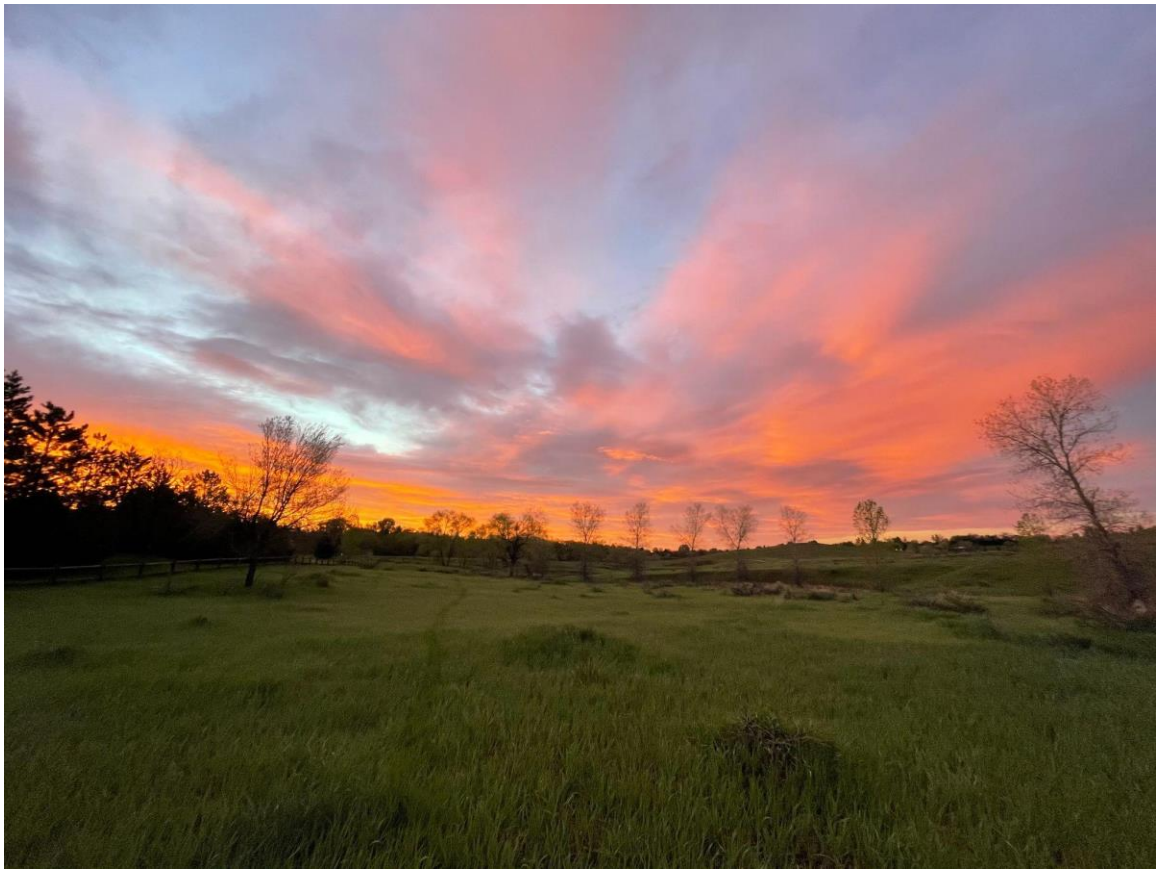
Breeding Bird Monitoring in The City of Fort Collins Foothills Natural Areas

2021 Report



Bird Conservancy of the Rockies

Connecting People, Birds and Land

BIRD CONSERVANCY OF THE ROCKIES

***Mission**: To conserve birds and their habitats*

***Vision**: Native bird populations are sustained in healthy ecosystems*

***Core Values**: (Our goals for achieving our mission)*

1. ***Science** provides the foundation for effective bird conservation.*
2. ***Education** is critical to the success of bird conservation.*
3. ***Stewardship** of birds and their habitats is a responsibility we all share.*

Bird Conservancy accomplishes its mission by:

***Monitoring** long-term trends in bird populations as a scientific foundation for conservation action.*

***Researching** bird ecology and response to anthropogenic and natural processes. Our research informs management and conservation strategies using the best available science.*

***Educating** people of all ages to instill an awareness and appreciation for birds and a conservation ethic.*

***Fostering** good stewardship on private and public lands through voluntary, cooperative partnerships that create win-win solutions for wildlife and people.*

***Partnering** with local, state and federal agencies, private citizens, schools, universities, and other organizations for bird conservation.*

***Sharing** the latest information on bird populations, land management and conservation practices to create informed publics.*

***Delivering** bird conservation at biologically relevant scales by working across political and jurisdictional boundaries in the Americas.*

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Contact information:
Rob Sparks: rob.sparks@birdconservancy.org
Erin Youngberg: erin.youngberg@birdconservancy.org
Bird Conservancy of the Rockies
230 Cherry Street
Fort Collins, CO 80521
970-482-1707

Executive Summary

The Foothills Natural Areas of northern Colorado are of high conservation value due to the high biodiversity, social, and economic services it provides to our community. Monitoring wildlife populations can be an effective tool for guiding management decisions. The City of Fort Collins manages several Natural Areas along the northern Front Range. The objective of this long-term monitoring project is to determine population density and distributions of breeding birds that inhabit these natural areas to assist with management planning and prioritization.

In 2021, Bird Conservancy of the Rockies staff surveyed points in the Foothills shrubland habitat using a point-transect survey method developed by Bird Conservancy. Using data collected, we generated density estimates using a hierarchical distance-sampling model. The benefit of this hierarchical distance-sampling framework is the ability to provide spatially explicit density estimates as functions of covariates.

We used a focal species approach and identified five focal species; Vesper Sparrow, Grasshopper Sparrow, Spotted Towhee, Blue-gray Gnatcatcher and Yellow-breasted Chat. These species integrate ecological processes that contribute to the maintenance of foothill shrubland ecosystem function. Management actions aimed at conserving these focal species will also protect a larger number of species occurring in the management areas. We mapped the relationship of focal species richness to habitat patch size and connectivity across the foothills properties. The highest incidence of species richness occurred on the western-most edges of the Natural Areas, where there are larger patches of shrubland habitat.

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Introduction

Foothill shrublands are found in the foothills, canyon slopes and lower mountains of the Rocky Mountains and on hogbacks/outcrops in the west (NatureServe 2021). This ecosystem extends from southern New Mexico through Colorado, north into Wyoming, and west into the Intermountain region (NatureServe 2021). In Colorado, foothill shrublands occur at lower montane elevations skirting mountains forming a transitional belt between grasslands and mixed coniferous forests running north to south. These shrublands form large habitat communities at elevations between 4900 and 9500 feet, and can be characterized by a variety of mixed montane shrublands, Rocky Mountain Juniper, and Ponderosa Pine. These communities form quilt-like vegetation mosaics across the landscape that can change substantially over short distances. These patches of habitat are extremely important for wildlife, as they provide specific cover, food sources, and structure for breeding birds that cannot be found in the neighboring grasslands to the east, or montane regions to the west.

Foothills property showing mix of grassland and shrubland (Reservoir Ridge photo by K. Jenkins)

Anthropogenic disturbances to foothill shrublands are increasing due to human population growth along the Front Range, and increasing demand for recreational opportunities. Extensive modification of shrubland communities due to conversion of lands to urban development are a threat to sustaining wildlife populations. Several bird species are sensitive to human disturbance, and studies have shown species abundance and diversity decreases as patch size decreases (Helzer and Jelinski, 1999). More fragmented habitat patches can also increase the edge effect, and reduce nest success for breeding birds (Winter et al. 2000). Monitoring birds and defining their habitat relationships can inform wildlife management plans, trail route designation, and seasonal access to natural areas.

Management for most species requires reliable abundance estimates (Bowden et al. 2003). Abundance estimates allow us to measure changes in population size and to assess the impact of habitat loss or harvesting over time (Buckland et al. 2008). Relating species density or abundance to a landscape and its habitat structure is also fundamental to understanding the ecology of an area. Royle (2004) developed hierarchical models that account for spatial variation in abundance and detection probability at sampling units. These models can be used to create maps of species estimated abundance (Sillette et al. 2012) for an area of interest, such as a single Natural Area, or across properties. This is appealing for conservation managers in that they can characterize the structure of local populations at specific sites (Royle 2004), and set vegetation and habitat management targets.

We used a focal species approach and identified five focal species; Grasshopper Sparrow, Vesper Sparrow, Blue-gray Gnatcatcher, Spotted Towhee and Yellow-breasted Chat. The Grasshopper and Vesper Sparrow are in the Colorado State Wildlife Action Plan as Tier 2 species. The other three species are common birds we want to see stay common, as they contribute to the maintenance of foothill shrubland ecosystem function, and are indicators of adequate, healthy habitat. Understanding the habitat use and distribution of these focal species can help guide management actions while also protecting a larger number of species occurring in the same areas. In this report, we show how the focal species' richness relates to habitat connectivity and patch size. We also created a map for all species' richness across the foothills properties to help guide land manager's decision-making.

Mitigating biodiversity loss due to land use change and habitat fragmentation, in addition to natural adaptation and maintaining species populations under climate change involves conserving connectivity, and the ability of species to move across landscapes (Heller and Zavaleta 2009).

Methods

Study Area

The survey locations were in City Natural Areas along the foothills west of Fort Collins (Fig 1).

