Raptor Migration Monitoring in the Jewel Basin
Autumn 2023 – Annual Report

4 March 2024

A Report to:

USDA Forest Service: Flathead National Forest

Agreement #20-CS-11011000-026
Flathead Audubon Society

(Immature American Goshawk photo by bj Worth)

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Executive Summary. The 2023 migration season at the Jewel Basin Hawk Watch concluded 1 November; snow precluded surveys after that date. A season characterized by few major weather events and consistent coverage led to above average numbers across almost all species, but record numbers for only two: Broad-winged Hawk (60), and American Kestrel (104). Our final survey 1 November was the 47th survey of the season. Ten primary observers conducted 1-13 surveys each, averaging 6.4 hours and 67 birds counted (1050 birds/100hr). We tallied 3,131 raptors of 17 species. Along the way we recorded our 28,000th Accipiter, our 20,000th Sharp-shinned Hawk, our 6,000th Cooper's Hawk, 6,000th Golden Eagle and our 2,000th falcon over the history of our count. We have now counted more than 43,167 raptors at the site since 2007 (our pilot year). Our 2023 season totals exceeded our 15-yr mean counts for 15 species, with only Northern Goshawks (34), Red-tailed Hawk (157) and Golden Eagle (257) recorded in below average numbers. We once again analyzed and report herein the observed age and sex classification of the flight, by species, where appropriate.

As always, the success of the Jewel Basin Hawk Watch depended on Flathead Audubon members and others who volunteered their time to help spot and tally passing birds. This year at least 57 people joined our eight volunteer and two contracted primary counters for at least one day. We are thankful for the 800 hours, 2,924 miles of personal car use, and foregone per diem which served as in-kind support to the project, which in addition to donated administrative efforts (120 hr) resulted in a total in-kind donation of $21,674 to the project. Cash reimbursements to our paid technicians (mileage, per diem and stipend) and other primary observers (mileage and per diem) totaled just $4,630 and were supported in part by both the Flathead National Forest and Montana Audubon.

Introduction. This report summarizes the 16th annual season-long survey 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.

More detailed descriptions of the location, history, funding partners, participants and regional context of the Jewel Basin site and our surveys there have been included in past annual reports (e.g. Casey and Bissell 2021) and are not reiterated here. The Hawk Watch continues to be conducted through a funding partnership between Flathead Audubon and Flathead National Forest, currently through Agreement #20-CS-11011000-026, under which this report has been prepared. We have also been pleased to receive a Wildlife Fund Grant from Montana Audubon to support our efforts in recent years.

This annual report summarizes the extent and results of our efforts during the 2023 field season (25 August – 1 November) and includes data summaries for the last 16 years (plus our pilot year in 2007) Additional data and photos may be requested from Flathead Audubon through Dan Casey. Data from the last eight survey years are also stored by the Hawk Migration Association of North America (HMANA), at www.Hawkcount.org.

Flathead Audubon contracted with two experienced technicians for the to complete up to 35 raptor survey days, depending on weather, during the 2023 field season. We relied on our growing cadre of experienced volunteers to survey on intervening days. Flathead Audubon provided Joshua Covill and bj Worth daily stipends, reimbursement for personal car mileage and per diem for the 23 days they spent as primary counters this season. We also made per diem and mileage reimbursement available as an option to those volunteers who also served as primary counters. Coordination with Flathead Audubon's Raptor Day and word-of-mouth through 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 in past years, 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.

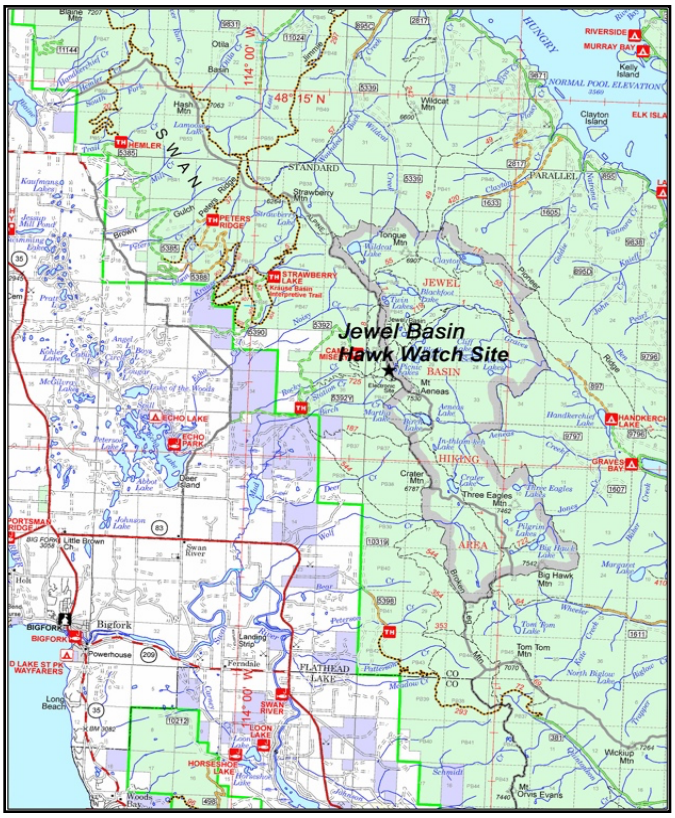

Figure 1. Location of the Jewel Basin Hawk Watch site, Flathead Co., Montana, northwest of Mt. Aeneas, Jewel Basin Hiking Area, Flathead National Forest (48.1552°N, -113.93294°W).

This year, the following eight individuals served as primary counters in addition to our paid technician: Dee Baginski, Lisa Bate, Jake Bramante, Nicki Broesel, Dan Casey, Diane Lundgren, Beth Mendelsohn, and Denny Olson. They committed a total of 251.4 hours (counting travel time) over 24 successful days of observation at the Jewel Basin observation site. Joshua Covill was reimbursed $1,936 for 13 survey days., and bj Worth was reimbursed $1,459 for 10 days. These primary counters were also joined by at least 57 additional volunteers to serve as extra observers on one or more days. These secondary observers donated another 730 in observation and travel time. Flathead Audubon also provided an additional 120 hr of administration time for training, financials, and coordination. All in all, these amounted to $15,844 in hourly donations, $1,608 in mileage donations, and $1,222 in per diem donations for a total of $21,674 in donated match. A full accounting of donated and billed time is available upon request.

