Raptor Migration Monitoring in the Jewel Basin
Autumn 2021 – Annual Report

31 March 2022

Immature Northern Goshawk at owl decoy, 21 October 2021 (Dan Casey photo)

A Report to:

USDA Forest Service: Flathead National Forest

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Flathead Audubon Society

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Executive Summary.

Flathead Audubon volunteers and one paid technician were able to conduct 50 surveys at the Jewel Basin Hawk Watch during the 2021 monitoring season (25 Aug – 5 Nov). This was only the second time we have managed to conduct 50 or more surveys in a season, and our results exceeded expectations, with new high counts for 10 species, above average counts for six more, and our highest overall count total in our 14 years of surveys at this site (4,418 raptors counted). We have now counted 37,185 raptors over 14 seasons at the Jewel Basin site. This year we recorded our 17,000th Sharp-shinned Hawk, our 24,000th Accipiter, our 6,000th eagle, and our 3,000th Red-tailed Hawk.

As always, the success of the Jewel Basin Hawk Watch depended on a large number of Flathead Audubon members and others who volunteered their time to help spot and tally passing birds. This year seven people served as primary observers for at least one day (in addition to our paid technician), and at least 30 others served as additional observers. These volunteers provided 791 hours of in-kind support to the project, which in addition to additional travel (88 trips) and administrative efforts (160 hr) resulted in a total in-kind donation of $19,115 to the project.

Introduction. The purpose of this project was to continue (for the 14th consecutive year) annual season-long surveys of autumn raptor migration above Jewel Basin along the Swan Range near Mount Aeneas, on the Flathead National Forest northeast of Bigfork, MT (Figure 1). In addition to providing data to a network of migration monitoring sites in the region, our efforts continue to energize a citizen science base that can be used to conduct annual surveys during future migration seasons, providing valuable educational outreach to the surrounding communities.

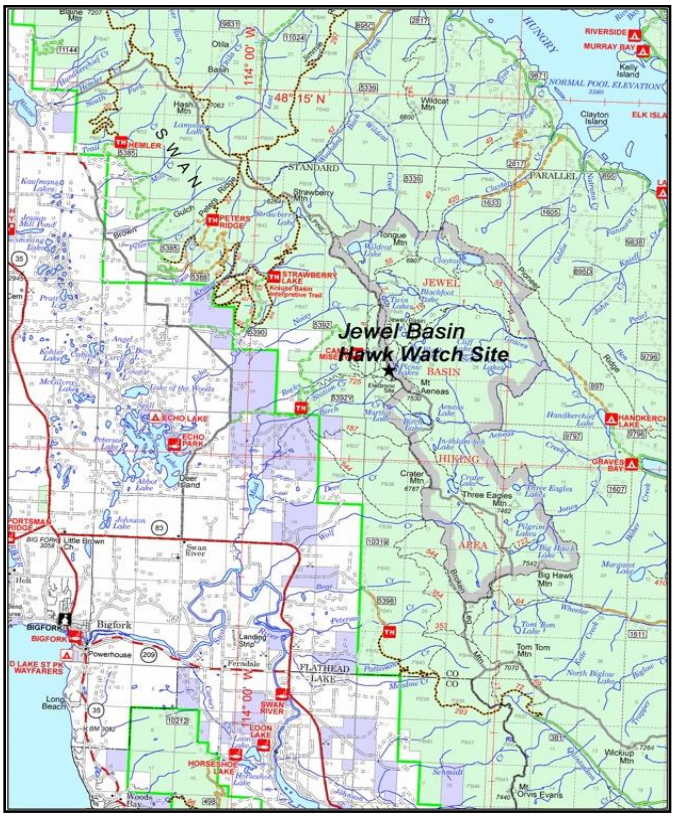


Figure 1. Location of the Jewel Basin Hawk Watch site, Flathead Co., Montana, northwest of Mt. Aeneas, Jewel Basin Hiking Area, Flathead National Forest (48.1552°N, -113.93294°W).

This annual report summarizes the extent and results of our efforts during the 2021 field season (25 August – 5 November) and includes data summaries for the last 14 years (including our pilot year in 2007) and recent photos from the site. Fourteen-year trend data are also briefly summarized. Additional data and photos may be requested from Flathead Audubon through Dan Casey. Data from the last five survey years are also stored by the Hawk Migration Association of North America (HMANA) at www.Hawkcount.org .

The Jewel Basin Hawk Watch site, at an elevation of 7,100 ft on the northwest flank of Mt. Aeneas in the Flathead National Forest northeast of Bigfork (Figure 1), is uniquely situated for stunning views of passing migrant raptors. The site that serves to concentrate large numbers of raptors, particularly hawks in the genus *Accipiter* (Sharp-shinned Hawk, Cooper's Hawk, Northern Goshawk). These forest-dwelling species are relatively poorly represented at other Northern Rocky Mountain raptor monitoring sites (i.e., Bridger Mountains site near Bozeman, MPG Ranch in the Bitterroot Valley, and the Rogers Pass/Nora Ridge site east of Lincoln). These species are also poorly monitored by other standardized monitoring programs such as the Integrated Monitoring by Bird Conservation Region (Bird Conservancy of the Rockies, Avian Science Center at the University of Montana, Intermountain Bird Observatory), or the Breeding Bird Survey (USFWS). The Jewel Basin Hawk Watch site has shown potential to assess the long-term health and status of all forest-dwelling diurnal raptors inhabiting the northern Rocky Mountains and boreal areas to the north. This information could prove useful in evaluating long-term changes in raptor populations in respect to forest health and productivity. In addition, this site clearly has good potential for public viewing and education, since the site is relatively accessible to the residents of Flathead Valley and adjacent areas.

Background. The Jewel Basin was identified as a prospective hawk watch site in 2007. The location (Figure 1) offers an exceptionally narrow pathway for a great diversity of migrating raptors. Using grants, donations, and other funds from the USDA Forest Service (Flathead National Forest), Flathead Audubon Society (Flathead Audubon), Montana Fish, Wildlife & Parks, individuals, and other organizations, we have continued to conduct annual season-long surveys, counting 1,638 – 3,411 raptors of 15-17 species over 36-53 days of surveys during the fall migration periods of 2008 through 2020 (Casey and Bissell 2021). Our results have continued to confirm the value of the site for monitoring accipiters, which have comprised 65% of all birds seen. More importantly, the proximity of the passing birds allowed us to identify >95% of passing raptors to species, and to classify more than 80% of the birds by age class (immature vs. adult), which gives us an index to reproductive performance in these populations.

Partners, Funding, and Match. Past funding for the Jewel Basin Hawk Watch was included in previous annual reports (e.g. Casey 2009, Casey and Bissell 2020). Flathead Audubon, a 501(c)(3) non-profit organization based in the Flathead Valley, assumed primary responsibility of the Jewel Basin Hawk Watch beginning in 2015, through a 5-year cost-share agreement (#15-CS-11011000-043) with the Flathead National Forest. A second five-year non-funded agreement was signed by both the Forest Service and Flathead Audubon Society in June 2020. Together these funding partners have provided up to $3,000 needed annually over the past 13 years to fund contracted qualified primary observers by providing per diem, mileage, meals, and transportation.

Flathead Audubon contracted with one experienced technician, Joshua Covill for the second consecutive year to complete up to 30 raptor survey days, depending on weather, during the 2021 field season at the Jewel Basin site. We relied on other experienced volunteers to survey on intervening days. Flathead Audubon reimbursed Joshua via stipend plus approximately another daily reimbursement for personal car mileage and per diem. He served as the primary observer for 19 of the 50 surveys this year. The Flathead National Forest provided bear training and the optional use of a vehicle from their District Office in Bigfork to the Jewel Basin parking lot for some of the primary observers. Coordination with Flathead Audubon's Raptor Day (abridged due to Covid in 2021), and raptor ID workshops provided by Denny Olson of Flathead Audubon and Amy Seaman of Montana Audubon

helped to increase interest and skills of volunteer observers this year, and we continue to attract new volunteers due to their efforts. This year's Jewel Basin Hawk Watch project could not have been undertaken without all the support provided from these organizations and volunteers and, for this, Flathead Audubon is deeply grateful.