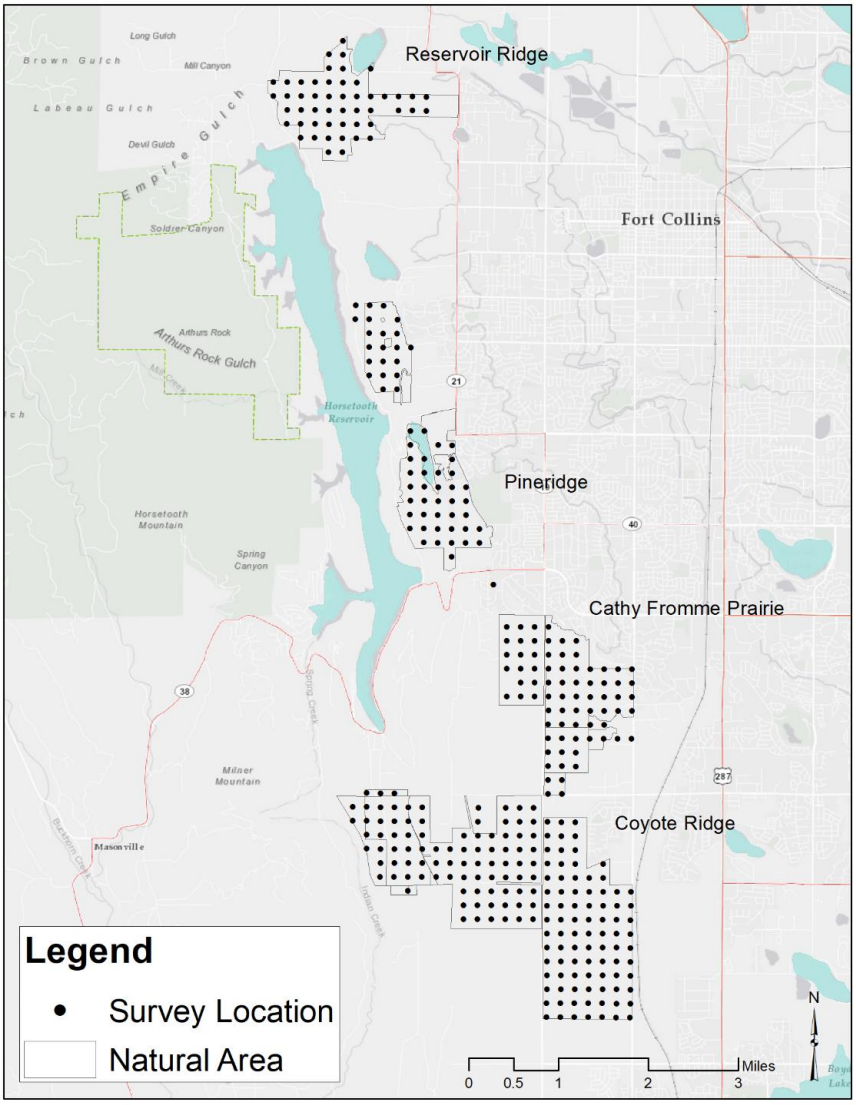

Figure 1. City of Fort Collins Natural Areas breeding bird survey study area.

Sampling Design and Methods

A systematic 250-m grid of 376 point count stations was created by the City of Fort Collins Natural Areas Department to survey the properties. Point count surveys start one half-hour before sunrise and end no later than 11 a.m., often earlier.

Observers navigated to point count locations on foot using a handheld GPS unit. We recorded atmospheric data (temperature, cloud cover, precipitation, and wind speed) and

time of day at the start and end of each daily survey effort. All GPS data were logged in Universal Transverse Mercator (UTM) North American Datum 1983.

At each station, we conducted a six-minute point count survey consisting of six consecutive one-minute intervals. This protocol, which is described more fully by Youngberg (2022), uses Distance sampling (Buckland et al. 2001) and removal sampling (Farnsworth et al. 2002). For each bird detected, observers recorded species, sex, how it was detected (call, song, visual, wing beat, other), horizontal distance from observer at time of detection, and the 1-minute interval in which it was detected. We measured distances using Bushnell Yardage Pro laser rangefinders.

In order to ensure consistent bird detectability, we did not conduct point counts during periods of decreased bird activity as a result of heavy snow, rain, or wind greater than 12 mph. Between point count surveys, we recorded the presence of high-priority and other rare or unusual bird species, but we did not use these observations in our analyses.

Density Estimation

We used a hierarchical distance sampling model described in Sillett et al. (2012). This hierarchical model includes sub-models that allow for the density process and the detection process to vary as functions of covariates i.e., grass height. In the density component of the model, the number of birds at each point (N_i) was modeled using a Poisson random variable. The expectation for the number of birds at a point count is $E[N_i] = \lambda$. The detection process in the model is based on classical distance sampling methods developed by Buckland et al. (2001). We used a half normal scale parameter and only considered constant models on detection. We estimated parameters of the generalized multinomial mixture model by maximizing the integrated likelihood function in R (R Development Core Team 2019) using the 'unmarked' package (Fiske et al. 2010).

Species Richness

We derived species richness by overlaying the focal species distribution models (Sparks and Youngberg 2021) and developed a species richness index for all species based on counts from our surveys. The focal species richness map produced by overlaying respective distribution models shows areas of high and low focal species richness. The species richness index for all species detected on count surveys shows areas of high species richness for all species detected.

Model Covariates

We used year to develop annual density estimates. The detection model was held constant for all models.

Landscape Connectivity

We explored shrubland/grassland connectivity using the LANDFIRE existing vegetation type layer (USGS 2014). We used the grainscape package in R (Chubaty et al. 2020) which looks at connectivity between features of interest. Here we looked at shrubland and grassland connectivity where each node is a grassland/shrubland habitat patch which is part of a larger network. We define a habitat patch as a contiguous area of native vegetation, with the edges determined at the point where land use changes. Each habitat patch is distinct from the others, and represented by a different color (Fig 2). We can then characterize connectivity relationships among habitat patches, and map potential paths for bird dispersal between patches. Interpretation of the provided maps consists of measuring the connectivity between habitat patches in the network using one of several metrics, such as least-cost path and resistance distance. Native habitat for determining patches included; Central Mixed Grass Prairie Shrubland, Rocky Mountain Lower Montane Foothill Shrubland, Western Great Plains Piedmont Grassland, Western Great Plains Short-Grass Prairie, Central Mixedgrass Prairie Grassland, Western Great Plains Sand Prairie. We overlaid focal species richness onto habitat patch maps based on predicted density, and an all species richness index based on survey counts also using the shrubland/grassland connectivity layer.

Results

Density Estimates

Bird Conservancy biologists surveyed 462 points in 2021. Surveys were conducted from May 14 to June 1 in the Foothills/ Shrubland natural areas along the Front Range west of Fort Collins. We observed a total of 82 bird species (Appendix A). Fourteen of these are considered priority species by Partners in Flight, Colorado Parks & Wildlife, and US Fish & Wildlife Service.

We estimated yearly density for five focal species; Vesper Sparrow, Grasshopper Sparrow, Spotted Towhee, Blue-gray Gnatcatcher and Yellow-breasted Chat. Density estimates spanning 10 years between 2011 and 2021 are presented in Table 1.

Table 1. Annual Density estimates (2011-2021) on Foothill Shrubland Natural Area properties (D = # of birds/ acre), SE = Standard Error, and 95% lower (LCL) and upper (UCL) confidence limits.

Species	Year	D/ acre	SE	LCL	UCL
Vesper Sparrow	2011	0.155	0.012	0.13	0.29
	2012	0.147	0.012	0.12	0.27

	2016	0.118	0.009	0.10	0.22
	2020	0.205	0.016	0.17	0.38
	2021	0.179	0.014	0.15	0.33
	2011	0.086	0.007	0.07	0.16
	2012	0.049	0.004	0.04	0.09
Grasshopper Sparrow	2016	0.147	0.012	0.12	0.27
	2020	0.106	0.009	0.09	0.20
	2021	0.024	0.002	0.02	0.04
	2011	0.255	0.020	0.21	0.47
	2012	0.239	0.019	0.20	0.44
Spotted Towhee	2016	0.179	0.014	0.15	0.33
	2020	0.245	0.020	0.21	0.45
	2021	0.206	0.016	0.17	0.38
	2011	0.053	0.004	0.04	0.10
	2012	0.047	0.004	0.04	0.09
Blue-gray Gnatcatcher	2016	0.035	0.003	0.03	0.06
	2020	0.066	0.005	0.06	0.12
	2021	0.031	0.002	0.03	0.06
	2011	0.045	0.004	0.04	0.08
	2012	0.043	0.003	0.04	0.08
Yellow-breasted Chat	2016	0.047	0.004	0.04	0.09
	2020	0.051	0.004	0.04	0.09
	2021	0.018	0.001	0.02	0.03

Density estimates of all five focal species have fluctuated the last ten years, but remained fairly stable (Table 1). Decreases in density seem to have occurred in Grasshopper Sparrow (.086 birds/ acre in 2011 vs .024 in 2021), a tall-grass obligate species, and Yellow-breasted Chat (.045 in 2011 vs .018 in 2021), a dense shrubland obligate species.

Species Richness and Landscape Connectivity

The largest area of contiguous habitat is the complex that includes the western half of Coyote Ridge, the Gindler property, and the southern portion of Cathy Fromme. Focal species richness was also highest in that area (Fig 2). The western areas of Reservoir Ridge, Maxwell, and Pineridge Natural Areas had higher focal species richness, most likely due to the shrubland component preferred by most of the species. Grasshopper sparrows are the only focal species that prefer tall native grass with little-to-no shrub cover.

