FOURTH 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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December, 2022

Weminuche Audubon Society

San Juan Headwaters Forest Health Partnership

Mountain Studies Institute
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Audubon | Rockies

Abstract:
Over the past four years, volunteers from the Weminuche Audubon Society in Pagosa Springs, CO, have conducted a bird monitoring project in dry, mixed-conifer forests in our area. 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 2023 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 85 bird species have been identified, with a total of 7117 birds counted. Thirty-five bird species were observed in every year 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 50% of the birds counted. The 35 most frequently observed bird species accounted for 83% of the birds counted. In the 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 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 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 four years of the study. Their names (in alphabetical order) are: (Note: a = 2019 participant; b = 2020 participant; c = 2021 participant; d = 2022 participant)

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Tony Aldwell[d]	Rita Peck[b]	Gary Hopkins[b]	Chuck Rhiem[d]
Ben Bailey[a, c]	Becky Endres[a, c, d]	Donna Huffman[c, d]	Joan Rohwer[b, c, d]
Bill Breding[a, b, d]	Bob Endres[a, b, c, d]	Kurt Huffman[c, d]	Darryl Saffer[a]
Brenda Breding[a, b, d]	Karissa Foster[b]	Liz Jamison[b, c, d]	Anna Schneider[c]
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Keith Bruno[a, b, c, d]	Gloria Godo[b]	Jennifer Marsh[d]	Loyette Stewart[a, b, c, d]
Tricia Byers[a, b, c, d]	Byron Greco[a, b, c, d]	Charles Martinez[a, b, c, d]	Anne Stevens[a, b, c, d]
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We also appreciate the assistance of USFS personnel Anthony Garcia, Mat Tuten and Fred Ellis in locating prospective study sites, and Dana Guinn and Anthony Culpepper of Mountain Studies Institute for providing treatment and vegetation data used to characterize the sites chosen for our study. Thanks also go to several unnamed reviewers who commented on earlier drafts of this report.

FOURTH 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). 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 background 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 2022 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.

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 (Grover et. al. 2020), and 2021 (Grover et. al., 2021).

The ASCC project sites included in 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.

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 JMN site 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. The understory is very dense – 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; and 2021)
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 2022, 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. A sufficient number of birders volunteered for the study in 2022 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 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 52 different volunteer observers involved, with about 25 observers actively participating in the study each year, and 13 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 three 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, reflecting 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 2022.

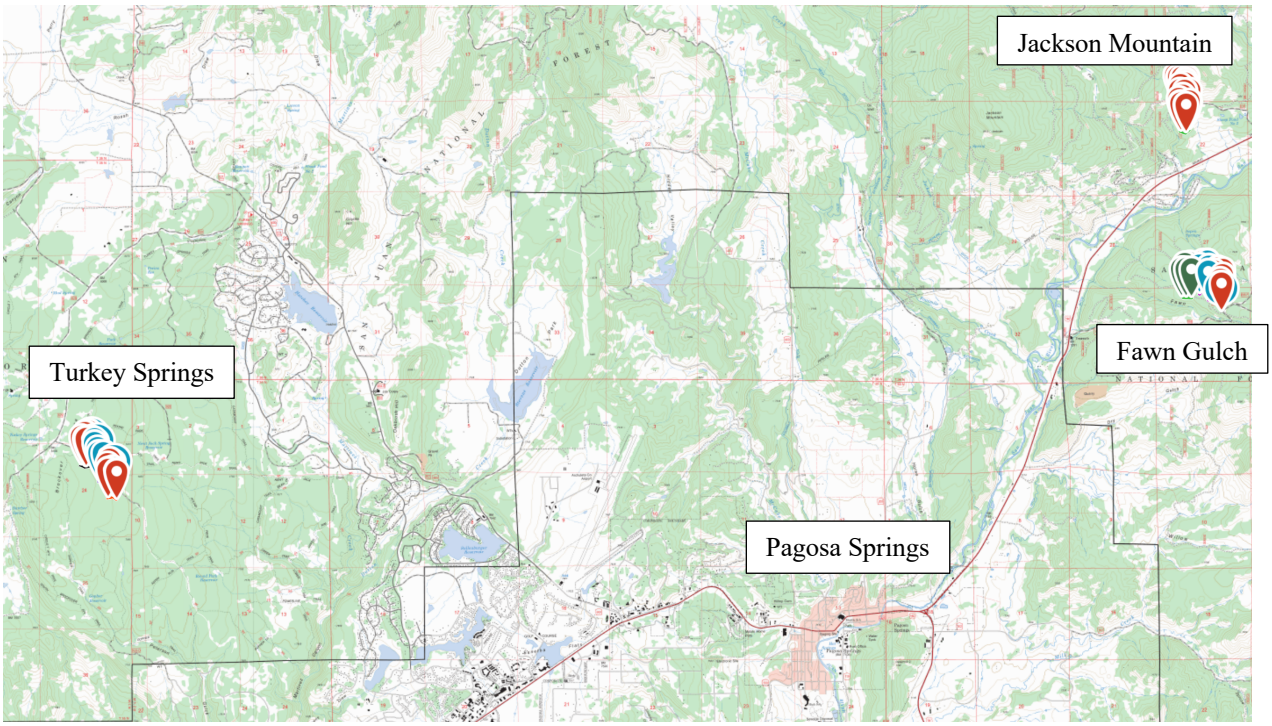

Figure 1. Map showing locations of Turkey Springs, Fawn Gulch, and Jackson Mountain study areas.

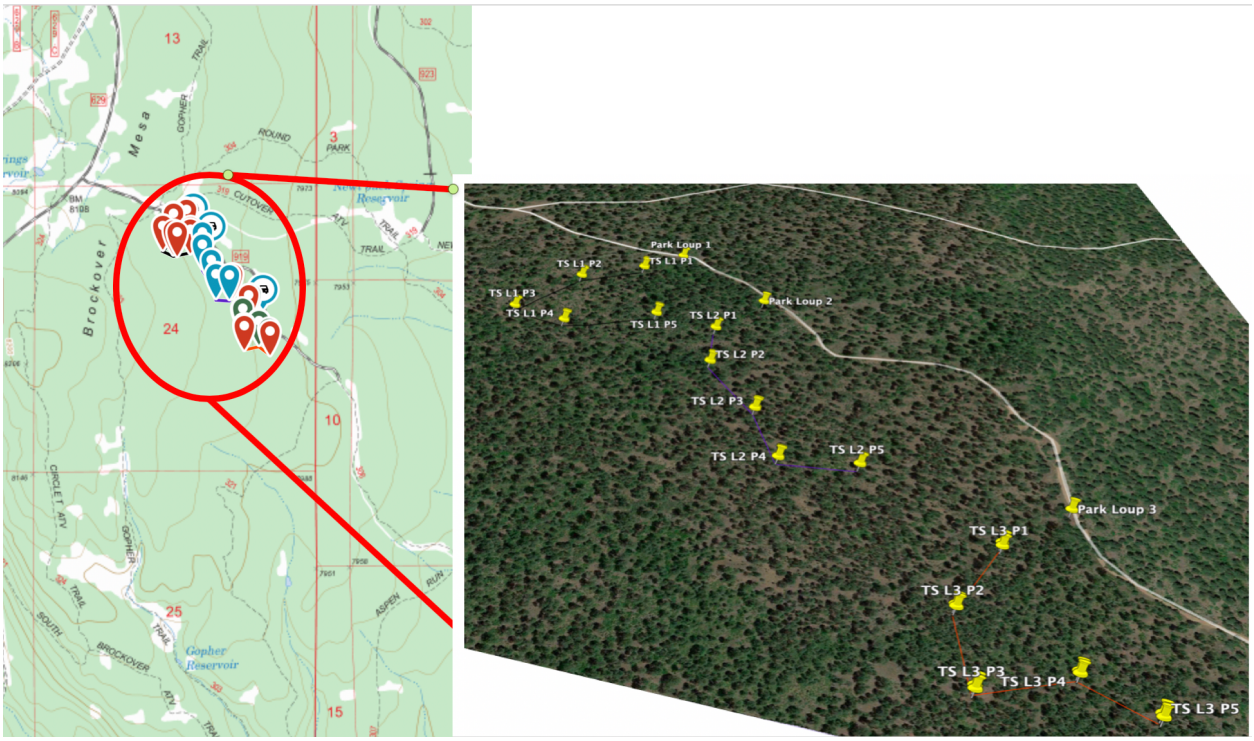

Figure 2. Map showing locations of monitoring points within Turkey Springs study area. TS = Turkey Springs; L # = Loop number; P # = Monitoring point number.

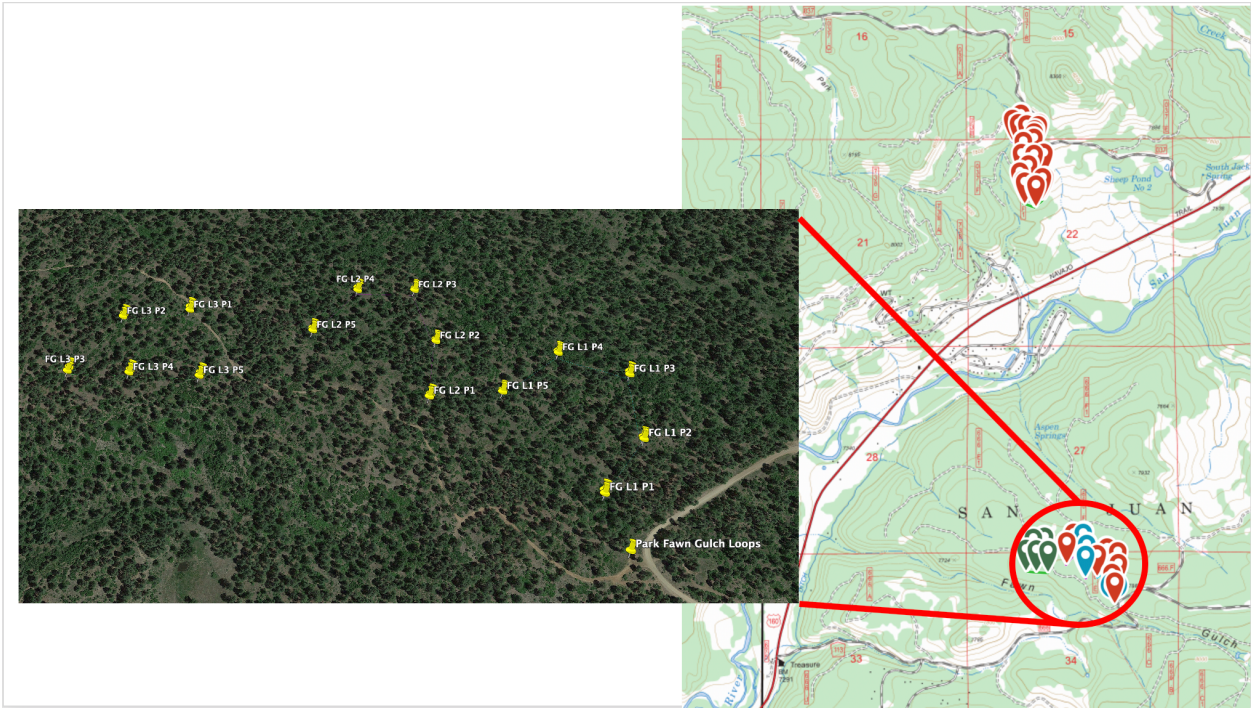

Figure 3. Map showing locations of monitoring points within Fawn Gulch study area. FG = Fawn Gulch; L # = Loop number; P # = Monitoring point number.