This year, the following individuals served as primary observers in addition to our paid technician: Lisa Bate, Jake Bramante, Nicki Broesel, Dan Casey, Bo Crees, Pete Fisher, Michelle Tohtz, and bj Worth. They committed a total of 315.5 hours (counting travel time) over 31 successful days of observation at the Jewel Basin observation site. Joshua served as the contract primary observer and was reimbursed $2,514 for the other 19 days (before leaving the country 12 October for other commitments). Josh and the seven other primary observers also joined at least 30 additional volunteers to serve as extra observers on one or more days. These secondary observers donated another 475.1 hr in observation and travel time. Dan Casey provided 120 additional hours of oversight, data and logistics coordination, analysis and report preparation. Rod Wallette and Gael Bissel of Flathead Audubon each provided an additional administration time for training, financials and coordination. All in all, these amounted to $11,859 in hourly donations (790.6 hr @ $15), $2,200 in mileage donations (4,400 mi @$0.50), and $1,056 in per diem donations (88 days @ $12), for a total of $19,115 in donated match. A full accounting of donated and billed time is available upon request.

Methods. Our annual goal is to survey on as many of the 75 days between 25 August and 7 November as weather, access to the site, and availability of observers will allow. This year we began on 25 August, and our "survey window" closed after our last count on 5 November, when snow and ice precluded safe travel on the road and trail to the site. Increased interest, communication and availability of trained primary observers has helped us improve coverage over the years, and this year we missed only eight days during the survey window where conditions were suitable, but no observer was available. These all fell after 10 October, when our paid observer had left for other commitments. Surveys varied in length depending on apparent passage rates, weather conditions, and volunteer availability, ranging from 2.0 to 8.5 (average 6.6) hours per survey, totaling 329.9 survey hours for the season. All surveys were conducted from the primary observation point selected based on preliminary (2007) data (Figure 1), a site at 7,100 ft in elevation on the northwest flank of Mt. Aeneas (48.1552°N, -113.93294°W). Primary (and additional) observers for each survey were identified through an email network. This was the sixth year that we used on-site electronic data entry through the use of Dunkadoo data entry software (www.dunkadoo.org) on personal cell phones or an I-pad (with extra batteries) that was linked to the internet via cell towers so that data could be entered in real time. Dan Casey provided significant daily/weekly field support via phone and email.

Count and weather data were entered during each survey. All raptors passing by in a southerly direction were identified to species, age and sex where feasible, with apparent local birds (identified by their hunting behavior, and/or local movements) excluded from daily and seasonal totals. A plastic owl decoy on a pole (see cover photo) was placed in a prominent point above the counters during most surveys, which attracted many birds closer to the viewpoint and allowed closer study for identification and classification.

Count data were recorded for each hourly period beginning and ending on the hour, with weather variables (e.g. wind speed and direction, ambient temperature, cloud cover, visibility) recorded every hour on the half hour. We also recorded characteristics of the flight according to Hawk Watch International protocols, using codes developed by HMANA, for the majority of passing birds during each hourly survey period. These included the average height above, direction to, and distance from the hawk watch site. All 2021 survey data were entered into the database that is automatically linked via Dunkadoo to interactive database on the Hawk Count website (www.hawkcount.org). This site allows interested parties to review data not only from this site, by year and date; but data from other sites across the continent.

Results. Our total count of 4,418 raptors for 2021 was our highest total count in the 14 years of full-season surveys at the site. Our season-long passage rate of 13.4 birds per hour was also our highest ever. We set new high count totals for ten of the 17 raptor species we recorded this year, and above-average numbers for all but

Golden Eagles (see species accounts that follow). Our highest one-day count this season of 488 birds (58/hr) occurred 5 October, a bit later in the season than our usual peak migration, but as per most years, the majority (60%) of migrants passed 21 September – 6 October. Complete daily survey results for the 2021 season, by species, are included in Appendix A. Accipiters (Sharp-shinned Hawk, Cooper's Hawk and Northern Goshawk) again comprised the majority of the raptor flight (72%) with 3,189 birds counted. Eagles comprised 11 % of the birds recorded, buteos 10%, and falcons 5% (Figure 2).

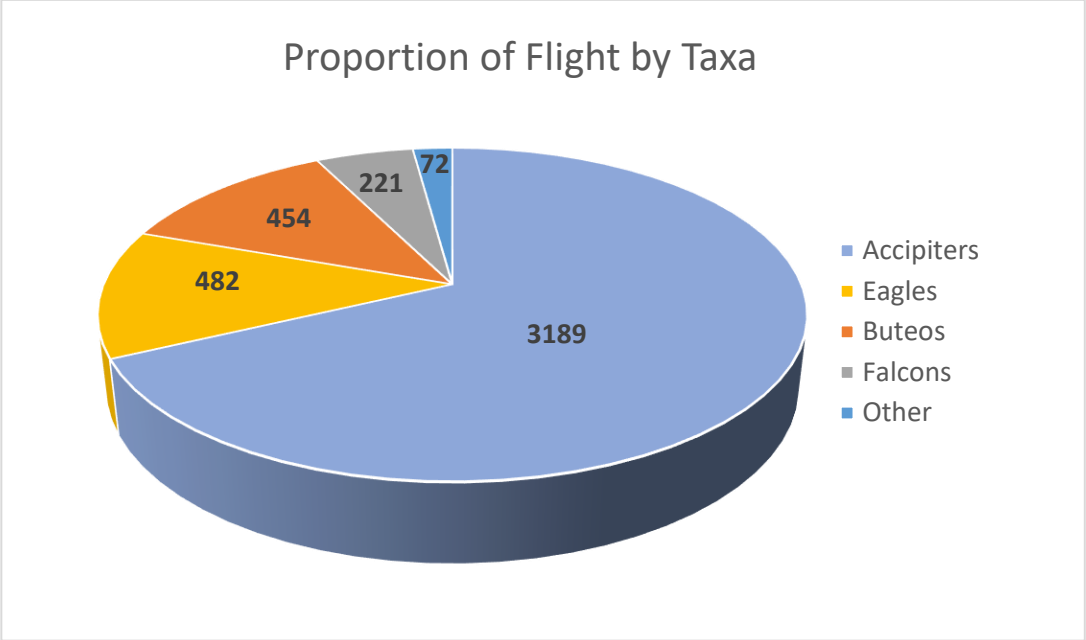


Figure 2. Composition of observed hawk migration at the Jewel Basin Hawk Watch site, fall 2021, by category. Numbers are total counts for the season.

Species Accounts. The brief species accounts that follow describe the extent and nature of the migration data we collected in 2021, with comparisons to (and summaries of) our data from previous 13 years (Table 1). We have included adjustment of totals per unit effort (birds per 100hr). We include cursory analysis of sex and age ratios, timing and proportion of the flight, and any indication of trends revealed by this year's data.