Methods. Our annual goal has been 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 our first survey was 25 August, and our "survey window" closed after our last count on 1 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 three days during the survey window where conditions were suitable, but no observer was available. Surveys varied in length depending on apparent passage rates, weather conditions, and volunteer availability, ranging from 3.2 to 8.0 (average 6.4) hours per survey, totaling 298.6 survey hours for the season. Nearly all surveys were conducted from the primary observation point selected based on preliminary (2007) data, a site (Figure 1) at 7,100 ft in elevation on the northwest flank of Mt. Aeneas (48.1552°N, -113.93294°W). One exception was the survey conducted 31 October,when the survey was conducted from the lower, second observation site. This was the eighth 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 that was linked to the internet via cell towers so that data could be entered in real time. Dan Casey, the Jewel Basin Coordinator, 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 2023 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 also data from other sites across the continent.

Results. Our total count of 3,131 raptors for 2023 (Table 1) was our fourth-highest total over the 16 years of full-season surveys at the site. Our season-long passage rate of 10.5 birds per hour was also above long-term average (9.4 birds/hr). We recorded above average numbers for all but two of the 17 species we recorded (see species accounts that follow). Our highest one-day count this season of 160 birds (22/hr) occurred 16 September, slightly earlier than the typical seasonal peak. This year's counts showed no pronounced peak; the eleven days where we counted >100 birds spanned the period from 15 September through 20 October. Complete daily survey results for the 2023 season, by species, are included in Appendix A.

Species Accounts. Accipiters (Sharp-shinned Hawk, Cooper's Hawk and American Goshawk) comprised the majority of the raptor flight (72%) with 2,264 birds counted. Eagles comprised 10% of the birds recorded, buteos 8%, and falcons 6% (Figure 2). The brief species accounts that follow describe the extent and nature of the migration data we collected in 2023, with comparisons to (and updated summaries of) our data from 16 full seasons at the site (Table 1). We have included adjustment of totals per unit effort (#/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. Note that throughout this section, we use the term "immature" to mean first-year (juvenile) birds, unless otherwise specified. Age ratios are expressed as the number of immatures per 100 adults (e.g. 58/100ad).

Turkey Vulture. 2023 Total: 5 (2/100hr) 16-yr Average: 3 (1/100hr)

This species has never comprised any significant portion of the flight at this ridgetop site.

Osprey. 2023 Total: 19 (6/100hr) 16-yr Average: 9 (3/100hr)

It was our best year to date year for this surprisingly uncommon migrant at our site. Occasional resident birds were seen in the area early in the season. We had migrant individuals on 13 days between 25 August and 4 October, with a high count of four birds on 25 September.

Bald Eagle. 2023 Total: 60 (20/100hr) 16-yr Average: 59 (21/100hr)

One of a handful of species that can sometimes be hard to count accurately at our site, there are resident Bald Eagles of all ages present in the area throughout the season. For this reason, we count only obvious north-south

migrants, and do not include circling/feeding birds or those flying perpendicular to the ridge (i.e. into the valley or into the South Fork). We had average numbers this year, and recorded them throughout the season, from 25 August to 1 November, with a high count of nine individuals on 20 October. We were able to classify100% of the 60 birds to age class, with 62% adults, 27% immatures (1-2 yr olds) and 11% subadults (3-5 yr olds). Although Bald Eagles seem to be doing well across their range, our observed ratio of non-adults to adults (62/100 ad) seems lower than we would expect for a growing population.

Table 1. Season totals for raptors counted at the Jewel Basin Hawk Watch site, 2008-2023. New (or tied) season-high totals are in **bold**. Updated all-time totals include limited data from preliminary surveys in 2007. All surveys were conducted between 25 Aug and mid-November, dependent on weather and volunteer availability.

Species	2008-2022 Minimum	2008-2022 Maximum	2008-2022 Mean	2023 Total	All-time Total
Turkey Vulture	0	7	3	5	46
Osprey	4	19	8	**19**	140
Bald Eagle	25	107	59	60	958
Northern Harrier	13	102	45	81	759
Sharp-shinned Hawk	687	2,490	1,250	1,710	20,586
Cooper's Hawk	215	603	388	488	6,338
Northern Goshawk	24	62	36	34	574
Unidentified Accipiter	32	93	57	32	894
Broad-winged Hawk	2	57	21	**60**	373
Swainson's Hawk	0	7	2	**7**	32
Red-tailed Hawk	136	328	214	157	3,395
Ferruginous Hawk	0	4	1	2	15
Rough-legged Hawk	1	41	21	26	335
Unidentified Buteo	8	22	16	10	247
Golden Eagle	212	600	386	257	6,089
American Kestrel	35	100	70	**104**	1,158
Merlin	9	66	25	36	407
Peregrine Falcon	3	24	13	14	202
Prairie Falcon	1	27	11	13	187
Gyrfalcon	0	1	0	0	2
Unidentified Falcon	1	14	5	8	84
Unidentified Eagle	0	6	3	2	33
Unidentified Raptor	8	46	20	6	313
TOTAL	1,638	4,418	2,651	3,131	43,167
Survey Days	36	52	44	47	719
Effort: In hours	226.0	339.0	280.0	298.6	4,533
Passage Rate (per hr)	6.3	13.4	9.4	10.5	9.5
Total Species	15	17	16	17	18