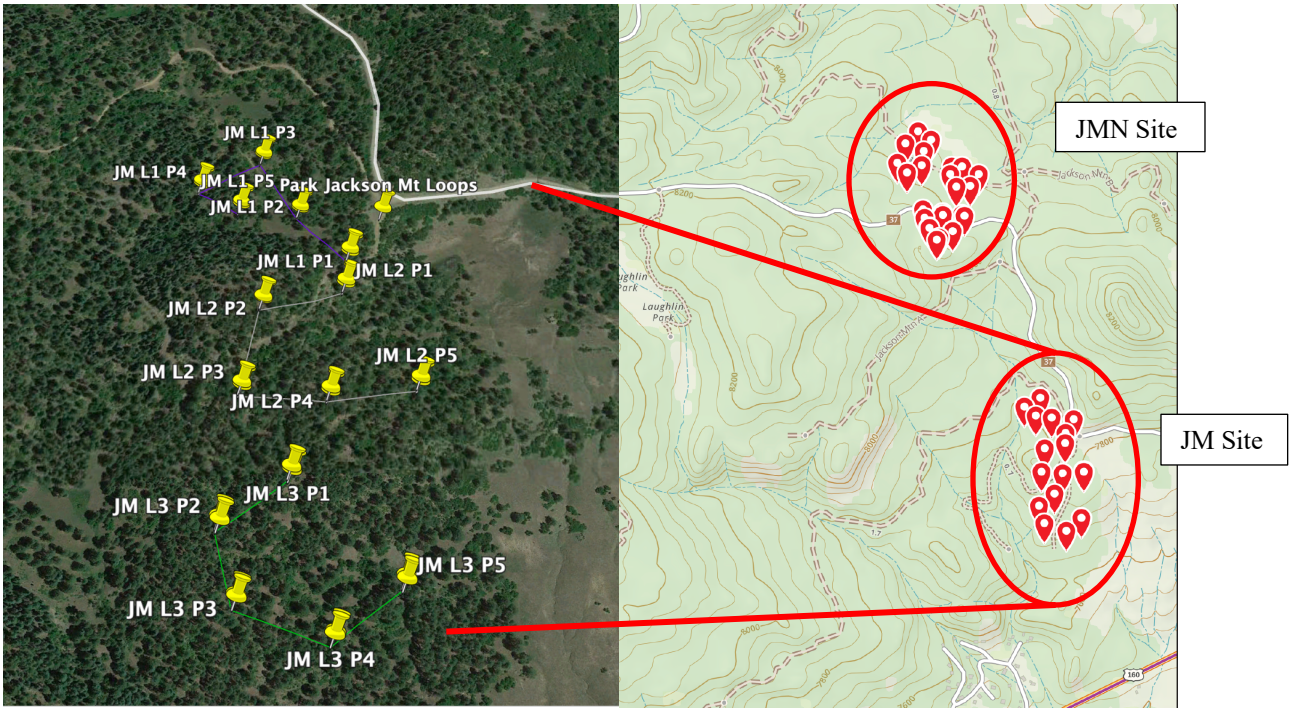

Figure 4. Map showing locations of monitoring points within Jackson Mountain study area (JMN shown on topo only). JM = Jackson Mountain; L # = Loop number; P # = Monitoring point number.

Table 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 New	
	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

* 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 2022 that were common to all three sites; unique to each of the three sites; or observed at two of the three sites. Of the 56 total species recorded for 2022, 23 were found at all three sites this year. Comparing sites in 2022, 37 total species were recorded at FG, with 5 species unique to that site; 41 total species were recorded at JM, with 6 species unique to that site; and 38 total species were recorded at JMN, with 8 species unique to that site.

In 2022, the number of birds counted across all three sites, totaling 2086, were unevenly distributed across the three sites, with 32% at FG; 45% at JM; and 23% at JMN (Tables 2 and 3). Corresponding data tables from our first, second, and third-year reports are included as Appendix A to this report (see also Grover et al., 2019; 2020; and 2021).

Definitions:
Common – bird species that have been reported at more than one study site or in more than one year, including those 32 species observed in all three 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 23 species common to all three sites totaled about 87% of all sightings (Table 2; calculations not shown). At FG and JMN, the common bird species accounted for about 70% of the birds observed at that site, with slightly greater cumulative relative abundances of 77% at JMN.

With the exception of Common Nighthawks at FG; American Crows at JM; and Ruby-crowned Kinglets at JMN, the bird species unique to a particular site were observed in small numbers (i.e., 1, 2, or 3 individuals), with cumulative relative abundances for unique species ranging from 6.7% at JMN, to 2.9% at FG, and 1.5% at JM. For those bird species found at any two sites, the cumulative relative abundances varied greatly, from a maximum of 23% for FG x JM and JM x JMN; to less than 5% for FG x JMN. This indicates that species common to all three sites represented the majority of bird sightings recorded, and that those common bird species were more-or-less evenly distributed across all three sites.

As shown in Table 3, 85 different species of birds have been recorded across the four years of this study, with a total of 7117 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.

The number of species common to all sites within years is also shown in Table 3, ranging from 15 in 2019, to 26 in 2020. Nine species were seen at all three sites in all four years.

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.

Table 2. 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

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 45, and 43 species in 2020 and 2021, respectively; and 41 species in 2022 (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, in addition to year-to-year variability, 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 2022 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 fell within the range noted for FG and JM in 2022 (Fig. 5), reflecting a similarly well-developed understory layer comparable to JM.

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; and 2021)

Year	2019	2020	2021	2022	All Years
Total # Different Species	54	58	60	56	85
Total # Birds Counted	949	2227	1855	2086	7117
# Unique Bird Species by Site:					
Turkey Springs	4	4	6	NA	2
Fawn Gulch	11	7	7	5	11
Jackson Mountain (original)	8	11	11	6	5
Jackson Mountain (new)	NA	NA	NA	8	2
Species Common to All Sites	15	26	22	23	9

Table 4. Summary of bird species numbers and relative abundances grouped across or within years by site. Note that Turkey Springs was not monitored in 2022 in lieu of including the new JMN site.

	Turkey Springs (TS)		Fawn Gulch (FG)		Jackson Mountain (JM)		Jackson Mountain New (JMN)	
	# Species	Cum Rel Abund (%)	# Species	Cum Rel Abund (%)	# Species	Cum Rel Abund (%)	# Species	Cum Rel Abund (%)
TOTAL Species	49 (2019 to 2021)		63		61		38 (2022 only)	
All Years	18*	85.3*	18	77.4	25	89.1	NA	NA
Any 3 Years	NA	NA	11	12.6	8	6.3	NA	NA
Any 2 Years	13*	10.9*	11	4.2	9	1.4	NA	NA
Only 1 Year	18*	3.8*	23	5.8	19	3.2	38**	100**
2019	6*	3.2*	7	11.6	2	2.9	NA	NA
2020	6*	4.5*	7	7.2	5	1.8	NA	NA
2021	6*	3.3*	7	1.7	6	1.4	NA	NA
2022	NA	NA	2	3.2	7	5.7	38**	100**

Special Notes: * - 2019 to 2021 sample season only; ** - 2022 sample season only.

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 (see Table 2) may be a result of fewer number of loop visits (Table 1) at that site in addition to differences in habitat.

As noted in previous year's reports (Grover et al. 2019; 2020; and 2021), 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).

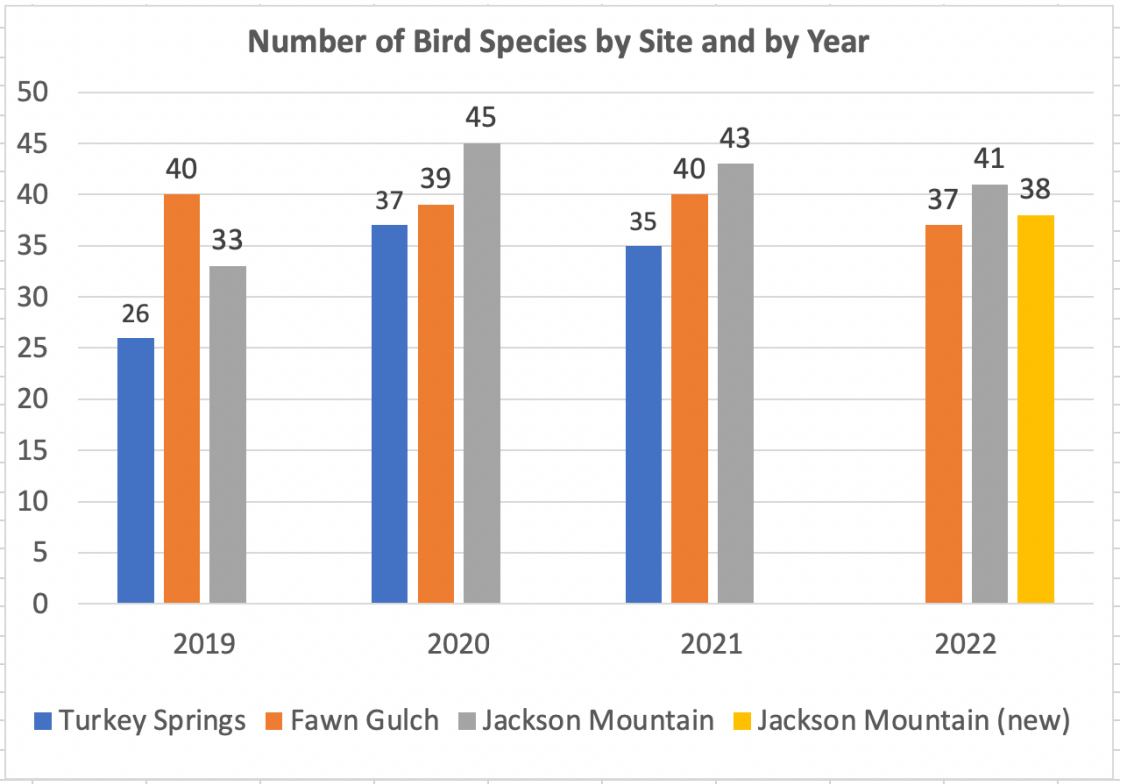

Figure 5. Summary of number of bird species observed by site and by year.