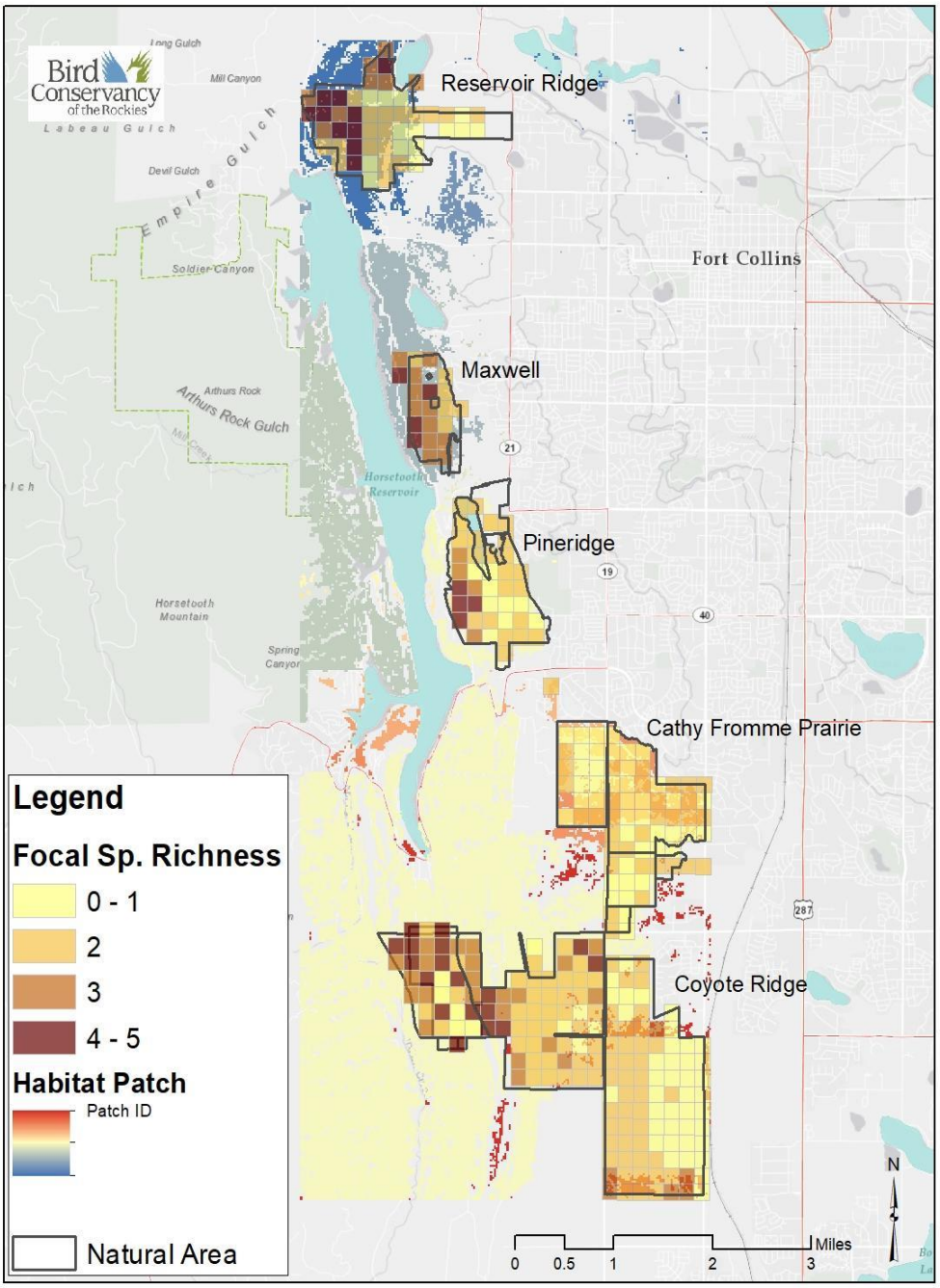

Figure 2. Focal species richness overlaid on native shrubland/grassland connectivity layer. The connectivity layer shows unique inter-connected patches by color.

Pineridge Natural Area had the largest concentration of species richness for all bird species (Fig 3). This Natural Area has a mix of habitat types such as: short and mixed-grass prairie, prairie dog colony, large pond/wetland, small deciduous forest, lodge pole forest and shrublands, which attracts a high diversity of bird species.

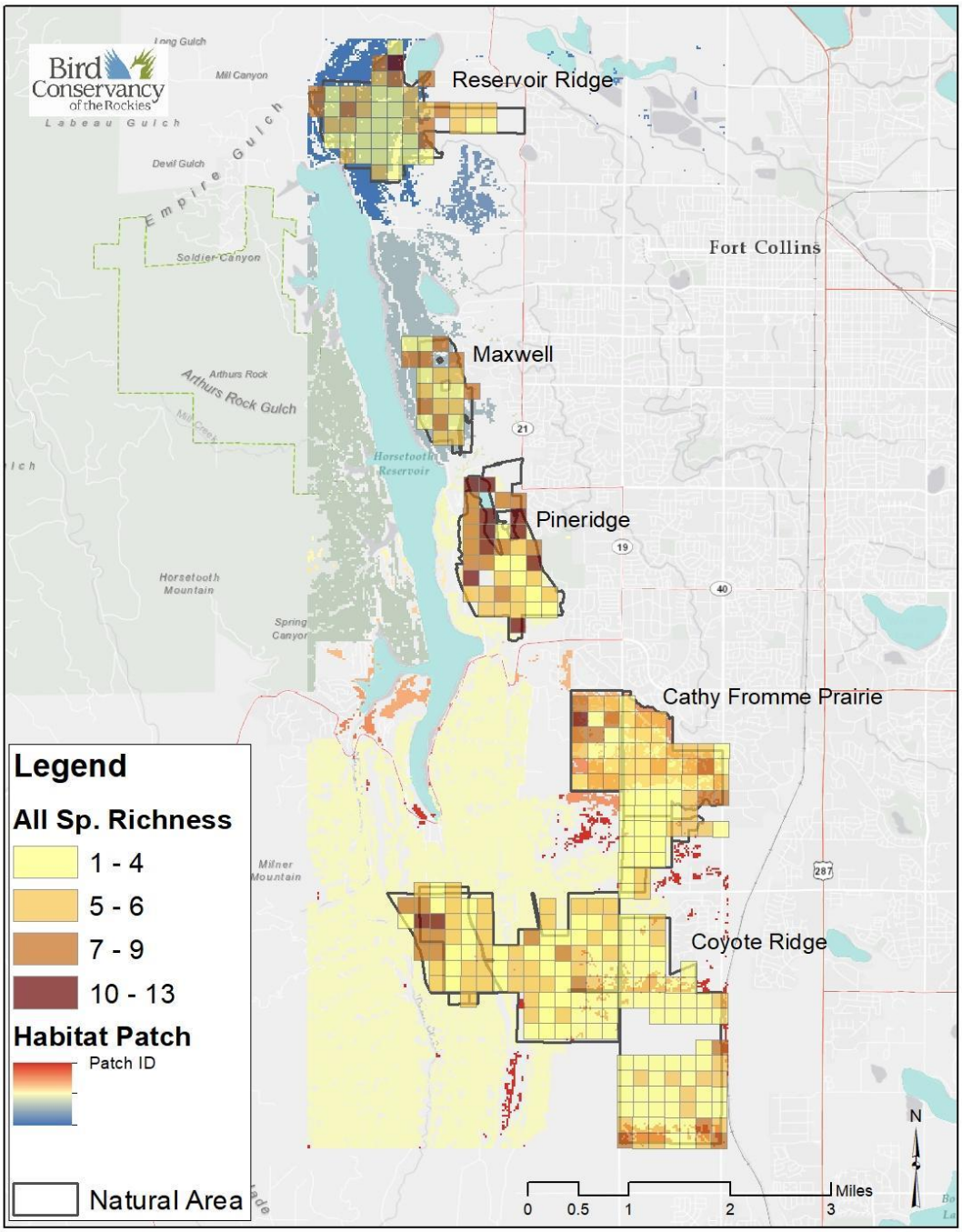

Figure 3. All species richness index based on surveys overlaid on native shrubland/grassland connectivity layer. The connectivity layer shows unique inter-connected patches by color.

Discussion

The foothill shrubland area is like no other place in northern Colorado. This transition from native grasslands to the foothills of the Rocky Mountains instills a sense of vastness

and untouched natural character. The continuity of these protected Natural Areas and Open Spaces preserves the richness of this landscape where so many come to live and play. The balance of conserving these areas includes leaving large enough patches of the habitat and landscape undisturbed so the birds and other wildlife that rely on the native shrubs and grasses can thrive, creating the scenery desired by those who come to recreate in and around those same areas.

We built upon last year's results and used two metrics 1) focal species richness and 2) all species richness and overlaid them with the connectivity layer. These maps can be used as tools to show where structural connectivity and the physical patches of native habitat occur, along with functional connectivity, species richness distributions, and how they relate to the connectivity layer. These maps can also be used to prioritize management planning. We present yearly density estimates for focal species to look at variation over time. Focal species density relationships to habitat patch size and connectivity, along with the predictive distribution models from the 2020 report (Appendix B) can aid in Natural Areas management and decision making. Those areas with higher focal species richness such as western portions of Reservoir Ridge, Maxell, Pineridge, Cathy Fromme, and the Gindler parcel should be protected from development and fragmentation, and recreational impacts should be minimized. Trails, roads, or structures should be built on the edge of, or a reasonable distance from areas of higher species richness.

