RUSTY BLACKBIRD (*EUPHAGUS CAROLINUS*) FALL MIGRATORY HABITAT DYNAMICS IN MISSOURI

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Master of Science

by

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TABLE OF CONTENTS

RUSTY BLACKBIRD (*EUPHAGUS CAROLINUS*) FALL MIGRATORY HABITAT DYNAMICS IN MISSOURI

An Abstract of the Thesis by

Lauren Canham

Rusty Blackbird (*Euphagus carolinus*) populations are considered the fastest declining among songbirds in North America and consequently it is important to develop region-specific conservation strategies. Causes for these declines are largely unknown but may be due in part to wetland loss throughout migratory stopover and wintering locations, as Rusty Blackbirds primarily use wooded wetlands. Use of stopover sites throughout Missouri is important for refueling before continuing to wintering or breeding grounds during migration; therefore, my objective was to elucidate specific habitat use patterns at these migratory stopover sites. I did not detect any Rusty Blackbirds during fall migration transect surveys in 2012 and 2013. The most eBird reports of fall migrating Rusty Blackbirds over a 15-year time period were from herbaceous-dominated wetlands. Detections were reported in a greater variety of land cover types than was originally expected, suggesting that Rusty Blackbirds are not following strict habitat requirements during migration.

List of Tables

List of Figures

List of Appendices

RUSTY BLACKBIRD MIGRATORY HABITAT DYNAMICS IN NORTHEAST AND CENTRAL MISSOURI

Introduction

The Rusty Blackbird (*Euphagus carolinus*) is a migratory species that breeds in wet boreal forests across the northern part of North America, including Canada, Alaska, and northern New England, and winters in forested wetlands in the southeastern United States (Avery 2013). Christmas Bird Count data over a 50-year time period were analyzed to determine the species' nonbreeding range and found that the Mississippi Alluvial Valley and Middle Atlantic Coast were the areas with the most reoccurring Rusty Blackbirds (Hamel et al. 2008). In the winter they have been found foraging in various forested wetlands, but were also observed in adjacent agricultural fields foraging with other blackbirds (Luscier et al 2010). They are known to eat a substantial number and variety of aquatic invertebrates, as well as acorn seeds and some fruits (Avery 2013). They forage mostly on the ground, sometimes in shallow water, and flip over leaves with their beaks when foraging for aquatic invertebrates (Avery 2013).

As humans have changed the landscape of North America throughout the past centuries, it is thought that Rusty Blackbirds have not been as able to take advantage of the land that has been converted for agriculture as well as Red-winged Blackbirds (*Agelaius phoenicus*) and Common Grackles (*Quiscalus quiscula*) (Avery 2013; Greenberg and Droege 1999; Mettke-Hofmann et al. 2010). Rusty Blackbirds are unique among blackbirds in that they primarily use wooded wetlands (Greenberg and Droege 1999). However, a study in the breeding range in Alberta, Canada noted that a few Rusty Blackbirds used one-year postharvest mixedwood stands for nesting sites (Hobson and Schiek 1999), suggesting that they do have a degree of flexibility for inhabiting disturbed or converted habitat. Water availability plays an important role in

habitat quality for this species during both the breeding and wintering seasons. The shallow water of forested wetlands provides good habitat for the aquatic invertebrates that constitute a significant portion of their diet.

Very little is known about the migratory stopover sites that Rusty Blackbirds use and the duration of their stopover visits. Stopover habitats are a key resource for migratory species and can influence the success of a population in the breeding and wintering areas, which necessitates their inclusion in conservation strategies (Sheehy et al. 2011). Stopover sites provide food and shelter to migratory birds as they travel hundreds or even thousands of miles during short time periods, often only one to three weeks in length. When choosing a stopover site, birds of a variety of species may be able to assess the habitat quality by the amount of forest cover on a patch of land (Buler et al 2007). Identifying and utilizing stopover sites with abundant resources will allow individuals to maximize their food and energy intake while minimizing the time spent at these sites. Rusty Blackbird spacing in breeding habitats ranges from isolated pairs to loose colonies (Avery 2013). For an individual of a loose colony, arriving earlier than conspecifics at the breeding ground could allow them to secure a more desirable territory which could then translate to an increased chance that they will find a suitable mate and increase their fitness.

Another important factor to note is the migratory divide between populations wintering in the Mississippi Alluvial Valley, which breed in western Canada, and the Atlantic coastal plain, which breed in eastern Canada (Hobson et al. 2010). The populations that winter in the Mississippi Alluvial Valley migrate farther than those in the Atlantic coastal plain, so understanding migratory stopover dynamics for both populations is extremely important when developing conservation strategies (Hobson et al. 2010). More research about Rusty Blackbird migratory stopover habitat is needed to connect research being done in the breeding and

wintering habitats to support both local and regional conservation initiatives. By determining where Rusty Blackbirds are stopping during migration in northeastern Missouri, a plan can be formed in cooperation with the Missouri Department of Conservation and other conservation organizations to perhaps ensure that suitable stopover habitat is available to the species each year.

In an attempt to increase in knowledge of Rusty Blackbird migration, a two-season fall migration study was completed at various public and private lands throughout Northeast and Central Missouri. The four main objectives of this study were: 1) to determine the habitats that Rusty Blackbirds use during fall migration, 2) to determine the habitat quality of the survey sites by arthropod surveys, 3) to estimate their population's stopover time, and 4) to estimate numbers of individuals that stop in the area by means of occupancy. A secondary objective was to record all other bird species that were using these habitats as either stopover sites or for permanent residency. The species richness or abundance values at each survey site could potentially indicate habitat quality, or the presence of other key indicator species (e.g., Red-winged Blackbirds and Common Grackles) might represent potential Rusty Blackbird habitat.

Methods

Study Area

I conducted Rusty Blackbird and bird species richness surveys throughout northeast and central Missouri. Survey sites were established on Missouri public lands, including Rebel's Cove Conservation Area, Atlanta Conservation Area, and Swan Lake National Wildlife Refuge (Figure 1.1). I also surveyed four urban areas in Columbia, including Garth Nature Area, Forum Nature Area, Nifong Park, and the Columbia Audubon Nature Sanctuary. All sites are dominated by oak-hickory forest (*Quercus* sp. and *Carya* sp.). Rebel's Cove Conservation Area also contains grasslands, croplands, old fields, wetlands, and ponds, although the majority of the land is forested and includes bottomland hardwood forest. Atlanta Conservation Area is composed of mixed hardwoods in the lowland forest, along with areas of grassland, corn crops, and managed marshes. Swan Lake National Wildlife Refuge contains many areas of moist soil and marshes, as well as grasslands and croplands. A strip of forest surrounds Yellow Creek, which runs on the south edge of the refuge.

