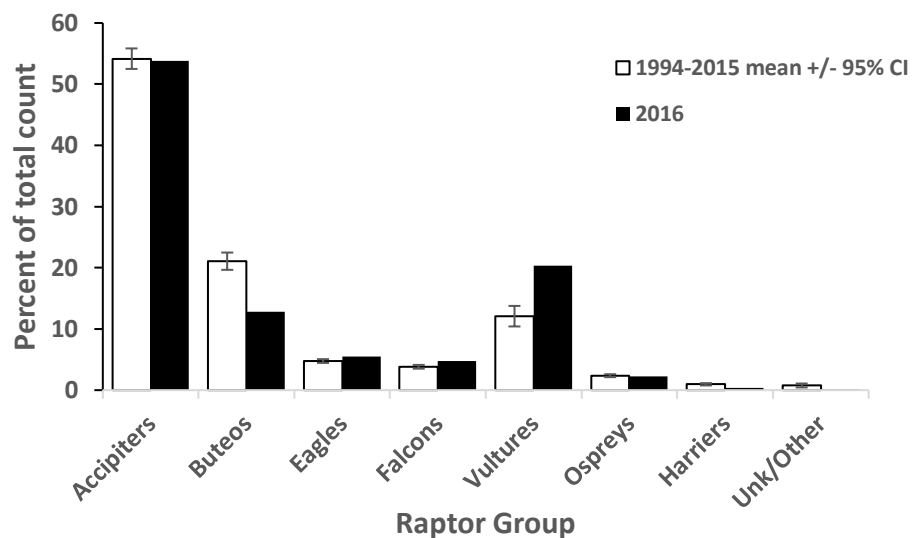


Figure 3. Fall raptor migration flight composition by major species groups at Bonney Butte, Oregon: 1994–2014 versus 2015.

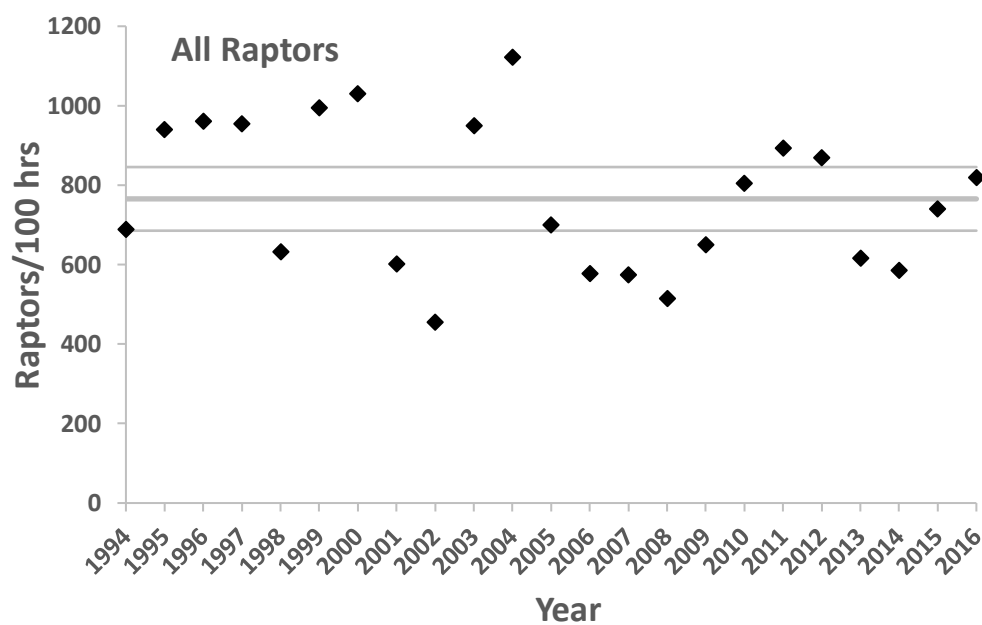


Figure 4. Fall migration passage rates at Bonney Butte, OR for all migrating raptors: 1994-2016. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1998-2015) at Bonney Butte.