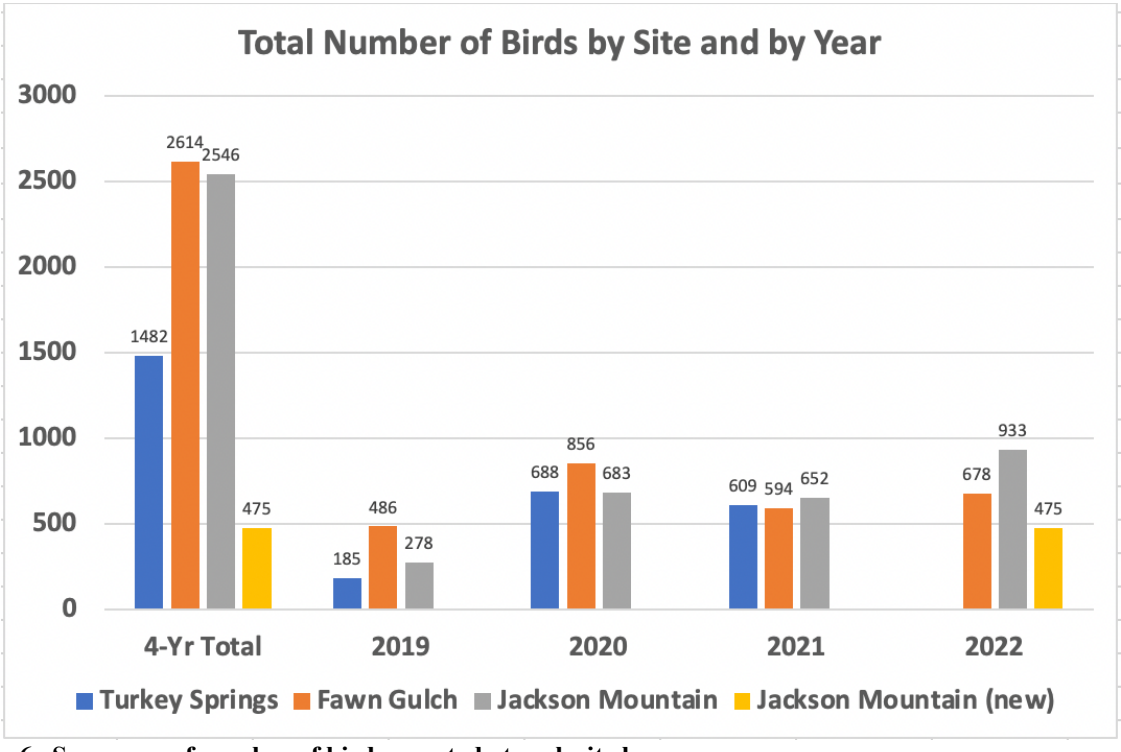

Figure 6. Summary of number of birds counted at each site by year.

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.

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 85 total bird species recorded over the first four years of this study, 49 were recorded at TS; 63 at FG; 61 at JM; and 38 at JMN (see also Fig. 5). At TS and FG, 18 species were observed in all years of the study (3 years for TS vs. 4 years for FG), with 25 species observed in all years of the study at JM. At TS and JM, the species common to all years accounted for 85% and 89% of the birds counted at those sites, respectively. FG stands out as having 77.4% of the birds observed accounted for by species common to all years, and a much higher proportion of birds unique to each year of the study (mean of ~ 6%) compared to TS (mean of ~ 3.6%) and JM (mean of ~ 3%).

Tables 5, 6, 7, and Figure 7 contain summaries of the species-specific data across years for the TS, FG, and JM sites, respectively. Since JMN was only sampled in 2022, data for that site are shown in Table 2. As shown in the tables and in Figure 7, the cumulative relative abundance of bird species shared across all years ranged from about 69% at FG in 2020, to a high of 95% for TS in 2019. The abundance of several species accounts for this range – sightings of House Wrens, Mourning Doves, Plumbeous Vireos, and Warbling Vireos, which were also reported at FG in 2021; and Band-tailed Pigeons, Black-capped Chickadees, and Grace's Warblers, which were reported at FG only in 2020, were all recorded in relatively high numbers in 2020 (Table 6 and Fig. 7). Although some other species were observed in lesser numbers at FG in 2020 compared to other years (e.g., Green-tailed towhee; Stellar's Jay; Northern Flicker), the number of species observed in greater numbers in 2020, and their abundances, exceeded those for species whose numbers were smaller across years. These results, coupled with the fact that FG had the highest number of different species observed across all four years (63 vs. 49 at TS, and 58 at JM; Table 4), and slightly higher numbers of bird species recorded in individual years compared to the other two sites (10 or more at FG vs. 9 or fewer at TS and JM; Table 4), suggests that a significant component of the bird community at FG varies more from year-to-year than has been observed for the other two sites. The uniformly lower numbers in relative abundance of shared species in 2022 are heavily influenced by the large numbers of Western Wood-Pewees at FG and JM, and their absence from JMN.

Table 8 contains a listing of the 35 bird species observed in all four years. Within each year, the birds listed in Table 8 accounted for a range of 59% in 2019 to almost 90% of birds counted in 2022. Summing across years, there were a total of 7117 birds counted across 85 species identified by observers in this study, with 5936 birds represented by the 35 common species listed in Table 8, or about 83% 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 35 common species across the four years of the project reported on here (see Grover et al. 2021).

Of the 35 bird species common to all four years, 9 species were seen at all sites in all four years (Table 8). Not surprisingly, 6 of those species were among the top ranked species by relative abundance. Summing relative abundances of the 9 species reveals that about 50% of the birds counted were among those species found at all sites in all four years of the study.

With a relative abundance of 10.7%, the Western Wood-Pewee, which was among 7 species observed in at least two sites in each year of the study, ranks as the second most abundant species in our study (Table 8). The Western Wood-Pewee was not observed at the JMN site in 2022. 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 8).

The majority of bird species observed in any single year of the study, or across any two years of the study, were recorded as single bird sightings, or as three or fewer birds (Table 9). There were 22 bird species observed in only a single year of the study; 19 species observed in any two years of the study; and 9 species observed in any three years (Table 9).

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

TURKEY SPRINGS											
2019			2020			2021			Three Year TOTALS	
Total Birds Counted	185		Total Birds Counted	688		Total Birds Counted	609		1482	
	Abund	Rel Abund		Abund	Rel Abund		Abund	Rel Abund	ABUND	REL ABUND
American Crow	10	5.41	American Crow	6	0.87	American Crow	5	0.82	21	1.42
American Robin	43	23.24	American Robin	77	11.19	American Robin	59	9.69	179	12.08
Broad Tailed Hummingbird	1	0.54	Broad-tailed Hummingbird	6	0.87	Broad-tailed Hummingbird	2	0.33	9	0.61
Chipping Sparrow	6	3.24	Chipping Sparrow	23	3.34	Chipping Sparrow	35	5.75	64	4.32
Common Nighthawk	6	3.24	Common Nighthawk	3	0.44	Common Nighthawk	7	1.15	16	1.08
Hairy Woodpecker	2	1.08	Hairy Woodpecker	10	1.45	Hairy Woodpecker	6	0.99	18	1.21
Mourning Dove	1	0.54	Mourning Dove	36	5.23	Mourning Dove	3	0.49	40	2.70
Northern Flicker	16	8.65	Northern Flicker	14	2.03	Northern Flicker	27	4.43	57	3.85
Plumbeous Vireo	2	1.08	Plumbeous Vireo	2	0.29	Plumbeous Vireo	15	2.46	19	1.28
Pygmy Nuthatch	17	9.19	Pygmy Nuthatch	81	11.77	Pygmy Nuthatch	92	15.11	190	12.82
Steller's Jay	1	0.54	Steller's Jay	7	1.02	Stellar's Jay	1	0.16	9	0.61
Turkey Vulture	1	0.54	Turkey Vulture	1	0.15	Turkey Vulture	1	0.16	3	0.20
Violet Green Swallow	29	15.68	Violet Green Swallow	109	15.84	Violet-green Swallow	77	12.64	215	14.51
Western Bluebird	5	2.70	Western Bluebird	30	4.36	Western Bluebird	53	8.70	88	5.94
Western Tanager	1	0.54	Western Tanager	10	1.45	Western Tanager	17	2.79	28	1.89
Western Wood Pewee	20	10.81	Western Wood-Pewee	63	9.16	Western Wood-Pewee	55	9.03	138	9.31
White Breasted Nuthatch	11	5.95	White-breasted Nuthatch	23	3.34	White-breasted Nuthatch	34	5.58	68	4.59
Yellow Rumped Warbler	4	2.16	Yellow-rumped Warbler	53	7.70	Yellow-rumped Warbler	45	7.39	102	6.88
Brown-headed Cowbird	2	1.08	Brown-headed Cowbird	1	0.15				3	0.20
Osprey	1	0.54	Osprey	1	0.15				2	0.13
			Black-capped Chickadee	4	0.58	Black-capped Chickadee	3	0.49	7	0.47
			Cassin's Finch	2	0.29	Cassin's Finch	3	0.49	5	0.34
			Common Raven	14	2.03	Common Raven	4	0.66	18	1.21
			Dark-eyed Junco	46	6.69	Dark-eyed Junco	17	2.79	63	4.25
			Green-tailed Towhee	5	0.73	Green-tailed Towhee	4	0.66	9	0.61
			House Wren	15	2.18	House Wren	7	1.15	22	1.48
			Mountain Chickadee	4	0.58	Mountain Chickadee	1	0.16	5	0.34
			Spotted Towhee	3	0.44	Spotted Towhee	5	0.82	8	0.54
			Townsend's Solitaire	6	0.87	Townsend's Solitaire	7	1.15	13	0.88
			Warbling Vireo	1	0.15	Warbling Vireo	3	0.49	4	0.27
			White-crowned sparrow	1	0.15	White-crowned Sparrow	1	0.16	2	0.13
Bullocks Oriole	1	0.54							1	0.07
Downy Woodpecker	1	0.54							1	0.07
Lewis Woodpecker	1	0.54							1	0.07
MacGillvery's Warbler	1	0.54							1	0.07
Red Tailed Hawk	1	0.54							1	0.07
Williamson's Sapsucker	1	0.54							1	0.07
										0.00
			Collared Dove	3	0.44				3	0.20
			Cordilleran Flycatcher	5	0.73				5	0.34
			European Starling	1	0.15				1	0.07
			Pine Siskin	3	0.44				3	0.20
			Red Crossbill	17	2.47				17	1.15
			Red-breasted Nuthatch	2	0.29				2	0.13
						Brown Creeper	1	0.16	1	0.07
						Grace's Warbler	15	2.46	15	1.01
						Great-Horned Owl	1	0.16	1	0.07
						Mallard	1	0.16	1	0.07
						Mountain Bluebird	1	0.16	1	0.07
						Sharp-shinned Hawk	1	0.16	1	0.07