Species Accounts:

Turkey Vulture. 2021 Total: 3 (<1 per 100 survey hours) 13-yr Average: 2 (<1/100hr)

This species continues to comprise a minor component of the migration at this Northern Rockies ridgeline location. We have counted just 36 Turkey Vultures (range, 0-7 per year) at the Jewel Basin Hawk Watch site since 2007. This year we counted single birds on three dates, 6-16 September. Interestingly, this species is seen in abundance at the MPG Ranch monitoring site south of Missoula, MT, a much lower elevation site (bj Worth photo, Jewel Basin, 2015)

Table 1. Season totals for raptors counted at the Jewel Basin Hawk Watch site, 2008-2021. Minimum, maximum and mean season totals 2008-2020, plus 2021 and all-time (14-yr) totals. All-time totals include limited preliminary totals from 2007. All surveys were conducted between 25 Aug and mid-November, dependent on weather and volunteer availability. New all-time season totals in **bold**.

Species	13-yr Minimum	13-yr Maximum	13-yr Mean	2021 Total	All-time Total
Turkey Vulture	0	7	2	3	36
Osprey	4	19	8	11	113
Bald Eagle	25	107	55	97	827
Northern Harrier	13	102	45	49	630
Sharp-shinned Hawk	687	1,778	1,148	**2,490**	17,543
Cooper's Hawk	215	504	371	**603**	5,458
Northern Goshawk	24	62	36	37	517
Unidentified Accipiter	32	93	56	59	800
Broad-winged Hawk	2	43	16	**57**	266
Swainson's Hawk	1	3	1	**7**	21
Red-tailed Hawk	136	321	204	**328**	3,004
Ferruginous Hawk	0	1	1	**4**	11
Rough-legged Hawk	1	41	19	36	282
Unidentified Buteo	8	22	15	22	224
Golden Eagle	212	600	382	379	5,388
American Kestrel	35	100	67	**100**	976
Merlin	9	39	22	**66**	346
Peregrine Falcon	3	22	12	**24**	178
Prairie Falcon	1	21	10	**27**	162
Gyrfalcon	0	1	0	0	2
Unidentified Falcon	1	14	6	4	76
Unidentified Eagle	0	6	2	6	28
Unidentified Raptor	8	46	22	9	297
TOTAL	1,638	3,411	2,499	**4,418**	37,185
Survey Days	36	52	44	50	574
Effort: In hours	226.0	339.0	277.1	329.9	3,560
Passage Rate (per hr)	6.3	11.6	9.0	**13.4**	10.4
Total Species	15	17	16	17	18

Osprey. 2021 Total: 11 (3 per 100 survey hours) 13-yr Average: 8 (3/100hr)

Representing another minor component of migration at the Jewel Basin site, we have counted just 4-19 Ospreys per year since 2007. This year the first was seen on 29 August, and the last two on 5 October. We occasionally saw local birds traversing the ridge, as in past years. Breeding season surveys at valley nesting areas provide better indices of population health for this easily surveyed species. (Dan Casey photo)

Bald Eagle. 2021 Total: 97 (29 per 100 survey hours) 13-yr Average: 55 (22/100hr)

The 97 Bald Eagles we counted in 2021 was above average (55) for the site. This year the first was seen 29 August, and the last on 5 November, with a peak count of nine birds on 5 October. We likely would have exceeded our previous high season-long count for this species (107) had we not missed conducting surveys on eight days with suitable conditions during the latter part of the season (after 11 October). Additional local birds were seen in the vicinity of the site throughout the season. We classified all Bald Eagles to age class, with immature birds (photo) comprising 23.7% of the flight (38 per 100 adults). (bj Worth photo, Jewel Basin, 2021)

Northern Harrier. 2021 Total: 49 (15 per 100 survey hours) 13-yr Average: 45 (16/100hr)

Harriers were observed from 28 August through 17 October, with high counts of five each on 7 and 8 September. This grassland species can be surprisingly common at higher elevations. Harriers are one of the few species for which we can classify not only age (98%), but sex (100% of adults). The 2021 flight was once again heavily dominated by immature birds (77%). Seven of the eleven adult birds classified to sex were males; this is the first time that males have outnumbered females (photo) in our surveys. (bj Worth photo, Jewel Basin, 2021)

Sharp-shinned Hawk. 2021 Total: 2,490 (755 per 100hr) 13-yr Average: 1,148 (447/100hr)

The Jewel Basin remains the best currently monitored site in the Northern Rockies for the Sharp-shinned Hawk. It continues to be far and away the most abundant migrant raptor at the Jewel Basin site, with 17,543 (687- 2,490/yr) counted since 2007. We recorded an all-time high of 2,490 Sharp-shinned Hawks, on all but four of our 50 survey days this year, and this species comprised >56% of all raptors counted. We tallied more than 100 Sharp-shinneds on eight survey days, with a high of 334 counted on 5 October, and recorded our highest adjusted abundance (755/100hr) to date (Figure 3). We classified the age of 94% of the Sharp-shinned Hawks; surprisingly, despite our high total counts, less than 34% were immatures (51/100 adults, Figure 3). This is the lowest ratio of immatures to adults (photo) that we have recorded for the species since 2008. Abundance data for this species at our site, corrected for unit effort (birds/100hr), has shown no apparent trend, appearing to be nearly cyclic over our 13 full seasons of monitoring (Figure 4). (bj Worth photo, Jewel Basin, 2021)

Cooper's Hawk. 2021 Total: 603 (183 per 100 survey hours) 13-yr Average: 371(140/100hr)

This year (on 13 September) we counted our 5,000th Cooper's Hawk since 2007, and we concluded the season with a record of 603 (215-603/yr, Table 1). They passed the site from 25 August through 19 October, with a high of 61 recorded on 14 September. We classified 94.5% of the individuals to age this year, with 54% being immature birds (119 imm /100 ad), the third lowest ratio over 14 years of surveys (Figure 4). This annual index of Cooper's Hawk reproduction has been consistently higher than that of Sharp-shinned Hawks (Figure 3), averaging 176 immatures:100 adults (photo) over the 13 previous years of season-long surveys. Adjusted abundance (birds/100hr) has increased over the past two years (Figure 5) after a low in 2018, but appears to be relatively stable of the 4 years of our surveys. (bj Worth photo, Jewel Basin, 2021)

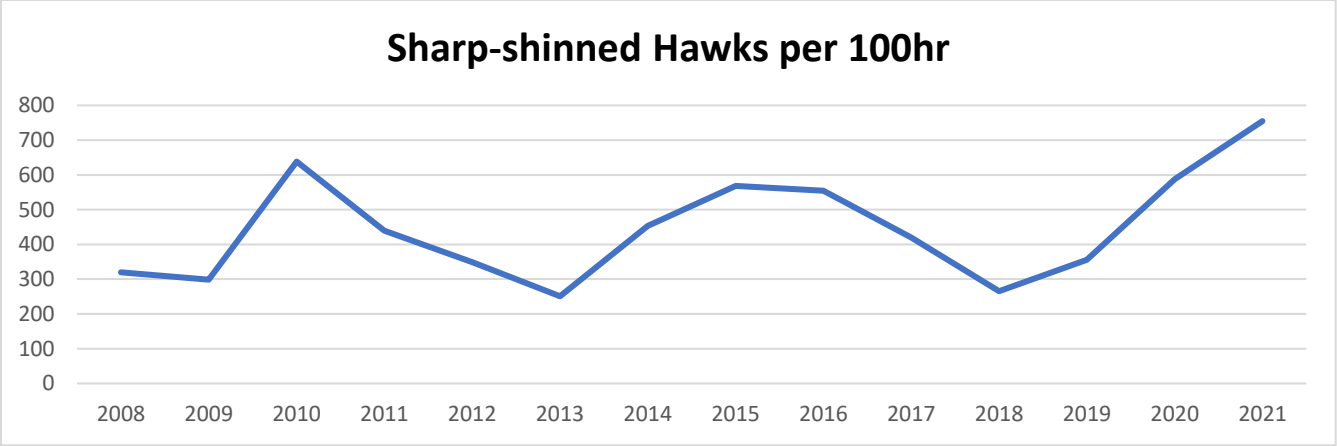


Figure 3. Abundance of Sharp-shinned Hawks reported at the Jewel Basin Hawk Watch site, corrected for effort (birds/100hr), 2008-2021.

