Fall 2016 Golden Eagle Migration Survey
Big Belt Mountains, Montana

Photo by Ronan Dugan

Montana Audubon, Helena, Montana
March 2017

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March 2017

Table of Contents

List of Tables

List of Figures

Introduction

The majority of North American diurnal raptor species migrate bi-annually between their breeding and wintering grounds, instinctively following predictable migration routes. During migration raptors often concentrate along specific geographic features (especially high mountain ridges and coastlines) associated with optimal flying conditions, providing excellent opportunities for researchers to quantify long-term trends in migrant raptor populations, and, for some species, assess year-to-year demographic changes. It has been well established that standardized scientific annual counts at established hawk-watch sites are a cost-effective method for tracking long-term raptor population trends (Zalles and Bildstein 2000, Farmer et al. 2007).

Diurnal raptors are also key biological indicators, since trends in their populations can serve as useful barometers of the overall health of ecosystem function within their preferred habitat (Bildstein 2001). The monitoring of migratory Golden Eagles in western North America is especially critical because migrant populations passing through the Rocky Mountain West have been in steady decline since the late 1990s (Smith et al. 2008, Sherrington 2016a & b). Migration counts in the Bridger Mountains, a historically significant site for censusing migrant Golden Eagles located approximately 60 miles south-southeast of the Big Belts (near Bozeman), have documented statistically significant declines of 35-40% in counts of Golden Eagles using this flyway (Smith et al. 2008, Davis et al. 2017). As the changing global climate is rapidly affecting northern latitudes, monitoring populations of North American Golden Eagles breeding in far northern latitudes (many of which migrate via the Rocky Mountain Flyway) has become increasingly important.

The Big Belt Mountains were first recognized as a significant migration flyway for Golden Eagles in 2007 by Tim Pitz and Vince Slabe of Raptor View Research Institute (RVRI), based out of Missoula, Montana. Steve Hoffman, founder of Hawk Watch International and former Executive Director of Montana Audubon, launched additional exploratory raptor migration counts there in October 2014. On 11 October 2014 Hoffman and associates documented 284 migrating Golden Eagles in 6.75 hours of observation. Additional counts in the Big Belts in fall 2014 consistently yielded greater numbers of Golden Eagles (compared to the Bridgers) on corresponding days. Data on Golden Eagle migration patterns from migrating birds equipped (by RVRI) with satellite transmitters indicated that a significant number of migrant Golden Eagles, after traversing the length of the Big Belts, migrated directly east to the Crazy Mountains, and thus would not have been observed at the Bridger Mountains site. Hoffman hypothesized that annual season-long autumn migration counts in the Big Belts would likely contribute significantly to understanding regional long-term trends in Golden Eagle populations using this prominent Rocky Mountain flyway.

In Fall 2015 Ronan Dugan and Bret Davis conducted the first standardized, scientific raptor migration count in the Big Belts (Davis & Hoffman 2016). From 15 September-3 November Dugan and Davis camped at Duck Creek Pass and conducted daily migration counts, weather permitting. An astonishing 2,630 Golden Eagles were recorded during 352.8 hours of observation, yielding one of the highest Golden Eagle passage rates known in North America (Yates et al. 2001, McIntyre and Lewis 2016, Davis et al. 2017). The Big Belts also proved to be an active site for many other migrating raptor species; remarkably, on 23 September all 17 species of raptors known to migrate through the region were recorded – an unprecedented

occurrence which, to our knowledge, has heretofore neverbeen recorded at any hawk watch site in the American West!

Ronan Dugan returned as the primary observer and site supervisor for the 2016 season. He was joined by biologist Jeff Grayum to assist with the daily counts. Efforts began 15 days earlier than in 2015, with Dugan and Grayum beginning official counts on 1 September 2016. The season was a collaborative effort among four entities: Montana Audubon, Last Chance Audubon Society, Montana Fish, Wildlife and Parks, and the US Forest Service (Helena-Lewis & Clark National Forest), with each organization contributing unique and important roles. This collective effort was christened the **Golden Eagle Migration Survey (GEMS)** in honor of the Big Belt's star migrant.

Ronan and Jeff spent ten weeks immersed in the mountains, documenting migrating raptors daily, weather permitting. The fall 2016 study represents the longest period of daily, standardized raptor migration observation ever conducted in the Big Belt Mountains.

The primary long-term objectives of this long-term study are to:

1. Annually quantify numbers and movement patterns of all diurnal raptor species, especially Golden Eagles, as they pass through the Big Belt Mountains to assess long-term population trends.
2. Determine the population demographics of diurnal raptors (classifying each migrant as to age and sex, as appropriate) using the Big Belt flyway.
3. Collect daily and regional weather data to help better understand the migrants' behavioral responses to weather patterns, and how weather factors may influence our counts.
4. Engage local communities and develop meaningful public education opportunities to share the science as well as the amazing spectacle of the fall raptor migration in the Big Belts.

Study Site

The Big Belts are a 75-mile long, northwest-southeast trending section of the Rocky Mountains, situated in the Helena–Lewis & Clark National Forest in west-central Montana (Fig. 1). The range is bordered to the west by Canyon Ferry Lake, a 35,181-acre artificial reservoir created by the damming of the Upper Missouri River. To the east of the Big Belts lie the Shields Valley and Crazy Mountains. Immediately to the south of the Big Belt Mountains are the Bridger Mountains (Fig. 1), an important location for documenting migrating diurnal raptors since 1991, and likely where many of the raptors migrating through the Big Belt Mountains also pass.

Strong, prevailing southwesterly winds constantly buffet the Big Belts. These consistent winds, in combination with the southern Big Belts' steep, westerly slopes generate powerful updrafts, providing ideal flying conditions for migrating raptors. These persistent updrafts, combined with the Big Belts' prominent, single ridge at their southern end, concentrate migrating raptors in great numbers during fall migration.

During fall 2016 we utilized three observation sites at various elevations on the west slope of the Big Belts. 'Far Down Hill' was the primary lookout utilized during the 2016 season (Fig. 1). This site is located along the crest of the southern Big Belts, 1.4 miles south of Duck Creek Pass (N = 46.476962 degrees, W = -111.256572 degrees). Our observation point was approximately

200m downslope from a radio communications tower, at an elevation of 8180 feet. Surveys occurred from this location 50 of the 60 days that data were recorded, totaling 389.2 hours of observation time. This lookout affords exceptionally close views of the migrating raptors, allowing observers to accurately determine the age and/or sex for many of the passing migrants. Although it is possible to drive to this primary observation site, the road is steep with loose rock, thus most visitors chose to park at Duck Creek Pass and hike the final 1.4 miles to the communications tower.

When fog and low cloud cover limited visibility at the primary site, researchers occasionally found it necessary to survey from a lower elevation. The secondary observation site, 'Saddle Knoll', was located at an elevation of 7,580 feet, about three miles north of Far Down Hill (N = 46.502518 degrees, W = -111.273463 degrees). This site was easily accessible by vehicle, and provided an ideal location to educate visitors and field-trip participants unable to make the steep hike to Far Down Hill. It is important to note that, when data was collected from both sites simultaneously (e.g., 1 October, when field-trip attendees were present at both sites), only observations from Far Down Hill were used for the official count.

Rarely, when extreme weather prevented counts to be conducted at Far Down Hill or Saddle Knoll, we moved our observation site to a much lower elevation site on Duck Creek Road ('Lower Duck Creek Road'). This site is two miles west of Saddle Knoll (N = 46.29398 degrees, W = -111.18738), and proved to be an effective observation point to escape from the fog and document migrating birds. Raptors were documented from this location only three of the 60 days that counts were conducted (11.5 hours of total observation). This site was better suited to detecting large raptors, due to its considerable distance from the ridgetop.

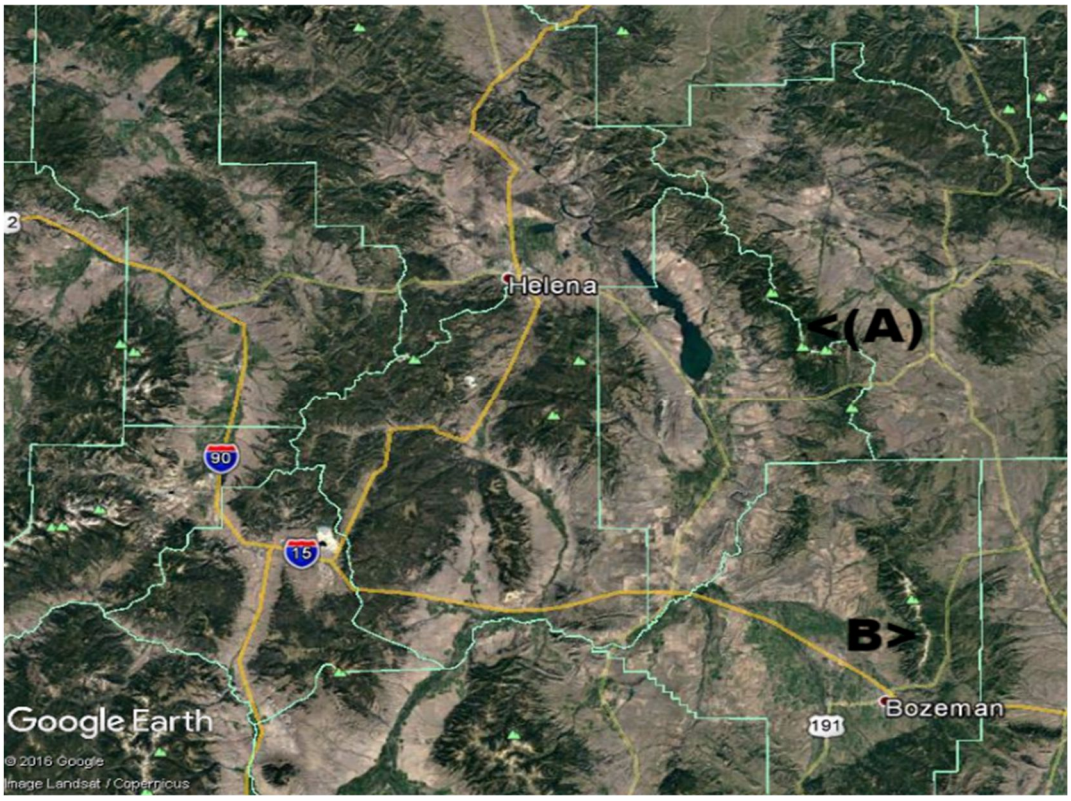

Figure 1. Location of the Big Belt (A) and Bridger (B) Raptor Migration Surveys.

Methods

From 1 September – 5 November 2016 two highly experienced, trained observers conducted daily counts of migrating raptors from one of three standardized observation points (as described above, under "Study Site"), weather permitting. Primary observer Ronan Dugan began the 2016 season with a wealth of "in the field" raptor experience, including extensive work monitoring breeding Golden Eagles in Scotland. Ronan proved to be an outstanding observer and photographer during the 2015 season, thus all were happy to see his return. Secondary observer Jeff Grayum began the project with over a decade of birding experience, but lacked any formal training conducting raptor migration counts. Steve Hoffman held one all-day raptor identification training session before the start of the count to ensure accurate scientific data collection. In addition to the official observers, exceptionally qualified US Forest Service (USFS) employees assisted in the count twice a week to provide each official observer with at least one day off each week. The USFS biologists' contributions and skills were invaluable, and critical to the success of the project.

Observation hours generally began at 0900 H, and most often concluded at 1700 H MST. However, during peak Golden Eagle migration observations often began earlier in the morning and continued observing later in the afternoon to ensure that no substantial migratory flights of Golden Eagles were missed. All data were recorded following standardized protocol established by HawkWatch International (see below for specifics).

Decoy owls were erected near each observation point to lure migrating raptors close to the observers to enhance the quality of data collected. At Far Down Hill a single decoy owl was erected east of the observers, 20m upslope. On 1 October observers added a second owl approximately 150m downslope from the observers on top of a prominent dead tree, as suggested by Steve Hoffman. The addition of this owl substantially increased the number of raptor migrants that mobbed the owl decoy, likely due to its greater distance from human activity. An owl decoy was also erected at Saddle Knoll in various dead trees or poles as required.