Landscape fragmentation has had profound effects on the distribution and density of bird species (Herkert et al. 1994). As habitat becomes less available, evidence shows nesting success of grassland birds can decline below levels necessary for population maintenance (Herkert et al. 1994). There is a true challenge of managing Natural Areas for wildlife health, while planning recreation routes and sites that simultaneously reduce fragmentation, minimize disturbance, and preserve large patches of intact and healthy habitat to support populations of birds and other wildlife species.

The relationship between bird species richness, and vertical and horizontal structural complexity of vegetation has been found to be important for shrubland birds (Wiens and Rotenberry 1981). Foothill shrubland focal species showed a greater species richness in larger patches of habitat with high connectivity. This is consistent with these focal species habitat preferences, which include a grassland/shrub component.

Grasshopper Sparrow generally avoids extensive shrub cover, and prefers patches of mid - tall native grasslands greater than 15ha (Davis, 2004). They prefer dense patches of native grasses like Needle and Thread, Bluestem, Western Wheatgrass, Junegrass, and Ricegrass species. This bird species can be sensitive to human activity, avoiding roads, trails, and structures up to 150m (Askins, 2007) and is also sensitive to poor habitat

quality and quantity (Davis, 2004). Managing native grassland areas for this focal species will benefit other grassland species in decline such as Baird's Sparrow, Savannah Sparrow, Western Meadowlark, and Bobolink. Detections for this species were mainly in the Coyote Ridge, Cathy Fromme Natural Areas, with one detection in the grassland portion of Pineridge (Fig 4). We recommend not building trails through intact patches of grass, or building structures in areas of dense native grassland that may deter this species.

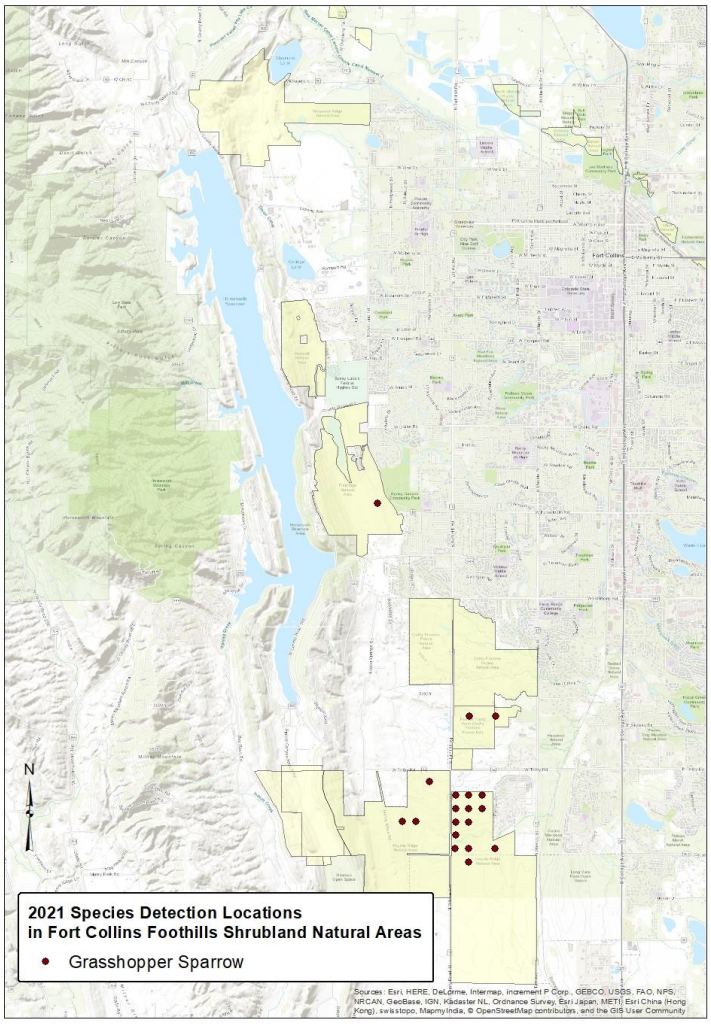

Figure 4: Grasshopper Sparrow detections in Fort Collins Foothills Shrubland Natural Areas

Vesper Sparrow generally occupies sparser, more open grasslands with a shrub component. Shrub height was found to be correlated with density (Rotenberry and Wiens 1980). This species is relatively tolerant to a moderate level of human activity (Askins, 2007), but susceptible to nest predation as a ground-nesting bird when near residential areas that attract predators like outdoor cats, raccoons, and skunks (Winter et al., 2000). Managing a mixed grassland/ shrubland habitat for Vesper Sparrow will benefit other charismatic bird species such as Lark Sparrow, Lark Bunting, Western Meadowlark, Loggerhead Shrike, and Blue Grosbeak. Detections for this species were more

widespread throughout Coyote Ridge and Cathy Fromme Natural Areas, with a few detections in Reservoir Ridge and the Gindler parcel (Fig 5). We recommend maintaining available habitat for these species at a safe distance from residential areas to reduce small mammalian predation.

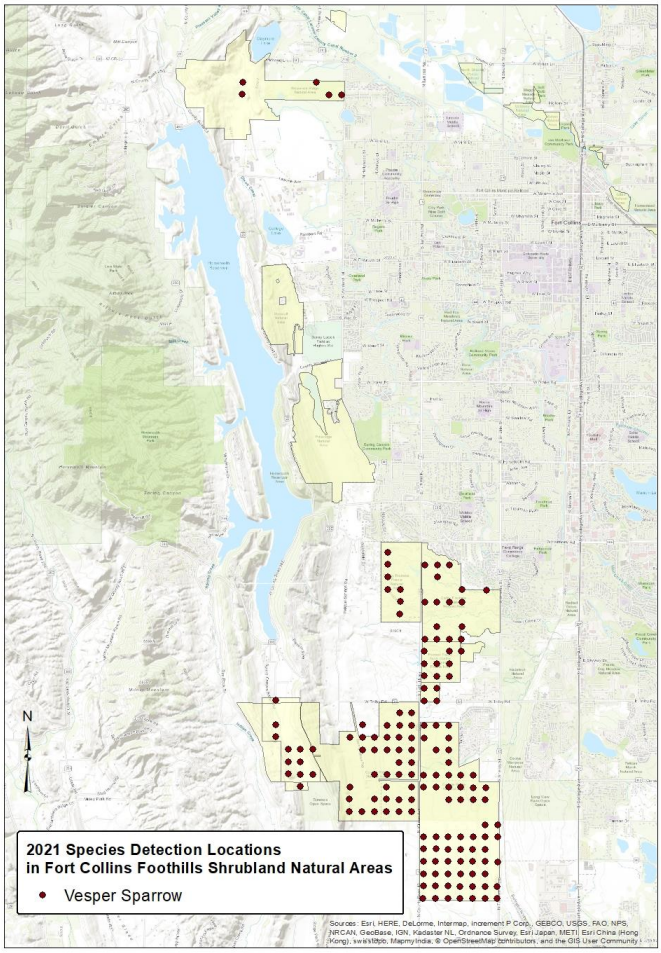

Figure 5: Vesper Sparrow detections in Fort Collins Foothills Shrubland Natural Areas

Spotted Towhee, Yellow-breasted Chat, and Blue-gray Gnatcatcher breed in dense shrub cover along the foothills, or in areas with thick undergrowth in woodlands (Sparks and Youngberg, 2021) (Burhans and Thompson, 1999). The greatest threat to these species is increased edge effect from fragmentation, which increases activity of mid-sized mammalian predators (Winter et al., 2000). Spotted Towhees were ubiquitous across all of the Natural Areas in portions dominated by shrublands (Fig 6). Yellow-breasted Chat were detected in more limited areas of dense shrubland near drainages or steep, shaded terrain (Fig 7). Blue-gray Gnatcatchers were detected in even more limited areas of dense shrubland, often near small Ponderosa stands, or minimal over story cover (Fig 8). Management of habitat for these species should focus on preserving large intact patches of foothills shrubland, and encouraging heterogeneity in vegetative vertical structure.