Study Design

I conducted surveys along 22 separate 200-meter line transects that were established randomly across a variety of habitats. Transects of particular interest were those located in bottomland hardwood forests with moist leaf litter and minimal amounts of forest floor growth, which have been noted to be good habitat for foraging Rusty Blackbirds (Avery 2013). The number of transects varied between one and five at each site, depending on the size of the public land. I counted the number of individual Rusty Blackbirds along the transect and recorded the distance of the individual from the line. From these data, the density (birds/km^2) of individuals

in an area could be estimated. I conducted surveys between 07:30 and 13:00 from late October until the end of November in 2012 and 2013. I recorded all other bird species that were observed along the transect and their distance from the line to identify other species that are found in the different habitats that might be interacting with Rusty Blackbirds.

I sampled the leaf litter along each transect at 100 meter intervals to survey for macroinvertebrates, with the exception of Rebel's Cove Conservation Area and Atlanta Conservation Area due to delays in the permitting process each year. I placed a 25 cm x 25 cm square down on the leaf litter adjacent to the transect line, alternating sides of the line. I then collected the leaf litter found within the square in a Ziploc bag and brought the samples back to the lab where Berlese funnels were used to collect any macroinvertebrates from the samples. The leaf litter was placed in a large funnel that opens into a small jar of ethanol. A light was then placed over the leaf litter for a minimum of 4 hours, causing the macroinvertebrates to move down, away from the light, into the ethanol.

For quantifying habitat characteristics at survey sites, I used the random pairs method and established vegetation plots at the beginning and end of all transects. The random pairs method assumes that trees are not uniformly spaced in nature, so it attempts to find an average distance between trees to then determine tree density (Cottam and Curtis 1949). This is done by locating the survey point and finding the tree closest to that point. From that tree, the next closest tree, 180 degrees away through the center of the survey point, is located. The distance between the two trees and the diameter at breast height and species of both trees were recorded. I also utilized vegetation plots at the beginning and end of each transect. I first used a plot with a 5-meter radius to count shrub and sapling stems and to measure percent ground cover. I then

established a plot with a radius of 11.3 meters that surrounded the smaller plot to count the number of snags, large trees, and small trees.

Data Analysis

A list of variables that potentially influence Rusty Blackbird occupancy and fall migration stopover duration were outlined (Appendix 1.1) and a set of candidate models (Appendix 1.2) were developed *a priori* to possibly explain any Rusty Blackbird data that was collected. Programs Distance 6.0 (Thomas et al., 2010), MARK (White and Burnham 1999) and R version 2.12.0 (R Development Core Team, 2010) can be used for data analysis. The information theoretic approach and Akaike information criterion (AIC; Burnham and Anderson 2002) can be used to rank the models according to their relative goodness of fit. I was not able to use the information theoretic approach because of a lack of Rusty Blackbird detections along the survey transects. The USGS COMDYN program SPECRICH2 (Rexstad and Burnham 1991) was used to generate species richness estimates for each survey site by year. I visually examined the overlap among 95% confidence intervals to evaluate the difference among species richness estimates at each survey site and across years.

Results

Rusty Blackbirds were not detected along any of the survey transects during the fall of 2012 or 2013. Due to a lack of Rusty Blackbird detections, the candidate models (Appendix 1.2) were not tested. Two groups of Rusty Blackbirds were detected near survey areas in 2012: one group of 10 foraging individuals in Swan Lake NWR and one group of 7 individuals in Nifong Park, about 5 miles away from Forum Nature Area. Both locations feature ponds, but the areas where the Rusty Blackbirds were detected were dry and at least several hundred meters from water.

Species richness estimates were calculated for each location over the whole survey period. Forum Nature Area and Swan Lake NWR had greater species richness estimates than Atlanta Conservation Area, Columbia Audubon Nature Sanctuary, and Garth Nature Area in 2012, according to the differences in upper and lower limits of the 95% confidence intervals for sites (Figure 1.2). Forum Nature Area and Garth Nature Area had greater species richness estimates than Atlanta Conservation Area and Rebel's Cove Conservation Area in 2013. Garth Nature Area also had a greater species richness estimate than Columbia Audubon Nature Sanctuary in 2013. Swan Lake NWR was the only site with a difference in species richness estimates across the two years.

A total of 35 species were detected across all sites in the fall of 2012 and 28 in the fall of 2013. Black-capped chickadees were detected the most in 2012 with 29 detections and Red-headed Woodpeckers were detected the most in 2013 with 30 detections (Table 1.1). Table 1.2 shows the species detected and number of detections per transect at each survey site during the fall migration seasons of 2012 and 2013.

Macroinvertebrates were not found in any leaf litter samples in the fall of 2012. In the fall of 2013, one annelid belonging to the order Opisthopora was found at Garth Nature Area, and one arthropod larva of the order Lepidoptera was found in a leaf litter sample at Forum Nature Area. One annelid of the order Opisthopora and two arthropod larvae belonging to the orders Hymenoptera and Lepidoptera were collected at Columbia Audubon Nature Sanctuary. At Swan Lake NWR, one Coleoptera arthropod and two arthropod larvae of the orders Lepidoptera and Hymenoptera were collected in leaf litter samples on the same survey day.

Discussion

Due to the lack of Rusty Blackbird detections along survey transects, the candidate models were not able to be tested and occupancy rates and stopover time of individuals were unable to be estimated. An important factor that might have played a role in the lack of detections in 2012 was the impact of the year's drought. Swan Lake NWR averages 50-60 inches of precipitation each year, but only received between 30 and 35 inches in 2012 with approximately 23.5 inches during the months before surveys began (NWS 2013). When surveyed, areas of bottomland hardwood forest that were known to be moist and contain macroinvertebrates in the past were completely dried and leaf litter samples contained no macroinvertebrates. Likewise, nearby streams, creeks, and ponds were either shallow or entirely dry. Migrant Rusty Blackbirds might shorten their stopover durations if water availability plays a role in their habitat selection, is limited, and affects foraging opportunities, which can then mean that they are less likely to be detected in an area by observers (Lehnen and Krementz 2005). Swan Lake NWR received approximately 31 inches of rainfall before surveys started in the fall of 2013 and 40-50 inches throughout the year (NWS 2013), so the amount of rainfall might not have played as much of a role in explaining the lack of detections in 2013. Although 2013 experienced more rainfall, streams and creeks were still very shallow or dry.