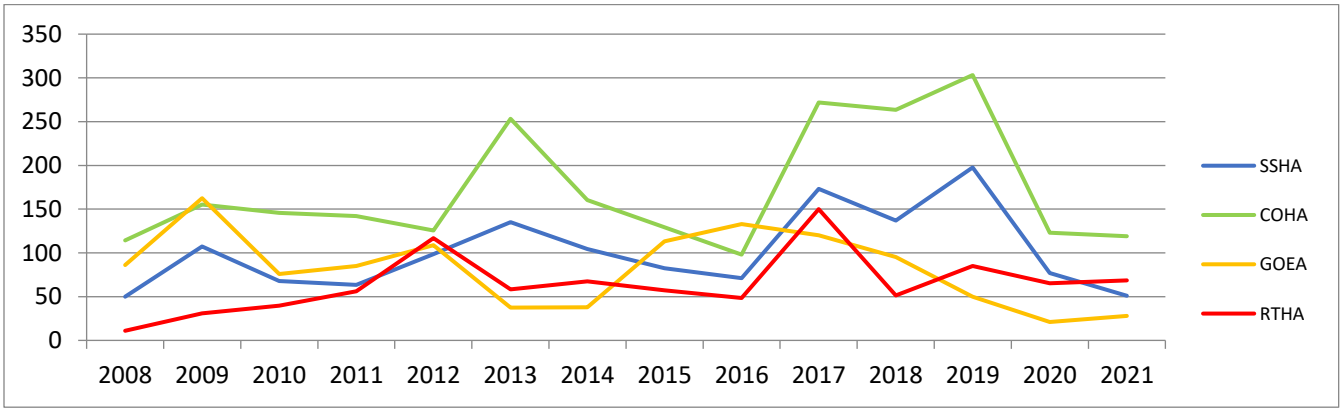


Figure 4. Ratios of immatures per 100/adults counted at the Jewel Basin Hawk Watch, 2008 – 2021, for the four most common species surveyed. SSHA = Sharp-shinned Hawk; COHA = Cooper's Hawk; GOEA = Golden Eagle; RTHA = Red-tailed Hawk

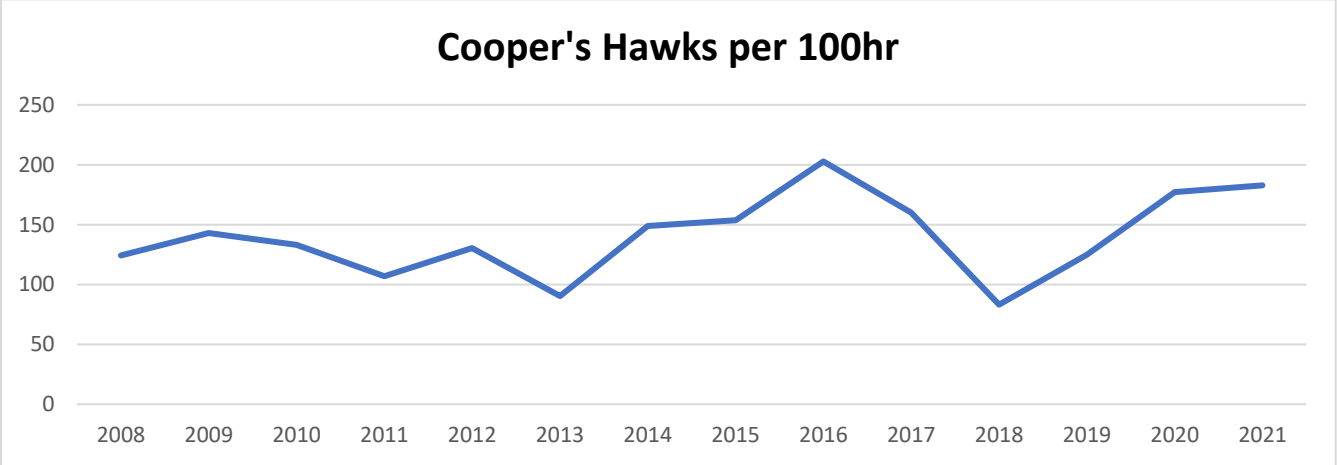


Figure 5. Abundance of Cooper's Hawks reported at the Jewel Basin Hawk Watch site, corrected for effort (birds/100hr), 2008-2021.

Northern Goshawk. 2021 Total: 37 (11 per 100 survey hours) 13-yr Average: 36 (13/100hr)

Our Northern Goshawk total for the season (37) was just above our average of 36 (24-62/yr) at the Jewel Basin Hawk Watch site since 2007 (Table 1). This year the first observation was on 31 August, and the last on 3 November, with a peak count of five on 17 October. The ratio of immature birds to adults (300:100) was below the 13-yr average of 551 immatures/adults (highest for any species monitored at our site), with 75% of the individuals counted this year being immature birds. This may indicate higher productivity for this species, or it could be that because of the timing of our surveys, we miss adults (photo) migrating later in season (>15 October). Resident Goshawks, both adults and immatures, were also frequent visitors to our owl decoy, as seen in our cover photo. (Dan Casey photo, Jewel Basin, 2013)

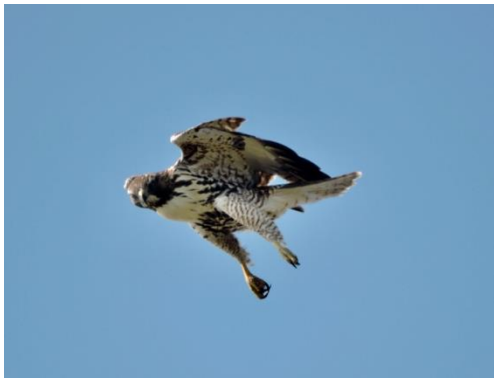
Broad-winged Hawk. 2021 Total: 57 (17 per 100 survey hours) 13-yr Average: 16 (7/100hr)

We recorded a recorded a record number of Broad-winged Hawks at the site this migration season (57), more than three times our annual average of 16 (Table 1). This year we recorded the species on 16 days between 6 September and 16 October, with a remarkable 30 counted on 14 September, the first time we have had small "kettles" of multiple Broad-wingeds flying together. The observed age ratio was 57 imm/100 ad. Five dark morph birds were seen. Results from this hawk watch site and others in Montana (e.g. MPG Ranch, Cutbank Hawk Watch) indicate increased use of western migration routes. (bj Worth photo, immature Broad-winged Hawk, Jewel Basin, 2021)

Swainson's Hawk. 2021 Total: 7 (2 per 100 survey hours) 13-yr Average: 1 (<1/100hr)

We have now counted just 21 Swainson's Hawks (0-7/yr) at the Jewel Basin Hawk Watch site since 2007 (Table 1). We recorded a new high count of seven birds this year, including three dark morph adults, two dark morph immatures, and two light morph immatures. The first was seen 30 August, and the last 24 September. Our site is certainly of minor importance as a migration route to this early migrating, predominantly prairie-nesting species. (bj Worth photo, light adult Swainson's Hawk, Jewel Basin, 2018)

Red-tailed Hawk. 2021 Total: 328 (99 per 100 survey hours) 13-yr Average: 204 (77/100hr)



