FIFTH Year Report: The Effects of Prescribed Fire and Shrub-layer Mastication on Bird Communities in Ponderosa Pine Forests of the San Juan Mountains, CO

A Citizen Science Project conducted by members of the
Weminuche Audubon Society
and
Audubon Rockies

In cooperation with
The San Juan Headwaters Forest Health Partnership
and
Mountain Studies Institute

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WEMINUCHE AUDUBON SOCIETY

San Juan Headwaters FOREST HEALTH PARTNERSHIP

Mountain Studies Institute SAN JUAN MOUNTAINS COLORADO

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Abstract:
Over the past five years, volunteers from the Weminuche Audubon Society in Pagosa Springs, CO, have conducted a bird monitoring project in dry, mixed-conifer forests in southwestern Colorado, USA. Of the four sites in our study, one was subject to prescribed fire in 2019 at the start of our study (Turkey Springs, TS); one was subject to shrub-layer thinning in 2017 (Fawn Gulch, FG); and the other two sites, located on Jackson Mountain (JM and JMN), have not been subject to wildland fuel reduction treatments or logging for many decades. The newest site (JMN) is scheduled for selective logging treatments in 2024 as part of the Adaptive Silviculture for Climate Change research program. Fifteen monitoring points were established in each study site. Each monitoring point was visited between 8 and 10 times for six-minute sampling intervals between late May and mid-July in each year of the study. A total of 88 bird species have been identified, with a total of 10020 birds counted. Thirty-five bird species were observed in all years of the study, with the American Robin, Pygmy Nuthatch, and Violet-green Swallow the most common species. Nine bird species were observed at all sites in all years of the study, which in addition to those named above, included the Western Tanager, Northern Flicker, Yellow-rumped Warbler, Steller's Jay, White-breasted Nuthatch, and Hairy Woodpecker. Those species observed at all sites across all years of the study accounted for about 48% of the birds counted. The 37 most frequently observed bird species accounted for 84% of the birds counted. In this year's report, we discuss the implications of commonness vs. rarity in bird species observed; feeding behaviors of component species (most are insectivorous); and nesting behaviors, and the importance of standing dead snag trees to cavity nesting species. In addition, we found that about half of the bird species we observed (47 species) are resident to the Pagosa Springs area, with most of them documented in our local Christmas Bird Count. The remaining non-resident (migratory) bird species (41 species) include examples that disperse across the western hemisphere, with implications for the integrity of forest ecosystems in Central America and South America. We also incorporate findings of the State of the Birds reports to discuss those bird species exhibiting notable population declines.

Acknowledgments:
The data and information generated by this study is the work of many dedicated volunteers who collectively contributed more than 600 hours to the completion of this project in each of the five years of the study. Their names (in alphabetical order) are: (Note: a = 2019 participant; b = 2020 participant; c = 2021 participant; d = 2022 participant; e = 2023 participant)

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FIFTH Year Report – A Citizen Science Project:
The Effects of Prescribed Fire and Shrub-layer Mastication on Bird Communities in Ponderosa Pine Forests of the San Juan Mountains, CO

SPECIAL NOTE:
Several sections of this report are continued, with appropriate updates, from earlier year's project reports (Grover et al., 2019; 2020; 2021; 2022). Copies of these reports can be downloaded from the website for the Weminuche Audubon Society's website at http://www.weminucheaudubon.org/bird-community-monitoring/.

Each year's report has also been accompanied by a video summarizing the findings for that year. These videos may be viewed through the following links:

2019 bird monitoring project video (26 minutes) – https://youtu.be/mfBiFN0gR6A
2020 bird monitoring project video (32 minutes) – https://youtu.be/zI1QNo7qZBU
2021 bird monitoring project video (28 minutes) – https://youtu.be/7DZ8xIk-Xhk
2021 bird monitoring project video (10 minutes) - https://youtu.be/xEFBj8EjotM
2022 bird monitoring project video (33 minutes) - https://youtu.be/mwUGLwi9ah0

Introduction:
In 2019, members of the Weminuche Audubon Society (WAS - http://www.weminucheaudubon.org), partnering with Audubon Rockies (https://rockies.audubon.org), the San Juan Headwaters Forest Health Partnership (SJHFHP - http://sanjuanheadwaters.org) and its member organizations and agencies (e.g., Mountain Studies Institute - https://www.mountainstudies.org), and the United States Forest Service (USFS) Pagosa Ranger District - https://www.fs.usda.gov/detail/sanjuan/about-forest/districts/?cid=stelprdb5154746), initiated a study of how bird community species composition and structure in Ponderosa Pine forests in the San Juan Mountains of southwestern Colorado might be affected by mastication and/or prescribed fire treatments designed to reduce wildland fuel loads. The study was modified in 2022 to collect baseline information on the bird community in sites planned for inclusion in a nationwide study called Adaptive Silviculture for Climate Change (ASCC), evaluating alternative forest harvesting strategies affecting forest response to climate change (see https://www.adaptivesilviculture.org). The results from the 2023 sample season for this project are the primary focus of this report, along with comparisons to earlier years of the study; implications of our findings for managing this forest landscape; and a discussion of the implications of our findings for managing forested landscapes more broadly.

There is a vast literature detailing the consequences of livestock grazing and forest management practices on the buildup of wildland fuel loads and increased densities of woody understory growth in dry and moist mixed-conifer forests across the western United States (e.g., Baker, 2018; Block and Conner, 2016; Covington, 1994; Harrington and Sackett, 1990; Korb et. al., 2013; McWethy et. al. 2019; and Romme et. al. 2009). As evidenced by the record expanse of wildland fires in western states over the past several years, and the catastrophic consequences of these fires for residential communities located in the wildland-urban interface (WUI) (e.g., Ager et. al., 2019), moderating the buildup of wildland fuel loads is receiving much greater emphasis by managers of forested landscapes. Notably, current forest management practices emphasize various approaches to reducing wildland fuel loads, including selective harvesting and/or thinning; prescribed fires; and understory removal by mastication (i.e., mowing). These management practices have the potential to impact wildlife in affected areas, including forest bird communities (see Block and Conner, 2016; and Lowe et. al., 1978) by modifying forest composition and structure, thereby affecting habitat quality and food resources for a wide variety of species.

USFS personnel with the Pagosa Ranger District in the San Juan National Forest, in collaboration with the SJHFHP, have been proactive in implementing understory mastication and prescribed fire treatments to establish strategically defensible areas in the dry and moist mixed-conifer forests surrounding Pagosa Springs, CO. This led some local residents interested in bird conservation to wonder how fire mitigation practices implemented in these forests might affect the distribution and abundance of bird species in and around the treatment areas, resulting in a citizen science bird monitoring project initiated in 2019 (Grover et. al., 2019) that has continued with data collection in 2020 through 2023 (Grover et. al. 2020; 2021; 2021; 2022).

The ASCC project sites added to our study in 2022 have been designated for selective tree harvesting treatments in the coming year (https://www.adaptivesilviculture.org). Sites will be logged with different proportions of Ponderosa Pine, Douglas Fir, or White Fir canopy species harvested to examine how selective logging practices might affect ecosystem response to future climatic conditions that are projected to be warmer and drier than presently exist in our region. Background data on bird community composition and structure for these sites are lacking, prompting us to collect pre-treatment data that will inform future research.

As a citizen science project, this study incorporates several objectives complementary to the primary scientific question that is being investigated (i.e., the response of the bird community to wildland fuel reduction treatments).

For example, volunteers participating in this study have become better informed regarding:

- the ecology of fire and its importance to our surrounding forest ecosystems;
- how and why catastrophic wildfires have become more common and destructive;
- what agencies charged with forest management are doing to mitigate wildfire occurrence and severity; and
- why the residents living in the WUI should be interested in this issue.

Added benefits of the study include opportunities for participants to:

- improve their birding skills by learning from one another;
- gain a better understanding of how scientific field studies are conducted; and,
- strengthen the community of conservation-minded birders in our area.

We consider these complementary objectives of equal importance to addressing the primary scientific question examined in this study.

Study Areas:
Detailed descriptions of the three study areas included in this project, and methodologies for characterizing these sites – Turkey Springs (TS); Fawn Gulch (FG); and Jackson Mountain (JM) – are found in the first-year report (Grover et. al., 2019; http://www.weminucheaudubon.org/bird-community-monitoring/). All three sites sampled in 2019 through 2021are located within approximately 16 km (~10 miles) of Pagosa Springs, CO, and are comparable in elevation and slope characteristics. The original three sites differ, however, in overstory tree densities and shrub-layer characteristics, due in large part to the timing and types of fire mitigation measures aimed at reducing wildland fuel loads at TS and FG, while no such measures have been implemented for many decades at JM. The TS site was subject to prescribed fire at the outset of the 2019 sample season in early June; the FG site was subject to shrub-layer mastication treatment in 2017; while there is no record of the JM site ever having been subject to intentional management to reduce wildland fuel loads.

The Jackson Mountain North site (JMN; previously referred to as Jackson Mountain New) added in 2022 is located approximately 1.5 km (1 mile) to the north and east of the original Jackson Mountain (JM) site (Fig. 4). The JMN site is still considered a dry-mixed conifer forest (see https://www.adaptivesilviculture.org/San-Juan-National-Forest/project-site), but as it is on an east-to northeast facing slope, the site is noticeably more moist than the other three sites. For example, JMN is dominated by mature Douglas Fir, White Fir and Aspen, with Ponderosa Pine still present as an overstory species, but less dominant than observed in our other three sites. Compared to our other sites, the understory of JMN is more dense over much of the site – dominated by Gambel's Oak and other shrub species, with notably more ladder fuels and down-and-dead tree boles. As noted for the JM site, there is no evidence that the JMN site has been subject to wildland fuel reduction treatments in recent years, and there is little evidence of substantial logging as well.

Bird Community Sampling Methodology: (see also Grover et. al. 2019; 2020; 2021; 2022)
The bird community sampling design employed in this study is a modification of established methodologies used by the Bird Conservancy of the Rockies to study riparian areas in southwestern Colorado (see van Boer et. al., 2018) and other similar studies of bird community response to wildland fuel reduction treatments or wildland fires (e.g., Hurteau et al., 2008; Jentsch et al., 2008). We identified areas within each study site where three "loops" of five monitoring points each were established. Monitoring points were located at least 75 m away from forest roads, and at distances of approximately 75 m from one another (Figs. 2, 3, and 4). By arranging monitoring points in "loops",

monitoring teams would end their session closer to the starting point of their transect, minimizing "downtime" walking back to their starting point. The total area encompassed by our study loops at each site ranged from about 16 ha (~ 40 acres) at JM to about 26 ha (~ 62 acres) at FG.

The sampling protocols established in 2019 were followed in subsequent years of the study for collecting data from each loop of monitoring points as follows:

- Teams of at least two volunteers each were identified and assigned responsibility to collect data for two loops per team at a particular study site over a period of about seven weeks, beginning about the third week of May, and ending about the second week of July.
- Each team was asked to visit their assigned loops at least four times over the period of the study. In addition, each team was asked to visit 2 loops at each of the other two sites. Team members were also encouraged to visit additional sites with other teams to gain from, or contribute to the birding experience of co-participants.
- Data collection consisted of visiting each point on each assigned loop for 6 minutes, and recording and counting birds identified by sight or song during that 6-minute sampling interval.
- In 2022, teams added the use of the Merlin smartphone APP for identifying birds by song (see https://merlin.allaboutbirds.org/). One or more members of a team would activate the APP at the beginning of a sample period. At the end of the 6-minute sample session at a monitoring point, the team would review the findings of the Merlin APP with only those bird species that could be confirmed by human hearing included in our analysis.
- Only birds within approximately 35 m of a monitoring point, or halfway between points, were recorded.
- All sampling at the monitoring points was completed between the hours of 6 am and 10 am.
- Incidental bird identifications during the walk from one point to the next were recorded separately;
- Incidental bird identifications in areas separate from established study loops (i.e., at or near where vehicles were parked) were also recorded separately.

In 2023, the overall study design consisted of 3 loops at each of the 3 sites previously described – FG; JM and JMN – the TS site was not monitored in 2022 or 2023. A sufficient number of birders volunteered for the study in 2023 to assign 3 teams to each site, with one additional team "floating" across all three sites. The experience of the team members varied from accomplished birders to those self-identified as being at an intermediate or beginner skill level. Each team was led by at least one experienced birder and each site had at least one team of accomplished birders assigned. This design provided redundancy in loop coverage, and allowed for each site to be visited on a regular basis by a team of accomplished birders.

Over the course of the study, there have been more than 50 different volunteer observers involved, with about 25 observers actively participating in the study each year, and at least 11 who have participated in all four years of the study (see Acknowledgements). Table 1 summarizes the number of loop visits per site by year. In the total dataset for 2019, FG received more site visits than TS and JM. To make the data comparable across sites in that year, 4 FG site visits were selectively removed to re-balance the project dataset. The details of that process are explained in our first-year project report (Grover et. al. 2019). Greater care was exercised in subsequent years to coordinate site visits to yield a dataset that was balanced across sites in terms of number of loop visits. In the process of analyzing our 2020 dataset, we determined that 10 visits to each loop was the most efficient strategy for our study – i.e., a greater number of loop visits did not yield additional information critical to our analysis.

Table 1 also summarizes the number of observer-visits that took place at each site across the four years of this study. Observer-visits represents the summation of the number of team members per loop-visit across the time of the study each year. While we set goals for the number of team visits to each site and loop, the number of team members varied based on volunteer availability.

With the benefit of the experience from the previous four field seasons, the bird identification skills of many of our observers markedly improved. It is worth noting that across the first three years of our study, between 50% and 75% of bird identifications were by sight; the remainder being by song. In the 2022 sample season, identification by song increased to between 55% and 68% of all identifications, and in 2023, identification by song increased to between 70% and 80%. The increasing trend in identification by song reflects improved birding by song skills by team members, complemented by the use of the Merlin bird identification smartphone APP.

We conservatively estimate that each observer-visit entails a minimum of 2.5 hours of volunteer time. Add to this estimated time involved in orientation sessions; site preparation; tree sampling visits (2019 only); and data analysis and report preparation yields estimates of over 500 volunteer hours in 2019; over 900 hours in 2020; over 800 hours in 2021; and over 600 hours in 2022 and 2023.

Table 1. Summary of number of loops visited per site and total number of volunteer observers visiting each site by year. (see also Grover et. al. 2019 and 2020)

Site	Turkey Springs		Fawn Gulch*		Jackson Mountain		Jackson Mountain North	
	Loop Visits	Observer-visits	Loop Visits	Observer-visits	Loop Visits	Observer-visits	Loop Visits	Observer-visits
2019	22	44	19	42	18	42	*NA*	*NA*
2020	34	108	35	114	36	100	*NA*	*NA*
2021	31	105	31	84	30	98	*NA*	*NA*
2022	*NA*	*NA*	28	96	30	86	26	67
2023	*NA*	*NA*	30	55	30	49	30	65

* 2019 data shown for FG are re-balanced. (See Grover et. al. 2019 for detailed explanation)

Results and Discussion:

Table 2 summarizes the bird species observed for 2023 that were common to all three sites; unique to each of the three sites; or observed at two of the three sites. Of the 64 total species recorded for 2023, 27 were found at all three sites this year. Comparing sites in 2023, 50 total species were recorded at FG, with 8 species unique to that site; 48 total species were recorded at JM, with 5 species unique to that site; and 38 total species were recorded at JMN, with 6 species unique to that site.

In 2023, the number of birds counted across all three sites, totaling 2903, were fairly evenly distributed across the three sites, with 33% at FG; 37% at JM; and 30% at JMN (Tables 2 and 3). Corresponding data tables from our first through fourth-year reports are included as Appendix A to this report (see also Grover et al., 2019; 2020; 2021; and 2022).

Definitions:
Common – bird species that have been reported at more than one study site or in more than one year, including those 35 species observed in all five years of the study, or those species ranked in the top 15 species by relative abundance.
Uncommon or rare – bird species observed in small numbers, typically fewer than 10, and observed at only one or two sites or in only one or two years of the study.
Unique – bird species observed at only one site or in only one year; typically, in small numbers (fewer than 5 birds).

The cumulative relative abundance for the 27 species common to all three sites in 2023 totaled about 77% of all sightings (Table 2, calculations not shown). At FG the common bird species accounted for about 69% of the birds observed at that site; at JM 83%; and 79% at JMN.

There were several species observed in fairly high numbers in 2023 that were not among the 27 species common to all three sites (Table 2). Among them were Common Nighthawks at FG, where a nest site was observed for the third year in a row; Ruby-crowned Kinglets, which were unique to this site in both 2022 and 2023, and Williamson's Sapsucker at JMN; Cassin's Finch, Grace's Warbler, Green-tailed Towhees, Plumbeous Vireos, Western Bluebirds, and Western Wood-Pewees at FG and JM; Mourning Doves at JM; and Brown Creepers and Red-breasted Nuthatches at JMN. Ruby-crowned Kinglets were the second most abundant bird species observed at JMN, with Red-breasted Nuthatches far more abundant at JMN compared to JM – the only other site where they were observed. Other bird species found to be unique at our three study sites, or found at only two of the three sites, were typically observed in small numbers.

Notably, species unique to individual sites accounted for 5.7% of the birds counted across sites, with Common Nighthawk sitings at FG and Ruby-crowned Kinglets at JMN having the highest numbers (Table 2). The high number of Ruby-crowned Kinglets observed at JMN (105 birds) were responsible for a cumulative abundance of 14.2% for birds unique to JMN. There were several bird species counted at both FG and JM in high numbers, resulting in almost 28% of the birds counted at FG also occurring at JM, where 15.6% of the birds counted were also seen at FG.

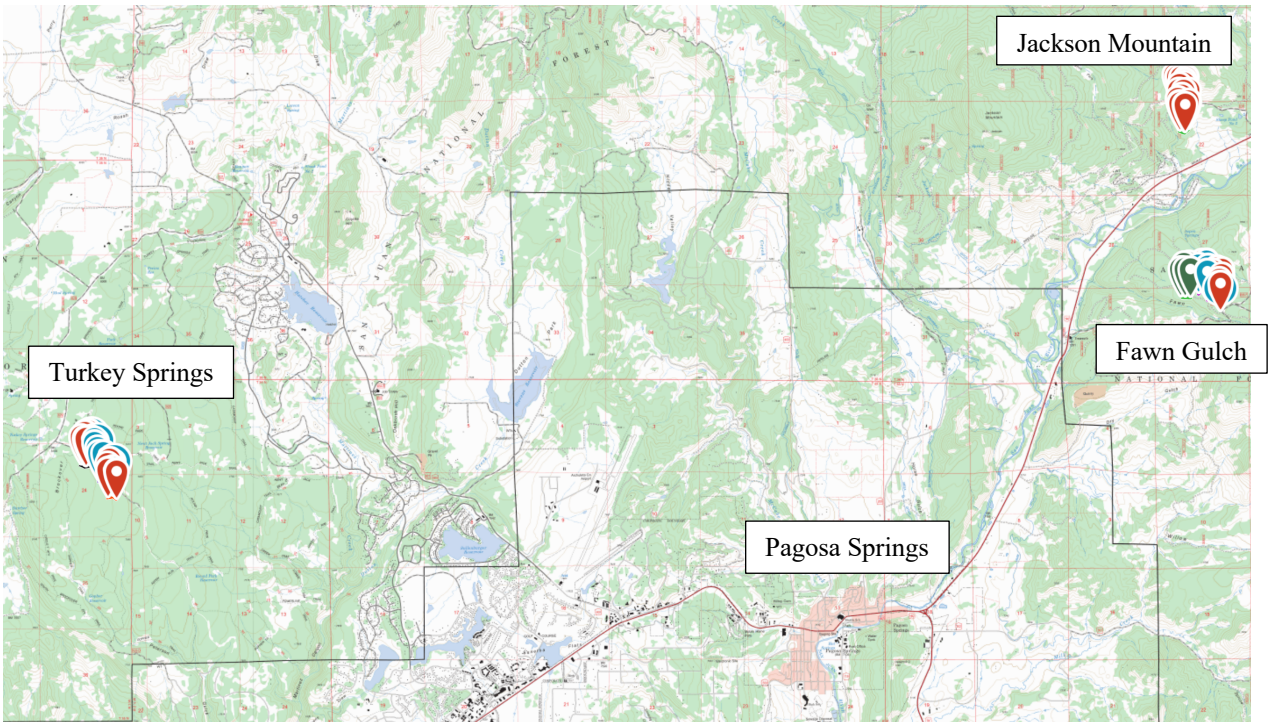


Figure 1. Map showing locations of Turkey Springs, Fawn Gulch, and Jackson Mountain study areas.

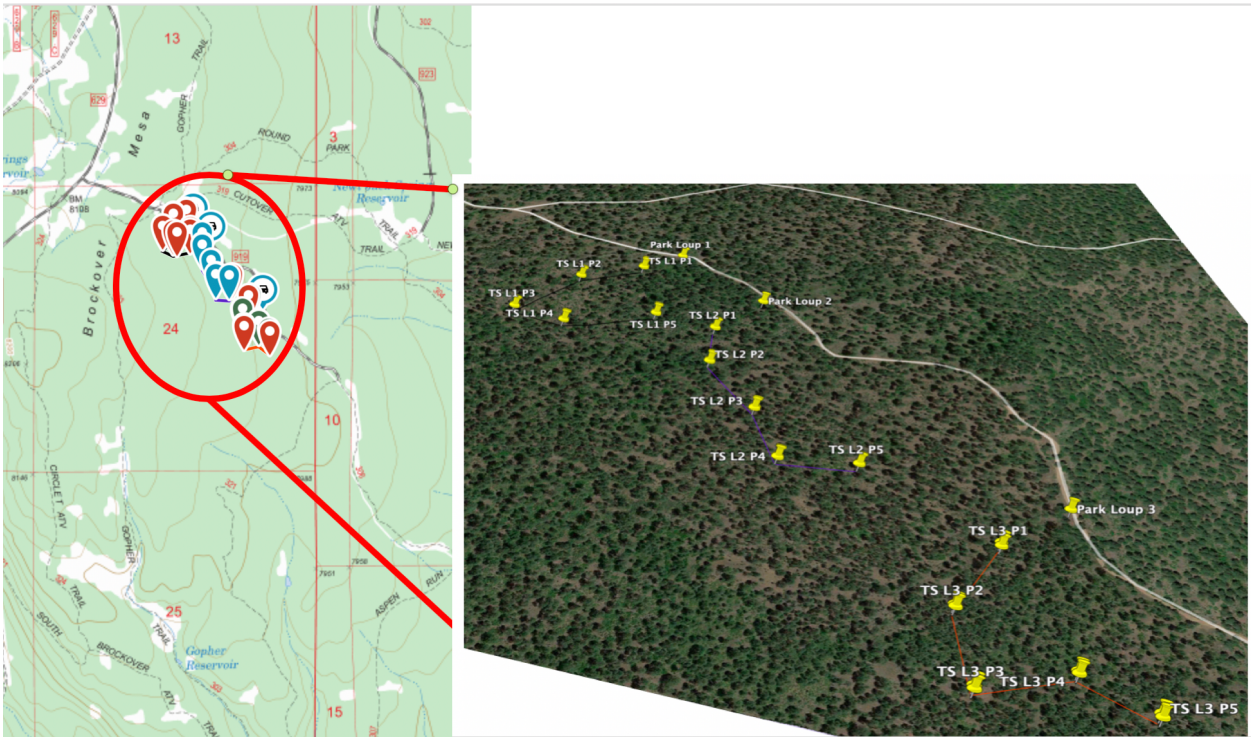


Figure 2. Map showing locations of monitoring points within Turkey Springs study area. TS = Turkey Springs; L # = Loop number; P # = Monitoring point number.

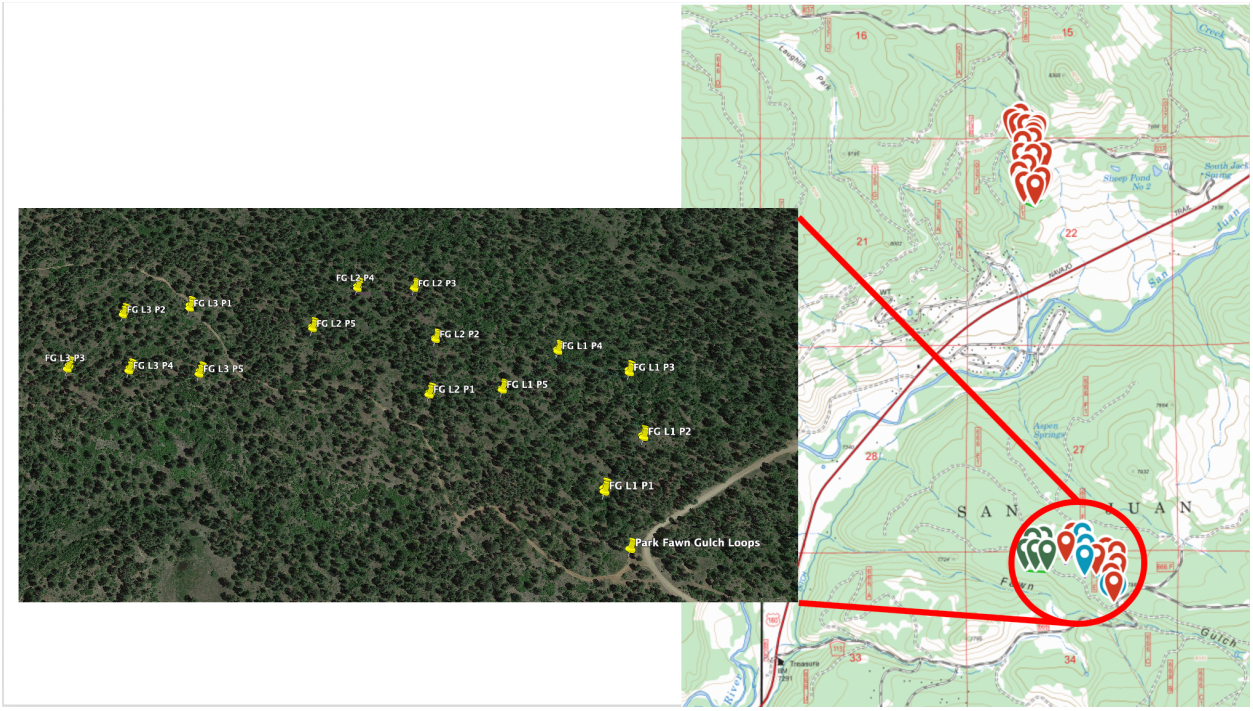


Figure 3. Map showing locations of monitoring points within Fawn Gulch study area. FG = Fawn Gulch; L # = Loop number; P # = Monitoring point number.