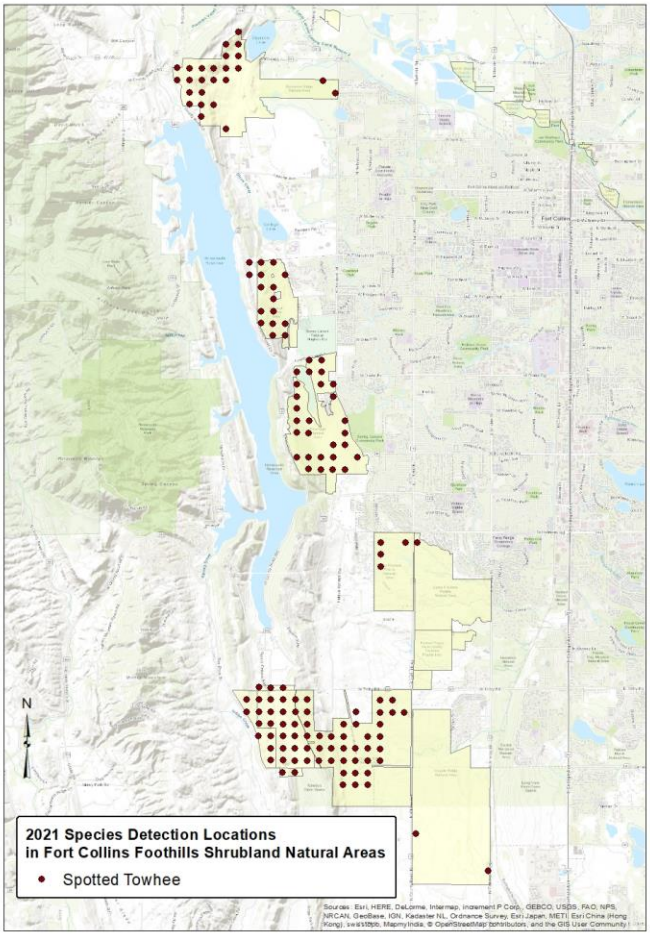

Figure 6: Spotted Towhee detections in Fort Collins Foothills Shrubland Natural Areas

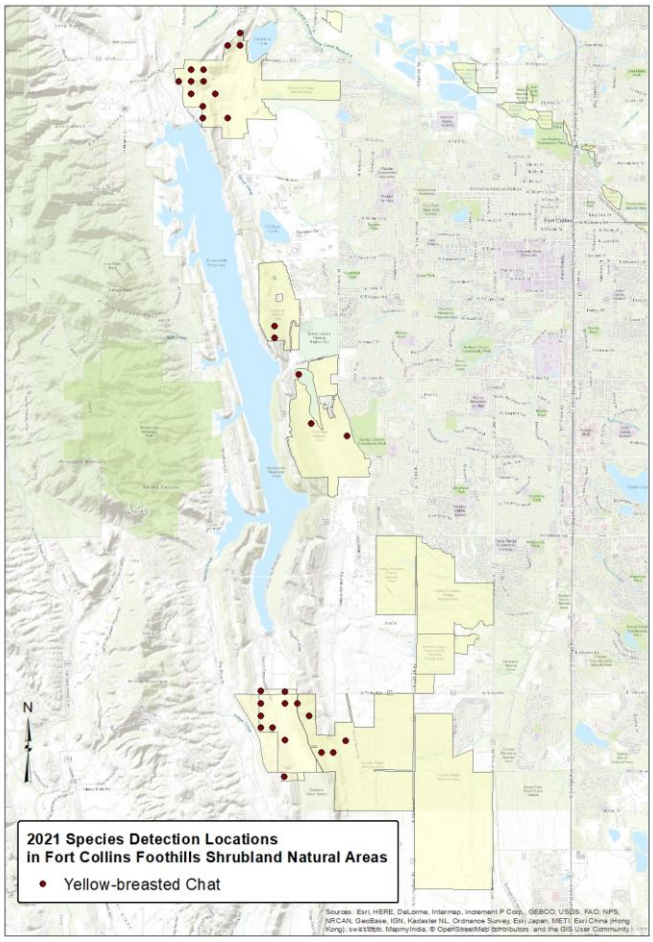

Figure 7: Yellow-breasted Chat detections in Fort Collins Foothills Shrubland Natural Areas

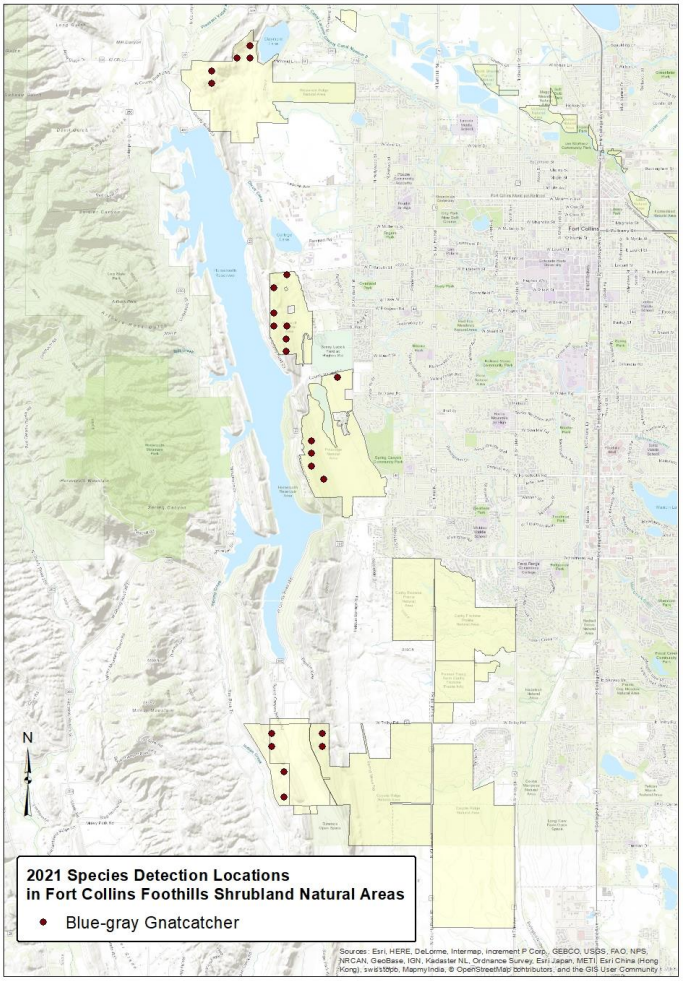

Figure 8: Blue-gray Gnatcatcher detections in Fort Collins Foothills Shrubland Natural Areas

Maintaining the diversity of unique habitats such as native grasslands, shrublands, wetlands, wet meadows and riparian habitat embedded in these foothills natural areas will be important for supporting the wildlife biodiversity and natural landscapes that attract people to this area.

Natural Areas Department staff, land managers, and Bird Conservancy staff meet annually to share data and results and determine management and conservation goals using birds as indicators. These discussions inform and direct future actions and survey efforts.

Acknowledgements

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APPENDIX A. Number of detections for bird species recorded in the Foothills shrubland Habitat in 2020 - 2021.

Species	*Scientific Name*	2020 Detections	2021 Detections
American Crow	*Corvus brachyrhynchos*	4	8
American Goldfinch	*Carduelis tristis*	92	70
American Kestrel	*Falco sparverius*	12	13
American Redstart	*Setophaga ruticilla*	3	
American Robin	*Turdus migratorius*	116	60
American Three-toed Woodpecker	*Picoides dorsalis*	1	
Baird's Sparrow*	*Ammodramus bairdii*	1	
Bald Eagle	*Haliaeetus leucocephalus*	3	
Baltimore Oriole	*Icterus galbula*	1	
Bank Swallow	*Riparia riparia*	2	
Barn Swallow	*Hirundo rustica*	37	47
Black-billed Magpie	*Pica hudsonia*	92	111
Black-capped Chickadee	*Poecile atricapillus*	9	3
Black-chinned Hummingbird	*Archilochus alexandri*	2	
Black-headed Grosbeak	*Pheucticus melanocephalus*	13	1
Blue Grosbeak	*Passerina caerulea*	21	6
Blue Jay	*Cyanocitta cristata*	9	8
Blue-gray Gnatcatcher	*Polioptila caerulea*	62	27
Blue-winged Teal	Anas discors		3
Bobolink*	Dolichonyx oryzivorus		8
Brewer's Blackbird	*Euphagus cyanocephalus*	15	2
Brewer's Sparrow	*Spizella breweri*	28	11
Broad-tailed Hummingbird	*Selasphorus platycercus*	94	
Brown Thrasher	*Toxostoma rufum*	4	3
Brown-headed Cowbird	*Molothrus ater*	90	40
Bullock's Oriole*	*Icterus bullockii*	53	47
Burrowing Owl*	*Athene cunicularia*	3	
Bushtit	*Psaltriparus minimus*	1	6
Canada Goose	*Branta canadensis*	17	33
Canyon Wren	*Catherpes mexicanus*	8	
Cassin's Finch	*Carpodacus cassinii*	2	
Cassin's Sparrow*	*Aimophila cassinii*	5	
Cedar Waxwing	*Bombycilla cedrorum*	2	
Chipping Sparrow	*Spizella passerina*	48	56
Clay-colored Sparrow	*Spizella pallida*	1	6
Cliff Swallow	*Petrochelidon pyrrhonota*	9	34
Common Grackle	*Quiscalus quiscula*	35	60

Species	*Scientific Name*	2020 Detections	2021 Detections
Common Nighthawk	*Chordeiles minor*	2	1
Common Poorwill	Phalaenoptilus nuttallii		2
Common Raven	*Corvus corax*	67	75
Common Yellowthroat	*Geothlypis trichas*	8	10
Cooper's Hawk	*Accipiter cooperii*	2	
Cordilleran Flycatcher*	*Empidonax occidentalis*	4	3
Dark-eyed Junco	*Junco hyemalis*	9	
Double-crested Cormorant	*Phalacrocorax auritus*	1	
Downy Woodpecker	*Picoides pubescens*	4	2
Dusky Flycatcher	*Empidonax oberholseri*	1	
Dusky Grouse	*Dendragapus obscurus*	5	
Eastern Kingbird	*Tyrannus*	2	2
Eurasian Collared-Dove	*Streptopelia decaocto*	7	1
European Starling	*Sturnus vulgaris*	40	54
Grasshopper Sparrow*	*Ammodramus savannarum*	131	29
Gray Catbird	*Dumetella carolinensis*	1	4
Great Blue Heron	*Ardea herodias*	2	1
Great Horned Owl	*Bubo virginianus*	4	5
Green-tailed Towhee	*Pipilo chlorurus*	38	3
Hairy Woodpecker	*Picoides villosus*	17	
Hammond's Flycatcher	*Empidonax hammondii*	5	1
Horned Lark	*Eremophila alpestris*	143	61
House Finch	*Carpodacus mexicanus*	43	59
House Sparrow	Passer domesticus		2
House Wren	*Troglodytes aedon*	162	
Killdeer	*Charadrius vociferus*	13	13
Lark Bunting	*Calamospiza melanocorys*	29	3
Lark Sparrow	*Chondestes grammacus*	55	58
Lazuli Bunting	*Passerina amoena*	73	30
Lesser Goldfinch	*Carduelis psaltria*	56	14
Lincoln's Sparrow	*Melospiza lincolnii*	1	
Loggerhead Shrike	*Lanius ludovicianus*	2	
Long-billed Curlew*	*Numenius americanus*	2	1
MacGillivray's Warbler	*Oporornis tolmiei*	13	
Mallard	*Anas platyrhynchos*	13	31
Mountain Bluebird	*Sialia currucoides*	27	
Mountain Chickadee	*Poecile gambeli*	1	
Mourning Dove	*Zenaida macroura*	145	133
Northern Flicker	*Colaptes auratus*	27	13
Northern Harrier*	*Circus cyaneus*	4	5