Red-tailed Hawk (photo) is the fourth-most common migrant raptor species at our site, with 3,004 having been counted over the history of the count. The 328 counted this year was a new season high. The species has shown slight upward trend in observed abundance (#/100hr) at our site over time, and this year was the second highest over our 14 years of full-season surveys (Figure 6). We saw Red-tailed Hawks throughout the season, on all but seven surveys, with a season high of 24 birds on 14 September. We classified 93% of the individuals to age class, with an observed ratio of 69 immatures to 100 adults. This metric of reproductive success does appear to have a slight upward trend over the 14 years of our surveys (Figure 3). Forty-five (14%) of the 314 individuals classified to color morph were dark birds. "Harlan's" Red-tailed Hawk, a small and typically dark subspecies which breeds in the high arctic, has been a rare but regular migrant at the Jewel Basin (they winter regularly in Montana). This year we recorded six dark morph Harlan's between 3 and 9 October. (Dan Casey photo, Jewel Basin, 2021)

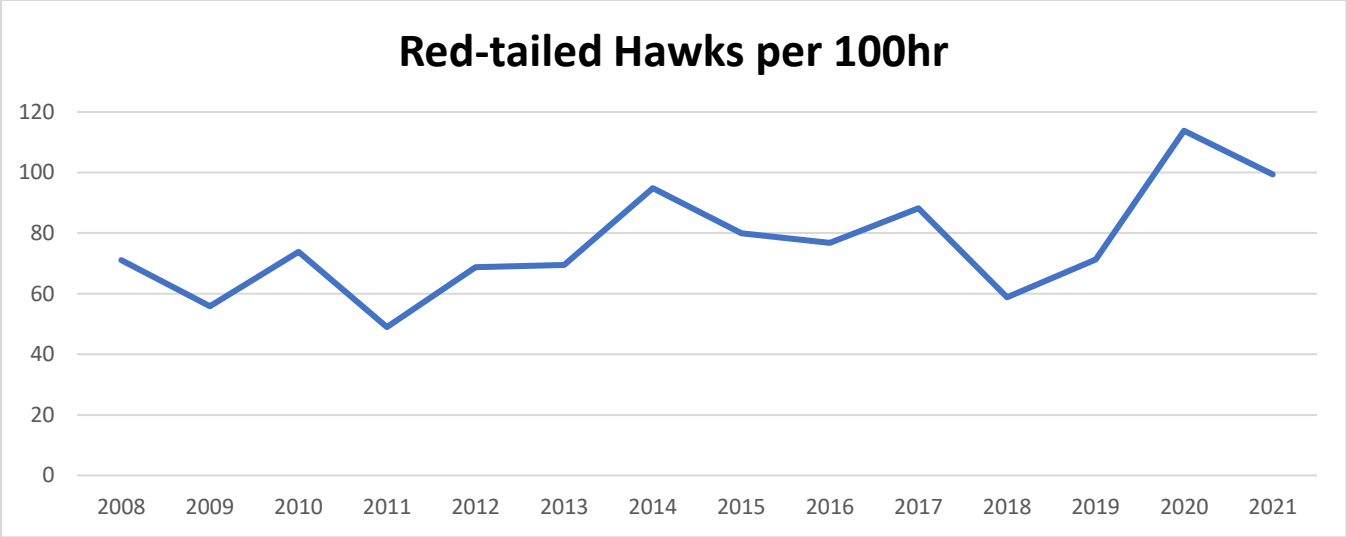


Figure 6. Abundance of Red-tailed Hawks reported at the Jewel Basin Hawk Watch site, corrected for effort (birds/100hr), 2008-2021.

Ferruginous Hawk. 2021 Total: 4 (1 per 100 survey hours) 13-yr Average: <1 (<1/100hr)

The Ferruginous Hawk (light immature, photo) is primarily a bird of the prairies and is a rare migrant at the Jewel Basin Hawk Watch site, with just seven previously recorded since 2007 (Table 1). This year, four individuals were seen, on 25 and 26 August, 24 September, and 4 October. They included one adult dark morph, and three light morph birds (1 ad, 2 imm). It is a testament to just what a rewarding season 2021 was at the Jewel Basin site, that we recorded record numbers of not only our most common species, but also species such as this (and Swainson's Hawk, Broad-winged Hawk, Prairie Falcon) which are generally less common in western Montana. (bj Worth photo, Jewel Basin, 2021.)

Rough-legged Hawk. 2021 Total: 36 (11 per 100 survey hours) 13-yr Average: 19 (7/100hr)

Our previous 13 years of surveys had shown that this locally abundant wintering species does not seem to rely heavily on ridgeline routes here, even though migration into the area is often well underway by late September. This year we saw nearly twice the average seen in previous years (range 1-41, Table 1). This year we recorded Rough-legged Hawks on nine days between 5 October and 5 November, with a daily high of 12 birds on 19 October. Eleven adults (photo) were classified to sex (7M, 4F), and 42% of the 26 birds classified to age were immatures. Just four dark morph birds were seen. (Dan Casey photo)

Golden Eagle. 2021 Total: 379 (115 per 100 survey hours) 13-yr Average: 382 (137/100hr)

The Golden Eagle is the second-most abundant migrant raptor species at the Jewel Basin site, with 5,388 now counted over 14 seasons (212-600/yr). A total of 379 Golden Eagles were seen this year, during 41 of our 50 surveys, with a high count of 60 on 5 October. We assessed the age class of 338 (89%) of the passing birds, with 219 (65%) of those being adults (photo), 57 subadults or non-adult (17%), and 62 immatures (18%). This year's observed age ratio (28 imm/100 ad) was slightly up, after four years of declines (Figure 3), but still well below our longer-term average of 82 per 100 adults. Missing surveys on eight days with suitable weather after 10

October definitely suppressed our total count for this typically late-season migrant, but adjusted abundance of Golden Eagles counted at our site has also declined since a peak in 2013 (Figure 7). Indeed, this was the only species counted in below average numbers during our 2021 season (Table 1). (bj Worth photo, Jewel Basin, 2021)

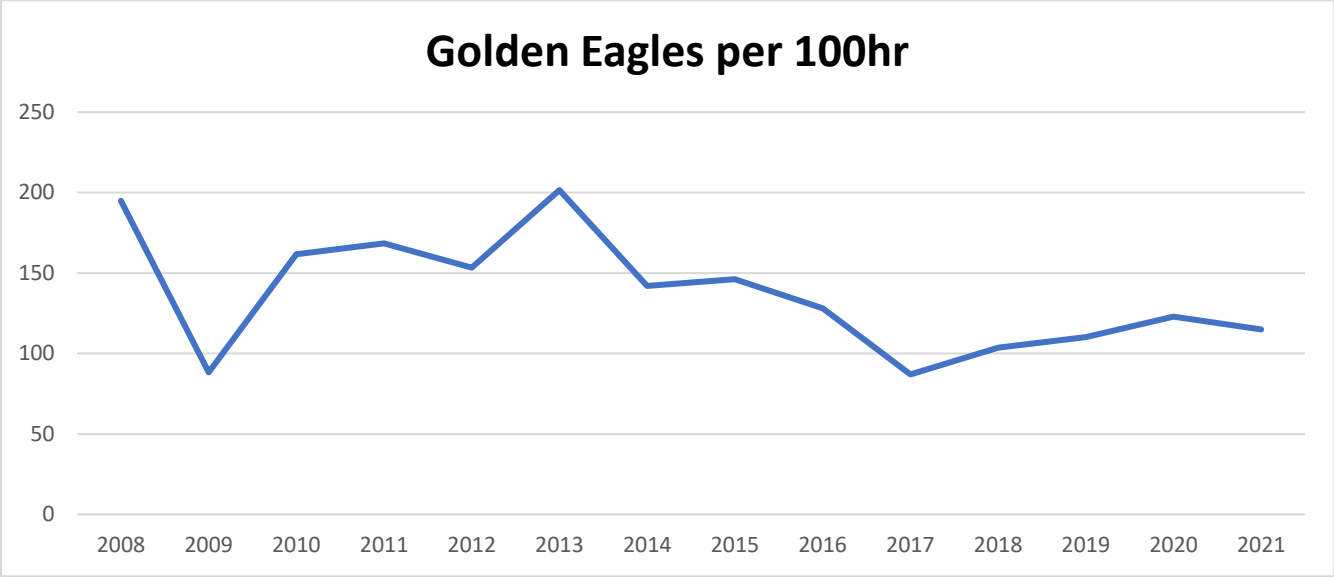


Figure 7. Abundance of Golden Eagles reported at the Jewel Basin Hawk Watch site, corrected for effort (birds/100hr), 2008-2021.

