Raptor Migration Monitoring in the Jewel Basin
Autumn 2022 – Annual Report

31 March 2023

Adult Sharp-shinned Hawk (bj Worth photo)

A Report to:

USDA Forest Service: Flathead National Forest

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Flathead Audubon Society

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Executive Summary. The 2022 migration season at the Jewel Basin Hawk Watch concluded 20 October, as a dramatic shift in the weather dropped enough snow to make safe access to the site no longer possible. A season characterized by sunny skies and consistent coverage led to above average numbers across almost all species, but record numbers for none. Our final survey 20 October was the 49th survey of the season, our third highest survey effort in 15 seasons. Nine primary observers conducted 1-23 surveys each, averaging 6.6 hours and 58 birds counted (88 birds/100hr). We tallied 2,851 raptors of 17 species. Along the way we recorded our 26,000th Accipiter, our 18,000th Sharp-shinned Hawk, our 4,000th Buteo and our 1,000th American Kestrel over the history of our count. We have now counted more than 40,000 raptors at the site since 2007 (our pilot year). Our 2022 season totals exceeded our 14-yr mean counts for 15 species, with only Northern Goshawks (23) and Peregrine Falcons (10) recorded in below average numbers.

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 at least 49 people joined our primary counters as volunteer observers for at least one day. We are thankful for the 801 hours, 4110 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 (128 hr) resulted in a total in-kind donation of $25,324 to the project. Cash reimbursements our paid technician (mileage, per diem and stipend) and one other primary observer (mileage and per diem) totaled just $3,704.

Introduction. This report summarizes the 15th 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 2022 field season (25 August – 5 November) and includes data summaries for the last 15 years (plus our pilot year in 2007) Additional data and photos may be requested from Flathead Audubon through Dan Casey. Data from the last six survey years are also stored by the Hawk Migration Association of North America (HMANA), at www.Hawkcount.org.

Flathead Audubon contracted with an experienced technician for the third consecutive year to complete up to 30 raptor survey days, depending on weather, during the 2022 field season. We relied on our growing cadre of experienced volunteers to survey on intervening days. Flathead Audubon provided Joshua a daily stipend and reimbursement for personal car mileage and per diem primary counter this season. We also made per diem and mileage reimbursement available as an option to those volunteers who also served as primary counters, but just one of eight took advantage of that opportunity. 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 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.

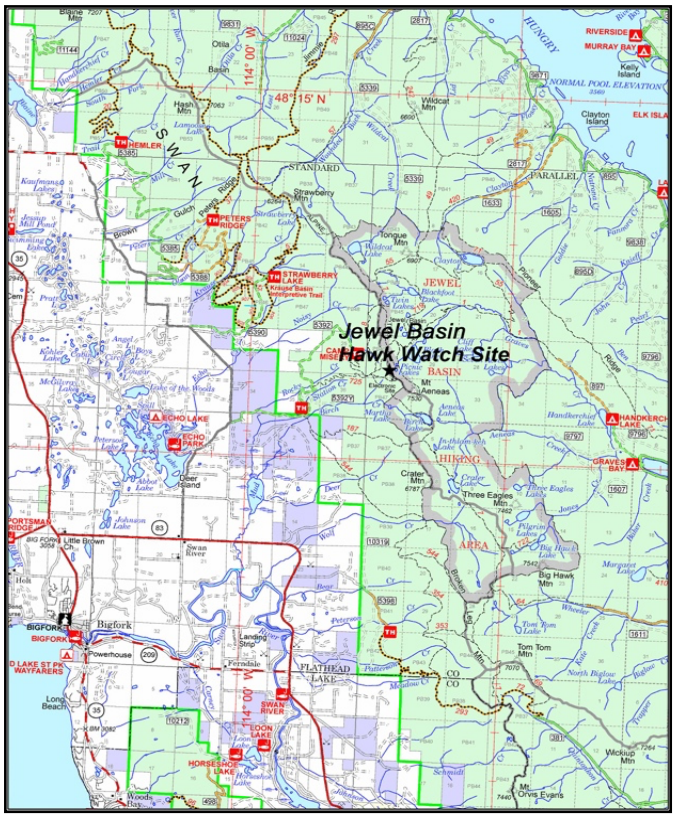

Figure 1. Location of the Jewel Basin Hawk Watch site, Flathead Co., Montana, northwest of Mt. Aeneas, Jewel Basin Hiking Area, Flathead National Forest (48.1552°N, -113.93294°W).