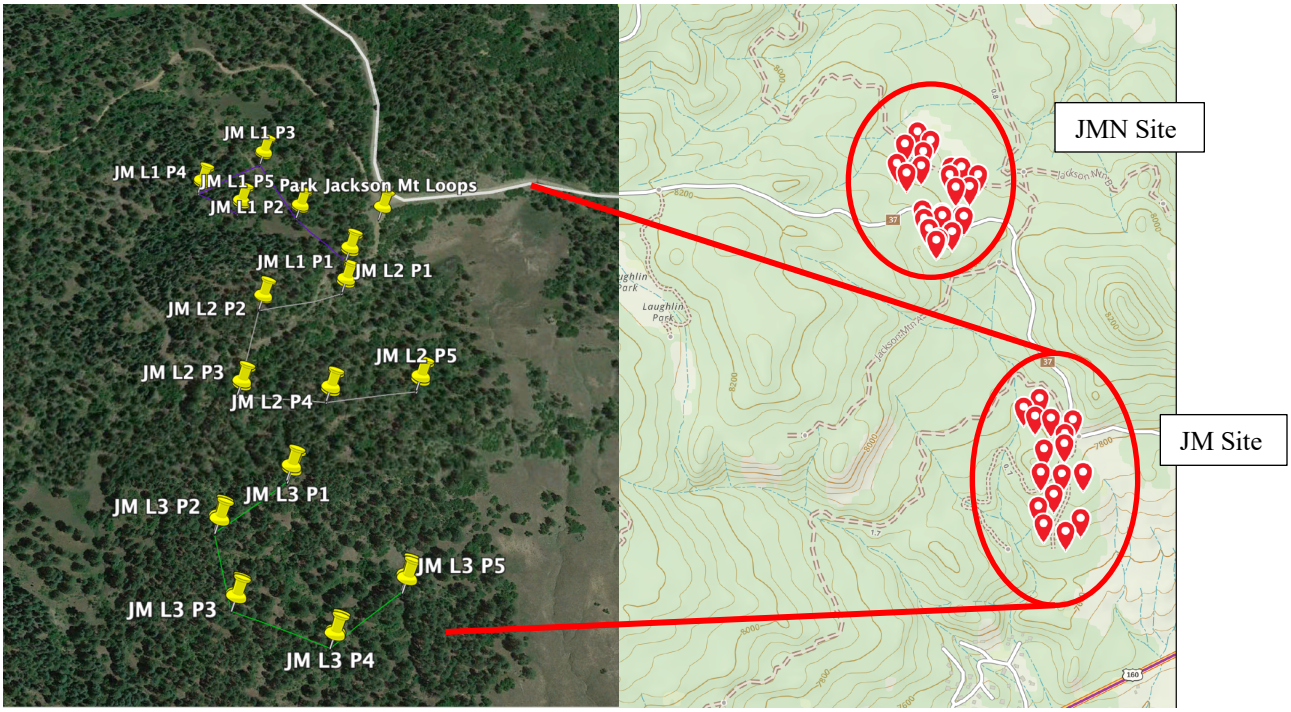


Figure 4. Map showing locations of monitoring points within Jackson Mountain study area (JMN shown on topo only). JM = Jackson Mountain; L # = Loop number; P # = Monitoring point number.

Table 2. Summary of the 64 different bird species observed across the three study areas in 2023. Data shown are the number of sample points at which respective bird species were recorded (i.e., frequency); and the number of birds of the respective species observed (i.e., abundance). Species lists represent those found at all three sites, sorted by abundance within the respective sites; those unique at any one of the three sites, sorted by abundance within the respective sites; and those found at two of the three sites, unsorted

2023	Fawn Gulch (FG)				Jackson Mountain (JM)					Jackson Mountain North (JMN)				
Number of Species	50				Number of Species	48				Number of Species	38			
# Point Records	814	# Birds	952		# Point Records	901	# Birds	1075		# Point Records	771	# Birds	876	
	Frequency	Rel Freq	Abundance	Rel Abund		Frequency	Rel Freq	Abundance	Rel Abund		Frequency	Rel Freq	Abundance	Rel Abund
Species Found At All Three Sites (sorted by Abundance)														
American Robin	104	12.78	136	14.29	American Robin	113	12.54	149	13.86	Hammond's Flycatcher	84	10.89	101	11.53
Western Tanager	85	10.44	99	10.40	Western Tanager	89	9.88	102	9.49	Warbling Vireo	81	10.51	93	10.62
Yellow-rumped Warbler	51	6.27	55	5.78	Warbling Vireo	75	8.32	85	7.91	Western Tanager	77	9.99	85	9.70
Warbling Vireo	44	5.41	49	5.15	Yellow-rumped Warbler	68	7.55	73	6.79	Mountain Chickadee	45	5.84	52	5.94
Northern Flicker	34	4.18	45	4.73	House Wren	49	5.44	63	5.86	Yellow-rumped Warbler	50	6.49	52	5.94
Chipping Sparrow	31	3.81	34	3.57	Pygmy Nuthatch	39	4.33	60	5.58	Hermit Thrush	42	5.45	50	5.71
Pygmy Nuthatch	23	2.83	32	3.36	Violet-green Swallow	30	3.33	59	5.49	Dark-eyed Junco	33	4.28	33	3.77
White-breasted Nuthatch	27	3.32	32	3.36	Hammond's Flycatcher	42	4.66	48	4.47	Orange-crowned Warbler	29	3.76	31	3.54
Dusky Flycatcher	26	3.19	28	2.94	Northern Flicker	41	4.55	45	4.19	Chipping Sparrow	23	2.98	28	3.20
House Wren	24	2.95	25	2.63	Black-headed Grosbeak	33	3.66	35	3.26	Northern Flicker	25	3.24	25	2.85
Black-Headed Grosbeak	20	2.46	21	2.21	Chipping Sparrow	31	3.44	33	3.07	Steller's Jay	20	2.59	25	2.85
Virginia's Warbler	17	2.09	18	1.89	Virginia's Warbler	29	3.22	31	2.88	American Robin	20	2.59	20	2.28
Dark-eyed Junco	14	1.72	15	1.58	Steller's Jay	22	2.44	29	2.70	Violet-green Swallow	11	1.43	20	2.28
Violet-green Swallow	3	0.37	13	1.37	Broad-tailed Hummingbird	11	1.22	11	1.02	House Wren	18	2.33	19	2.17
Steller's Jay	8	0.98	9	0.95	White-breasted Nuthatch	10	1.11	10	0.93	Pine Siskin	10	1.30	13	1.48
Broad-tailed Hummingbird	8	0.98	8	0.84	Hermit Thrush	9	1.00	9	0.84	Red Crossbill	10	1.30	12	1.37
Mountain Chickadee	7	0.86	7	0.74	Common Raven	7	0.78	8	0.74	Common Raven	4	0.52	7	0.80
Orange-crowned Warbler	5	0.61	6	0.63	Hairy Woodpecker	5	0.55	7	0.65	Hairy Woodpecker	6	0.78	6	0.68
Hammond's Flycatcher	3	0.37	4	0.42	Dark-eyed Junco	6	0.67	6	0.56	Black-headed Grosbeak	5	0.65	5	0.57
Red-tailed Hawk	4	0.49	4	0.42	Orange-crowned Warbler	5	0.55	6	0.56	White-breasted Nuthatch	3	0.39	4	0.46
Hermit Thrush	3	0.37	3	0.32	Pine Siskin	6	0.67	6	0.56	Broad-tailed Hummingbird	3	0.39	3	0.34
American Crow	2	0.25	2	0.21	Dusky Flycatcher	5	0.55	5	0.47	Virginia's Warbler	3	0.39	3	0.34
Common Raven	2	0.25	2	0.21	Red-tailed Hawk	5	0.55	5	0.47	Pygmy Nuthatch	2	0.26	2	0.23
Pine Siskin	2	0.25	2	0.21	American Crow	4	0.44	4	0.37	American Crow	1	0.13	1	0.11
Red Crossbill	2	0.25	2	0.21	Turkey Vulture	4	0.44	4	0.37	Dusky Flycatcher	1	0.13	1	0.11
Hairy Woodpecker	1	0.12	1	0.11	Mountain Chickadee	3	0.33	3	0.28	Red-tailed Hawk	1	0.13	1	0.11
Turkey Vulture	1	0.12	1	0.11	Red Crossbill	1	0.11	1	0.09	Turkey Vulture	1	0.13	1	0.11
Species Unique to Respective Sites (Sorted by Abundance)														
Common Nighthawk	19	2.33	20	2.10										
Cassin's Vireo	2	0.25	2	0.21										
Cedar Waxwing	1	0.12	2	0.21										
Evening Grosbeak	1	0.12	2	0.21										
Mallard	1	0.12	2	0.21										
Great Blue Heron	1	0.12	1	0.11										
Sharp-shinned Hawk	1	0.12	1	0.11										
Song Sparrow	1	0.12	1	0.11										
					Black Swift	2	0.22	5	0.47					
					White-throated Swift	1	0.11	2	0.19					
					Olive-sided Flycatcher	1	0.11	1	0.09					
					Red-naped Sapsucker	1	0.11	1	0.09					
					Wild Turkey	1	0.11	1	0.09					
										Ruby-crowned Kinglet	91	11.80	105	11.99
										Williamson's Sapsucker	7	0.91	9	1.03
										MacGillivray's Warbler	5	0.65	5	0.57
										Black-capped Chickadee	2	0.26	2	0.23
										Great Horned Owl	2	0.26	2	0.23
										Northern Pygmy Owl	1	0.13	1	0.11
Species Found at Two Respective Sites (Alphabetical)														
Brown-headed Cowbird	1	0.12	1	0.11	Brown-headed Cowbird	1	0.11	2	0.19					
Cassin's Finch	13	1.60	15	1.58	Cassin's Finch	4	0.44	4	0.37					
Cordilleran Flycatcher	2	0.25	2	0.21	Cordilleran Flycatcher	1	0.11	1	0.09					
Grace's Warbler	30	3.69	36	3.78	Grace's Warbler	19	2.11	22	2.05					
Green-tailed Towhee	42	5.16	47	4.94	Green-tailed Towhee	9	1.00	9	0.84					
House Finch	2	0.25	2	0.21	House Finch	1	0.11	1	0.09					
Mourning Dove	1	0.12	1	0.11	Mourning Dove	18	2.00	22	2.05					
Plumbeous Vireo	40	4.91	42	4.41	Plumbeous Vireo	13	1.44	15	1.40					
Red-winged Blackbird	2	0.25	2	0.21	Red-winged Blackbird	5	0.55	5	0.47					
Spotted Towhee	7	0.86	7	0.74	Spotted Towhee	4	0.44	4	0.37					
Western Bluebird	10	1.23	13	1.37	Western Bluebird	3	0.33	4	0.37					
Western Wood-Pewee	78	9.58	94	9.87	Western Wood-Pewee	63	6.99	68	6.33					
Yellow Warbler	1	0.12	1	0.11	Yellow Warbler	4	0.44	4	0.37					
					Brown Creeper	4	0.44	4	0.37	Brown Creeper	18	2.33	19	2.17
					Red-breasted Nuthatch	1	0.11	1	0.09	Red-breasted Nuthatch	33	4.28	37	4.22
					Townsend's Solitaire	2	0.22	2	0.19	Townsend's Solitaire	1	0.13	1	0.11
Ash-throated Flycatcher	1	0.12	2	0.21						Ash-throated Flycatcher	1	0.13	1	0.11
Downy Woodpecker	1	0.12	1	0.11						Downy Woodpecker	1	0.13	1	0.11

Even though the 27 bird species common to all three sites accounted for 79% of the birds counted at JMN, the abundance of Ruby-crowned Kinglets, unique to JMN, and the relatively large number of Brown Creepers and Red-breasted Nuthatches at that site underscores important differences in habitat quality at JMN compared to FG and JM. As noted earlier, JMN is east-facing with a more diverse canopy which includes Douglas Fir, White Fir, and Aspen, along with Ponderosa Pine.

As shown in Table 3, 88 different species of birds have been recorded across the five years of this study, with a total of 10020 birds counted. The number of species unique to a site varied from 4 at TS in 2019; to 11 at FG in 2019 and JM in 2020 and 2021. These numbers are also summarized in detail in Table 2, and in Appendix A.

Table 3. Summary of total number of bird species and birds counted across years at all four sites. The heading "All Years" represents summations across all years of the study. Unique bird species refers to species observed only at a respective site in a given year or across multiple years. (see also Grover et al. 2019; 2020; 2021; 2022)

Year	2019	2020	2021	2022	2023	All Years
Total # Different Species	54	58	60	56	64	88
Total # Birds Counted	949	2227	1855	2086	2903	10020
Species Common to All Sites	15	26	22	23	27	9
# Unique Bird Species by Site:						
Turkey Springs	4	4	6	NA	NA	2*
Fawn Gulch	11	7	7	5	8	8*
Jackson Mountain Original Site (JM)	8	11	11	6	5	9*
Jackson Mountain Site added in 2022 (JMN)	NA	NA	NA	8	6	2*

* Number of species observed only at that site across years

The number of species common to all sites within years is also shown in Table 3, ranging from 15 in 2019, to 27 in 2023. Nine species were seen at all three sites in all five years of the study.

Figure 5 further illustrates how the numbers of bird species identified per site differed across years. In particular, the number of bird species recorded for TS increased from 26 in 2019, to 37 and 35 species in 2020 and 2021, respectively. This likely reflects the response of the bird community to recovery of the understory following the prescribed fire treatment that was implemented on this site concurrent with the initiation of the study in 2019.

While the number of bird species reported at FG remained very similar across years, there was a notable increase in numbers of bird species observed at JM, from 33 in 2019, to 49 species in 2023 (Fig. 5). As noted previously, JM differs substantially from the other two sites in terms of shrub-layer height and density. This makes bird identification more challenging in that identification by song becomes more important as shrub-layer foliage density impairs sight identification. It is likely that, over the course of this study, the observers visiting JM on a regular basis improved their skills at identification by song, which was supplemented by the use of the Merlin APP in 2022 and 2023. In addition, year-to-year variability in bird numbers could account for the trend observed in numbers of species documented at JM. Another contributing factor to greater number of birds and bird species observed at JM from 2020 to 2023 is the continued thinning and logging activity taking place in the areas surrounding our study sites, which could make our study site a refuge area for some birds.

The number of bird species identified at JMN remained the same across the two years of sampling at that site, but was notably lower than either of the two sites in 2023 (Fig 5). Reviewing the data shown in Table 2 reveals that the FG and JM sites shared 13 species in addition to the 27 species found at all three sites. Those 13 species accounted for 27.6% of the birds counted at FG, and 25% of the birds counted at JM in 2023. This indicates that JMN offered less suitable habitat for a relatively large number of species that resided at FG and JM in 2023, possibly as a result of logging and thinning activities in the area. It is also possible that these differences reflect year-to-year variability in those species.

The numbers of birds counted at each site in each year of the study is illustrated by site in Figure 6. The number of birds counted at FG was about the same in 2022 compared to earlier years, but JM numbers increased. This in part reflects a slightly greater number of loop visits (30 vs. 28 at FG and 26 at JMN; Table 1), but use of the Merlin APP to supplement identification by song likely contributed to this outcome as well. The relatively lower number of birds reported for JMN in 2022 (see also Table 2) may be a result of fewer number of loop visits (see Table 1) at that site in addition to differences in habitat. That pattern was less distinct in 2023 numbers (Fig. 6), which may reflect year-to-year variability in bird numbers, or improved identification skills by observers in the second year sampling that site.

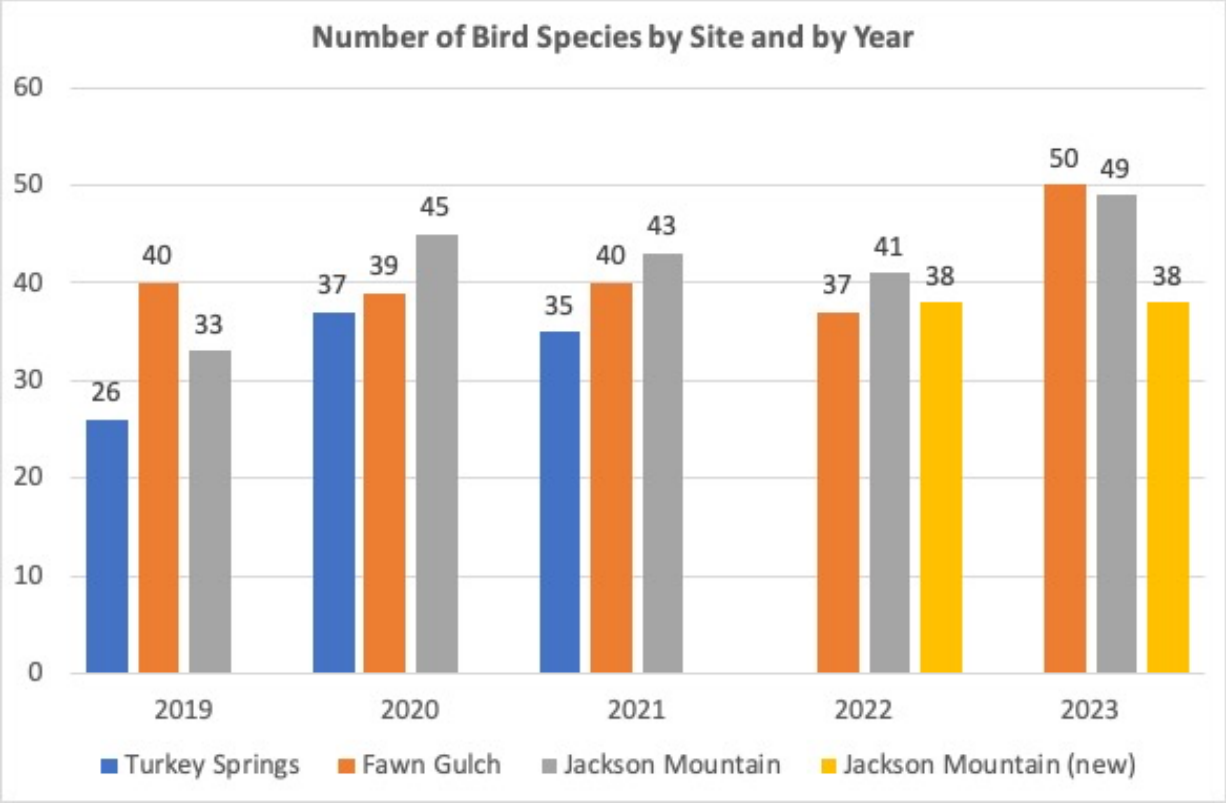


Figure 5. Summary of number of bird species observed by site and by year.

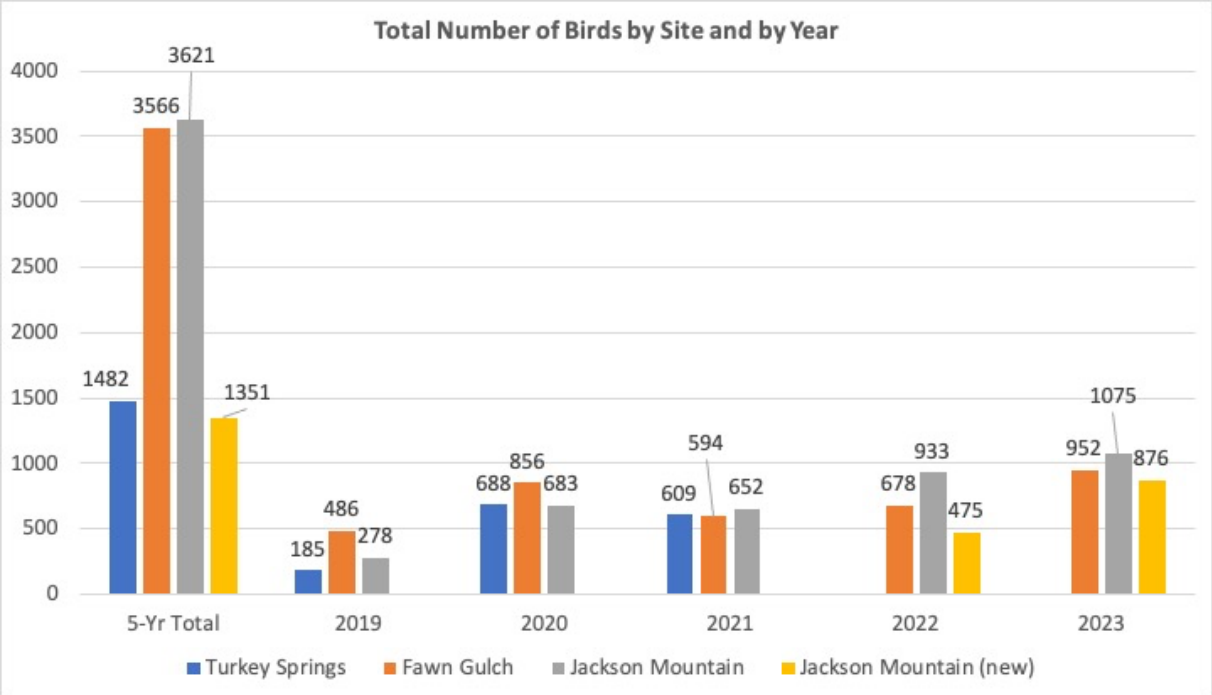


Figure 6. Summary of number of birds counted at each site by year.

As noted in previous year's reports (Grover et al. 2019; 2020; 2021; 2022), the impacts of the 2019 prescribed fire on the TS bird community likely accounts for the lower number of bird species and lower number of birds observed at that site compared to other sites (Table 3). Bird counts at TS increased substantially in subsequent years, corresponding to recovery of the understory shrub-layer (Fig. 6).

At FG, there were substantially more birds counted in 2020 than in 2019 (a 43% difference of 370 birds), 2021 (a 31% difference of 262 birds), or 2022 (a 21% difference of 178 birds) (Fig. 6). Sample density may account for some proportion of this increase as the number of loops and points visited in 2020 (see Table 1) was greater at FG than in other years or at other sites, and the number of observer-visits (114; Table 1) was also greatest at FG in 2020 compared to the other sites. However, year-to-year variability in bird numbers and bird community composition may certainly be a contributing factor as well.

The number of birds counted at FG, JM, and JMN increased in 2023 compared to earlier years of the study, reflecting possible year-to-year variability in bird numbers, but also the use of the Merlin APP to identify birds by song. In earlier years of the study, identification by song ranged from about 50% to 60% (Grover et al. 2022). In 2023, identification by song increased to 75% of bird identifications at FG; 77% at JM; and 83% at JMN. The use of Merlin APP is a significant contributor to this trend, but as noted in the methodology section of this report, only those bird species that could be confirmed by an observer's hearing were recorded. None-the-less, the inability of Merlin and observers to accurately discern distance to a singing bird could contribute to inflated numbers.

Table 4 summarizes the distribution of the number of common or unique bird species observed at each site within and across years. For example, of the 88 total bird species recorded over the five years of this study, 49 were recorded at TS; 69 at FG; 61 at JM; and 48 at JMN (see also Fig. 5). At TS and FG, 18 species were observed in all years of the study (3 sample years for TS vs. 5 sample years for FG), with 24 species observed in all years of the study at JM, and 28 species at JMN. Cumulative relative abundance data reveals that at TS and JM, the species common to all years accounted for 85% and 91.5% of the birds counted at those sites, respectively, with FG having 74.9% of the birds observed accounted for by species common to all years.

Table 4. Summary of bird species numbers and relative abundances grouped across or within years by site. Note that Turkey Springs was not monitored after 2021 due to addition of the new JMN site.

	Turkey Springs (TS)		**Fawn Gulch (FG)**		**Jackson Mountain (JM)**		**Jackson Mountain North (JMN)**	
	# Species	**Cum Rel Abund (%)**	**# Species**	**Cum Rel Abund (%)**	**# Species**	**Cum Rel Abund (%)**	**# Species**	**Cum Rel Abund (%)**
TOTAL Species	49 (2019 to 2021)		69		61		48 (2022 to 2023)	
All Years	18*	85.3*	18	74.9	24	91.5	28	95.9
Any 4 Years	NA	NA	10	13.1	8	5	NA	NA
Any 3 Years	18	85.3	7	5.6	5	.5	NA	NA
Any 2 Years	13*	10.9*	13	2.7	10	2	28	25.9
Only 1 Year	18*	3.8*	21	3.7	26	1	20**	4.1**
2019	6*	3.2*	5	10.2	2	2.9	NA	NA
2020	6*	4.5*	6	7.1	3	.4	NA	NA
2021	6*	3.3*	3	1	6	1.4	NA	NA
2022	*NA*	*NA*	1	.3	4	.6	10**	5.1**
2023	*NA*	*NA*	7	1.6	11	3.1	10**	3.7**

Special Notes: * - 2019 to 2021 sample seasons only; ** - 2022 and 2023 sample seasons only.

Tables 5 through 8 and Figure 7 contain summaries of the species-specific data across years for the TS, FG, JM and JMN sites, respectively. As shown in the tables and in Figure 7, the cumulative relative abundance of bird species

shared across all years at a site ranged from about 60% at FG in 2022 (Table 6), to a high of about 96% for TS in 2019 (Table 5) and 95% to 96% for JMN in 2022 and 2023 (Table 8).

Focusing on summary data across all years sampled at each site (Tables 5 through 8) reveals that at TS, 35% of the species observed at that site accounted for 85% of the birds counted; 26% of the bird species at FG accounted for 75% of the birds counted; 40% of the bird species at JM accounted for 91% of the birds counted; and 58% of the bird species at JMN accounted for 96% of the birds counted. These findings underscore a pattern often reported in the ecological literature (e.g., Gaston, 2011) – that a small number of species are typically found in large numbers in most ecosystems studied.

Table 9 contains a listing of the 34 bird species observed in all five years of the study. Within each year, the birds listed in Table 9 accounted for a range of 73% in 2019 to almost 90% of birds counted in 2022. Summing across years, there were a total of 10020 birds counted across 88 species identified by observers in this study, with 8425 birds represented by the 34 common species listed in Table 9, or about 84% of all birds counted. Adding the JMN site and dropping the TS site from our study in 2022 contributed to a drop from 37 common species across the first three years of the study to 34 common species across the five years of the project reported on here (see Grover et al. 2021 and 2022).

The commonness pattern is further revealed in the analysis supported by Table 9 where the 9 species observed at all sites in all five years of this study are shown to account for 48 % of the birds counted. The most common species observed across all sites and all year was the American Robin, accounting for 13% of all birds counted. Interestingly, the second most common bird species was the Western Wood-Pewee, which was abundant at TS, FG, and JM, but absent from JMN. Pygmy Nuthatches were third most abundant, followed by Western Tanagers and Violet-green Swallows to round off the top five most common and most abundant bird species in our study. Most other bird species recorded across all years of this study were found in low numbers – with relative abundances < 3%, and most often < 1% (Table 9).

Table 10 summarizes relative abundance data across years to reveal differences in the most abundant species at our respective study sites. For this comparison bird species with a relative abundance of 3.5% or higher are listed. Notably, the American Robin ranks as the most abundant bird species at TS, FG, and JM, and is by far the most abundant bird species observed across all years, but, with a relative abundance of 2.3 (see Table 8), does not meet the criteria to be listed on this table for JMN. With the highest total number of bird species reported for FG (69; see Table 6), but only 7 species listed in Table 10, FG stands out for having the lowest (less than 60%) of the bird species observed in this grouping. There are more complex indices that can be used to make a point about species diversity, but this analysis indicates that the FG site supports a higher number of bird species (i.e. greater species richness) with fewer clearly dominant bird species (i.e. greater species evenness) than any of the other three sites.

JMN stands out as having the most unique suite of bird species in the rankings shown in Table 10, with only four of the ten species listed for JMN shared with the other three sites (Chipping Sparrow; Warbling Vireo; Western Tanager; and Yellow-rumped Warbler). Most notable among the common bird species unique to JMN was the Ruby-crowned Kinglet, which was unique to that site in both 2022 (see Table 4 in Appendix A) and 2023 (Table 2). The other species listed in Table 10 that were unique to JMN were Hammond's Flycatcher; Hermit Thrush; and Red-breasted Nuthatch, all of which were reported for at least one other study site, but in smaller numbers.

Bird species observed as incidentals in at least one year of the study are listed in Table 11. Notable among the species listed in Table 11 are the Fox Sparrow, Lincoln Sparrow, and Woodhouse's Scrub Jay, all observed for the first time in 2023, and none of which were observed at any of our monitoring points. The Lincoln Sparrow siting was confirmed photographically. All other bird species reported as incidentals in at least one year of the study were observed at at least one monitoring point in other years of the study.