Observers recorded the following data daily:

1. Species, subspecies, age, sex and color-morph of each migrating raptor, whenever appropriate and possible.
2. The hour of passage for each migrating raptor (e.g., 1200-1300 H).
3. Weather data: average and maximum wind velocity, wind direction, ambient temperature, barometric pressure, approximate percent cloud cover and type (e.g. "0-15%; stratus"), forms of precipitation (when applicable), and estimated thermal lift code (poor, fair, good, excellent). Weather data were recorded every hour, on the half-hour (e.g., 0930, 1030, etc.).
4. Flight path codes estimating the average direction, altitude, and horizontal distance of migrating raptors relative to the observers. This information was recorded at the end of each hour.
5. A visitor-disturbance rating describing the degree to which the official observers were distracted by visitors (none, low, medium, high).
6. Mean number of observers present (including official observers and actively participating visitors) for the hour, and total minutes of observation per hour.
7. Start and end times for each official observer.
8. Names and contact information for each visitor.

9. Presence and behavior of resident raptors, including information describing the criteria utilized to determine resident status.
10. Resident and migratory songbird activity.

Results and Discussion

Observation Effort and Weather Summary

Observers conducted counts on 60 of 66 possible count days from 1 September through 5 November 2016. Severe, inclement weather made observation efforts impossible on six days. Additionally, there were five days when daily observation hours totaled less than four hours (Table 1). The season was characterized by frequent cold fronts and a much cooler-than-normal September, an unsettled and stormy October with frequent snowstorms, and an unseasonably mild and pleasant end to the season in early November.

Table 1. Inclement weather days, Fall 2016 season.

Date	Weather conditions
4 September	NO COUNT. Rain turning into snow. Fog and low cloud-cover; zero visibility.
8 September	180 minutes of observation. Fog and poor visibility.
5 September	NO COUNT. Snow, low cloud-cover, fog; zero visibility.
22 September	NO COUNT. Fog with heavy precipitation; zero visibility.
23 September	NO COUNT. Snow and zero visibility
3 October	NO COUNT. Heavy snow, zero visibility.
5 October	150 minutes of observation. Very heavy cloud-cover and fog.
11 October	NO COUNT. Low cloud-cover and fog; zero visibility. Snow showers throughout the day.
17 October	180 minutes of observation. Heavy snow and fog in the morning.
19 October	180 minutes of observation. Heavy fog in the morning.
29 October	195 minutes of observation. No visibility due to fog.

Flight Summary

From 1 September – 5 November observers logged 443.4 observation hours (H) actively counting all migrating raptors utilizing the Big Belt flyway. A total of 4,389 migrating raptors of 17 species were recorded, with an average passage rate of 12.4 raptors/H. The maximum daily count occurred on 13 October, with 243 raptors documented in 9 hours (average rate = 27 raptors/H). The greatest passage rate for any 5-day period occurred from 11-15 October, with an effort-adjusted passage rate of 2295.5 raptors/100H. The total flight was comprised of 63% eagles, 21% accipiters, 10% buteos, 4% falcons, and 2% all other raptors (Fig. 2).

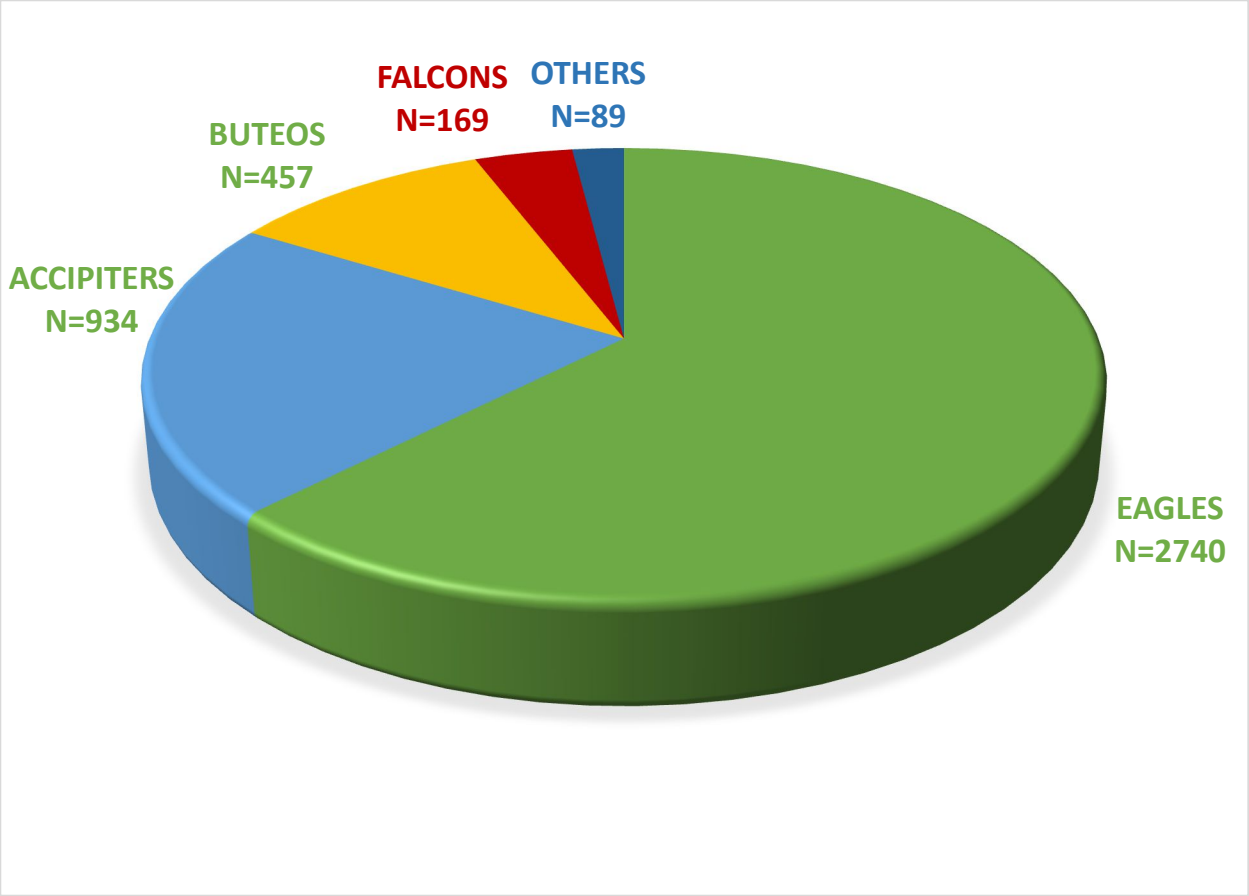

Figure 2. Proportion of Flight by Taxa – Fall 2016.

Species Accounts (See Table 2 for flight summary, and Table 9 for common and scientific names, species codes, and regularly-applied age, sex and color-morph classifications. Tables 10-13 list daily counts for each species.)

Golden Eagle (GE): The Golden Eagle was by far the most numerous migrant raptor; observers documented 2,620 Golden Eagles in fall 2016 (which is remarkably similar to the 2,630 recorded in 2015!), comprising 59.7% of all raptor migrants. Our Big Belt count recorded the greatest number of Golden Eagles of any raptor migration site in the contiguous United States during fall 2016! The average hourly passage rate from 1 September – 5 November was 7.4 Golden Eagles/H. Golden Eagle numbers reached a peak on 13 October, with 223 recorded in 9H (24.8/H). The highest 5-day passage rate for Golden Eagles occurred from 11-15 October (Fig. 6), with an effort-adjusted rate of 1665.7/100H. Observers determined age class for 77.6% of all Golden Eagles, and nearly two-thirds of those classified were adults.

Bald Eagle (BE): A total of 116 Bald Eagles were documented (12% more than the 104 in 2015), representing 2.6% of all raptors tallied in 2016. Observations peaked on 30 September, when 12 individuals were observed in 8.25H (1.45/H). Adults were more numerous than all other age classes combined, encompassing 58.6% of all Bald Eagles. The greatest 5-day passage rate occurred from 31 October - 4 November, with an effort-adjusted rate of 44.7/100H (Fig. 7).

Sharp-shinned Hawk (SS): The second most abundant migrant raptor was the Sharp-shinned Hawk. A total of 673 individuals were recorded (which is remarkably similar to the 656 counted in 2015), comprising 13.9% of all raptors counted. The number of Sharp-shinned Hawks reached a daily high on 9 October, with 66 individuals counted in 9.5H. The peak 5-day rate of passage was 26-30 September, with an effort-adjusted rate of 445.6/100H (Fig. 8).

Cooper's Hawk (CH): Observers recorded 116 Cooper's Hawks (14% above the 102 counted in 2015), comprising 2.6% of all migrant raptors tallied in 2016. The daily peak flight occurred on 15 October, when 15 were tallied in 10.5H (1.4/H). The greatest 5-day passage occurred on 26-30 September, with an effort-adjusted rate of 83.2/100H (Fig. 8).

Northern Goshawk (NG): Northern Goshawks are known to be cyclic, irruptive migrants; their decision to migrate is likely dictated by the abundance of prey on their breeding grounds, and particularly the density of snowshoe hares (Doyle & Smith 1994). In fall 2016 observers recorded 107 Northern Goshawks (26% more than the 85 recorded in 2015), representing 2.4% of all raptors in 2016. Counts reached a daily maximum on 9 October, when 8 goshawks were documented in 9.5H (0.84/H). The 5-day period with the greatest passage rate was 31 October-4 November (44.7/100H; Fig. 8).

Rough-legged Hawk (RL): This arctic breeder is the most numerous buteo in the Big Belts, with 214 individuals tallied, comprising 4.9% of all raptors. As a relatively late migrant, most roughlegs (96%) were observed after 8 October, although the first encounter was quite early (19 September). The 5-day effort-adjusted maximum passage period was 21-25 October (166.7/100H; Fig. 9). Interestingly, the 2015 season total for Rough-legged Hawks was one bird more than the 2016 total (215).

Red-tailed Hawk (RT): A total of 203 individuals were recorded (15% more than the 176 counted in 2015), representing 4.6% of all raptors tallied in 2016. Most redtails (67%; n=136) were observed before 1 October. Light-morph individuals represented 78.3% (n=159) of the total classified. The maximum effort-adjusted 5-day passage rate was 114.3/100H, occurring very early in the season (6-10 September). The Harlan's subspecies was included in the redtail total; we documented a total of 6 Harlan's Hawks, recording single birds on 1, 8 and 15 October, and 5 November, with 2 Harlan's on 21 October (Fig 9).

Broad-winged Hawk (BW): Although the Broad-winged Hawk is an extremely abundant migrant at eastern raptor migration sites, this species is generally a rare migrant throughout western North America. A mere 17 (0.34% of all migrant raptors) were recorded in the Big Belts (41% less than the 29 recorded in 2015). A relatively early migrant, all broadwings were observed in the month of September, with maximum daily totals (n=3) occurring on 15 (H=10.5), 18 (H=10), and 27 September (H=8). The greatest passage rate was from 16-20 September, with an effort-adjusted rate of 16.8/100H (Fig. 9).

Ferruginous Hawk (FH): Our largest buteo and a rare migrant atop the Big Belts, only two Ferruginous Hawks (one each dark morph and a light morph) were tallied (compared to 7 tallied in 2015). Observers recorded single individuals on 9 and 24 October. Both were detected at the primary observation site, Far Down Hill.

Swainson's Hawk (SW): This species is an early and relatively uncommon migrant along western ridgetops. Two Swainson's Hawks were recorded as migrants this season (same as in

2015). The first was observed on the opening day of observation, 1 September, and the second was recorded on 29 September.

Merlin (ML): Thirty Merlins were observed during the 2016 season (compared to 58 counted in 2015, a 48% decrease in 2016), with the daily maximum occurring on 28 September (N=4; H=8.5). Five-day passage rates reached a maximum for this species on 26-30 September, averaging 16.1/100H (Fig. 10).

American Kestrel (AK): The most common migrating falcon species tallied, a total of 83 American Kestrels was recorded (compared with 59 counted in 2015, a 41% increase this season). The highest 5-day passage rate occurred 26-30 September (67.1/100H). Observers recorded a daily maximum of 11 American Kestrels on both 1 and 28 September (H=8 & 8.5, respectively; Fig. 10).

