Monitoring Breeding Birds along the Cache la Poudre River in The City of Fort Collins Natural Areas

Photo Rob Sparks

Photo Aran Meyer

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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Executive Summary

The riparian Natural Areas 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 Poudre River urban corridor. The objective of this program is to determine population density and distributions of breeding birds that inhabit these natural areas to assist with management planning.

In 2019 Bird Conservancy of the Rockies staff surveyed 158 points in riparian habitat using a point-transect survey method developed by Bird Conservancy. Using data collected, Bird Conservancy 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. The hierarchical distance sampling model also allowed us to address two important issues when monitoring wildlife populations, 1) spatial sampling and 2) detection probability.

We used a focal species approach and identified six focal species; Northern Flicker, Western Wood-Pewee, Yellow Warbler, Common Yellowthroat, Bullock's Oriole and Song Sparrow. These species integrate ecological processes that contribute to the maintenance of riparian ecosystem function. Management actions aimed at conserving these focal species will also protect a larger number of species occurring in the management areas. We show how species density relationships to landscape metrics and vegetation structure along with predictive distribution models can be used as an effective tool to assist with management planning. Riparian forest cohesion, vegetation structure and percent area of wetland influenced focal species density along both ends of the landscape and vegetation continuum.

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INTRODUCTION

Approximately only one third of the world's longest rivers remain free flowing. Free flowing rivers create a dynamic network of ecological and economic services across the landscape. These dynamic waterways are crucial for the economy and health of our communities by providing sediment and water for crops, mitigating the impact of floods and droughts, drinking water, recreation opportunities and habitat for fish and wildlife. Western riparian ecosystems and wetlands occupy from 0.8 to 2% of the landscape (Naiman et al. 2005), but provide habitat, water, and other resources to over half the wildlife species in the region. They maintain the highest bird, reptile/amphibian, insect, plant and mammal biodiversity of any terrestrial ecosystem.

Anthropogenic disturbances to riparian ecosystems are well documented and increasing due to human population growth. Extensive modification of natural flow regimes, development, grazing, conversion of lands to agriculture, and forest clearing along many rivers in the western U.S. have led to loss and simplification of native riparian forests and to population declines of riparian-dependent bird species (Skagen et al. 2005).

Rivers continue to tie communities to the land even in the face of increased degradation. Human modification, pollution and fragmentation of our rivers are a stark reality we must tackle. These threats have reduced water flows, reduced water quality and habitat for wildlife. In Colorado 63% of all rivers and streams have been altered by humans and less than 80% of all rivers in the West are flowing at their natural levels (Harrison-Atlas et al. 2017).

The Poudre River flows from the Rocky Mountains down to its confluence with the South Platte River, a designated "urban waters location" under the Urban Waters Federal Partnership. The Colorado Poudre River Basin faces enormous challenges in sustaining these important economic and ecological functions. This basin is home to the growing Front Range communities (such as Boulder, Loveland, Greeley, and Fort Collins) which account for much of the Front Range's economic activity.

The Lower Poudre River Flood Recovery and Resilience Master Plan and the Cache la Poudre River Natural Areas Management Plan address these challenges by identifying and prioritizing opportunities to improve river health, enhance recreation opportunities, manage the river to minimize potentially hazardous conditions, encourage learning and community awareness.

The Colorado State Wildlife Action Plan (SWAP) identifies water management, natural system modification and urbanization as major threats to aquatic systems. Past bird monitoring along the Poudre River has documented twenty six bird species of Species of Greatest Conservation Need (SGCN). The Poudre River urban corridor is an Important Bird Area crucial for breeding and

migratory bird species. The diversity of species is high with Bald Eagles and Ospreys, Eastern Screech-Owl, Sora, Northern Flicker, Western Wood-Pewee, Yellow Warbler, Common Yellowthroat, Bullock's Oriole and Song Sparrow breeding along the river.

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 (Buckland et al. 2008). Relating species density or abundance to landscape and habitat structure is also fundamental to ecological science. Royle et al. (2004) developed hierarchical models that account for spatial variation in abundance and detection probability at sampling units. These models can be used to create spatially explicit maps (Sillette et al. 2012). This is appealing for conservation managers in that they can characterize the structure of local populations in space (Royle et al. 2004).

We used a focal species approach and identified six focal species; Northern Flicker, Western Wood-Pewee, Yellow Warbler, Common Yellowthroat, Bullock's Oriole and Song Sparrow. These species integrate ecological processes that contribute to the maintenance of riparian ecosystem function. Understanding the habitat use and distribution of these focal species can help to guide management actions and also protect a larger number of species occurring in the same areas. We show how species density relationships to landscape metrics and vegetation structure along with predictive distribution models can be used as an effective tool to assist with management planning. Riparian forest cohesion, vegetation structure and percent area of wetland influenced focal species density along both ends of the landscape and vegetation continuum.

STUDY AREA

The City of Fort Collins survey locations were in the City Natural Areas along the Cache la Poudre River Corridor at Butterfly Woods, North Shields Ponds, McMurry, Salyer, Gustav Swanson, Springer, Kingfisher Point, Riverbend Ponds, Running Deer, and Arapahoe Bend Natural Areas (Fig 1).