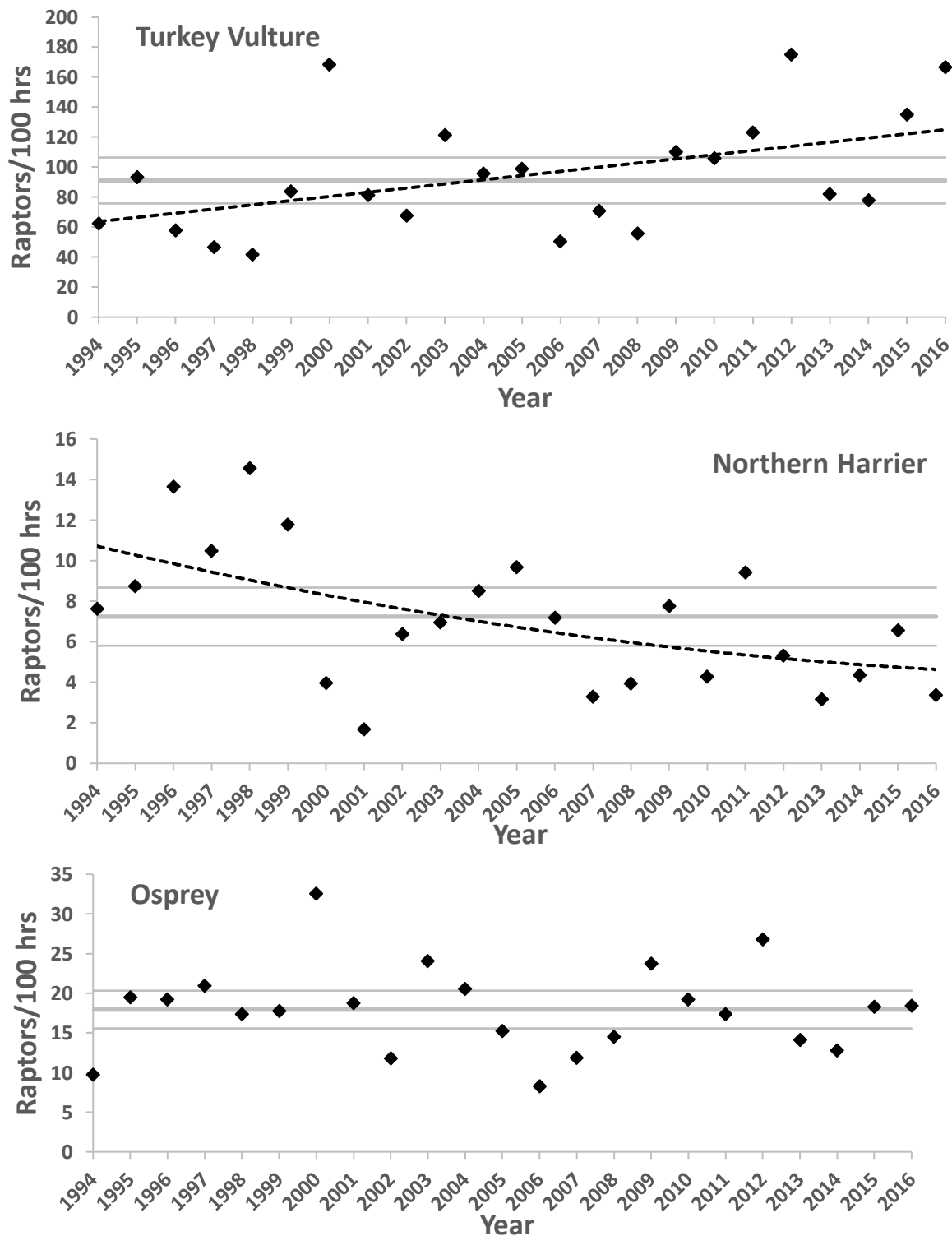


Figure 5a. Fall-migration passage rates at Bonney Butte, OR for Turkey Vultures, Ospreys, and Northern Harriers: 1994–2016. Dashed lines indicate trends for significant ($p < 0.05$) linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1994-2015).