Several of the uncommon bird species listed in Table 9 were fly-overs (e.g., several raptor species, Canada Geese), local visitors (e.g., Band-tailed Pigeons), or may have been exploring the margins of their typical home range (e.g., Black-billed Magpie, European Starling, Red-winged Blackbird). Of greater concern are several species whose occasional presence in low numbers may signal population declines at a broader scale.

As shown in Table 9, nine species were seen only in 2019; 10 species only in 2020; and 10 species only in 2021. The most numerous species recorded only in 2019 were Canada Geese (17 birds) observed at FG and JM, and Northern Rough-winged Swallows (25 birds) observed at FG (see Table 3, and Appendix A). In 2020, a total of five

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

Fawn Gulch															
2019			2020			2021			2022				Four-Year Totals	
Total Birds Counted	354		Total Birds Counted	856		Total Birds Counted	594		Total Birds Counted	528			2332	
	Abund	Rel Abund		Abund	Rel Abund		Abund	Rel Abund		Abund	Rel Abund		Abund	Rel Abund
Species Observed in All Four Years														
American Robin	81	22.9	American Robin	110	12.9	American Robin	140	23.6	American Robin	60	8.7		391	16.8
Black-headed Grosbeak	5	1.4	Black-headed Grosbeak	9	1.1	Black-headed Grosbeak	7	1.2	Black-headed Grosbeak	4	0.6		25	1.1
Cassins Finch	1	0.3	Cassin's Finch	6	0.7	Cassin's Finch	2	0.3	Cassin's Finch	5	0.7		14	0.6
Chipping Sparrow	8	2.3	Chipping Sparrow	12	1.4	Chipping Sparrow	15	2.5	Chipping Sparrow	29	4.2		64	2.7
Cordilleran Flycatcher	3	0.8	Cordilleran Flycatcher	19	2.2	Cordilleran Flycatcher	2	0.3	Cordilleran Flycatcher	3	0.4		27	1.2
Green Tailed Towhee	16	4.5	Green-tailed Towhee	35	4.1	Green-tailed Towhee	53	8.9	Green-tailed Towhee	49	7.1		153	6.6
Hairy Woodpecker	1	0.3	Hairy Woodpecker	7	0.8	Hairy Woodpecker	7	1.2	Hairy Woodpecker	2	0.3		17	0.7
Northern Flicker	35	9.9	Northern Flicker	10	1.2	Northern Flicker	19	3.2	Northern Flicker	1	0.1		65	2.8
Pygmy Nutatch	4	1.1	Pygmy Nuthatch	55	6.4	Pygmy Nuthatch	27	4.5	Pygmy Nuthatch	1	0.1		87	3.7
Red-tailed Hawk	1	0.3	Red-tailed Hawk	4	0.5	Red-tailed Hawk	1	0.2	Red-tailed Hawk	1	0.1		7	0.3
Steller's Jay	5	1.4	Steller's Jay	16	1.9	Stellar's Jay	33	5.6	Steller's Jay	15	2.2		69	3.0
Western Bluebird	4	1.1	Western Bluebird	16	1.9	Western Bluebird	8	1.3	Western Bluebird	28	4.1		56	2.4
Western Tanager	27	7.6	Western Tanager	36	4.2	Western Tanager	37	6.2	Western Tanager	61	8.8		161	6.9
Western Wood-Pewee	64	18.1	Western Wood-Pewee	153	17.9	Western Wood-Pewee	94	15.8	Western Wood-Pewee	90	13.0		401	17.2
White-breasted Nuthatch	17	4.8	White-breasted Nuthatch	29	3.4	White-breasted Nuthatch	20	3.4	White-breasted Nuthatch	23	3.3		89	3.8
Yellow-rumped Warbler	8	2.3	Yellow-rumped Warbler	41	4.8	Yellow-rumped Warbler	19	3.2	Yellow-rumped Warbler	34	4.9		102	4.4
Turkey Vulture	3	0.8	Turkey Vulture	3	0.4	Turkey Vulture	2	0.3	Turkey Vulture	5	0.7		13	0.6
Violet-green Swallow	7	2.0	Violet-green Swallow	38	4.4	Violet-green Swallow	14	2.4	Violet-green Swallow	6	0.9		65	2.8
Species Observed in Any Three Years														
American Crow	4	1.1	American Crow	2	0.2	American Crow	3	0.5					9	0.4
Broad-tailed Hummingbird	1	0.3	Broad-tailed Hummingbird	3	0.4				Broad-tailed Hummingbird	5	0.7		9	0.4
Common Raven	1	0.3				Common Raven	1	0.2	Common Raven	2	0.3		4	0.2
			Dark-eyed Junco	8	0.9	Dark-eyed Junco	3	0.5	Dark-eyed Junco	2	0.3		13	0.6
			House Wren	32	3.7	House Wren	2	0.3	House Wren	10	1.4		44	1.9
			Mountain Chickadee	6	0.7	Mountain Chickadee	3	0.5	Mountain Chickadee	1	0.1		10	0.4
			Mourning Dove	63	7.4	Mourning Dove	11	1.9	Mourning Dove	1	0.1		75	3.2
			Orange-crowned Warbler	6	0.7	Orange-crowned Warbler	2	0.3	Orange-crowned Warbler	2	0.3		10	0.4
			Plumbeous Vireo	19	2.2	Plumbeous Vireo	5	0.8	Plumbeous Vireo	1	0.1		25	1.1
			Spotted Towhee	4	0.5	Spotted Towhee	13	2.2	Spotted Towhee	11	1.6		28	1.2
			Warbling Vireo	30	3.5	Warbling Vireo	19	3.2	Warbling Vireo	18	2.6		67	2.9
Species Observed in Any Two Years														
Bald Eagle	2	0.6							Bald Eagle	1	0.1		3	0.1
Brown-headed Cowbird	3	0.8							Brown-headed Cowbird	1	0.1		4	0.2
						Common Nighthawk	16	2.7	Common Nighthawk	12	1.7		28	1.2
			Grace's Warbler	11	1.3				Grace's Warbler	18	2.6		29	1.2
Pine Siskin	2	0.6							Pine Siskin	2	0.3		4	0.2
Red Crossbill	1	0.3	Red Crossbill	9	1.1								10	0.4
Say's Phoebe	2	0.6				Say's Phoebe	2	0.3					4	0.2
			Townsend's Solitaire	1	0.1	Townsend's Solitaire	2	0.3					3	0.1
Tree Swallow	7	2.0				Tree Swallow	1	0.2					8	0.3
						Virginia's Warbler	1	0.2	Virginia's Warbler	1	0.1		2	0.1
			Williamson's Sapsucker	1	0.1				Williamson's Sapsucker	1	0.1		2	0.1
Species Observed in Only One Year														
American Goldfinch	3	0.8											3	0.1
						Ash-throated Flycatcher	1	0.2					1	0.0
			Band-tailed Pigeon	34	4.0								34	1.5
			Black-capped Chickadee	21	2.5								21	0.9
			Black-chinned Hummingbird	1	0.1								1	0.0
Canada Goose	6	1.7											6	0.3
						Cassin's Vireo	1	0.2					1	0.0
Downy Woodpecker	3	0.8											3	0.1
									Dusky Flycatcher	20	2.9		20	0.9
			Dusky Grouse	1	0.1								1	0.0
			Evening Grosbeak	1	0.1								1	0.0
						Great Blue Heron	1	0.2					1	0.0
			Great Horned Owl	3	0.4								3	0.1
Black-billed Magpie	1	0.3											1	0.0
									Mountain Bluebird	2	0.3		2	0.1
						Olive-sided Flycatcher	1	0.2					1	0.0
Northern Rough Winged Swa	25	7.1											25	1.1
Red Naped Sapsucker	1	0.3											1	0.0
						Red-winged Blackbird	1	0.2					1	0.0
			Song Sparrow	1	0.1								1	0.0
						Three-toed Woodpecker	3	0.5					3	0.1
						Wild Turkey	2	0.3					2	0.1
Yellow Warbler	2	0.6											2	0.1

Red- breasted Nuthatches were observed at TS and JM. In 2021, 3 birds each were observed for the Three-toed Woodpecker and the Wild Turkey. Notably, the Three-toed Woodpecker was documented as an incidental at TS in 2020, but was observed at our monitoring points at FG in 2021. Wild Turkeys were observed at both FG (2 birds) and JM (1 bird) in 2021 (see Table 3, and Appendix A).