Trophic-level Impacts: Effects of Bird Predation on Herbivorous Invertebrates-

Studies examining the role of birds in controlling folivorous arthropod populations consistently find a reduction in herbivorous invertebrates in many different ecosystem types (e.g., Atlegrim, 1992; Holmes, 1990, Heyman and Gunnarsson, 2011). In view of the difficulties associated with quantifying bird predation on arthropods (see Dahlsten et. al., 1990), the most compelling findings come from studies in which various methods are used to

Table 5. Summary of bird species observed at Turkey Springs (TS) site across the 2019 to 2021 years of this study.

Turkey Springs												
2019			2020			2021			All Years			
Number of Species	28		Number of Species	39		Number of Species	37		51			
Total Birds Counted	184		Total Birds Counted	688		Total Birds Counted	609		1481			
	Abund	Rel Abund		Abund	Rel Abund		Abund	Rel Abund	Abund	Rel Abund		
American Crow	10	5.4	American Crow	6	0.9	American Crow	5	0.8	21	1.42		
American Robin	43	23.4	American Robin	77	11.2	American Robin	59	9.7	179	12.09		
Broad-tailed Hummingbird	2	1.1	Broad-tailed Hummingbird	6	0.9	Broad-tailed Hummingbird	2	0.3	10	0.68		
Chipping Sparrow	6	3.3	Chipping Sparrow	23	3.3	Chipping Sparrow	35	5.7	64	4.32		
Common Nighthawk	6	3.3	Common Nighthawk	3	0.4	Common Nighthawk	7	1.1	16	1.08		
Hairy Woodpecker	1	0.5	Hairy Woodpecker	10	1.5	Hairy Woodpecker	6	1.0	17	1.15		
Mourning Dove	1	0.5	Mourning Dove	36	5.2	Mourning Dove	3	0.5	40	2.70		
Northern Flicker	17	9.2	Northern Flicker	14	2.0	Northern Flicker	27	4.4	58	3.92		
Plumbeous Vireo	2	1.1	Plumbeous Vireo	2	0.3	Plumbeous Vireo	15	2.5	19	1.28		
Pygmy Nuthatch	20	10.9	Pygmy Nuthatch	81	11.8	Pygmy Nuthatch	92	15.1	193	13.03		
Stellar's Jay	1	0.5	Steller's Jay	7	1.0	Stellar's Jay	1	0.2	9	0.61		
Turkey Vulture	1	0.5	Turkey Vulture	1	0.1	Turkey Vulture	1	0.2	3	0.20		
Violet-green Swallow	16	8.7	Violet-green Swallow	109	15.8	Violet-green Swallow	77	12.6	202	13.64		
Western Bluebird	5	2.7	Western Bluebird	30	4.4	Western Bluebird	53	8.7	88	5.94		
Western Tanager	1	0.5	Western Tanager	10	1.5	Western Tanager	17	2.8	28	1.89		
Western Wood PeWee	29	15.8	Western Wood-Pewee	63	9.2	Western Wood-Pewee	55	9.0	147	9.93		
White-breasted Nuthatch	11	6.0	White-breasted Nuthatch	23	3.3	White-breasted Nuthatch	34	5.6	68	4.59		
Yellow-rumped Warbler	4	2.2	Yellow-rumped Warbler	53	7.7	Yellow-rumped Warbler	45	7.4	102	6.89		
Sub Total	**176**	**95.7**	**Sub Total**	**554**	**80.5**	**Sub Total**	**534**	**87.7**	**1264**	**85.35**		
Brown-headed Cowbird	2	1.1	Brown-headed Cowbird	1	0.1				3	0.20		
Osprey	1	0.5	Osprey	1	0.1				2	0.14		
			Black-capped Chickadee	4	0.6	Black-capped Chickadee	3		7	0.47		
			Cassin's Finch	2	0.3	Cassin's Finch	3		5	0.34		
			Common Raven	14	2.0	Common Raven	4	0.7	18	1.22		
			Dark-eyed Junco	46	6.7	Dark-eyed Junco	17	2.8	63	4.25		
			Green-tailed Towhee	5	0.7	Green-tailed Towhee	4	0.7	9	0.61		
			House Wren	15	2.2	House Wren	7	1.1	22	1.49		
			Mountain Chickadee	4	0.6	Mountain Chickadee	1	0.2	5	0.34		
			Spotted Towhee	3	0.4	Spotted Towhee	5	0.8	8	0.54		
			Townsend's Solitaire	6	0.9	Townsend's Solitaire	7	1.1	13	0.88		
			Warbling Vireo	1	0.1	Warbling Vireo	3	0.5	4	0.27		
			White-crowned sparrow	1	0.1	White-crowned Sparrow	1	0.2	2	0.14		
Sub Total	**3**	**1.6**	**Sub Total**	**103**	**15.0**	**Sub Total**	**55**	**8.0**	**161**	**10.9**		
Bullock's Oriole	1	0.5							1	0.07		
Downy Woodpecker	1	0.5							1	0.07		
Lewis's Woodpecker	1	0.5							1	0.07		
MacGillivary's Warbler	1	0.5							1	0.07		
Red-tailed Hawk	1	0.5							1	0.07		
Williamson's Sapsucker	1	0.5							1	0.07		
			Cordilleran Flycatcher	5	0.7				5	0.34		
			Eurasian Collared Dove	3	0.4				3	0.20		
			European Starling	1	0.1				1	0.07		
			Pine Siskin	3	0.4				3	0.20		
			Red Crossbill	17	2.5				17	1.15		
			Red-breasted Nuthatch	2	0.3				2	0.14		
						Brown Creeper	1		1	0.07		
						Grace's Warbler	15	2.5	15	1.01		
						Great-Horned Owl	1	0.2	1	0.07		
						Mallard	1	0.2	1	0.07		
						Mountain Bluebird	1	0.2	1	0.07		
						Sharp-shinned Hawk	1	0.2	1	0.07		
Sub Total	**6**	**3.2**	**Sub Total**	**31**	**4.5**	**Sub Total**	**19**	**3.0**	**56**	**3.8**		

exclude bird predation from vegetation (i.e., netting exclosures; Bridgeland et al. 2010; Heyman and Gunnarsson, 2010; Schwenk et al. 2010), coupled in some cases with insecticide applications to additionally suppress arthropod populations (e.g., Marquis and Whelan, 1994). The general consensus from these and other studies is that bird predation may effectively limit prey population densities when at endemic levels, especially during bird breeding season, but insect outbreaks often overwhelm the ability of bird populations to control such irruptions (Holmes, 1990). Venier and others (2009), however, were able to quantify enhanced breeding success in several warbler species common to the eastern boreal forests when spruce budworm outbreaks occurred.

The indirect consequences of bird predation on plant growth have also been demonstrated for sugar maple seedlings in the eastern deciduous forest (Strong et. al., 2000), and white oak in hardwood forests of Missouri (Marquis and Whelan, 1994). Finally, experimental work by Heyman and Gunnarsson (2010) in suburban deciduous forests in Sweden confirms that removal of the forest understory, through impacts on various arthropod populations, significantly reduces bird population densities as well.

Table 6. Summary of bird species observed at the Fawn Gulch (FG) site across the four years of this study.

Fawn Gulch																				
2019			2020			2021			2022			2023			Five-Year Totals					
Number of Species	34		Number of Species	39		Number of Species	40		Number of Species	37		Number of Species	50			69				
Total Birds Counted	354		Total Birds Counted	856		Total Birds Counted	594		Total Birds Counted	528		Total Birds Counted	950			3282				
	Abund	Rel Abund		Abund	Rel Abund		Abund	Rel Abund		Abund	Rel Abund		Abund	Rel Abund		Abund	Rel Abund			
Species Observed in All Five Years																				
American Robin	81	22.9	American Robin	110	12.9	American Robin	140	23.6	American Robin	60	8.7	American Robin	136	14.3		527	16.06			
Black-headed Grosbeak	5	1.4	Black-headed Grosbeak	9	1.1	Black-headed Grosbeak	7	1.2	Black-headed Grosbeak	4	0.6	Black-headed Grosbeak	21	2.2		46	1.40			
Cassins Finch	1	0.3	Cassin's Finch	6	0.7	Cassin's Finch	2	0.3	Cassin's Finch	5	0.7	Cassin's Finch	15	1.6		29	0.88			
Chipping Sparrow	8	2.3	Chipping Sparrow	12	1.4	Chipping Sparrow	15	2.5	Chipping Sparrow	29	4.2	Chipping Sparrow	34	3.6		98	2.99			
Cordilleran Flycatcher	3	0.8	Cordilleran Flycatcher	19	2.2	Cordilleran Flycatcher	2	0.3	Cordilleran Flycatcher	3	0.4	Cordilleran Flycatcher	2	0.2		29	0.88			
Green Tailed Towhee	16	4.5	Green-tailed Towhee	35	4.1	Green-tailed Towhee	53	8.9	Green-tailed Towhee	49	7.1	Green-tailed Towhee	47	4.9		200	6.09			
Hairy Woodpecker	1	0.3	Hairy Woodpecker	7	0.8	Hairy Woodpecker	7	1.2	Hairy Woodpecker	2	0.3	Hairy Woodpecker	1	0.1		18	0.55			
Northern Flicker	35	9.9	Northern Flicker	10	1.2	Northern Flicker	19	3.2	Northern Flicker	1	0.1	Northern Flicker	45	4.7		110	3.35			
Pygmy Nutatch	4	1.1	Pygmy Nuthatch	55	6.4	Pygmy Nuthatch	27	4.5	Pygmy Nuthatch	1	0.1	Pygmy Nuthatch	32	3.4		119	3.63			
Red-tailed Hawk	1	0.3	Red-tailed Hawk	4	0.5	Red-tailed Hawk	1	0.2	Red-tailed Hawk	1	0.1	Red-tailed Hawk	4	0.4		11	0.34			
Steller's Jay	5	1.4	Steller's Jay	16	1.9	Stellar's Jay	33	5.6	Steller's Jay	15	2.2	Steller's Jay	9	1.0		78	2.38			
Western Bluebird	4	1.1	Western Bluebird	16	1.9	Western Bluebird	8	1.3	Western Bluebird	28	4.1	Western Bluebird	13	1.4		69	2.10			
Western Tanager	27	7.6	Western Tanager	36	4.2	Western Tanager	37	6.2	Western Tanager	61	8.8	Western Tanager	99	10.4		260	7.92			
Western Wood-Pewee	64	18.1	Western Wood-Pewee	153	17.9	Western Wood-Pewee	94	15.8	Western Wood-Pewee	90	13.0	Western Wood-Pewee	94	9.9		495	15.08			
White-breasted Nuthatch	17	4.8	White-breasted Nuthatch	29	3.4	White-breasted Nuthatch	20	3.4	White-breasted Nuthatch	23	3.3	White-breasted Nuthatch	32	3.4		121	3.69			
Yellow-rumped Warbler	8	2.3	Yellow-rumped Warbler	41	4.8	Yellow-rumped Warbler	19	3.2	Yellow-rumped Warbler	34	4.9	Yellow-rumped Warbler	55	5.8		157	4.78			
Turkey Vulture	3	0.8	Turkey Vulture	3	0.4	Turkey Vulture	2	0.3	Turkey Vulture	5	0.7	Turkey Vulture	1	0.1		14	0.43			
Violet-green Swallow	7	2.0	Violet-green Swallow	38	4.4	Violet-green Swallow	14	2.4	Violet-green Swallow	6	0.9	Violet-green Swallow	13	1.4		78	2.38			
SUB TOTALS	**290**	**81.9**	**SUB TOTALS**	**599**	**70.0**	**SUB TOTALS**	**500**	**84.2**	**SUB TOTALS**	**417**	**60.4**	**SUB TOTALS**	**653**	**68.6**		**2459**	**74.92**			
Species Observed in Any Four Years																				
American Crow	4	1.1	American Crow	2	0.2	American Crow	3	0.5				American Crow	2	0.2		11	0.34			
Broad-tailed Hummingbird	1	0.3	Broad-tailed Hummingbird	3	0.4				Broad-tailed Hummingbird	5	0.7	Broad-tailed Hummingbird	8	0.8		17	0.52			
Common Raven	1	0.3				Common Raven	1	0.2	Common Raven	2	0.3	Common Raven	2	0.2		6	0.18			
			House Wren	32	3.7	House Wren	2	0.3	House Wren	10	1.4	House Wren	25	2.6		69	2.10			
			Mountain Chickadee	6	0.7	Mountain Chickadee	3	0.5	Mountain Chickadee	1	0.1	Mountain Chickadee	7	0.7		17	0.52			
			Mourning Dove	63	7.4	Mourning Dove	11	1.9	Mourning Dove	1	0.1	Mourning Dove	1	0.1		76	2.32			
			Orange-crowned Warbler	6	0.7	Orange-crowned Warbler	2	0.3	Orange-crowned Warbler	2	0.3	Orange-crowned Warbler	6	0.6		16	0.49			
			Plumbeous Vireo	19	2.2	Plumbeous Vireo	5	0.8	Plumbeous Vireo	1	0.1	Plumbeous Vireo	42	4.4		67	2.04			
			Spotted Towhee	4	0.5	Spotted Towhee	13	2.2	Spotted Towhee	11	1.6	Spotted Towhee	7	0.7		35	1.07			
			Warbling Vireo	30	3.5	Warbling Vireo	19	3.2	Warbling Vireo	18	2.6	Warbling Vireo	49	5.2		116	3.53			
SUB TOTALS	**6**	**1.7**	**SUB TOTALS**	**165**	**19.3**	**SUB TOTALS**	**59**	**9.9**	**SUB TOTALS**	**51**	**7.4**	**SUB TOTALS**	**149**	**15.7**		**430**	**13.10**			
Species Observed in Any Three Years																				
Brown-headed Cowbird	3	0.8							Brown-headed Cowbird	1	0.1	Brown-headed Cowbird	1	0.1		5	0.15			
						Common Nighthawk	16	2.7	Common Nighthawk	12	1.7	Common Nighthawk	20	2.1		48	1.46			
			Dark-eyed Junco	8	0.9	Dark-eyed Junco	3	0.5	Dark-eyed Junco	2	0.3	Dark-eyed Junco	15	1.6		28	0.85			
			Grace's Warbler	11	1.3				Grace's Warbler	18	2.6	Grace's Warbler	36	3.8		65	1.98			
Pine Siskin	2	0.6							Pine Siskin	2	0.3	Pine Siskin	2	0.2		6	0.18			
Red Crossbill	1	0.3	Red Crossbill	9	1.1							Red Crossbill	2	0.2		12	0.37			
						Virginia's Warbler	1	0.2	Virginia's Warbler	1	0.1	Virginia's Warbler	18	1.9		20	0.61			
SUB TOTALS	**6**	**1.7**	**SUB TOTALS**	**28**	**3.3**	**SUB TOTALS**	**20**	**3.4**	**SUB TOTALS**	**36**	**5.2**	**SUB TOTALS**	**94**	**9.9**		**184**	**5.61**			
Species Observed in Any Two Years																				
						Ash-throated Flycatcher	1	0.2				Ash-throated Flycatcher	2	0.2		3	0.09			
Bald Eagle	2	0.6							Bald Eagle	1	0.1					3	0.09			
						Cassin's Vireo	1	0.2				Cassin's Vireo	2	0.2		3	0.09			
Downy Woodpecker	3	0.8										Downy Woodpecker	1	0.1		4	0.12			
									Dusky Flycatcher	20	2.9	Dusky Flycatcher	28	2.9		48	1.46			
			Evening Grosbeak	1	0.1							Evening Grosbeak	2	0.2		3	0.09			
						Great Blue Heron	1	0.2				Great Blue Heron	1	0.1		2	0.06			
						Red-winged Blackbird	1	0.2				Red-winged Blackbird	2	0.2		3	0.09			
Say's Phoebe	2	0.6				Say's Phoebe	2	0.3								4	0.12			
			Townsend's Solitaire	1	0.1	Townsend's Solitaire	2	0.3								3	0.09			
Tree Swallow	7	2.0				Tree Swallow	1	0.2								8	0.24			
			Williamson's Sapsucker	1	0.1				Williamson's Sapsucker	1	0.1					2	0.06			
Yellow Warbler	2	0.6										Yellow Warbler	1	0.11		3	0.09			
SUB TOTALS	**16**	**4.5**	**SUB TOTALS**	**3**	**0.4**	**SUB TOTALS**	**9**	**1.5**	**SUB TOTALS**	**22**	**3.2**	**SUB TOTALS**	**39**	**4.1**		**89**	**2.71**			
Species Observed in Only One Year																				
American Goldfinch	3	0.8														3	0.09			
			Band-tailed Pigeon	34	4.0											34	1.04			
			Black-capped Chickadee	21	2.5											21	0.64			
			Black-chinned Hummingbird	1	0.1											1	0.03			
Canada Goose	6	1.7														6	0.18			
			Dusky Grouse	1	0.1											1	0.03			
			Great Horned Owl	3	0.4											3	0.09			
Black-billed Magpie	1	0.3														1	0.03			
									Mountain Bluebird	2	0.3					2	0.06			
						Olive-sided Flycatcher	1	0.2								1	0.03			
Northern Rough Winged Swallow	25	7.1														25	0.76			
Red Naped Sapsucker	1	0.3														1	0.03			
			Song Sparrow	1	0.1							Song Sparrow	1	0.1		2	0.06			
						Three-toed Woodpecker	3	0.5								3	0.09			
						Wild Turkey	2	0.3								2	0.06			
												Hammond's Flycatcher	4	0.4		4	0.12			
												Hermit Thrush	3	0.3		3	0.09			
												Cedar Waxwing	2	0.2		2	0.06			
												Mallard	2	0.2		2	0.06			
												Shrp-shinned Hawk	1	0.1		1	0.03			
												House Finch	2	0.2		2	0.06			
SUB TOTALS	**36**	**10.2**	**SUB TOTALS**	**61**	**7.1**	**SUB TOTALS**	**6**	**1.0**	**SUB TOTALS**	**2**	**0.3**	**SUB TOTALS**	**15**	**1.6**		**120**	**3.66**			

The results of our study are consistent with research showing that understory removal reduces bird densities (e.g., Heyman and Gunnarsson 2010). Simplifying forest understory structure, as was accomplished with prescribed fire at the TS site at the onset of our study, resulted in at least a short-term reduction in bird abundance (see Figs. 5 and 6) and bird community diversity (see Figs. 8, 9, and 10). As discussed in Grover et al., 2021, mastication at FG, which occurred at least 2 years before our study began, did not have prolonged impacts on bird species richness (Fig. 5 in Grover et al. 2021); apparent abundance (see Fig. 6 in Grover et al. 2021); or bird species diversity.

Spruce budworm and bark beetle infestations that have significantly impacted forests across the western states, and in particular in higher elevation forests surrounding our area, do not seem to be a problem in the vicinity of our study sites. Although difficult to confirm, bird predation may be a contributing factor to the apparent absence of insect outbreaks in dry-mixed conifer forests in our area.

Species-level response – Feeding Guilds-

Tables 12-A & B summarize the categorization of bird species encountered in our study with respect to their feeding habits using lists contained in Lowe et al., (1978); Bock and Lynch (1970); and life history characteristics published by the Cornell Laboratory of Ornithology (www.allaboutbirds.org; see also Grover et. al., 2019, 2020, 2021; 2022).

Table 7. Summary of bird species observed at the Jackson Mountain (JM) site across the five years of this study.

Jackson Mountain (Original Site)																				
2019			2020			2021			2022			2023			Five-Year Totals		
Number of Species	32		Number of Species	44		Number of Species	42		Number of Species	40		Number of Species	49		60		
Total Birds Counted	278		Total Birds Counted	682		Total Birds Counted	651		Total Birds Counted	933		Total Birds Counted	1080		3451		
	Abun	Rel Abund		Abund	Rel Abund		Abund	Rel Abund		Abund	Rel Abund		Abund	Rel Abund	Abund	Rel Abund	
Species Observed in All Five Years																	
American Crow	2	0.7	American Crow	8	1.2	American Crow	3	0.5	American Crow	7	0.8	American Crow	4	0.4	24	0.70	
American Robin	75	27.0	American Robin	103	15.1	American Robin	85	13.1	American Robin	92	9.9	American Robin	149	13.8	504	14.60	
Black Headed Grosbeak	5	1.8	Black-headed Grosbeak	7	1.0	Black-headed Grosbeak	10	1.5	Black-headed Grosbeak	16	1.7	Black-headed Grosbeak	35	3.2	73	2.12	
Broad Tailed Hummingbird	2	0.7	Broad-tailed Hummingbird	11	1.6	Broad-tailed Hummingbird	3	0.5	Broad-tailed Hummingbird	5	0.5	Broad-tailed Hummingbird	11	1.0	32	0.93	
Common Raven	11	4.0	Common Raven	12	1.8	Common Raven	8	1.2	Common Raven	12	1.3	Common Raven	8	0.7	51	1.48	
Green Tailed Towhee	7	2.5	Green-tailed Towhee	29	4.3	Green-tailed Towhee	11	1.7	Green-tailed Towhee	31	3.3	Green-tailed Towhee	9	0.8	87	2.52	
Hairy Woodpecker	1	0.4	Hairy Woodpecker	5	0.7	Hairy Woodpecker	15	2.3	Hairy Woodpecker	5	0.5	Hairy Woodpecker	7	0.6	33	0.96	
Hermit Thrush	1	0.4	Hermit Thrush	3	0.4	Hermit Thrush	1	0.2	Hermit Thrush	4	0.4	Hermit Thrush	9	0.8	18	0.52	
House Wren	4	1.4	House Wren	8	1.2	House Wren	7	1.1	House Wren	39	4.2	House Wren	63	5.8	121	3.51	
Mountain Chickadee	4	1.4	Mountain Chickadee	8	1.2	Mountain Chickadee	2	0.3	Mountain Chickadee	8	0.9	Mountain Chickadee	3	0.3	25	0.72	
Mourning Dove	1	0.4	Mourning Dove	9	1.3	Mourning Dove	39	6.0	Mourning Dove	12	1.3	Mourning Dove	22	2.0	83	2.41	
Northern Flicker	29	10.4	Northern Flicker	52	7.6	Northern Flicker	49	7.5	Northern Flicker	58	6.2	Northern Flicker	45	4.2	233	6.75	
Orange Crowned Warbler	2	0.7	Orange-crowned Warbler	3	0.4	Orange-crowned Warbler	9	1.4	Orange-crowned Warbler	3	0.3	Orange-crowned Warbler	6	0.6	23	0.67	
Plumbeous Vireo	12	4.3	Plumbeous Vireo	25	3.7	Plumbeous Vireo	10	1.5	Plumbeous Vireo	10	1.1	Plumbeous Vireo	15	1.4	72	2.09	
Pygmy Nuthatch	12	4.3	Pygmy Nuthatch	57	8.4	Pygmy Nuthatch	90	13.8	Pygmy Nuthatch	107	11.5	Pygmy Nuthatch	60	5.6	326	9.45	
Steller's Jay	11	4.0	Steller's Jay	52	7.6	Stellar's Jay	30	4.6	Steller's Jay	33	3.5	Steller's Jay	29	2.7	155	4.49	
Turkey Vulture	8	2.9	Turkey Vulture	10	1.5	Turkey Vulture	6	0.9	Turkey Vulture	5	0.5	Turkey Vulture	4	0.4	33	0.96	
Violet Green Swallow	3	1.1	Violet-green Swallow	41	6.0	Violet-green Swallow	45	6.9	Violet-green Swallow	78	8.4	Violet-green Swallow	59	5.5	226	6.55	
Virginia's Warbler	3	1.1	Virginia's Warbler	21	3.1	Virginia's Warbler	5	0.8	Virginia's Warbler	16	1.7	Virginia's Warbler	31	2.9	76	2.20	
Warbling Vireo	7	2.5	Warbling Vireo	17	2.5	Warbling Vireo	27	4.1	Warbling Vireo	31	3.3	Warbling Vireo	85	7.9	167	4.84	
Western Tanager	16	5.8	Western Tanager	49	7.2	Western Tanager	47	7.2	Western Tanager	90	9.6	Western Tanager	102	9.4	304	8.81	
Western Wood-Pewee	14	5.0	Western Wood-Pewee	29	4.3	Western Wood-Pewee	59	9.1	Western Wood-Pewee	120	12.9	Western Wood-Pewee	68	6.3	290	8.40	
White-breasted Nuthatch	4	1.4	White-breasted Nuthatch	17	2.5	White-breasted Nuthatch	14	2.2	White-breasted Nuthatch	31	3.3	White-breasted Nuthatch	10	0.9	76	2.20	
Yellow-rumped Warbler	12	4.3	Yellow-rumped Warbler	11	1.6	Yellow-rumped Warbler	18	2.8	Yellow-rumped Warbler	10	1.1	Yellow-rumped Warbler	73	6.8	124	3.59	
SUBTOTAL	**246**	**88.5**	**SUBTOTAL**	**587**	**86.1**	**SUBTOTAL**	**593**	**91.1**	**SUBTOTAL**	**823**	**88.2**	**SUBTOTAL**	**907**	**84.0**	**3156**	**91.45**	
Species Observed in Any Four Years																	
Black-capped Chickadee	1	0.4	Black-capped Chickadee	11	1.6	Black-capped Chickadee	5	0.8	Black-capped Chickadee	2	0.2			0.0	19	0.55	
Brown Headed Cowbird	1	0.4	Brown-headed Cowbird	2	0.3	Brown-headed Cowbird	4	0.6			0.0	Brown-headed Cowbird	2	0.2	7	0.20	
			Dark-eyed Junco	8	1.2	Dark-eyed Junco	5	0.8	Dark-eyed Junco	9	1.0	Dark-eyed Junco	6	0.6	22	0.64	
			Cordilleran Flycatcher	4	0.6	Cordilleran Flycatcher	18	2.8	Cordilleran Flycatcher	4	0.4	Cordilleran Flycatcher	1	0.1	26	0.75	
			Chipping Sparrow	37	5.4	Chipping Sparrow	6	0.9	Chipping Sparrow	27	2.9	Chipping Sparrow	33	3.1	70	2.03	
			Red-breasted Nuthatch	3	0.4			0.0	Red-breasted Nuthatch	3	0.3	Red-breasted Nuthatch	1	0.1	6	0.17	
Red-tailed Hawk	6	2.2	Red-tailed Hawk	4	0.6			0.0	Red-tailed Hawk	6	0.6	Red-tailed Hawk	5	0.5	16	0.46	
Townsend's Solitaire	3	1.1	Townsend's Solitaire	1	0.1	Townsend's Solitaire	2	0.3			0.0	Townsend's Solitaire	2	0.2	6	0.17	
SUBTOTAL	**11**	**4.0**	**SUBTOTAL**	**70**	**10.3**	**SUBTOTAL**	**40**	**6.1**	**SUBTOTAL**	**51**	**5.5**	**SUBTOTAL**	**50**	**4.6**	**172**	**4.98**	
Species Observed in Any Three Years																	
			Brown Creeper	1	0.1			0.0	Brown Creeper	1	0.1	Brown Creeper	4	0.4	2	0.06	
			Dusky Flycatcher	1	0.1			0.0	Dusky Flycatcher	3	0.3		5	0.5	4	0.12	
			Grace's Warbler	4	0.6	Grace's Warbler	3	0.5			0.0	Grace's Warbler	22	2.0	7	0.20	
			Western Bluebird	1	0.1				Western Bluebird	3	0.3	Western Bluebird	4	0.4	5	0.14	
Williamson's Sapsucker	7	2.5				Williamson's Sapsucker	1	0.2	Williamson's Sapsucker	1	0.1						
SUBTOTAL	**7**	**2.5**	**SUBTOTAL**	**7**	**1.0**	**SUBTOTAL**	**4**	**0.6**	**SUBTOTAL**	**8**	**0.9**	**SUBTOTAL**	**35**	**3.2**	**18**	**0.52**	
Species Observed in Any Two Years																	
			Eurasian Collared Dove	1	0.1	Eurasian Collared Dove	1	0.2			0.0			0.0	2	0.06	
Common Nighthawk	2	0.7	Common Nighthawk	1	0.1						0.0			0.0	3	0.09	
						Downy Woodpecker	1	0.2	Downy Woodpecker	1	0.1			0.0	2	0.06	
			Great blue heron	1	0.1	Great Blue Heron	1	0.2			0.0			0.0	2	0.06	
									Hammond's Flycatcher	34	3.6	Hammond's Flycatcher	48	4.4	34	0.99	
			Red Crossbill	8	1.2						0.0	Red Crossbill	1	0.1	8	0.23	
			Say's Phoebe	4	0.6	Say's Phoebe	2	0.3			0.0			0.0	6	0.17	
									Spotted Towhee	10	1.1	Spotted Towhee	4	0.4	10	0.29	
Tree Swallow	4	1.4	Tree Swallow	1	0.1						0.0			0.0	5	0.14	
						Wild Turkey	1	0.2			0.0	Wild Turkey	1	0.1	1	0.03	
SUBTOTAL	**6**	**2.2**	**SUBTOTAL**	**15**	**2.2**	**SUBTOTAL**	**5**	**0.8**	**SUBTOTAL**	**45**	**4.8**	**SUBTOTAL**	**54**	**5.0**	**71**	**2.06**	
Species Observed in Only One Year																	
									American Kestrel	1	0.1				1	0.03	
						Bald Eagle	1	0.2							1	0.03	
						Band-tailed Pigeon	1	0.2							1	0.03	
						Bullock's Oriole	2	0.3							2	0.06	
Canada Goose	5	1.8													5	0.14	
			Cooper's Hawk	1	0.1										1	0.03	
									Dusky Grouse	2	0.2				2	0.06	
			Goshawk	1	0.1										1	0.03	
			Gray Catbird	1	0.1										1	0.03	
						Lewis's Woodpecker	3	0.5							3	0.09	
									Olive-sided Flycatcher	2	0.2				2	0.06	
									Osprey	1	0.1				1	0.03	
						Peregrine Falcon	1	0.2							1	0.03	
						Western Meadowlark	1	0.2							3	0.09	
White Throated Swift	3	1.1													9	0.26	
												Pine Siskin	6	0.6		0.00	
												Black Swift	5	0.5		0.00	
												White-throated Swift	2	0.2		0.00	
												Olive-sided Flycatcher	1	0.1		0.00	
												Red-naped Sapsucker	1	0.1		0.00	
												Cassin's Finch	4	0.4		0.00	
												House Finch	1	0.1		0.00	
												Red-winged Blackbird	5	0.5		0.00	
												Spotted Towhee	4	0.4		0.00	
												Yellow Warbler	4	0.4		0.00	
												Red-breasted Nuthatch	1	0.1		0.00	
SUBTOTAL	**8**	**2.9**	**SUBTOTAL**	**3**	**0.4**	**SUBTOTAL**	**9**	**1.4**	**SUBTOTAL**	**6**	**0.6**	**SUBTOTAL**	**34**	**3.1**	**34**	**0.99**	

The relative abundances of species in the most common of these feeding guilds are illustrated in Fig. 8. Bird species categorized as ground-brush foraging (GBF) (e.g., American Robin, Green-tailed Towhee; Northern Flicker; see Table 12-A) are most common at FG and JM, constituting about 40% of birds counted at that site across years.