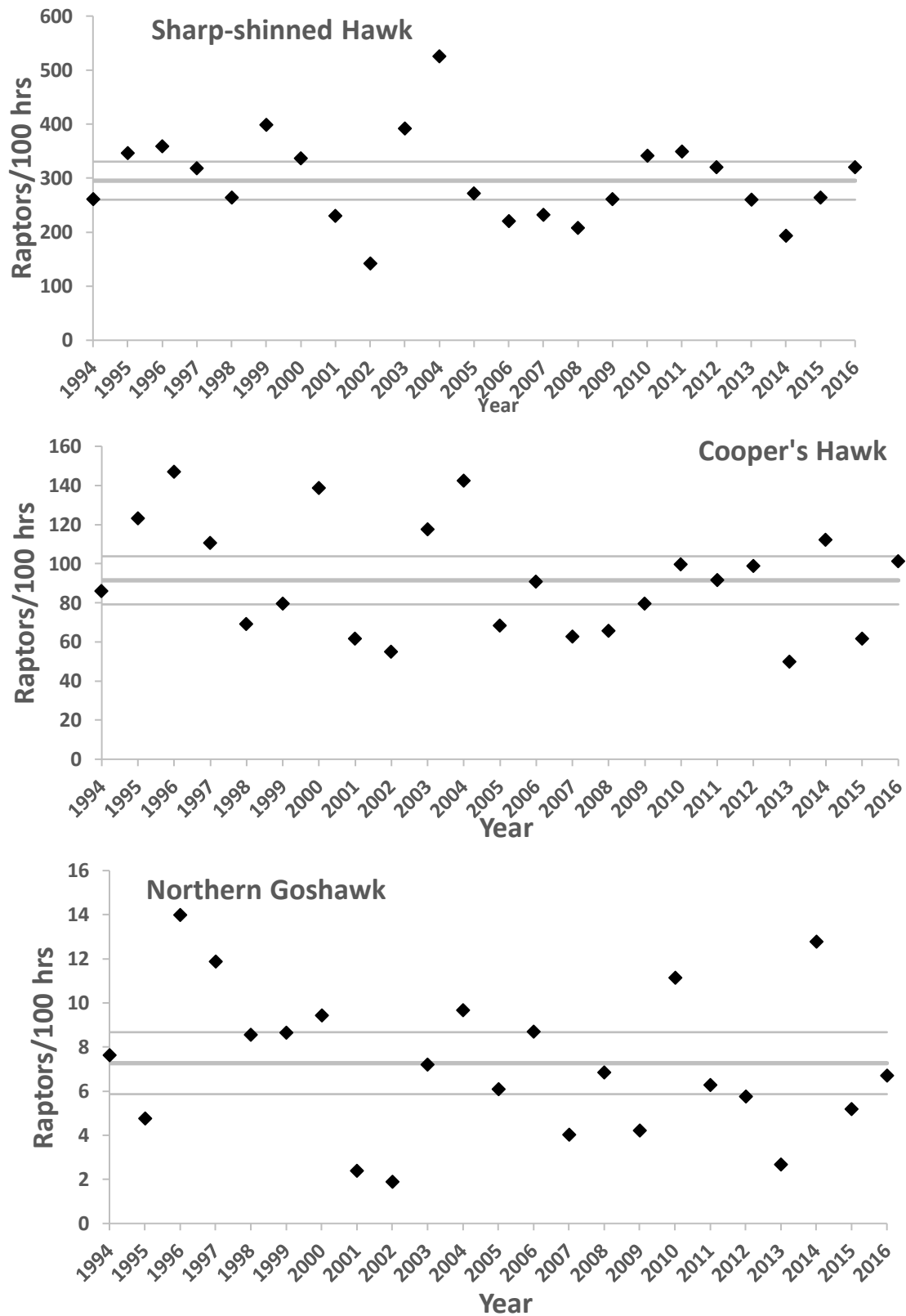


Figure 5b. Fall-migration passage rates at Bonney Butte, OR for the three North American accipiter species: 1994–2016. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1994-2015).