Table 10 lists the bird species observed as "incidentals only" in the respective years of this study. For example, the American Kestrel was noted as an incidental in 2019, but was not observed at any of the established monitoring sites in that year, or in 2020 or 2021 either, but was observed at JM in 2022. Pine Siskins and Red Crossbills were observed at monitoring points in 2019 and 2020, but recorded only as incidentals in 2021, with the Pine Siskin reported at FG and JMN in 2022, but Red Crossbills were not observed at all in 2022. Wild Turkeys were encountered during routine monitoring in 2021and 2022, but only noted as incidentals in 2020. The small number of birds noted as "incidentals only" compared to the total number of bird species documented in this study reinforces our confidence that our sampling protocol was effective in representing the composition of the bird communities in our three study areas.

Table 7. Summary of bird species observed at Jackson Mountain site across the four years of this study.

Jackson Mountain (Original Site)														
2019			2020			2021			2022				Four-Year Totals	
Total Birds Counted	278		Total Birds Counted	683		Total Birds Counted	652		Total Birds Counted	933			2546	
	Abun	Rel Abund		Abund	Rel Abund		Abund	Rel Abund		Abund	Rel Abund		Abund	Rel Abund
Species Observed in All Four Years														
American Crow	2	0.7	American Crow	8	1.2	American Crow	3	0.5	American Crow	7	0.8		20	0.8
American Robin	75	27.0	American Robin	103	15.1	American Robin	85	13.0	American Robin	92	9.9		355	13.9
Black-capped Chickadee	1	0.4	Black-capped Chickadee	11	1.6	Black-capped Chickadee	5	0.8	Black-capped Chickadee	2	0.2		19	0.7
Black Headed Grosbeak	5	1.8	Black-headed Grosbeak	7	1.0	Black-headed Grosbeak	10	1.5	Black-headed Grosbeak	16	1.7		38	1.5
Broad Tailed Hummingbird	2	0.7	Broad-tailed Hummingbird	11	1.6	Broad-tailed Hummingbird	3	0.5	Broad-tailed Hummingbir	5	0.5		21	0.8
Common Raven	11	4.0	Common Raven	12	1.8	Common Raven	8	1.2	Common Raven	12	1.3		43	1.7
Green Tailed Towhee	7	2.5	Green-tailed Towhee	29	4.2	Green-tailed Towhee	11	1.7	Green-tailed Towhee	31	3.3		78	3.1
Hairy Woodpecker	1	0.4	Hairy Woodpiecker	5	0.7	Hairy Woodpecker	15	2.3	Hairy Woodpecker	5	0.5		26	1.0
Hermit Thrush	1	0.4	Hermit Thrush	3	0.4	Hermit Thrush	1	0.2	Hermit Thrush	4	0.4		9	0.4
House Wren	4	1.4	House Wren	8	1.2	House Wren	7	1.1	House Wren	39	4.2		58	2.3
Mountain Chickadee	4	1.4	Mountain Chickadee	8	1.2	Mountain Chickadee	2	0.3	Mountain Chickadee	8	0.9		22	0.9
Mourning Dove	1	0.4	Mourning Dove	9	1.3	Mourning Dove	39	6.0	Mourning Dove	12	1.3		61	2.4
Northern Flicker	29	10.4	Northern Flicker	52	7.6	Northern Flicker	49	7.5	Northern Flicker	58	6.2		188	7.4
Orange Crowned Warbler	2	0.7	Orange-crowned Warbler	3	0.4	Orange-crowned Warbler	9	1.4	Orange-crowned Warbler	3	0.3		17	0.7
Plumbeous Vireo	12	4.3	Plumbeous Vireo	25	3.7	Plumbeous Vireo	10	1.5	Plumbeous Vireo	10	1.1		57	2.2
Pygmy Nuthatch	12	4.3	Pygmy Nuthatch	57	8.3	Pygmy Nuthatch	90	13.8	Pygmy Nuthatch	107	11.5		266	10.4
Steller's Jay	11	4.0	Steller's Jay	52	7.6	Stellar's Jay	30	4.6	Steller's Jay	33	3.5		126	4.9
Turkey Vulture	8	2.9	Turkey Vulture	10	1.5	Turkey Vulture	6	0.9	Turkey Vulture	5	0.5		29	1.1
Violet Green Swallow	3	1.1	Violet-green Swallow	41	6.0	Violet-green Swallow	45	6.9	Violet-green Swallow	78	8.4		167	6.6
Virginia's Warbler	3	1.1	Virginia's Warbler	21	3.1	Virginia's Warbler	5	0.8	Virginia's Warbler	16	1.7		45	1.8
Warbling Vireo	7	2.5	Warbling Vireo	17	2.5	Warbling Vireo	27	4.1	Warbling Vireo	31	3.3		82	3.2
Western Tanager	16	5.8	Western Tanager	49	7.2	Western Tanager	47	7.2	Western Tanager	90	9.6		202	7.9
Western Wood-Pewee	14	5.0	Western Wood-Pewee	29	4.2	Western Wood-Pewee	59	9.0	Western Wood-Pewee	120	12.9		222	8.7
White-breasted Nuthatch	4	1.4	White-breasted Nuthatch	17	2.5	White-breasted Nuthatch	14	2.1	White-breasted Nuthatch	31	3.3		66	2.6
Yellow-rumped Warbler	12	4.3	Yellow-rumped Warbler	11	1.6	Yellow-rumped Warbler	18	2.8	Yellow-rumped Warbler	10	1.1		51	2.0
Species Observed in Any Three Years														
Brown Headed Cowbird	1	0.4	Brown-headed Cowbird	2	0.3	Brown-headed Cowbird	4	0.6					7	0.3
			Chipping Sparrow	37	5.4	Chipping Sparrow	6	0.9	Chipping Sparrow	27	2.9		70	2.7
			Cordilleran Flycatcher	4	0.6	Cordilleran Flycatcher	18	2.8	Cordilleran Flycatcher	4	0.4		26	1.0
			Dark-eyed Junco	8	1.2	Dark-eyed Junco	5	0.8	Dark-eyed Junco	9	1.0		22	0.9
Red-tailed Hawk	6	2.2	Red-tailed Hawk	4	0.6				Red-tailed Hawk	6	0.6		16	0.6
Townsend's Solitaire	3	1.1	Townsend's Solitaire	1	0.1	Townsend's Solitaire	2	0.3					6	0.2
		0.0	Western Bluebird	1	0.1	Western Meadowlark	1	0.2	Western Bluebird	3	0.3		5	0.2
Williamson's Sapsucker	7	2.5				Williamson's Sapsucker	1	0.2	Williamson's Sapsucker	1	0.1		9	0.4
Species Observed in Any Two Years														
			Brown Creeper	**1**	**0.1**				Brown Creeper	1	0.1		2	0.1
			Eurasian Collared Dove	**1**	**0.1**	Eurasian Collared Dove	1	0.2					2	0.1
Common Nighthawk	**2**	**0.7**	**Common Nighthawk**	**1**	**0.1**								3	0.1
						Downy Woodpecker	1	0.2	Downey Woodpecker	1	0.1		2	0.1
			Grace's Warbler	**4**	**0.6**	Grace's Warbler	3	0.5					7	0.3
			Great blue heron	**1**	**0.1**	Great Blue Heron	1	0.2					2	0.1
			Say's Phoebe	**4**	**0.6**	Say's Phoebe	2	0.3					6	0.2
			Red-breasted Nuthatch	**3**	**0.4**				Red-breasted Nuthatch	3	0.3		6	0.2
Tree Swallow	**4**	**1.4**	**Tree Swallow**	**1**	**0.1**								5	0.2
Species Observed in Only One Year														
									American Kestrel	1	0.1		1	0.0
						Bald Eagle	1	0.2					1	0.0
						Band-tailed Pigeon	1	0.2					1	0.0
						Bullock's Oriole	2	0.3					2	0.1
Canada Goose	5	1.8											5	0.2
			Cooper's Hawk	1	0.1								1	0.0
			Dusky Flycatcher	1	0.1				Dusky Flycatcher	3	0.3		4	0.2
									Dusky Grouse	2	0.2		2	0.1
			Goshawk	1	0.1								1	0.0
			Gray Catbird	1	0.1								1	0.0
									Hammond's Flycatcher	34	3.6		34	1.3
						Lewis's Woodpecker	3	0.5					3	0.1
									Olive-sided Flycatcher	2	0.2		2	0.1
									Osprey	1	0.1		1	0.0
						Peregrine Falcon	1	0.2					1	0.0
			Red Crossbill	8	1.2								8	0.3
									Spotted Towhee	10	1.1		10	0.4
White Throated Swift	3	1.1											3	0.1
						Wild Turkey	1	0.2					1	0.0

Special Note- Project reports from 2019, 2020, and 2021 contain sections in which simple Community Similarity Indices and Species Diversity Indices were calculated and interpreted (see Grover et. al., 2019; 2020; and 2021). Those calculations, revealing that FG showed greater year-to-year variability, and that JM had the greatest bird species diversity, were not repeated in this fourth-year report.

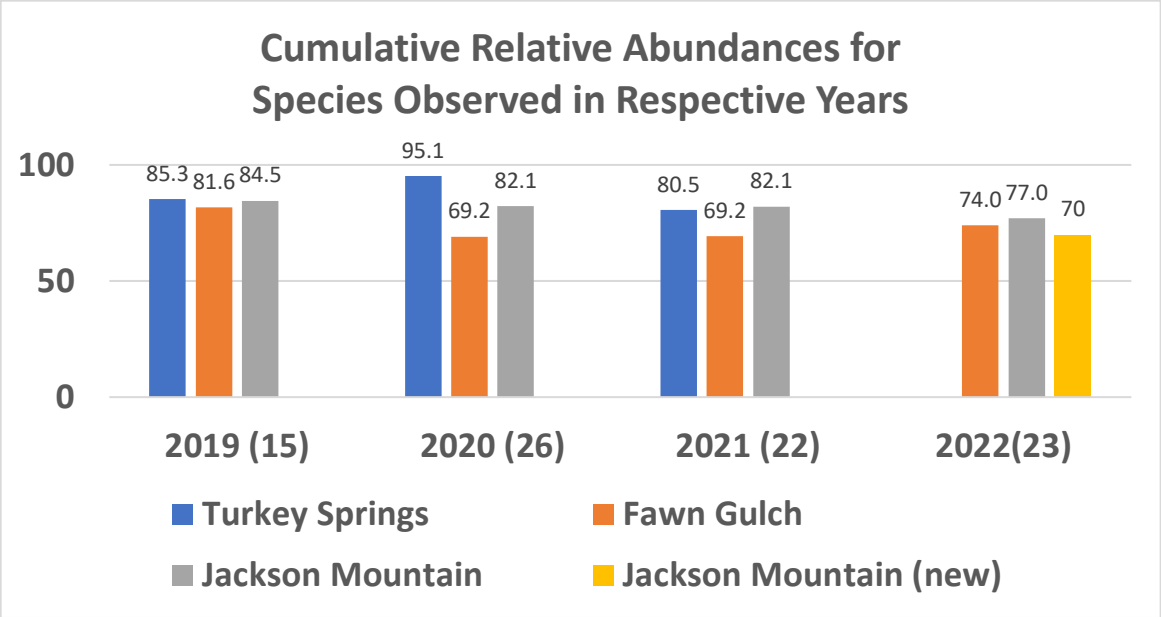

Figure 7. Summary of cumulative relative abundances for the bird species common to all three sites recorded in respective years at each site. Numbers in parentheses are the number of species common to all three sites in that respective year. (see also Tables 4, 6, 7, 8, and 9)

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 exclude bird predation from vegetation (i.e., netting exclosures; Bridgeland et al. 2010; Heyman and Gunnarsson, 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.