The variation in species richness estimates may be attributed to several factors including differences in land management at each of the public lands that were surveyed. Missouri Department of Conservation lands are heavily managed for deer, turkey, and other game populations, while Swan Lake NWR is heavily managed for migrating waterfowl in the fall. The City of Columbia parks and nature areas are managed for human recreation and Columbia Audubon Nature Sanctuary is managed for native bird populations. These different land

management plans can influence the habitat suitability for various bird species. Since the public lands ranged from small to large tracts of land, the size of the public land could have influenced the species richness estimates. A previous study showed that bird species richness estimates increase as the area of public green spaces increases (Chamberlain et al. 2007). Location could have also played a role, with more isolated areas having a lower species richness estimate. Forum Nature Area falls within a connected network of parks in Columbia, which could act as a corridor for birds and other wildlife, possibly explaining the high species richness estimates at that site. Although Forum Nature Area had consistently higher species richness estimates, the area had an overall tree density of 13.49 trees per hectare (Appendix 1.3).

Currently there is little information in the literature regarding Rusty Blackbird migratory habitat preferences, so there are no suggestions for the features individuals use when selecting stopover sites. There are several other factors that could be influencing the detection rates and/or absence of Rusty Blackbirds in northeast and central Missouri including normal variation in migration patterns and stopover sites due to annual variation in wind speed and direction and other meteorological factors (Robinson et al. 2010). Red-winged Blackbirds and Common Grackles were detected four and two times, respectively, in 2012, but Red-winged Blackbirds were only detected once and no Common Grackles were detected in 2013 (Table 1.1). Rusty Blackbirds are sometimes seen foraging in mixed species flocks in wintering habitats (Luscier et al. 2010) and have been observed in mixed species flocks in their migration range.

This study was limited in the resources available, and several logistical issues prevented a greater survey effort. This could have restricted the number of bird detections in each season. Only public lands were surveyed, leading to a potential bias with the exclusion of possible use of private lands. The short transect length could have limited the number of detections, but a length

of 200 meters was required for the small area of some of the surveyed lands. Future research could involve more observers, more sites across northeast and central Missouri, and more survey transects to increase the likelihood of detecting Rusty Blackbirds. Additional information will be needed in order to develop conservation strategies in the region, but wildlife managers in Missouri could contribute to the research effort by managing shallow wetlands and surveying for Rusty Blackbirds during fall and spring migration. These research programs could potentially be a collaborative effort between wildlife managers and experienced birdwatchers. Overall, more research is needed to identify conservation strategies for migrating Rusty Blackbirds in Missouri.

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Tables

Table 1.1: All species detected at survey sites in northeast and central Missouri during fall migration 2012 and 2013.

		2012		2013	
Common Name	Scientific Name	Number of Detections	Number of Individuals	Number of Detections	Number of Individuals
Canada Goose	*Branta canadensis*	1	2		
Mallard	*Anas platyrhynchos*	1	40	7	312
Great Blue Heron	*Ardea herodias*	3	5		
Turkey Vulture	*Cathartes aura*	1	1	4	18
Bald Eagle	*Haliaeetus leucocephalus*	2	3		
Red-tailed Hawk	*Buteo jamaicensis*	1	1	1	1
Mourning Dove	*Zenaida macroura*	1	2		
Belted Kingfisher	*Megaceryle alcyon*			1	1
Red-headed Woodpecker	*Melanerpes erythrocephalus*	9	15	30	31
Red-bellied Woodpecker	*Melanerpes carolinus*	7	8	3	3
Downy Woodpecker	*Picoides pubescens*	6	6	3	4
Hairy Woodpecker	*Picoides villosus*	5	5	2	2
Northern Flicker	*Colaptes auratus*	3	3	2	3
Blue Jay	*Cyanocitta cristata*	19	25	18	19
American Crow	*Corvus brachyrhynchos*	9	10	8	8
Black-capped Chickadee	*Poecile atricapillus*	29	40	28	27
Tufted Titmouse	*Baeolophus bicolor*	19	41	8	11
Red-breasted Nuthatch	*Sitta canadensis*	1	1		
White-breasted Nuthatch	*Sitta carolinensis*	2	3	7	7
Carolina Wren	*Thryothorus ludovicianus*			1	1
Golden-crowned Kinglet	*Regulus satrapa*	1	1	1	1
Eastern Bluebird	*Sialia sialis*	6	11		
American Robin	*Turdus migratorius*	11	136	21	117
Northern Mockingbird	*Mimus polyglottos*	1	1	1	1
European Starling	*Sturnus vulgaris*	1	1	2	7
Cedar Waxwing	*Bombycilla cedrorum*	3	32	1	2
Common Yellowthroat	*Geothlypis trichas*			1	1
Chipping Sparrow	*Spizella passerina*	1	1	7	25
Field Sparrow	*Spizella pusilla*			1	1
Song Sparrow	*Melospiza melodia*	5	19		
White-throated Sparrow	*Zonotrichia albicollis*	9	23	21	51
Dark-eyed Junco	*Junco hyemalis*	11	77	7	27
Northern Cardinal	*Cardinalis cardinalis*	23	24	26	32
Red-winged Blackbird	*Agelaius phoeniceus*	4	2064	1	1
Common Grackle	*Quiscalus quiscula*	2	5		
House Finch	*Haemorhous mexicanus*	2	2		
Purple Finch	*Haemorhous purpureus*	1	4		
American Goldfinch	*Spinus tristis*	7	43	3	4
House Sparrow	*Passer domesticus*	1	3		

Table 1.2: Detections per transect for each species recorded during surveys in 7 public lands throughout northeast and central Missouri during fall migration seasons of 2012 and 2013.

	Atlanta CA		Columbia Audubon NS		Forum NA		Garth NA		Nifong Park	Rebel's Cove CA		Swan Lake NWR	
Species	2012	2013	2012	2013	2012	2013	2012	2013	2013	2012	2013	2012	2013
Canada Goose					0.25								
Mallard												0.2	1.4
Great Blue Heron												0.6	
Turkey Vulture					0.25	0.75							0.2
Bald Eagle										0.25		0.2	
Red-tailed Hawk					0.25			0.5					
Mourning Dove			0.5										
Belted Kingfisher						0.25							
Red-headed Woodpecker												1.8	6
Red-bellied Woodpecker			1.5		0.25		0.5	0.5		0.25	0.25	0.2	0.2
Downy Woodpecker					0.25			1		0.25		0.8	0.2
Hairy Woodpecker			0.5		0.5			0.5		0.25		0.2	0.2
Northern Flicker				0.5	0.5	0.25						0.2	
Blue Jay			1.5	2	2.5	0.25	1	2.5	1	0.5	0.25	0.4	1.2
American Crow	0.75	0.5							4	0.5	0.5	0.8	
Black-capped Chickadee	0.5	0.75	4	2.5	1.5	1.75	1.5	2	1	1.5	1	0.8	0.8
Tufted Titmouse	0.25	0.5	2		0.25	0.25	0.5	0.5		1	1	1.6	
Red-breasted Nuthatch												0.2	
White-breasted Nuthatch	0.25	0.25										0.2	0.4
Carolina Wren								0.5					
Golden-crowned Kinglet								0.5				0.2	
Eastern Bluebird					1.25		0.5						
American Robin					1	0.5	3.5	9.5					
Northern Mockingbird					0.25			0.5					
European Starling					0.25	0.5							
Cedar Waxwing							1	0.5				0.2	
Common Yellowthroat				0.5									
Chipping Sparrow					0.25	0.75		1.5					0.2
Field Sparrow						0.25							
Song Sparrow	0.25									0.25		0.6	
White-throated Sparrow				1.5	1	0.75	2.5	6.5					0.4
Dark-eyed Junco			1.5	1.5	1.25	0.25		0.5		0.25	0.5	0.4	
Northern Cardinal	0.25	1.25	1.5	0.5	2.75	1	1.5	4		0.75	1	0.4	0.8
Red-winged Blackbird								0.5		0.25		0.6	
Common Grackle												0.4	
House Finch					0.25		0.5						
Purple Finch					0.25								
American Goldfinch	0.25	0.25			1.25	0.25	0.5	0.5					
House Sparrow					0.25								