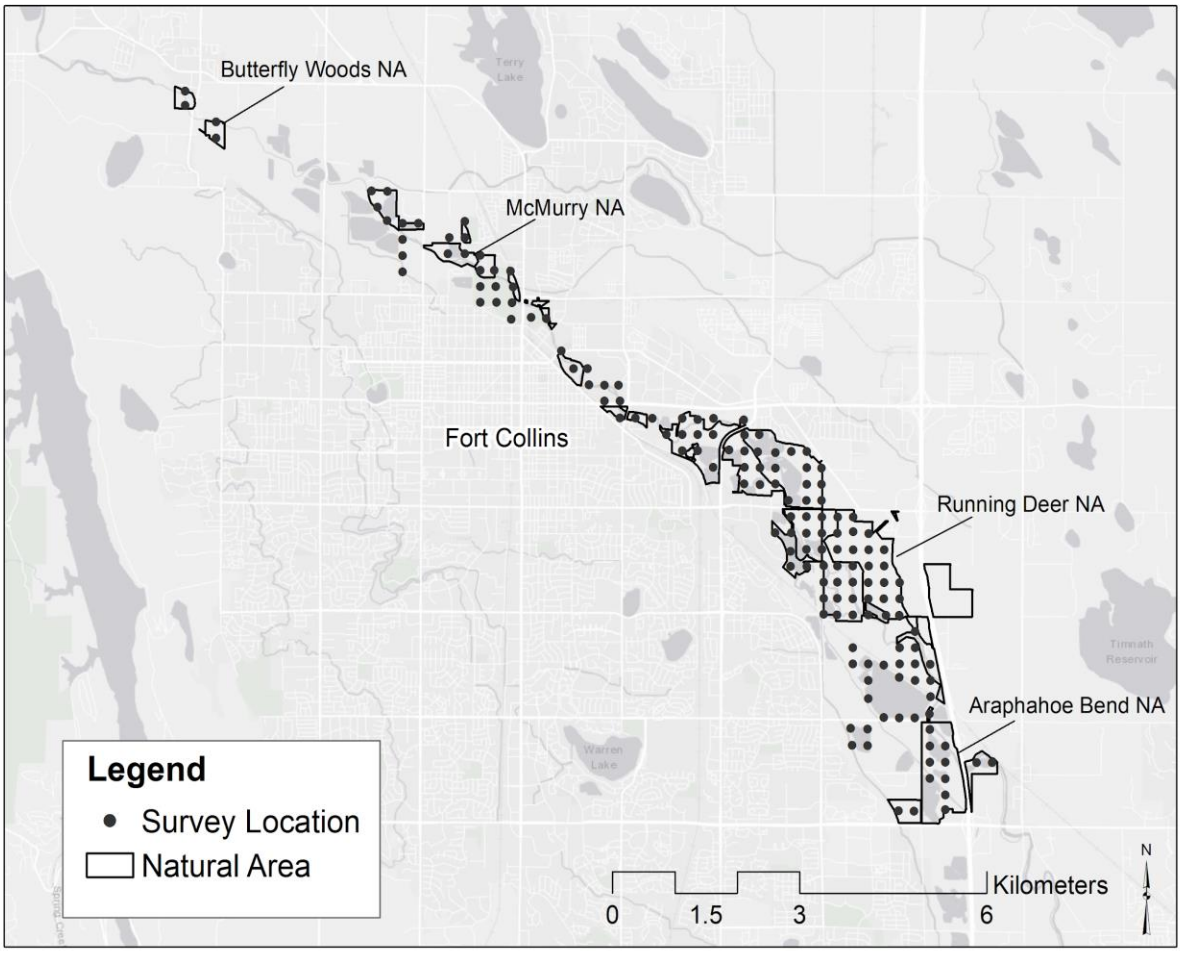

Figure 1. City of Fort Collins Riparian Natural Areas breeding bird survey study area.

METHODS

Sampling Design and Methods

In the spring 2019 we used a systematic 250-m grid of point count stations created in Arc Map 9.3.1 to survey the properties. There were 158 point count stations that were surveyed once between May 22nd and June 16th (Fig 1). Point count surveys started one half-hour before sunrise and ended by 11 a.m., often earlier.

Point count locations were navigated to 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 6-minute point count survey consisting of six consecutive 1-minute intervals. This protocol, which is described more fully by Hanni et al. (2016), 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), distance from observer at time of detection, and the 1-minute interval in which it was detected. We measured distances using a Bushnell Yardage Pro laser rangefinder.

Point counts were not conducted during periods of heavy snow, rain, or wind greater than 10 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. We also noted the presence of any other wildlife or interesting site observations.

Abundance/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 abundance process and the detection process to vary as functions of covariates i.e., riparian forest area. In the abundance 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 program R software (R Development Core Team 2019) using the 'unmarked' package (Fiske, Chandler & Royle 2010). We included a year effect when estimating density for 2019.

We used an information theoretic approach to select the top models (Burnham and Anderson 2002). We ranked models by the Akaike Information Criterion (AIC) (Akaike 1973) and

considered a set of candidate models to be the best if AIC values were within ΔAIC < 2. If overdispersion was detected we used QAIC (Burnham & Anderson 2002). We developed distribution models by using the top model to predict abundance/densities throughout the riparian Natural Areas.

Model Covariates

In program R we used the landscapemetrics package (Hesselbarth et al. 2019*)* with LANDFIRE existing vegetation type layer (USGS 2014), global tree cover (Hansen et al. 2013) and LIDAR data to derive landscape metrics and vegetation height diversity within the sampling unit (250 x 250 meters square, (15.44 acres)). The landscape metric covariates were riparian forest cohesion, area of riparian forest and wetland, and vegetation height diversity. We used LIDAR data to estimate mean vegetation height and used the standard deviation of vegetation height to quantify variation in vegetation height (vegetation height diversity). We fit a quadratic effect on riparian forest cover for Western Wood-Pewee, Yellow Warbler and Bullock's Oriole. We developed eight a priori models to observe bird density response to landscape and vegetation structure covariates. The detection model was held constant for all models.

RESULTS

Density Estimates

The biologists surveyed 158 points in 2019. Surveys were conducted from May 22 to June 16 in riparian natural areas along the Poudre River urban corridor.

The biologist observed a total of 127 species in the riparian natural areas (Appendix A). Seventeen of these species are priority species designated by Colorado Parks and Wildlife and Partners In Flight.

We estimated abundance and developed distribution models for seven species; Northern Flicker,Western Wood-Pewee, Yellow Warbler, Common Yellowthroat, Bullock's Oriole, Song Sparrow. Density results are presented in Table 1.

Table 1. Density estimates in 2019 in riparian natural areas (D = # of birds/ km^2), SE = Standard Error, and 95% lower (LCL) and upper (UCL) confidence limits.

Species	**D**	**SE**	**LCL**	**UCL**
Northern Flicker	3.50	0.74	2.31	5.30
Western Wood-Pewee	5.84	1.25	3.84	8.89
Yellow Warbler	13.58	1.88	10.36	17.80
Common Yellowthroat	6.57	1.07	4.78	9.03
Bullock's Oriole	11.24	2.21	7.65	16.53
Song Sparrow	9.60	1.55	7.00	13.18

Northern Flicker's top model included riparian forest cover, and vegetation height diversity (Table 2). Density increased with riparian forest area and structural vegetation diversity (Table 3). Strong positive effects were seen with vegetation height diversity (Table 3). Northern Flicker occurred in higher densities in McMurry, Springer and Cottonwood Hollow natural areas (Figure 2).

Western Wood-Pewee's top model included riparian forest cover, and vegetation height diversity (Table 2). Density increased with riparian forest area and structural vegetation diversity (Table 3). Strong effects were seen for riparian forest area and vegetation height diversity (Table 3). There was a quadratic effect for riparian forest area suggesting a threshold on the amount of

riparian forest. Western Wood-Pewee densities were higher in McMurry, Springer, Salyer and Cottonwood Hollow natural areas (Figure 3).

Yellow Warbler's top model included riparian forest area (Table 2). Density increased with riparian forest area (Table 3). Strong positive effects were seen for riparian forest area (Table 3). There was a quadratic effect for riparian forest cover suggesting a threshold on the amount of riparian forest. Yellow Warbler densities varied across all riparian natural areas (Figure 4).

Common Yellowthroat's top model included riparian forest cohesion, riparian forest area, vegetation height diversity and wetland area (Table 2). Density increased with wetland area and riparian forest cohesion (Table 3). Strong positive effects were seen for wetland area, riparian forest cohesion and a negative effect for vegetation height diversity (Table 3). Common Yellowthroat densities were higher in Vangbo, Riverbend Ponds, Cottonwood Hollow and Running Deer natural areas (Figure 5).

Bullock's Oriole's top model included riparian forest area, and wetland area (Table 2). Density increased with riparian forest area and decreased with wetland area (Table 3). Strong positive effects were seen for riparian forest area (Table 3). There was a quadratic effect for riparian forest area suggesting a threshold on the amount of riparian forest. Bullock's Oriole varied across all natural areas (Figure 6).