This year, the following eight individuals served as primary counters in addition to our paid technician: Jake Bramante, Nicki Broesel, Dan Casey, Bridger Donaldson, Diane Lundgren, Beth Mendelsohn, Denny Olson, and bj Worth. They committed a total of 274.75 hours (counting travel time) over 26 successful days of observation at the Jewel Basin observation site. Joshua Covill once again served as the contracted primary counter and was reimbursed $3,344 for the other 23 survey days. These primary counters were also joined at least 49 additional volunteers to serve as extra observers on one or more days. These secondary observers donated another 959.5 hr in observation and travel time. Flathead Audubon also provided an additional 128 hr of administration time for training, financials, and coordination. All in all, these amounted to $18,292.50 in hourly donations, $2,260.50 in mileage donations, and $1,571 in per diem donations for a total of $25,324 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 27 August, and our "survey window" closed after our last count on 20 October, 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 two 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 2.0 to 8.6 (average 6.6) hours per survey, totaling 325.1 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). This was the seventh 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 2022 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 2,851 raptors for 2022 (Table 1) was slightly above our average for the previous 14 years of full-season surveys at the site. Our season-long passage rate of 8.8 birds per hour was below our long-term average (9.4 birds/hr). We did however record slightly 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 176 birds (22/hr) occurred 27 September, the typical seasonal peak. This year 28% of our season total passed the site 24-28 September. Complete daily survey results for the 2022 season, by species, are included in Appendix A.

Species Accounts. Accipiters (Sharp-shinned Hawk, Cooper's Hawk and Northern Goshawk) again comprised the majority of the raptor flight (64%) with 1,810 birds counted. Eagles comprised 18 % of the birds recorded, buteos 12%, and falcons 4% (Figure 2). The brief species accounts that follow describe the extent and nature of the migration data we collected in 2022, with comparisons to (and updated summaries of) our data from 15 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. 2022 Total: 5 (2/100hr) 15-yr Average: 3 (1/100hr)

It was a typical year for vultures at our site; apart from a few local flybys at the beginning of the season, we recorded just 5 migrants, with two birds 30 August, two 17 September, and a single bird 25 September. This species has never comprised any significant portion of the flight at this ridgetop site.

Osprey. 2022 Total: 8 (2/100hr) 15-yr Average: 8 (3/100hr)

It was an average 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 eight days all between 4 September and 4 October.

Bald Eagle. 2022 Total: 71 (22/100hr) 15-yr Average: 59 (22/100hr)

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 slightly above average numbers this year, and recorded them throughout the season, from 28 August to 20 October, with high counts of six on 10 and 12 Otober. We were able to classify100% of the 71 birds to age class, with 48% adults, 25% immatures (1-2 yr olds) and 27% subadults (3-5 yr olds). Although Bald Eagles seem to be doing well across their range, our observed ratio of non-adults to adults (108/100 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, 2022, with updated minimum, maximum and mean season totals 2008-2022. 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	15-yr Minimum	15-yr Maximum	15-yr Mean	2022 Total	All-time Total
Turkey Vulture	0	7	3	5	41
Osprey	4	19	8	8	121
Bald Eagle	25	107	59	71	898
Northern Harrier	13	102	45	48	678
Sharp-shinned Hawk	687	2,490	1,250	1,333	18,876
Cooper's Hawk	215	603	388	392	5,850
Northern Goshawk	24	62	36	23	540
Unidentified Accipiter	32	93	56	62	862
Broad-winged Hawk	2	57	21	47	313
Swainson's Hawk	0	7	2	4	25
Red-tailed Hawk	136	328	214	234	3,238
Ferruginous Hawk	0	4	1	2	13
Rough-legged Hawk	1	41	21	27	309
Unidentified Buteo	8	22	16	13	237
Golden Eagle	212	600	386	444	5,832
American Kestrel	35	100	70	78	1,054
Merlin	9	66	25	25	371
Peregrine Falcon	3	24	13	10	188
Prairie Falcon	1	27	11	12	174
Gyrfalcon	0	1	0	0	2
Unidentified Falcon	1	14	5	0	76
Unidentified Eagle	0	6	3	3	31
Unidentified Raptor	8	46	20	10	307
TOTAL	1,638	4,418	2,651	2,851	40,036
Survey Days	36	52	44	49	672
Effort: In hours	226.0	339.0	280.0	325.1	4,210
Passage Rate (per hr)	6.3	13.4	9.4	13.4	9.5
Total Species	15	17	16	17	18