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 (see Fig. 5); apparent abundance (see Fig. 6); 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.

Table 8. Summary of bird species observed in all years of the study.

TOTALS BY YEAR	2019		2020		2021		2022		ALL YEARS	
NUMBER OF SPECIES	54		58		62		56		85	
BIRDS COUNTED (All Species)	949		2227		1855		2086		7117	
	Abund	Rel Abund (%)	Abund	Rel Abund (%)	Abund	Rel Abund (%)	Abund	Rel Abund (%)	Abund	Rel Abund (%)
TOTALS ACROSS GROUPINGS	695	73	1753	78.7	1614	87.0	1874	89.8	5936	83.4
Bird Species Recorded At All Sites In All Years = 9										
American Robin	199	21.0	290	13.0	284	15.3	177	8.5	950	13.3
Pygmy Nuthatch	33	3.5	193	8.7	209	11.3	199	9.5	634	8.9
Violet-green Swallow	39	4.1	188	8.4	136	7.3	97	4.7	460	6.5
Western Tanager	44	4.6	95	4.3	101	5.4	194	9.3	434	6.1
Northern Flicker	80	8.4	76	3.4	95	5.1	113	5.4	364	5.1
Yellow-rumped Warbler	12	1.3	94	4.2	64	3.5	63	3.0	233	3.3
Steller's Jay	17	1.8	75	3.4	64	3.5	70	3.4	226	3.2
White-breasted Nuthatch	28	3.0	52	2.3	54	2.9	64	3.1	198	2.8
Hairy Woodpecker	4	0.4	22	1.0	28	1.5	9	0.4	63	0.9
SUB-TOTALS	456	48.1	1085	48.7	1035	55.8	986	47.3	3562	50.0
Bird Species Recorded In At Least Two Sites In Each Year = 7										
Western Wood-Pewee	98	10.3	245	11.0	208	11.2	210	10.1	761	10.7
Chipping Sparrow	14	1.5	35	1.6	50	2.7	77	3.7	176	2.5
Plumbeous Vireo	14	1.5	27	1.2	25	1.3	48	2.3	114	1.6
Mourning Dove	2	0.2	45	2.0	42	2.3	14	0.7	103	1.4
American Crow	16	1.7	16	0.7	11	0.6	7	0.3	50	0.7
Turkey Vulture	12	1.3	14	0.6	9	0.5	10	0.5	45	0.6
Broad-tailed Hummingbird	3	0.3	17	0.8	5	0.3	14	0.7	39	0.5
SUB-TOTALS	159	16.8	399	17.9	350	18.9	380	18.2	1288	18.1
Bird Species Recorded In At Least One Site In Each Year = 17										
Black-capped Chickadee	1	0.1	11	0.5	5	0.3	7	0.3	24	0.3
Black-headed Grosbeak										
Brown-headed Cowbird	1	0.1	2	0.1	4	0.2	1	0.0	8	0.1
Common Nighthawk	6	0.6	3	0.1	7	0.4	12	0.6	28	0.4
Common Raven										
Cordilleran Flycatcher	3	0.3	19	0.9	2	0.1	8	0.4	32	0.4
Dark-eyed Junco	0	0.0	62	2.8	22	1.2	33	1.6	117	1.6
Green-tailed Towhee	16	1.7	35	1.6	53	2.9	85	4.1	189	2.7
Hermit Thrush										
House Wren	4	0.4	8	0.4	7	0.4	69	3.3	88	1.2
Mountain Chickadee	4	0.4	8	0.4	2	0.1	39	1.9	53	0.7
Orange-crowned Warbler	2	0.2	3	0.1	9	0.5	15	0.7	29	0.4
Red-tailed Hawk	1	0.1	4	0.2	1	0.1	9	0.4	15	0.2
Virginia's Warbler	3	0.3	21	0.9	5	0.3	17	0.8	46	0.6
Warbling Vireo	7	0.7	17	0.8	27	1.5	93	4.5	144	2.0
Western Bluebird										
Williamson's Sapsucker	2	0.2	1	0.0	1	0.1	2	0.1	6	0.1
SUB-TOTALS	76	8.0	262	11.8	225	12.1	500	24.0	1063	14.9
Bird Species Recorded At Only One Site In Each Year = 2										
Cassin's Finch	1	0.1	6	0.3	2	0.1	5	0.2	14	0.2
Townsend's Solitaire										
SUB-TOTALS	4	0.4	7	0.3	4	0.2	8	0.4	23	0.3

Species-level response – Feeding Guilds-

Table 11 summarizes 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, and 2021).

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 11) are most common at FG and JM, constituting about 36% and 33% of birds counted in that category. Timber-foliage searching (TFS) species were second most abundant at FG and JM (e.g., Plumbeous Vireo, Warbling Vireo, Yellow-rumped Warbler; see Table 11), accounting for about 24% and 22% of birds counted. In contrast, TFS species are most common at JMN, with about 47% 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 11).

Table 9. Summary of bird species recorded in any of a combination of one, two, or three years of the study.

	2019		2020		2021		2022	
	Abund	Rel Abund	Abund	Rel Abund	Abund	Rel Abund	Abund	Rel Abund
Species Recorded In Any Single Year								
American Goldfinch	3	0.3						
Black-billed Magpie	2	0.2						
Canada Goose	17	1.8						
Northern Rough-winged Swallow	25	2.6						
White-throated Swift	3	0.3						
Yellow Warbler	2	0.2						
Black-chinned Hummingbird			1	0.1				
European Starling			1	0.1				
Evening Grosbeak			1	0.1				
Goshawk			1	0.1				
Gray Catbird			1	0.1				
Song Sparrow			1	0.1				
Ash-throated Flycatcher					1	0.1		
Cassin's Vireo					1	0.1		
Mallard					1	0.1		
Peregrine Falcon					1	0.1		
Red-winged Blackbird					1	0.1		
Three-toed Woodpecker					3	0.2		
Western Meadowlark					1	0.1		
Hammond's Flycatcher							60	9.1
House Finch							1	0.2
Ruby-crowned Kinglet							19	4
Species Recorded in Any Two Years								
Red Crossbill	1	0.1	34	1.5				
Bullock's Oriole	2	0.2			2	0.1		
Lewis's Woodpecker	1	0.1			1	0.1		
American Kestrel	1	0.1					1	0.1
MacGillivray's Warbler	1	0.1					1	0.2
Red-naped Sapsucker	2	0.2					2	0.4
Band-tailed Pigeon			34	1.5	1	0.1		
Brown Creeper			1	0.1	1	0.1		
Eurasian Collared Dove			4	0.2	1	0.1		
Great Blue heron			1	0.1	2	0.1		
Great Horned Owl			3	0.1	1	0.1		
White-crowned sparrow			1	0.1	1	0.1		
Cooper's Hawk			1	0.1			2	0.4
Dusky Flycatcher			1	0.1			23	3.2
Dusky Grouse			1	0.1			2	0.2
Red-breasted Nuthatch			5	0.2			38	7.7
Olive-sided Flycatcher					1	0.1	2	0.2
Sharp-shinned Hawk					1	0.1	2	0.4
Wild Turkey					3	0.2	2	0.4
Species Recorded in Any Three Years								
Say's Phoebe	2	0.6	4	0.6	4	0.6		
Tree Swallow	11	2.8	1	0.1	1	0.1		
Osprey	1	0.1	1	0.1			1	0.1
Pine Siskin	2	0.2	3	0.1			4	0.6
Bald Eagle	2	0.2			1	0.1	1	0.1
Downy Woodpecker	4	0.4			1	0.1	1	0.1
Mountain Bluebird	1	0.1			1	0.1	1	0.1
Grace's Warbler			15	0.7	18	1	20	3.1
Spotted Towhee			7	0.3	18	1	21	2.7

Table 10. 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.

Species	2019	2020	2021	2022
American Kestrel	INC ONLY	none	none	JM
Dark-eyed Junco	INC ONLY	TS, FG, JM	TS, FG, JM	FG, JM, JMN
Mountain Bluebird	INC ONLY	none	TS	FG
Western Meadowlark	none	INC ONLY	JM	INC ONLY
Sharp-shinned Hawk	none	INC ONLY	TS	JMN
Wild Turkey	none	INC ONLY	FG, JM	JMN
Canada Goose	FG, JM	none	INC ONLY	none
Pine Siskin	FG	TS	INC ONLY	FG, JMN
Red Crossbill	FG	TS, FG, JM	INC ONLY	none
Red-naped Sapsucker	none	none	INC ONLY	JMN

Aerial flycatchers (AF) (e.g., Violet-green Swallow; see Table 11), flycatchers (F), and timber-drilling/gleaning species (TDG) (e.g., Hairy Woodpecker, Pygmy Nuthatch, White-breasted Nuthatch; see Table 11) were abundant at all three sites, but generally in lesser numbers at JMN. Interestingly, at JM, increasing trends in the abundance of AF, F and TDG bird species were accompanied by a decreasing trend in GBF species across years (Fig. 8). 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 11).