Figures

Figure 1.1: Sites surveyed for migrating Rusty Blackbirds in Northern Missouri during fall 2012 and 2013. Nifong Park was only surveyed in 2013.

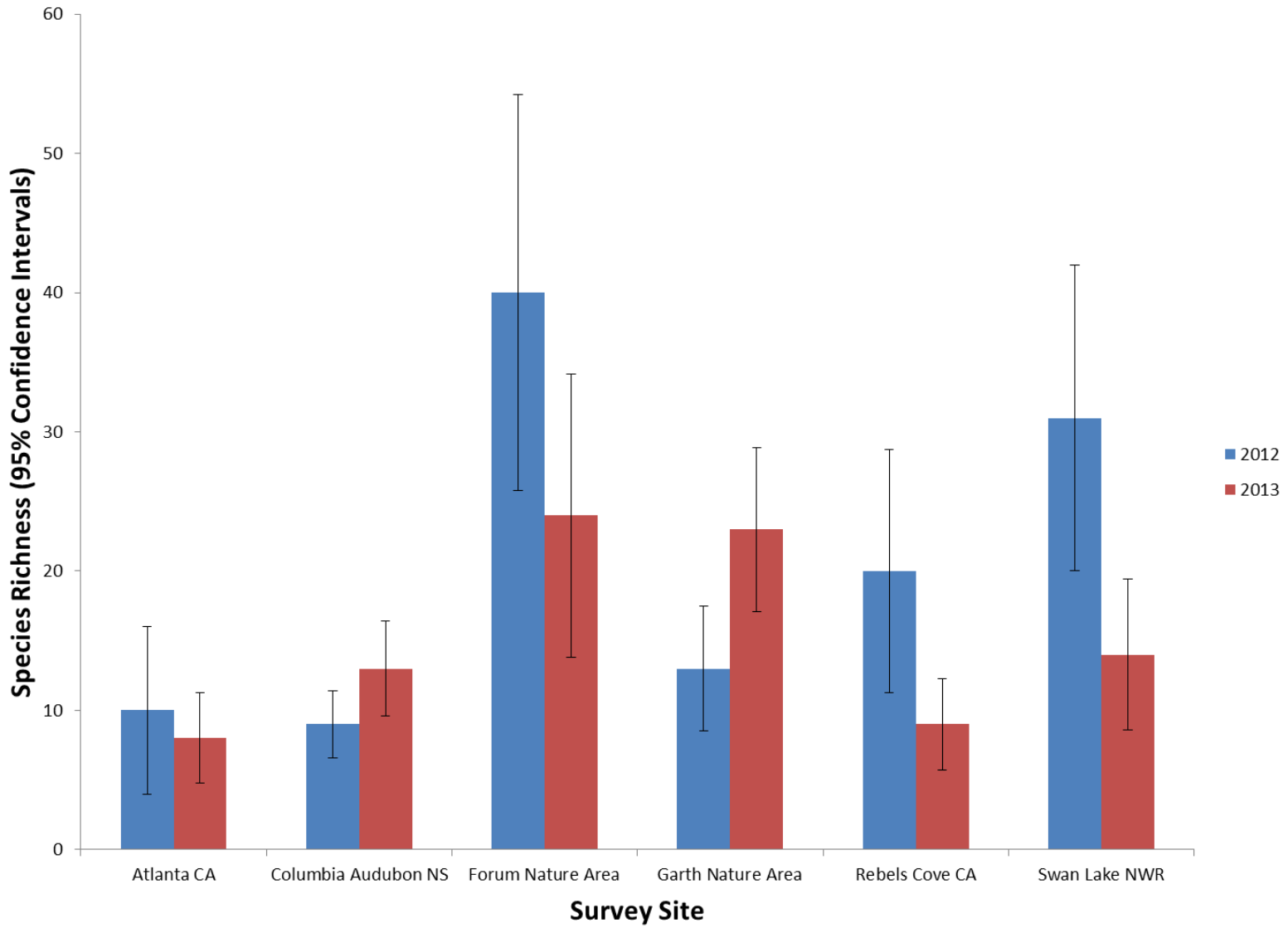

Figure 1.2: Species richness estimates for each survey location in northeast and central Missouri during fall 2012 and 2013 migration.

Appendices

Appendix 1.1: Potential variables that influence Rusty Blackbird occupancy and fall migration stopover duration in Northern Missouri in 2012 and 2013.

Mnemonic	Variable	Description and methods
COVER	Amount of hardwood forest cover	Measured at transect
WATER	Depth of water at survey site	Measured at transect
HEIGHT	Height of forest floor growth	Measured during vegetation survey
DISTANCE	Distance to water source	Estimated at transect
HABITAT	Type of habitat	Determined during vegetation survey
UNDISTURBED	Area of undisturbed habitat surrounding survey site	Estimated using map
BOTTOMLAND	Area of bottomland hardwood forest surrounding survey site	Estimated using map
QUALITY	Habitat quality at the survey site	Habitat quality measured by arthropod surveys along each transect.
TEMPERATURE	Temperature at field site	Measured temperature at beginning of transect
WIND SPEED	Wind speed at field site	Measured using Beaufort scale
PRECIPITATION	Amount of precipitation at site (or near site) in the past 24 hours	Measured at nearby weather station
CLOUD COVER	Amount of cloud cover at field site	Estimated at start of transect
WIND DIRECTION	Wind direction at field site	Estimated at start of transect

Appendix 1.2: Candidate models for estimating Rusty Blackbird occupancy in Northern Missouri during fall migration seasons of 2012 and 2013.