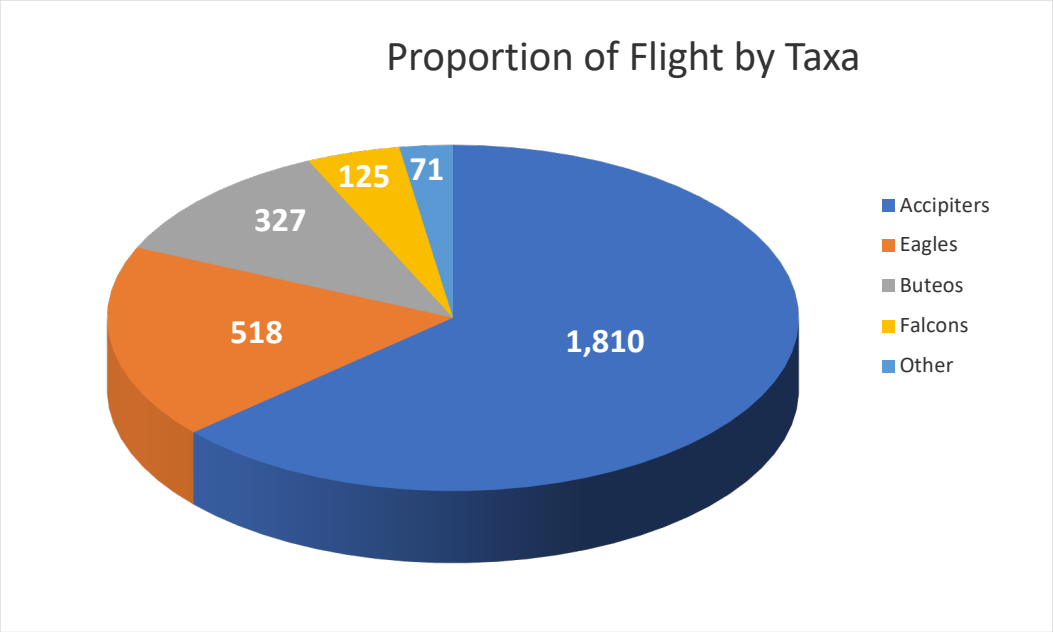

Figure 2. Composition of observed hawk migration at the Jewel Basin Hawk Watch site, fall 2022, by category. Numbers are total counts for the season.

Northern Harrier. 2022 Total: 48 (15/100hr) 15-yr Average: 45 (16/100hr)

Harriers were recorded at slightly above-average totals, and once again we were able to classify a large percentage of the birds to age class (92%). Just 11 of the 48 were adults, and of those, just 2 were males. Most of the flight, 33 birds (75%), were immatures, yielding a ratio of 300/100ad. We recorded harriers on more than half of our surveys (27, or 55%), including both our first (27 August) and last (20 October) surveys of the year. At least one local immature bird was seen near the survey site throughout much of the survey season.

Sharp-shinned Hawk. 2022 Total: 1,333 (410/100hr) 15-yr Average: 1,250 (445/100hr)

We 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 this year, as we counted 1,333 (47% of the 2,851 birds counted!). They were recorded on all but two of our 49 surveys, with a high count of 110 on 27 September, but our corrected passage rate (410/hr) was well below last year'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 74/100ad, below our long-term average (104/100ad) for the third consecutive year (Figure 4).

Cooper's Hawk. 2022 Total: 392 (121/100hr) 15-yr Average: 388(139/100hr)

Cooper's Hawk is typically the third-most abundant migrant at our site, and such was the case this year, as we counted 392 birds on 38 surveys between 28 August and 15 October. Our high count was 30 birds on 25 September. Adjusted Cooper's Hawk numbers have fluctuated somewhat less dramatically than Sharp-shinned Hawks at our site (Figure 5), and were somewhat below average this year at 121/100hr. Like Sharp-shinned, the observed ratio of immatures to adults was below average (138/100ad) for the third 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 able to classify 91% of the passing Cooper's Hawks to age class.

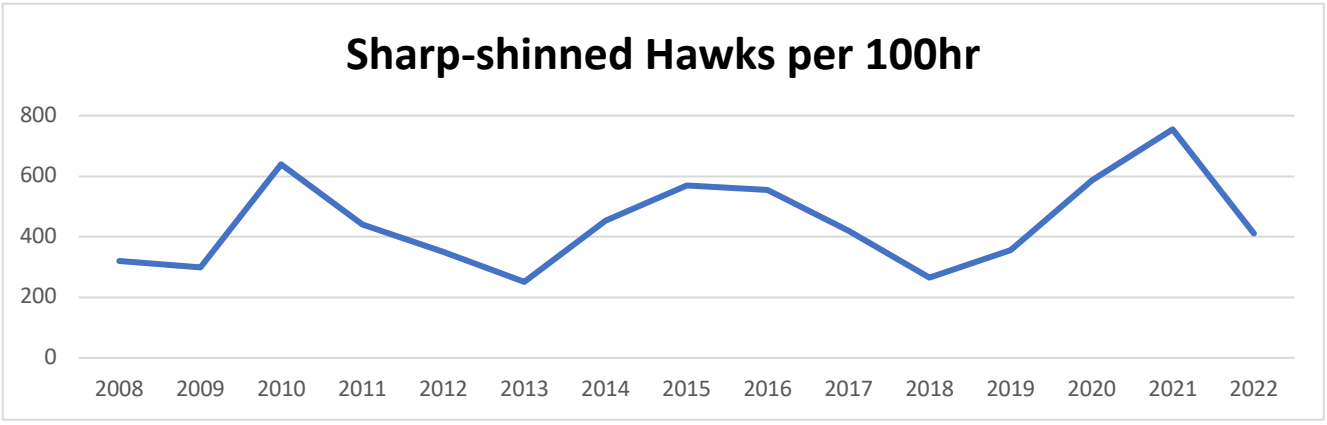

Figure 3. Abundance of Sharp-shinned Hawks reported at the Jewel Basin Hawk Watch site, corrected for effort (birds/100hr), 2008-2022.