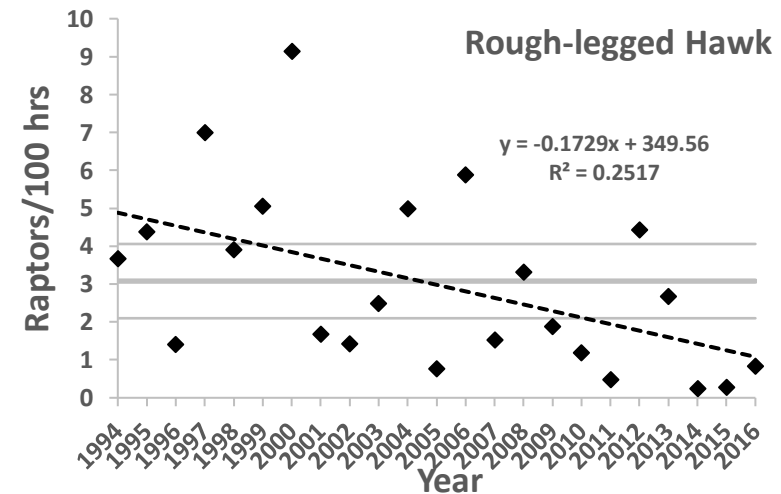
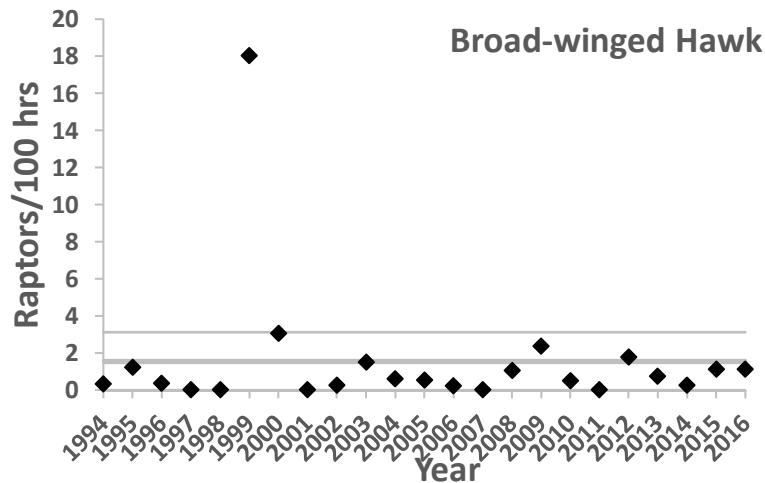
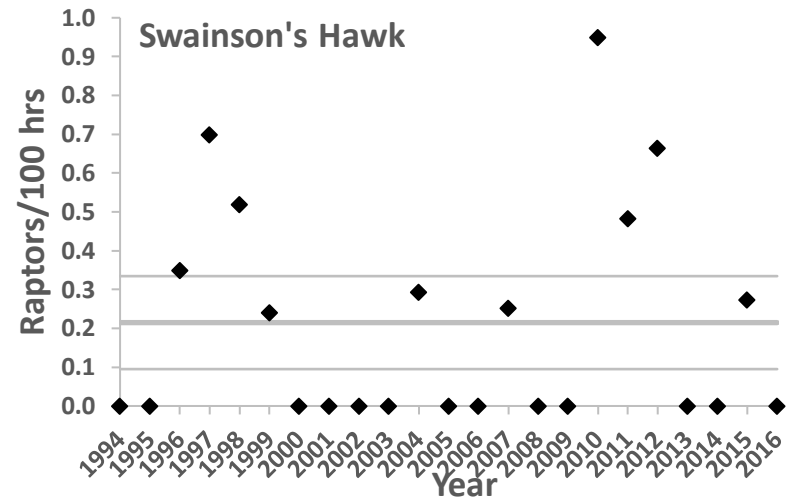
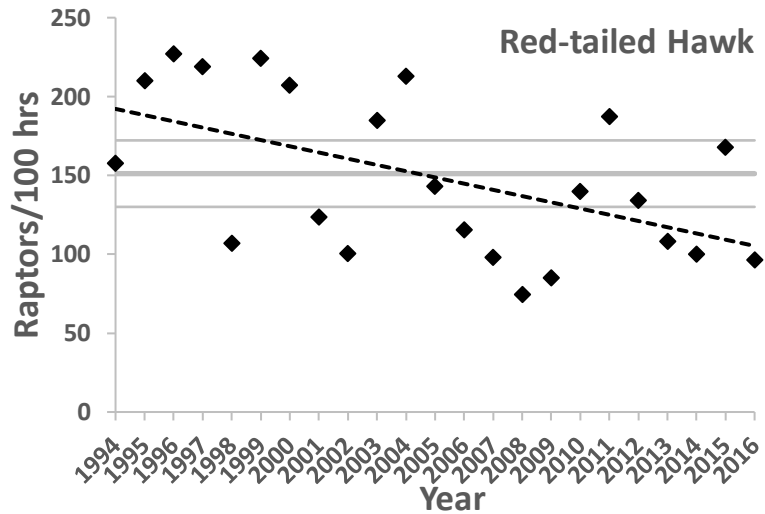


Figure 5c. Fall-migration buteo passage rates at Bonney Butte, OR: 1994–2016. Dashed lines indicate significant ($p < 0.05$) population trends based on linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1994-2015).