At JM, the decreasing trend in the relative abundance of GBF species shown in 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 (Table 11). 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 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, or "other," nesters (where "other" refers to use of crevices or ledges on buildings or other structures); and cavity nesters. Using these information resources, 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).

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

Table 11. Summary of bird species by 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 (New)	
	2019		2020		2021		2022		2019		2020		2021		2022		2022	
	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	75	26.2	103	15.1	85	13	92	9.9	25	5.3
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
Black-headed Grosbeak	5	1	9	1.1	1	0.2	4	0.6	5	1.8			10	1.5	16	1.7	4	0.8
Brown-headed Cowbird	3	0.6					1	0.1	1	0.001	2	0.3	4	0.6				
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										
Chipping Sparrow	10	2	12	1.4	15	2.5	29	4.2			37	5.4	6	0.9	27	2.9	21	4.4
Dark-eyed Junco	1	0.2	8	0.9	3	0.5	2	0.3			8	1.2	5	0.8	9	1	22	4.6
Dusky Grouse			1	0.1											2	0.2		
Eurasian Collared Dove											1	0.1	1	0.2				
European Starling																		
Evening Grosbeak			1	0.1														
Gray Catbird											1	0.1						
Green-tailed Towhee	19	3.8	35	4.1	53	8.9	49	7.1	7	2.5	29	4.2	11	1.7	31	3.3	5	1.1
Hermit Thrush									1	0.4	3	0.4	1	0.2	4	0.4	35	7.4
House Finch																	1	0.2
House Wren			32	3.7	2	0.3	10	1.4	1	1.4	8	1.2	7	1.1	39	4.2	20	4.2
Mountain Bluebird	1	0.2					2	0.3										
Mourning Dove			63	7.4	11	1.9	1	0.1	1	0.4	9	1.3	39	6	12	1.3	1	0.2
Northern Flicker	44	8.8	10	1.2	19	3.2	46	6.8	29	10.1	52	7.6	49	7.5	58	6.2	9	1.9
Pine Siskin	2	0.4					2	0.3									1	0.2
Red Crossbill	1	0.2	9	1.1							8	1.2						
Red-winged Blackbird					1	0.2												
Song Sparrow			1	0.1														
Spotted Towhee			4	0.4	13	2.2	11	1.6							10	1.1		
Townsend's Solitaire			1	0.1	2	0.3			3	1.1	1	0.1	2	0.3			3	0.6
Western Bluebird	5	1	16	1.9	8	1.3	28	4.1			1	0.1			3	0.3		
Western Meadowlark													1	0.2				
White-crowned sparrow																		
Wild Turkey					2	0.34											2	0.4
Sub-TOTALS	**240**	**47.9**	**373**	**43.7**	**270**	**45.4**	**250**	**36.3**	**129**	**45.951**	**274**	**39.9**	**228**	**35.1**	**305**	**32.7**	**152**	**32**
Timber-Foliage Searching																		
Caissin's Vireo					**1**	**0.2**												
MacGillvery's Warbler																	1	0.2
Mountain Chickadee	1	0.2	6	0.7	3	0.5	1	0.1	4	1.4	8	1.2	2	0.3	8	0.9	27	5.7
Orange-crowned Warbler			5	0.7	2	0.3	2	0.3	2	0.7	3	0.4	9	1.4	3	0.3	7	1.5
Plumbeous Vireo			19	2.2	5	0.8	32	4.7	12	4.2	25	3.7	10	1.5	10	1.1	6	1.3
Red-breasted Nuthatch											3	0.4			3	0.3	35	7.4
Ruby-crowned Kinglet																	19	4
Steller's Jay	10	2	16	1.9	33	5.6	15	2.2	11	3.9	52	7.6	30	4.6	33	3.5	22	4.6
Virginia's Warbler					1	0.2	1	0.1	3	1	21	3.1	5	0.8	16	1.7		
Warbling Vireo	1	0.2	30	3.5	19	3.2	18	2.6	7	2.5	17	2.5	27	4.1	31	3.3	44	9.3
Western Tanager	32	6.4	36	4.2	37	6.2	61	8.8	16	5.6	49	7.2	47	7.2	90	9.6	43	9.1
Yellow-rumped Warbler	13	2.6	41	4.8	19	3.2	34	4.9	12	4.2	11	1.6	18	2.8	10	1.1	19	4
Sub-TOTALS	**57**	**11.4**	**153**	**18**	**119**	**20**	**164**	**23.7**	**67**	**23.5**	**189**	**27.7**	**148**	**22.7**	**204**	**21.8**	**223**	**47.1**
Aerial Flycatcher																		
Common Nighthawk					16	2.7	12	1.7	2	0.7	1	0.1						
Northern Rough-winged Swallow	25	5																
Olive-sided Flycatcher					1	0.2									2	0.2		
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	3	1.1	41	6	45	6.9	78	8.4	13	2.7
White-throated Swift									3	1.1								
Sub-TOTALS	**43**	**8.6**	**38**	**4.4**	**32**	**5.5**	**18**	**2.6**	**12**	**4.3**	**43**	**6.2**	**45**	**6.9**	**80**	**8.6**	**13**	**2.7**
Flycatcher																		
Cordilleran Flycatcher	3	0.6	19	2.2	2	0.3	3	0.4			4	0.6	18	2.8	4	0.4	1	0.2
Dusky Flycatcher							20	2.9			1	0.1			3	0.3		
Grace's Warbler			11	1.3			18	2.6			4	0.6	3	0.5			2	0.4
Hammond's Flycatcher															34	3.6	26	5.5
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	14	4.9	29	4.2	59	9	120	12.9		
Yellow Warbler	2	0.4																
Sub-TOTALS	**90**	**18**	**183**	**21.4**	**98**	**16.4**	**131**	**18.9**	**14**	**4.9**	**42**	**6.1**	**85**	**13.1**	**161**	**17.2**	**29**	**6.1**
Timber Drilling/Gleaning																		
Brown Creeper					1	0.2					1	0.1			1	0.1	7	1.5
Downy Woodpecker	3	0.6													1	0.1		
Hairy Woodpecker	2	0.4	7	0.8	7	1.2	2	0.3	1	0.4	5	0.7	15	2.5	5	0.5	2	0.4
Pygmy Nuthatch	7	1.4	55	6.4	17	4.5	68	10	12	4.2	57	8.3	90	13.8	107	11.5	24	5.1
Red-naped Sapsucker	2	0.4															2	0.4
Three-toed Woodpecker					3	0.5												
White-breasted Nuthatch	23	4.6	29	3.4	20	3.4	23	3.3	4	1.4	17	2.5	14	2.1	31	3.3	10	2.1
Williamson's Sapsucker			1	0.1	1	0.1	1	0.1	7	2.45			1	0.2	1	0.1		
Sub-TOTALS	**37**	**7.4**	**92**	**10.7**	**49**	**9.9**	**94**	**13.7**	**24**	**8.45**	**80**	**11.6**	**120**	**18.6**	**146**	**15.6**	**45**	**9.5**
Corvid																		
American Crow	4	0.8	2	0.2	3	0.5			2	0.7	8	1.2	3	0.5	7	0.8		
Common Raven	1	0.2			1	0.2	2	0.3	11	3.9	12	1.8	8	1.2	12	1.3	2	0.4
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**	**2**	**0.4**
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														
Osprey															1	0.1		
Red-tailed Hawk	1	0.2	4	0.5	1	0.2	1	0.1	6	2.1	4	0.6			6	0.6	1	0.2
Sharp-shinned Hawk													1	0.2			2	0.4
Turkey Vulture	6	1.2	3	0.4	2	0.3	5	0.7	8	2.8	10	1.5	6	0.5	5	0.5		
Sub-TOTALS	**10**	**2**	**10**	**1.3**	**3**	**0.5**	**7**	**0.9**	**14**	**4.9**	**16**	**2.3**	**8**	**0.9**	**13**	**1.3**	**5**	**1**
Nectar Feeding																		
Black-chinned Hummingbird			1	0.1														
Broad-tailed Hummingbird	2	0.4	3	0.4			5	0.7	2	0.7	11	1.6	3	0.5	5	0.5	4	0.8
Sub-TOTALS	**2**	**0.4**	**4**	**0.5**	**0**	**0**	**5**	**0.7**	**2**	**0.7**	**11**	**1.6**	**3**	**0.5**	**5**	**0.5**	**4**	**0.8**
Other																		
Great Blue Heron											1	0.2						