Model	Description
$\Psi_{COVER+HABITAT}$	Occupancy rates vary by the amount of hardwood forest cover and the type of habitat.
$\Psi_{WATER+HEIGHT}$	Occupancy rates vary by the depth of water at the survey site and the height of forest floor growth.
$\Psi_{DISTANCE}$	Occupancy rates vary by the distance to a water source.
$\Psi_{HABITAT}$	Occupancy rates vary by the type of habitat.
$\Psi_{QUALITY}$	Occupancy rates vary by the habitat quality.
$\Psi_{BOTTOMLAND+WATER}$	Occupancy rates vary by the area of bottomland hardwood forest surrounding the survey site and the depth of water at the survey site.
$\Psi_{UNDISTURBED+HABITAT}$	Occupancy rates vary by the area of undisturbed habitat surrounding the survey site and the type of habitat.
$\Psi_{CLOUD\ COVER\ +\ PRECIPITATION}$	Stopover time varies by the amount of cloud cover and precipitation within the past 24 hours at the field site.
$\Psi_{TEMPERATURE}$	Stopover time varies by the temperature at the field site.
$\Psi_{QUALITY}$	Stopover time varies by the habitat quality at the field site.

Appendix 1.3: Vegetation characteristics at each survey site in northeast and central Missouri with minimum and maximum measured values in parentheses.

Survey Site	Overall Tree Density (trees/hectare)	Average Percent Shrub	Average Number Saplings	Average Ground Cover (%)	Average Number Snags	Average Number Small Trees	Average Number Large Trees	Average Diameter at Breast Height (cm)
Atlanta CA	4.47	14.00 (0-50)	9.65 (0-32)	66.25 (0-100)	4.71 (0-17)	16.50 (0-51)	7.04 (0-14)	55.53 (0-116.1)
Columbia Audubon NS	27.58	25.50 (5-55)	1.38 (0-7)	64.19 (10-100)	1.00 (0-6)	7.25 (0-23)	3.81 (0-7)	56.89 (0-110.7)
Forum Nature Area	13.49	10.63 (0-35)	1.69 (0-11)	86.56 (5-100)	0.19 (0-2)	4.81 (0-17)	1.81 (0-12)	30.15 (0-42.5)
Garth Nature Area	17.79	14.19 (0-35)	1.75 (0-8)	43.75 (5-100)	0.31 (0-1)	9.12 (0-22)	3.56 (0-10)	51.43 (0-127.0)
Rebel's Cove CA	12.14	18.20 (0-50)	3.08 (0-15)	32.64 (0-98)	0.87 (0-4)	12.92 (0-34)	4.54 (0-11)	59.2 (23-126.5)
Swan Lake	1.19	15.19 (0-80)	1.00 (0-5)	54.06 (0-95)	0.75 (0-6)	4.50 (0-25)	3.00 (0-14)	24.69 (0-71.5)

PREDICTING HABITAT SUITABILITY FOR RUSTY BLACKBIRDS IN MISSOURI

Introduction

The Rusty Blackbird is considered one of the fastest declining bird species in North America and consequently it is important to develop region-specific conservation strategies for these populations. The species has experienced an approximately 90% reduction in population size since the 1960's (Greenberg and Droege 1999). Their population declines are due to a combination of factors: conversion of forested wetlands to agriculture, effects of acid rain on breeding range boreal forests, and exposure to methyl mercury and the associated negative effects on reproduction (Greenberg and Droege 1999, Edmonds et al. 2010). There is evidence that climate change is negatively affecting Rusty Blackbirds, which may be due in part to changes in macroinvertebrate phenology or to decreases in macroinvertebrate abundance in the breeding wetlands (McClure et al. 2012). In addition, fragmentation of wooded wetlands and bottomland forests could make the habitats even less suitable for Rusty Blackbirds by exposing them to increased predation and also increased competition with Common Grackles and other blackbirds (Greenberg and Matsuoka 2010).

In Missouri alone more than 80% of the original wetlands have been lost, mostly from the major river floodplains (Browers and Erickson 1990). Despite the large-scale loss in wetland habitats throughout North America, little is known about landscape-level habitat features Rusty Blackbirds use when choosing migratory stopover locations. Rusty Blackbirds use stopover sites in Missouri to rest and refuel before continuing on to wintering or breeding grounds during migration. Region-specific conservation strategies would be better informed if more was known about local landscape features important for stopover dynamics.

Species of birds, whether generalists or specialists, have a set of ecological characteristics, such as habitat type, distance to water, and prey type, that they prefer and where they are most often found. Since these species are expected to occur nonrandomly throughout the biosphere, it can be helpful when studying a particular species to produce and use maps that indicate areas where the species is likely to be found. The goal of habitat suitability modeling is to predict where individuals are likely to be observed, based on measured environmental variables (Guisan and Zimmermann, 2000). Habitat suitability modeling can be especially informative when working with a rare or understudied species, like the Rusty Blackbird.

In an attempt to advance the study of Rusty Blackbird migratory habitat requirements, I used statewide Rusty Blackbird detections gathered by citizen scientists (i.e., birdwatchers) and land use/land cover maps to create habitat suitability maps. These maps can be used to identify potential stopover hotspots and to elucidate patterns in habitat use on a landscape level for Rusty Blackbirds during fall migration. This information should be considered for conservation management and a focus for future studies in Missouri.

Methods

Study Area

The entire state of Missouri was examined for Rusty Blackbird habitat suitability. There are four ecoregions within the state: the Central Dissected Till Plains, Osage Plains, Ozark Highlands, and Mississippi River Alluvial Basin (Figure 2.1; Nigh and Schroeder 2002). The Central Dissected Till Plains are described as a mosaic of cropland, pasture, and second growth woodlands. This region has more trees and invasive timber in woodlands now than it did a century ago, although fragmentation is greater. The prairies of the Osage Plains were converted to cropland and many wetlands along streams were converted to cropland as well. Currently, the land cover remains open in pasture, cropland, and prairies. The Ozark Highlands have two distinct subregions: the western Ozarks which is occupied mostly by cropland and pasture and the eastern Ozarks which is more heavily forested. Almost 95% of the Mississippi Alluvial Basin has been converted to farmland, with very little of the land as pasture. Remnants of the original lowland forests remain in small, managed tracts.