Timber-foliage searching (TFS) species were second most abundant at FG and JM (e.g., Plumbeous Vireo, Warbling Vireo, Yellow-rumped Warbler; see Table 12-A), with an increasing trend from about 15% of birds at that site in 2019, and ramping up to about 30% in 2023. In contrast, TFS species are most common at JMN, with about 50 % of birds counted – led by Warbling Vireo; Western Tanager; Red-breasted Nuthatch; and Mountain Chickadee – all of which were found at FG and JM, but in smaller numbers (Table 12-A).

Table 8. Summary of bird species observed at Jackson Mountain (new) (JMN) site across the five years of this study.

Jackson Mountain North (Established 2022)								
2022				2023			All Years	
Number of Species	38			Number of Species	38		48	
Total Birds Counted	475			Total Birds Counted	876		1351	
	Abund	Rel Abund			Abund	Rel Abund	Abund	Rel Abund
Species Observed In Both Years								
American Robin	25	5.3		American Robin	20	2.28	45	3.33
Black-capped Chickadee	5	1.1		Black-capped Chickadee	2	0.23	7	0.52
Black-headed Grosbeak	4	0.8		Black-headed Grosbeak	5	0.57	9	0.67
Broad-tailed hummingbird	4	0.8		Broad-tailed Hummingbird	3	0.34	7	0.52
Brown Creeper	7	1.5		Brown Creeper	19	2.17	26	1.92
Chipping Sparrow	21	4.4		Chipping Sparrow	28	3.20	49	3.63
Common Raven	2	0.4		Common Raven	7	0.80	9	0.67
Dark-eyed Junco	22	4.6		Dark-eyed Junco	33	3.77	55	4.07
Hairy Woodpecker	2	0.4		Hairy Woodpecker	6	0.68	8	0.59
Hammond's Flycatcher	26	5.5		Hammond's Flycatcher	101	11.53	127	9.40
Hermit Thrush	35	7.4		Hermit Thrush	50	5.71	85	6.29
House Wren	20	4.2		House Wren	19	2.17	39	2.89
MacGillivray's Warbler	1	0.2		MacGillivray's Warbler	5	0.57	6	0.44
Mountain Chickadee	27	5.7		Mountain Chickadee	52	5.94	79	5.85
Northern Flicker	9	1.9		Northern Flicker	25	2.85	34	2.52
Orange-crowned Warbler	7	1.5		Orange-crowned Warbler	31	3.54	38	2.81
Pine Siskin	1	0.2		Pine Siskin	13	1.48	14	1.04
Pygmy Nuthatch	24	5.1		Pygmy Nuthatch	2	0.23	26	1.92
Red-breasted Nuthatch	35	7.4		Red-breasted Nuthatch	37	4.22	72	5.33
Red-tailed Hawk	1	0.2		Red-tailed Hawk	1	0.11	2	0.15
Ruby-crowned Kinglet	19	4.0		Ruby-crowned Kinglet	105	11.99	124	9.18
Steller's Jay	22	4.6		Steller's Jay	25	2.85	47	3.48
Townsend's Solitaire	3	0.6		Townsend's Solitaire	1	0.11	4	0.30
Violet-green Swallow	13	2.7		Violet-green Swallow	20	2.28	33	2.44
Warbling Vireo	44	9.3		Warbling Vireo	93	10.62	137	10.14
Western Tanager	43	9.1		Western Tanager	85	9.70	128	9.47
White-breasted Nuthatch	10	2.1		White-breasted Nuthatch	4	0.46	14	1.04
Yellow-rumped Warbler	19	4.0		Yellow-rumped Warbler	52	5.94	71	5.26
Sub Total	**451**	**94.9**		**Sub Total**	**844**	**96.3**	**1295**	**95.9**
Species Observed in Only One Year								
				American Crow	1	0.11	1	0.07
				Ash-throated Flycatcher	1	0.11	1	0.07
Cooper's Hawk	2	0.4					2	0.15
Cordilleran Flycatcher	1	0.2					1	0.07
				Downy Woodpecker	1	0.11	1	0.07
				Dusky Flycatcher	1	0.11	1	0.07
Grace's Warbler	2	0.4					2	0.15
				Great Horned Owl	2	0.23	2	0.15
Green-tailed Towhee	5	1.1					5	0.37
House Finch	1	0.2					1	0.07
Mourning Dove	1	0.2					1	0.07
				Northern Pygmy Owl	1	0.11	1	0.07
Plumbeous Vireo	6	1.3					6	0.44
				Red Crossbill	12	1.37	12	0.89
Red-naped Sapsucker	2	0.4					2	0.15
Sharp-shinned Hawk	2	0.4					2	0.15
				Turkey Vulture	1	0.11	1	0.07
				Virginia's Warbler	3	0.34	3	0.22
Wild Turkey	2	0.4					2	0.15
				Williamson's Sapsucker	9	1.03	9	0.67
Sub Total	**24**	**5.1**		**Sub Total**	**32**	**3.7**	**56**	**4.1**

Table 9. Summary of bird species abundances observed across years.

TOTALS BY YEAR	2019		2020		2021		2022		2023		ALL YEARS	
NUMBER OF SPECIES	54		58		62		56		64		88	
BIRDS COUNTED (All Species)	949		2227		1855		2086		2903		10020	
	Abund	Rel Abund (%)	Abund	Rel Abund (%)	Abund	Rel Abund (%)	Abund	Rel Abund (%)	Abund	Rel Abund (%)	Abund	Rel Abund (%)
TOTALS ACROSS GROUPINGS	**698**	**73.6**	**1777**	**79.8**	**1638**	**88.3**	**1874**	**89.8**	**2466**	**84.9**	**8453**	**84.4**
Bird Species Recorded At All Sites In All Years = 9												
American Robin	199	21.0	290	13.0	284	15.3	177	8.5	386	13.3	1336	13.3
Hairy Woodpecker	4	0.4	22	1.0	28	1.5	9	0.4	5	0.2	68	0.7
Northern Flicker	80	8.4	76	3.4	95	5.1	113	5.4	115	4.0	479	4.8
Pygmy Nuthatch	33	3.5	193	8.7	209	11.3	199	9.5	94	3.2	728	7.3
Steller's Jay	17	1.8	75	3.4	64	3.5	70	3.4	63	2.2	289	2.9
Violet-green Swallow	39	4.1	188	8.4	136	7.3	97	4.7	92	3.2	552	5.5
Western Tanager	44	4.6	95	4.3	101	5.4	194	9.3	286	9.9	720	7.2
White-breasted Nuthatch	28	3.0	52	2.3	54	2.9	64	3.1	46	1.6	244	2.4
Yellow-rumped Warbler	12	1.3	94	4.2	64	3.5	63	3.0	180	6.2	413	4.1
SUB-TOTALS	**456**	**48.1**	**1085**	**48.7**	**1035**	**55.8**	**986**	**47.3**	**1267**	**43.6**	**4829**	**48.2**
Bird Species Recorded In At Least Two Sites In Each Year = 8												
Chipping Sparrow	14	1.5	35	1.6	50	2.7	77	3.7	95.0	3.3	271	2.7
Common Raven	10	1.1	26	1.2	13	0.7	16	0.8	17.0	0.6	82	0.8
Green-tailed Towhee	16	1.7	35	1.6	53	2.9	85	4.1	56.0	1.9	245	2.4
Mourning Dove	2	0.2	45	2.0	42	2.3	14	0.7	23.0	0.8	126	1.3
Mountain Chickadee	4	0.4	8	0.4	2	0.1	39	1.9	62.0	2.1	115	1.1
Plumbeous Vireo	14	1.5	27	1.2	25	1.3	48	2.3	57.0	2.0	171	1.7
Turkey Vulture	12	1.3	14	0.6	9	0.5	10	0.5	6.0	0.2	51	0.5
Warbling Vireo	7	0.7	17	0.8	27	1.5	93	4.5	227.0	7.8	371	3.7
Western Bluebird	8	0.8	47	2.1	61	3.3	31	1.5	17.0	0.6	164	1.6
Western Wood-Pewee	98	10.3	245	11.0	208	11.2	210	10.1	162.0	5.6	923	9.2
SUB-TOTALS	**185**	**19**	**499**	**22**	**490**	**26**	**623**	**30**	**722**	**25**	**2519**	**25.1**
Bird Species Recorded In At Least One Site In Each Year = 17												
American Crow	16	1.7	16	0.7	11	0.6	7	0.3	7.0	0.2	57	0.6
Black-capped Chickadee	1	0.1	11	0.5	5	0.3	7	0.3	2.0	0.1	26	0.3
Black-headed Grosbeak	10	1.1	7	0.3	17	0.9	24	1.2	61.0	2.1	119	1.2
Broad-tailed Hummingbird	3	0.3	17	0.8	5	0.3	14	0.7	22.0	0.8	61	0.6
Brown-headed Cowbird	1	0.1	2	0.1	4	0.2	1	0.0	3.0	0.1	11	0.1
Cassin's Finch	1	0.1	8	0.4	5	0.3	5	0.2	19.0	0.7	38	0.4
Common Nighthawk	6	0.6	3	0.1	7	0.4	12	0.6	20.0	0.7	48	0.5
Cordilleran Flycatcher	3	0.3	19	0.9	2	0.1	8	0.4	3.0	0.1	35	0.3
Dark-eyed Junco	0	0.0	62	2.8	22	1.2	33	1.6	54.0	1.9	171	1.7
Hermit Thrush	1	0.1	3	0.1	1	0.1	39	1.9	62.0	2.1	106	1.1
House Wren	4	0.4	8	0.4	7	0.4	69	3.3	107.0	3.7	195	1.9
Orange-crowned Warbler	2	0.2	3	0.1	9	0.5	15	0.7	43.0	1.5	72	0.7
Red-tailed Hawk	1	0.1	4	0.2	1	0.1	9	0.4	10.0	0.3	25	0.2
Townsend's Solitaire	3	1.3	8	0.4	11	0.6	3	0.1	3.0	0.1	28	0.3
Virginia's Warbler	3	0.3	21	0.9	5	0.3	17	0.8	52.0	1.8	98	1.0
Williamson's Sapsucker	2	0.2	1	0.0	1	0.1	2	0.1	9.0	0.3	15	0.1
SUB-TOTALS	**57**	**7.0**	**193**	**8.7**	**113**	**6.1**	**265**	**12.7**	**477**	**16.4**	**1105**	**11.0**

Table 10. Summary of bird species across years by site with cumulative relative abundances of 3.5 or higher.

Turkey Springs (TS)			Fawn Gulch (FG)			Jackson Mountain (JM)			Jackson Mountain North (JMN)			ALL SITES		
Num Spp = 9	Abund	Cum Abund %	Num Spp = 7	Abund	Cum Abund %	Num Spp = 10	Abund	Cum Abund %	Num Spp = 10	Abund	Cum Abund %	Num Spp = 7	Abund	Cum Abund %
TOTALS	1101	74.35	TOTALS	1874	57.18	TOTALS	2450	71.1	TOTALS	927	68.7	TOTALS	5458	54.5
American Robin	179	12.1	American Robin	527	16.1	American Robin	504	14.6				American Robin	1336	13.3
Chipping Sparrow	64	4.32							Chipping Sparrow	49	3.6			
									Dark-eyed Junco	55	4.1			
			Green-tailed Towhee	200	6.1									
									Hammond's Flycatcher	127	9.4			
									Hermit Thrush	85	6.3			
						House Wren	121	3.5						
									Mountain Chickadee	79	5.9			
Northern Flicker	58	3.92				Northern Flicker	233	6.8				Northern Flicker	479	4.8
Pygmy Nuthatch	193	13.03	Pygmy Nuthatch	119	3.63	Pygmy Nuthatch	326	9.5				Pygmy Nuthatch	728	7.3
									Red-breasted Nuthatch	72	5.3			
									Ruby-crowned Kinglet	124	9.2			
						Steller's Jay	155	4.5						
Violet-green Swallow	202	13.64				Violet-green Swallow	226	6.6				Violet-green Swallow	552	5.5
			Warbling Vireo*	116	3.53	Warbling Vireo	167	4.8	Warbling Vireo	137	10.1			
			Western Tanager	260	7.92	Western Tanager	304	8.8	Western Tanager	128	9.5	Western Tanager	720	7.2
Western Bluebird	88	5.94												
Western Wood-Pewee	147	9.9	Western Wood-Pewee	495	15.1	Western Wood-Pewee	290	8.4				Western Wood-Pewee*	923	9.2
White-breasted Nuthatch	68	4.6												
Yellow-rumped Warbler	102	6.9	Yellow-rumped Warbler	157	4.8	Yellow-rumped Warbler	124	3.6	Yellow-rumped Warbler	71	5.3	Yellow-rumped Warbler	720	7.2

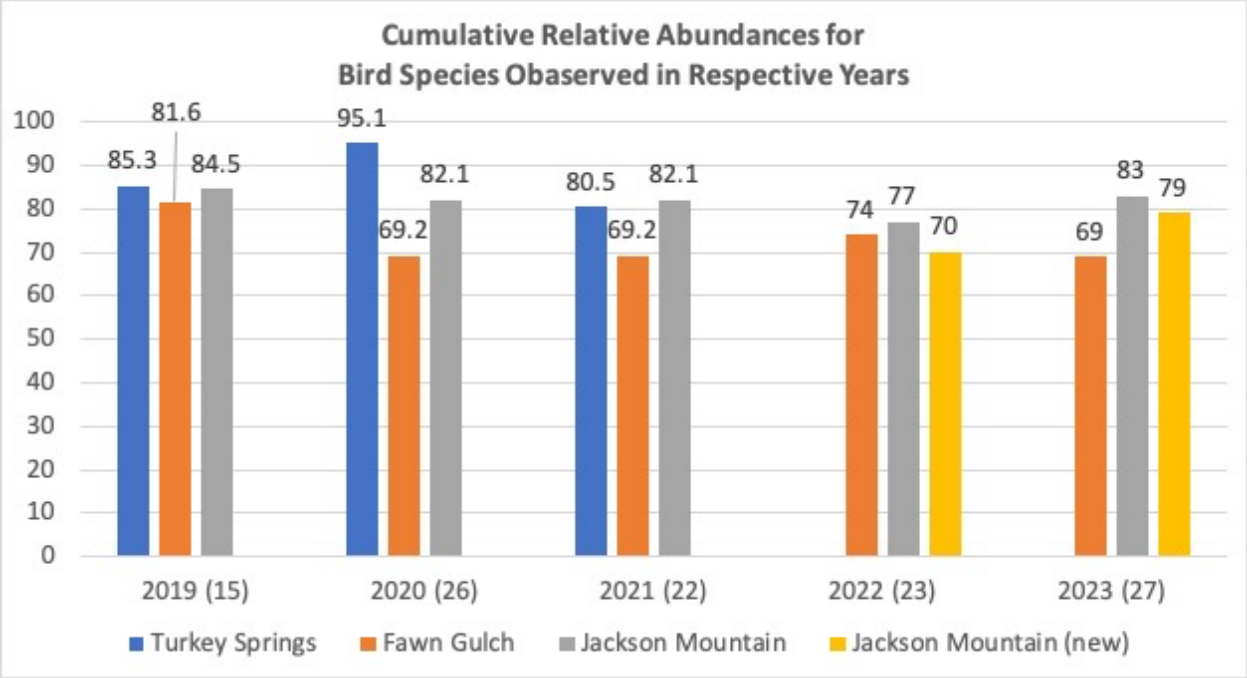


Figure 7. Summary of cumulative relative abundances for the bird species common to all three sites recorded in respective years at each site. Numbers in parentheses are the number of species common to all three sites in that respective year. (see also Tables 4, 6, 7, 8, and 9)

Table 11. List of bird species identified as incidental in respective years that were not observed at monitoring points in those years. INC ONLY = incidental only that year; none = no sightings; TS = Turkey Springs site; FG = Fawn Gulch site; JM = Jackson Mountain site; JMN = Jackson Mountain North site established in 2022.

Species	2019	2020	2021	2022	2023
American Kestrel	INC ONLY	none	none	JM	none
Canada Goose	FG, JM	none	INC ONLY	none	none
Dusky Grouse	none	FG	none	JM	INC ONLY
Lincoln Sparrow	none	none	none	none	INC ONLY
Pine Siskin	FG	TS	INC ONLY	FG, JMN	FG, JM, JMN
Red Crossbill	FG	TS, FG, JM	INC ONLY	none	FG, JM, JMN
Red-naped Sapsucker	none	none	INC ONLY	JMN	JM
Sharp-shinned Hawk	none	INC ONLY	TS	JMN	FG
Western Meadowlark	none	INC ONLY	JM	INC ONLY	none
Wild Turkey	none	INC ONLY	FG, JM	JMN	JM
Woodhouse's Scrub Jay	none	none	none	none	INC ONLY

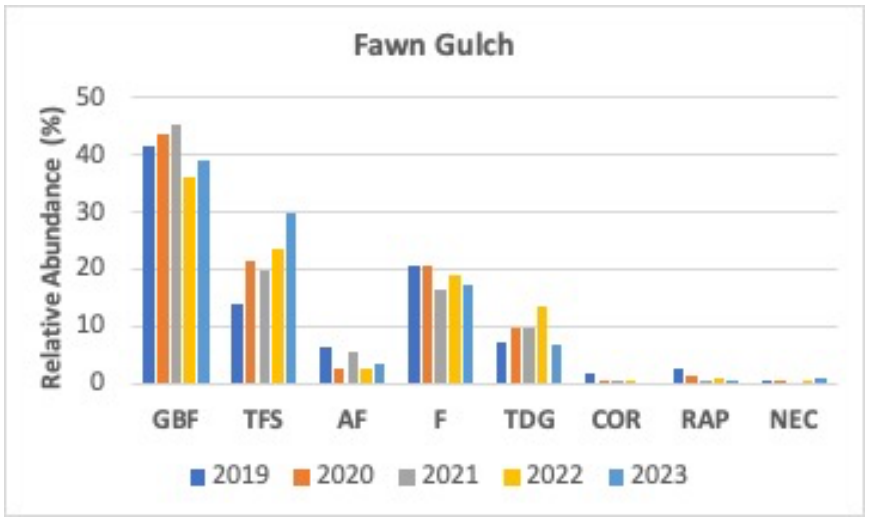
Aerial flycatchers (AF) (e.g., Violet-green Swallow; see Table 12-B), flycatchers (F), and timber-drilling/gleaning species (TDG) (e.g., Hairy Woodpecker, Pygmy Nuthatch, White-breasted Nuthatch; see Table 12-B) were abundant at all three sites, but generally in lesser proportions at JMN. Interestingly, at JM, increasing trends in the abundance of AF, F and TDG bird species through 2022 were accompanied by a decreasing trend in GBF species through 2022 (Fig. 8), but that trend is not sustained by 2023 data. There was an increasing trend in TFS species at FG, and F species were more abundant than observed at JM or JMN, reflecting the more open canopy structure at that site, which favored Western Wood-Pewee, Grace's Warbler, and Cordilleran Flycatcher species (Table 12-A).

Table 12-A. Summary of bird species by Ground-Brush Foraging (GBF), and Timber-Foliage Searching (TFS) feeding habit (i.e., feeding guilds) across sites. Categorization of bird species based on Lowe et al., 1978; Bock and Lynch, 1970; and Cornell Lab of Ornithology (www.allaboutbirds.org).

	Fawn Gulch										Jackson Mountain										Jackson Mountain North			
	2019		2020		2021		2022		2023		2019		2020		2021		2022		2023		2022		2023	
	ABUND	REL ABUND	ABUND	REL ABUND	ABUND	REL ABUND	ABUND	REL ABUND	ABUND	REL ABUND	ABUND	REL ABUND	ABUND	REL ABUND	ABUND	REL ABUND	ABUND	REL ABUND	ABUND	REL ABUND	ABUND	REL ABUND	ABUND	REL ABUND
Ground-Brush Foraging																								
American Goldfinch	3	0.6																						
American Robin	130	25.9	110	12.9	140	23.6	60	8.7	136	14.3	75	26.2	103	15.1	85	13	92	9.9	149	13.9	25	5.3	20	2.8
Band-tailed Pigeon			34	4																				
Black-capped Chickadee			21	2.5							1	0.3	11	1.6	5	0.8	2	0.2			5	1.1	2	0.23
Black-headed Grosbeak	5	1	9	1.1	1	0.2	4	0.6	21	2.2	5	1.8			10	1.5	16	1.7	35	3.3	4	0.8	5	0.57
Brown-headed Cowbird	3	0.6					1	0.1	1	0.1	1	0.001	2	0.3	4	0.6			2	0.2				
Bullock's Oriole	1	0.2													2	0.3								
Canada Goose	12	2.4									5	1.75												
Cassin's Finch	3	0.6	6	0.7	2	0.3	5	0.7	15	1.6									4	0.4				
Chipping Sparrow	10	2	12	1.4	15	2.5	29	4.2	34	3.6			37	5.4	6	0.9	27	2.9	33	3.1	21	4.4	28	3.2
Dark-eyed Junco	1	0.2	8	0.9	3	0.5	2	0.3	15	1.6			8	1.2	5	0.8	9	1	6	0.6	22	4.6	33	3.8
Dusky Grouse			1	0.1													2	0.2						
Eurasian Collared Dove													1	0.1	1	0.2								
European Starling																								
Evening Grosbeak			1	0.1					2	0.2														
Gray Catbird													1	0.1										
Green-tailed Towhee	19	3.8	35	4.1	53	8.9	49	7.1	47	4.9	7	2.5	29	4.2	11	1.7	31	3.3	9	0.9	5	1.1		
Hermit Thrush									3	0.3	1	0.4	3	0.4	1	0.2	4	0.4	9	0.8	35	7.4	50	5.71
House Finch									2	0.2									1	0.1	1	0.2		
House Wren			32	3.7	2	0.3	10	1.4	25	2.6	1	1.4	8	1.2	7	1.1	39	4.2	63	5.9	20	4.2	19	2.2
Mountain Bluebird	1	0.2					2	0.3																
Mourning Dove			63	7.4	11	1.9	1	0.1	1	0.1	1	0.4	9	1.3	39	6	12	1.3	22	2.1	1	0.2		
Northern Flicker	44	8.8	10	1.2	19	3.2	46	6.8	45	4.7	29	10.1	52	7.6	49	7.5	58	6.2	45	4.2	9	1.9	25	2.85
Pine Siskin	2	0.4					2	0.3	2	0.2									6	0.6	1	0.2	13	1.48
Red Crossbill	1	0.2	9	1.1					2	0.2			8	1.2					1	0.1			12	1.4
Red-winged Blackbird					1	0.2			2	0.2									5	0.5				
Song Sparrow			1	0.1					1	0.1														
Spotted Towhee			4	0.4	13	2.2	11	1.6	7	0.7							10	1.1	4	0.4				
Townsend's Solitaire			1	0.1	2	0.3					3	1.1	1	0.1	2	0.3			2	0.2	3	0.6	1	0.11
Western Bluebird	5	1	16	1.9	8	1.3	28	4.1	13	1.4			1	0.1			3	0.3	4	0.4				
Western Meadowlark															1	0.2								
White-crowned sparrow																								
Wild Turkey					2	0.34													1	0.1	2	0.4		
Sub-TOTALS	**240**	**47.9**	**373**	**43.7**	**270**	**45.4**	**250**	**36.3**	**374**	**39.2**	**129**	**45.951**	**274**	**39.9**	**228**	**35.1**	**305**	**32.7**	**400**	**37.7**	**152**	**32**	**208**	**24.35**
Timber-Foliage Searching																								
Caissin's Vireo					1	0.2			2	0.2														
Cedar Waxwing									2	0.2														
MacGillvery's Warbler																					1	0.2	5	0.6
Mountain Chickadee	1	0.2	6	0.7	3	0.5	1	0.1	7	0.7	4	1.4	8	1.2	2	0.3	8	0.9	3	0.3	27	5.7	52	5.94
Orange-crowned Warbler			5	0.7	2	0.3	2	0.3	6	0.6	2	0.7	3	0.4	9	1.4	3	0.3	6	0.6	7	1.5	28	3.2
Plumbeous Vireo			19	2.2	5	0.8	32	4.7	42	4.4	12	4.2	25	3.7	10	1.5	10	1.1	15	1.4	6	1.3		
Red-breasted Nuthatch													3	0.4			3	0.3	1	0.1	35	7.4	37	4.22
Ruby-crowned Kinglet																					19	4	105	12
Steller's Jay	10	2	16	1.9	33	5.6	15	2.2	9	1	11	3.9	52	7.6	30	4.6	33	3.5	29	2.7	22	4.6	25	2.9
Virginia's Warbler					1	0.2	1	0.1	178	1.9	3	1	21	3.1	5	0.8	16	1.7	31	2.9			3	0.34
Warbling Vireo	1	0.2	30	3.5	19	3.2	18	2.6	49	5.1	7	2.5	17	2.5	27	4.1	31	3.3	85	8	44	9.3	93	10.6
Western Tanager	32	6.4	36	4.2	37	6.2	61	8.8	99	10.4	16	5.6	49	7.2	47	7.2	90	9.6	102	9.5	43	9.1	85	9.7
Yellow-rumped Warbler	13	2.6	41	4.8	19	3.2	34	4.9	55	5.8	12	4.2	11	1.6	18	2.8	10	1.1	73	6.8	19	4	52	5.9
Sub-TOTALS	**57**	**11.4**	**153**	**18**	**119**	**20**	**164**	**23.7**	**445**	**29.9**	**67**	**23.5**	**189**	**27.7**	**148**	**22.7**	**204**	**21.8**	**345**	**32.3**	**223**	**47.1**	**485**	**55.4**

Table 12-B. Summary of bird species by Aerial Flycatcher (AF), Flycatcher (F), Timber-Drilling/Gleaning (TDG), Corvid (COR), Raptor (RAP), Nectar Feeding (NEC), and Other feeding habits (i.e., feeding guilds) across sites. Categorization of bird species based on Lowe et al., 1978; Bock and Lynch, 1970; and Cornell Lab of Ornithology (www.allaboutbirds.org).