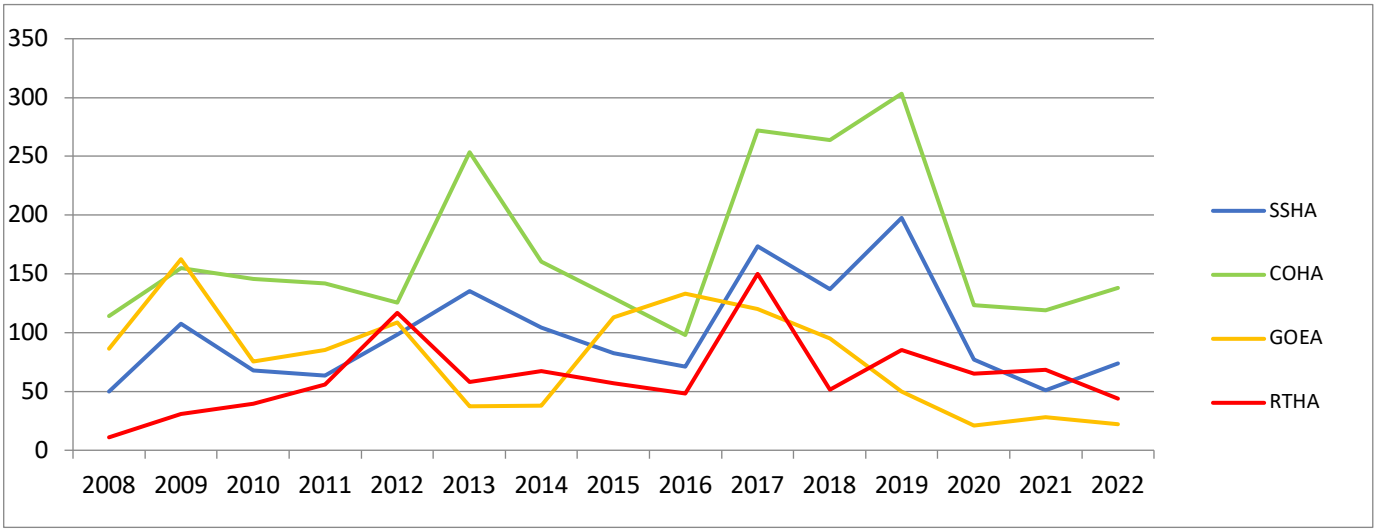

Figure 4. Ratios of immatures per 100/adults counted at the Jewel Basin Hawk Watch, 2008 – 2022, for the four most common species surveyed. SSHA = Sharp-shinned Hawk; COHA = Cooper's Hawk; GOEA = Golden Eagle; RTHA = Red-tailed Hawk

Northern Goshawk. 2022 Total: 23 (7/100hr) 15-yr Average: 36 (13/100hr)

We recorded goshawks at essentially half the usual relative abundance, with just 7/100hr, perhaps in part because we had yet another fall season when snows in mid-October cut our surveys short. We saw them on 8 (44%) of our October surveys, and just 9 (35%) of our September surveys. At least one local immature Northern Goshawk was present in the area throughout the season; hopefully we were judicious enough in our sampling protocols to keep it from inflating our observed age ratio (200/100ad) for this species. This ratio was nevertheless well below our previous age ratio estimates which have averaged over 400/100ad. This ratio is also almost certainly inflated by not being able to survey later into most seasons, when the ratios of adults in the flight increases. The relatively early end of our season may also account for the fact that this was one of only two species counted in below average numbers this year. But our high daily count of 5 birds on 7 September was our earliest seasonal peak count to date.