Peregrine Falcon (PG): We documented 28 migrating Peregrine Falcons (compared with 36 in 2015, a 22% decrease in 2016). The maximum 5-day passage rate occurred from 26-30 September (16.1/100H). The days of greatest passage (n=3) were 6, 14 and 29 September (H= 9.5, 8 & 5, respectively; Fig. 11).

Prairie Falcon (PR): As the least abundant falcon utilizing the Big Belt flyway, 15 Prairie Falcons were recorded throughout the 2016 season (compared to 19 tallied in 2015). The maximum daily counts were made on 24 (H=8.25) and 30 October (H=7.5), when two birds were recorded each day. The peak 5-day passage rate was from 21-25 October (9.5/100H; Fig. 11).

Northern Harrier (NH): An uncommon ridgetop migrant, we recorded 45 Northern Harriers during the season (compared with 32 in 2015, a 41% increase in 2016). On 28 September, an astonishing 14 Northern Harriers were recorded in 8.5H! The 5-day period of maximum effort-adjusted passage rate was 26-30 September (61.7/100H; Fig. 12).

Osprey (OS): An early migrant, 17 Ospreys were recorded this season (compared to 9 tallied in 2015), with the last one counted on 28 September. The highest 5-day passage rate was 6-10 September (13.6/100H; Fig. 12).

Turkey Vulture (TV): A rare ridgetop migrant, only one Turkey Vulture was documented this season (compared to 3 in 2015). This occurred 28 September, a day of light winds, warm temperatures, and strong thermals.

Age Ratios

Age ratios were calculated for both Golden Eagles and Sharp-shinned Hawks, the two most numerous migrants during the 2016 season. Golden Eagles were classified as either immatures (hatch-year birds), sub-adults, non-adults, or adults (see Appendix, Table 8). Sharp-shinned Hawks were aged as either immature or adult birds.

Table 2. Flight summary for all migrating diurnal raptor species observed in the Big Belt Mountains, Fall 2016. "Most Active" periods were determined by calculating effort-adjusted 5-day passage rates.

Species	Sp. Total	First Observed	Last Observed	Most Active 5-day period
GE	2,620	1-Sep	5-Nov	11-15 Oct
BE	116	1-Sep	5-Nov	11-15 Oct
SS	673	1-Sep	5-Nov	26-30 Sep
CH	116	1-Sep	30-Oct	26-30 Sep
NG	107	10-Sep	5-Nov	31 Oct-4 Nov
RL	214	19-Sep	5-Nov	21-25 Oct
RT	203	1-Sep	5-Nov	6-10 Sept
BW	17	9-Sep	29-Sep	16-20 Sept
FH	2	9-Oct	24-Oct	21-25 Oct
SW	2	1-Sep	29-Sep	1-5 Sep
PG	28	6-Sep	22-Oct	26-30 Sep
PR	15	11-Sep	30-Oct	26-30 Sep
ML	30	1-Sep	27-Oct	26-30 Sep
AK	83	1-Sep	23-Oct	26-30 Sep
NH	45	2-Sep	2-Nov	26-30 Sep
OS	17	2-Sep	28-Sep	6-10 Sep
TV	1	28-Sep	28-Sep	26-30 Sep

Table 3. A summary of all age data for Golden Eagles (GE) and Sharp-shinned Hawks (SS) for the 2016 season in the Big Belts. (Note the age classes "subadult" and "non-adult" are not applicable for SS.) For comparative purposes, all non-adult GEs (immature, subadults, and non-adults) were combined to determine non-adult:adult ratios.

	Immature	Subadult	Non-adult	Adult	Unidentified	Non-adult : Adult 2016	Non-adult : Adult 2015
GE	348	307	76	1301	588	0.56 : 1	0.54 : 1
SS	89	N/A	N/A	384	200	0.23 : 1	0.21 : 1

Adult birds greatly outnumbered non-adult birds in both species (Table 3). Although long-term demographic data do not yet exist for the Big Belt flyway, the Bridger Raptor Migration Project has been collecting detailed data on migrating raptors since 1992, providing a useful comparison for our age-specific observations in the Big Belts (which may provide valuable information on annual breeding success). In fall 2016, the ratio of non-adult-to-adult Golden Eagles using the Big Belt flyway was 0.56:1 (which is nearly identical to the 0.54:1 age ratio found in 2015). This is well below the 1992-2015 average non-adult-to-adult ratio in the Bridgers (1.2:1), and quite different from the observed ratios in the Bridgers during 2016 (1.1 non-adults to 1 adult) (Davis et al. 2017). The disparity in age ratios between the Bridgers and Big Belts in 2016 is problematic, and may suggest the possibility of differing age-specific migration routes. Hence, at this point we are unable to interpret this information, and certainly it would be premature to draw any sweeping conclusions from our Big Belt age ratios regarding Golden Eagle breeding success in 2016.

Age ratios for Sharp-shinned Hawks were quite similar for both the Big Belts and Bridgers in 2016 (such parallel findings did not occur in 2015), suggesting the possibility of a particularly poor breeding season for this species with an immature-to-adult ratio of 0.2:1 at both sites in 2016. This ratio is substantially lower than the 1992-2015 average immature-to-adult ratio for Sharp-shinned Hawk documented in the Bridgers of 0.6:1 (Eberly et al. 2016).

Seasonal Timing

Young, inexperienced raptors are often first to migrate from their breeding grounds as food resources become scarce and weather conditions more hostile (Omland & Hoffman 1996). Furthermore, adult birds often remain on their breeding territory later into the fall, typically long after the immature birds have dispersed and begun their autumn migration. This well-documented age-specific difference in seasonal timing was clearly observed for both Golden Eagles and Sharp-shinned Hawks in the Big Belts during the 2016 season (Figs. 3 & 4).

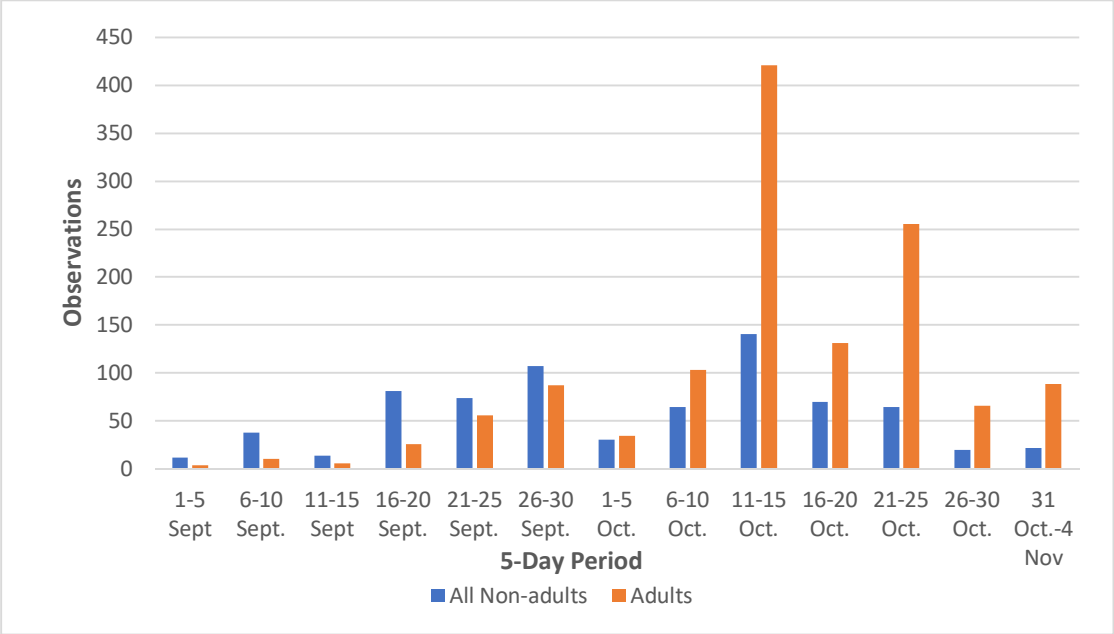

Figure 3. Five-day passage periods of all non-adult and adult Golden Eagles.

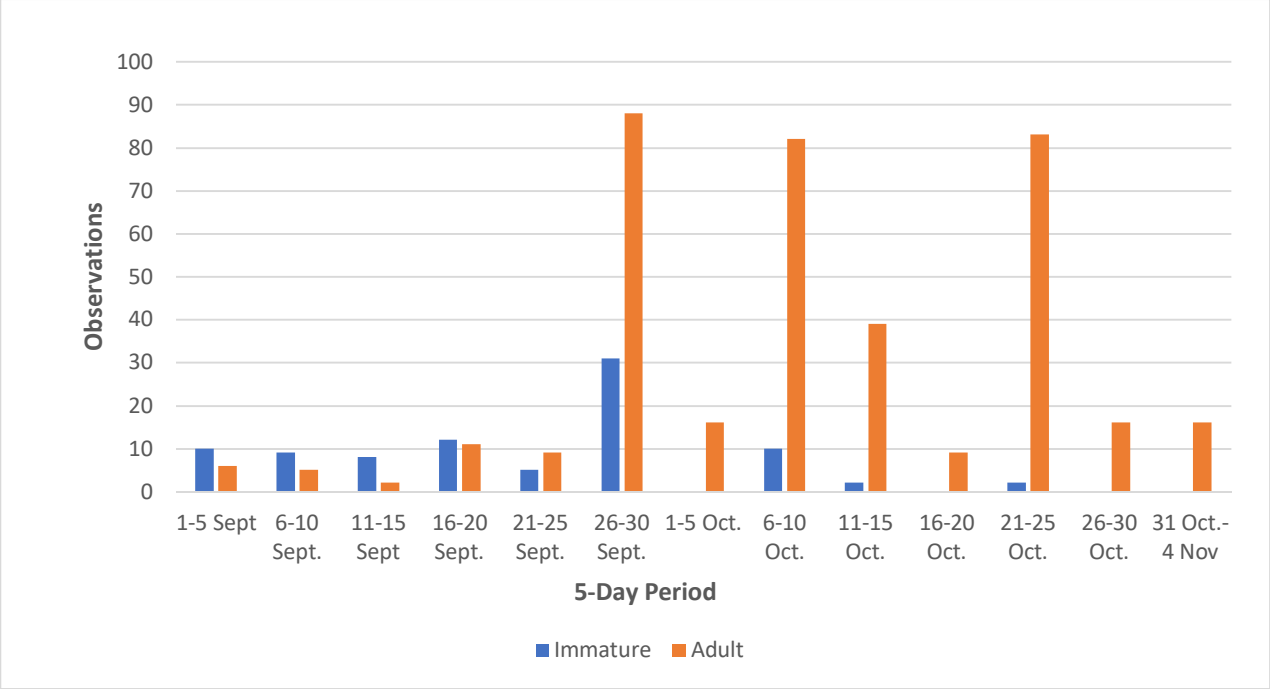

Figure 4. Five-day passage periods for immature and adult Sharp-shinned Hawks.

The Big Belt Count: 2015 vs. 2016 Season

In addition to being an extremely successful season of data collection, the fall 2015 season was partly a year of exploration for conducting future raptor migration surveys in the Big Belt

Mountains. The 2015 count began atypically late, a full 14 days later than the start of the 2016 season (although only 3.7% of the migrating Golden Eagles in 2016 were tallied before 15 September), and total observation hours were significantly lower. In fall 2015 various lookouts were evaluated to determine the optimal location for a standardized fall migration count, with the observers ultimately selecting Far Down Hill as the primary site. Due to these variables limited comparisons can be made between the two seasons. Despite these differences, the count totals for many species were remarkably similar (see Table 4).

Table 4. A comparison of species-specific totals between the 2015 and 2016 seasons in the Big Belts.