Species	*Scientific Name*	2020 Detections	2021 Detections
Northern Mockingbird	*Mimus polyglottos*	9	
Northern Rough-winged Swallow	Stelgidopteryx serripennis		2
Olive-sided Flycatcher*	Contopus cooperi		2
Orange-crowned Warbler	*Vermivora celata*	1	
Peregrine Falcon	*Falco peregrinus*	1	
Pine Siskin	*Carduelis pinus*	2	
Plumbeous Vireo*	*Vireo plumbeus*	19	1
Prairie Falcon*	*Falco mexicanus*	1	3
Pygmy Nuthatch	*Sitta pygmaea*	20	19
Red Crossbill	*Loxia curvirostra*	12	
Red-breasted Nuthatch	*Sitta canadensis*	11	
Red-headed Tanager	*Piranga erythrocephala*	1	
Red-headed Woodpecker	*Melanerpes erythrocephalus*	1	1
Red-tailed Hawk	*Buteo jamaicensis*	15	24
Red-winged Blackbird	*Agelaius phoeniceus*	260	294
Rock Pigeon	*Columba livia*	6	9
Rock Wren	*Salpinctes obsoletus*	140	19
Rusty Blackbird*	*Euphagus carolinus*	1	
Savannah Sparrow	*Passerculus sandwichensis*	17	10
Say's Phoebe	*Sayornis saya*	14	16
Sharp-shinned Hawk	*Accipiter striatus*	1	
Song Sparrow	*Melospiza melodia*	8	1
Spotted Towhee	*Pipilo maculatus*	333	240
Steller's Jay	*Cyanocitta stelleri*	20	
Swainson's Hawk	*Buteo swainsoni*	6	
Townsend's Solitaire	*Myadestes townsendi*	23	
Tree Swallow	*Tachycineta bicolor*	8	1
Turkey Vulture	*Cathartes aura*	11	3
Vesper Sparrow	*Pooecetes gramineus*	358	304
Violet-green Swallow	*Tachycineta thalassina*	16	11
Virginia's Warbler*	*Vermivora virginiae*	32	2
Warbling Vireo	*Vireo gilvus*	1	2
Western Bluebird	*Sialia mexicana*	5	
Western Kingbird	*Tyrannus verticalis*	50	59
Western Meadowlark	*Sturnella neglecta*	1053	503
Western Sandpiper	*Calidris mauri*	1	
Western Tanager	*Piranga ludoviciana*	65	4
Western Wood-Pewee	*Contopus sordidulus*	59	7
White-breasted Nuthatch	Sitta carolinensis		3
White-crowned Sparrow	*Zonotrichia leucophrys*	1	3

Species	*Scientific Name*	2020 Detections	2021 Detections
Wild Turkey	*Meleagris gallopavo*	4	3
Williamson's Sapsucker*	*Sphyrapicus thyroideus*	1	
Wilson's Snipe	*Gallinago delicata*	1	
Wilson's Warbler	*Wilsonia pusilla*	5	
Wood Duck	*Aix sponsa*	3	
Yellow Warbler	*Dendroica petechia*	19	25
Yellow-breasted Chat	*Icteria virens*	97	34
Yellow-rumped Warbler	*Dendroica coronata*	19	
	TOTAL	**4,785**	**2,884**

Species with a * are species of concern as listed by Partners in Flight (PIF 2022), US Fish & Wildlife Service and Colorado Parks and Wildlife.

APPENDIX B. Predictive distribution maps for focal species and overall species richness along the Foothills shrubland Natural Areas properties.

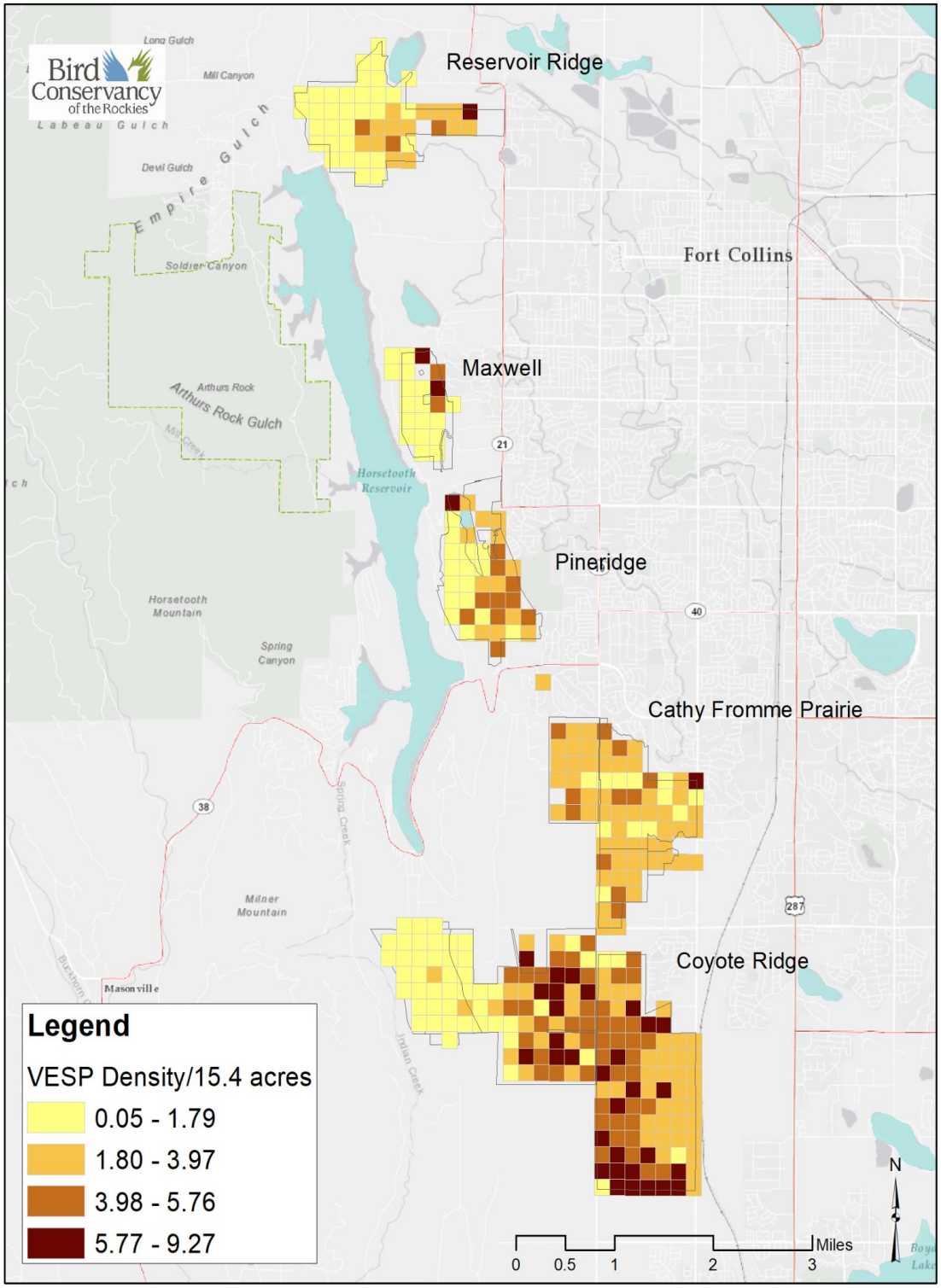

Figure 9. Density and distribution of Vesper Sparrow in the Foothills Shrubland Natural Areas