Study Design

I compiled Rusty Blackbird fall migration observations across Missouri from eBird (2012) for the years 1999-2013. Data for 2013 included detections of one or more individuals that were reported by email as well as eBird reports. I gathered the Universal Transverse Mercator (UTM) coordinate information from the location of the eBird map marker. Spatially explicit data layers, including the 2005 land cover layer and the streams and rivers layer, were obtained from the Missouri Spatial Data Information Service (MSDIS) (2011). The land cover layer contained 30 x 30-meter cells that were labelled as one of 14 different land cover categories

ranging from impervious to open water (Figure 2.2). I defined suitable habitat for migrating Rusty Blackbirds as forested wetlands and river and stream edges (Avery 2013). The land cover layer divided wetlands into woody-dominated wetlands and herbaceous-dominated wetlands. Woody-dominated wetlands are defined in the map layer as "forest with greater than 60% cover of trees with semi-permanent or permanent flood waters" and herbaceous-dominated wetlands are defined as "woody shrubland with less than 60% cover of trees with semi-permanent or permanent flood waters" (MSDIS 2011). Both wetland categories were included in the available suitable habitat map. River and stream edges were included in the definition of suitable habitat because it is thought that they may provide seasonal macroinvertebrate foraging habitat that would be categorized as open water by the land cover layer, especially along the Mississippi and Missouri alluvial plains where some cropland has been converted to managed wetlands (Nigh and Schroeder 2002).

A map displaying the suitable habitat available in Missouri as previously defined was created with ArcGIS 10.1 (ESRI 2012) to show the habitat available to migrating Rusty Blackbirds according to the literature. I first extracted the woody-dominated and herbaceous-dominated wetland cells from the land cover layer using the "extract" geoprocessing tool (Figure 2.3). I then created thirty-meter buffers around the rivers and streams by using the "buffer" geoprocessing tool (Figure 2.4). These buffers were created to account for temporary wetland habitats along rivers and streams that are suitable for Rusty Blackbird foraging, but are not identified on the land cover layer as a wetland type. Figure 2.5 shows the compiled map with the total suitable habitat available. I then assigned a suitability rank to each of the 14 land use categories (Table 2.1). The woody-dominated and herbaceous-dominated wetlands received the highest rank, while impervious, urban, batten, and open water areas received the lowest rank. I

used the “weighted overlay” geoprocessing tool, which uses the ranked habitat types in Table 2.1as the input, to create a map displaying the ranked land use categories (Figure 2.6).

The eBird Rusty Blackbird detections (Figure 2.7) were broken down by the land cover category in which they were observed. The land use category at each detection site (Figure 2.8) was found by using the “sample” geoprocessing tool. I then used this information to create a map that ranked the land cover categories by the detection frequencies with the use of the “weighted overlay” geoprocessing tool (Figure 2.9). I calculated the mean flock size reported for each land cover category. I then used the “weighted overlay” geoprocessing tool to create a map that displayed the ranges of mean flock size for each land use category (Figure 2.10).

Results

A total of 223 Rusty Blackbird detections across 100 sites in Missouri were reported over 15 years. The total number of detections reported at each site varied from 1 to 32 (Figure 2.11). One detection was reported at 65 of the 100 sites, 15 sites received two detections, three detections were reported at six sites, and 14 sites had four or more detections over the 15 year time period. The greatest number of detections was reported at Squaw Creek National Wildlife Refuge with 32 observations. Flock sizes ranged from 1-275 individuals and the mean flock size of each year consisted of 25 or fewer individuals (Table 2.2). The largest reported flock size of 275 individuals was detected at Otter Slough Conservation Area in November 2011.

Calculations from the land use layer revealed that 1.81% of the land available in Missouri is categorized as woody-dominated wetland and 0.40% is categorized as herbaceous-dominated wetland (Figure 2.12). Grassland is the dominant land cover category in the state with 32.27% of the available land. According to the previous definition of suitable habitat, the majority of the land cover in Missouri is considered somewhat unsuitable or neutral for Rusty Blackbirds during migration (Figure 2.6). The very suitable and somewhat suitable habitat is dispersed throughout the state, mostly as small patches. This patchiness can be seen in the land use layer over Columbia, Missouri, where woody-dominated wetlands are found in thin segments around the city or bordering the Missouri River (Figure 2.13). The Rusty Blackbird detections reported throughout the state are also patchy and are most prevalent near highly populated areas and popular birding sites (Figure 2.7). Forty-three detections were reported in herbaceous-dominated wetlands (the most number of detections of any habitat category), equaling 19.2% of the total detections (Figure 2.12). Grassland, cropland, and deciduous forest constitute the majority of the land cover in Missouri and had 15.2%, 14.3%, and 8.5% of the detections, respectively. A chi-

square goodness of fit test run on collapsed land use categories showed that the number of detections in each category is independent of the amount of that land use category available in the state ($X2 = 743.9$, $df = 3$, $p<0.001$).

Discussion

Rusty Blackbird detections were reported in land cover types that are not usually identified as suitable habitat for the species. Although low intensity and high intensity urban areas only comprise a combined 2.05% of the land cover in the state, 10.7% of the detections were reported in these areas. A few reports posted on the Audubon Society of Missouri's listserv indicated that Rusty Blackbirds were seen at yard feeders in residential areas that were categorized as low intensity urban areas. Drastic changes in weather patterns could cause them to be detected more frequently in these areas or just more likely to be detected. This could mean that the birds are possibly more flexible in their habitat requirements during migration. This would be a favorable behavior since the amount of woody-dominated and herbaceous-dominated wetland available throughout the state is so small. Although the conservation and management of these wetlands is encouraged, perhaps other conservation strategies could be developed that focus on land cover types that are not widely known as suitable habitat for the species. Of course, more research is needed to determine if the citizen science data is accurately predicting that these habitats are providing resources for Rusty Blackbirds or if they are briefly stopping before moving on to a new area.

There are many advantages to using citizen science data. These data are usually readily available and provide a large amount of data that would have otherwise required much time and money to collect. Citizen science data, especially eBird records, can also provide information for private lands, which make up a large portion of the state and are harder to gain access for formal surveys. Citizen scientists should be encouraged to monitor and report birds in their own yards, in addition to the wildlife areas where they usually report detections. Regular monitoring of residential areas can promote conservation practices on these private lands, potentially leading

to changes in land-use practices with long-term effects (Cooper et al. 2007). There are also some problems when using data from sources like eBird. Reported bird detections are biased towards popular birding sites, areas with greater accessibility for birders, and cities and towns with larger human population sizes. We assume that eBird reports are accurate and that the species detections provided are identified correctly, but the accuracy of the reports is dependent on the birders skill level, which is not provided with the reports (Cohn 2008). Unless using a research protocol that requires volunteers to undergo training before submitting data, this skill level is unknown. The detection markers that are displayed on eBird range and point maps may not reflect the actual detection location at the site, which might lead to the misidentification of the actual land cover category during analysis. This becomes a greater problem when the designated area is large and contains several different land cover types.

This method is helpful when starting out a research project or trying to gather information regarding an understudied or rare species, but there are some limitations. A potential problem with public map layers is that they may be outdated, the effect of which varies depending on the specific layers being used. The land cover layer used in this project was published in 2005 and it is thought that land cover could have changed in several areas in the nine year time span since the data was collected. Updated land cover maps could provide more current and accurate information for the development of future research and conservation strategies. Nevertheless, map layers provided to the public by a local, state, or federal agency are useful resources that contain a vast amount of information, often on several different natural resources. Habitat suitability maps that use these public map layers are then easily transferrable to government agencies for conservation and management planning.