Song Sparrow's top model included riparian forest cohesion, riparian forest area, vegetation height diversity and wetland area (Table 2). Density increased with riparian forest cohesion, riparian forest area and wetland area (Table 3). Strong positive effects were seen with riparian forest cohesion and strong negative effects were seen with vegetation height diversity (Table 3). Song Sparrow densities were higher in the southern riparian natural areas (Figure 7).

Table 2. Model selection for the density (λ) of 6 focal species at riparian natural areas (using data from 2009 - 2019). The model selection metrics are the number of parameters (*K*), value of the Akaike Information Criterion for small sample size (AICc), difference between model and minimum AICc values (ΔAICc) and the weight of each model (AICcWt). Cohesion = riparian forest cohesion, SDH = vegetation height diversity, Forest = riparian forest area, Wetland = wetland area and Year = Year.

Song Sparrow				
Model	***K***	***QAICc***	***Delta_QAICc***	***QAICcWt***
Cohesion+SDH+Forest+Wetland+Year	11	2410.51	0	1
SDH+Forest+Year	9	2444.75	34.23	0
SDH+Forest+Wetland+Year	10	2446.44	35.93	0
Cohesion+Wetland+Year	9	2476.08	65.57	0
Cohesion+Forest+Wetland+Year	10	2476.14	65.62	0
Forest+Year	8	2497.52	87.01	0
Forest+Wetland+Year	9	2498.44	87.93	0
Wetland+Year	8	2504.32	93.81	0
Yellow Warbler				
	K	**AICc**	**Delta_AICc**	**AICcWt**
Forest+Year	8	3182.7	0	0.47
SDH+Forest+Year	9	3184.71	2.01	0.17
Forest+Wetland+Year	9	3184.72	2.02	0.17
Cohesion+Forest+Wetland+Year	10	3186.1	3.4	0.09
SDH+Forest+Wetland+Year	10	3186.73	4.03	0.06
Cohesion+SDH+Forest+Wetland+Year	11	3188.09	5.39	0.03
Cohesion+Wetland+Year	8	3199.67	16.97	0
Wetland+Year	7	3212.69	29.99	0
Northern Flicker				
	K	**AICc**	**Delta_AICc**	**AICcWt**

SDH+Forest+Year	8	1753.46	0	0.62
SDH+Forest+Wetland+Year	9	1755.44	1.98	0.23
Cohesion+SDH+Forest+Wetland+Year	10	1756.26	2.79	0.15
Cohesion+Forest+Wetland+Year	9	1791.57	38.11	0
Cohesion+Wetland+Year	8	1793.44	39.98	0
Forest+Year	7	1794.36	40.9	0
Forest+Wetland+Year	8	1796.41	42.95	0
Wetland+Year	7	1823.82	70.36	0
Western Wood-Peewee				
	K	**AICc**	**Delta_AICc**	**AICcWt**
SDH+Forest+Year	9	1721.43	0	0.63
SDH+Forest+Wetland+Year	10	1723.23	1.8	0.26
Cohesion+SDH+Forest+Wetland+Year	11	1724.86	3.43	0.11
Forest+Year	8	1752.66	31.23	0
Forest+Wetland+Year	9	1754.67	33.25	0
Cohesion+Forest+Wetland+Year	10	1756.71	35.28	0
Cohesion+Wetland+Year	8	1768.41	46.98	0
Wetland+Year	7	1794	72.58	0
Common Yellowthroat				
	K	**AICc**	**Delta_AICc**	**AICcWt**
Cohesion+SDH+Forest+Wetland+Year	10	2118.13	0	1
SDH+Forest+Wetland+Year	9	2137.23	19.1	0
SDH+Forest+Year	8	2139.47	21.34	0
Cohesion+Forest+Wetland+Year	9	2260.92	142.79	0
Forest+Wetland+Year	8	2267.81	149.68	0
Wetland+Year	7	2268.08	149.95	0

Cohesion+Wetland+Year	8	2268.71	150.58	0
Forest+Year	7	2273.42	155.29	0
Bullock's Oriole				
	K	**AICc**	**Delta_AICc**	**AICcWt**
Forest+Wetland+Year	9	2692.61	0	0.31
Forest+Year	8	2693.08	0.47	0.24
Cohesion+Forest+Wetland+Year	10	2694.02	1.41	0.15
SDH+Forest+Wetland+Year	10	2694.61	2.01	0.11
SDH+Forest+Year	9	2695.12	2.51	0.09
Cohesion+SDH+Forest+Wetland+Year	11	2696.06	3.45	0.05
Wetland+Year	7	2698.02	5.42	0.02
Cohesion+Wetland+Year	8	2698.13	5.52	0.02

Table 3: Best model parameter estimates, standard errors (SE) and lower and upper 95% confidence limits (LCL and UCL, respectively) for the density (λ) of focal species.

Species	Model Covariates	Estimate	SE	UCL	LCL
Song Sparrow	(Intercept)	-0.75	0.160	-1.070	-0.440
	Cohesion	0.57	0.110	0.360	0.790
	SDH	-0.49	0.060	-0.610	-0.370
	Forest	0.09	0.070	-0.050	0.240
	Wetland	0.08	0.110	-0.130	0.290
	2015	0.94	0.170	0.610	1.280
	2014	1.00	0.170	0.660	1.330
	2010	0.68	0.180	0.320	1.050
	2009	0.52	0.200	0.130	0.910

Yellow Warbler	(Intercept)	-0.2517	0.138	-0.523	0.019
	Forest	0.2688	0.052	0.168	0.370
	$Forest^2$	-0.0766	0.045	-0.165	0.012
	2015	0.6067	0.153	0.307	0.906
	2014	0.8262	0.151	0.531	1.121
	2010	1.4785	0.140	1.204	1.753
	2009	1.0096	0.149	0.717	1.302
Northern Flicker	(Intercept)	-1.397	0.212	-1.813	-0.981
	SDH	0.508	0.078	0.355	0.660
	Forest	0.099	0.076	-0.050	0.248
	2015	0.964	0.227	0.519	1.409
	2014	0.77	0.240	0.301	1.240
	2010	0.752	0.247	0.268	1.237
	2009	0.701	0.250	0.212	1.190
Western Wood-Pewee	(Intercept)	-1.24821	0.214	-1.668	-0.828
	SDH	0.46975	0.083	0.307	0.632
	Forest	0.22583	0.117	-0.004	0.455
	$Forest^2$	-0.05735	0.080	-0.215	0.100
	2015	-0.00478	0.256	-0.507	0.497
	2014	-0.12969	0.275	-0.669	0.410
	2010	1.00354	0.220	0.573	1.434
	2009	1.21169	0.213	0.794	1.629
Common Yellowthroat	(Intercept)	-1.132	0.162	-1.450	-0.814
	Cohesion	0.38	0.093	0.198	0.563