YEAR	2015	2016
Total Observation Hours	352.8	443.4
Golden Eagle	2630	2620
Sharp-shinned Hawk	656	673
Cooper's Hawk	102	116
Unid. Accipiter	42	38
Red-tailed Hawk	176	203
Swainson's Hawk	2	2
Unid. Buteo	29	19
American Kestrel	59	83
Unidentified Falcon	8	13
Northern Harrier	32	45
Osprey	9	17
Unid. Raptor	14	26
Bald Eagle	104	116
Broad-winged Hawk	29	17
Ferruginous Hawk	7	2
Merlin	58	30
Northern Goshawk	85	107
Peregrine Falcon	36	28
Prairie Falcon	19	15
Rough-legged Hawk	215	214
Turkey Vulture	3	1
Unid. Eagle	3	4
Total Migrants	4318	4389

Golden Eagles were recorded in very similar numbers in both 2015 and 2016, despite a considerably later starting date and 90.6 fewer total observation hours in 2015. This could reflect a less productive 2016 breeding season, unusually poor weather conditions (making observations

difficult or impossible during the peak migration period for Golden Eagles), perhaps the result of an unusually late fall migration in 2016, or any combination of these factors. Based on Golden Eagle counts made during the first half of November to the north on Mt Lorette (in Alberta, Canada; P. Sherrington, pers. comm.), several hundred Golden Eagles likely migrated through the Big Belts after our Big Belt observations concluded on November 5th. Golden Eagle movement was still remarkably steady in early November, with 23 Golden Eagles recorded in the Big Belts on the final day of observation. Golden Eagle counts in November at Mt. Lorette reached record highs this year. For example, observers on Mt. Lorette recorded 111 Golden Eagles on 7 November 2016, and overall Golden Eagle counts for the month of November were 173.3% above the long-term average (although their total Golden Eagle count for the entire fall season was 12.4% below average). This may be an indication that the lower passage rate of Golden Eagles observed in the Big Belts in 2016 (Table 5) was at least partly due to an unusually late fall migration, with significant numbers likely passing after the count period ended on 5 November.

Table 5. Golden Eagles per 100 hours of observation in the Big Belts.

Year	2015	2016
Golden Eagles/100H	745.4	590.9

Numbers of Ospreys and American Kestrels counted in the Big Belts increased sharply in 2016 (compared to 2015; Table 4). Observers documented 89% more Ospreys and 41% more American Kestrels. These species are early-season migrants, and this increase is likely due to a much earlier start date in 2016. Interestingly, Broad-winged Hawks, another relatively early migrant, decreased by 41% in 2016.

A Comparison of the Big Belt Counts with Other Relevant Raptor Migration Counts

Observers in the Big Belts recorded more Golden Eagles than any other hawk-watch site in Montana (Table 6 provides a comparison among these sites). Nora Ridge documented the highest effort-adjusted Golden Eagle passage rate, although it should be noted that a greater proportion of their observation period occurred during the peak passage time frame for Golden Eagles (thus substantially inflating their Golden Eagle passage rates). Mount Lorette, which consistently records the greatest seasonal total of Golden Eagles anywhere in North America, surpassed the Big Belts in total Golden Eagle numbers by 351 eagles (or +13%; 2971 vs. 2620). Observers at Mt. Lorette surveyed 10 days later into November, documenting 281 Golden Eagles after the count concluded in the Big Belts. It should be noted that Mt. Lorette and Nora Ridge are located on the same Rocky Mountain Front flyway as the Big Belts.

Each of the Montana/Alberta sites (Fig. 13) reported a lower-than-average Golden Eagle count in 2016 (excepting the Bridgers and Nora Ridge). This may be an indication that fall 2016 weather patterns were more favorable for birds to continue flying directly south to the Bridger Mountains after traversing the Big Belts, as opposed to heading east toward the Crazy Mountains. One possible reason for this, and as our observations suggest, under cloudy conditions Golden Eagles are more reliant on ridgetop updrafts during their migration. During October 2016, we had

unseasonably cool and cloudy weather, thus Golden Eagles (and other raptors) were likely more dependent upon ridgetop lift (as compared to thermal lift), making it more likely that migrants would continue south to the Bridgers. The Crazy Mountains are an isolated mountain range some 30 miles directly east across the Shields Valley from the Big Belts, so we can speculate that without thermals and buoyant air eagles would likely have preferred to continue south along the ridge to the Bridgers rather than cross the open Shields Valley. In addition, during October 2016 we noticed the Crazy Mountains often held weather systems with low cloud cover, hence migrating Golden Eagles may not have been able to see these mountains while migrating, and thus would have been more likely to continue south to the Bridgers.

Table 6. A comparison of 2016 raptor migration count totals for Montana hawk count sites and Mt Lorette (located in Alberta, Canada).

Site	Fall 2016 GE Count	Ave. GE Count	2016 Obs. Hours	GE/100H	Start Date	End Date
Big Belts	2620	26255	443.42	590.86	1-Sep	5-Nov
Bridgers	1437	1329	381.83	375.56	27-Aug	5-Nov
Jewel Basin	302	469	235.5	128.24	26-Aug	13-Nov
MPG	141	158	376.25	37.48	1-Sep	11-Nov
Nora Ridge	1699	1205	240	707.92	8-Sep	30-Oct
Mt Lorette	2973	3465	577.1	515.16	20-Sep	15-Nov

Increased Golden Eagle migration activity occurred simultaneously across all Montana hawk-count sites during the 2016 season (Fig. 5). Long-term monitoring at standardized hawk-watch sites has reliably demonstrated increases in passage rates immediately prior to cold fronts (Yates et al. 2001). This was confirmed various times throughout season (e.g., the increase in rate of passage from 1-5 October preceded a strong cold front). Furthermore, Golden Eagle passage rates also increased simultaneously across all Montana sites immediately following a period of severely inclement weather (21-25 September). Awaiting optimum conditions, Golden Eagles may be held up by poor flight conditions, thereby concentrated in a "traffic jam" - resulting in a strong movement of birds once migration conditions again become favorable. Peak Golden Eagle passage rates of 11-15 October occurred immediately after a long period of inclement weather in northern Montana and southern Canada (this peak flight occurred slightly later in the Bridgers, Montana's southernmost site).

Wing-tagged Golden Eagles

Wing-tagging Golden Eagles enables researchers to collect valuable data on movement patterns, seasonal variation in the use of specific migration flyways, dispersal patterns and survivorship. Observers in the Big Belts documented a significant number of wing-tagged Golden Eagles during the 2016 season. Six wing-tagged Golden Eagles were confirmed (Table 8), with several additional probable sightings. Observers successfully read the specific tag number on one of these individuals (thanks to Ronan Dugan's phenomenal photography!), an

adult Golden Eagle with a blue and white tag that read "237." This individual was tagged at Rogers Pass on Montana's Rocky Mountain Front on 12 October 2014 by Rob Domenech, founder of RVRI. Based on plumage molt, it was determined to be a near-adult male in its fourth calendar year at the time of capture. At that time the bird weighed only 3500 grams (7.7 pounds)!

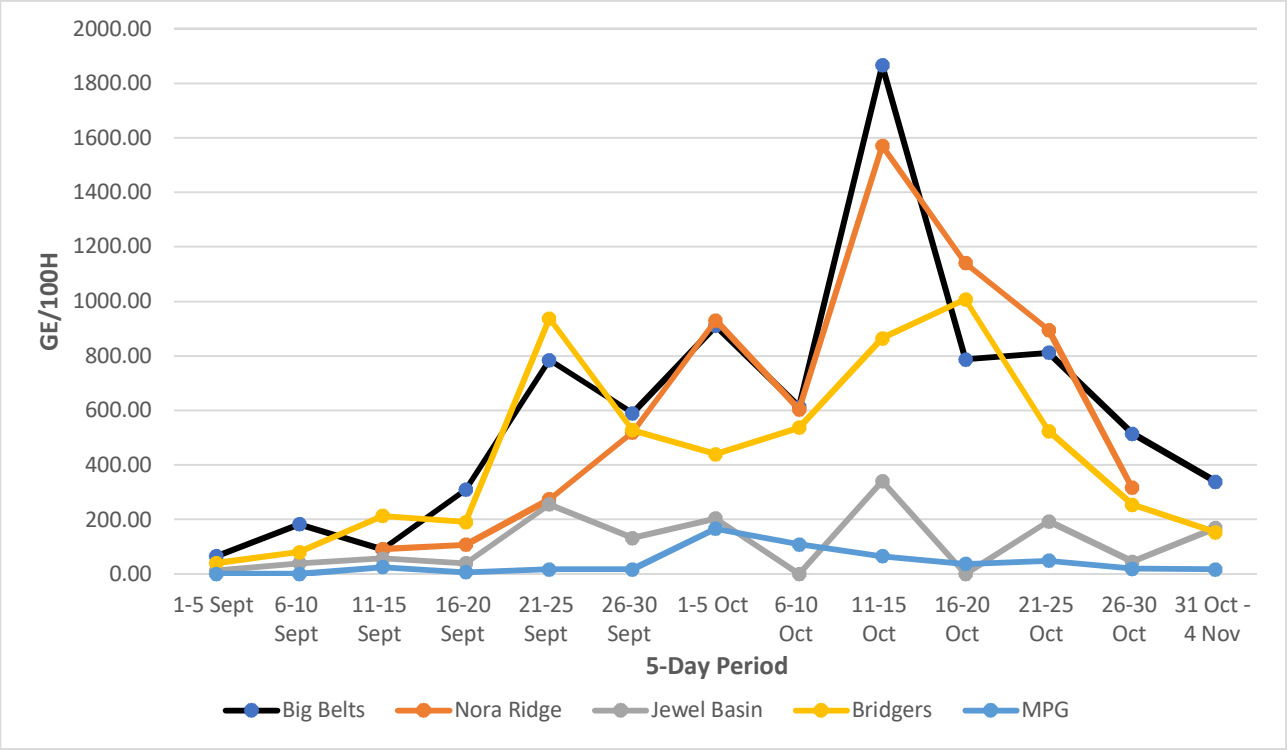

Figure 5. Effort-adjusted Golden Eagle passage rates at migration sites in Montana.

Table 7. Sightings of wing-tagged Golden Eagles in the Big Belt Mountains by date, Fall 2016.

Date	Time of Sighting and Description
27-Sep	1143: Adult GE. orange left, green right. Tagged at Rogers Pass between 2004 – 2012. Tags were photographed and seen to be curling.
1-Oct	1050-1100: Two Adult GEs with blue tags.
12-Oct	1658: Immature GE with blue tags. Shaking in flight – likely tagged at Rogers Pass that morning.
13-Oct	1220: Adult GE with two pale-white wing tags. Likely tagged in southern California.
24-Oct	1113: Adult GE with blue/white tags; #237.

Resident Raptors

Raptors displaying non-migrant behavior were assumed to be year-round residents. Resident behavior included active hunting, perching, performing territorial displays, and flying in a

direction atypical of migrating birds. Observers kept a detailed, daily journal of resident bird activity.

A pair of Golden Eagles was regularly seen displaying in September. These displays usually consisted of "rollercoaster displays" (repeatedly gaining altitude before steeply diving) and birds circling as a pair to the west of the observation sites. We did not, however, record resident Golden Eagles 'escorting' migrants through their territory, which is often reported at other migration sites. A brood of Golden Eagle triplets was seen throughout September several miles to the west of the observation site. From our incidental observations, it appears likely that the forest-edge habitat and open grasslands in the foothills and surrounding the Big Belts holds a healthy population of breeding Golden Eagles.

Resident Red-tailed Hawks were seen frequently throughout much of the early and middle parts of the season. Red-tails were observed flying north, hover-hunting (especially in the late afternoon), and escorting migrants. Resident accipiters (all three species) were also commonly observed. The Big Belts appear to harbor a healthy population of Northern Goshawks, and these birds were seen aggressively harassing migrating raptors, and/or repeatedly mobbing the decoy owl before continuing north or perching, and actively hunting while on a northward flight trajectory. Resident Cooper's and Sharp-shinned hawks also were infrequently recorded (particularly early in the season) flying in a direction atypical for migration.

Other Wildlife

Observers spent the duration of the study camping in the Big Belt Mountains, and thus witnessed a diverse array of wildlife in addition to the daily flight of migrating raptors. A variety of passerines winter in the Big Belts, and the observers often enjoyed the company of Clark's Nutcrackers, Gray Jays, Red Crossbills, Northern Flickers, Mountain Chickadees, Pine Siskins and Townsend's Solitaires. Ruffed and Dusky Grouse were frequently flushed while hiking up to the Far Down Hill observation point. Migrating Common Loons were irregularly observed flying southeast toward Canyon Ferry Lake (eight were noted on 10 October). Of course, Common Ravens were constantly present everywhere in the Big Belts.