	Fawn Gulch										Jackson Mountain										Jackson Mountain North			
	2019		2020		2021		2022		2023		2019		2020		2021		2022		2023		2022		2023	
	ABUND	REL ABUND	ABUND	REL ABUND	ABUND	REL ABUND	ABUND	REL ABUND	ABUND	REL ABUND	ABUND	REL ABUND	ABUND	REL ABUND	ABUND	REL ABUND	ABUND	REL ABUND	ABUND	REL ABUND	ABUND	REL ABUND	ABUND	REL ABUND
Aerial Flycatcher																								
Common Nighthawk					16	2.7	12	1.7	20	2.1	2	0.7	1	0.1										
Northern Rough-winged Swallow	25	5																						
Olive-sided Flycatcher					1	0.2											2	0.2	1	0.1				
Tree Swallow	7	1.4			1	0.2					4	1.4	1	0.1										
Violet-green Swallow	11	2.2	38	4.4	14	2.4	6	0.9	13	1.4	3	1.1	41	6	45	6.9	78	8.4	59	5.5	13	2.7	20	2.3
White-throated Swift											3	1.1							2	0.2				
Sub-TOTALS	**43**	**8.6**	**38**	**4.4**	**32**	**5.5**	**18**	**2.6**	**33**	**3.5**	**12**	**4.3**	**43**	**6.2**	**45**	**6.9**	**80**	**8.6**	**62**	**5.8**	**13**	**2.7**	**20**	**2.3**
Flycatcher																								
Ash-throated Flycatcher									2	0.21													1	0.1
Cordilleran Flycatcher	3	0.6	19	2.2	2	0.3	3	0.4	2	0.2			4	0.6	18	2.8	4	0.4	1	0.1	1	0.2		
Dusky Flycatcher							20	2.9	28	2.9			1	0.1			3	0.3	5	0.5			1	0.11
Grace's Warbler			11	1.3			18	2.6	36	3.8			4	0.6	3	0.5			22	2.1	2	0.4		
Hammond's Flycatcher									4	0.4							34	3.6	48	4.5	26	5.5	101	11.5
Lewis's Woodpecker															3	0.5								
Say's Phoebe	2	0.4			2	0.3							4	0.6	2	0.3								
Western Wood-Pewee	83	16.6	153	17.9	94	15.8	90	13	94	9.9	14	4.9	29	4.2	59	9	120	12.9	68	6.3				
Yellow Warbler	2	0.4							1	0.1									4	0.4				
Sub-TOTALS	**90**	**18**	**183**	**21.4**	**98**	**16.4**	**131**	**18.9**	**165**	**17.3**	**14**	**4.9**	**42**	**6.1**	**85**	**13.1**	**161**	**17.2**	**148**	**13.9**	**29**	**6.1**	**102**	**11.61**
Timber Drilling/Gleaning																								
Brown Creeper					1	0.2							1	0.1			1	0.1	4	0.4	7	1.5	19	2.2
Downy Woodpecker	3	0.6							1	0.1							1	0.1					1	0.11
Hairy Woodpecker	2	0.4	7	0.8	7	1.2	2	0.3	1	0.1	1	0.4	5	0.7	15	2.5	5	0.5	7	0.7	2	0.4	6	0.7
Pygmy Nuthatch	7	1.4	55	6.4	17	4.5	68	10	32	3.4	12	4.2	57	8.3	90	13.8	107	11.5	60	5.6	24	5.1	2	0.23
Red-naped Sapsucker	2	0.4																	1	0.1	2	0.4		
Three-toed Woodpecker					3	0.5																		
White-breasted Nuthatch	23	4.6	29	3.4	20	3.4	23	3.3	32	3.4	4	1.4	17	2.5	14	2.1	31	3.3	10	0.9	10	2.1	4	0.46
Williamson's Sapsucker			1	0.1	1	0.1	1	0.1			7	2.45			1	0.2	1	0.1					9	1
Sub-TOTALS	**37**	**7.4**	**92**	**10.7**	**49**	**9.9**	**94**	**13.7**	**66**	**7**	**24**	**8.45**	**80**	**11.6**	**120**	**18.6**	**146**	**15.6**	**82**	**7.7**	**45**	**9.5**	**41**	**4.7**
Corvid																								
American Crow	4	0.8	2	0.2	3	0.5			2	0.2	2	0.7	8	1.2	3	0.5	7	0.8	4	0.4			1	0.11
Common Raven	1	0.2			1	0.2	2	0.3	2	0.2	11	3.9	12	1.8	8	1.2	12	1.3	8	0.7	2	0.4	7	0.8
Black-billed Magpie	2	0.4																						
Sub-TOTALS	**7**	**1.4**	**2**	**0.2**	**4**	**0.7**	**2**	**0.3**			**13**	**4.6**	**20**	**3**	**11**	**1.7**	**19**	**2.1**	**12**	**1.1**	**2**	**0.4**	**8**	**0.91**
Raptor																								
American Kestrel	1	0.2															1	0.1						
Bald Eagle	2	0.4					1	0.1							1	0.2								
Cooper's Hawk													1	0.1							2	0.4		
Goshawk													1	0.1										
Great Horned Owl			3	0.4																			2	0.23
Northern Pygmy Owl																							1	0.1
Osprey																	1	0.1						
Red-tailed Hawk	1	0.2	4	0.5	1	0.2	1	0.1	4	0.4	6	2.1	4	0.6			6	0.6	5	0.5	1	0.2	1	0.11
Sharp-shinned Hawk									1	0.1					1	0.2					2	0.4		
Turkey Vulture	6	1.2	3	0.4	2	0.3	5	0.7	1	0.1	8	2.8	10	1.5	6	0.5	5	0.5	4	0.4			1	0.11
Sub-TOTALS	**10**	**2**	**10**	**1.3**	**3**	**0.5**	**7**	**0.9**	**6**	**0.6**	**14**	**4.9**	**16**	**2.3**	**8**	**0.9**	**13**	**1.3**	**9**	**0.9**	**5**	**1**	**5**	**0.55**
Nectar Feeding																								
Black-chinned Hummingbird			1	0.1																				
Broad-tailed Hummingbird	2	0.4	3	0.4			5	0.7	8	0.8	2	0.7	11	1.6	3	0.5	5	0.5	11	1	4	0.8		
Sub-TOTALS	**2**	**0.4**	**4**	**0.5**	**0**	**0**	**5**	**0.7**	**8**	**0.8**	**2**	**0.7**	**11**	**1.6**	**3**	**0.5**	**5**	**0.5**	**11**	**1**	**4**	**0.8**	**0**	**0**
Other																								
Great Blue Heron									1	0.1			1	0.2										



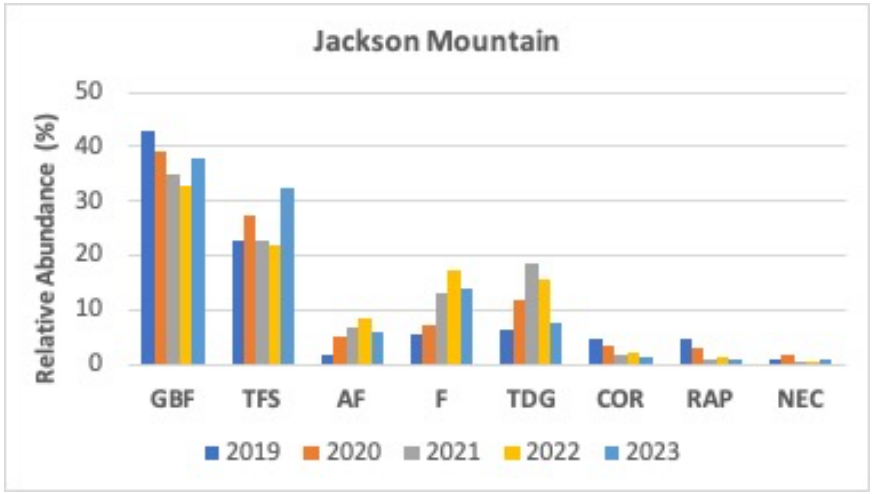


Figure 8. Relative abundances of bird species feeding guilds at Fawn Gulch; Jackson Mountain; and Jackson Mountain (New) study sites. GBF = Ground/Brush Foraging; TFS = Timber Foliage Searching; AF = Aerial Flycatcher; F = Flycatcher; TDG = Timber Drilling/Gleaning; COR = Corvids; RAP = Raptors; and NEC = Nectar Feeding.

At JM, the decreasing trend in the relative abundance of GBF species occurring through 2022 (Fig. 8) does not reflect a decrease in numbers of birds representing species in this category, which actually increased, but rather a concurrent increase in abundance and relative abundance of TDG species (Tables 12 A & B). Indeed, numbers of American Robins, Chipping Sparrows, Green-tailed Towhees, and Northern Flickers (all GBF species) increased or remained relatively constant across years at JM, with a concurrent increase in numbers of Hairy Woodpeckers, Pygmy Nuthatches, and White-breasted Nuthatches (all TDG species) at that site. This result may reflect, at least in part, year-to-year variability, but as discussed earlier, improved birding skills of observers and inclusion of the Merlin APP for identifying birds by song may partially account for this result as well.

Species-level response – Nesting Behaviors-

The availability of nesting sites is expected to have a significant influence on bird species present at a site (see Coe, 2014). Using information from the Cornell Lab (www.allaboutbirds.org; see also Coe, 2014), we categorized birds as tree/shrub nesters; ground/cliff nesters, or "other," nesters (where "other" refers to use of crevices or ledges on buildings or other structures); or cavity nesters.

Over the five years of this study, nests, or clear evidence of nests (e.g., presence of recent fledglings) of at least 25 bird species were observed, including: American Robin; Broad-tailed Hummingbird; Cassin's Finch; Common Nighthawk; Chipping Sparrow; Cordilleran Flycatcher; Dusky Flycatcher; Great Horned Owl; Hammond's Flycatcher; House Wren; Northern Flicker; Plumbeous Vireo; Pygmy Nuthatch; Red-breasted Nuthatch; Red-tailed Hawk; Ruby-crowned Kinglet; Violet-green Swallow; Warbling Vireo; Western Bluebird; Western Tanager; Western Wood-Pewee; White-breasted Nuthatch; Wild Turkey; Williamson's Sapsucker; and Yellow-rumped Warbler.

Nest sites for tree/shrub and ground nesting species is widely available at our sites, but, suitable sites for cavity nesters may be a limiting factor. We categorized cavity nesters into primary (species that excavate or enlarge nest cavities each breeding season); secondary (species that use existing cavities from primary excavators); or primary or secondary nesters (species that may be weak excavators and may use existing cavities if available) (Table 13).

Cavity nesting species are of great interest in the conservation community because of potentially limited availability of sites amenable to cavity excavation (e.g., standing dead trees or "snags", or living trees with soft or decaying areas on branches or boles); important interdependencies that exist between primary and secondary cavity nesters; and the implications of this group to ecosystem function (Bednarz et. al., 2004; Coe, 2004; Ibarra et. al., 2017; Martin and Li, 1992). In this context, the concept of "nest-webs" and the role of primary nest cavity excavators as "keystone" species (see Bednarz et. al., 2004; Coe, 2014; and Ibarra et. al., 2017) has particular relevance for forest managers. Primary cavity excavators (e.g., Hairy Woodpecker, Northern Flicker) are keystone species in the sense that they are essential to the reproductive success of weak nest excavator species (e.g., Lewis's Woodpeckers; many Chickadee species) and bird species that rely exclusively on pre-existing cavities for reproduction. Cavity nest excavators also play a role in other ecosystem functions, in particular wood decomposition, through the dispersal of fungal spores during nest excavation and foraging (Farris et. al., 2004). The work of Ibarra et. al., (2017) provides compelling evidence that cavity nesters are also important determinants of forest ecosystem resilience in the context of forest management practices.

Looking across all 88 species encountered through the five years of our study, we identified 44 tree/shrub nesting species; 19 ground/cliff/other species; and 20 cavity nesting species (see Table 13; only data for cavity nesters is shown). Among the 20 cavity nesting species, 5 are categorized as primary nesting species (Downy Woodpecker, Hairy Woodpecker, Northern Flicker, Three-toed Woodpecker, and Williamson's Sapsucker); 10 species fall into the secondary nesting category (American Kestrel, Ash-throated Flycatcher, European Starling, House Wren, Mountain Bluebird, Mountain Chickadee, Tree Swallow, Violet-green Swallow, Western Bluebird, White-breasted Nuthatch); with 5 species capable of either excavating new cavities or using existing cavities for their nests (Table 13). Notably, cavity nesting species were observed at between 29% and 38% of the bird monitoring points in each year of the study. In terms of relative abundance across all years, 45% of birds counted at TS were cavity nesters, predominantly Violet-green Swallows and Pygmy Nuthatches; with 19% of birds counted at FG; 31% of birds counted at JM; and 24% of birds counted at JMN falling into this category. Pygmy Nuthatches; Northern Flickers; Violet-green Swallows; House Wrens; and White-breasted Nuthatches, in that order, were the most abundant cavity nesting species across all three sites.

Table 13. Summary of cavity nesting species identified across all three years of the study. Primary cavity nesters are those species that actively excavate new cavities in each breeding season; secondary cavity nesters occupy existing cavities left by primary excavators. Freq = number of monitoring points where species was observed; Rel freq = Freq/total number of monitoring points sampled (270) (Categorizations based on data obtained from www.allaboutbirds.org; and Coe, 2014) (Conservation Scores are from Table 15)

Cavity Nesting Species																
	2019			2020			2021			2022			2023			Conservation
Species	Sites	Freq	Rel Freq	Sites	Freq	Rel freq	Sites	Freq	Rel freq	Sites	Freq	Rel freq	Sites	Freq	Rel freq	Score
Primary Cavity Nesters																
Downy Woodpecker	TS, FG	2	0.3	none	none	none	JM	1	0.1	JM	1	0.1	FG, JMN	2.0	0.1	7
Hairy Woodpecker	TS, FG, JM	9	1.4	TS, FG, JM	20	1.3	TS, FG, JM	23	1.7	FG, JM, JMN	9	0.7	FG, JM, JMN	12.0	0.9	6
Three-toed Woodpecker	none	none	none	none	none	none	FG	2	0.2	none	none	none	none	none	none	10
Northern Flicker	TS, FG, JM	33	5.1	TS, FG, JM	64	4.1	TS, FG, JM	79	6.0	FG, JM, JMN	95	7.5	FG, JM, JMN	100.0	7.4	10
Williamson's Sapsucker	TS, JM	5	0.8	FG	1	0.1	JM	1	0.1	FG, JM	2	0.2	JMN	7.0	0.5	12
Primary or Secondary Cavity Nesters																
Black-capped Chickadee	JM	1	0.2	TS, FG, JM	25	1.6	TS, JM	6	0.5	JM, JMN	6	0.5	JMN	2.0	0.1	7
Lewis's Woodpecker	TS	1	0.2	none	none	none	JM	3	0.2	none	none	none	none	none	none	15
Red-breasted Nuthatch	none	none	none	TS, JM	2	0.1	none	none	none	JM, JMN	33	2.6	JM, JMN	34	2.5	6
Red-naped Sapsucker	FG	2	0.3	none	none	none	none	none	none	JMN	2	0.2	JM	1	0.1	9
Pygmy Nuthatch	TS, FG, JM	48	7.4	TS, FG, JM	114	7.2	TS, FG, JM	117	8.8	FG, JM, JMN	110	8.7	FG, JM, JMN	64.0	4.7	11
Secondary Cavity Nesters																
American Kestrel	FG	1	0.2	none	none	none	none	none	none	JM	1	0.1	none	none	none	11
Ash-throated Flycatcher	none	none	none	none	none	none	FG	1	0.8	none	none	none	FG, JMN	2	0.1	8
European Starling	none	none	none	TS	1	0.1	none	none	none	none	none	none	none	none	none	5
House Wren	JM	2	0.3	TS, FG, JM	45	2.9	TS, FG, JM	13	1.0	FG, JM, JMN	59	4.7	FG, JM, JMN	91.0	6.7	5
Mountain Bluebird	FG	1	0.2	none	none	none	TS	1	0.1	FG	1	0.1	none	none	none	12
Mountain Chickadee	FG, JM	3	0.5	TS, FG, JM	12	0.8	none	none	none	FG, JM, JMN	34	2.7	FG, JM, JMN	55	4.1	10
Tree Swallow	FG, JM	4	0.6	JM	1	0.1	none	none	none	none	none	none	none	none	none	8
Violet-green Swallow	TS, FG, JM	97	14.9	TS, FG, JM	89	5.6	TS, FG, JM	74	5.6	FG, JM, JMN	57	4.5	FG, JM, JMN	44.0	3.3	9
Western Bluebird	TS, FG	9	1.4	TS, FG, JM	34	2.2	TS, FG	40	3.0	FG, JM	14	1.1	FG, JM	13.0	1.0	9
White-breasted Nuthatch	TS, FG, JM	31	4.7	TS, FG, JM	55	3.5	TS, FG, JM	61	4.6	FG, JM, JMN	55	4.4	FG, JM, JMN	40.0	3.0	6

Northern Flickers and Hairy Woodpeckers were the most abundant primary cavity nesters seen at all sites in each year of the study, along with Violet-green Swallows, House Wrens, and White-breasted Nuthatches as the most abundant and widespread secondary cavity nesters, and Pygmy Nuthatches the most common species fulfilling either category (Table 13).

Other less common species that increased across years were Black-capped Chickadees, House Wrens, Mountain Chickadees, and Western Bluebirds. Williamson's Sapsuckers and Tree Swallows were uncommon in our study and were present in very low numbers, along with Downy Woodpeckers and Lewis's Woodpeckers. The observation that these uncommon species decreased from 2019 to 2022, or were observed only in a subset of the five years of study, suggests that their presence or absence was a consequence of year-to-year variability in bird community composition.

Most notable among the cavity nesters are those exhibiting conservation scores of 12 or higher (see Table 15), indicating some concern for the sustainability of their populations. These include Williamson's Sapsucker, Lewis's Woodpecker, and the Mountain Bluebird. Regardless of conservation status, cavity nesting bird species fulfill a critical role in forest ecosystems through their consumption of insects and other invertebrates that, if their population numbers are left unchecked, may have significant impacts on other measures of ecosystem function. Preserving the dead snags that constitute a critical resource for these species is therefore increasingly important as wildland fuel reduction treatments, logging, and thinning activities in our forests expand.

Community -level observations-

The fields of population and community ecology have, for over a century of field research, addressed questions concerning the causes and consequences of the distribution and abundance of various species' populations or groups of species. Regardless of the taxonomic group of interest, one uniform outcome of these studies is that a relatively small number of species tend to be very common, with a greater number of species found to be uncommon or rare in a region surveyed (e.g., Flather and Sieg, 2007; Gaston, 2011). The results of our study are consistent with this general pattern.

As already noted, of the 88 different bird species observed over the five years of this study, 34 species, representing about 84% of the birds counted, were observed in all four years (Tables 9 and 14). Of those 34 species, 9 were present at all sites across all years of the study, accounting for about 48% of all birds counted. The remaining 54 species of birds observed in this study account for the remaining 16% of birds counted – or about 1600 birds.

This raises an important question – should conservationists be more concerned about patterns in the distribution and abundance of common species, or focus their attention on the uncommon or rare species? As a corollary to this question, we know very little about the long-term trends in population numbers for those birds observed in our study at only one or two sites per year. Are those bird species less common in our study because they are in low numbers, passing through, elusive, or are they in decline? The data summarized in Tables 14, 15, and 16 address this very important question, and one that we did not anticipate addressing with our study at its inception.

The data shown in Table 14 simply documents the presence or absence of bird species across sites and across years. As shown, three sites were monitored in each year of the study. The "Commonness Score" (CoSc) is a tally of the presence of a species at a site in the respective years shown. The nine most common bird species attained a CoSc score of 15 – meaning that species was present at each site across the five years of the study. Conversely, 13 species attained a CoSc of 1, meaning they were observed at only one site in one year of the study, with an additional 13 species with a CoSc of 2.

The North American Bird Conservation Initiative (see https://nabci-us.org/how-we-work/state-of-the-birds), through the Cornell Lab of Ornithology, produces reports on the status of North American birds (see also https://www.stateofthebirds.org/2022/). In their 2022 report, they estimate that 3 billion birds have been lost across NA and Canada, with 70 bird species approaching a tipping point in their population numbers. Moreover, populations of bird species across the US are showing decreasing trends in almost all habitats, except for wetlands where conservation efforts affecting waterfowl are having some positive impacts. According to their research, 19 species of western forest birds are in decline, with several species having lost more than 50% of their population

numbers since 1970, among them the Williamson's Sapsucker, which is one of the species reported in our study (Table 2).

The shading in Table 14 cross-references to Tables 15 and 16, which summarize the findings of the 2016 SONAB report (SONAB, 2016) and the 2022 SOTB report (SOTB, 2022), as follows. Species highlighted in ▭ are noted as being in decline in the SONAB report; those highlighted in ▭ are reported as having stable population numbers in SONAB; and those highlighted in ▭ are reported as being in decline in either the SONAB or SOTB reports, or both (see Tables 15 and 16). The 2022 SOTB report identified 70 bird species of particular concern because of long-term or short-term (i.e., over three generations) declines in population numbers. Twenty-one of those species were observed in our study, as shown in Table 16. Interestingly, several of the species noted for population declines in the SOTB report are shown to have stable population numbers in the SONAB report (Table 15) and are highlighted in yellow.

The 2016 SONAB report provides a detailed summary of the conservation status of over eleven-hundred bird species in North America, summarized with a score reflecting the level of concern for each species (Table 15). Factors included in the SONAB assessment include population size, breeding distribution, nonbreeding distribution, threats to breeding, threats to nonbreeding, and population trends (see www.stateofthebirds.org). The resulting conservation concern (CC) scores range from 4 for common, widespread bird species that are thriving, to 20 for species of greatest concern for the sustainability of that species.

According to the SONAB and SOTB reports, of the 88 bird species observed over the course of our study, 27 species have shown population declines since the late 1960's, and 35 species have CC scores of 10 or greater (Table 16). Seven of the species we recorded over the four years of our study – Lewis's Woodpecker, Grace's Warbler, Virginia's Warbler, Band-tailed Pigeon, Cassin's Finch, Evening Grosbeak, and Olive-sided Flycatcher – are included on the bird conservation watch list because of steep declines in population numbers, resulting in some cases inclusion in their "near-threatened" status category (Cornell, 2019). Although the Lewis's Woodpecker is commonly observed in several areas surrounding Pagosa Springs, it was recorded as a single bird at the TS site in our study in 2019, noted as an incidental in 2020, with three Lewis's Woodpecker sightings at JM in 2021, and no recorded sightings in 2022. Interestingly, Virginia's Warbler was documented only at the JM site in 2019 and 2020, recorded at FG and JM in 2021, and at FG and JM in 2022, but was observed at all three sites in 2023 (Table 14). Cassin's Finch was one of the unique species at the FG site in 2019, but occurred at the TS site in 2020, was seen at both TS and FG in 2021, at FG in 2022, and at both FG and JM in 2023 (Table 14). The recurring sightings of Band-tailed Pigeons at the FG site was one of the most exciting observations of 2020, complemented by a single siting at JM in 2021, but no sightings in 2022. Grace's Warbler was noted as an incidental in 2019, but was sighted much more commonly at both FG and JM in 2020, at TS and JM in 2021, at FG and JMN in 2022, and at FG and JM in 2023. Finally, an Olive-sided Flycatcher was recorded at JM in 2021, 2022, and again at JM in 2023 (Table 14).

One of the most exhilarating sightings across all five years of our study was that of a nesting pair of Common Nighthawks at the TS site in 2019 (Grover et. al., 2019), and at FG in 2021, 2022, and 2023. The Common Nighthawk is a reclusive species typically observed foraging for flying insects at dawn or dusk (Conservancy, 2019) and has been documented as a component of Ponderosa Pine bird communities in our region (Gillihan, 1997). It is estimated that Common Nighthawk populations have declined by more that 60% since the late 1960's (Ornithology, 2019), for reasons that are not well understood. Volunteers at the TS site observed a ground nest with 2 eggs in early June, 2019, which may have been destroyed when the area was burned at that time. Subsequent site visits confirmed that the nest was re-occupied after the initial prescribed fire and the parents were apparently successful in hatching either the original or a second brood consisting of two eggs. In 2021, a Common Nighthawk nest was identified at both the FG and TS sites, and we were able to document fledgling success for both nests. In 2022 and 2023, Common Nighthawk nests were observed at FG, and observers were able to document that both nests successfully fledged two offspring as well.

The Pine Siskin, another species in steep decline, was observed at the FG site in 2019 (Table 14). In 2020, Pine Siskins were observed in small numbers at TS (see Table 10 and Appendix A), were not recorded at any of our study sites in 2021, but were observed at FG and JMN in 2022, and at all three sites in 2023. The estimated 80% decline in this species over the past 50 years has been attributed to predation and disease, particularly in suburban habitats (Cornell, 2019). Its presence in forested sites dominated by White Fir and along forest roads, has been reported in

our region (Gillihan, 1997). As discussed in earlier annual reports for our study (see Grover et. al., 2019; 2020; 2021; 2022), the FG site had the lowest tree density and greatest inter-tree distances, representing conditions consistent with Gillihan's observations regarding the preferred habitat for Pine Siskin.

Equally notable was the discovery of Plumbeous Vireo, Warbling Vireo, Williamson's Sapsucker, and House Wren nests at the JM site, and the cavity nest for Northern Flickers at the TS, FG, and JM sites in each year of the study. A Red-breasted Nuthatch nest was also observed at the JMN site in 2022 and 2023. All of these species were observed in earlier studies in Ponderosa Pine forests in our region by Gillihan (1997). Because of its relatively low estimated global population estimate (300k; see Table 10), the Williamson's Sapsucker has a CC score of 12. CC scores for the Northern Flicker and Plumbeous Vireo species reflect less concern (CC scores of 10; see Table 10), but both of these species are estimated to have declined by 49% and 56%, respectively, since the late 1960's (Cornell, 2019). The House Wren has a very stable or increasing population status and is not of particular concern with regard to its conservation status. It was particularly rewarding that volunteers were able to track the successful hatching of young from the nests of each of these species. Violet-green Swallow nests were present in several standing dead trees at both the TS and JM sites in 2020, and at the FG and JM sites in 2021, 2022, and 2023. These same "snags" also housed Williamson's Sapsucker and House Wrens at the same time, underscoring the significance of preserving standing dead trees as critical nesting habitat for several bird species.