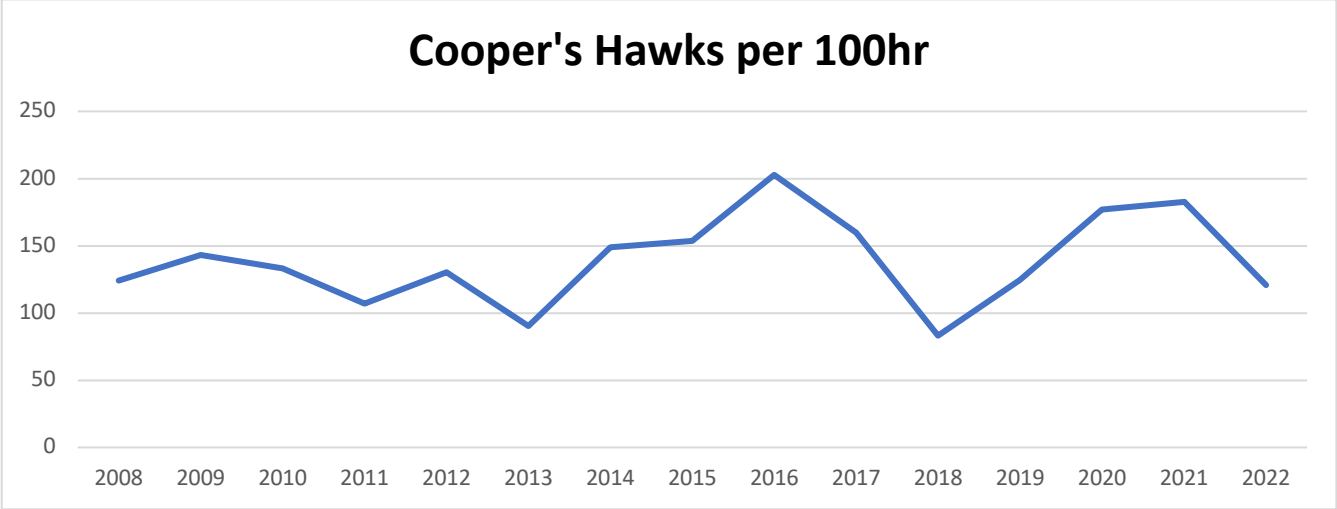

Figure 5. Abundance of Cooper's Hawks reported at the Jewel Basin Hawk Watch site, corrected for effort (birds/100hr), 2008-2022.

Broad-winged Hawk. 2022 Total: 47 (14/100hr) 15-yr Average: 21 (7/100hr)

We have now seen 313 Broad-winged Hawks over the 15 years of full-season surveys (Table 1), with our second-highest single-season total of 47 seen this year. They were counted on 14 surveys, with peak daily counts of 13 birds on both 20 September and 24 September. One seen on 15 October was a new record late date for the species at this site. We classified 85% to age class; 48% were adult. Just three dark morph individuals were seen.

Swainson's Hawk. 2022 Total: 4 (1/100hr) 15-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 single individuals were seen on four surveys, the first on 5 September, and the last on 21 September.

Red-tailed Hawk. 2022 Total: 234 (72/100hr) 15-yr Average: 214(76/100hr)

We recorded Red-tailed Hawks on all but five of our 2022 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 second consecutive year that our corrected abundance (72/100hr) was down from the 2020 peak (Figure 6). Our peak daily count of 34 birds on 3 October was the latest seasonal peak count we have recorded for the species at this site We were able to assign an age class to 219 individuals (94%), with an observed ratio of 44/100 ad, well below average, and the lowest age ratio we have seen since 2010 (Figure 4). Dark morph birds (34) comprised 15% of the 223 individuals we classified to color morph (95%).

Ferruginous Hawk. 2022 Total: 2 (<1/100hr) 15-yr Average: 1 (<1/100hr)

We have now recorded just 13 individuals of this species over the history of the count (Table 1). This year single birds were seen, 14 September and 12 October.

Rough-legged Hawk. 2022 Total: 27(8/100hr) 15-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 our surveys continue into November. This year, we had above-average

numbers nevertheless (Table 1), all between 3 October and 19 October, with a peak count of 5 on the latter date. Seven individuals were dark morphs (Figure 7), and seven of 12 adult birds we classified appeared to be males.