Bohemian Waxwings and Gray-crowned Rosy-finches began migrating in great abundance throughout mid-to-late October. Flocks of 200+ birds (of both species) were seen multiple times daily. Mountain Bluebirds were also observed regularly (primarily in September) in small migrant flocks. American Crows, which were not observed at all during the fall 2015 season, were seen migrating south in flocks of 3-5 individuals along the ridge several times in mid-to-late October.

The amazing abundance and variety of nocturnal raptors encountered during the 2015 season was not observed in 2016. A few Northern Saw-whet Owls were lured in with recorded calls, and a Great-horned Owl awoke the observers on several nights. Northern Pygmy-owls were infrequently heard and occasionally sighted during the season. On 6 October, Anna Fasoli, a visitor and skilled birder, photographed a Great Gray Owl perched near camp (the only Great Gray documented this season). Primary observer Ronan Dugan noted a significant drop in the small mammal populations in 2016 compared to 2015. This may have been an important contributing factor to the perceived decrease in owl numbers in 2016.

The Big Belts are also home to a variety of mammal species. Elk were spotted intermittently at the primary observation site and while exploring near camp. Both mule and white-tailed deer were seen regularly in good numbers. Moose were observed several times throughout the season, and as in 2015 they appeared to favor higher elevations later in the season. Snowshoe hares were frequently encountered, and weasels were observed irregularly, wearing either their summer or winter coats. On an atypically warm night in late September observers camped at the summit of Mount Baldy and enjoyed a close encounter with nine mountain goats!

The Big Belts also host an exciting variety of large predators. Black bear tracks were often present when snow accumulated, at times eerily close to camp. Ronan Dugan experienced the only direct black bear encounter of the season while biking in the backcountry in September. Trail cams recorded footage of mountain lions, bobcats, and coyotes.

Visitation

The Big Belts' proximity to Helena, ease of accessibility, and fantastic views of migrating raptors make for an ideal location to host educational field trips and share knowledge with curious visitors. During the 2016 season, observers enjoyed frequent interactions with guests, most of whom journeyed into the mountains solely to witness the spectacle of migrating raptors and learn valuable identification skills. The Big Belts is still a relatively new and unknown site, and many visitors were unaware of the location until reading an article featured in the Great Falls Tribune – which was later picked up by *USA Today*. Observers noted a significant increase in visitation after the article was published.

On 1 and 15 October Steve Hoffman led field trips into the Big Belts after teaching a course in raptor identification to attendees the previous evening. Both field trips were well attended (official observers were honored to be joined by legendary hawk-watcher Jerry Liguori on 15 October), and guests enjoyed viewing a strong flight of migrating raptors while honing their newly-developed identification skills. The funding generated from field trip admittance costs was invaluable in offsetting project expenses. Numerous field trip participants returned to the site later in the season to again experience the magnificent flight of raptors.

Recommendations

Based on our first two mostly-full seasons of study in the Big Belts, we recommend the Golden Eagle Migration Survey be continued. We aim to develop a long-term, standardized science-based raptor migration count, with the primary goal of monitoring migrant Golden Eagle populations passing through the region.

We hope the Golden Eagle Migration Survey in the Big Belts will compliment other standardized, long-term raptor migration counts in the region. We look forward to sharing our findings with Golden Eagle researchers from Alaska, Canada and the U.S. to gain a better understanding of Golden Eagle movements, population dynamics and overall health. The importance of studying migrant populations of arctic and sub-arctic apex predators (i.e., Golden Eagles) in this age of global climate disruption cannot be over-emphasized. Hence, we shall continue to work hard to source and secure reliable, annual funding to enable an effective long-term monitoring effort.

The Golden Eagle Migration Survey in the Big Belts is still in its infancy, and each season reveals the potential for improvements. Golden Eagle movement was steady on both the start and end dates of the survey. However, a season ranging from 15 September – 10 November would likely yield a more focused and accurate count of migrating Golden Eagles. However, counting later in the season will increase the likelihood of working in severe, inclement weather.

Our partnerships with both the U.S. Forest Service and Montana Fish, Wildlife and Parks are tremendously appreciated. Their funding and logistic support have been critical to the project's success during its initial two years. In addition to their financial support, we wish to acknowledge their donations of personnel and equipment, which has been vital to the project. We look forward to the possibility to continue expanding our partnerships and collaborations with other interested partners in Montana and beyond.

Camping in the Big Belts for a prolonged period throughout autumn was a punishing experience. Observers in 2016 had the luxury of a camp trailer donated by FWP, as well as a second trailer donated by Conrad Evarts beginning in late September. Although the trailers substantially enhanced living conditions at our Duck Creek Pass camp, they also presented many challenges. Heavy snow accumulations in November could create dangerous conditions for towing trailers down the mountain. In addition, these trailers were poorly insulated and attracted moisture, making drying out damp equipment and clothing problematic. We believe that both issues could be alleviated by substituting a wall tent and wood stove for the trailers.

On multiple occasions during the fall 2016 season, observers documented migrating Golden Eagles flying under a full moon, long after the sun had set. To our knowledge, this behavior has not been previously recorded. Therefore, it is strongly recommended that future observers make a special effort to collect data on this phenomenon whenever possible. This knowledge may substantially enhance our understanding of Golden Eagle migration.

Conditions at the observation site can and should be improved if observers are to remain at the ridgetop site throughout the day during inclement weather. An improved shelter, with greater wind protection, would increase the time observers could count on poor-weather days. It would also reduce the risk of exposure to the elements and fatigue towards the end of the season. In addition, providing cover for the observers and visitors would reduce the potential to disturb the migrating raptors, particularly Golden Eagles.
The observers often noted that visitors at the site had binoculars not suited for raptor observation. Education (and funding!) are often dependent on a positive visitor experience, and having quality binoculars stored at the site would likely pay huge dividends, increasing enthusiasm and interest. Lastly, the official counters were often inundated with answering the same few questions daily. Hence, we suggest developing and posting a highly visible "Frequently Asked Questions" sign at the observation site to minimize levels of visitor disturbance on busy days.

Closing Remarks

In addition to the sheer abundance of migrating Golden Eagles -- a species which seems to attract greater public interest than any other raptor -- the Big Belts awards visitors with many exceptionally close views of not only Golden Eagles, but all migrant raptors. The unique experience of viewing such inspiring birds at close range presents outstanding opportunities for

education, public awareness, and superlative avian photography. Importantly, such inspirational experiences offered to visitors likely will allow the project to be promoted from multiple perspectives, and could lead to additional funding opportunities from a more diverse array of agencies.

Acknowledgments

The 2016 raptor migration study in The Big Belt Mountains ("GEMS") was a collaborative effort among four entities: Montana Audubon (MA), Last Chance Audubon Society (LCAS), Montana Fish, Wildlife, and Parks (FWP), and the US Forest Service (USFS; Helena-Lewis & Clark National Forest). The unique contributions and generous funding from each of these entities were critical to the success of the project, and deeply appreciated. The project greatly benefited from additional financial contributions by the Montana Outdoor Legacy Foundation, Hawk Migration Association of North America, Tenmile Brewery and Loft Studio (both of Helena), Mitch Stocks, several anonymous donors and many more individual contributors – thanks to all for your support in helping us monitor and protect these magnificent raptors!

This study would not have been possible without the immense effort put forth by every member of the GEMS Committee. A sincere and heartfelt thanks to: Janice Miller for her super-human committee leadership, and her efforts to keep the official observers well-stocked with supplies and cheer, her generous hospitality and remarkable positive attitude; Steve Hoffman for his wealth of knowledge and expertise, as well as his daily guidance and energetic, never-ending commitment to the project; Bob Martinka for his donation of the generator and numerous other essential camping supplies; Stephen & Patty Turner for their amazing hospitality (including substantial donations of food) and specifically Steve's persistent, pro-active efforts to generate funding for the project; Liz Hiltunen for her hard work publicizing the project and its associated events, as well as her donation of the internet hotspot; Dan Ellison for thoughtfully donating the critical, timely snow shovels and assisting with project logistics, including field trips and public educational efforts; Allison Begley for obtaining crucial FWP funding for the project as well as supplying the FWP camping trailer for the observers (generously hauled to Duck Creek Pass by Jay Kolbe); USFS biologist Denise Pengeroth for providing cost-share funding and her seasonal employees (Shaun Hyland, Erin Brekstad, Sara Sylte, Kristin Alexander and others) who provided twice weekly assistance as day-long raptor migration observers throughout the season (Shaun's generous donations of camping supplies and food were also greatly appreciated!).

Additional observation support was provided by Anna Fasoli, Mikaela Howie, Chris Smith and many others. Cory Llewelyn, USFS District Ranger (Townsend), capably facilitated acquisition of the USFS "Extended Camping Permit" for the project. Pat Grantham and Christian Meny provided essential support for the educational field trips. The observers were truly appreciative of the frequent food donations by many visitors, as well as the informative and timely Golden Eagle migration updates from Mt. Lorette, (Alberta, Canada), reported via email by Peter Sherrington, Founder and President of the Rocky Mountain Eagle Foundation.

We also wish to express huge thanks to Lisa Rhodin of FWP's Montana WILD for arranging the exciting release of four rehabilitated Golden and Bald Eagles in late September at Duck Creek Pass. The observers also wish to express their deepest appreciation to Conrad Evarts for his generous donation of an additional camping trailer during the latter half of the season, which helped the crew overcome key challenges to difficult project logistics at this time of year.

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Appendices

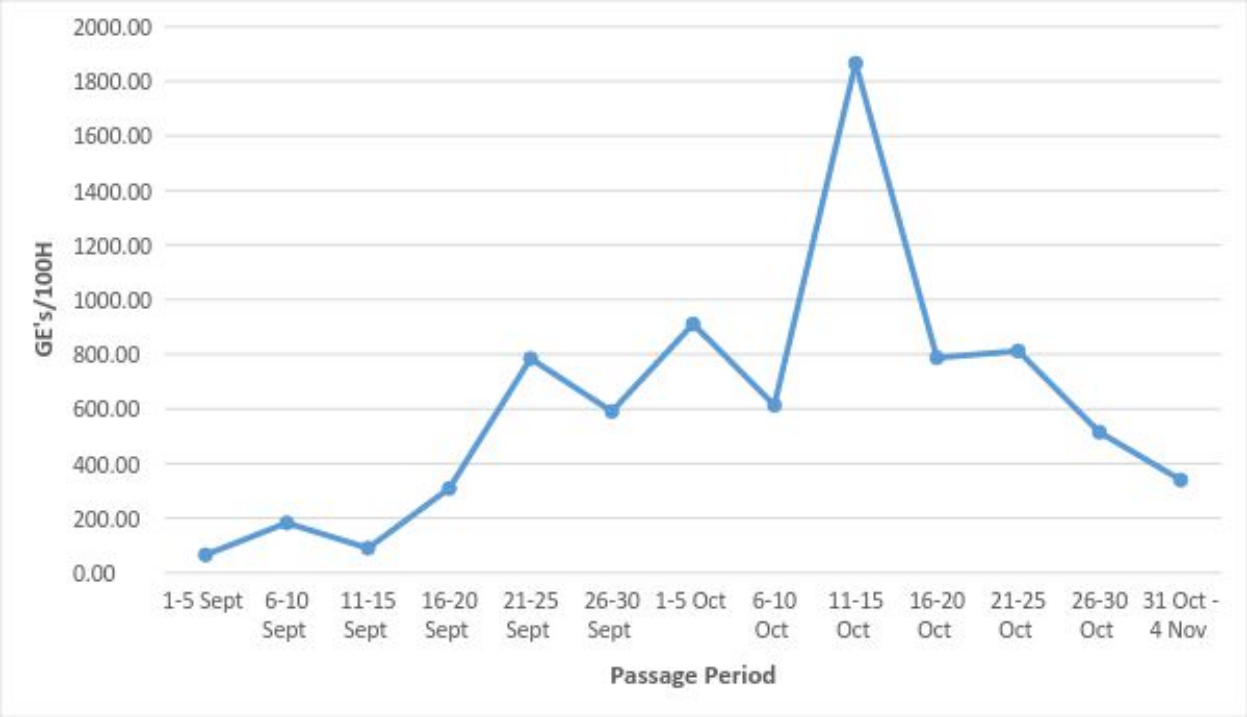

Figure 6. Effort-adjusted 5-day passage rates for Golden Eagles.