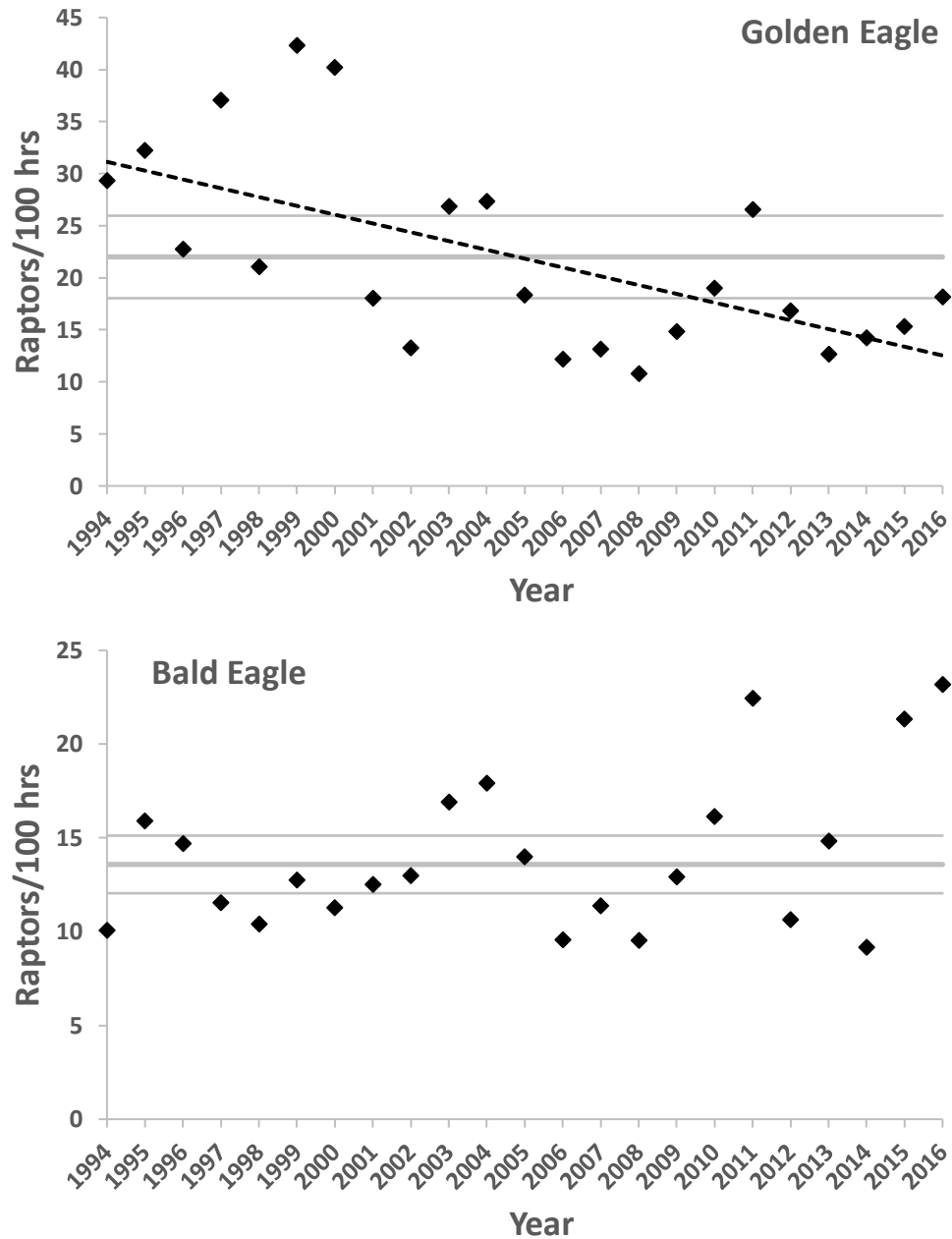


Figure 5d. Eagle passage rates for the fall migration at Bonney Butte, OR: 1994–2016. Dashed lines indicate trends for significant ($p < 0.05$) linear or quadratic regressions. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1994-2015).