American Kestrel. 2021 Total: 100 (30 per 100 survey hours) 13-yr Average: 67 (25/100hr)

With above average passage rates and birds seen almost daily from 26 August through 8 October, we tied our previous season high with 100 American Kestrels counted. Our high count was 14 birds counted 25 September, and the last bird of the season was seen 19 October. Like the Rough-legged Hawk, this species is prone to migrating in the valley bottoms under certain weather conditions, which may explain the variability in our survey data year to year (35-100/yr, Table 1). Among the 81 birds (81%) classified to sex, the ratio was 1.9 males (photo) per female, outside the range we have observed (1:1 to 1.6:1) in previous years. We appeared to have a pair of resident kestrels near the hawk watch site for much of the first half of our survey season. (bj Worth photo, Jewel Basin, 2020)

Merlin. 2021 Total: 66 (20 per 100 survey hours) 13-yr Average: 22 (9/100hr)

We counted three times our average season total of Merlins, and at rates more than double our long-term average. They were seen on 27 surveys from 26 August through 24 October, with a (new high) peak daily count of 16 birds on 5 October. We did not collect sex and age data for the majority of these birds, given the difficulty of classifying these birds in flight, and the variability in the three subspecies known to occur at the site. We did record both “Prairie” and “Taiga” subspecies (photo) when possible, tallying six of the former and 51 of the latter. Only the Prairie Race is safely separable by sex, and we recorded three males and three females of this race. (bj Worth photo, Jewel Basin, 2021)

Peregrine Falcon. 2021 Total: 24 (7 per 100 survey hours). 13-yr Average: 12 (5/100hr)

We recorded a new season-long high count of Peregrines; they were seen on 13 surveys between 6 September and 5 October, with a daily high of four on 17 September. The 24 birds consisted of 19 adults (photo) and 5 immatures. (bj Worth photo, Jewel Basin, 2021)

Prairie Falcon. 2021 Total: 27 (8 per 100 survey hours) 13-yr Average: 10 (4/100hr)

Although they are not abundant at our site, Prairie Falcons were also seen in record numbers this year. We saw them on 15 survey days from 28 August through 9 October, with a high count of 5 birds on 30 August. With sex and age classes essentially indistinguishable (photo), no classification data were recorded for this species. (bj Worth photo, Jewel Basin, 2020)

Gyrfalcon. 2021 Total: 0 13-yr Average: <1 (<1/100hr)

Only two Gyralcons have been recorded at the Jewel Basin Hawk Watch site since 2007, each during the first week of November (2012, 2016). It is the only one of 18 raptor species we have recorded at the site that was not seen this season. This irregular winter visitor to the western valleys of Montana has been only very rarely encountered at western ridgeline hawk counts.

Classification Data. We continue to be able to classify a high percentage of the passing birds to species, age, and (for some species) sex, because so many of the migrants at the Jewel Basin site fly within 50 meters of the observers. This year we identified 98% (4,318) of all birds to species, including 98% (3,130) of all accipiters, 95% (432) of all buteos, 99% (476) of all eagles, and 98% (217) of all falcons. We recorded age class of 88% (3,902) of all raptors, and sex of 43% of Northern Harriers, Rough-legged Hawks, American Kestrels, and Merlins (in combination). We do know that the seasonal distribution of our surveys can influence observed age ratios, with immature birds generally flying earlier in the season, and we have generally had more consistent coverage in the first half of the season. This was indeed the case in both 2017, 2019, and 2020, This year, although we did miss some opportunity in October, we still conducted seven surveys beyond mid-October. We therefore may not have overestimated the proportion of first year birds in the flight for early migrant species (e.g. Sharp-shinned and Cooper's Hawks), which we may have done in those seasons. But it is important to note that our observed age ratios are indices, not estimates, and for some late migrant species such as eagles and Northern Goshawks, we may regularly overestimate the number of immatures in the flight.

Passage Rate. The vast majority of our 2021 survey efforts once again took place between the hours of 1000 and 1700, with daily peak rates between 1100 and 1600. Our season-long passage rate of 13.4 birds/hr was the highest we have recorded, and we have now averaged >10 birds/hr over the history of our survey (Table 1).

Summary Discussion. Data collected over the last 14 years indicate that the Jewel Basin site is one of the best places in the northern Rockies to monitor passing accipiters. It appears that with adequate coverage (and suitable weather), we can expect to consistently record and classify 2,000 – 4,000 birds annually at the site, although poor weather and access issues can sometimes suppress survey efforts. Accipiters consistently comprise the bulk (51%-72%) of the flight in the Jewel Basin, with 3,189 (72%) counted this year. This combination of an abundance of accipiters, and a diversity of other raptors seen, make the Jewel Basin a valuable addition to the network of monitoring sites in the state and the West.

Our final tally of 4,418 birds was the highest seasonal total over 14 years of surveys (range, 1,638 – 4,418), and our highest ever season-long passage rate (13.4/hr). We have now counted 37,185 raptors of 18 species since our

initial efforts in 2007. As arbitrary as it might be, our observers have come to consider 100-bird days as "great day on the ridge". This year we had more such days (16) that in any previous years, and twice as many 200-bird days (8) than any previous year. In fact we averaged an all-time high of 88 birds per survey. Our best day (5 October) provided nearly a bird a minute (58/hr) and our second best one-day total ever, with 488 birds counted. These are the days that keep our primary observers and our many volunteers excited about future days on the ridge.

Our season-long passage rates of 6.3 – 13.4 birds/hr (10.4 overall) over the 14 years of surveys to date (Table 1) are comparable to, or surpass historic rates at other hawk migration monitoring sites in Montana. A direct comparison of our data with selected survey data from other sites (Casey 2011) showed that our individual species totals are also comparable or exceed those for the other sites, although it appears that migrating Golden Eagles use the Jewel Basin less than other Montana monitoring sites, even nearby Mt. Brown in Glacier National Park. The long-term monitoring site at the MPG Ranch outside of Missoula, has also been recording far fewer Golden Eagles in than the more traditional monitoring sites in Montana (Bridgers, Rogers Pass, Nora Ridge). But that site has had far more Turkey Vultures, Northern Harriers, Red-tailed Hawks and American Kestrels, and far fewer accipiters than the Jewel Basin site during the fall migration season. Clearly, having a diversity of sites across the state will allow us to gain a broader perspective on the diversity of migrant raptor populations in the region, under a variety of weather influences.