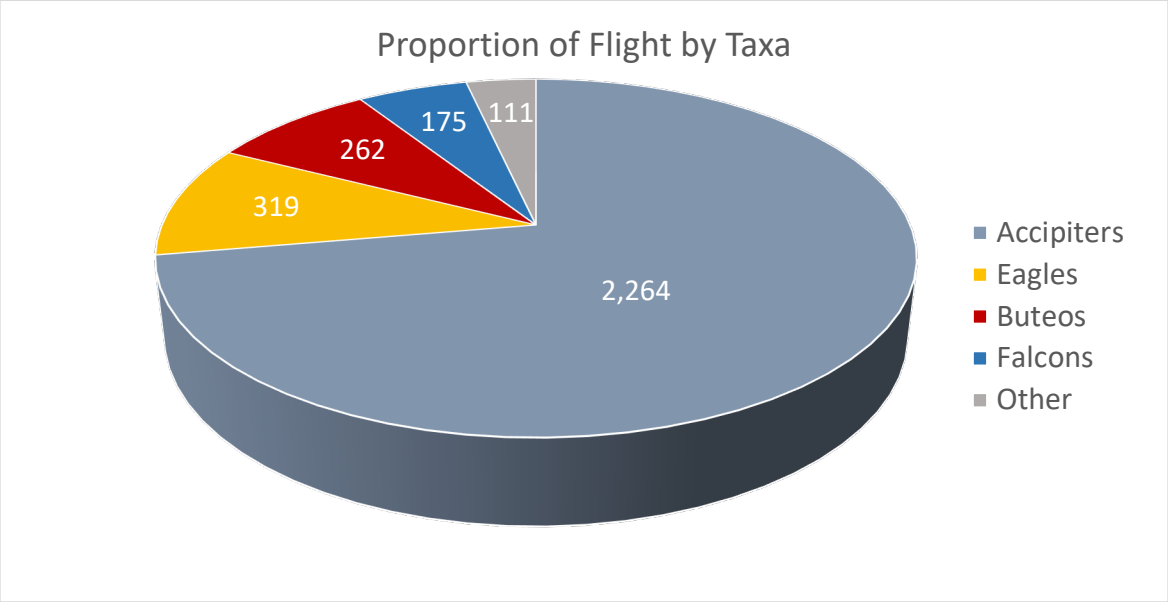

Figure 2. Composition of observed hawk migration at the Jewel Basin Hawk Watch site, fall 2023, by category. Numbers are total counts for the season.

Northern Harrier. 2023 Total: 81 (27/100hr) 16-yr Average: 47 (17/100hr)

Harriers were recorded in well above average numbers, and once again we were able to classify a large percentage of the birds to age class (94%). Just six adults were counted, all females. A remarkable 92% of the birds were were immatures (see photo by bj Worth), yielding a ratio of 1167/100ad. We recorded harriers on 34 (72%) of our 47 surveys, 27 August through our last survey of the year (1 November). At least one local immature bird was seen near the survey site throughout much of the survey season.

Sharp-shinned Hawk. 2023 Total: 1,710 (573/100hr) 16-yr Average: 1,279 (456/100hr)

We continue to record more Sharp-shinned Hawks at the Jewel Basin site than any other Montana hawk watch, both in total numbers and as a percentage of the flight. They make up 47% of the fall flight here on average (Table 1), and did so again this year, as we counted 1,710 (47% of the 3,131 birds counted). They were recorded on all but one of our 47 surveys, with a high count of 95 on the surprisingly late date of 20 October. Our passage rate of 573 birds per 100 hr was above average, but well below 2021's all-time high of 755/100hr (Figure 3). We were able to classify 88% of the birds to age class, with an observed ratio of 87imm/100ad, below our long-term average (104/100ad) for the fourth consecutive year (Figure 4).

Cooper's Hawk. 2023 Total: 488 (163/100hr) 16-yr Average: 394 (140/100hr)

Cooper's Hawk is typically an abundant migrant at our site, and such was the case this year, as we counted 488 birds on 40 surveys between 25 August and 21 October. Our high count was 46 birds on 16 September. Adjusted Cooper's Hawk numbers have fluctuated somewhat less dramatically than Sharp-shinned Hawks at our site (Figure 5) and were somewhat above average this year at 163/100hr. Like Sharp-shinned, the observed ratio of immatures to adults was below average (129/100ad) for the fourth year in a row, following three years of apparent high productivity (Figure 4). Our confidence in expressing these ratios remains high for these close-flying accipiters; this year we were once again able to classify 91% of the passing Cooper's Hawks to age class.

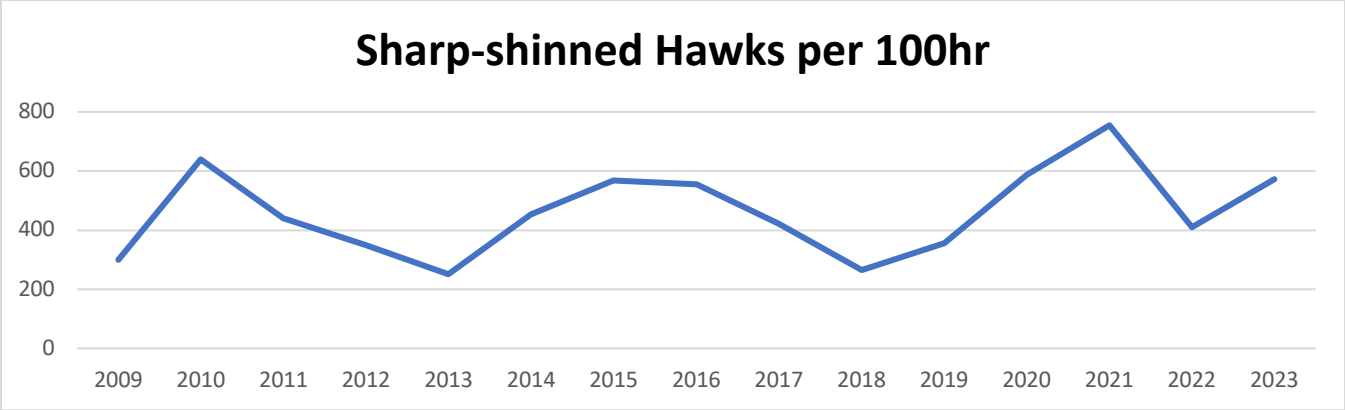

Figure 3. Abundance of Sharp-shinned Hawks reported at the Jewel Basin Hawk Watch site, corrected for effort (birds/100hr), 2008-2023.

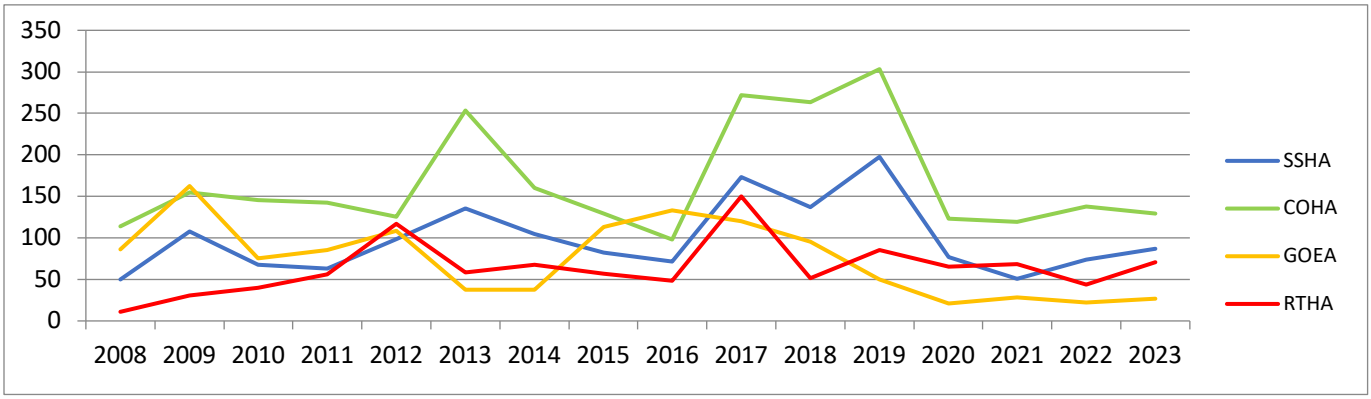

Figure 4. Ratios of immatures per 100 adults counted at the Jewel Basin Hawk Watch, 2008 – 2023, for the four most common species surveyed. SSHA = Sharp-shinned Hawk; COHA = Cooper's Hawk; GOEA = Golden Eagle; RTHA = Red-tailed Hawk