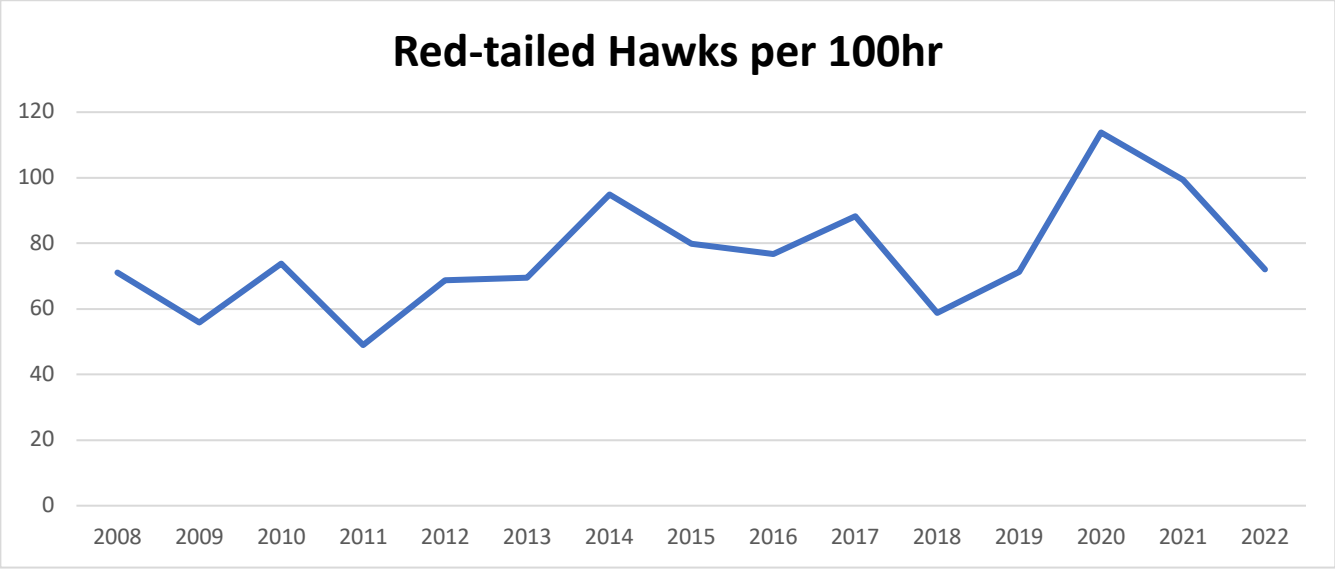

Figure 6. Abundance of Red-tailed Hawks reported at the Jewel Basin Hawk Watch site, corrected for effort (birds/100hr), 2008-2022.

Figure 7. Adult (likely male) dark morph Rough-legged Hawk, Jewel Basin Hawk Watch, fall 2022. (Joshua Covill photo)

Golden Eagle. 2022 Total: 444 (137 per 100 survey hours) 15-yr Average: 386 (137/100hr)

A family of local Golden Eagles was present in the survey area throughout the season, but were typically easy to identify as such based on their flight patterns. The first migrant was counted 6 September, and they were seen on all but two surveys thereafter. Peak migration was during the first two weeks of October, with a high count of 68

on 12 October. This is typically our second-most abundant species, and the 444 (137/100hr) counted matched our long-term average count (Figure 8), and represented our fifth year of increasing numbers even though we were unable to survey beyond 20 October. Past years have shown that the eagle flight can continue well into November. We classified 94% of the Golden Eagles to age class; 67% were adults. This marked the third consecutive year of well below-average numbers of immatures (22/100ad) in the flight (Figure 4). Immatures were classified by the characteristic white "windows" in the primary bases and tail feathers (Figure 9).

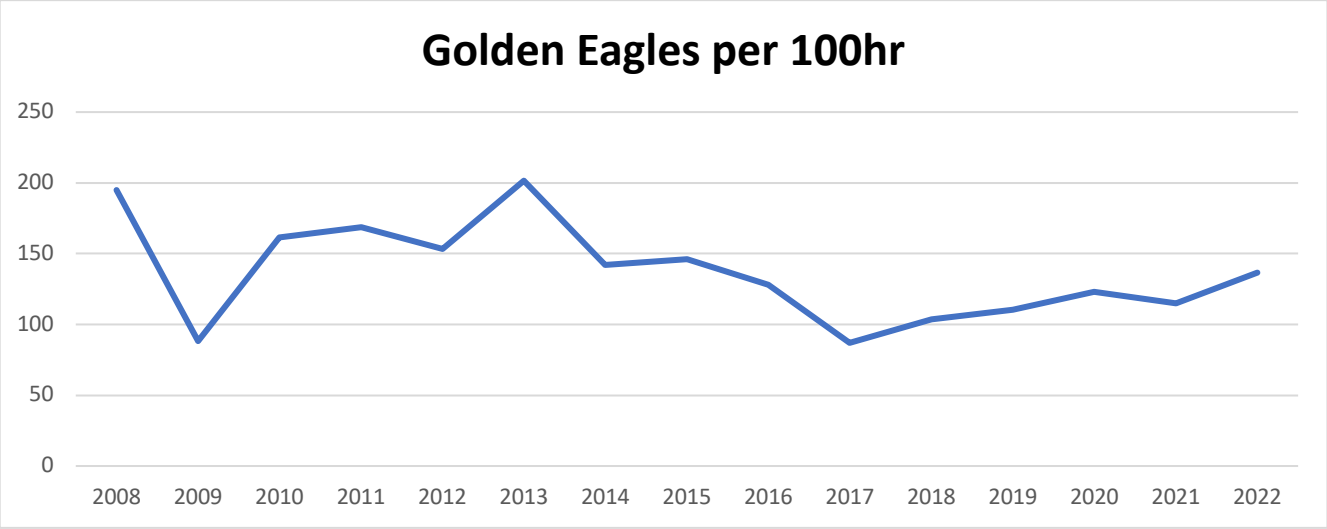

Figure 8. Abundance of Golden Eagles reported at the Jewel Basin Hawk Watch site, corrected for effort (birds/100hr), 2008-2022.

Figure 9. Immature Golden Eagle passing the Jewel Basin Hawk Watch, showing the characteristic wing and tail patches used to identify this age class (bj Worth photo).