Future Survey Recommendations. The value of survey data such as these is enhanced not only by comparison and synthesis with data from other sites, but also from long-term continuity. We believe that surveys should be continued annually at the Jewel Basin site, with target dates of 25 Aug through mid-Nov, weather permitting. We expect continued community support for this project, based on the very favorable response to our results and outreach efforts over the past ten years, particularly with volunteers. Flathead Audubon has assumed primary responsibility of the Jewel Basin Hawk Watch, and we very much depend on our continued partnership with Flathead National Forest. For the past two years Flathead Audubon contracted with only one Hawk Watch technician but coordinated with other skilled volunteers to fill in as primary observers. This is preferable to our previous model of reimbursing several different contracted technicians. This year we were fortunate to have Josh Covill available to serve as our contract primary observer. Josh has volunteered at the Jewel Basin Hawk Watch for many prior years and is a top-notch primary observer. But in spite of contracting with him to conduct up to 30 surveys, he left the state during the second week of October. Without adequate communication prior to that time, we were unable to keep daily coverage throughout October, and missed 8 potential survey days because of it. Because volunteer interest often wanes as the days get colder and hunting seasons begin, we will need to emphasize the responsibility of contracted observers to be available late in the season. To sustain a minimum of 35 to 45 surveys/year, we will continue to need sources of funding to ensure the consistent coverage throughout the season.

While season long surveys of eight hours per day from the last week of August through the first or second week of November will maximize coverage, we have found that travel logistics, weather and volunteer availability will invariably impede thorough coverage. Every attempt has been (and should be) made to ensure that at least the period 1100-1600 each day with suitable weather is covered, as it typically represents more than 75% of the flight. Likewise, most of the flight occurs between 15 Sep and 15 Oct, and if funds or volunteers ever become limited, this time period should be the focus of survey efforts. Indeed, this year 70% of the raptors were recorded during that period.

We have developed a summary (Table 2) of our seasonal coverage since 2011 to assess how well we have done at maximizing our survey efforts during our target season, from 25 Aug through 7 Nov (N=75 days). as weather and observer availability/interest would allow. Beginning in 2011, we made a concerted effort to track the number of days during that period where weather was suitable for counts, and the number (%) of days surveys were conducted. Suitable days have varied from just 43 during that 75-day window in 2017, to a high of 59 days in 2018. This year was just the second year in the last seven where 75% of the 75-day survey period had weather

suitable for surveys. It was also the ninth year where we managed to conduct surveys on 85% or more of the days with suitable weather (Table 2). In fact, we have never surveyed on fewer than 76% of the suitable days since we began tracking this statistic.

We have further defined our survey opportunity and effort during each annual "survey window", or those dates from the first survey each year until the last (when access is not longer safe). This survey window has varied from a low of 52 days (2020), to a high of 81 days in 2016, when our last survey was l3 November. This year that window was 73 days (25 August – 5 November) we completed surveys on 50 (68%) of those days, including every day with suitable weather from 25 August through 10 October. Fifteen days (21%) had poor weather, and we missed 8 days (11%) when no observer was available late in the season (Appendix B). Our continued ability to conduct surveys on most suitable days is a testament to outreach efforts and our growing pool of qualified observers, for a site with moderately difficult access and without a season-long, full-time onsite observer.

Table 2. Seasonal survey effort, Jewel Basin Hawk Watch, 2011-2020. Percent of days by category by Season (25 Aug – 7 Nov; N=75) and by Survey Window (days between first and last survey each year, inclusive; N=49-81).

Year:	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Suitable Days: Season	77%	73%	71%	77%	67%	64%	57%	79%	49%	60%	77%
Suitable Days: Surveyed	87%	87%	91%	90%	94%	79%	98%	76%	97%	91%	86%
Window Days Surveyed	61%	64%	64%	78%	72%	49%	66%	75%	68%	79%	68%
Window Days Bad Weather	21%	21%	24%	15%	23%	33%	22%	5%	26%	12%	21%
Window Days No Access	9%	9%	7%	7%	5%	17%	2%	20%	2%	8%	0%
Window Days Suitable No Survey	0%	5%	5%	0%	0%	0%	11%	0%	4%	2%	11%
Window Days No Data	8%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Flathead Audubon continues to offer field trips and one on one training for individuals interested or with experience in raptor observations. We have had 36 people serve as primary observers for at least one survey since this project began and have a solid base of more than a dozen experienced local observers still available, including eight who have served as primary observers 10 or more (14-118) times. We still plan to contract with at least one individual to cover up to 30 survey days/season in future seasons, to ensure that we continue to maximize efforts when weather access allow. Montana Audubon staff have been involved as observers for the past two years, and we expect that partnership to continue, improving training and coverage.

Summary. The U.S. Forest Service is a primary forest steward in the Northern Rockies. Our efforts at this monitoring site indicate that it is an excellent site to monitor the migration and age structure of regional populations of forest-dwelling raptors (e.g. Sharp-shinned Hawk, Cooper's Hawk, Northern Goshawk). Monitoring results from this site complement data collected at other raptor monitoring sites in the state and region, and we are now entering our data directly into the www.hawkcount.org website to make them available to the public and to other researchers, in addition to our annual reports. Because this site allows close study of passing birds, we can track age and (for some species) sex ratios, in addition to overall abundance, indicating the health of populations (and therefore the health of forest ecosystems) over time. The accipiters passing this site are certainly reliant on both public and corporate timberlands; indeed, as they continue south from this site they pass over and through extensive corporate timber and USFS lands. We have observed that a large percentage of the passage birds at this site have full crops, indicating that these birds rely on local habitats to feed before proceeding on migration, though we have not quantified the extent of the phenomenon. Clearly, all the lands along this important migration corridor play a role in its continued value to these birds.

Montana Audubon and the Flathead Audubon Society are committed to environmental education and developing citizen science opportunities. Because of its accessibility, the Jewel Basin Hawk Watch site offers exceptional opportunity to involve the local community and educate and inform them about the ties between sustainable forest management and bird conservation. It may also allow the Flathead National Forest, Montana Audubon and Flathead Audubon to nurture a volunteer base for other bird monitoring efforts in the region. This was evidenced by the continued overwhelming response by volunteers interested in participating in the 2008-2021 survey efforts. We have also have received inquiries in the past from home-schoolers, public school teachers, youth programs, and environmental outreach organizations (e.g. Montana Natural History Center, Glacier Institute, Montana Audubon) about opportunities to get children and adults involved in the surveys as an "outdoor classroom". This is another area of outreach to explore and expand in future years.

Many of the hawk watch sites in North America (including two sites in Montana) supplement their counting efforts with additional efforts to trap, band and release raptors to improve our understanding of migration patterns, distribution, longevity, plumage/molt, and more. We feel that the potential to add a raptor banding component to the Jewel Basin Hawk Watch effort is something that should be considered by partners. There are several master banders in Montana that might be available and willing to initiate a pilot effort in future years. We would like to initiate a dialogue with Flathead National Forest and the Hungry Horse District about that possibility in the coming year.

There are a few other components we feel could be added to the Jewel Basin Hawk Watch that would improve coverage, attract observers, and improve safety in 2022 and beyond. We have had very preliminary discussions with USFS personnel on the following topics, and look forward to enhancing our partnership further for the 2022 field season and beyond:

- Limited use of the Camp Misery cabin by our contracted primary observer and/or limited others for a portion of the survey season, with responsibilities and expectations explicitly stated (e.g. public outreach, maintenance, winterizing). This would improve safety (fewer tired trips up and down the access road), coverage (based on being onsite with reduced travel time), and public outreach (presence for other Jewel Basin users). Logically, perhaps the cabin could be available from the time it is vacated by USFS seasonal staff until 10-15 October, under a signed agreement?
- Installation of a webcam at the Hawk Watch site, to view onsite weather and perhaps to provide remote viewing of birds approaching the owl decoy.
- Continued bear awareness training and optional use of a USFS vehicle for primary observer(s). Perhaps combined with training in raptor identification and the use of the Dunkadoo software.

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APPENDIX A. Daily count data, Jewel Basin Hawk Watch, 25 August – 5 November 2021. Species codes listed below table.