Scanning the conservation notes from SONAB (Cornell, 2019) regarding the species encountered in our study (Tables 15 and 16) reveals several species that could benefit from the prescribed fire and shrub-layer thinning treatments applied to the TS and FG sites included in our study. For example, Lewis's Woodpecker, Cassin's Finch, MacGillvary's Warbler, Warbling Vireo, and Downy Woodpeckers respond negatively to over-mature forest conditions. Other species, cavity nesters in particular, benefit from dead trees common in mature forest stands intergrading with patches of younger forested areas recovering from fire, and the presence of a well-developed shrub layer (e.g., Mountain Bluebird, Williamson's Sapsucker, Pygmy Nuthatch, Green-tailed Towhee, etc.). This leads us to agree with Brawn et. al. (2001), that forest heterogeneity, resulting from the prescribed fire and thinning treatments encountered in our study areas, represents a net benefit to the extended bird community in the forests of the San Juan Mountains, if done at the proper scale and with moderate intensity.

Comparative Studies -

Previous studies in Ponderosa Pine forests across the American southwest reported increases in populations of GBF and AF species, and decreases in TFS species in recently burned sites, consistent with the trends observed in this study (Blake, 1982; Lowe et al., 1978). Kalies et al., (2010) in their meta-analysis of 25 studies on fire and thinning effects on Ponderosa Pine forests across Arizona noted that thinning and fuel reduction treatments favored passerine bird populations in general, with neutral impacts on GBF bird species and neutral to positive impacts on AF and TDG species.

Western Bluebirds are reported to respond positively to prescribed fire (Hurteau et al., 2008). This is consistent with our observations, with Western Bluebirds sighted at the recently burned TS site and masticated FG site, but absent from the non-treated JM site in 2019 and 2021 (Grover et al. 2021), and JMN site studied in 2022. However, Western Bluebirds were observed in the JM site in other years of the study (Table 14). In the same study by Hurteau et al., (2008), Mountain Chickadee populations were noted to decline in thinned areas. Our findings are consistent with this finding as well, with Mountain Chickadees absent from TS in 2019, but returned in 2020 and 2021 (Grover et al. 2021), and this species was the third most abundant species at JMN in 2022, where the forest canopy is most dense (Grover et al. 2022). Indeed, Mountain Chickadees were observed at all three sites in 2020 through 2023 (Table 14).

Brawn and Balda (1988) noted a positive impact of increased tree density and canopy cover on the Western Wood-Pewee and Black-headed Grosbeak. Dickson et al., (2009) also noted a short-term decline in Western Wood-Pewee in response to prescribed fire across several Ponderosa Pine sites in Arizona and New Mexico. These patterns are not consistent with our findings, in which the Western Wood-Pewee is among the 5 most abundant species at TS and FG in both 2019 and 2020 (Table 2), but drops to the third most abundant species at JM in 2019, and the ninth most abundant species at that site in 2020, where tree density and canopy cover is greatest (Grover et. al., 2021). Western Wood-Pewees were also abundant at FG and JM sites in 2022 and 2023, but have not been observed at the JMN site (Table 14), which has the densest tree canopy of the sites included in our study (Grover et al. 2022).

Table 14. Summary of presence or absence of bird species recorded at study sites in each year of the project. Commonness score represents the sum of observations across years. Shading reflects inclusion of species in State of the Birds databases (see Cornell, 2019; and SOTB, 2022). = in decline (SONAB); = in decline (SOTB); and = stable (SONAB). See text for detailed description.

	2019				2020				2021				2022				2023			
TOTALS	27	41	30		38	38	45		36	39	42			37	41	38	50	48	38	Commonness
	TS	FG	JM	JMN	TS	FG	JM	JMN	TS	FG	JM	JMN	TS	FG	JM	JMN	FG	JM	JMN	SCORE
American Robin	x	x	x		x	x	x		x	x	x			x	x	x	x	x	x	15
Hairy Woodpecker	x	x	x		x	x	x		x	x	x			x	x	x	x	x	x	15
Northern Flicker	x	x	x		x	x	x		x	x	x			x	x	x	x	x	x	15
Pygmy Nuthatch	x	x	x		x	x	x		x	x	x			x	x	x	x	x	x	15
Steller's Jay	x	x	x		x	x	x		x	x	x			x	x	x	x	x	x	15
Violet-green Swallow	x	x	x		x	x	x		x	x	x			x	x	x	x	x	x	15
Western Tanager	x	x	x		x	x	x		x	x	x			x	x	x	x	x	x	15
White-breasted Nuthatch	x	x	x		x	x	x		x	x	x			x	x	x	x	x	x	15
Yellow-rumped Warbler	x	x	x		x	x	x		x	x	x			x	x	x	x	x	x	15
Chipping Sparrow	x	x			x	x	x		x	x	x			x	x	x	x	x	x	14
Mountain Chickadee		x	x		x	x	x		x	x	x			x	x	x	x	x	x	14
Turkey Vulture	x	x	x		x	x	x		x	x	x			x	x		x	x	x	14
Warbling Vireo		x	x		x	x	x		x	x	x			x	x	x	x	x	x	14
Green-tailed Towhee		x	x		x	x	x		x	x	x			x	x	x	x	x		**13**
Mourning Dove	x		x		x	x	x		x	x	x			x	x	x	x	x		**13**
Plumbeous Vireo	x	x			x	x	x		x	x	x			x	x	x	x	x		**13**
Western Wood-Pewee	x	x	x		x	x	x		x	x	x			x	x		x	x		13
American Crow	x	x	x		x	x	x		x	x	x				x		x	x	x	13
Broad-tailed Hummingbird	x	x	x		x	x	x		x					x	x	x	x	x	x	13
Common Raven		x	x		x		x		x	x	x			x	x	x	x	x	x	13
Dark-eyed Junco		x			x	x	x		x	x	x			x	x	x	x	x	x	13
House Wren			x		x	x	x		x	x	x			x	x	x	x	x	x	13
Red-tailed Hawk	x	x	x		x		x			x				x	x	x	x	x	x	12
Cordilleran Flycatcher		x			x	x	x			x	x			x	x	x	x	x		**11**
Western Bluebird	x	x			x	x	x		x	x				x	x		x	x		11
Black-headed Grosbeak		x				x	x			x	x			x	x	x	x	x	x	11
Orange-crowned Warbler			x			x	x			x	x			x	x	x	x	x	x	11
Townsend's Solitaire			x		x	x	x		x	x	x					x		x	x	10
Black-capped Chickadee			x		x	x	x		x		x				x	x			x	9
Brown-headed Cowbird	x	x	x		x		x				x			x			x	x		9
Virginia's Warbler			x				x			x	x			x	x		x	x	x	9
Common Nighthawk	x		x		x		x		x	x				x			x			8
Cassin's Finch		x			x	x			x	x				x			x	x		8
Grace's Warbler						x	x		x		x			x		x	x	x		8
Spotted Towhee					x	x			x	x				x	x		x	x		8
Hermit Thrush			x				x				x				x	x	x	x	x	**8**
Williamson's Sapsucker	x		x			x					x			x	x				x	**7**
Pine Siskin		x			x									x		x	x	x	x	**7**
Red Crossbill		x			x	x	x										x	x	x	**7**
Brown Creeper							x		x						x	x		x	x	**6**
Downy Woodpecker	x	x									x				x		x		x	**6**
Red-breasted Nuthatch					x		x								x	x		x	x	6
Dusky Flycatcher							x							x	x		x	x	x	**6**
Hammond's Flycatcher															x	x	x	x	x	**5**
Say's Phoebe		x					x			x	x									4
Tree Swallow	x	x					x			x										4
Great Blue Heron							x		x		x						x			4
Wild Turkey										x	x					x		x		4
Bald Eagle		x									x			x						3
Bullock's Oriole	x	x									x									3
Eurasian Collared Dove					x		x				x									3
Mountain Bluebird		x							x					x						3
Osprey	x				x										x					3
Great-Horned Owl						x			x										x	3
MacGillivray's Warbler	x															x			x	3
Olive-sided Flycatcher										x					x			x		3
Red-naped Sapsucker		x														x		x		3
Sharp-shinned Hawk									x							x	x			3
Ash-throated Flycatcher										x							x		x	3
House Finch																x	x	x		3
Red-winged Blackbird										x							x	x		3
Yellow Warbler		x															x	x		3
American Kestrel		x													x					2
Band-tailed Pigeon						x					x									2
Canada Goose		x	x																	2
Cooper's Hawk							x									x				2
Dusky Grouse						x									x					2
Lewis's Woodpecker	x										x									2
White-crowned Sparrow					x				x											2
Cassin's Vireo										x							x			2
Evening Grosbeak						x											x			2
Mallard									x								x			2
Ruby-crowned Kinglet																x			x	2
Song Sparrow						x											x			2
White Throated Swift			x															x		2
American Goldfinch		x																		1
Black-billed Magpie		x																		1
Black-chinned Hummingbird						x														1
European Starling					x															1
Northern Goshawk							x													1
Gray Catbird							x													1
Northern Rough Winged Swallow		x																		1
Peregrine Falcon											x									1
Three-toed Woodpecker										x										1
Western Meadowlark											x									1
Cedar Waxwing																	x			1
Black Swift																		x		1
Northern Pygmy Owl																			x	1

Table 15. Summary of conservation status for bird species observed in this study as reported in SONAB (Cornell, 2019; see also www.allaboutbirds.org). Abundances represent numbers of birds of a species observed at a site in sequential years of the study. Shading indicates species that are reported as of concern due to declining population numbers in the 2022 State of the Birds report (SOTB 2022; see also Tables 14 and 16).

Common Name	Commonness Score	Concern Score	Population Status	% decline	Notes
Black Swift	1	15	declining	50%	threats - unknown, not enough information
Lewis's Woodpecker	2	15	decline	72	threats - increased forest densities due to fire suppression
Grace's Warbler	6	14	declining	52	threats - habitat loss; fire suppression
Virginia's Warbler	6	14	decline/uncommon	46	threats - nest parasitism; loss of breeding habitat due to prescribed fire
Band-tailed Pigeon	2	13	decline	63	threats - hunting; habitat destruction
Cassin's Finch	6	13	near threatened	nr	threats - over-mature forests; lack of thinning and fires
Evening Grosbeak	1	13	declining	74	threats - logging; disease; development; changes in forest tree species
Olive-sided Flycatcher	2	13	decline	79%	Threats - vulnerable to loss of wintering habitat
Broad-tailed Hummingbird	10	12	decline/common	52	threats - climate variability affecting food availability
MacGillvary's Warbler	2	12	decline	56	threats - loss of habitat - favor early to mid-successional forest stands
Mountain Bluebird	3	12	decline/common	24	require combination of open forests for foraging and old-growth for nest cavities
Williamson's Sapsucker	6	12	stable	na	return to burned areas within decade after fire
American Kestrel	2	11	decline	50	threats - pesticide pollution; access to nesting cavities
Bullock's Oriole	3	11	decline/numerous	29	threats - pesticide pollution; habitat loss
Common Nighthawk	7	11	steep decline/common	61	threats - food supply; access to nest sites
Cordilleran Flycatcher	9	11	stable	na	
Dusky Flycatcher	3	11	stable	na	
Dusky Grouse	2	11	stable	na	
Northern Goshawk	1	11	stable	na	
Northern Pygmy Owl	1	11	stable	na	
Pygmy Nuthatch	12	11	stable	na	threats - loss of large dead trees for nesting
Steller's Jay	12	11	stable	na	
Western Wood-Pewee	11	11	decline	48	threats - logging and forest fires
American Three-toed Woodpecke	1	10	increasing	na	
Black-chinned Hummingbird	1	10	increasing	na	
Cassin's Vireo	1	10	increasing	na	5M
Green-tailed Towhee	11	10	stable	na	benefits - favor shrubby habitats following forest fires
Hammond's Flycatcher	2	10	stable/increasing	na	threats - logging of mature/old-growth forests
Mountain Chickadee	11	10	decline	53	
Northern Flicker	12	10	decline/common	49	
Northern Rough-winged Swallow	1	10	decline/common	18	threats - pesticide pollution; reduced food availability
Peregrine Falcon	1	10	stable	na	vulnerable to pesticides, especially DDT
Pine Siskin	4	10	steep decline/common	80	threats - predation; disease
Plumbeous Vireo	11	10	decline	79	
Townsend's Solitaire	8	10	stable	na	benefits from forest thinning
Western Meadowlark	1	10	decline	37	threats - habitat loss or degradation (grasslands);
White-throated Swift	1	10	decline	56	population decline uncertain; pesticide pollution and reduced food source
Bald Eagle	3	9	increasing/recovered	na	recovered from endangered status
Black-headed Grosbeak	8	9	stable/increasing	na	
Cassin's Vireo	1	9	stable/increasing	na	
Orange-crowned Warbler	8	9	decline/common	34	64% decline in US; benefit from increased shrub cover in forests
Red-naped Sapsucker	2	9	stable	na	
Say's Phoebe	4	9	increasing/common	na	
Violet-green Swallow	12	9	decline/common	28	threats - pesticide pollution; reduced food availability
Western Bluebird	9	9	stable	na	threats - habitat loss; fire suppression; lack of nest cavities
Chipping Sparrow	11	8	decline/common	36	
Dark-eyed Junco	10	8	decline/numerous	50	
Red Crossbill	4	8	decline	12	threats - feed on conifer seeds; extensive forest fires etc. reduce food source
Tree Swallow	4	8	decline/common	49	threats - reduced cavity nesting sites; food availability
Warbling Vireo	11	8	increasing/numerous	na	benefit from forest clearing/thinning
Western Tanager	12	8	increasing/common	na	benefits from forest patchiness/edges

Table 16. Summary of bird species observed in this study identified as species of concern in the 2022 State of the Birds report for long-term or short-term declines in population numbers. (SOTB 2022; see also Tables 13 and 14).

	1970 - 2019	Short-Term*
Common Name	Change %/Yr	Change %/Yr
Evening Grosbeak	-4.60	-0.76
Grace's Warbler	-1.46	-0.35
Cassin's Finch	-1.31	1.68
Lewis's Woodpecker	-1.26	0.47
Western Wood-Pewee	-1.24	-0.31
Broad-tailed Hummingbird	-0.96	-1.84
Mountain Chickadee	-0.89	-1.64
Virginia's Warbler	-0.87	-1.62
MacGillivray's Warbler	-0.71	-0.65
Cordilleran Flycatcher	-0.33	0.66
Dusky Flycatcher	-0.26	-1.13
Plumbeous Vireo	-0.07	1.34
Dusky Grouse	0.07	0.03
Williamson's Sapsucker	0.20	-0.48
Western Bluebird	0.44	0.37
Black-headed Grosbeak	0.45	0.71
Townsend's Solitaire	0.50	-0.59
Hammond's Flycatcher	0.63	-1.57
Western Tanager	0.87	0.49
Cassin's Vireo	1.11	-0.46
Red-naped Sapsucker	1.12	-2.82
* - change across three generations		

The length of time since fire disturbance has an influence on bird species found at a site. Lowe et al., (1978) studied bird community composition across several Ponderosa Pine sites in Arizona subject to wildfires at intervals of 1, 3, 7, and 20 years before monitoring. They identified a pattern of increasing total bird densities in the early years after a burn, then decreasing total bird population numbers as the forest recovered, as demonstrated by the Western Bluebird, a member of the GBF feeding guild. A similar pattern was particularly evident in their data for birds in the TFS feeding guild (e.g., Yellow-rumped Warbler and Steller's Jay). Timber-Drilling/Gleaning (TDG) species, in particular the Pygmy Nuthatch, showed a decreasing trend across years. Dickson et al., (2009), reported similar findings with a positive response to prescribed fire for Steller's Jay, Plumbeous Vireo, and Hairy Woodpeckers.

A temporal gradient is not as well represented in our study compared to findings reported by Lowe et al., (1978), and our sample size is small compared to many other studies reported in the literature, but comparing FG to the other sites in our study yields similar patterns in total bird counts and species richness to their results, suggesting that FG represents a forest community in which feeding habitat is more productive for a wider range of bird species than provided by either the TS (recently burned), JM (untreated), or JMN sites (see Tables 12A and 12B). Gillihan (1997) also noted a positive response of several bird species to the presence of Gambel Oak, including the Brown-headed Cowbird, Green-tailed Towhee, and Virginia's Warbler, all of which were found at both our FG, JM and JMN sites, where the oak shrub layer was well developed (Table 14).

In contrast to the findings of Lowe et al., (1978), TDG species show an increasing trend in relative abundance across our study sites in 2019 through 2022 with JM > FG > JMN, with declines in this feeding guild at all sites in 2023 (see Fig. 8). One reason reported in the literature for TDG bird species increasing in response to recent prescribed fire has to do with a concurrent increase in bark beetles following a burn over the following seasons (Pope et al., 2009). A parallel finding regarding the abundance of Hairy Woodpeckers in recently burned Ponderosa Pine stands subject to wildfire indicates an increase in this species in the first few years following burning in response to elevated populations of bark beetles and wood borers (Covert-Bratland et al., 2006). Findings reported in the literature regarding TDG bird species is consistent with the increasing trend in relative abundance of TDG species noted for the TS site in our study from 2019 to 2021 (see Grover et. al., 2021).

Migratory Species-

Worldwide, it is estimated that about 20% of bird species exhibit some degree of migratory behavior (Somveille, 2016; and Watts, 2017), with many species traveling extreme distances from Northern to Southern latitudes (see

Weidensaul, 2021). For bird species, the principal strategy driving this instinctive behavior is to reach suitable breeding grounds where resources are abundant during critical periods for nesting and rearing of young, or to avoid unfavorable environmental conditions during the non-breeding season. The evolutionary origins of this behavior are complex, but none-the-less, for those bird species undergoing extreme physiological changes (see Watts, 2017), and investing incredible energy in the process, the strategy has, until recent decades, been effective in their long-term reproductive success. Habitat fragmentation and destruction in breeding grounds, or in over-wintering grounds, and even in those areas the birds pass through during migration, is diminishing the "return on investment" for many bird species and may be the primary contributing factor to the population decline observed for many bird species over the past several decades, as noted in the SONAB and SOTB reports (Cornell, 2019; SOTB, 2022). The implications of declines in bird population numbers worldwide to regional ecosystems serving as breeding or overwintering grounds is not well understood, but as noted in the section on feeding behaviors of bird species observed in this study, the impacts could be locally important – especially with regard to moderation or control of insect population irruptions.

Table 15 provides a summary of the 88 bird species observed in our study with regard to their migratory behavior, Commonness Score (CoSc), and conservation status. The definitions used to categorize general migratory behavior are taken from Somveille (2016), and resources summarized in the Cornell Lab of Ornithology website (see https://www.allaboutbirds.org) In that context, Nearctic refers to those bird species in the Northern Hemisphere that are resident to a locale or region; exhibit seasonal short-distance migrations (e.g., to lower elevations) to avoid unfavorable environmental conditions; or medium-distance migration to regions as far south as Mexico for the same purpose. Neotropical migrants travel further distances to Central or Southern America, or to islands in the Caribbean.

As shown in Table 17, 47 of the 88 species observed in our study are listed as resident species in the Cornell database, with 44 of those species also observed in the Christmas Bird Count (CBC) data for our area. The three species not included in our CBC are the Dusky Grouse, Three-toed Woodpecker, and Plumbeous Vireo. These species are typically found in forested habitats not included in our CBC survey (e.g., Dusky Grouse and Three-toed Woodpecker), or migrate locally to lower elevations (e.g., Plumbeous Vireo).

Interestingly, all bird species observed in our study (Table 17) can be categorized as Nearctic based on their migratory behavior, with 72 species falling into the Neotropical category as well (12 resident, Nearctic-Neotropical cross-overs; 31 non-resident, Nearctic-Neotropical cross-overs). Of the resident Nearctic-Neotropical species, four are relatively common in our study (i.e., CoSc >8) – Mourning Dove, Red-tailed Hawk, Chipping Sparrow, and Plumbeous Vireo. The population numbers of 8 of those 13 resident, Nearctic-Neotropical species are in decline, including Chipping Sparrows and Plumbeous Vireos common to our study. Our dataset is inadequate to determine whether the other resident species showing population declines across their ranges (e.g., Pine Siskin, Red Crossbill, American Kestrel, Chipping Sparrow, Northern Goshawk, and Plumbeous Vireo) are decreasing, stable, or increasing in our area.

Using 8 as a threshold CoSc for common species reveals that 14 of the 47 (30%) resident, Nearctic-Neotropical species, and 12 of 41 (29%) non-resident Nearctic-Neotropical migratory species achieving that score. Using a CoSc of 4 as a threshold for uncommon species reveals that 24 resident species (51%) and 20 non-resident species (49%) fit that category.

With regard to their conservation status, resident, Nearctic-Neotropical species are fairing better overall compared to non-resident, Nearctic-Neotropical bird species observed in our study (Table 17). Nine of the resident species in our study (shown in yellow in Table 17) are reportedly in decline as per the SOTB 2022 report, and 7 species are in decline as reported in the 2016 SONAB report (shown in tan in Table 17; Cornell, 2019). Notable among these species for having CoSc's > 8 are the Mountain Chickadee, Northern Flicker, Dark-eyed Junco, Townsend's Solitaire, Chipping Sparrow, and Plumbeous Vireo. Their CoSc's indicate that they are fairly common in our region while noted by other studies as declining overall across the rest of their range (Cornell, 2019, SOTB, 2022).

More striking is the number of non-resident, Nearctic-Neotropical bird species noted as in decline in the studies we cite – with 16 species noted in the SOTB 2022 report (shown in yellow in Table 17), and 9 species cited in the SONAB report (shown in tan in Table 16; Cornell, 2019) – or 61% of bird species exhibiting longer-range migratory behaviors. Notable among the non-resident, Nearctic-Neotropical migrants in decline globally, but relatively

Table 17. Summary of bird migration strategies for species encountered in our study. Definitions are from Somveille (2016). Shading reflects inclusion of species in State of the Birds databases (see Cornell, 2019, and SOTB 2022). = in decline (SONAB); = in decline (SOTB); and = stable (SONAB). See text for detailed description. The CBC notation indicates those resident species recorded in the Christmas Bird Count for our area.

Resident Species							
	Species Totals	43 (40 CBC)	54	64	42	15	13
	Commonness	Nearctic			Neotropical		
	SCORE	Resident	Short-Dist	Mexico	Cent Am	Carribean	Sth Am
Pygmy Nuthatch	12	x (CBC)					
Steller's Jay	12	x (CBC)					
White-breasted Nuthatch	12	x (CBC)					
Mountain Chickadee	11	x (CBC)					
Common Raven	10	x (CBC)					
Black-capped Chickadee	8	x (CBC)					
Downy Woodpecker	4	x (CBC)					
Wild Turkey	3	x (CBC)					
Great-Horned Owl	2	x (CBC)					
Northern Pygmy Owl	1	x(CBC)					
American Robin	12	x (CBC)	x				
Cedar Waxwing	1	x(CBC)	x				
Hairy Woodpecker	12	x (CBC)	x				
Northern Flicker	12	x (CBC)	x				
American Crow	10	x (CBC)	x				
Red-breasted Nuthatch	4	x (CBC)	x				
Canada Goose	2	x (CBC)	x				
Lewis's Woodpecker	2	x (CBC)	x				
Black-billed Magpie	1	x (CBC)	x				
Evening Grosbeak	1	x (CBC)	x				
Dark-eyed Junco	10	x (CBC)	x	x			
Townsend's Solitaire	8	x (CBC)	x	x			
Cassin's Finch	6	x (CBC)	x	x			
Williamson's Sapsucker	6	x (CBC)	x	x			
Bald Eagle	3	x (CBC)	x	x			
Eurasian Collared Dove	3	x (CBC)	x	x			
White-crowned Sparrow	2	x (CBC)	x	x			
American Goldfinch	1	x (CBC)	x	x			
House Finch	1	x (CBC)	x	x			
Mallard	1	x (CBC)	x	x			
Song Sparrow	1	x (CBC)	x	x			
Pine Siskin	4	x (CBC)	x	x	x		
Red Crossbill	4	x (CBC)	x	x	x		
Red-winged Blackbird	1	x (CBC)	x	x	x		
Ruby-crowned Kinglet	1	x (CBC)	x	x	x		
Mourning Dove	11	x (CBC)	x	x	x	x	
Red-tailed Hawk	9	x (CBC)	x	x	x	x	
European Starling	1	x (CBC)	x	x	x	x	
Great Blue Heron	3	x (CBC)	x	x	x	x	x
American Kestrel	2	x (CBC)	x	x	x	x	x
Sharp-shinned Hawk	2	x (CBC)	x	x	x	x	x
Chipping Sparrow	11	x (CBC)	x				
Northern Goshawk	1	x (CBC)	x	x			
Brown Creeper	4	x (CBC)	x	x	x		
Dusky Grouse	2	x					
Three-toed Woodpecker	1	x	x				
Plumbeous Vireo	11	x		x	x		

Non-Resident Species							
	Commonness	Nearctic			Neotropical		
	SCORE	Resident	Short-Dist	Mexico	Cent Am	Carribean	Sth Am
Green-tailed Towhee	11		x	x			
Cordilleran Flycatcher	9		x	x			
Western Bluebird	9		x	x			
Black-headed Grosbeak	8		x	x			
Brown-headed Cowbird	7		x	x			
Virginia's Warbler	6		x	x			
Mountain Bluebird	3		x	x			
Red-naped Sapsucker	2		x	x			
Black-chinned Hummingbird	1		x	x			
Western Meadowlark	1		x	x			
Orange-crowned Warbler	8		x	x	x		
Grace's Warbler	6		x	x	x		
Spotted Towhee	6		x	x	x		
Hermit Thrush	5		x	x	x		
Say's Phoebe	4		x	x	x		
Bullock's Oriole	3		x	x	x		
Dusky Flycatcher	3		x	x	x		
Cooper's Hawk	2		x	x	x		
Ash-throated Flycatcher	1		x	x	x		
White Throated Swift	1		x	x	x		
Northern Rough Winged Swallow	1		x	x	x	x	
Osprey	3		x	x	x	x	x
House Wren	10		x	x	x		x
Black Swift	1			x	x		x
Violet-green Swallow	12			x	x		
Western Tanager	12			x	x		
Hammond's Flycatcher	2			x	x		
MacGillivray's Warbler	2			x	x		
Warbling Vireo	11			x	x		
Broad-tailed Hummingbird	10			x	x		
Cassin's Vireo	1			x	x		
Yellow-rumped Warbler	12			x	x	x	
Tree Swallow	4			x	x	x	
Western Wood-Pewee	11			x	x	x	x
Common Nighthawk	7			x	x	x	x
Gray Catbird	1			x	x	x	x
Peregrine Falcon	1			x	x	x	x
Yellow Warbler	1			x	x	x	x
Turkey Vulture	11			x	x		x
Band-tailed Pigeon	2			x	x		x
Olive-sided Flycatcher	2			x	x		x

common in our study (i.e., CoSc > 8) are the Cordilleran Flycatcher, Western Bluebird, Black-headed Grosbeak, Orange-crowned Warbler, Violet-green Swallow, Western Tanager, Broad-tailed Hummingbird, and Western-Wood-Pewee. As we stated with regard to resident species, we are unable, using our dataset, to discern whether those bird species that are uncommon in our study (i.e., CoSc <4) are in decline, stable, or increasing in our region (e.g., Mountain Bluebird, Red-naped Sapsucker, Dusky Flycatcher, Hammond's Flycatcher, MacGillivray's Warbler, Cassin's Vireo). With CoSc's of 6, and population numbers in decline according to the SOTB 2022 report, the Virginia's Warbler and Grace's Warbler, are of particular concern.