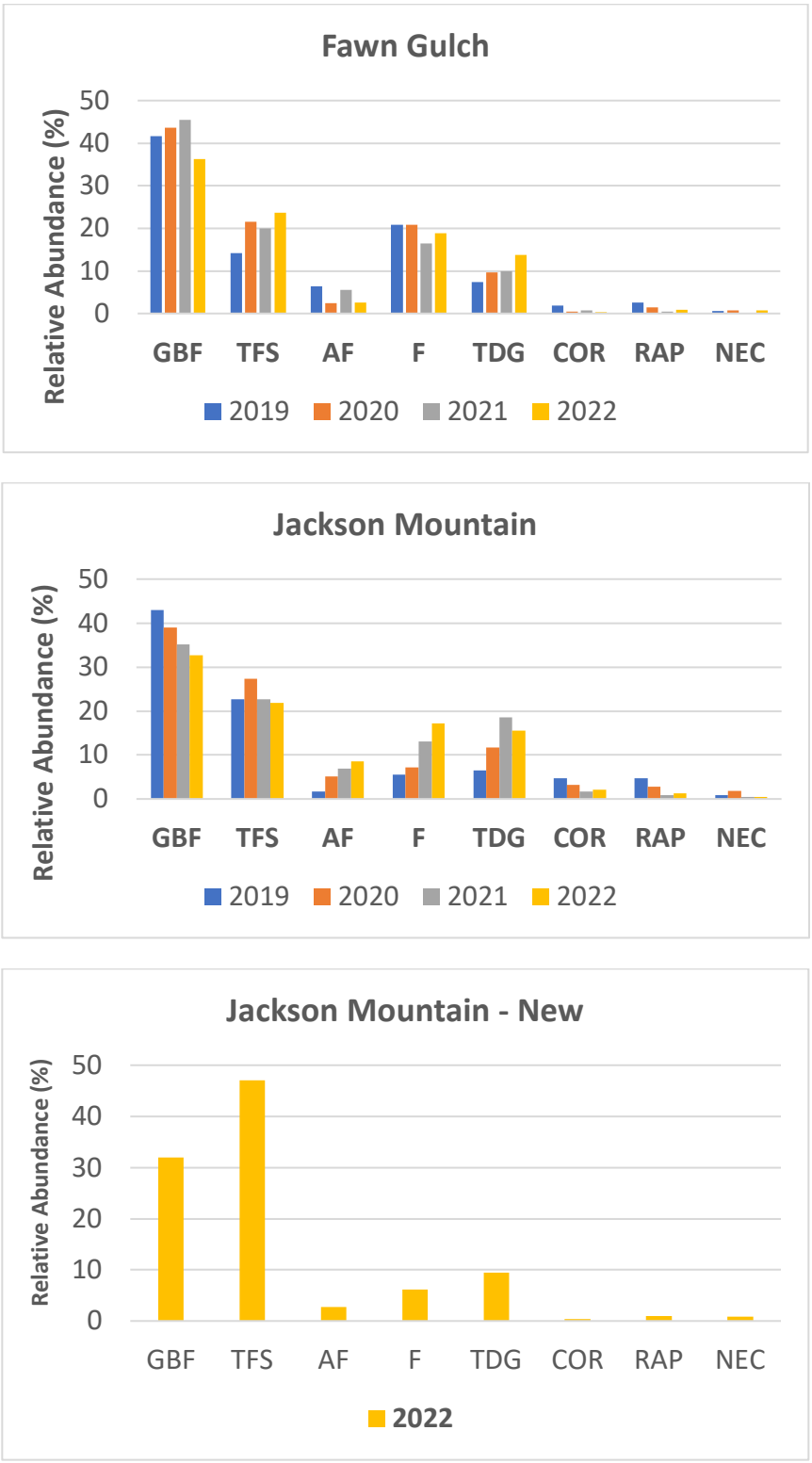

Figure 8. Relative abundances of bird species feeding guilds at Fawn Gulch; Jackson Mountain; and Jackson Mountain (New) study sites. GBF = Ground/Brush Foraging; TFS = Timber Foliage Searching; AF = Aerial Flycatcher; F = Flycatcher; TDG = Timber Drilling/Gleaning; COR = Corvids; RAP = Raptors; and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

compelling evidence that cavity nesters are also important determinants of forest ecosystem resilience in the context of forest management practices.

Looking across all 85 species encountered through the three years of our study, we identified 42 tree/shrub nesting species; 19 ground/cliff/other species; and 20 cavity nesting species (see Table 12; 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 12). Notably, cavity nesting species were observed at about 30% of the bird monitoring points in each year of the study (35% in 2019; 27% in 2020; 31% in 2021; and 32% in 2022). 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 21% of birds counted at FG; 29% of birds counted at JM; and 31% of birds counted at JMN falling into this category. Northern Flickers, White-breasted Nuthatches, and Pygmy Nuthatches were the most widespread cavity nesting species at all three sites, with House Wrens observed most frequently at JM.

In our study, Hairy Woodpeckers and Northern Flickers were the most abundant primary cavity nesters seen at all sites in each year of the study, along with Violet-green Swallows and White-breasted Nuthatches as abundant secondary cavity nesters, and Pygmy Nuthatches the most common species fulfilling either category (Table 9).

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

Table 12. 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. (Categorizations based on data obtained from www.allaboutbirds.org; and Coe, 2014) (Conservation Scores are from Table 14)

Cavity Nesting Species													
	2019			2020			2021			2022			Conservation
Species	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	0.7	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	6.2	6
Three-toed Woodpecker	none	none	none	none	none	none	FG	2	0.2	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	65.8	10
Williamson's Sapsucker	TS, JM	5	0.8	FG	1	0.1	JM	1	0.1	FG, JM	2	1.4	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	4.5	7
Lewis's Woodpecker	TS	1	0.2	none	none	none	JM	3	0.2	none	none	none	15
Red-breasted Nuthatch	none	none	none	TS, JM	2	0.1	none	none	none	JM, JMN	33	25.1	6
Red-naped Sapsucker	FG	2	0.3	none	none	none	none	none	none	JMN	2	1.5	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	76.7	11
Secondary Cavity Nesters													
American Kestrel	FG	1	0.2	none	none	none	none	none	none	JM	1	0.7	11
Ash-throated Flycatcher	none	none	none	none	none	none	FG	1	0.8	none	none	none	8
European Starling	none	none	none	TS	1	0.1	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	41.5	5
Mountain Bluebird	FG	1	0.2	none	none	none	TS	1	0.1	FG	1	0.7	12
Mountain Chickadee	FG, JM	3	0.5	TS, FG, JM	12	0.8	none	none	none	FG, JM, JMN	34	25.1	10
Tree Swallow	FG, JM	4	0.6	JM	1	0.1	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	39.0	9
Western Bluebird	TS, FG	9	1.4	TS, FG, JM	34	2.2	TS, FG	40	3.0	FG, JM	14	10.0	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	38.5	6

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 one or two of the three 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 14), 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 85 different bird species observed over the four years of this study, 35 species, representing about 83% of the birds counted, were observed in all four years (Tables 8 and 13). Of those 35 species, 7 were present at all sites across all years of the study, accounting for about 44% of all birds counted. Note that in our summary of the first three years of the study (Grover et.al., 2021), 37 species representing about 93% of all birds counted were reported, with 12 species observed at all three sites, representing about 67% of all birds counted. The absence of the Western Wood-Pewee in the JMN site added in 2022 accounts for most of this difference. The remaining 50 species of birds observed in this study account for the remaining 17% of birds counted – or about 1200 birds (Table 9). The Western Wood-Pewee accounts for the vast majority of these, with a total count across years of 761 birds (Table 8).

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 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 13, 14, and 15 address this very important question, and one that we did not anticipate addressing with our study at its inception.

The data shown in Table 13 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 simply 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 12 – meaning that species was present at each site across the four years of the study. Conversely, 20 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 13 cross-references to Tables 14 and 15, 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 14 and 15). 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 15. 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 14) 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 14). 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 85 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 15). 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 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. Similarly, 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 (Table 13). 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, and at FG in 2022 (Table 13). 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, and at FG and JMN in 2022. Finally, an Olive-sided Flycatcher was recorded at FG in 2021, and at JM in 2022 (Table 13).

Of the remaining bird species with CC scores > 10, four were found at all three of our study sites in 2019 (Table 13). These include the Broad-tailed Hummingbird, Pygmy Nuthatch, Steller's Jay, Western Wood-Pewee, and Northern Flicker. The Western Wood-Pewee, Northern Flicker, and Steller's Jay were relatively common in our dataset. In 2020 we documented the presence of single individuals of Dusky Grouse and Northern Goshawk at FG; and Dusky Flycatcher and Black-chinned Hummingbird at JM, each of which has conservation scores of 10 and 11. Overall, FG and JM stand out as the sites with the greatest number of sightings of bird species with CC scores > 10 (Table 13).

One of the most exhilarating sightings across all four 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 and 2022. 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, another Common Nighthawk nest was observed at FG, and that nest 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 JMN in 2022. 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; and 2021), 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. 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. 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 (Table 14) 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 (Grover et al. 2021), and JMN site studied in 2022. 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.

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). Finally, Western Wood-Pewees were not observed at the JMN site, which has the densest tree canopy of the sites included in our study.

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

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

Table 14. 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 13 and 15).

Common Name	Commonness Score	Concern Score	Population Status	% decline	Notes
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	
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 Woodpecker	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 15. 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		

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 Table 11). 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 and JM sites, where the oak shrub layer was well developed, but not at the JMN site.

In contrast to the findings of Lowe et al., (1978), TDG species show an increasing trend in relative abundance across our study sites across years with JM > FG > JMN (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 decline of 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 16 provides a summary of the 85 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 16, 43 of the 85 species observed in our study are listed as resident species in the Cornell database, with 40 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 16) can be categorized as Nearctic based on their migratory behavior, with 42 species falling into the Neotropical category as well (12 resident, Nearctic-Neotropical cross-overs; 30 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 7 of those 12 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 16 of the 43 resident, Nearctic-Neotropical species (37%), and 13 of 42 non-resident Nearctic-Neotropical migratory species (31%) achieving that score. Using a CoSc of 4 as a threshold for uncommon species reveals that 27 resident species (63%) and 21 non-resident species (50%) fit that category.

With regard to their conservation status, resident, Nearctic-Neotropical species are faring better overall compared to non-resident, Nearctic-Neotropical bird species observed in our study (Table 16). Eight of the resident species in our study (shown in yellow in Table 16) 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 16; 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 15 species noted in the SOTB 2022 report (shown in yellow in Table 16), and 9 species cited in the SONAB report (shown in tan in Table 16; Cornell, 2019) – or 57% of bird species in exhibiting longer-range migratory behaviors. Notable among the non-resident, Nearctic-Neotropical migrants in decline globally, but

Table 16. 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.

	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)					
American Robin	12	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		
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
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

relatively 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 42 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 16), with more than half (23) of those species noted of concern in the SONAB and SOTB reports. This is in contrast to 15 of the resident species (35%) 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 or fragmentation in wintering grounds or 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 – and, perhaps, even unanswerable.

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 four-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). With only one year 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 revealed by the findings of our study. Of the 85 bird species observed across the four years of this study, 35 were observed in all years, and 7 of those bird species were observed at all three sites in all years (Table 13). Notably, the 7 species observed at all four sites across years were among the most abundant species counted (Tables 8 and 9).

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 uncommon or rare today, 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 12). 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 12), 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 11). 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 85 bird species observed over the four years of our study, about half are resident species that are present in the Pagosa Springs area year-round, or are mostly short-distance or medium-distance migrants (Table 16). Of those resident species, about 37% are very common (CoSc >/=8), with about 63% uncommon (CoSc</=4). In contrast, the 42 bird species capable of short-distance to long-distance migrations are composed of about 31% common species and about 50% 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 16; see Cornell, 2019; and SOTB, 2022). In this case, about 35% of resident species are in decline, with 57% 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 fifth 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 adequate data for our analysis. Continued engagement of participants in bird identification workshops, particularly identification by song, has also proven to be very valuable.

As noted in our earlier reports (Grover et. al., 2019, 2020, and 2021), 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.

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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%	