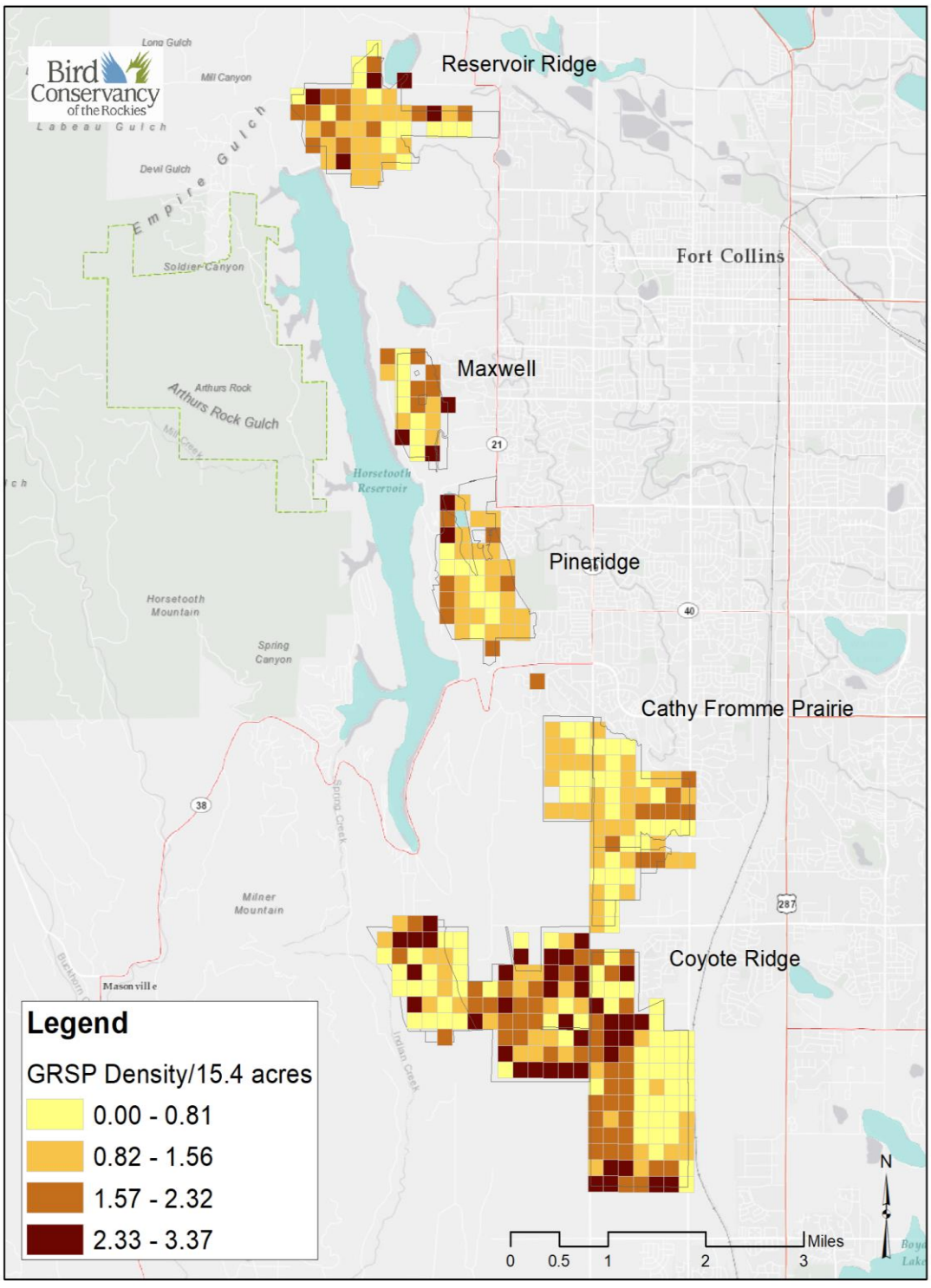

Figure 10. Density and distribution of Grasshopper Sparrow in the Foothills Shrubland Natural Areas

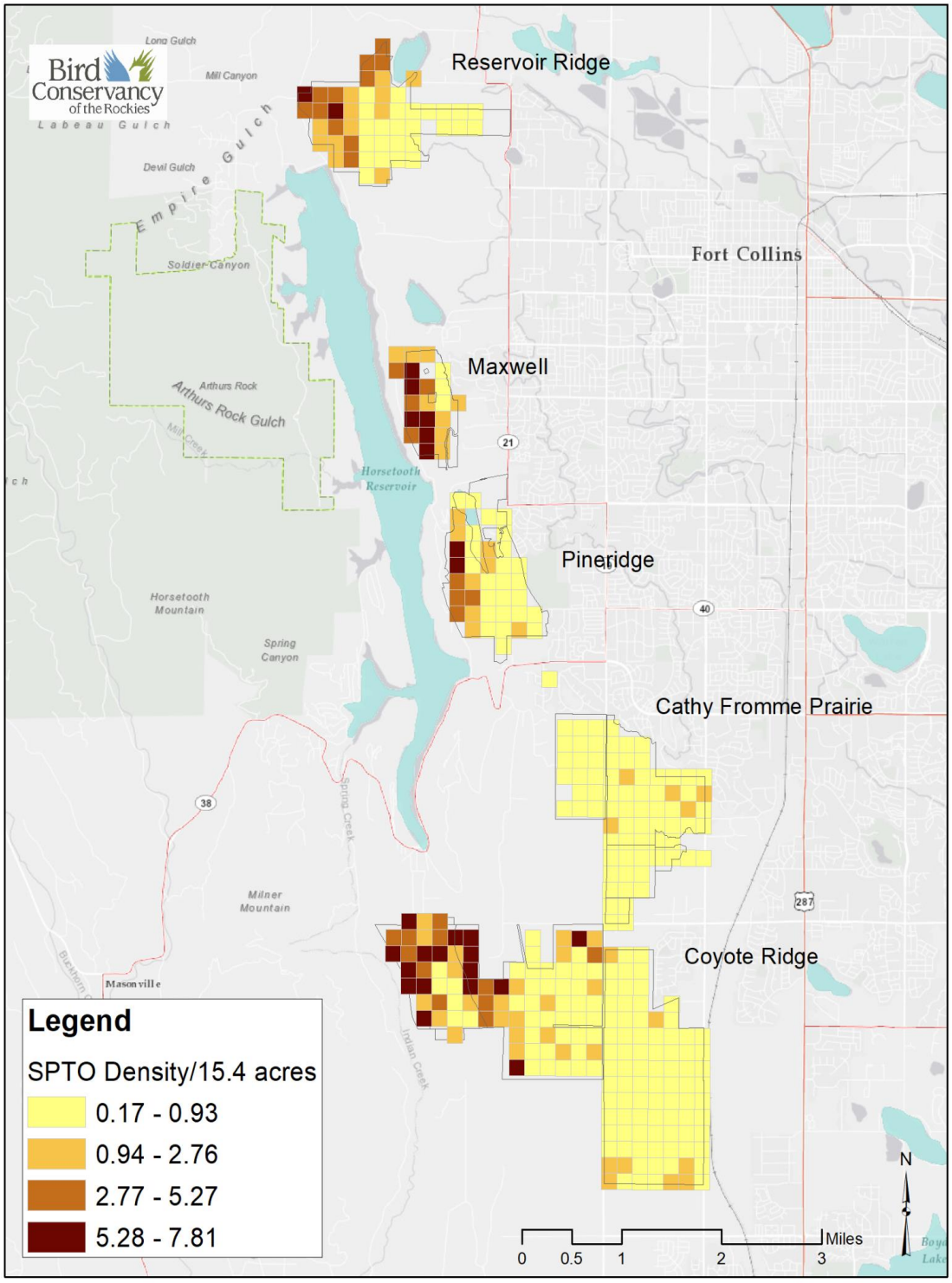

Figure 11. Density and distribution of Spotted Towhee in the Foothills Shrubland Natural Areas