Clearly, our analysis indicates that the 41 non-resident bird species following moderate-distance to long-distance migratory routes to Mexico, Central America, South America, and the Caribbean are at greatest risk of population declines (Table 17), with more than half (25) of those species noted of concern in the SONAB and SOTB reports. This is in contrast to 16 of the resident species (34%) showing population declines. The implications of these patterns in bird species and bird population numbers to forestry management practices employed in our area remain unclear, but greater attention needs to be paid to how wildland fuel reduction treatments; forest canopy and shrub-layer thinning; and logging practices impact bird community composition and structure. It is known that mortality risks increase substantially during migration due to a number of factors, including the physiological fitness of the birds at the beginning of migration, but the impacts of habitat destruction and fragmentation in wintering grounds and stop-over locations along migratory routes is unknown (see Somveille, 2016). It may very well be that active forest management has net positive benefits for many bird species by increasing spatial heterogeneity in forest structure (e.g., see Brawn et. al., 2001), but potential positive vs. negative impacts of management are scale-dependent and are not well understood. For example, the question of the scale at which spatial heterogeneity actually results in habitat fragmentation with cascading negative impacts on ecosystem structure and function remains unanswered.

Summary and Conclusions:

The scientific question examined by this study concerned the potential effects of wildland fuel reduction treatments (i.e., prescribed fire or shrub layer mastication) on bird community composition in the dry, mixed-conifer forests of southwestern Colorado. As a citizen science project, other complementary objectives of the study included raising awareness among participants regarding the principles of fire ecology and forest management, particularly with regard to wildland fuel management practices; engaging participants in the planning and conduct of field studies; improving the birding skills of participants through interactions of novice birders with skilled birders; and strengthening the sense of community among conservation-minded birders in our area. We viewed the achievement of these complementary objectives as equally important to investigating the scientific question we posed, and consequently some confounding variables (e.g., bird species mis-identification, uneven sampling frequencies, etc.) are embedded in the study, as may be the case with any citizen science project. Nonetheless, the dataset we have generated by returning to the same sites and monitoring points at the same time of year over a five-year period represents an invaluable resource for understanding year-to-year variability in bird community composition in our area; the response of the bird community to wildland fuel reduction treatments; the presence and prevalence of bird species whose populations are notably in decline across their range; and other factors that should be accounted for when considering alternative forest management practices.

Bird Community Response to Prescribed Fire and Mastication-

The primary objective of this project was to identify possible differences in bird community composition and structure between Ponderosa Pine forested sites recently subjected to wildland fuel reduction treatments compared to an untreated, old-growth site. Our data revealed a reduction in bird species richness, abundance, and overall diversity at the TS site immediately following prescribed fire treatments in early June, 2019. Recovery of the shrub layer at the TS site was clearly evident by 2021, with subsequent changes in the bird community to render this site more like FG and JM in species composition and feeding guilds.

Addition of the JMN site provided further insights into how forest structure affects bird community composition. The JMN site is characterized by greater dominance of Douglas-Fir and White Fir, with a greater presence of Aspen compared to the TS, FG, and JM sites. The tree canopy at JMN is more closed compared to the other sites as well, resulting in greater patchiness in the understory shrub layer. These factors likely contributed to a shift in bird

species composition, with a greater predominance of species exhibiting timber-foliage searching feeding habits compared to the other sites (Fig. 8). Now with two years of data as a reference, it appears that there are fewer bird species with high conservation scores at JMN compared to the other sites, but more years of data will be needed to confirm this outcome of our study.

Commonness vs. Rarity of Bird Species-

Patterns in commonness vs. rarity that have been noted in ecological studies over the past century of ecological research was reflected by the findings of our study. Of the 88 bird species observed across the five-years of this study, 37 were observed in all years, and 9 of those bird species were observed at all three sites in all years (Table 17). Notably, the 9 species observed at all four sites across years were among the most abundant species counted (Tables 9 and 10).

The commonness vs rarity issue begs the question: which species are more important to focus on when considering management options or when monitoring forest health – common species, or uncommon/rare species? Certainly, the most common and most abundant bird species are likely to have the greatest quantitative impact on populations of insects and other invertebrates that they feed upon, and which could potentially impair forest health through defoliation, tree death, or spread of disease by folivorous invertebrates. But the absence of uncommon or apparently rare bird species may have inordinate consequences for ecosystem functionality as well (e.g., Leitao et. al., 2016). Flather and Sieg (2007), and Gaston (2011) provide a thorough analysis of issues concerning uncommon/rare species' contributions to ecosystem function (e.g., functional complementarity, redundancy, and asynchrony), concluding that protection of uncommon species deserves our full attention in order to enhance ecosystem resilience in response to changing environments.

It is certainly possible that at least some of the bird species we observed in our study that are today uncommon or rare, were at one time more prevalent and may have played a more significant role in the control of herbivorous insect populations. The consequences of the decline in bird species noted in the SONAB and SOTB reports that are reflected in the bird community we have been studying is not known, but may have serious long-term implications to the health of the forest ecosystems in our region.

Certainly, issues surrounding the ecological roles of uncommon/rare species are superseded by the ethical precept that all species possess intrinsic value and that protecting biodiversity has value in and of itself (e.g., Sandler, 2012; Palmer et. al., 2014). Many writers, citing the life's work of icons such as Aldo Leopold; Stephen J. Gould; E.O. Wilson; and others, underscore the significance of the intrinsic value of species as foundational to the field of conservation biology (e.g., Piccolo, 2017; Schweiger, 2009). There is also a substantial literature produced by accomplished scientists invoking a theological basis for protecting species based on intrinsic value (e.g., DeWitt, 2000; Van Dyke, 2010). Hence, we conclude that evaluating and categorizing forest management practices based on potential impacts on common vs. uncommon/rare species is a false dichotomy – the potential impacts of management practices on all species must be carefully considered, regardless of their relative abundances.

Nesting vs. Feeding Behaviors and Ecosystem Resilience-

Ibarra et al. (2017) address complementary issues to the commonness/rarity topic in the context of forest resilience, with a focus on forest management practices that interfere with the success of tree cavity nesting bird species (e.g., logging; thinning; and fire). Indeed, the cavity nesting species identified across the four years of this study accounted for almost 30% of all birds counted, with the 6 most common cavity nesting species (Hairy Woodpecker, Northern Flicker, Pygmy Nuthatch, Violet-green Swallow, Western Bluebird, and White-breasted Nuthatch) accounting for more than a quarter of all birds counted (see Table 13). Moreover, looking across the range of cavity nesting species found at our sites, several feeding guilds are represented. Of the 20 cavity nesting species observed in our study (Table 13), 7 belong to the TDG feeding guild; 6 to the GBF guild; 2 to the TFS guild; 3 to the AF guild; 1 to the F guild; and 1 is a raptor (American Kestrel) (Table 12). Of the 6 most common cavity nesting species, 3 belong to the TDG guild (Hairy Woodpecker, Pygmy Nuthatch, and White-breasted Nuthatch); 2 to the GBF guild (Northern Flicker, Western bluebird); and 1 belongs to the AF guild (Violet-green Swallow). The distribution of cavity nesting bird species across feeding guilds, along with their numerical importance in this study, affirms that forest management practices that are protective of potential cavity nesting sites (e.g., dead snags) are

critical to enhancing forest resilience to changing environmental conditions that might promote population growth in potentially harmful insect or invertebrate species.

Migratory Species–
Of the 88 bird species observed over the five-years of our study, about half (53%) are resident species that are present in the Pagosa Springs area year-round, or are mostly short-distance or medium-distance migrants (Table 17). Of those resident species, about 34% are very common (CoSc >/=8), with about 52 % uncommon (CoSc</=4). In contrast, the 41 bird species capable of short-distance to long-distance migrations are composed of about 29% common species and about 54% uncommon species.

More revealing is the contrast between the number of resident vs. non-resident bird species reported in the literature with declining population numbers (Table 17; see Cornell, 2019; and SOTB, 2022). In this case, about 34% of resident species are in decline, with 61% of non-resident bird species falling into this category. Clearly, those bird species with the longest migratory routes between their breeding grounds in the Pagosa Springs area to wintering grounds as far away as Central and South America are at greatest risk of population declines.

This result warrants further attention when assessing the impacts of alternative forest management practices in our area so that the survival of bird species shown to be at risk are not further threatened by wildland fuel reduction treatments; tree or understory shrub thinning; logging practices; or even recreational development.

Secondary Objectives-
The secondary objectives of this study concerned raising the awareness of participants regarding the importance of fire in Ponderosa Pine forest ecosystems; the role of wildland fuel management in protecting residential communities in the WUI; and improving their understanding of how field studies are conducted. The feedback participants provided to project coordinators in each year of the study affirms that we have been very successful in accomplishing these objectives.

Finally, through the conduct of this project we anticipated that participants would benefit from improving their bird identification skills and, by working as teams to accomplish the goals of our study, they would also form a more cohesive group of citizen scientists concerned with conservation issues. In these regards, feedback from participants in both years of this study affirm that our study has been overwhelmingly successful. Certainly, among the most rewarding and somewhat surprising outcomes of this project was the dedication participants exhibited toward the success of this study, and their enthusiasm for continuing the project in coming years.

The value of this project to participants is also revealed by their personal statements included in the videos we have produced each year as well (e.g., 2021 bird monitoring project video (28 minutes) – https://youtu.be/7DZ8xIk-Xhk ; and 2021 bird monitoring project video (10 minutes) - https://youtu.be/xEFBj8EjotM)

Recommendations for Future Work:
Continuing this study to a sixth year would improve our understanding year-to-year variability in bird community composition in our region, and would also further our understanding of successional recovery from wildland fuel reduction and forest thinning treatments. The inclusion of the JMN site also provides invaluable baseline information that will improve the understanding of forest ecosystem response to the selective harvesting treatments planned for the ASCC project.

What we have learned from continuation of this study is that 10 visits to each loop provides an optimal dataset for our analysis. Continued engagement of participants in bird identification workshops, particularly identification by song (complemented by the use of the Merlin APP), has also proven to be very valuable.

As noted in our earlier reports (Grover et. al., 2019; 2020; 2021; 2022), the need for more detailed data on plant community structure is essential for understanding the response of the bird community to wildland fuel reduction treatments. In particular, tree heights and the size and distribution of Gambel Oak clusters have significant influences on bird communities. While we have some data regarding these habitat characteristics, we need to

standardize how we characterize measures of forest structure across sites and expand our dataset to more effectively represent the shrub layer.

Works Cited:

Ager, Alan A., P. Palaiologou, C.R. Evers, M.A. Day, C. Ringo, and K. Short. 2019. Wildfire exposure to the wildland urban interface in the western US. *Applied Geography*, 111:102059

American Bird Conservancy. 2019. Accessed November 6, 2019. Retrieved from American Bird Conservancy: https://abcbirds.org/bird/common-nighthawk/

Atlegrim, O. 1992. Mechanisms regulating bird predation on a herbivorous Larva guild in boreal coniferous forests. *Ecography*, 15 (1): 19-24. https://doi.org/10.1111/j.1600-0587.1992.tb00003.x

Augosti, A.T., N. Atkins, A. Ben-Naim, S. Bignall, G. Hunter, M. Tunnicliffe, and A. Radosz. 2021. A new diversity index. *Physical Biology*, 18:066004. https//doi.org/10.1088/1478-3975/ac264e.

Baker, W.L. 2018. Historical Fire Regimes in Ponderosa Pine and Mixed-Conifer Landscapes of the San Juan Mountains, Colorado, USA, from Multiple Sources. *Fire*, 1, 23; doi:10.3390/fire1020023.

Bednarz, J.C., D. Ripper, and P.M. Radley. 2004. Emerging Concepts and Research Direction in the Study of Cavity-Nesting Birds: Keystone Ecological Processes. The Condor, 106:1-4

Blake, J. 1982. Influence of fire and logging on nonbreeding bird communities of ponderosa pine forests. *Journal of Wildlife Management*, 46:404-415.

Block, W. M., and L.M. Conner (eds.) 2016. *Effects of Prescribed Fire on Wildlife and Wildlife Habitat in Selected Ecosystems of North America.* The Wildlife Society, Technical Review 16-01.

Bloom, S. A. 1981. Similarity Indices in Community Studies: Potential Pitfalls. *Marine Ecology - Progress Series*, (5):125-128.

Bock, C. E., and J.F. Lynch. 1970. Breeding bird populations of burned and unburned conifer forest in the Sierra Nevada. *Condor*, 72:182-189.

Brawn, J.D., and R.P. Balda. 1988. The influence of silvicultural activity on ponderosa pine forest bird communities in the southwestern United States. *Bird Conservation*, 3:3-21.

Brawn, J.D., S.K. Robinson, and F.R. Thompson III. 2001. The Role of Disturbance in the Ecology and Conservation of Birds. Annu. Rev. Ecol. Syst. 32:251-76.

Bridgeland, W.T., P. Beier, T. Kolb, and T.G. Whitman. 2010. A conditional trophic cascade: Birds benefit faster with strong links between predators and plants. *Ecology*, 91(1): 73-84

Coe, F.C. 2014. Cavity-Nesting Birds and Small Woodlands. Woodland Fish and Wildlife, Oregon Forest Resources Institute.

Cornell. 2019. Cornell Laboratory of Ornithology. Accessed November 30, 2019. http://www.mountainstudies.org

Covert-Bratland, K. A., W.M. Block, and T.C. Theimer. 2006. Hairy Woodpecker Winter Ecology in Ponderosa Pine Forests Representing Different Ages Since Wildfire. *Journal of Wildlife Management*, 70(5):1379-1392.

Covington, W.W., and M.M. Moore. 1994. Post settlement changes in natural fire regimes and forest structur: ecological restoration of old-growth ponderosa pine forests. *J. Sustain. For.*, (2) 153-181.

Cox, G. W. 2002. *General Ecology Laboratory Manual, 8th edition.* McGraw-Hill, NY.

eBird. 2019. Accessed May 15, 2019. Retrieved from eBird Archuleta County, CO: https://ebird.org/subnational2/US-CO-007?yr=all&m=&rank=mrec

Dahlsten, D.L., W.A. Cooper, D.I., Rowney, and P.K. Kleintjes. 1990. Quantifying bird predation of arthropods in - forests. *Studies in Avian Biology*, 13:44-52.

DeWitt, C.B., 2000. Behemoth and Batrachians in the Eye of God: Responsibility to Other Kinds in Biblical Perspective, pp. 291-316. In: Hessel, D. T., and R. R. Ruether, eds., *Christianity and Ecology: Seeking the Well-Being of Earth and Humans*. Harvard Univ. Press., Cambridge.

Dickson, Brett G., B.R. Noon, C.H. Flather, S. Jentsch, and W.M. Block. 2009. Quantifying the multi-scale response of avifauna to prescribed fire experiments in the southwest United States. *Ecological Applications*, 19(5):608-621

Dykstra, B.L., M.A. Rumble, and L.D. Flake. 1997. Effects of timber harvesting on birds in the Black Hills of South Dakota and Wyoming, USA. https://www.fs.fed.us/rm/pubs_other/rmrs_1997_dykstra_m001.pdf

Farris, K.L., M.J. Huss, and S. Zack. The Role of Foraging Woodpeckers in the Decomposition of Ponderosa Pine Snags. The Condor, 106:50-59

Flather, C.H., and C.H. Sieg. 2007. Species Rarity: Definition, Causes, and Classification. IN: M.G. Raphael, and R. Molina, eds. 2007. *Conservation of rare or little-known species*. Island Press. Washington, D.C. pp 40-66.

Franzerb, K.E., and R.D. Ohmart. 1978. The effects of timber harvesting on breeding birds in a mixed-coniferous forest. *Condor*, 80:431-441

Gaston, K.J. 2011. Common Ecology. *BioScience*, 61(5):354-362.

Gillihan, S. W. 1997. *The Influence of White Fir Invasion and Road Presence on Ponderosa Pine Bird Communities in the San Juan National Forest.* Brighton, Colorado: Colorado Bird Observatory for the USFS Pagosa Ranger District.

Grover, H., J. Zirnhelt, and K. Bruno. 2019. The Effects of Prescribed Fire and Shrub-layer Mastication on Bird Communities in Ponderosa Pine Forests of the San Juan Mountains, CO. Report can be accessed at http://www.weminucheaudubon.org/bird-community-monitoring/

Grover, H., J. Zirnhelt, and K. Bruno. 2020. The Effects of Prescribed Fire and Shrub-layer Mastication on Bird Communities in Ponderosa Pine Forests of the San Juan Mountains, CO. Report can be accessed at http://www.weminucheaudubon.org/bird-community-monitoring/

Grover, H., J. Zirnhelt, and K. Bruno. 2021. The Effects of Prescribed Fire and Shrub-layer Mastication on Bird Communities in Ponderosa Pine Forests of the San Juan Mountains, CO. Report can be accessed at http://www.weminucheaudubon.org/bird-community-monitoring/

Grover, H., J. Zirnhelt, and K. Bruno. 2022. The Effects of Prescribed Fire and Shrub-layer Mastication on Bird Communities in Ponderosa Pine Forests of the San Juan Mountains, CO. Report can be accessed at http://www.weminucheaudubon.org/bird-community-monitoring/

Harrington, M.G., and S.S. Sackett. 1990. Using fire as a management tool in southwestern ponderosa pine. *Proceedings of Effects of Fire Management on Southwestern Natural Resources* (pp. 122-133). Tucson, AZ: Gen Tech Rep RM-191, USDA, Forest Service, Rocky Mountain Forest Range and Experiment Station, Fort Collins, CO, USA.

Heyman, E., B. Gunnarsson. 2011. Management effect on bird and arthropod interaction in suburban woodlands. *BMC Ecology*, 2(8):

Holmes, R.T., 1990. Ecological and evolutionary impacts of bird predation on forest insects:: An overview. *Studies in Avian Biology*, (13):6-13.

Hurteau, S.T., T.D. Sisk, W.M. Block, and B.G. Dickson. 2008. Fuel-Reduction Treatment Effects on Avian Community Structure and Diversity. *Journal of Wildlife Management,* 72(5):1168-1174

Hurteau, S. T., T. Sisk, B. Dickson, and W. Block. 2010. Variability in Nest Density, Occupancy, and Home Range Size of Western Bluebirds after Forest Treatments. *Forest Science 56(1)*, 131-138.

Ibarra, J.T., M. Martin, K.L. Cockle, and K. Martin. 2017. Maintaining Ecosystem Resilience: Functional Responses of Tree Cavity nesters to Logging in Temperate Forests of the Americas. Sci Rep. 7:4467. (doi: 10.1038/s41598-017-04733-2). (PMID: 28667282)

Jentsch, S. R., R.W. Mannan, B.G. Dickson, and W.M. Block. 2008. Associations Among Breeding Birds and Gambel Oak in Southwestern Ponderosa Pine Forests. *Journal of Wildlife Management*, 72(4):994-1000.

Jost, L. 2006. Entropy and diversity. OIKOS, 113:363-375.

Jost, L. 2009. The new synthesis of diversity indices and similarity measures. http://www.loujost.com/Statistics%20and%20Physics/Diversity%20and%20Similarity/EffectiveNumberOfSpecies.htm

Kalies, E. L., C. L. Chambers, and W.W. Covington. 2010. Wildlife responses to thinning and burning treatments in southwestern conifer forests: a meta-analysis. *Forest Ecology and Management.*, 259:333-342.

Kalies, E. L., and S.S. Rosenstock. 2013. Stand Structure and Breeding Birds: Implications for Restoring Ponderosa Pine Forests. *The Journal of Wildlife Management.*, 77(6):1157-1165.

Korb, J.E., P.Z. Fule, and R. Wu. 2013. Variability of warm/dry mixed conifer forests in southwestern Colorado. *Forest Ecology and Management*, 304:182-191.

Lecoq, L., A. Ernoult, and C. Mony. 2021. Past landscape structure drives the functional assemblages of plants and birds. Natureportfolio, 11:3443. https//doi.org/10.1038/s41598-021-82851-8

Leitao, R.P., et. al., 2016. Rare species contribute disproportionately to the functional structure of species assemblages. Proc. R. Soc. B., 283:20160084. https//dx.doi.org/10.1098/rspb.2016.0084

Lowe, P. O., P.F. Ffolliot, J.H. Dieterich, and D.R. Patton. 1978. *Gen Tech Rep RM-52; Determining Potential Wildlife Benefits from Wildfire in Arizona Ponderosa Pine Forests.* Rocky Mountain Forest and Range Experiment Station.

Martin, T.E., and P. Li. 1992. Life History Traits of Open vs. Cavity-Nesting Birds. Ecology, 73(2):579-592

Marquis, R.J., and C.J. Whelan. 1994. Insectivorous birds increase growth of White Oak through consumption of leaf-chewing insects. Ecology, 75(7):2007-2014.

McWethy, D.B., T. Schoennagel, P.E. Higuera, M. Krawchuk, B.J. Harvey, E.C. Metcalf, C. Schultz, C. Miller, A.L. Metcalf, B. Buma, A. Virapongse, J.C. Kulig, R.C. Stedman, Z. Ratajczak, C.R. Nelson, and C. Kolden. 2019. Rethinking resilience to wildfire. *Nature Sustainability*, https://doi.org/10.1038/s41893-019-0353-8 .

Mitchell, K. 2015. Quantitative Analysis by the Point-Centered Quarter Method. http://people.hws.edu/mitchell/PCQM.pdf

Morris, E.K., et. al., 2014. Choosing and using diversity indices: Insights fro ecological applications from the German Biodiversity Exploratories. *Ecol Evol*, 18:3514-3524. Doi: 10.1002/ece3.1155

MSI. Unpublished data. Mountain Studies Institute. http://www.mountainstudies.org

Ornithology, C. L. 2019. Accessed November 6, 2019. Retrieved from All About Birds - Common Nighthawk: https://www.allaboutbirds.org/guide/Common_Nighthawk/overview

Palmer, C., K. McShane, and R. Sandler. 2014. Environmental Ethics. Annu. Rev. Environ. Resour. 39:419-442.

Piccolo, J.J., 2017. Intrinsic vlues in nature: Objective good or simply half of an unhelpful dichotomy. J for Nature Conservation, 37:8-11.

Pope, T. L., W.M. Block, and P. Beier. 2009. Prescribed Fire Effects on Wintering, Bark-Foraging Birds in Northern Arizona. *Journal of Wildlife Management*, 73(5):695-700.

Pope, T. L., and W.M. Block. 2010. Effects of Prescribed Fire on Winter Assemblages of Birds in Ponderosa Pine Forests of Northern Arizona. *The Southwestern Naturalist*, 55(1):22-28.

Romme, W.H., M.R. Crist, M.L. Floyd, and H. Grissino-Mayer. 2009. Historical Range of Variability and Current Landscape Condition Analysis: South Central Highlands Section, Southwestern Colorado and Northwestern New Mexico. *ResearchGate*, https://www.researchgate.net/publication/264884775 .

Sallabanks, R., E.B. Arnett, and J.M. Marzluff. 2000. An evaluation of research on the effects of timber harvest on bird populations. Wildlife Society Bulletin, 28(4): 1144-1155.

Sandler, R. 2012. Intrinsic Value, Ecology, and Conservation. Nature Education Knowledge. 3:4-7

Schweiger, L.J., 2009. *Last Chance: preserving life on earth*. Fulcrum Pub., Golden, CO.

Somveille, M. 2016. The Global Ecology of Bird Migration: Patterns and Processes. Frontiers of Biogeography. 8(3). DOI 10.21425/F58332694.

SOTB. 2022. State of North American Birds. https://www.stateofthebirds.org/2022/download-pdf-report/?_gl=1*dbanm7*_ga*MjE2MjQ0NTM1LjE2NzY2MDIyMDk.*_ga_QR4NVXZ8BM*MTY3NjYwMjIwOS4xLjEuMTY3NjYwMjI1MC4xOS4wLjA.&_ga=2.237478784.1848212838.1676602210-216244535.1676602209

Strong, A.M., T.W. Sherry, and R.T. Holmes. 2000. Bird predation on herbivorous insects: Indirect effects on sugar maple saplings. *Oecologia*, 125:370-379.

Technosylva Inc., La Jolla, CA. December, 2018. *2017 Colorado Wildfire Risk Assessment Update.* Colorado State Forest Service.

USDA. 1974. *Soil Survey of Piedra Area, Colorado.* USDA.

van Boer, A. N. 2018. *Monitoring the Effects of Restoration on Riparian Birds: 2017 Field Season.* Brighton, Colorado: Technical Report. Bird Conservancy of the Rockies.

Van Dyke, Fred. 2010. *Between Heaven and Earth: Christian Perspectives on Environmental Protection*. Praeger. Santa Barbara, CA

Venier, L.A., J.L. Pearce, D.R. Fillman, D.K. McNicol, and D.A. Welsh. 2009. Effects of spruce budworm (*Choristoneura fumiferana*) outbreaks on boreal mixed-wood bird communities. Avian Conservation and Ecology, 4(1): 3-15.

Watts, H.E. 2017. Migration and Navigation in Birds. Encyclopedia of Reproduction, 2nd Ed. DOI 10.1016/B978-0-12-811899-3.20641-1

Weidensaul, S. 2021. *A World on the Wing.* Norton and Norton, NY. 400 pp.

Appendix A
Data Summaries from First, Second, and Third Year Reports:

Table 3 (from Grover et. al., 2019). Summary of all bird species observed across the three study areas monitored, including the FG Re-balanced data. Data shown are the number of birds counted (abundance) and number of monitoring points where the species were reported (frequency). Species lists represent those found at all three sites sorted by abundance; those unique to the sites shown sorted by abundance; or those found at two respective sites (unsorted).