Date	Hours	TV	OS	BE	NH	SS	CH	NG	UA	BW	SW	RT	FE	RL	UB	GE	AK	ME	PG	PR	GY	UF	UE	UU	TOTAL	Birds/Hr
25-Aug	5.50					3	4					4	1												12	2.2
26-Aug	5.60			4		6	1					16	1		6	1	1	2							38	6.8
28-Aug	3.50				1	3	1					1					1			1					8	2.3
29-Aug	6.00		1		1	5	6					6				2	1			2		1			25	4.2
30-Aug	6.17		1	1	1	16	3				1	6					3	1		5					38	6.2
31-Aug	6.60		1		1	18		4				2					6			3					35	5.3
1-Sep	7.00			2		2	3					2													9	1.3
2-Sep	6.25			1	1	4	4	1			1	1				1	2	2							18	2.9
3-Sep	7.00				1	13	7		1			5						1							28	4.0
4-Sep	7.25			1	1	20	5					1				1	1								30	4.1
5-Sep	7.60			1	1	35	10		1			6				1	3								58	7.6
6-Sep	7.50	1		3		28	7		5	2	1	9			1		3	1	2	1		1			65	8.7
7-Sep	6.50			1	5	23	9	1		1		2				1	3	1	1					1	49	7.5
8-Sep	7.75			3	5	58	12	1				11				1	6	1		1				1	100	12.9
9-Sep	8.00				2	63	37		1	1	1	7				1	2	1							116	14.5
10-Sep	6.50				2	9	5	1				3					2		1						23	3.5
12-Sep	5.50				1	34	13		2	2	1	8				5	1								67	12.2
13-Sep	8.25				2	29	24	1	1			10			1	2		1	1						72	8.7
14-Sep	8.25		1		4	77	61		2	30	1	24			2	4	5	2	2	2					217	26.3
15-Sep	7.50					31	12		1	1						9		1							55	7.3
16-Sep	8.00	1		1		46	29	2	1	1		20			1	4	5								111	13.9
17-Sep	7.00	1	1			38	15					9				5	2		4						75	10.7
18-Sep	2.00																								0	0.0
21-Sep	8.00			2	3	100	54	1	3	2		16			1	13	3		2	1		2		2	205	25.6
22-Sep	7.75			1	1	194	62	2		2		18			3	11	5	2	1						302	39.0
23-Sep	8.50		1	1		40	12		5			10			2	5									76	8.9
24-Sep	8.40			1	4	45	24	1	6		1	6	1			10	1	1	2	1					104	12.4
25-Sep	8.00		1		1	178	30		2	2		9			1	7	14	1	2					1	249	31.1
26-Sep	7.75		1	8		161	24		1	7		16				12	4	3	2	3					242	31.2
27-Sep	8.20		1	2		43	13	2	1	1		6				3	1	1							74	9.0

APPENDIX A (cont'). Daily count data, Jewel Basin Hawk Watch, 25 August – 5 November 2021. Species codes listed below table.

Date	Hours	TV	OS	BE	NH	SS	CH	NG	UA	BW	SW	RT	FE	RL	UB	GE	AK	ME	PG	PR	GY	UF	UE	UU	TOTAL	Birds/Hr
30-Sep	8.00			3	2	77	17	3	2			7				8	2	1	1						123	15.4
1-Oct	8.10					67	5					4				16	1								93	11.5
2-Oct	8.00			8		149	15	1	1	1		10			2	12	3	3		2					207	25.9
3-Oct	8.50			5		78	3	1	2			12			2	13	2	2						1	121	14.2
4-Oct	8.50			3	1	176	30		2	2		12	1			13	4	5		2					251	29.5
5-Oct	8.40		2	9	1	334	34	1				16		1		60	9	16	3	1			1		488	58.1
6-Oct	6.50			7	4	51	3	1	5	1		10		3		31	1	8		1				1	127	19.5
7-Oct	7.75			4		27	1					2		2		10	1								47	6.1
8-Oct	7.00					30			1			1				6	1	3							42	6.0
9-Oct	7.25			3	1	30		3				6				31		1		1					76	10.5
10-Oct	0.50					1										1									2	4.0
12-Oct	6.50			1	1	4	3	2	1			3		1		13									29	4.5
13-Oct	1.00															2									2	2.0
16-Oct	2.00			5		3			6	1						17									32	16.0
17-Oct	6.00			1	1	118	4	1	5					2		7		1						1	141	23.5
19-Oct	6.00					10	1	1	1					12		7	1								33	5.5
21-Oct	7.10			1		12		5				7		11		9		2							47	6.6
24-Oct	5.00			1		1						1				2		2					5	1	13	2.6
3-Nov	5.50			5				1				2		2		3									13	2.4
5-Nov	4.50			8								1		2		19									30	6.7
	TOTALS	**3**	**11**	**97**	**49**	**2,490**	**603**	**37**	**59**	**57**	**7**	**328**	**4**	**36**	**22**	**379**	**100**	**66**	**24**	**27**	**0**	**4**	**6**	**9**	**4,418**	**13.4**

Species Code:

TV	Turkey Vulture	UA	Unidentified Accipiter	GE	Golden Eagle	UE	Unidentified Eagle
OS	Osprey	BW	Broad-winged Hawk	AK	American Kestrel	UU	Unidentified Raptor
BE	Bald Eagle	SW	Swainson's Hawk	ML	Merlin		
NH	Northern Harrier	RT	Red-tailed Hawk	PG	Peregrine Falcon		
SS	Sharp-shinned Hawk	FH	Ferruginous Hawk	PR	Prairie Falcon		
CH	Cooper's Hawk	RL	Rough-legged Hawk	GY	Gyrfalcon		
NG	Northern Goshawk	UB	Unidentified Buteo	UF	Unidentified Falcon		

APPENDIX B. Dates and causes for those days where surveys were not conducted, Jewel Basin Hawk Watch, 25 August-7 November 2021

Date	Conditions
27 Aug	Weather conditions unsuitable for survey (rain, fog, low clouds and/or snow)
11 Sep	Weather conditions unsuitable for survey (rain, fog, low clouds and/or snow)
19 Sep	Weather conditions unsuitable for survey (rain, fog, low clouds and/or snow)
20 Sep	Weather conditions unsuitable for survey (rain, fog, low clouds and/or snow)
28 Sep	Weather conditions unsuitable for survey (rain, fog, low clouds and/or snow)
29 Sep	Weather conditions unsuitable for survey (rain, fog, low lcouds and/or snow)
11 Oct	Conditions suitable for survey, no observer available
14 Oct	Weather conditions unsuitable for survey (rain, fog, low clouds and/or snow)
15 Oct	Weather conditions unsuitable for survey (rain, fog, low clouds and/or snow)
18 Oct	Conditions suitable for survey, no observer available
20 Oct	Conditions suitable for survey, no observer available
22 Oct	Conditions suitable for survey, no observer available
23 Oct	Conditions suitable for survey, no observer available
25 Oct	Weather conditions unsuitable for survey (rain, fog, low clouds and/or snow)
26 Oct	Weather conditions unsuitable for survey (rain, fog, low clouds and/or snow)
27 Oct	Conditions suitable for survey, no observer available
28 Oct	Weather conditions unsuitable for survey (rain, fog, low clouds and/or snow)
29 Oct	Weather conditions unsuitable for survey (rain, fog, low clouds and/or snow)
30 Oct	Weather conditions unsuitable for survey (rain, fog, low clouds and/or snow)
31 Oct	Conditions suitable for survey, no observer available
1 Nov	Conditions suitable for survey, no observer available
2 Nov	Weather conditions unsuitable for survey (rain, fog, low clouds and/or snow)
4 Nov	Weather conditions unsuitable for survey (rain, fog, low clouds and/or snow)
6 Nov	Access to the site no longer safely available due to snow
7 Nov	Access to the site no longer safely available due to snow