American Kestrel. 2022 Total: 78 (24/100hr) 15-yr Average: 70 (25/100hr)

We had slightly above average numbers of American Kestrels this year, although when corrected for effort, the count was slightly below average. We recorded them on 30 surveys, from 27 August through 15 October, with high counts of six birds on 1 September and 6 October. We classified the sex of 65 (83%) of the birds; 54% were males. The ratio of 1.2 males per female fell within the range we have previously recorded at the site (1.1 – 1.9).

Merlin. 2022 Total: 25 (8/100hr) 15-yr Average: 25 (9/100hr)

Our Merlin count was about average, following the exceptionally high count of 2021. This year we saw them during 19 surveys, the first on 28 August, and the last on 15 October. Our daily high count was four birds on 20 September. Sixteen were identified as "Taiga" Merlins, the most expected subspecies; we also had four "Prairie" (Richardson's) Merlins, three of which were females (this race being the only one easily classified to sex).

Peregrine Falcon. 2022 Total: 10 (3/100 survey hours). 15-yr Average: 13 (4/100hr)

One of only two species seen in below-average numbers this year, Peregrines were seen on nine surveys. The first was 7 September, and the last was 12 October; we had a peak count of just two birds on 3 Octobers. Eight of the nine birds classified to age were adults.

Prairie Falcon. 2022 Total: 12 (4/100hr) 15-yr Average: 11 (4/100hr)

Another large falcon species seen on just nine surveys, Prairie Falcons were seen from 5 September through 18 October, with two birds seen on each of three surveys, the latest being 15 October (a new late seasonal high count for our site).

Gyrfalcon. 2022 Total: 0 15-yr Average: <1 (<1/100hr)

For the 13th time over 15 seasons at our site, no Gyrfalcons were recorded at the Jewel Basin Hawk Watch site in 2022. We only expect sporadic individuals of this rare winter visitor in those seasons when we are able to 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 (Figure 10). This year we identified 97% (2,764) of all birds to species, including 97% (1,749) of all accipiters, 96% (314) of all buteos, 99% (515) of all eagles, and 100% (125) of all falcons. We recorded age class of 85% (2,421) of all raptors, and sex of 51% 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 2017, 2019, 2020, and again this year. We therefore may have overestimated the proportion of first year birds in the flight for early migrant species (e.g. Sharp-shinned and Cooper's Hawks). Interestingly, both of those species showed decreased numbers of immatures in the flight, in spite of that potential bias. 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.

Figure 10. Immature Cooper's Hawk (left) and Adult Sharp-shinned Hawk (right) passing close at the Jewel Basin Hawk Watch, allowing identification to both species and age class (photos not to scale) (bj Worth photos).

Passage Rate. The vast majority of our 2022 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 8.8 birds/hr was slightly below our long-term average; we have now averaged 9.4 birds/hr over the history of our survey (Table 1).

Discussion. Our 15 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 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 1,810 (64%) 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.

We have now counted 40,036 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 58 birds per survey, with seven days >100. Our best day (27 September) totaled 176 birds, making this just the third year in the last ten where we did not have a day with >200 birds counted. We should measure success not onlyby the number of birds we count, but also by the level of participation we are experiencing. With no fewer than 58 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. 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 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 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 78% 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 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.

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 55 days (27 August – 20 October) and we completed surveys on 49 (89%) of those days, including all but two days with suitable weather. Extreme weather and dangerous access negated any surveys after 20 October. 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.

Table 2. Seasonal survey effort, Jewel Basin Hawk Watch, 2011-2022. 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 (55 in 2022).