Habitat suitability maps can provide a foundation for future field surveys by identifying areas that were previously overlooked, but might be of high importance. In the case of Rusty Blackbirds, it might be useful to conduct field surveys in the green spaces of urban areas or in other habitat types where detections were unexpected. Future research across the state, on both public and private lands, is needed to comprehensively study Rusty Blackbird migratory habitat preferences in Missouri. Analysis will also be needed to determine if the landscape composition affects habitat selection for stopover sites. Since such little information is available regarding migration, future research can only help the conservation of this vulnerable species.

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Tables

Table 2.1: Land cover categories ranked by suitability for Rusty Blackbird stopover sites during fall migration, based on Avery (2013).

Land Cover Category	Rank
Impervious	Not Suitable
High Intensity Urban	Not Suitable
Low Intensity Urban	Not Suitable
Barren/Sparsely Vegetated	Not Suitable
Cropland	Neutral
Grassland	Somewhat Unsuitable
Deciduous Forest	Neutral
Evergreen Forest	Neutral
Mixed Forest	Neutral
Deciduous Woody/Herbaceous	Somewhat Unsuitable
Evergreen Woody/Herbaceous	Somewhat Unsuitable
Woody-dominated Wetland	Very Suitable
Herbaceous-dominated Wetland	Somewhat Suitable
Open Water	Not Suitable

Table 2.2: The number of Rusty Blackbird detections, range of individuals, and mean cluster size of fall eBird for each year from 1999-2013. "X" indicates a report that noted the presence of a Rusty Blackbird(s) instead of the number of individuals.

Year	Number of Detections	Range of Individuals	Mean Flock Size
1999	1	X	X
2001	1	1	1
2002	6	X-50	22
2003	9	X-58	19
2004	2	X-50	25
2005	5	X-20	8
2006	10	X-11	4
2007	17	X-170	16
2008	15	X-100	13
2009	9	1-100	17
2010	27	X-50	12
2011	23	X-275	24
2012	53	X-130	15
2013	45	1-110	11

Figures

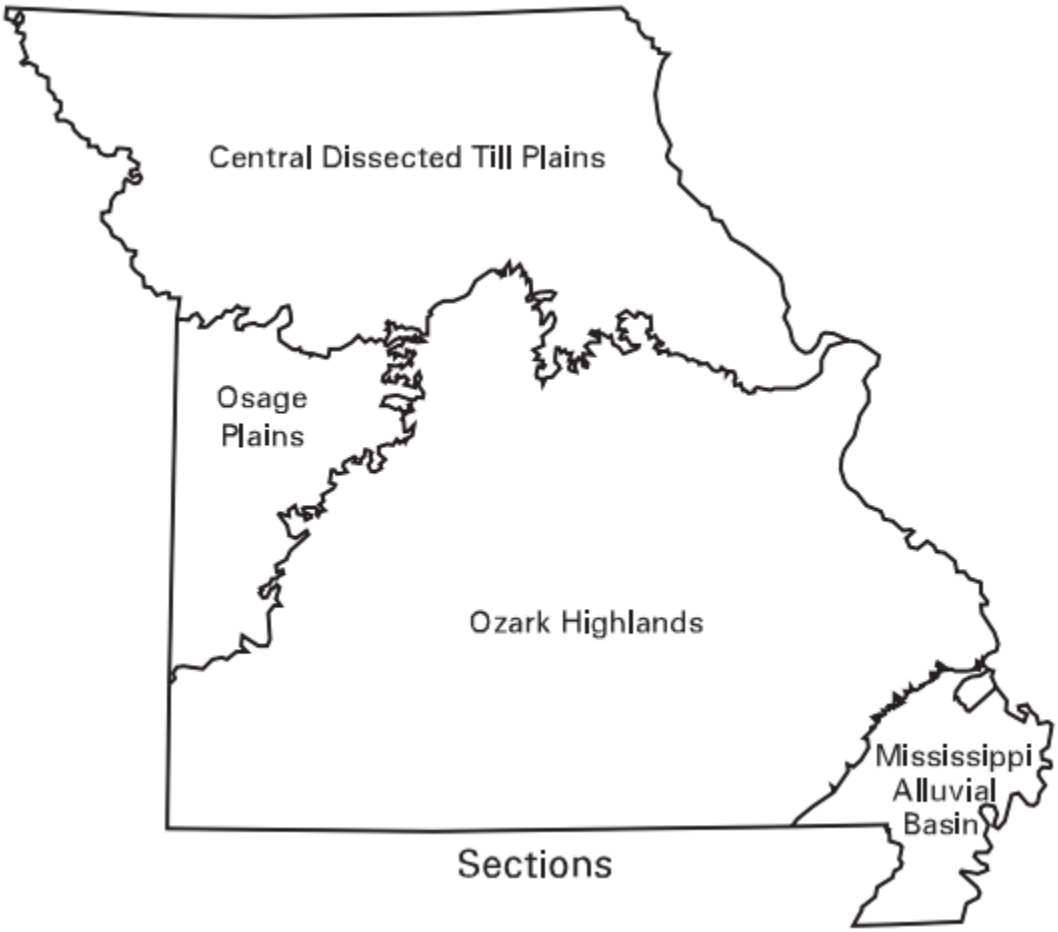

Figure 2.1: The four ecoregions of Missouri. Taken from Nigh and Schroeder (2002).