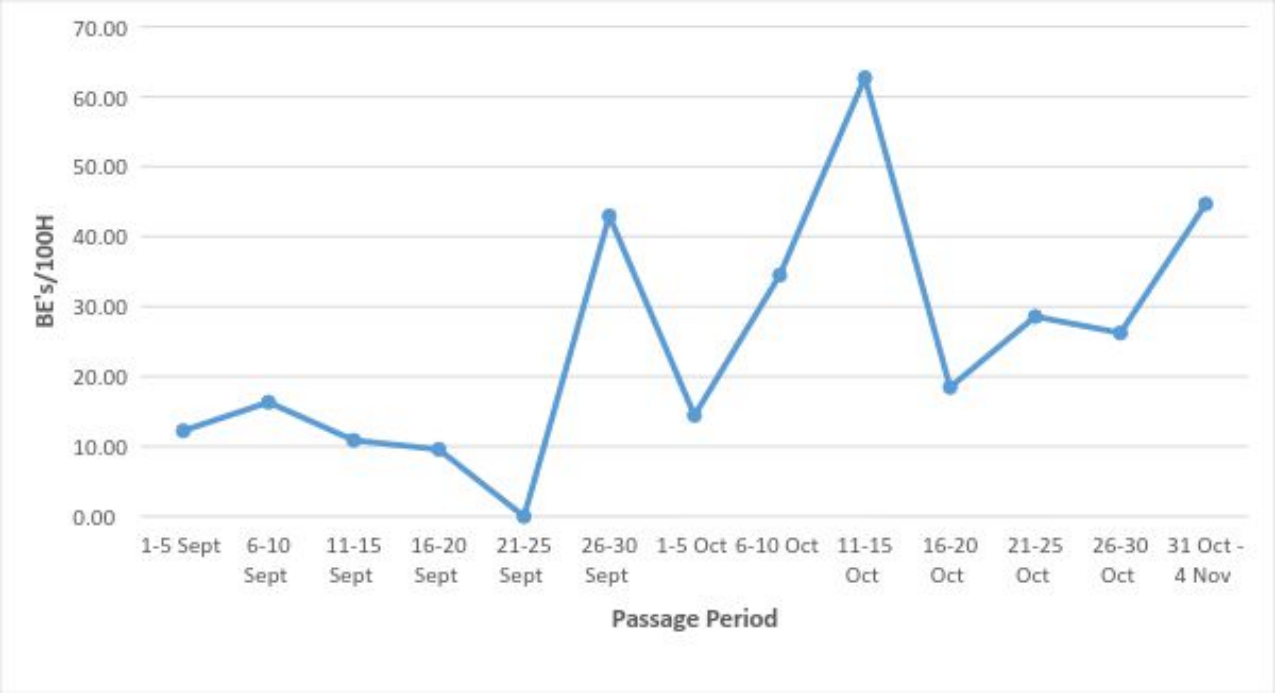

Figure 7. Effort-adjusted 5-day passage rates for Bald Eagles.

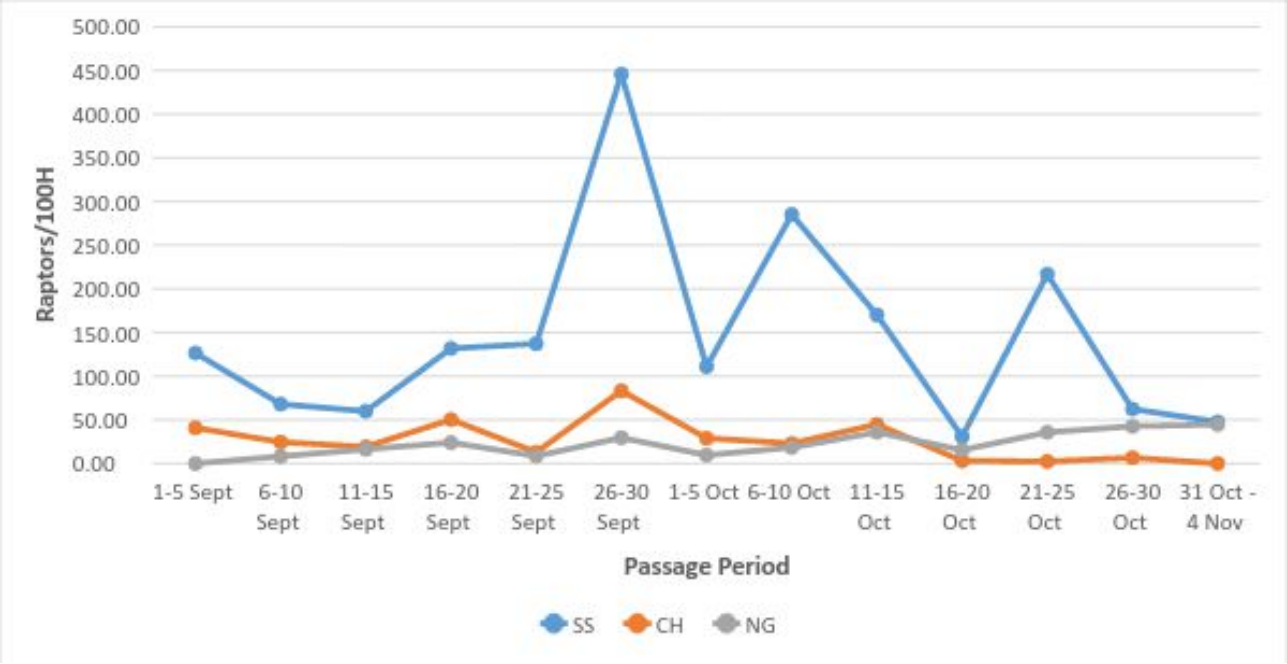

Figure 8. Effort-adjusted 5-day passage rates for Accipiter species.

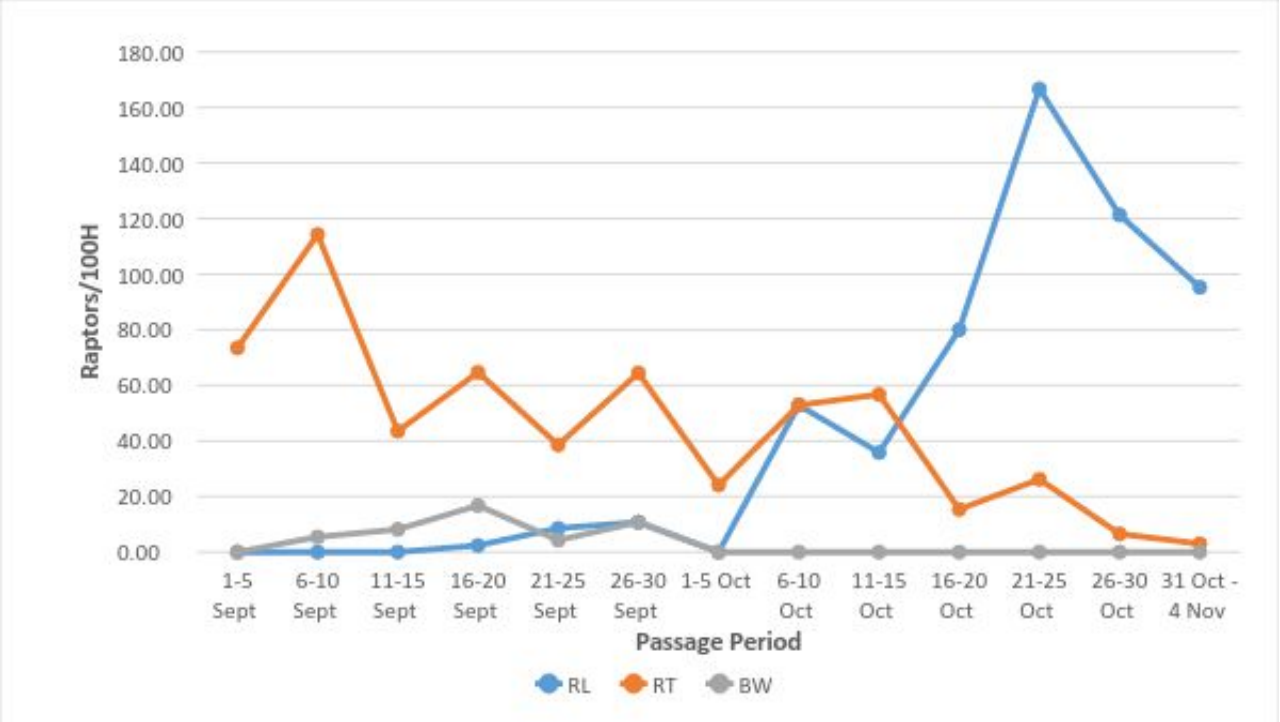

Figure 9. Effort-adjusted 5-day passage rates for Rough-legged, Red-tailed, and Broad-winged Hawks.

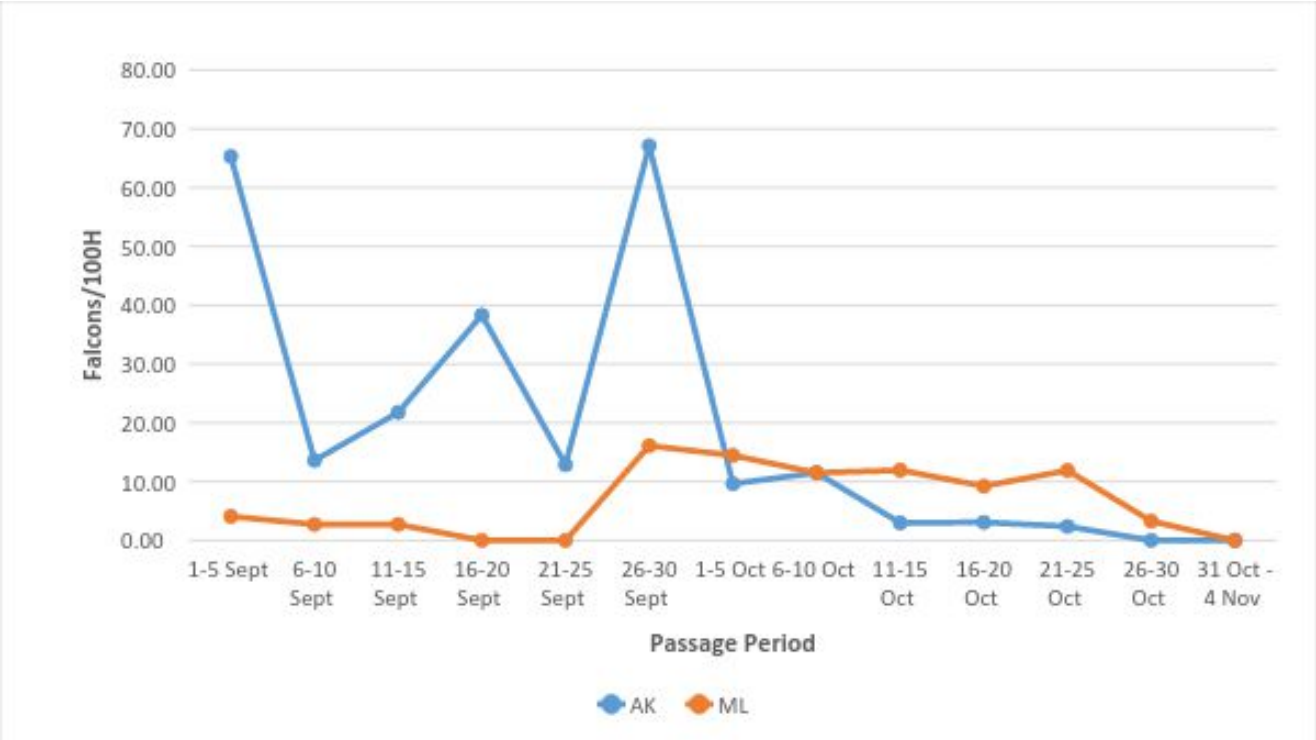

Figure 10. Effort-adjusted 5-day passage rates for small falcons.