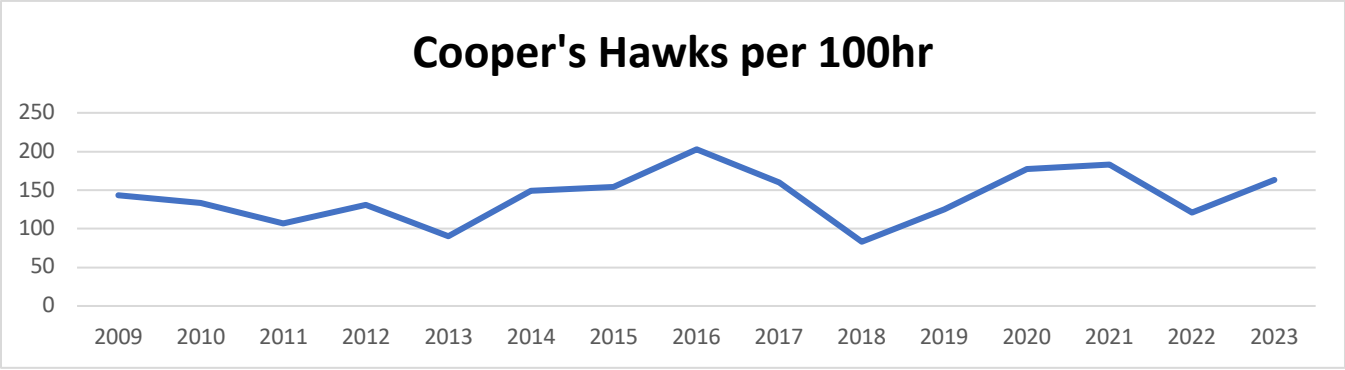

Figure 5. Abundance of Cooper's Hawks reported at the Jewel Basin Hawk Watch site, corrected for effort (birds/100hr), 2008-2023.

American Goshawk. 2023 Total: 34 (11/100hr) 16-yr Average: 36 (13/100hr)

We recorded American (formerly Northern) Goshawks on half (23) surveys, from 25 August through 31 October. Our peak count was four birds on 18 September. Relative abundance (11/100hr) was slightly below average, in part because we missed 14 days in October due to inclement weather. Missed surveys at this point in the season, when adult birds dominate the flight, contributed to this being one of just three species seen in below average numbers this season. This also contributed to a highly skewed observed age ratio this year for this species (1600imm/100ad). At least one local immature Northern Goshawk was present in the area throughout the season again this season. Hopefully we were judicious enough in our sampling protocols to keep it from further inflating our observed age ratio.

Broad-winged Hawk. 2023 Total: 60 (20/100hr) 16-yr Average: 23 (8/100hr)

We have now seen 313 Broad-winged Hawks over the 16 years of full-season surveys (Table 1), with a record total of 60 seen this year. They were counted on 15 surveys from 28 August through 4 October, with a peak daily count of 15 birds on 16 September. We classified 88% to age; 49% were adults. Just two dark morph birds were seen, both adults.

Swainson's Hawk. 2023 Total: 7 (2/100hr) 16-yr Average: 2 (1/100hr)

Seen at a rate of 1/100hr, the Swainson's Hawk continues to be scarce migrant at the Jewel Basin site, averaging just two birds per year (Table 1). This year we saw them during five surveys, the first on 29 August, and the last on 24 September. We recorded two birds each on the surveys conducted 6 and 24 September.

Red-tailed Hawk. 2023 Total: 157 (53/100hr) 16-yr Average: 211 (75/100hr)

We recorded Red-tailed Hawks on all but six of our 2023 surveys. This widespread and variable species has traditionally been the fourth-most abundant migrant at the Jewel Basin site, and one for which our data imply an upward trend overall. However, this was the third consecutive year that our corrected abundance (53/100hr) was down from the 2020 peak (Figure 6) and was the second lowest in our 16 years of surveys. Our peak daily count was 14 birds on 14 September. We were able to assign an age class to 146 individuals (89%), with an observed ratio of 27imm/100 ad, up from last year's 12-yr low (Figure 4), but well below our long-term average of 64imm/100ad. Dark morph birds (see photo by bj Worth) comprised 19% of the 145 individuals we classified to color morph (92%).

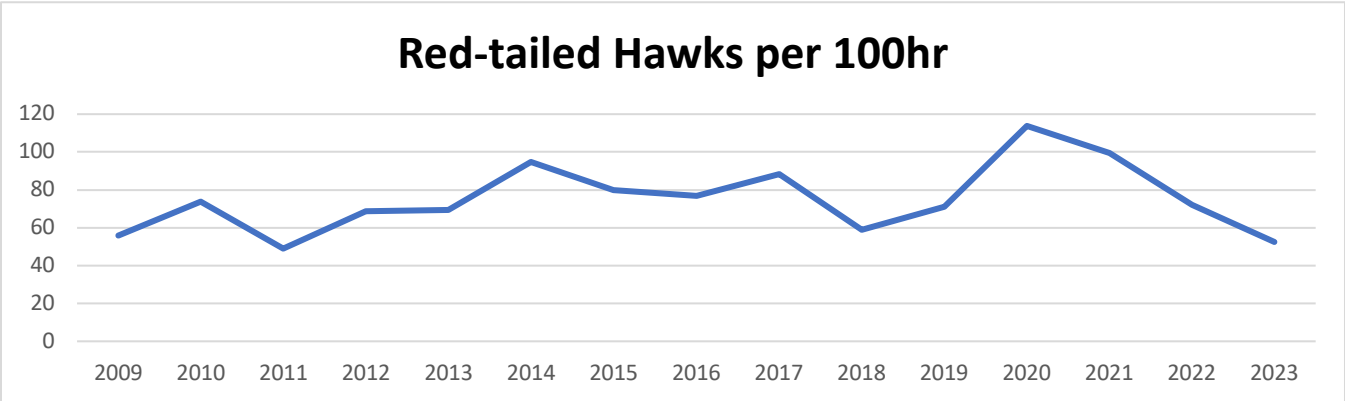

Figure 6. Abundance of Red-tailed Hawks reported at the Jewel Basin Hawk Watch site, corrected for effort (birds/100hr), 2008-2023.