	SDH	-0.861	0.077	-1.012	-0.710
	Forest	0.115	0.083	-0.047	0.278
	Wetland	0.26	0.113	0.040	0.481
	2015	0.369	0.175	0.026	0.712
	2014	0.223	0.185	-0.139	0.585
	2010	0.48	0.181	0.126	0.834
	2009	0.588	0.176	0.244	0.932
Bullock's Oriole	(Intercept)	-0.595	0.197	-0.980	-0.209
	Forest	0.159	0.066	0.029	0.289
	$Forest^2$	-0.187	0.064	-0.313	-0.061
	Wetland	-0.188	0.122	-0.427	0.051
	2015	1.061	0.206	0.657	1.465
	2014	1.177	0.207	0.771	1.582
	2010	1.523	0.202	1.127	1.920
	2009	1.281	0.208	0.873	1.690

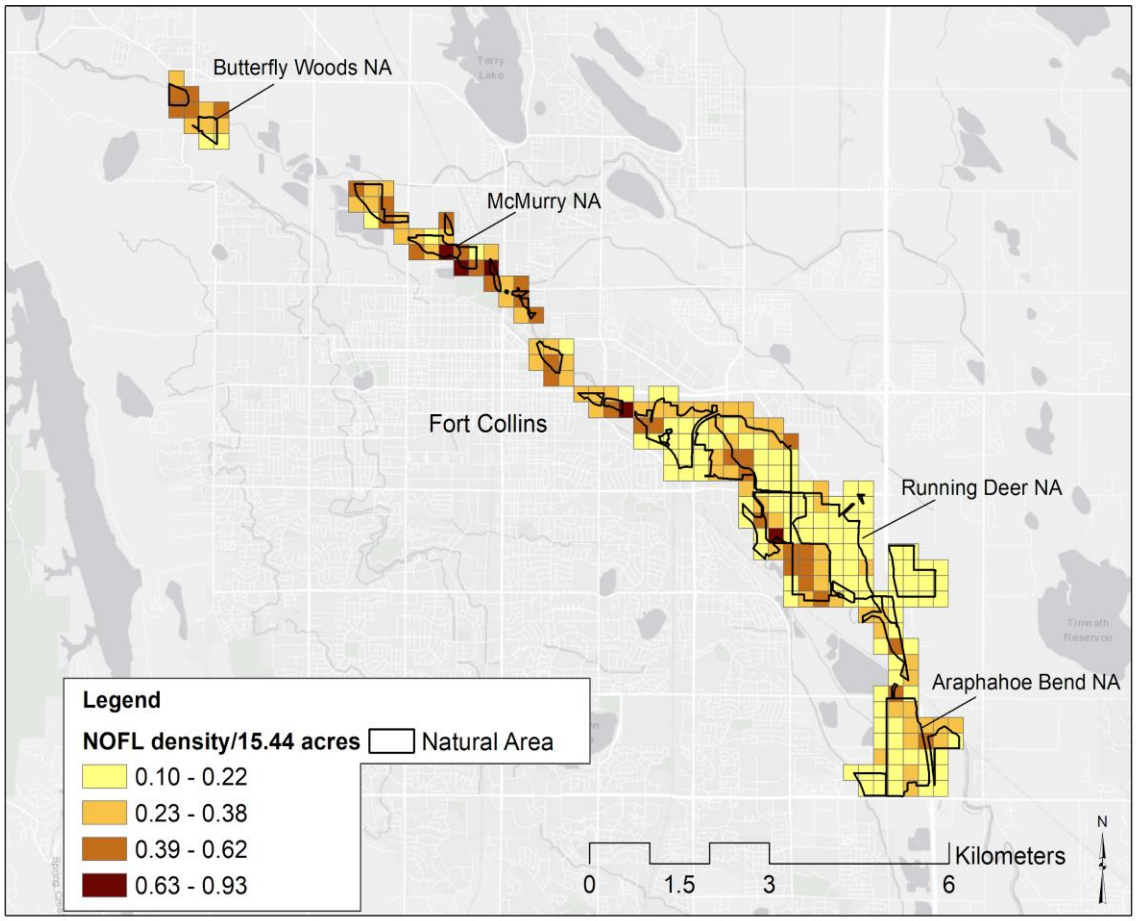

Figure 2: Density and distribution of Northern Flicker in the Poudre River Natural Areas

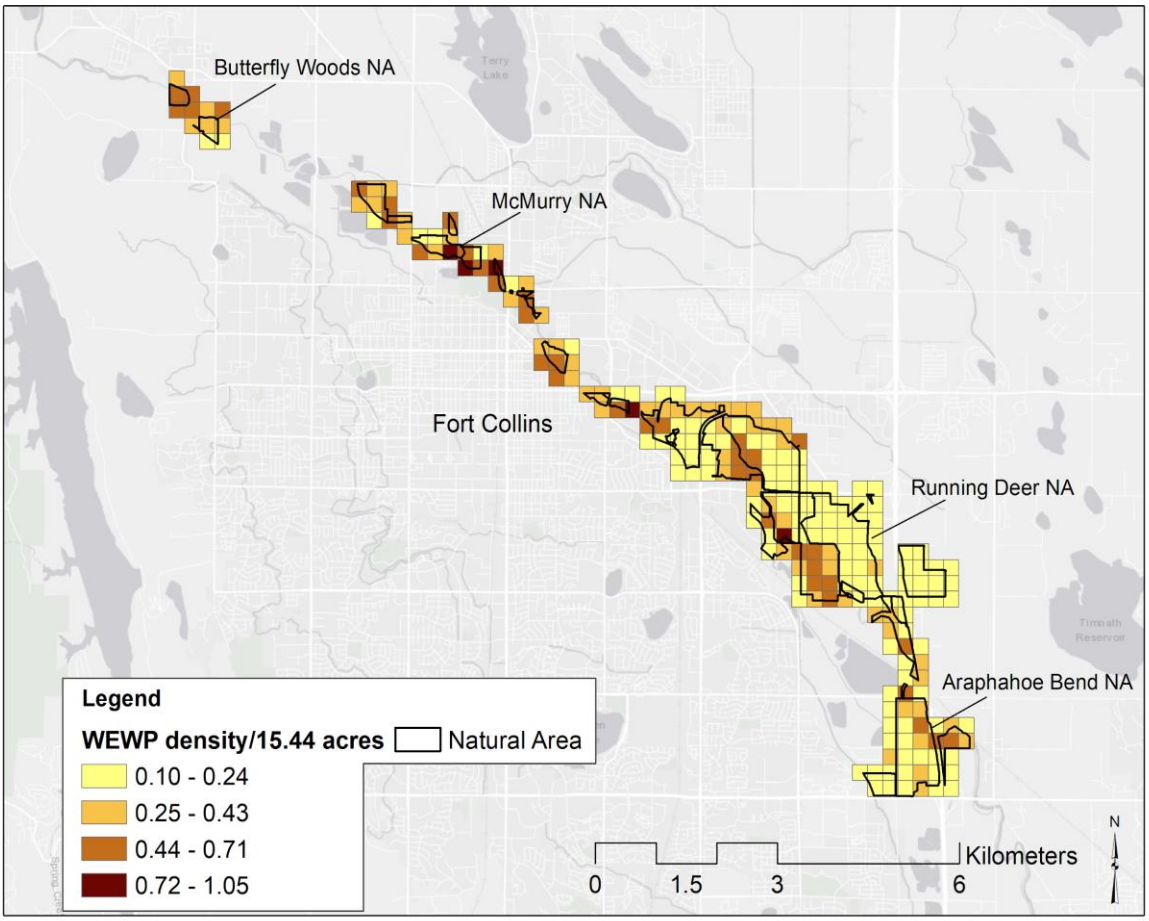

Figure 3: Density and distribution of Western Wood-peewee in the Poudre River Natural Areas