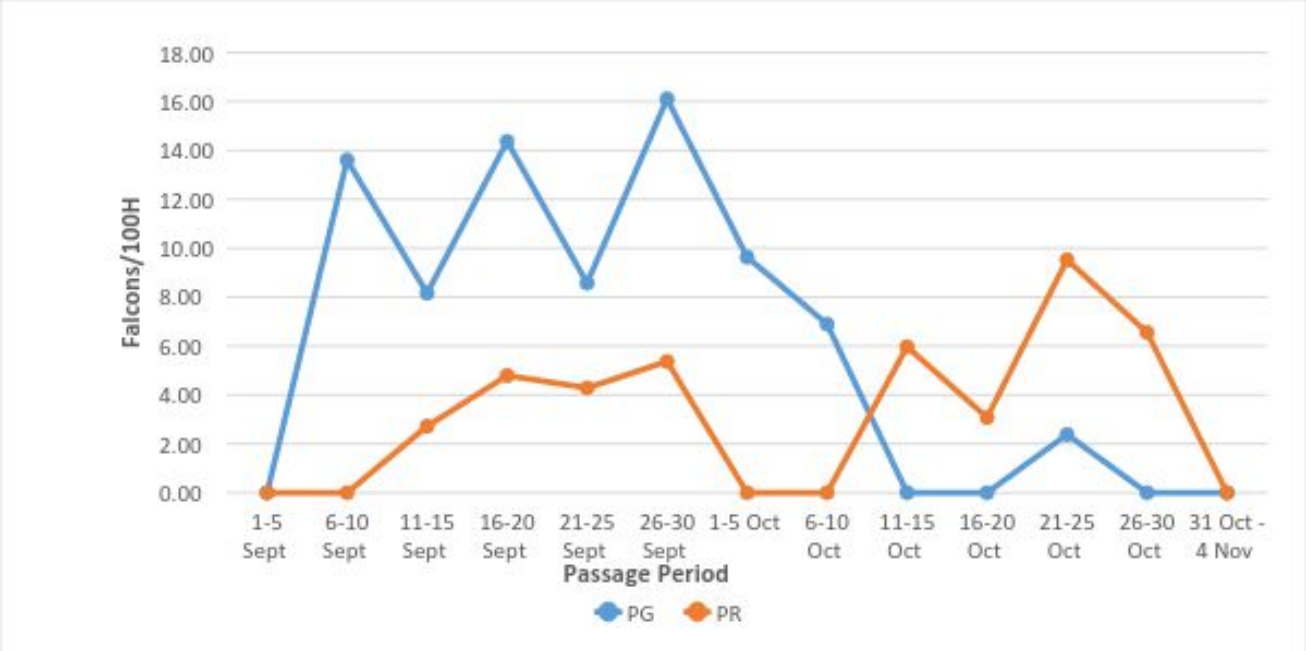

Figure 11. Effort-adjusted 5-day passage rates for large falcons.

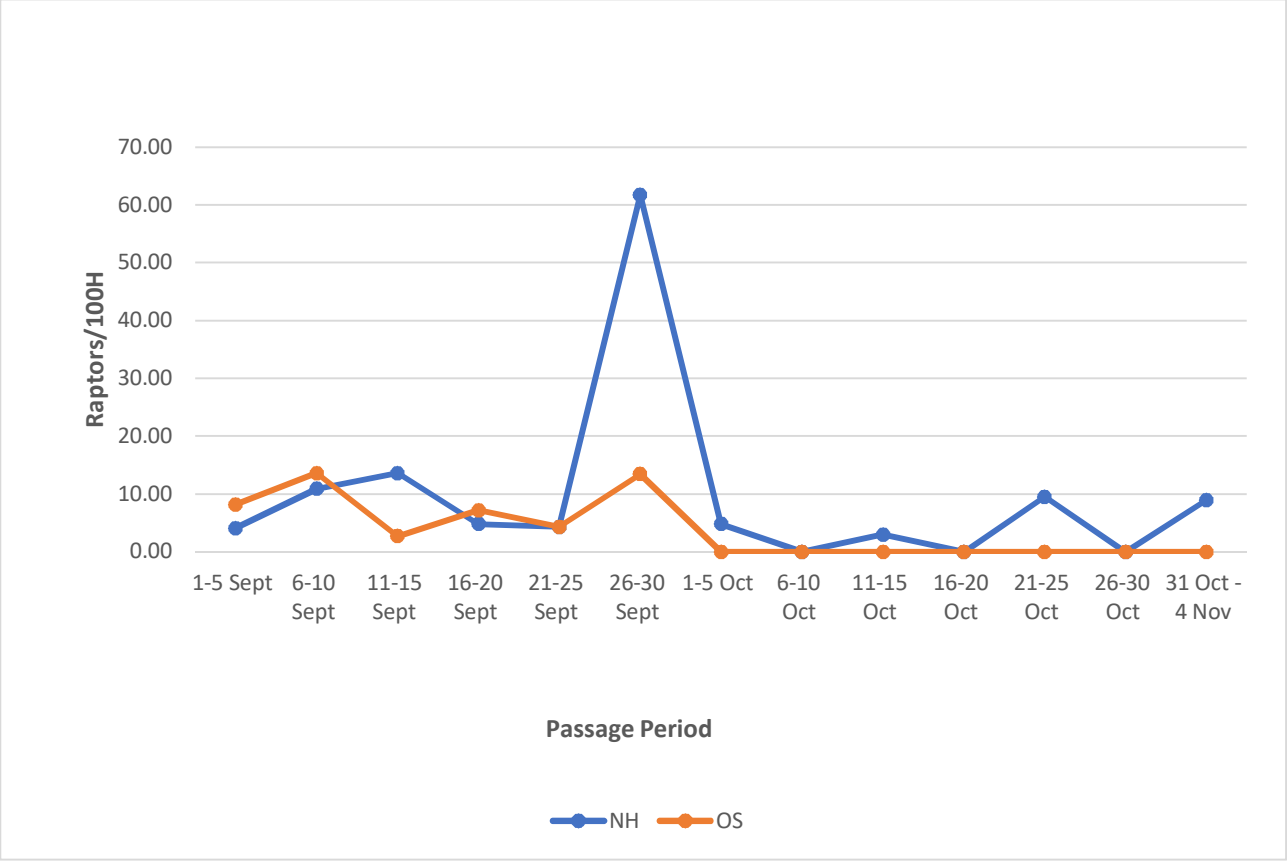

Figure 12. Effort-adjusted 5-day passage rates for Northern Harriers and Ospreys.

Table 8. Aging/sexing criteria for migrant raptors, relevant to the fall 2016 season.

Golden Eagle (Dunne et al. 2012: 214-223)

Immature: Uninterrupted, gleaming white stripe across base of the tail. Most often large, prominent white patches on underside of wing at base of primaries (size varies between individuals; white rarely absent on some individuals). Fresh plumage; no sign of any molt.

Subadult: Some gleaming white present in the tail; white band is not complete, as some tail feathers have been replaced with darker, 2nd-generation feathers. White may or may not be present on the underwing.

Adult: All dark plumage. No gleaming white present.

Sharp-shinned Hawk (Dunne et al. 2012: 88-94)

Immature: Brown-streaking on underside; dorsal plumage entirely brown.

Adult: Rufous barring on underside; dorsal plumage gray/slate-blue.

Figure 13. Approximate location of hawk-count sites in Montana, with the addition of Mt. Lorette in Alberta, Canada. A) Mt. Lorette; B) Jewel Basin; C) Nora Ridge; D) Big Belts; E) Bridgers; F) MPG.

Table 9. Common names, scientific names, species abbreviation codes, and applicable age, sex, and color-morph classifications for all diurnal raptor species observed during fall migration in the Big Belt Mountains. Common name, scientific name, abbreviation, and applicable classes are given (I= immature, S= subadult, NA= non-adult, A= adult, L= light, D= dark, BR= brown, U= unknown).

Golden Eagle *Aquila chrysaetos* GE I, S, NA, A, U
Bald Eagle *Haliaeetus leucocephalus* BE I, S1, S2, NA, A, U
Unknown Eagle *Aquila* or *Haliaeetus spp.* UE
Sharp-shinned Hawk *Accipiter striatus* SS I, A, U
Cooper's Hawk *Accipiter cooperii* CH I, A, U
Northern Goshawk *Accipiter gentilis* NG I, A, U
Unknown Small Accipiter *A. striatus* or *cooperii* SA I, A, U
Unknown Large Accipiter *A. cooperii* or *gentilis* LA I, A, U
Rough-legged Hawk *Buteo lagopus* RL I, A, D, L, U
Red-tailed Hawk *Buteo jamaicensis* RT I, A, D, L, U
Broad-winged Hawk *Buteo platypterus* BW I, A, D, L, U
Ferruginous Hawk *Buteo regalis* FH I, A, D, L, U
Swanson's Hawk *Buteo swainsoni* SW I, A, D, L, U
Unknown Buteo spp. UB I, D, L, U
American Kestrel *Falco sparverius* AK M, F, U
Merlin *Falco columbarius* ML AM BR, U
Prairie Falcon *Falco mexicanus* PR I, A, U
Peregrine Falcon *Falco peregrinus* PG I, A, U
Unknown Small Falcon *F. sparverius* or *columbarius* SF U
Unknown Large falcon *F. mexicanus* or *peregrinus* LF U
Unknown Falcon *Falco* spp. UF U
Unknown Raptor Falconiformes UR
Osprey *Pandion haliaetus* OS I, A, U
Northern Harrier *Circus cyaneus* NH I, M, F, BR, U
Turkey Vulture *Cathartes aura* TV U

Table 10. Daily count totals for eagles and accipiters (1 Sept-30 Sept).

Date	Duration	Observer	GE	BE	UE	SS	CH	UA
	(min)	(min ttl)						
1-Sep-2016	480	1600	8	1	0	13	8	3
2-Sep-2016	495	990	5	1	1	14	2	0
3-Sep-2016	495	990	3	1	0	4	0	1
6-Sep-2016	510	1020	6	1	0	7	0	0
7-Sep-2016	495	1950	4	0	0	1	3	2
8-Sep-2016	180	1575	5	0	0	2	2	0
9-Sep-2016	420	820	18	2	0	5	3	2
10-Sep-2016	600	1200	34	3	0	10	1	6
11-Sep-2016	495	1485	6	1	0	5	4	0
12-Sep-2016	270	540	0	0	0	0	1	0
13-Sep-2016	480	480	6	2	0	0	2	0
14-Sep-2016	480	1620	3	1	0	2	0	0
15-Sep-2016	480	1740	18	0	0	15	0	0
16-Sep-2016	510	1095	45	0	0	15	5	0
17-Sep-2016	525	1260	45	0	0	3	1	0
18-Sep-2016	480	1170	12	2	0	20	4	0
19-Sep-2016	510	1020	22	2	0	14	9	2
20-Sep-2016	480	1740	5	0	0	3	2	2
21-Sep-2016	450	1740	1	0	0	0	1	0
24-Sep-2016	930	3480	6	0	0	3	3	2
25-Sep-2016	540	1605	128	0	0	20	1	2
26-Sep-2016	495	990	31	1	0	18	8	0
27-Sep-2016	435	870	82	0	0	20	6	1
28-Sep-2016	510	2250	42	2	0	45	6	2
29-Sep-2016	300	1920	23	1	0	35	6	2
30-Sep-2016	495	1910	42	12	0	48	5	4

Table 10 continued. Daily count totals for eagles and accipiters (1 Oct-5 Nov).