Ferruginous Hawk. 2023 Total: 2 (<1/100hr) 16-yr Average: 1 (<1/100hr)

We have now recorded just 15 individuals of this prairie species over the history of the count (Table 1). This year single birds were seen 2 September and 7 September.

Rough-legged Hawk. 2023 Total: 26 (9/100hr) 16-yr Average: 21 (7/100hr)

The Rough-legged Hawk is a common winter resident in western Montana, and a boreal breeder. Not surprisingly, our annual counts have been highest when we have consistent coverage throughout October and into November. In spite of missing 14 bad weather days in October, we had slightly above-average numbers this year (Table 1), all between 6 October and 1 November. Twenty of these were seen during one four-day period (18-21 October). Four individuals were dark morphs, and six of the seven adult birds we classified appeared to be males. Six of 15 birds classified to age (40%) were immatures.

Golden Eagle. 2023 Total: 257 (86/100hr) 16-yr Average: 378 (135/10hr)

Local resident Golden Eagles always pose a challenge at our site, as they are present throughout the season. But our protocol to count only those birds clearly on a N-S migration path helps reduce (but not eliminate) the chance of biasing our survey data. This year we counted passing birds from our first survey to our last (25 August – 1 November), with a peak of 27 counted on 20 October; most (83%) passed after 1 October. Normally our second-most abundant species, this year they were one of just three species seen in below average numbers. This was one of three seasons when our observed abundance fell below 100 birds/100hr (Figure 7). We classified 94% of the Golden Eagles to age class; 64% were adults. This marked the fourth consecutive year of well below-average numbers of immatures (17/100ad) in the flight (Figure 4), although 36% of the birds we classified were “non adults”, defined as having extensive white in either the primaries or tail feathers. Immatures were classified by the characteristic white “windows” in the both the primary bases and tail feathers (see photo below by bj Worth).

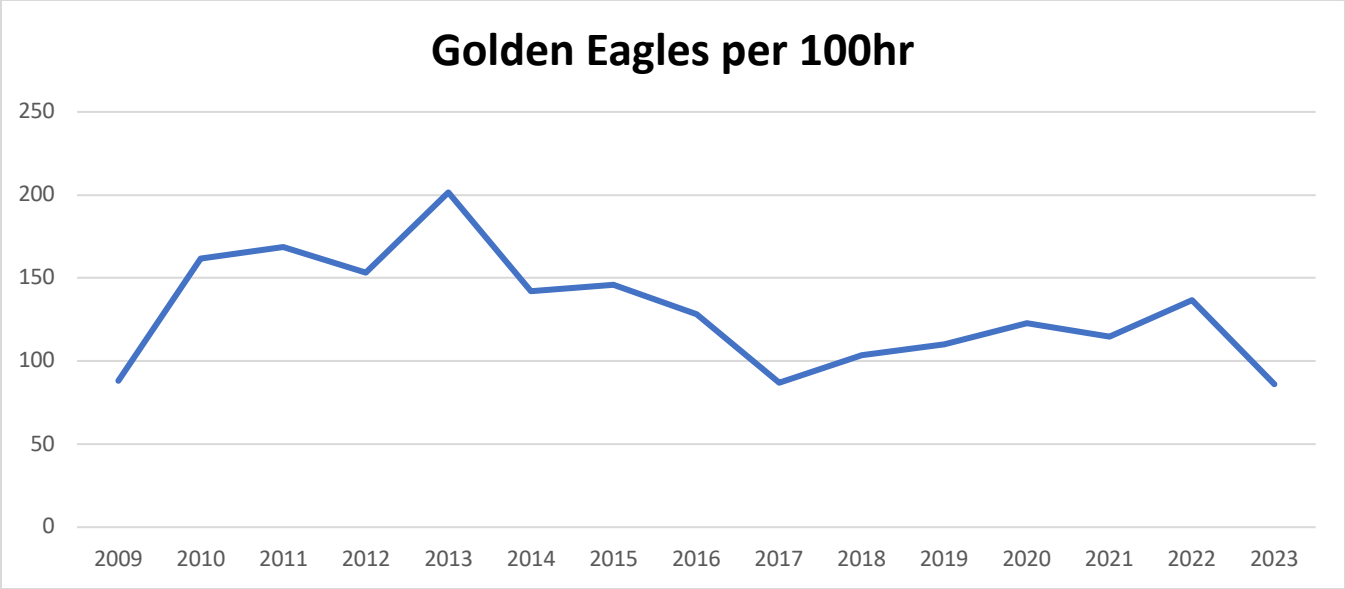

Figure 7. Abundance of Golden Eagles reported at the Jewel Basin Hawk Watch site, corrected for effort (birds/100hr), 2008-2023.

American Kestrel. 2023 Total: 104 (35/100hr) 16-yr Average: 72 (26/100hr)

We had record numbers of American Kestrels this year, recording them on 27 surveys from 25 August through 16 October. The high count was of 15 birds on 2 September. We classified the sex of 87 (84%) of the birds; 52% were males. The ratio of 1.1 males per female was at the low end of the range we have previously recorded at the site (1.1 – 1.9).

Merlin. 2023 Total: 36 (12/100hr) 16-yr Average: 25 (9/100hr)

Our Merlin count was above average; this year we saw them during 24 surveys, the first on 25 August, and the last on 19 October. Our daily high count was four birds on 18 September. "Taiga" Merlins, the most expected subspecies, comprised the majority of the flight (25 birds). We also had recorded two (female) "Prairie" (Richardson's) Merlins, and one "Black" Merlin (the Pacific Northwest subspecies)

Peregrine Falcon. 2023 Total: 14 (5/100hr). 16-yr Average: 13 (4/100hr)

Peregrines were seen on eleven surveys. The first was 7 September, and the last was 21 October; we had a peak count of three birds on 25 September. Eight of the 13 birds classified to age were adults.