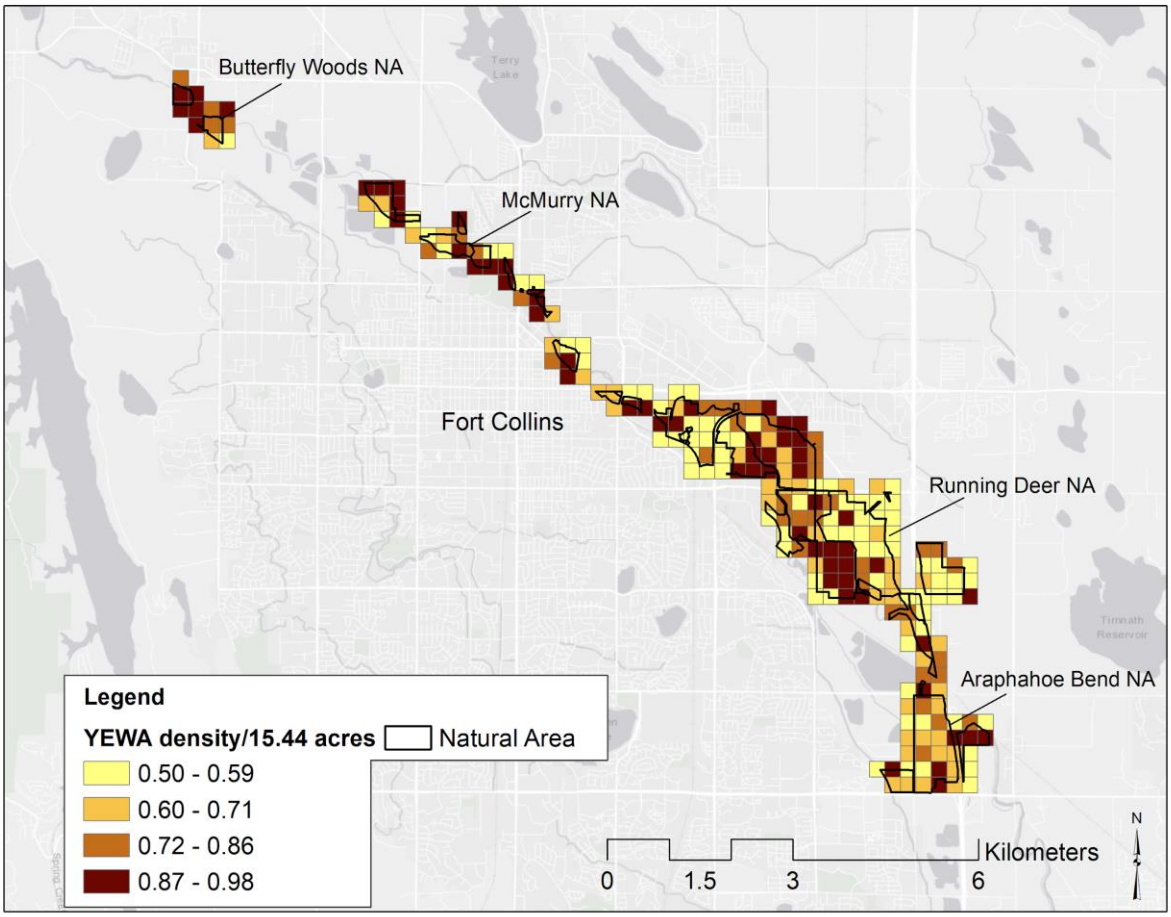

Figure 4: Density and distribution of Yellow Warbler in the Poudre River Natural Areas

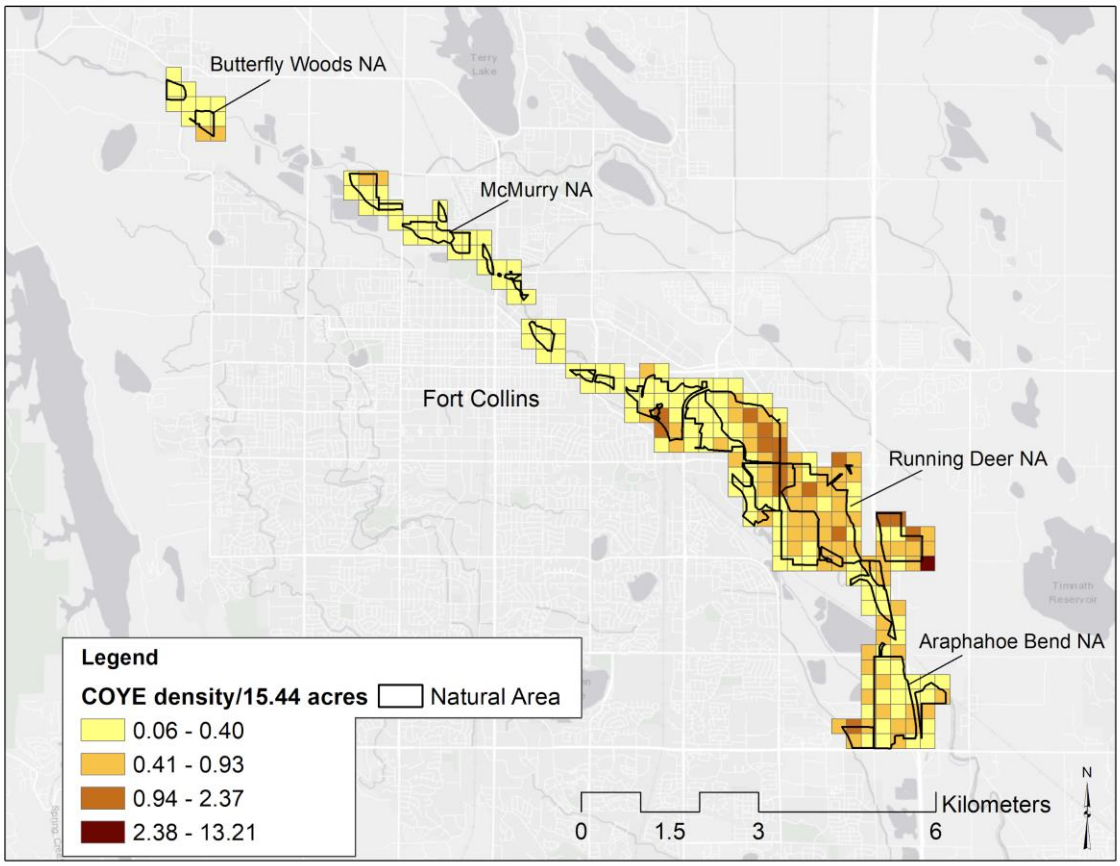

Figure 5: Density and distribution of Common Yellowthroat in the Poudre River Natural Areas