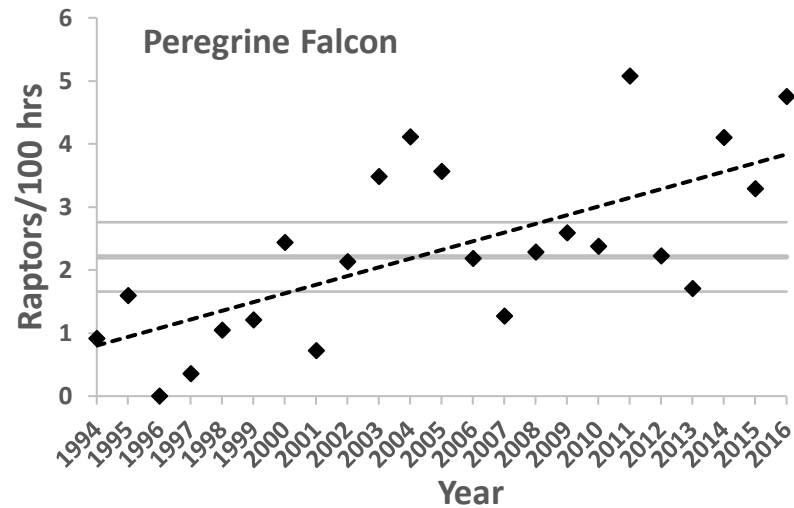
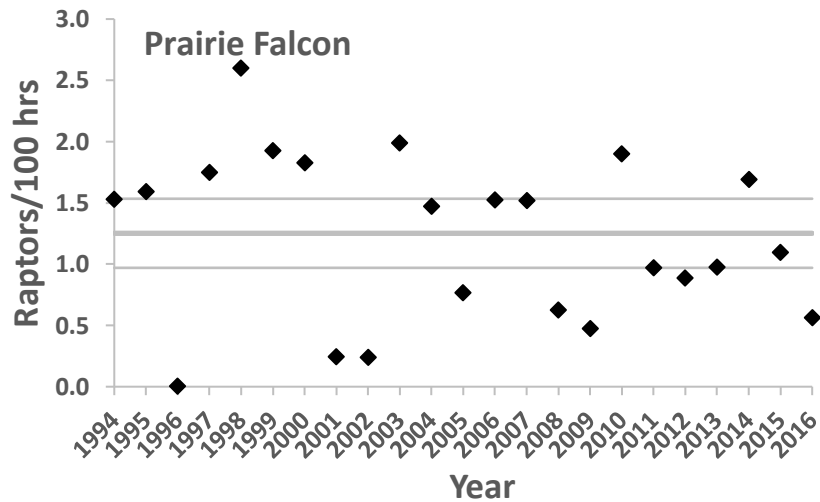
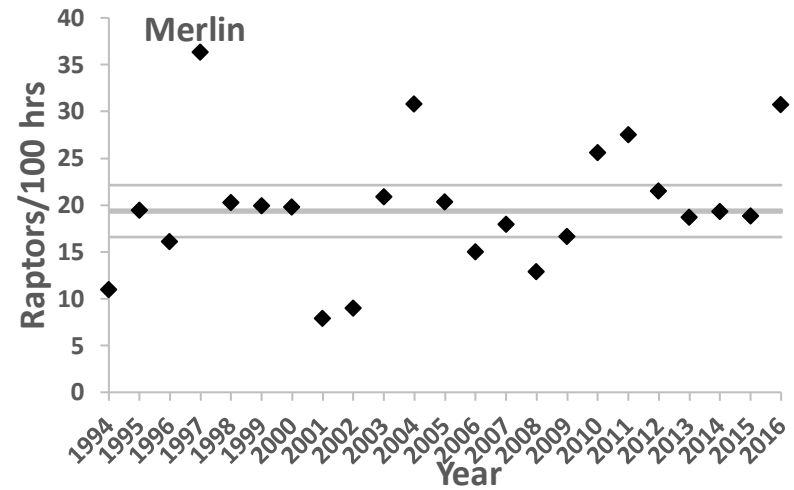
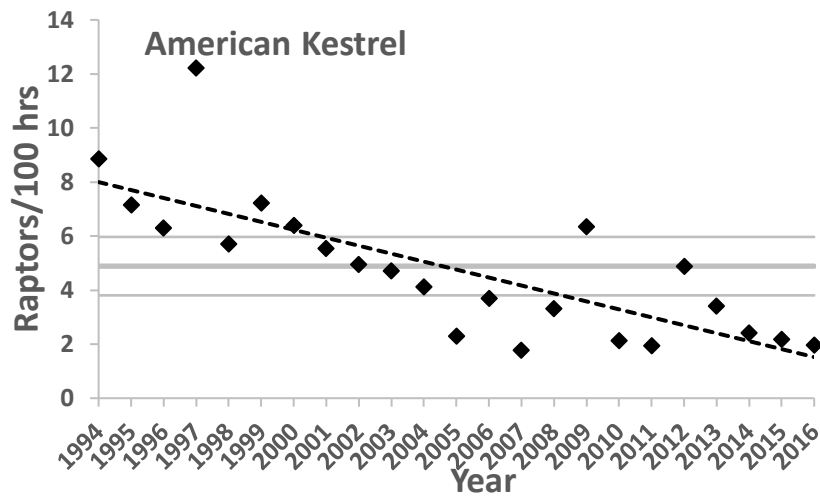