Date	Duration	Observer	GE	BE	UE	SS	CH	UA
	(min)	(min ttl)						
1-Oct-2016	330	555	43	2	0	15	5	0
2-Oct-2016	330	555	15	0	0	8	1	0
4-Oct-2016	450	900	131	1	0	0	0	1
5-Oct-2016	150	450	0	0	0	0	0	0
6-Oct-2016	315	1230	44	1	0	4	0	3
7-Oct-2016	570	1380	30	1	0	0	0	0
8-Oct-2016	585	1170	101	4	0	49	5	0
9-Oct-2016	570	1140	84	7	0	66	5	1
10-Oct-2016	570	1110	8	2	0	5	0	0
12-Oct-2016	555	2070	144	6	0	2	0	0
13-Oct-2016	540	2465	223	6	0	7	0	0
14-Oct-2016	285	570	148	0	0	6	2	0
15-Oct-2016	630	1380	110	9	0	42	13	0
16-Oct-2016	630	1830	90	2	3	5	0	0
17-Oct-2016	180	360	13	0	0	0	0	0
18-Oct-2016	600	1130	99	2	0	2	1	0
19-Oct-2016	180	360	17	2	0	1	0	0
20-Oct-2016	360	1350	37	0	0	2	0	0
21-Oct-2016	540	1080	74	1	0	35	1	0
22-Oct-2016	480	960	111	1	0	5	0	0
23-Oct-2016	495	1770	31	1	0	10	0	0
24-Oct-2016	495	990	52	7	0	13	0	0
25-Oct-2016	510	1020	73	2	0	28	0	0
26-Oct-2016	375	1905	16	2	0	7	0	0
27-Oct-2016	480	2370	39	5	0	8	0	0
28-Oct-2016	330	660	68	0	0	1	0	0
29-Oct-2016	195	510	13	0	0	0	0	0
30-Oct-2016	450	450	21	1	0	3	2	1
31-Oct-2016	390	780	12	2	0	0	0	0
1-Nov-2016	420	840	31	1	0	4	0	0
2-Nov-2016	450	1455	21	4	0	4	0	0
3-Nov-2016	450	900	19	1	0	2	0	0
4-Nov-2016	305	740	31	7	0	6	0	0
5-Nov-2016	405	1215	23	3	0	2	0	0

Table 11. Daily count totals for buteos (1 Sept-31 Sept).

Date	Duration	Observer	RT	SW	BW	FH	RL
	(min)	(min ttl)					
1-Sep-2016	480	1600	9	1	0	0	0
2-Sep-2016	495	990	5	0	0	0	0
3-Sep-2016	495	990	4	0	0	0	0
6-Sep-2016	510	1020	10	0	0	0	0
7-Sep-2016	495	1950	2	0	0	0	0
8-Sep-2016	180	1575	3	0	0	0	0
9-Sep-2016	420	820	11	0	1	0	0
10-Sep-2016	600	1200	16	0	1	0	0
11-Sep-2016	495	1485	8	0	0	0	0
12-Sep-2016	270	540	1	0	0	0	0
13-Sep-2016	480	480	2	0	0	0	0
14-Sep-2016	480	1620	2	0	0	0	0
15-Sep-2016	480	1740	3	0	3	0	0
16-Sep-2016	510	1095	12	0	1	0	0
17-Sep-2016	525	1260	4	0	0	0	0
18-Sep-2016	480	1170	6	0	3	0	0
19-Sep-2016	510	1020	5	0	1	0	1
20-Sep-2016	480	1740	0	0	2	0	0
21-Sep-2016	450	1740	0	0	0	0	0
24-Sep-2016	930	3480	0	0	1	0	0
25-Sep-2016	540	1605	5	0	0	0	2
26-Sep-2016	495	990	3	0	0	0	0
27-Sep-2016	435	870	0	0	3	0	0
28-Sep-2016	510	2250	12	0	0	0	2
29-Sep-2016	300	1920	3	1	1	0	2
30-Sep-2016	495	1910	6	0	0	0	0

Table 11 continued. Daily count totals for buteos (1 Oct-5 Nov).

Date	Duration	Observer	RT	SW	BW	FH	RL
	(min)	(min ttl)					
1-Oct-2016	330	555	2	0	0	0	0
2-Oct-2016	330	555	2	0	0	0	0
4-Oct-2016	450	900	1	0	0	0	0
5-Oct-2016	150	450	0	0	0	0	0
6-Oct-2016	315	1230	0	0	0	0	2
7-Oct-2016	570	1380	0	0	0	0	0
8-Oct-2016	585	1170	11	0	0	0	10
9-Oct-2016	570	1140	11	0	0	1	6
10-Oct-2016	570	1110	1	0	0	0	5
12-Oct-2016	555	2070	2	0	0	0	2
13-Oct-2016	540	2465	4	0	0	0	2
14-Oct-2016	285	570	2	0	0	0	0
15-Oct-2016	630	1380	11	0	0	0	8
16-Oct-2016	630	1830	3	0	0	0	3
17-Oct-2016	180	360	0	0	0	0	0
18-Oct-2016	600	1130	1	0	0	0	11
19-Oct-2016	180	360	0	0	0	0	5
20-Oct-2016	360	1350	1	0	0	0	7
21-Oct-2016	540	1080	5	0	0	0	2
22-Oct-2016	480	960	1	0	0	0	8
23-Oct-2016	495	1770	0	0	0	0	19
24-Oct-2016	495	990	1	0	0	1	16
25-Oct-2016	510	1020	4	0	0	0	25
26-Oct-2016	375	1905	0	0	0	0	8
27-Oct-2016	480	2370	0	0	0	0	10
28-Oct-2016	330	660	1	0	0	0	3
29-Oct-2016	195	510	0	0	0	0	9
30-Oct-2016	450	450	1	0	0	0	7
31-Oct-2016	390	780	1	0	0	0	5
1-Nov-2016	420	840	0	0	0	0	4
2-Nov-2016	450	1455	0	0	0	0	16
3-Nov-2016	450	900	0	0	0	0	2
4-Nov-2016	305	740	0	0	0	0	5
5-Nov-2016	405	1215	1	0	0	0	7

Table 12. Daily count totals for falcons (1 Sept-30 Sept).

Date	Duration	Observer	AK	ML	PG	PR
	(min)	(min ttl)				
1-Sep-2016	480	1600	11	1	0	0
2-Sep-2016	495	990	5	0	0	0
3-Sep-2016	495	990	0	0	0	0
6-Sep-2016	510	1020	1	1	3	0
7-Sep-2016	495	1950	1	0	0	0
8-Sep-2016	180	1575	0	0	0	0
9-Sep-2016	420	820	0	0	1	0
10-Sep-2016	600	1200	3	0	1	0
11-Sep-2016	495	1485	1	0	0	1
12-Sep-2016	270	540	0	0	0	0
13-Sep-2016	480	480	0	0	0	0
14-Sep-2016	480	1620	0	0	3	0
15-Sep-2016	480	1740	7	1	0	0
16-Sep-2016	510	1095	4	0	2	0
17-Sep-2016	525	1260	4	0	2	1
18-Sep-2016	480	1170	4	0	0	0
19-Sep-2016	510	1020	2	0	1	1
20-Sep-2016	480	1740	2	0	1	0
21-Sep-2016	450	1740	0	0	0	0
24-Sep-2016	930	3480	2	0	0	0
25-Sep-2016	540	1605	1	0	2	1
26-Sep-2016	495	990	2	0	0	1
27-Sep-2016	435	870	3	1	2	0
28-Sep-2016	510	2250	11	4	1	1
29-Sep-2016	300	1920	3	1	3	0
30-Sep-2016	495	1910	6	0	0	0

Table 12 continued. Daily count totals for falcons (1 Oct-5 Nov).

Date	Duration	Observer	AK	ML	PG	PR
	(min)	(min ttl)				
1-Oct-2016	330	555	2	3	2	0
2-Oct-2016	330	555	0	0	0	0
4-Oct-2016	450	900	0	0	0	0
5-Oct-2016	150	450	0	0	0	0
6-Oct-2016	315	1230	0	0	0	0
7-Oct-2016	570	1380	0	2	0	0
8-Oct-2016	585	1170	3	2	2	0
9-Oct-2016	570	1140	2	1	1	0
10-Oct-2016	570	1110	0	0	0	0
12-Oct-2016	555	2070	0	0	0	1
13-Oct-2016	540	2465	0	1	0	0
14-Oct-2016	285	570	0	0	0	0
15-Oct-2016	630	1380	1	3	0	1
16-Oct-2016	630	1830	0	2	0	0
17-Oct-2016	180	360	0	0	0	0
18-Oct-2016	600	1130	0	0	0	1
19-Oct-2016	180	360	0	0	0	0
20-Oct-2016	360	1350	1	1	0	0
21-Oct-2016	540	1080	0	3	0	0
22-Oct-2016	480	960	0	0	1	0
23-Oct-2016	495	1770	1	1	0	1
24-Oct-2016	495	990	0	0	0	2
25-Oct-2016	510	1020	0	1	0	1
26-Oct-2016	375	1905	0	0	0	0
27-Oct-2016	480	2370	0	1	0	0
28-Oct-2016	330	660	0	0	0	0
29-Oct-2016	195	510	0	0	0	0
30-Oct-2016	450	450	0	0	0	2
31-Oct-2016	390	780	0	0	0	0
1-Nov-2016	420	840	0	0	0	0
2-Nov-2016	450	1455	0	0	0	0
3-Nov-2016	450	900	0	0	0	0
4-Nov-2016	305	740	0	0	0	0
5-Nov-2016	405	1215	0	0	0	0

Table 13. Daily count totals for other raptors (1 Sept-30 Sept.)

Date	Duration	Observer	NH	OS	TV	UR
	(min)	(min ttl)				
1-Sep-2016	480	1600	0	0	0	0
2-Sep-2016	495	990	1	2	0	0
3-Sep-2016	495	990	0	0	0	0
6-Sep-2016	510	1020	0	1	0	0
7-Sep-2016	495	1950	0	1	0	0
8-Sep-2016	180	1575	0	1	0	0
9-Sep-2016	420	820	4	2	0	0
10-Sep-2016	600	1200	0	0	0	0
11-Sep-2016	495	1485	0	0	0	0
12-Sep-2016	270	540	0	1	0	0
13-Sep-2016	480	480	1	0	0	0
14-Sep-2016	480	1620	0	0	0	0
15-Sep-2016	480	1740	4	0	0	0
16-Sep-2016	510	1095	1	1	0	0
17-Sep-2016	525	1260	0	1	0	0
18-Sep-2016	480	1170	0	0	0	0
19-Sep-2016	510	1020	1	1	0	1
20-Sep-2016	480	1740	0	0	0	3
21-Sep-2016	450	1740	0	0	0	0
24-Sep-2016	930	3480	0	1	0	4
25-Sep-2016	540	1605	1	0	0	3
26-Sep-2016	495	990	1	2	0	1
27-Sep-2016	435	870	3	1	0	0
28-Sep-2016	510	2250	14	2	1	3
29-Sep-2016	300	1920	4	0	0	0
30-Sep-2016	495	1910	1	0	0	1

Table 13 continued. Daily count totals for other raptors (1 Oct-5 Nov).

Date	Duration	Observer	NH	OS	TV	UR
	(min)	(min ttl)				
1-Oct-2016	330	555	0	0	0	0
2-Oct-2016	330	555	0	0	0	1
4-Oct-2016	450	900	1	0	0	3
5-Oct-2016	150	450	0	0	0	0
6-Oct-2016	315	1230	0	0	0	0
7-Oct-2016	570	1380	0	0	0	0
8-Oct-2016	585	1170	0	0	0	0
9-Oct-2016	570	1140	0	0	0	0
10-Oct-2016	570	1110	0	0	0	1
12-Oct-2016	555	2070	1	0	0	0
13-Oct-2016	540	2465	0	0	0	0
14-Oct-2016	285	570	0	0	0	0
15-Oct-2016	630	1380	0	0	0	0
16-Oct-2016	630	1830	0	0	0	2
17-Oct-2016	180	360	0	0	0	0
18-Oct-2016	600	1130	0	0	0	1
19-Oct-2016	180	360	0	0	0	0
20-Oct-2016	360	1350	0	0	0	0
21-Oct-2016	540	1080	0	0	0	0
22-Oct-2016	480	960	0	0	0	0
23-Oct-2016	495	1770	1	0	0	0
24-Oct-2016	495	990	3	0	0	0
25-Oct-2016	510	1020	0	0	0	0
26-Oct-2016	375	1905	0	0	0	0
27-Oct-2016	480	2370	0	0	0	0
28-Oct-2016	330	660	0	0	0	0
29-Oct-2016	195	510	0	0	0	2
30-Oct-2016	450	450	0	0	0	0
31-Oct-2016	390	780	0	0	0	0
1-Nov-2016	420	840	1	0	0	0
2-Nov-2016	450	1455	2	0	0	0
3-Nov-2016	450	900	0	0	0	0
4-Nov-2016	305	740	0	0	0	0
5-Nov-2016	405	1215	0	0	0	0