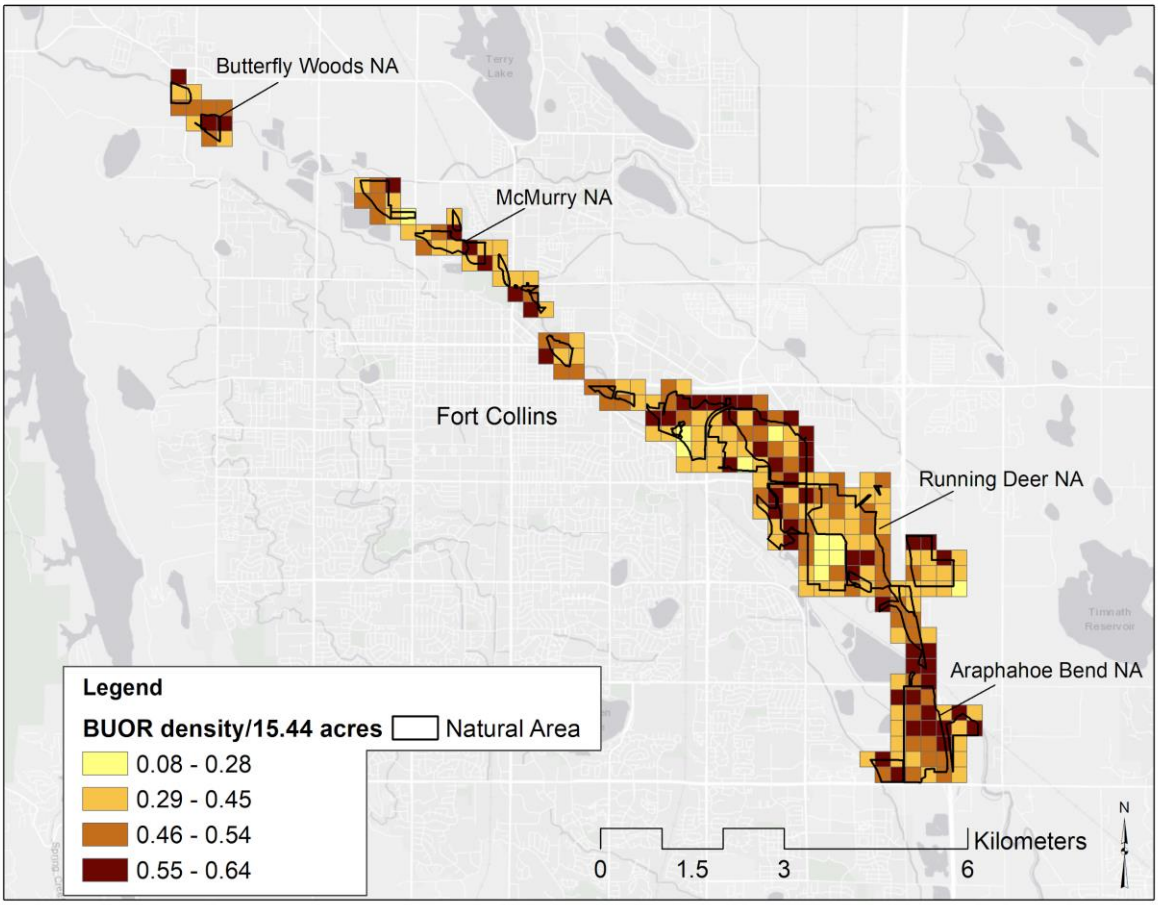

Figure 6: Density and distribution of Bullock's Oriole in the Poudre River Natural Areas

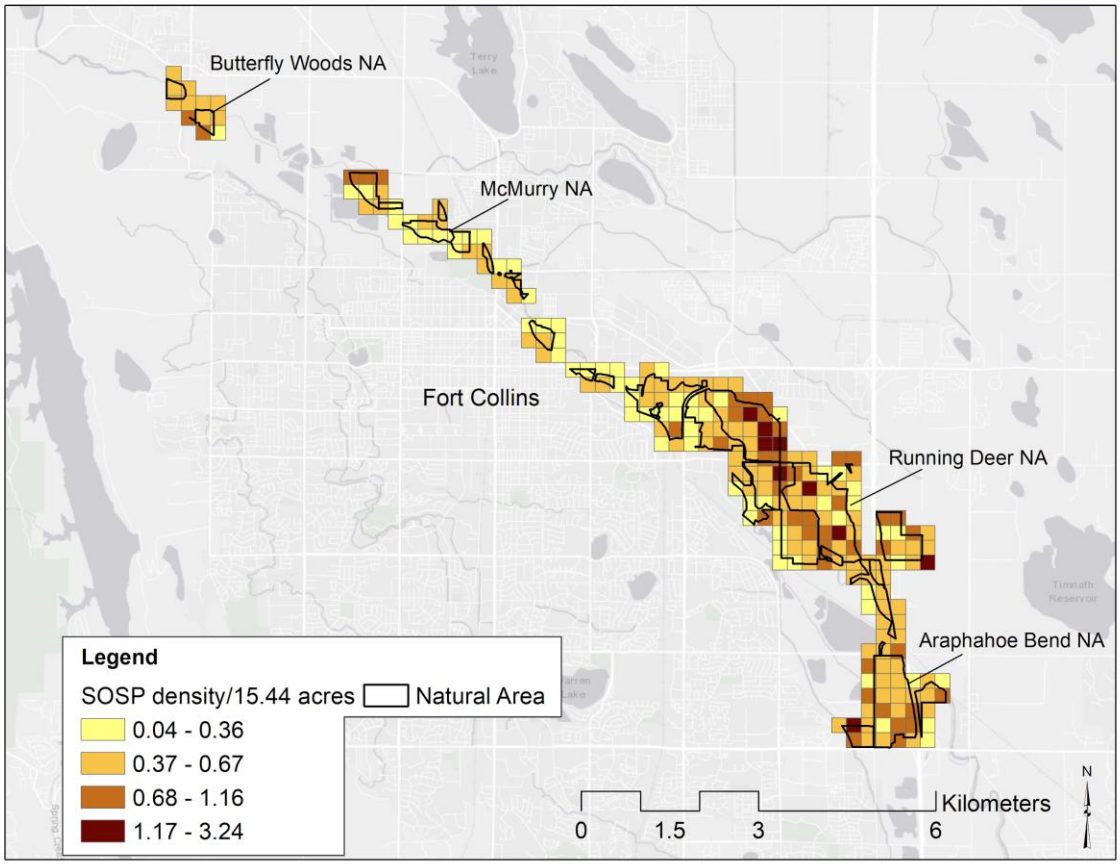

Figure 7: Density and distribution of Song Sparrow in the Poudre River Natural Areas