Prairie Falcon. 2023 Total: 13 (4/100hr) 16-yr Average: 12 (4/100hr)

Prairie Falcon data were typical of previous years at the site, with scattered individuals recorded throughout most of the season. This year we saw them on eleven surveys between 28 August and 19 October. Two birds were seen on each of the surveys of 28 August and 5 October.

Gyrfalcon. 2023 Total: 0 16-yr Average: <1 (<1/100hr)

For the 14th time over 16 seasons no Gyrfalcons were recorded at the Jewel Basin Hawk Watch site in 2023. We only expect sporadic individuals of this rare winter visitor in those seasons when we can sample into early or mid-November. Our two previous records (in 2012 and 2016) were both during the first week of that month.

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, often enhanced by their approach to our owl decoy (see photo by Joshua Covill). This year we identified 98% (3,073) of all birds to species, including 99% (2,264) of all accipiters, 96% (252) of all buteos, 99% (317) of all eagles, and 95% (167) of all falcons. We recorded age class of 92% (2,626) of all raptors, and sex of 45% 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. 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. Our hope is that these data can be looked at in combination with data from other migration sites across the West to clarify whether age ratios indicate any long-term trends in productivity.

Passage Rate. The vast majority of our 2023 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 10.5 birds/hr was slightly above our long-term average of 9.4 birds/hr over the history of our survey (Table 1).

Discussion. Our 16 years of season-long data continue to 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 (or more) 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 2,264 (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. As we prepared this year's report, we were approached by HMANA to include our data set in in their Raptor Population Index efforts to identify regional and continental trends. We are excited to perhaps see the realization of our local effort contributing to continental trend analysis.

We have now counted 43,167 raptors of 18 species since beginning our pilot efforts in 2007. As arbitrary as it might be, our observers have come to consider 100-bird days as "great day on the ridge". Those are the days that keep our primary counters and our many volunteer observers excited about future visits. This year we averaged 67 birds per survey, with twelve days >100. Our best day (16 September) totaled 160 birds, making this just the sixth year in 16 where we did not have a day with >200 birds counted. But of course, we measure success not only by the number of birds we count, but also by the level of participation we are experiencing. With no fewer than 67 people involved in observations this year, we are clearly succeeding in engaging the public. This is perhaps the greatest benefit of continuing this project into the future, as long-term data, in combination with an engaged public, should enhance conservation decisions and actions moving forward.

Future Survey Recommendations. Our recommendations have varied little over the recent years of our survey effort. 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 counters. Recent years have shown that contingencies often mean missed coverage as we move into the colder and potentially snowy days of October. 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 and may again need to split responsibilities between two paid counters.

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 of our most common species occurs between 15 Sep and 15 Oct (Figure 8), and if funds or volunteers ever become limited, this time period should be the focus of survey efforts. Interestingly, though, this year just 56% of the raptors were recorded during that period.

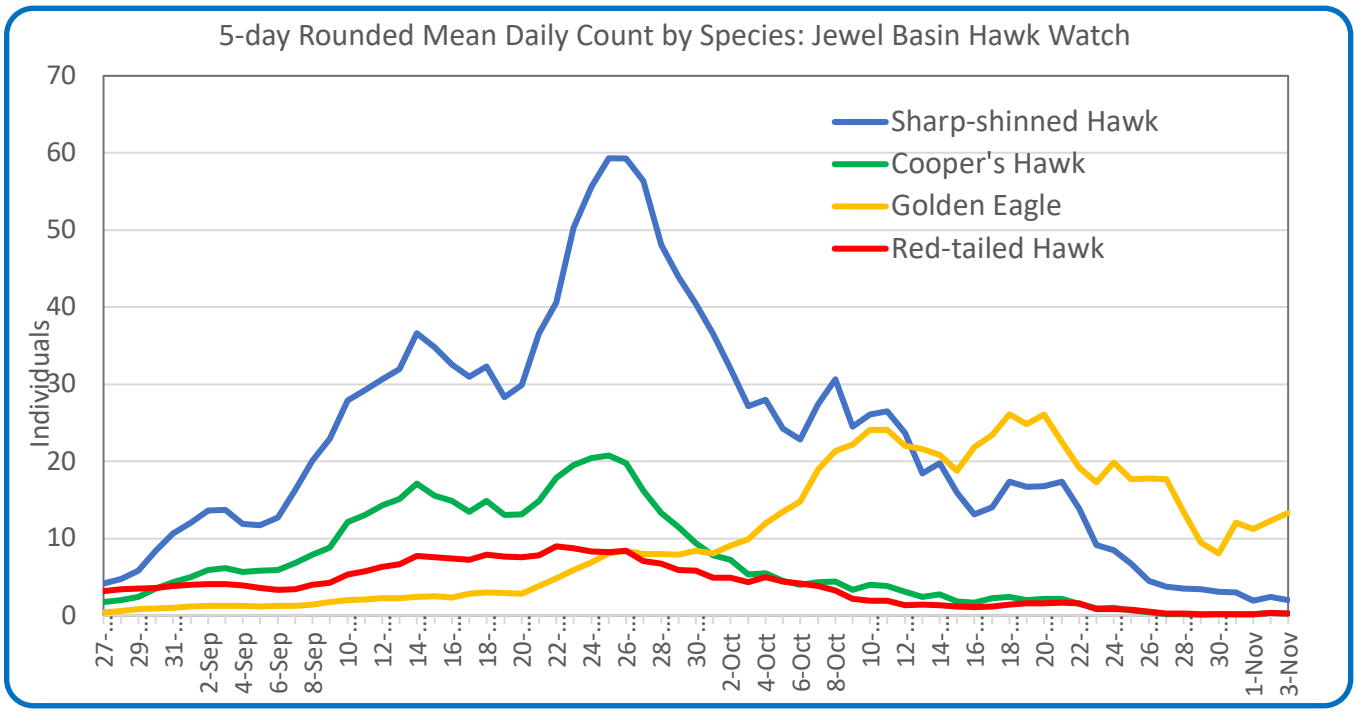

Figure 8. Five-day rounded mean daily count totals for the four most common raptor species at the Jewel Basin Hawk Watch, 2008-2019.

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 52 (69%) of the 75-day survey period had weather suitable for surveys, and we conducted surveys on 49 (94%) of those days (Table 2). We have never surveyed on fewer than 76% of the suitable days since we began tracking this statistic..

Table 2. Seasonal survey effort, Jewel Basin Hawk Watch, 2011-2023. 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 (69 in 2023).