	Turkey Springs					Fawn Gulch (Full Data)					Fawn Gulch (Re-balanced)					Jackson Mountain			
# Species	26				# Species	40				34				# Species	33			
# points w record	185		144		# points w record	486		300		354		204		# points w record	278		209	
	Abun	Rel Abun	Freq	Rel Freq		Abun	Rel Abun	Freq	Rel Freq	Abun	Rel Abun	Freq	Rel Freq		Abun	Rel Abun	Freq	Rel Freq
Species Found At All Three Sites (Sorted by Abundance)																		
American Robin	43	18.53	31	16.15	American Robin	130	25.95	67	21.47	81	22.88	47	23.04	American Robin	75	26.22	53	22.75
Violet-green Swallow	29	12.50	13	6.77	Western Wood-Pewee	83	16.57	59	18.91	64	18.08	41	20.10	Northern Flicker	29	10.14	25	10.73
Western Wood-Pewee	20	8.62	17	8.85	Northern Flicker	44	8.78	23	7.37	35	9.89	19	9.31	Western Tanager	16	5.59	14	6.01
Pygmy Nuthatch	17	7.33	14	7.29	Western Tanager	32	6.39	21	6.73	27	7.63	17	8.33	Western Wood-Pewee	14	4.90	13	5.58
Northern Flicker	16	6.90	13	6.77	White-breasted Nuthatch	23	4.59	14	4.49	17	4.80	9	4.41	Pygmy Nuthatch	12	4.20	6	2.58
White-breasted Nuthatch	11	4.74	11	5.73	Yellow-rumped Warbler	13	2.59	11	3.53	8	2.26	6	2.94	Yellow-rumped Warbler	12	4.20	9	3.86
American Crow	10	4.31	8	4.17	Violet-green Swallow	11	2.20	7	2.24	7	1.98	5	2.45	Steller's Jay	11	3.85	9	3.86
Yellow-rumped Warbler	4	1.72	3	1.56	Steller's Jay	10	2.00	10	3.21	5	1.41	5	2.45	Turkey Vulture	8	2.80	6	2.58
Brown-headed Cowbird	2	0.86	2	1.04	Pygmy Nutatch	7	1.40	4	1.28	4	1.13	2	0.98	Red-tailed Hawk	6	2.10	5	2.15
Hairy Woodpecker	2	0.86	1	0.52	Turkey Vulture	6	1.20	4	1.28	3	0.85	2	0.98	White-breasted Nuthatch	4	1.40	4	1.72
Broad-tailed Hummingbird	1	0.43	1	0.52	American Crow	4	0.80	3	0.96	4	1.13	3	1.47	Violet-green Swallow	3	1.05	1	0.43
Red-tailed Hawk	1	0.43	1	0.52	Brown-headed Cowbird	3	0.60	2	0.64	3	0.85	2	0.98	American Crow	2	0.70	2	0.86
Steller's Jay	1	0.43	1	0.52	Broad-tailed Hummingbird	2	0.40	2	0.64	1	0.28	1	0.49	Broad-tailed Hummingbird	2	0.70	2	0.86
Turkey Vulture	1	0.43	1	0.52	Hairy Woodpecker	2	0.40	2	0.64	1	0.28	1	0.49	Brown-headed Cowbird	1	0.00	1	0.43
Western Tanager	1	0.43	1	0.52	Red-tailed Hawk	1	0.20	1	0.32	1	0.28	1	0.49	Hairy Woodpecker	1	0.35	1	0.43
Species Unique to Respective Sites (Sorted by Abundance)																		
Lewis's Woodpecker	1	0.43	1	0.52														
MacGillvary's Warbler	1	0.43	1	0.52														
Osprey	1	0.43	1	0.52														
					Northern Rough-winged Swallow	25	4.99	10	3.21	25	7.06	10	4.90					
					American Goldfinch	3	0.60	2	0.64	3	0.85	2	0.98					
					Cassins's Finch	3	0.60	3	0.96	1	0.28	1	0.49					
					Cordilleran Flycatcher	3	0.60	2	0.64	3	0.85	2	0.98					
					Bald Eagle	2	0.40	2	0.64	2	0.56	2	0.98					
					Black-billed Magpie	2	0.40	2	0.64	1	0.28	1	0.49					
					Pine Siskin	2	0.40	1	0.32	2	0.56	1	0.49					
					Red-naped Sapsucker	2	0.40	2	0.64	1	0.28	1	0.49					
					Say's Phoebe	2	0.40	2	0.64	2	0.56	2	0.98					
					Yellow Warbler	2	0.40	2	0.64	2	0.56	2	0.98					
					American Kestrel	1	0.20	1	0.32									
					Dark-eyed Junco	1	0.20	1	0.32									
					Mountain Bluebird	1	0.20	1	0.32									
					Red Crossbill	1	0.20	1	0.32	1	0.28	1	0.49					
														House Wren	4	1.40	2	0.86
														Townsend's Solitaire	3	1.05	3	1.29
														Virginia's Warbler	3	1.05	2	0.86
														White-throated Swift	3	1.05	1	0.43
														Orange-crowned Warbler	2	0.70	1	0.43
														Black-capped Chickadee	1	0.35	1	0.43
														Hermit Thrush	1	0.35	1	0.43
Species Found At Two Respective Sites (Unsorted)																		
					Black-headed Grosbeak	5	1.00	5	1.60	5	1.41	5	2.45	Black-headed Grosbeak	5	1.75	5	2.15
Bullock's Oriole	1	0.43	1	0.52	Bullock's Oriole	1	0.20	1	0.32									
					Canada Goose	12	2.40	2	0.64	6	1.69	1	0.49	Canada Goose	5	1.75	1	0.43
Chipping Sparrow	6	2.59	5	2.60	Chipping Sparrow	10	2.00	5	1.60	8	2.26	3	1.47					
Common Nighthawk	6	2.59	7	3.65										Common Nighthawk	2	0.70	1	0.43
					Common Raven	1	0.20	1	0.32	1	0.28	1	0.49	Common Raven	11	3.85	9	3.86
Downy Woodpecker	1	0.43	1	0.52	Downy Woodpecker	3	0.60	1	0.32	3	0.85	1	0.49					
					Green-tailed Towhee	19	3.79	14	4.49	16	4.52	1	0.49	Green-tailed Towhee	7	2.45	7	3.00
					Mountain Chickadee	1	0.20	1	0.32					Mountain Chickadee	4	1.40	2	0.86
Mourning Dove	1	0.43	1	0.52										Mourning Dove	1	0.35	1	0.43
Plumbeous Vireo	2	0.86	2	1.04										Plumbeous Vireo	12	4.20	9	3.86
					Tree Swallow	7	1.40	3	0.96	7	1.98	3	1.47	Tree Swallow	4	1.40	1	0.43
					Warbling Vireo	1	0.20	1	0.32					Warbling Vireo	7	2.45	7	3.00
Western Bluebird	5	2.16	5	2.60	Western Bluebird	5	1.00	4	1.28	4	1.13	3	1.47					
Williamson's Sapsucker	1	0.43	1	0.52										Williamson's Sapsucker	7	2.45	4	1.72

Table 2 (from Grover et. al., 2020). Summary of all bird species observed across the three study areas in 2020. Data shown are the number of sample points at which respective bird species were recorded (i.e., frequency); and the number of birds of the respective species observed (i.e., abundance). Species lists represent those found at all three sites, sorted by abundance within the respective sites; those unique at one of the three sites, sorted by abundance within the respective sites; and those found at two of the three sites, unsorted

	Turkey Springs					Fawn Gulch					Jackson Mountain			
# Species	37				# Species	39				# Species	45			
# point records	471	# birds	688		# point records	571	# birds	856		# point records	536	# birds	683	
	Freq	Rel Freq	Abund	Rel Abund		Freq	Rel Freq	Abund	Rel Abund		Freq	Rel Freq	Abund	Rel Abund
Species Found At All Three Sites (Sorted by Abundance)														
Violet-green Swallow	50	10.2	109	15.7	Western Wood-Pewee	93	16.3	153	17.9	American Robin	76	14.2	103	15.1
Pygmy Nuthatch	44	9.0	81	11.6	American Robin	78	13.7	110	12.9	Pygmy Nuthatch	41	7.6	57	8.3
American Robin	61	12.5	77	11.1	Mourning Dove	32	5.6	63	7.4	Northern Flicker	44	8.2	52	7.6
Western Wood-Pewee	51	10.4	63	9.1	Pygmy Nuthatch	29	5.1	55	6.4	Steller's Jay	36	6.7	52	7.6
Yellow-rumped Warbler	35	7.2	53	7.6	Yellow-rumped Warbler	33	5.8	41	4.8	Western Tanager	34	6.3	49	7.2
Dark-eyed Junco	32	6.5	46	6.6	Violet-green Swallow	14	2.5	38	4.4	Violet-green Swallow	25	4.7	41	6.0
Mourning Dove	30	6.1	36	5.2	Western Tanager	28	4.9	36	4.2	Chipping Sparrow	25	4.7	37	5.4
Western Bluebird	19	3.9	30	4.3	Green-tailed Towhee	28	4.9	35	4.1	Green-tailed Towhee	24	4.5	29	4.2
Chipping Sparrow	20	4.1	23	3.3	House Wren	26	4.6	32	3.7	Western Wood-Pewee	27	5.0	29	4.2
White-breasted Nuthatch	21	4.3	23	3.3	Warbling Vireo	22	3.9	30	3.5	Plumbeous Vireo	23	4.3	25	3.7
Red Crossbill	4	0.8	17	2.4	White-breasted Nuthatch	18	3.2	29	3.4	Warbling Vireo	16	3.0	17	2.5
House Wren	12	2.5	15	2.2	Black-capped Chickadee	13	2.3	21	2.5	White-breasted Nuthatch	16	3.0	17	2.5
Northern Flicker	12	2.5	14	2.0	Cordilleran Flycatcher	15	2.6	19	2.2	Black-capped Chickadee	8	1.5	11	1.6
Hairy Woodpecker	9	1.8	10	1.4	Plumbeous Vireo	17	3.0	19	2.2	Broad-tailed Hummingbird	10	1.9	11	1.6
Western Tanager	9	1.8	10	1.4	Steller's Jay	13	2.3	16	1.9	Yellow-rumped Warbler	10	1.9	11	1.6
Steller's Jay	7	1.4	7	1.0	Western Bluebird	14	2.5	16	1.9	Turkey Vulture	9	1.7	10	1.5
American Crow	5	1.0	6	0.9	Chipping Sparrow	11	1.9	12	1.4	Mourning Dove	7	1.3	9	1.3
Broad-tailed Hummingbird	6	1.2	6	0.9	Northern Flicker	8	1.4	10	1.2	American Crow	8	1.5	8	1.2
Townsend's Solitaire	5	1.0	6	0.9	Red Crossbill	7	1.2	9	1.1	Dark-eyed Junco	8	1.5	8	1.2
Cordilleran Flycatcher	4	0.8	5	0.7	Dark-eyed Junco	6	1.1	8	0.9	House Wren	7	1.3	8	1.2
Green-tailed Towhee	4	0.8	5	0.7	Hairy Woodpecker	6	1.1	7	0.8	Mountain Chickadee	5	0.9	8	1.2
Black-capped Chickadee	4	0.8	4	0.6	Mountain Chickadee	5	0.9	6	0.7	Red Crossbill	1	0.2	8	1.2
Mountain Chickadee	2	0.4	4	0.6	Broad-tailed Hummingbird	3	0.5	3	0.4	Hairy Woodpiecker	5	0.9	5	0.7
Plumbeous Vireo	2	0.4	2	0.3	Turkey Vulture	3	0.5	3	0.4	Cordilleran Flycatcher	4	0.7	4	0.6
Turkey Vulture	1	0.2	1	0.1	American Crow	2	0.4	2	0.2	Townsend's Solitaire	1	0.2	1	0.1
Warbling Vireo	1	0.2	1	0.1	Townsend's Solitaire	1	0.2	1	0.1	Western Bluebird	1	0.2	1	0.1
Species Unique to Respective Sites (Sorted by Abundance)														
Pine Siskin	2	0.4	3	0.4										
European Starling	1	0.2	1	0.1										
Osprey	1	0.2	1	0.1										
White-crowned sparrow	1	0.2	1	0.1										
					Band-tailed Pigeon	6	1.1	34	4.0					
					Black-headed Grosbeak	8	1.4	9	1.1					
					Great Horned Owl	1	0.2	3	0.4					
					Black-chinned Hummingbird	1	0.2	1	0.1					
					Dusky Grouse	1	0.2	1	0.1					
					Evening Grosbeak	1	0.2	1	0.1					
					Song Sparrow	1	0.2	1	0.1					
					Williamson's Sapsucker	1	0.2	1	0.1					
										Virginia's Warbler	21	3.9	21	3.1
										Black-headed Grosbeak	7	1.3	7	1.0
										Say's Phoebe	4	0.7	4	0.6
										Hermit Thrush	2	0.4	3	0.4
										Brown Creeper	1	0.2	1	0.1
										Cooper's Hawk	1	0.2	1	0.1
										Dusky Flycatcher	1	0.2	1	0.1
										Northern Goshawk	1	0.2	1	0.1
										Gray Catbird	1	0.2	1	0.1
										Great Blue Heron	1	0.2	1	0.1
										Tree Swallow	1	0.2	1	0.1
Species Found At Two Respective Sites (Unsorted)														
Cassin's Finch	1	0.2	2	0.3	Cassin's Finch	4	0.7	6	0.7					
Spotted Towhee	3	0.6	3	0.4	Spotted Towhee	3	0.5	4	0.5					
					Grace's Warbler	11	1.9	11	1.3	Grace's Warbler	3	0.6	4	0.6
					Red-tailed Hawk	4	0.7	4	0.5	Red-tailed Hawk	4	0.7	4	0.6
					Orange-crowned Warbler	4	0.7	6	0.7	Orange-crowned Warbler	3	0.6	3	0.4
Brown-headed Cowbird	1	0.2	1	0.1						Brown-headed Cowbird	2	0.4	2	0.3
Collared Dove	2	0.4	3	0.4						Eurasian Collared Dove	1	0.2	1	0.1
Common Nighthawk	3	0.6	3	0.4						Common Nighthawk	1	0.2	1	0.1
Common Raven	5	1.0	14	2.0						Common Raven	9	1.7	12	1.8
Red-breasted Nuthatch	1	0.2	2	0.3						Red-breasted Nuthatch	1	0.2	3	0.4

Table 3. (From Grover et. al., 2021). Summary of the 60 different bird species observed across the three study areas in 2021. Data shown are the number of sample points at which respective bird species were recorded (i.e., frequency); and the number of birds of the respective species observed (i.e., abundance). Species lists represent those found at all three sites, sorted by abundance within the respective sites; those unique at any one of the three sites, sorted by abundance within the respective sites; and those found at two of the three sites, unsorted

2021	Turkey Springs					Fawn Gulch					Jackson Mountain				
Number of Species	35				Number of Species	40				Number of Species	43				
# Point Records	438	# Birds	609		# Point Records	422	# Birds	594		# Point Records	467	# Birds	652		
	Freq	Rel Freq	Abund	Rel Abund		Freq	Rel Freq	Abund	Rel Abund		Freq	Rel Freq	Abund	Rel Abund
Species Found At All Three Sites (Sorted by Abundance)															
Pygmy Nuthatch	48	11.0%	92	15.1%	American Robin	81	19.2%	140	23.6%	Pygmy Nuthatch	50	10.7%	90	13.8%
Violet-green Swallow	42	9.6%	77	12.6%	Western Wood-Pewee	67	15.9%	94	15.8%	American Robin	61	13.1%	85	13.0%
American Robin	49	11.2%	59	9.7%	Green-tailed Towhee	42	10.0%	53	8.9%	Western Wood-Pewee	44	9.4%	59	9.0%
Western Wood-Pewee	43	9.8%	55	9.0%	Western Tanager	24	5.7%	37	6.2%	Northern Flicker	40	8.6%	49	7.5%
Yellow-rumped Warbler	37	8.4%	45	7.4%	Stellar's Jay	24	5.7%	33	5.6%	Western Tanager	35	7.5%	47	7.2%
Chipping Sparrow	24	5.5%	35	5.7%	Pygmy Nuthatch	19	4.5%	27	4.5%	Violet-green Swallow	24	5.1%	45	6.9%
White-breasted Nuthatch	30	6.8%	34	5.6%	White-breasted Nuthatch	19	4.5%	20	3.4%	Mourning Dove	27	5.8%	39	6.0%
Northern Flicker	20	4.6%	27	4.4%	Northern Flicker	19	4.5%	19	3.2%	Stellar's Jay	20	4.3%	30	4.6%
Dark-eyed Junco	13	3.0%	17	2.8%	Warbling Vireo	11	2.6%	19	3.2%	Warbling Vireo	15	3.2%	27	4.1%
Western Tanager	13	3.0%	17	2.8%	Yellow-rumped Warbler	14	3.3%	19	3.2%	Yellow-rumped Warbler	16	3.4%	18	2.8%
Plumbeous Vireo	15	3.4%	15	2.5%	Chipping Sparrow	13	3.1%	15	2.5%	Hairy Woodpecker	13	2.8%	15	2.3%
House Wren	5	1.1%	7	1.1%	Violet-green Swallow	8	1.9%	14	2.4%	White-breasted Nuthatch	12	2.6%	14	2.1%
Townsend's Solitaire	6	1.4%	7	1.1%	Mourning Dove	10	2.4%	11	1.9%	Green-tailed Towhee	10	2.1%	11	1.7%
Hairy Woodpecker	5	1.1%	6	1.0%	Hairy Woodpecker	5	1.2%	7	1.2%	Plumbeous Vireo	8	1.7%	10	1.5%
American Crow	4	0.9%	5	0.8%	Plumbeous Vireo	4	0.9%	5	0.8%	Common Raven	7	1.5%	8	1.2%
Common Raven	4	0.9%	4	0.7%	American Crow	3	0.7%	3	0.5%	House Wren	6	1.3%	7	1.1%
Green-tailed Towhee	4	0.9%	4	0.7%	Dark-eyed Junco	2	0.5%	3	0.5%	Chipping Sparrow	5	1.1%	6	0.9%
Mourning Dove	3	0.7%	3	0.5%	Mountain Chickadee	2	0.5%	3	0.5%	Turkey Vulture	5	1.1%	6	0.9%
Warbling Vireo	3	0.7%	3	0.5%	House Wren	2	0.5%	2	0.3%	Dark-eyed Junco	2	0.4%	5	0.8%
Mountain Chickadee	1	0.2%	1	0.2%	Townsend's Solitaire	2	0.5%	2	0.3%	American Crow	3	0.6%	3	0.5%
Stellar's Jay	1	0.2%	1	0.2%	Turkey Vulture	2	0.5%	2	0.3%	Mountain Chickadee	1	0.2%	2	0.3%
Turkey Vulture	1	0.2%	1	0.2%	Common Raven	1	0.2%	1	0.2%	Townsend's Solitaire	2	0.4%	2	0.3%
Species Unique to Respective Sites (Sorted by Abundance)															
Brown Creeper	1	0.2%	1	0.2%										
Great-Horned Owl	1	0.2%	1	0.2%										
Mallard	1	0.2%	1	0.2%										
Mountain Bluebird	1	0.2%	1	0.2%										
Sharp-shinned Hawk	1	0.2%	1	0.2%										
White-crowned Sparrow	1	0.2%	1	0.2%										
					Three-toed Woodpecker	2	0.5%	3	0.5%					
					Ash-throated Flycatcher	1	0.2%	1	0.2%					
					Cassin's Vireo	1	0.2%	1	0.2%					
					Olive-sided Flycatcher	1	0.2%	1	0.2%					
					Red-tailed Hawk	1	0.2%	1	0.2%					
					Red-winged Blackbird	1	0.2%	1	0.2%					
					Tree Swallow	1	0.2%	1	0.2%					
										Brown-headed Cowbird	2	0.4%	4	0.6%
										Lewis's Woodpecker	3	0.6%	3	0.5%
										Bullock's Oriole	2	0.4%	2	0.3%
										Bald Eagle	1	0.2%	1	0.2%
										Band-tailed Pigeon	1	0.2%	1	0.2%
										Collared Dove	1	0.2%	1	0.2%
										Downy Woodpecker	1	0.2%	1	0.2%
										Hermit Thrush	1	0.2%	1	0.2%
										Peregrine Falcon	1	0.2%	1	0.2%
										Western Meadowlark	1	0.2%	1	0.2%
										Williamson's Sapsucker	1	0.2%	1	0.2%
Species Found At Two Respective Sites (Unsorted)															
Cassin's Finch	2	0.5%	3	0.5%	Cassin's Finch	2	0.5%	2	0.3%					
Common Nighthawk	5	1.1%	7	1.1%	Common Nighthawk	8	1.9%	16	2.7%					
Spotted Towhee	5	1.1%	5	0.8%	Spotted Towhee	11	2.6%	13	2.2%					
Western Bluebird	34	7.8%	53	8.7%	Western Bluebird	6	1.4%	8	1.3%					
					Black-headed Grosbeak	4	0.9%	7	1.2%	Black-headed Grosbeak	10	2.1%	10	1.5%
					Cordilleran Flycatcher	2	0.5%	2	0.3%	Cordilleran Flycatcher	12	2.6%	18	2.8%
					Great Blue Heron	1	0.2%	1	0.2%	Great Blue Heron	1	0.2%	1	0.2%
					Orange-crowned Warbler	2	0.5%	2	0.3%	Orange-crowned Warbler	8	1.7%	9	1.4%
					Say's Phoebe	2	0.5%	2	0.3%	Say's Phoebe	2	0.4%	2	0.3%
					Turkey	1	0.2%	2	0.3%	Turkey	1	0.2%	1	0.2%
					Virginia's Warbler	1	0.2%	1	0.2%	Virginia's Warbler	4	0.9%	5	0.8%
Black-capped Chickadee	3	0.7%	3	0.5%						Black-capped Chickadee	3	0.6%	5	0.8%
Broad-tailed Hummingbird	2	0.5%	2	0.3%						Broad-tailed Hummingbird	3	0.6%	3	0.5%
Grace's Warbler	10	2.3%	15	2.5%						Grace's Warbler	2	0.4%	3	0.5%

Table 2. (From Grover et al. 2022) Summary of the 56 different bird species observed across the three study areas in 2022. Data shown are the number of sample points at which respective bird species were recorded (i.e., frequency); and the number of birds of the respective species observed (i.e., abundance). Species lists represent those found at all three sites, sorted by abundance within the respective sites; those unique at any one of the three sites, sorted by abundance within the respective sites; and those found at two of the three sites, unsorted

2022	Fawn Gulch (FG)				Jackson Mountain (original site - JM)					Jackson Mountain (New Site - JMN)				
Number of Species	37				Number of Species	41		41		Number of Species	38		38	
# Point Records	554	# Birds	678		# Point Records	719	# Birds	933		# Point Records	393	# Birds	475	
	Freq	Rel Freq	Abund	Rel Abund		Freq	Rel Freq	Abund	Rel Abund		Freq	Rel Freq	Abund	Rel Abund
Species Found At All Three Sites (Sorted by Abundance)														
Pygmy Nuthatch	37	26.4	68	10.0	Pygmy Nuthatch	57	38.0	107	11.5	Warbling Vireo	37	28.5	44	9.3
Western Tanager	50	35.7	61	9.0	American Robin	71	47.3	92	9.9	Western Tanager	34	26.2	43	9.1
American Robin	48	34.3	60	8.8	Western Tanager	72	48.0	90	9.6	Mountain Chickadee	23	17.7	27	5.7
Green-tailed Towhee	45	32.1	49	7.2	Violet-green Swallow	46	30.7	78	8.4	American Robin	23	17.7	25	5.3
Northern Flicker	39	27.9	46	6.8	Northern Flicker	47	31.3	58	6.2	Pygmy Nuthatch	16	12.3	24	5.1
Yellow-rumped Warbler	31	22.1	34	5.0	House Wren	32	21.3	39	4.2	Steller's Jay	19	14.6	22	4.6
Plumbeous Vireo	28	20.0	32	4.7	Steller's Jay	27	18.0	33	3.5	Dark-eyed Junco	18	13.8	22	4.6
Chipping Sparrow	27	19.3	29	4.3	Green-tailed Towhee	30	20.0	31	3.3	Chipping Sparrow	16	12.3	21	4.4
White-breasted Nuthatch	21	15.0	23	3.4	Warbling Vireo	28	18.7	31	3.3	House Wren	17	13.1	20	4.2
Warbling Vireo	15	10.7	18	2.7	White-breasted Nuthatch	26	17.3	31	3.3	Yellow-rumped Warbler	16	12.3	19	4.0
Steller's Jay	13	9.3	15	2.2	Chipping Sparrow	26	17.3	27	2.9	Violet-green Swallow	7	5.4	13	2.7
House Wren	10	7.1	10	1.5	Black-headed Grosbeak	15	10.0	16	1.7	White-breasted Nuthatch	8	6.2	10	2.1
Violet-green Swallow	4	2.9	6	0.9	Common Raven	11	7.3	12	1.3	Northern Flicker	9	6.9	9	1.9
Broad-tailed Hummingbird	5	3.6	5	0.7	Mourning Dove	10	6.7	12	1.3	Orange-crowned Warbler	7	5.4	7	1.5
Orange-crowned Warbler	5	3.6	5	0.7	Plumbeous Vireo	9	6.0	10	1.1	Plumbeous Vireo	3	2.3	6	1.3
Black-headed Grosbeak	4	2.9	4	0.6	Yellow-rumped Warbler	8	5.3	10	1.1	Green-tailed Towhee	4	3.1	5	1.1
Mountain Chickadee	3	2.1	4	0.6	Dark-eyed Junco	9	6.0	9	1.0	Black-headed Grosbeak	4	3.1	4	0.8
Cordilleran Flycatcher	3	2.1	3	0.4	Mountain Chickadee	8	5.3	8	0.9	Broad-tailed hummingbird	4	3.1	4	0.8
Common Raven	2	1.4	2	0.3	Red-tailed Hawk	5	3.3	6	0.6	Common Raven	2	1.5	2	0.4
Dark-eyed Junco	2	1.4	2	0.3	Broad-tailed Hummingbird	5	3.3	5	0.5	Hairy Woodpecker	2	1.5	2	0.4
Hairy Woodpecker	2	1.4	2	0.3	Hairy Woodpecker	5	3.3	5	0.5	Cordilleran Flycatcher	1	0.8	1	0.2
Red-tailed Hawk	2	1.4	2	0.3	Cordilleran Flycatcher	3	2.0	4	0.4	Mourning Dove	1	0.8	1	0.2
Mourning Dove	1	0.7	1	0.1	Orange-crowned Warbler	3	2.0	3	0.3	Red-tailed Hawk	1	0.8	1	0.2
Species Unique to Respective Sites (Sorted by Abundance)														
Common Nighthawk	12	8.6	12	1.8										
Cassin's Finch	4	2.9	5	0.7										
Bald Eagle	1	0.7	1	0.1										
Brown-headed Cowbird	1	0.7	1	0.1										
Mountain Bluebird	1	0.7	1	0.1										
					American Crow	7	4.7	7	0.8					
					Dusky Grouse	1	0.7	2	0.2					
					Olive-sided Flycatcher	2	1.3	2	0.2					
					American Kestrel	1	0.7	1	0.1					
					Downey Woodpecker	1	0.7	1	0.1					
					Osprey	1	0.7	1	0.1					
										Ruby-crowned Kinglet	17	13.1	19	4.0
										Townsend's Solitaire	2	1.5	3	0.6
										Cooper's Hawk	1	0.8	2	0.4
										Red-naped Sapsucker	2	1.5	2	0.4
										Sharp-shinned Hawk	2	1.5	2	0.4
										Wild Turkey	1	0.8	2	0.4
										House Finch	1	0.8	1	0.2
										MacGillivray's Warbler	1	0.8	1	0.2
Species Found at Two Respective Sites (Unsorted)														
Dusky Flycatcher	20	14.3	20	2.9	Dusky Flycatcher	2	1.3	3	0.3					
Spotted Towhee	11	7.9	11	1.6	Spotted Towhee	10	6.7	10	1.1					
Turkey Vulture	4	2.9	5	0.7	Turkey Vulture	4	2.7	5	0.5					
Virginia's Warbler	1	0.7	1	0.1	Virginia's Warbler	15	10.0	16	1.7					
Western Bluebird	13	9.3	28	4.1	Western Bluebird	1	0.7	3	0.3					
Western Wood-Pewee	69	49.3	90	13.3	Western Wood-Pewee	85	56.7	120	12.9					
Williamson's Sapsucker	1	0.7	1	0.1	Williamson's Sapsucker	1	0.7	1	0.1					
					Black-capped Chickadee	1	0.7	2	0.2	Black-capped Chickadee	5	3.8	5	1.1
					Brown Creeper	1	0.7	1	0.1	Brown Creeper	7	5.4	7	1.5
					Hammond's Flycatcher	26	17.3	34	3.6	Hammond's Flycatcher	23	17.7	26	5.5
					Hermit Thrush	4	2.7	4	0.4	Hermit Thrush	26	20.0	35	7.4
					Red-breasted Nuthatch	3	2.0	3	0.3	Red-breasted Nuthatch	30	23.1	35	7.4
Grace's Warbler	18	12.9	18	2.7						Grace's Warbler	2	1.5	2	0.4
Pine Siskin	1	0.7	3	0.4						Pine Siskin	1	0.8	1	0.2