Year(s):	2011 - 2015	2016	2017	2018	2019	2020	2021	2022
Suitable Days: Season (N=75)	67 - 77%	64%	57%	79%	49%	60%	77%	69%
Suitable Days: Surveyed	87 - 94%	79%	98%	76%	97%	91%	86%	94%
Window Days Surveyed (N=49-81)	61 - 78%	49%	66%	75%	68%	79%	68%	89%
Window Days Bad Weather	15 - 23%	33%	22%	5%	26%	12%	21%	9%
Window Days No Access	5 - 9%	17%	2%	20%	2%	8%	0%	0%
Window Days Suitable No Survey	0 - 5%	0%	11%	0%	4%	2%	11%	<1%
Window Days No Data	0 - 8%	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 38 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 nine who have served as primary observers 10 or more (14-122) 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 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 2008-2022 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 feel could be added to the Jewel Basin Hawk Watch that would improve coverage, attract observers, and improve safety in 2023 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.
- 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, 27 August – 20 October 2022. 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
27-Aug	4.50				1	2						1					1								5	1.1
28-Aug	6.20			1		4	5					5					4	1					1		21	3.4
29-Aug	2.50								1			5					1								7	2.8
30-Aug	6.00	2			1	2	1		1			5													12	2.0
31-Aug	7.00			2		13	7	1				2					6								31	4.4
1-Sep	6.00				1	4	2		1			5					1								14	2.3
2-Sep	6.00				1	8	2					1													12	2.0
3-Sep	6.00				1	9	1										1	1							13	2.2
4-Sep	6.50		1	1		12	7					6					5								32	4.9
5-Sep	6.60			2		17	7				1	8			2		2			1					40	6.1
6-Sep	6.70		1	2	2	18	13	1				15				1	3			1					57	8.5
7-Sep	6.00			1		18	8	5	1							3	2		1						39	6.5
8-Sep	6.00				1	5	3					1				1									11	1.8
9-Sep	6.00			1		4	5		2	1		1												2	16	2.7
10-Sep	6.00		1		1	12	5		1			2				1									23	3.8
11-Sep	6.80		1		2	10	17	2	1			3				1	5	1							49.8	6.3
13-Sep	6.60			1		38	8	1				1			1	1	1								52	7.9
14-Sep	6.00				5	36	21		1		1	8	1		1	5	1	1							81	13.5
15-Sep	6.30				2	13	5					1				2		1							24	3.8
16-Sep	5.80				3	34	25		5			9				2	2	1							81	14.0
17-Sep	6.50	**2**			2	15	9		1	1		8			1	6			1						46	7.1
18-Sep	7.25				3	25	4		1			1				3		1	1						39	5.4
19-Sep	7.75			2		31	13	1	1	2	1	3				1	3		1						59	7.6
20-Sep	6.50			**5**		43	17			13		4				6	1	4	1					1	95	14.6
21-Sep	7.40				1	33	20	1	1	1	1	3				8	4								73	9.9
24-Sep	8.60		1	3	1	71	25	1	2	13		18			3	5	3	1	1	2				1	151	17.6
25-Sep	8.30	1	1		**5**	99	30	1	2	3		9			1	15	4	1						3	175	21.1
26-Sep	8.00			2	1	59	9		10	1		4				2		2						1	91	11.4
27-Sep	8.00		1	2	3	110	29		3	4		8				8	5	2		1					176	22.0
28-Sep	7.50					80	25	1	1	1		6				4	3								121	16.1

APPENDIX A (cont'). Daily count data, Jewel Basin Hawk Watch, 27 August – 20 October 2022. 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	2.00					2																			2	1.0
1-Oct	5.75			1	1	17	4					3				8	2								36	6.3
2-Oct	7.50			1	2	44	6		2	2		9				14	1	1							82	10.9
3-Oct	7.25			3	1	75	6	1	14	3		34		1	2	12	6		2	1					161	22.2
4-Oct	7.50		1	1	3	45	14		2	1		9				19	2							1	98	13.1
5-Oct	7.30			1		34	11	1	1			7		2		17	5	1		2					82	11.2
6-Oct	6.75				1	6		1				2				7	1	2	1						21	3.1
7-Oct	7.50			1		34	8	1	3			8		1		26									82	10.9
8-Oct	7.20			2		66	8	1				5		2		10	1	1							96	13.3
9-Oct	7.50			4		25			1			2		1		27				1					61	8.1
10-Oct	7.60			**6**		40	3	1	1			2		2		55	1	1							112	14.7
11-Oct	7.50			4		6										32									42	5.6
12-Oct	7.50			6		30	3					1	1	5	1	68		1	1				2	1	120	16.0
13-Oct	7.50			3		24			1			1		2		23									54	7.2
15-Oct	6.50			3	1	7	6	**1**	1	1		2			1	14	1	1		2					41	6.3
16-Oct	6.40			1		13						1		2		4									21	3.3
18-Oct	7.25			3	1	10						1		4		5				1					25	3.4
19-Oct	7.00			3		19						1		5		7									35	5.0
20-Oct	6.25			3	1	11		**1**				3				21									40	6.4
TOTALS	325.	5	8	71	48	1333	392	23	62	47	4	234	2	27	13	###	78	25	10	12	0	0	3	10	2851	6.6

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
25 Aug	Conditions suitable for survey, no observer available
26 Aug	Weather conditions unsuitable for survey (rain, fog, low clouds and/or snow)
12 Sep	Weather conditions unsuitable for survey (rain, fog, low clouds and/or snow)
22 Sep	Weather conditions unsuitable for survey (rain, fog, low clouds and/or snow)
23 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)
14 Oct	Conditions suitable for survey, no observer available
17 Oct	Conditions suitable for survey, no observer available
21 Oct	Weather conditions unsuitable for survey (rain, fog, low clouds and/or snow)
22 Oct	Weather conditions unsuitable for survey (rain, fog, low clouds and/or snow)
23 Oct	Access to the site no longer safely available due to snow
……..	Access to the site no longer safely available due to snow
7 Nov	Access to the site no longer safely available due to snow (end of season)