Year(s):	2011 - 2015	2016	2017	2018	2019	2020	2021	2022	2023
Suitable Days: Season (N=75)	67 - 77%	64%	57%	79%	49%	60%	77%	69%	77%
Suitable Days: Surveyed	87 - 94%	79%	98%	76%	97%	91%	86%	94%	81%
Window Days Surveyed (N=49-81)	61 - 78%	49%	66%	75%	68%	79%	68%	89%	68%
Window Days Bad Weather	15 - 23%	33%	22%	5%	26%	12%	21%	9%	17%
Window Days No Access	5 - 9%	17%	2%	20%	2%	8%	0%	0%	10%
Window Days Suitable No Survey	0 - 5%	0%	11%	0%	4%	2%	11%	<1%	4%
Window Days No Data	0 - 8%	0%	0%	0%	0%	0%	0%	0%	0%

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 69 days (25 August – 1 November) and we completed surveys on 47 (68%) of those days, including all but three days with suitable weather and safe access. Extreme weather and dangerous access negated any surveys after 1 November. See Appendix B for a summary of those days (and reasons) that surveys were not conducted. 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.

Flathead Audubon continues to offer field trips and one on one training for individuals interested or with experience in raptor observations. We have had 39 people serve as primary counters 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 ten who have served as primary observers 10 or more (10-132) 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 counters in the past and we hope and 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, American 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. Soon our long-term data will be used as part of the HMANA Raptor Population Index effort describing population status and trends at broader scales. 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 2008-2023 survey efforts. We have also 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. For 2023, we are already in discussion with Wild Montana about providing training and educational materials relative to raptors in general and to this survey effort.

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 years.

There are a few other components we continue to feel could be added to the Jewel Basin Hawk Watch to improve coverage, attract observers, and improve safety in 2024 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 2023 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. (We experimented with this in 2023).
- 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 whatever software will be used in replacement of Dunkadoo in future years.

References

Casey, D. et al. 2008. Raptor migration monitoring in the Jewel Basin. Autumn 2008 – Annual Report. Rept. to Plum Creek Foundation. American Bird Conservancy, Kalispell, MT, and the Plains, VA. 11 p. plus appendices.

Casey, D. et al. 2009. Raptor migration monitoring in the Jewel Basin. Autumn 2009 – Annual Report. Rept. to USDA Forest Service, Flathead National Forest (Agreement #09-CS-11011000-007). American Bird Conservancy, Kalispell, MT, and The Plains, VA. 13 p. plus appendices.

Casey, D. et al. 2011. Raptor migration monitoring in the Jewel Basin. Autumn 2010 – Annual Report. Rept. to USDA Forest Service, Flathead National Forest (Agreement #09-CS-11011000-007). American Bird Conservancy, Kalispell, MT, and The Plains, VA. 12 p. plus appendices.

Casey, D. et al. 2012. Raptor migration monitoring in the Jewel Basin. Autumn 2011 – Annual Report. Rept. to USDA Forest Service, Flathead National Forest (Agreement #09-CS-11011000-007). American Bird Conservancy, Kalispell, MT, and The Plains, VA. 12 p. plus appendices.

Casey, D. et al. 2013. Raptor migration monitoring in the Jewel Basin. Autumn 2012 – Annual Report. Rept. to USDA Forest Service, Flathead National Forest (Agreement #09-CS-11011000-007). American Bird Conservancy, Kalispell, MT, and The Plains, VA. 13 p. plus appendices.

Casey, D. et al. 2014. Raptor migration monitoring in the Jewel Basin. Autumn 2013 – Annual Report. Rept. to USDA Forest Service, Flathead National Forest (Agreement #09-CS-11011000-007, Mod. 005). American Bird Conservancy, Kalispell, MT, and The Plains, VA. 13 p. plus appendices.

Casey, D. et al. 2015. Raptor migration monitoring in the Jewel Basin. Autumn 2014 – Annual Report. Rept. to USDA Forest Service, Flathead National Forest (Agreement #09-CS-11011000-007, Mod. 005). American Bird Conservancy, Kalispell, MT, and The Plains, VA. 13 p. plus appendices.

Casey, D. et al. 2016. Raptor migration monitoring in the Jewel Basin. Autumn 2015 – Annual Report. Rept. to USDA Forest Service, Flathead National Forest (Agreement #09-CS-11011000-007, Mod. 005). American Bird Conservancy, Kalispell, MT, and The Plains, VA. 13 p. plus appendices

Casey, D. et al. 2017. Raptor migration monitoring in the Jewel Basin. Autumn 2016 – Annual Report. Rept. to USDA Forest Service, Flathead National Forest (Agreement #09-CS-11011000-007, Mod. 005). American Bird Conservancy, Kalispell, MT, and The Plains, VA. 13 p. plus appendices

Casey, D., and G. Bissell. 2020. Raptor Migration Monitoring in the Jewel Basin. Autumn 2019 – Annual Report. Rept. to USDA Forest Service, Flathead National Forest (Agreement #15-CS-11011000-043). Flathead Audubon, Kalispell MT. 17p. plus appendices

Casey, D., and G. Bissell. 2021. Raptor Migration Monitoring in the Jewel Basin. Autumn 2020 – Annual Report. Rept. to USDA Forest Service, Flathead National Forest (Agreement #20-CS-11011000-026). Flathead Audubon, Kalispell MT. 17p. plus appendices

Casey, D., et al. 2022. Raptor Migration Monitoring in the Jewel Basin. Autumn 2021 – Annual Report. Rept. to USDA Forest Service, Flathead National Forest (Agreement #20-CS-11011000-026). Flathead Audubon, Kalispell MT. 16p. plus appendices

Casey, D., et al. 2023. Raptor Migration Monitoring in the Jewel Basin. Autumn 2022 – Annual Report. Rept. to USDA Forest Service, Flathead National Forest (Agreement #20-CS-11011000-026). Flathead Audubon, Kalispell MT. 17p. plus appendices

Hawk Watch International. 2008. Hawk Watch International raptor migration observer procedures and protocols manual. HWI, Salt Lake City.

Kroeger, C., and J.P. Smith. 2009. Fall 2009 raptor migration study in the Bridger Mountains, Montana. Montana Audubon, Helena, and Hawk Watch International, Salt Lake City. 26p.

Yates, R.E., B.R. McClelland, P.T. McClelland, C.H. Key, and R.E. Bennetts. 2001. The influence of weather on Golden Eagle migration in northwestern Montana. J. Raptor Res. 35(2)81-90.