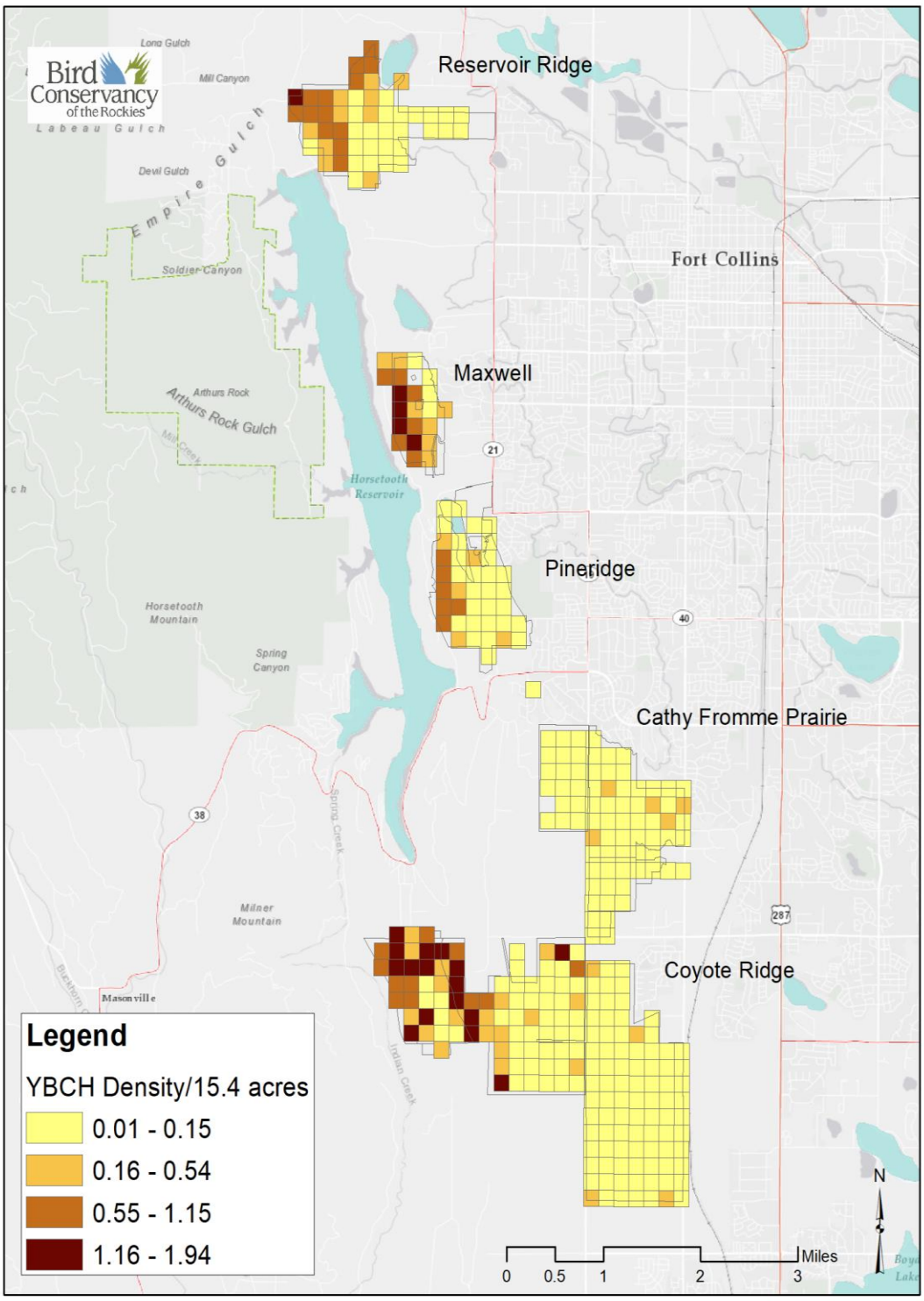

Figure 12. Density and distribution of Yellow-breasted Chat in the Foothills Shrubland Natural Areas

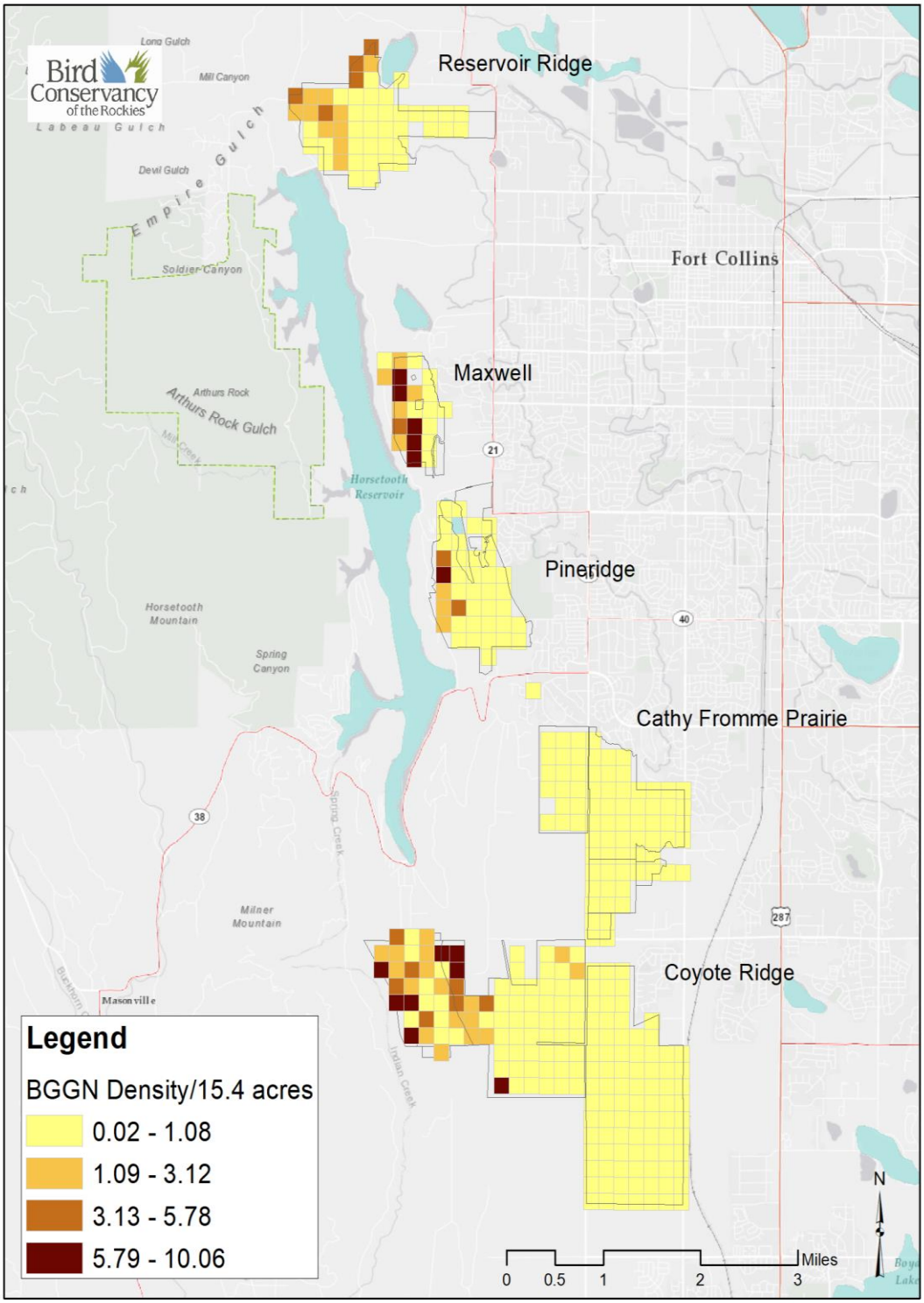

Figure 13. Density and distribution of Blue-gray Gnatcatcher in the Foothills Shrubland Natural Areas

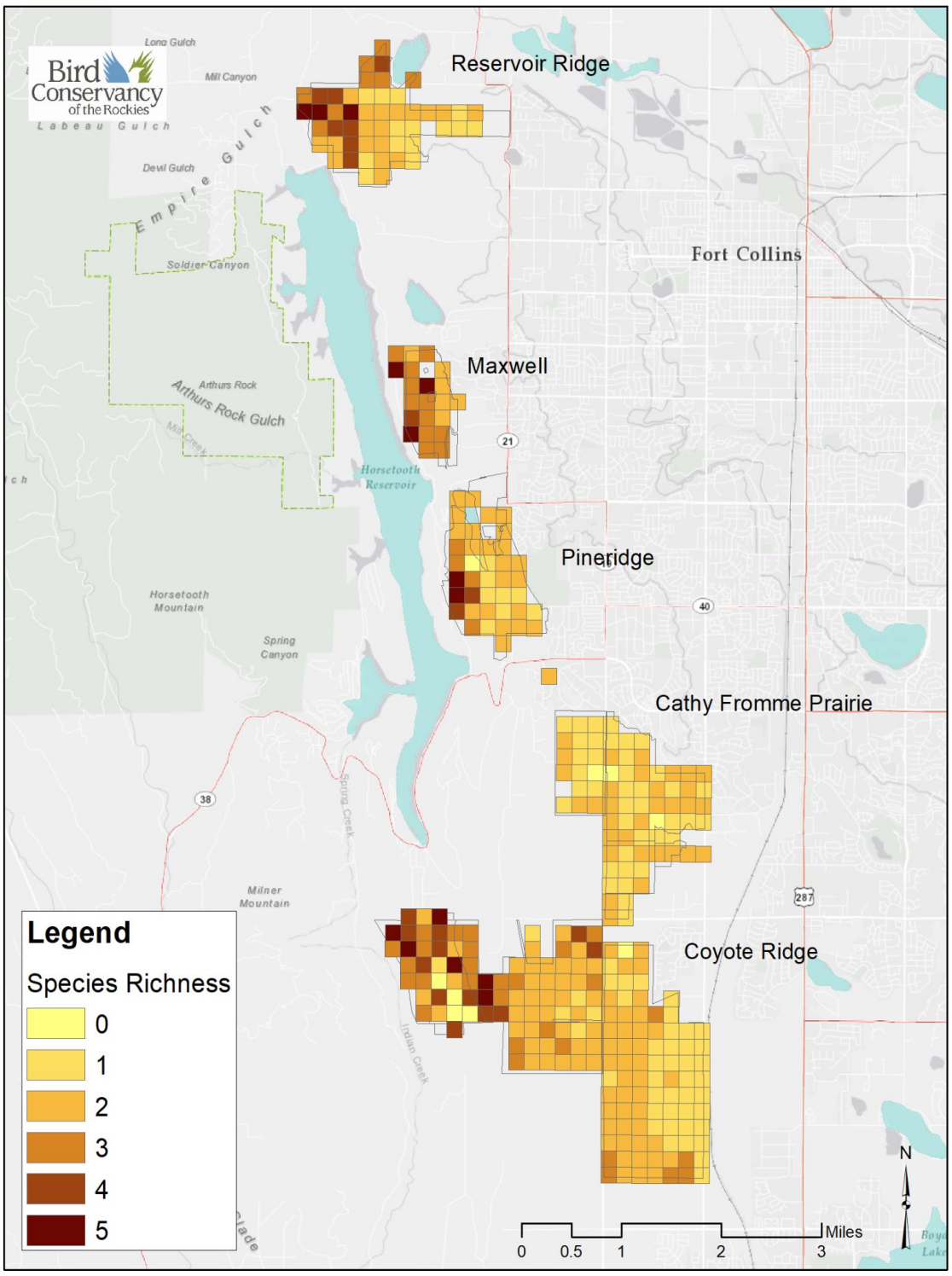

Figure 14. Distribution of focal species richness in the Foothills Shrubland Natural Areas.