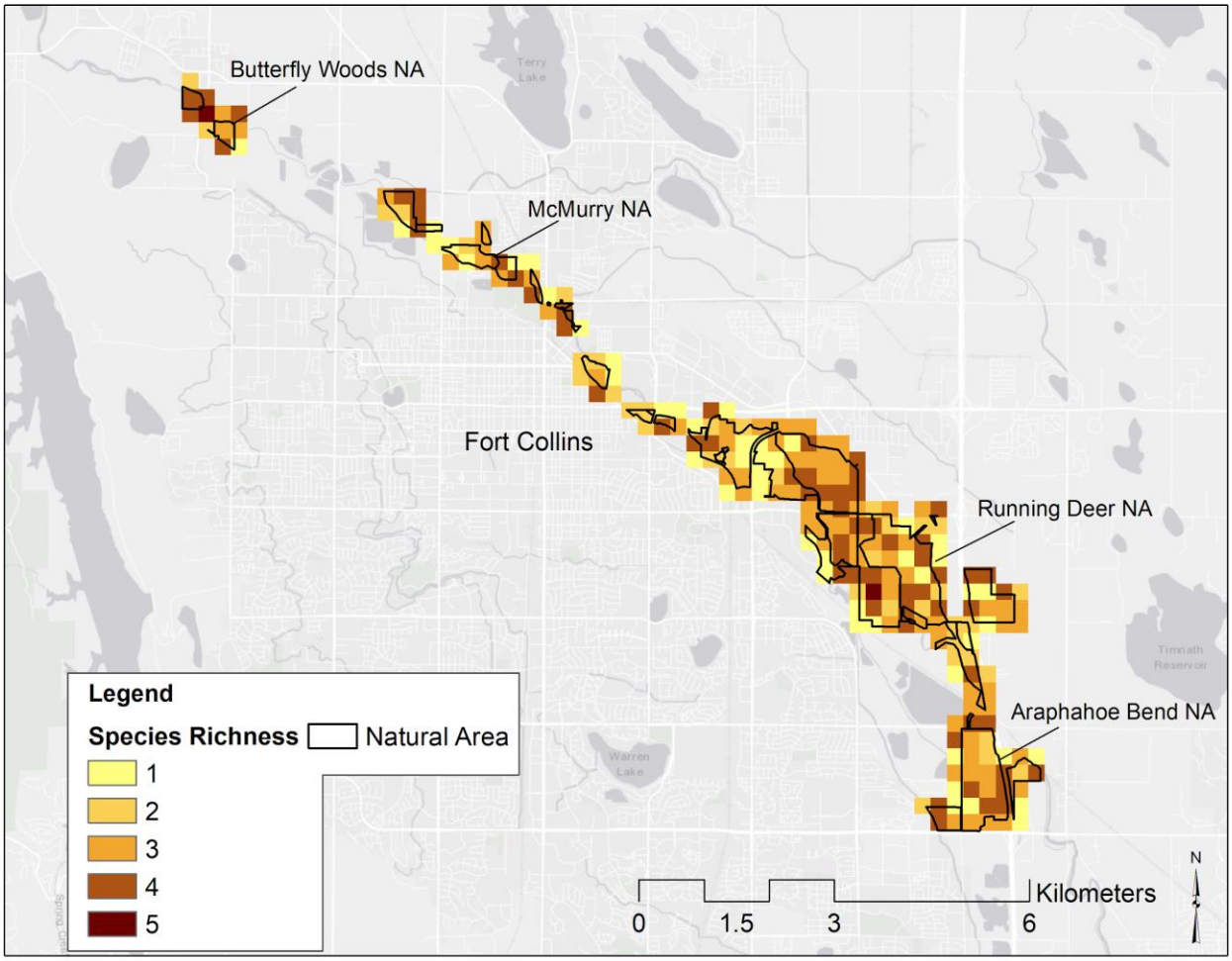

Figure 8: Overall species richness in the Poudre River Natural Areas

DISCUSSION

We demonstrate how a focal species approach can be used as a management tool to assist with natural areas planning. Management that focuses on single species outcomes may be too narrow to meet conservation goals (Moilanen 2005). An alternative approach is to identify species that integrate ecological processes that contribute to the maintenance of the ecosystem function while also functioning as focal species (Lindenmayer et al. 2014). This will allow management actions aimed at conserving the focal species to also protect a larger number of species occurring in the management area. We show how species density relationships to landscape metrics and habitat variables along with predictive distribution models can be used as an effective tool to assist with management planning. Riparian forest cohesion, riparian forest cover, vegetation height diversity and wetland cover influenced focal species bird density along both ends of the landscape and vegetation continuum.

All focal species responded positively to riparian forest cover. This highlights the importance of riparian forest for riparian bird species. Our results correspond with past studies that also found higher bird abundance in areas with riparian forest cover (Pennington et al. 2011) and higher species richness in riparian forests with open canopy (Sabb 2019). However riparian forest cover along the Poudre River urban corridor is limited by development and hydrological conditions, therefore activities that reduce tree cover should be avoided. Connecting the river bank to the floodplain along with restoring the hydrological flow will benefit plains cottonwood regeneration and create the necessary conditions for seed germination. This will also allow for lateral movement of riparian tree cover.

We found that Northern Flicker and Western Wood-Pewee responded positively to vegetation height diversity suggesting an understory component is being used by these species. Song Sparrow and Common Yellowthroat had a negative response to vegetation height diversity suggesting an avoidance to mid-canopy structure. Overall structural complexity in vegetation is lacking along the Poudre River urban corridor and lacks vegetation diversity, which also influences the structural complexity. Restoring areas with a variety of native trees and shrubs will improve structural diversity and increase species richness (Sandström et al. 2006). Understory vegetation structure may have been a more common condition prior to dam construction, when natural flooding disturbances created more patchiness in the mature forest canopy interspersed with younger cottonwood stands (Sabb 2009).

Riparian forest cohesion (connectivity) was high within our sampling plots, however this variable wasn't a strong predictor for the canopy dwelling focal species. This may be due to the scale used and habitat preferences of these species. Northern Flicker, Western Wood-Pewee,

Yellow Warbler and Bullock's Oriole prefer riparian forests with an open canopy and are tolerant of habitat edges, negating the need for high forest cohesion. Contrary to the canopy dwelling species, Song Sparrow and Common Yellowthroat had a strong relationship to forest cohesion. These species use a wetland shrub component along the riparian forest matrix and are localized within natural areas containing this feature. Increasing riparian forest cohesion at a larger scale will increase riparian forest cover and biodiversity along the Poudre River urban corridor.

The ability to characterize spatial variation in density at the sampling unit scale across the riparian natural areas will help inform conservation planning and quantify species response to vegetation and habitat covariates. The distribution models can be used to prioritize management actions and address key questions in conservation planning (Wilson et al. 2007). The predicted distribution maps (population size or density) can be summarized for any area of interest, such as administrative boundaries or management units, and confidence intervals can be computed with the parametric bootstrap (Sillette et al. 2012, Royle et al. 2007).

The predictive distribution maps showed variation of high density and species richness across the natural area properties. The larger properties in the southern portion of the study area provide restoration opportunities to improve riparian habitat conditions. However, the smaller properties in the northern portion of the study area had high bird densities for some species and should be viewed as an opportunity to increase riparian connectivity along the Poudre River urban corridor. Increasing riparian forest cover, understory vegetation, and connectivity will also benefit neotropical migrants that rely on this habitat as stopover habitat during their migration.