Figure 5e. Fall-migration falcon passage rates at Bonney Butte, OR: 1994–2016. Solid grey lines represent mean (thick) and upper and lower 95% confidence intervals (thin) of historic counts (1994-20)

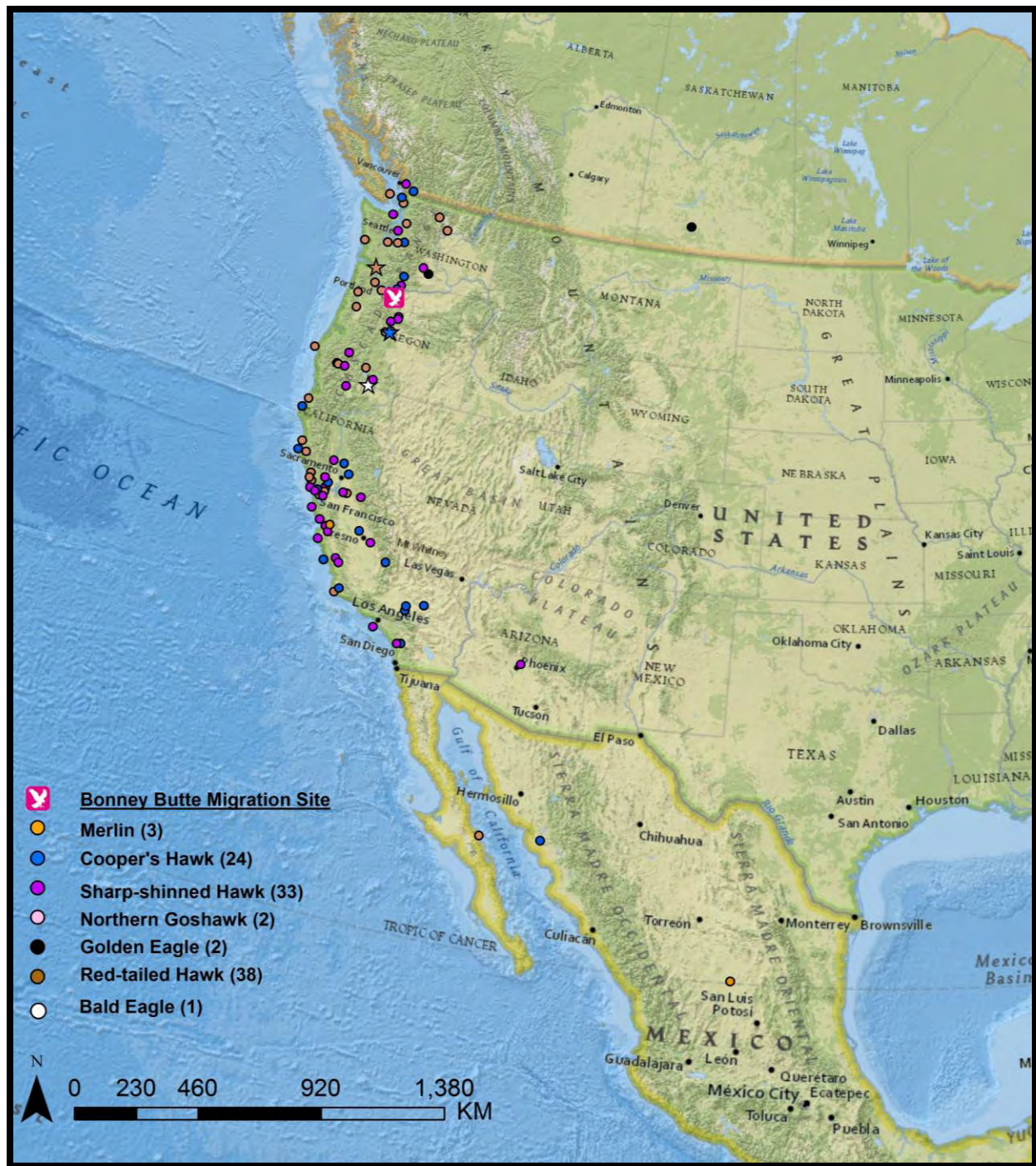


Figure 6. Recovery locations of raptors banded at Bonney Butte, OR. Circles indicate recoveries from 1995-2014, stars indicate 2015 recoveries.

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)
- 2016:** Two observers throughout: Scott Shively (1), Kate Owens (1), Ben Sweet (1), Sarah Hecoeks (0), Ceeanna Zulla (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 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	<i>Cathartes aura</i>	TV	U	U	NA
Osprey	<i>Pandion haliaetus</i>	OS	U	U	NA
Northern Harrier	<i>Circus cyaneus</i>	NH	AM AF I Br U	AM AF U	NA
Sharp-shinned Hawk	<i>Accipiter striatus</i>	SS	A I U	U	NA
Cooper's Hawk	<i>Accipiter cooperii</i>	CH	A I U	U	NA
Northern Goshawk	<i>Accipiter gentilis</i>	NG	A I U	U	NA
Unknown accipiter	<i>Accipiter spp.</i>	UA	U	U	NA
Red-shouldered Hawk	<i>Buteo lineatus</i>	RS	A, I, U	U	NA
Broad-winged Hawk	<i>Buteo platypterus</i>	BW	A I U	U	D L U
Swanson's Hawk	<i>Buteo swainsoni</i>	SW	U	U	D L U
Red-tailed Hawk	<i>Buteo jamaicensis</i>	RT	A I U	U	D L U
Ferruginous Hawk	<i>Buteo regalis</i>	FH	A I U	U	D L U
Rough-legged Hawk	<i>Buteo lagopus</i>	RL	U	U	D L U