APPENDIX A. Daily count data, Jewel Basin Hawk Watch, 25 August – 1 November 2023. 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	5.00	1	1	1		7	1	1				5				1	2	1	1						22	4.4
26-Aug	6.25					7	4	2				2			1	1	5			1		1			24	3.8
27-Aug	6.00				3	6	5		1			3				1	1					1			21	3.5
28-Aug	6.10		1		3	7	6			3		5				2	6	1		2					36	5.9
29-Aug	6.25				2	10				1	1	1					2	1							18	2.9
31-Aug	6.00		2	2	1	3	1	2				4				2									17	2.8
1-Sep	7.00			1	2	10	4	2		1	1	2				1	1								25	3.6
2-Sep	7.00	1			2	49	5					4	1			3	15	3		1					84	12.0
5-Sep	7.25					30	8	1				4				1									44	6.1
6-Sep	6.00		2	1	4	52	36		1	1	2	9					7	2		1					118	19.7
7-Sep	7.00				2	38	29		1	3		2	1						1						77	11.0
8-Sep	4.00				1	5	9																		15	3.8
9-Sep	7.00			1	5	32	8		2		1	7			3		7			1					67	9.6
10-Sep	6.50		1		3	26	14			1						1	1	2							49	7.5
11-Sep	7.00		1		5	29	12			2		4					5		1						59	8.4
13-Sep	7.00				1	23	11	2	1			8			1	1	1	1							50	7.1
14-Sep	6.00		1			25	13	1	1	8		14			1	4	2	1							71	11.8
15-Sep	7.10		1	1	1	80	32	1	5	7		9				2	7							1	147	20.7
16-Sep	7.40		1		2	82	46	1	1	15		6			1		1	2	2						160	21.6
17-Sep	6.50	2			2	80	26		3			5				1	4	1		1		1			126	19.4
18-Sep	6.80		2	1	2	81	31	4	1	4		1			1	7	5	4	1	1					146	21.5
19-Sep	6.20			2	1	65	16		1	8		3				3	5		1						105	16.9
20-Sep	7.25	1			4	18	4					1				2	4	1							35	4.8
23-Sep	7.00			2	1	40	4					1				1		1							50	7.1
24-Sep	7.00			1	1	31	10				2					6	1	1							53	7.6
25-Sep	7.25		**4**		4	78	26	1	2	4		6				4	8		3						140	19.3
26-Sep	6.00		1	2		61	22	1		1		2				1		1	1						93	15.5
27-Sep	3.20					9	1										3								13	4.1
29-Sep	4.00					13						1				6	1	1							22	5.5

APPENDIX A (cont'). Daily count data, Jewel Basin Hawk Watch, 25 August – 1 November 2023. 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
2-Oct	3.25				1	2	1									3									7	2.2
4-Oct	2.50		1	2	1	9	1			1		1				1									17	6.8
5-Oct	8.00			4	7	86	5	2				12				13	2	2		2				1	136	17.0
6-Oct	6.50			2	5	34	13	1				3		1	1	18	2		1						81	12.5
7-Oct	6.80			1	2	55	9	2	3			5				8								1	86	12.6
8-Oct	7.70			1	1	89	21	2	1			7				4	5	1							132	17.1
9-Oct	6.50			3		91	23	1				3		1		7			1			2	1		133	20.5
13-Oct	6.50			4		36						3				5									48	7.4
14-Oct	6.75				2	12	2									2		1		1					20	3.0
15-Oct	6.00			1		23	4	1				1				9									39	6.5
16-Oct	6.50			2	1	55	16	1				1		1		21	1	2		1		3		2	107	16.5
18-Oct	7.50			4		12	1	1	1			1		2		9		1							32	4.3
19-Oct	7.50			1	1	68	3	1	1			1		2		15		2		1					96	12.8
20-Oct	8.00			9	4	95						4		8	1	27		2					1		151	18.9
21-Oct	8.00			5	3	36	5	2	4			3		8		11		1	1					1	80	10.0
30-Oct	6.10			1												26									27	4.4
31-Oct	5.90			4		2		1	2			1		2		14									26	4.4
1-Nov	5.50			1	1	8						2		1		13									26	4.7
Totals	**298.6**	**5**	**19**	**60**	**81**	**1,710**	**488**	**34**	**32**	**60**	**7**	**157**	**2**	**26**	**10**	**257**	**104**	**36**	**14**	**13**	**0**	**8**	**2**	**6**	**3,131**	**10.5**

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
30 Aug	**Weather** conditions unsuitable for survey (rain, fog, low clouds)
3 Sep	**Weather** conditions unsuitable for survey (rain, fog, low clouds)
4 Sep	**Weather** conditions unsuitable for survey (rain, fog, low clouds)
12 Sep	Conditions suitable for survey, but **access** not available (road grading)
21 Sep	Conditions suitable for survey, but **access** not available (windthrown trees on road)
22 Sep	**Weather** conditions unsuitable for survey (rain/snow, fog, low clouds)
28 Sep	**Weather** conditions unsuitable for survey (rain/snow, fog, low clouds)
30 Sep	**Weather** conditions unsuitable for survey (rain/snow, fog, low clouds)
1 Oct	**Weather** conditions unsuitable for survey (rain/snow, fog, low clouds)
3 Oct	**Weather** conditions unsuitable for survey (rain/snow, fog, low clouds)
10 Oct	Conditions suitable, but bad weather was predicted and **no survey**
11 Oct	**Weather** conditions unsuitable for survey (rain/snow, fog, low clouds)
12 Oct	**Weather** conditions unsuitable for survey (rain/snow, fog, low clouds)
17 Oct	Conditions suitable, but very strong winds and **no survey**
22 Oct	Conditions suitable, but bad weather was predicted and **no survey**
23 Oct	**Weather** conditions unsuitable for survey (snow, low clouds)
24 Oct	**Weather** conditions unsuitable for survey (snow, low clouds)
25 Oct	Conditions suitable late in day, but assumed poor **access**
26 Oct	Weather marginal, but **access** to the site unsafe (road conditions)
27 Oct	Conditions suitable for survey, but **access** not available (road conditions)
28 Oct	Weather conditions unsuitable and **access** not available (icy road)
29 Oct	Conditions suitable for survey, but **access** not available (road conditions)
2-6 Nov	**Weather** conditions unsuitable for survey (snow, low clouds)
7 Nov	**Access** to the site no longer safely available due to snow and ice (end of season)