Annual meetings with the Natural Areas Department, land managers, and BCR to share data & results and determine management and conservation goals using birds as indicators would help inform and direct future actions and survey efforts.

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APPENDIX A - Species List. *Number of detections for species recorded in the Cache la Poudre River Natural Areas in 2019.*

Common Name	**Scientific Name**	**Count**
Canada Goose	*Branta canadensis*	52
Wood Duck	*Aix sponsa*	11
Gadwall	*Anas strepera*	1
Mallard	*Anas platyrhynchos*	52
Blue-winged Teal	*Anas discors*	4
Cinnamon Teal	*Anas cyanoptera*	2
Northern Shoveler	*Anas clypeata*	2
Green-winged Teal	*Anas crecca*	1
Redhead	*Aythya americana*	2
Bufflehead	*Bucephala albeola*	1
Common Merganser	*Mergus merganser*	7
Wild Turkey	*Meleagris gallopavo*	2
Pied-billed Grebe	*Podilymbus podiceps*	4
Western Grebe*	*Aechmophorus occidentalis*	1
American White Pelican*	*Pelecanus erythrorhynchos*	23
Double-crested Cormorant	*Phalacrocorax auritus*	27
Great Blue Heron	*Ardea herodias*	36
Great Egret	*Ardea alba*	4
Snowy Egret*	*Egretta thula*	2
Green Heron	*Butorides virescens*	4

Black-crowned Night-Heron	*Nycticorax nycticorax*	4
Turkey Vulture	*Cathartes aura*	6
Osprey*	*Pandion haliaetus*	4
Bald Eagle*	*Haliaeetus leucocephalus*	5
Northern Harrier*	*Circus cyaneus*	1
Cooper's Hawk*	*Accipiter cooperii*	1
Broad-winged Hawk	*Buteo platypterus*	1
Swainson's Hawk*	*Buteo swainsoni*	4
Red-tailed Hawk	*Buteo jamaicensis*	18
American Kestrel	*Falco sparverius*	6
Virginia Rail	*Rallus limicola*	1
Sora	*Porzana carolina*	8
American Coot	*Fulica americana*	1
Killdeer	*Charadrius vociferus*	36
American Avocet	*Recurvirostra americana*	4
Spotted Sandpiper	*Actitis macularius*	44
Short-billed Dowitcher	*Limnodromus griseus*	1
Wilson's Snipe	*Gallinago delicata*	3
Wilson's Phalarope	*Phalaropus tricolor*	1
Red-necked Phalarope	*Phalaropus lobatus*	1
Ring-billed Gull	*Larus delawarensis*	3
California Gull	*Larus californicus*	1
Forster's Tern*	*Sterna forsteri*	2

Rock Pigeon	*Columba livia*	4
Eurasian Collared-Dove	*Streptopelia decaocto*	10
Mourning Dove	*Zenaida macroura*	60
Great Horned Owl	*Bubo virginianus*	4
Black-chinned Hummingbird*	*Archilochus alexandri*	1
Broad-tailed Hummingbird*	*Selasphorus platycercus*	5
Belted Kingfisher	*Megaceryle alcyon*	10
Downy Woodpecker	*Picoides pubescens*	24
Hairy Woodpecker	*Picoides villosus*	2
Northern Flicker*	*Colaptes auratus*	33
Western Wood-Pewee	*Contopus sordidulus*	38
Willow Flycatcher*	*Empidonax traillii*	2
Least Flycatcher	*Empidonax minimus*	2
Hammond's Flycatcher	*Empidonax hammondii*	3
Dusky Flycatcher	*Empidonax oberholseri*	3
Say's Phoebe	*Sayornis saya*	8
Western Kingbird	*Tyrannus verticalis*	17
Eastern Kingbird	*Tyrannus tyrannus*	19
Plumbeous Vireo	*Vireo plumbeus*	5
Warbling Vireo	*Vireo gilvus*	20
Blue Jay	*Cyanocitta cristata*	93
Black-billed Magpie	*Pica hudsonia*	9
American Crow	*Corvus brachyrhynchos*	11

Horned Lark	*Eremophila alpestris*	12
Tree Swallow	*Tachycineta bicolor*	32
Violet-green Swallow	*Tachycineta thalassina*	18
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	12
Bank Swallow	*Riparia riparia*	8
Cliff Swallow	*Petrochelidon pyrrhonota*	57
Barn Swallow	*Hirundo rustica*	43
Black-capped Chickadee	*Poecile atricapillus*	70
White-breasted Nuthatch	*Sitta carolinensis*	7
House Wren	*Troglodytes aedon*	209
Marsh Wren	*Cistothorus palustris*	7
Blue-gray Gnatcatcher	*Polioptila caerulea*	4
Swainson's Thrush	*Catharus ustulatus*	19
American Robin	*Turdus migratorius*	214
Gray Catbird	*Dumetella carolinensis*	6
European Starling	*Sturnus vulgaris*	112
American Pipit	*Anthus rubescens*	1
Cedar Waxwing	*Bombycilla cedrorum*	43
Yellow Warbler	*Dendroica petechia*	83
Yellow-rumped Warbler	*Dendroica coronata*	46
American Redstart	*Setophaga ruticilla*	1
MacGillivray's Warbler	*Oporornis tolmiei*	5
Common Yellowthroat	*Geothlypis trichas*	74

Wilson's Warbler	*Wilsonia pusilla*	1
Yellow-breasted Chat	*Icteria virens*	2
Western Tanager	*Piranga ludoviciana*	13
Chipping Sparrow	*Spizella passerina*	14
Clay-colored Sparrow	*Spizella pallida*	8
Brewer's Sparrow*	*Spizella breweri*	2
Lark Sparrow	*Chondestes grammacus*	3
Savannah Sparrow	*Passerculus sandwichensis*	8
Song Sparrow	*Melospiza melodia*	75
Lincoln's Sparrow	*Melospiza lincolnii*	2
White-crowned Sparrow	*Zonotrichia leucophrys*	2
Black-headed Grosbeak	*Pheucticus melanocephalus*	9
Blue Grosbeak	*Passerina caerulea*	11
Lazuli Bunting*	*Passerina amoena*	3
Bobolink*	*Dolichonyx oryzivorus*	3
Red-winged Blackbird	*Agelaius phoeniceus*	453
Western Meadowlark	*Sturnella neglecta*	92
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	12
Common Grackle	*Quiscalus quiscula*	146
Great-tailed Grackle	*Quiscalus mexicanus*	2
Brown-headed Cowbird	*Molothrus ater*	77
Orchard Oriole	*Icterus spurius*	2
Bullock's Oriole	*Icterus bullockii*	37

House Finch	*Carpodacus mexicanus*	39
Pine Siskin*	*Carduelis pinus*	1
Lesser Goldfinch	*Carduelis psaltria*	3
American Goldfinch	*Carduelis tristis*	99
House Sparrow	*Passer domesticus*	8
Total		**2,987**

Species with a * are Species of Greatest Conservation Concern, or as Regional Stewardship Species as listed by CPW, USFWS, and Partners in Flight (PIF 2012).