Unknown buteo	<i>Buteo spp.</i>	UB	U	U	D L U
Golden Eagle	<i>Aquila chrysaetos</i>	GE	I, S, NA, A, U ⁴	U	NA
Bald Eagle	<i>Haliaeetus leucocephalus</i>	BE	I, S1, S2, NA, A, U ⁵	U	NA
Unknown eagle	<i>Aquila</i> or <i>Haliaeetus spp.</i>	UE	U	U	NA
American Kestrel	<i>Falco sparverius</i>	AK	U	M F U	NA
Merlin	<i>Falco columbarius</i>	ML	AM Br U	AM Br U	NA
Prairie Falcon	<i>Falco mexicanus</i>	PR	U	U	NA
Peregrine Falcon	<i>Falco peregrinus</i>	PG	A I U	U	NA
Unknown falcon	<i>Falco spp.</i>	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	2016	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	2016	Mean*	Total
Start date	27-Aug	27-Aug	29-Aug	---
End date	25-Oct	28-Oct	23-Oct	---
Blinds in operation	1	1	1.0	---
Station days	42	41	43.2	918
Station hours	306.5	266.2	284.1	6011.0
Captures/100 stn hrs	84.8	79.6	111.8	---
Species				
Northern Harrier	1	3	1.8	39
Sharp-shinned Hawk	147	149	177.2	3899
Cooper's Hawk	57	38	59.0	1299
Northern Goshawk	10	4	8.2	181
Red-shouldered Hawk	0	0	0.1	3
Broad-winged hawk	0	0	0.2	4
Red-tailed Hawk	34	10	46.1	1015
Rough-legged Hawk	0	0	0.3	7
Golden Eagle	2	1	1.6	35
Bald Eagle	0	0	0.1	3
American Kestrel	0	0	0.5	12
Merlin	6	6	6.1	134
Prairie Falcon	2	1	1.4	30
Peregrine Falcon	1	0	0.5	11
All Species	260	212	303.3	6672
Recaptures ¹	0	0	0.2	4
Foreign Recaptures ²	1	2	1.0	20

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.