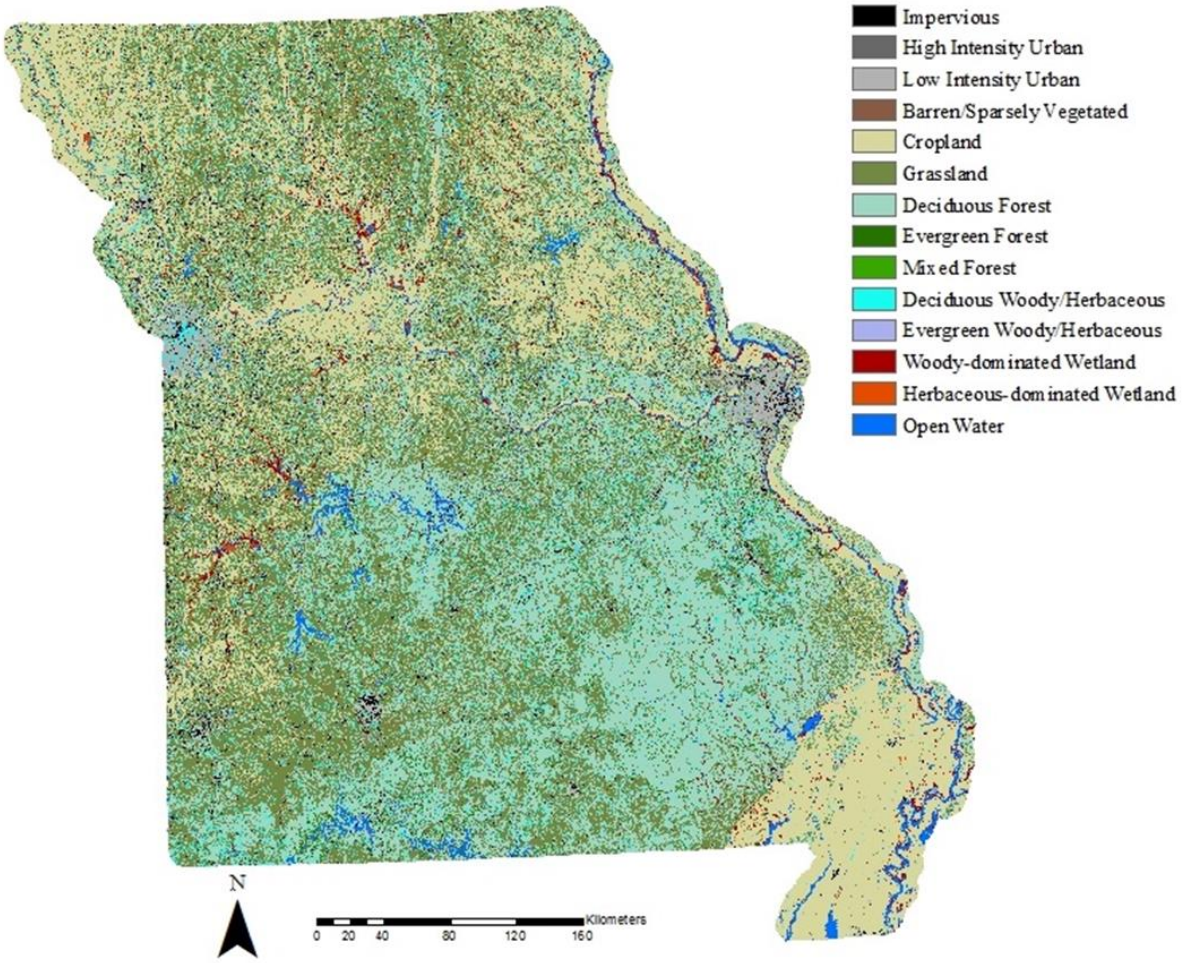

Figure 2.2: Land use categories in Missouri from the Land Use Land Cover 2005 MSDIS layer.

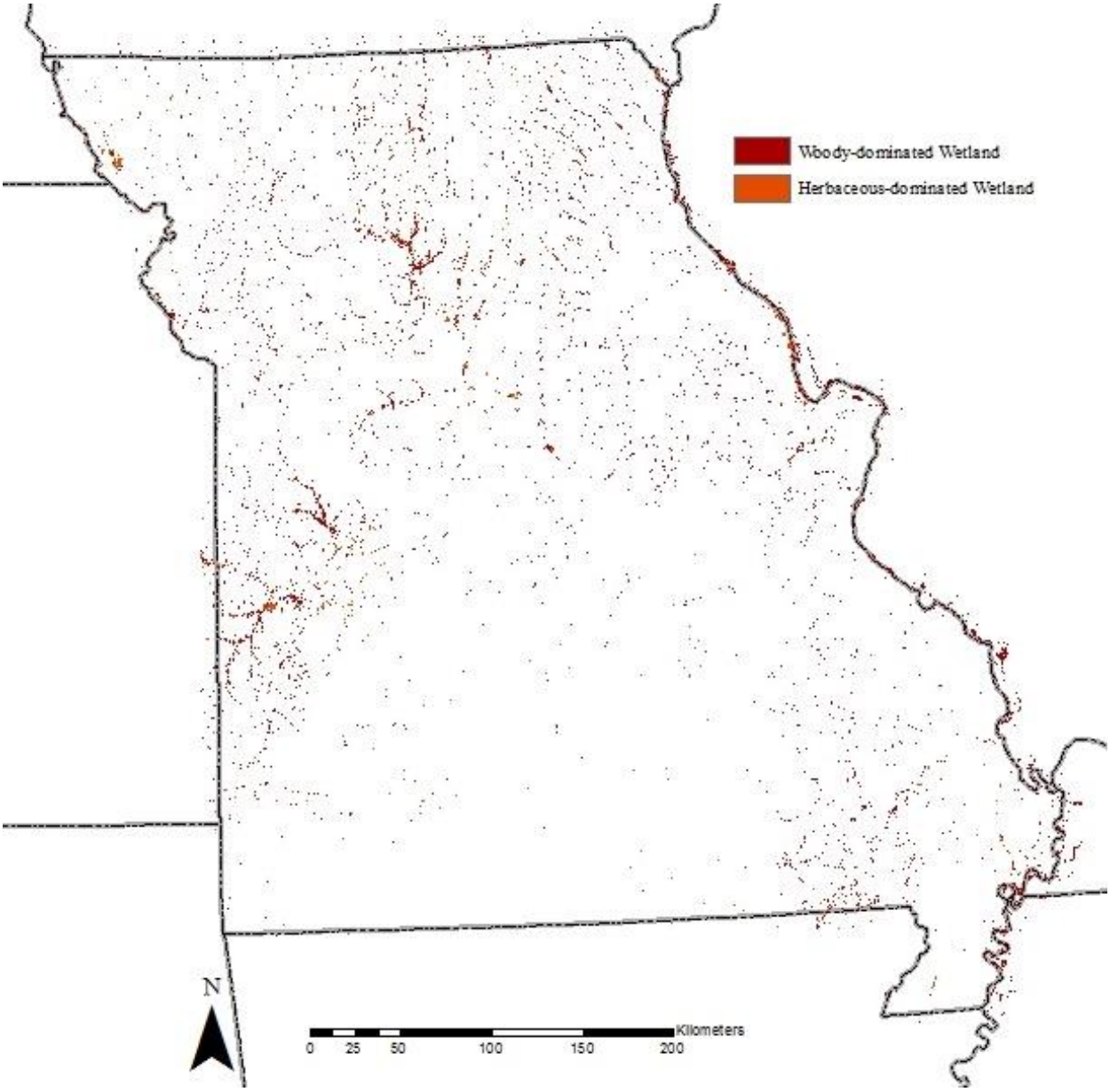

Figure 2.3: Woody-dominated and herbaceous-dominated wetlands available in Missouri as suitable habitat for Rusty Blackbirds.

Figure 2.4: Rivers and streams in Missouri with 30-meter buffers on each side.

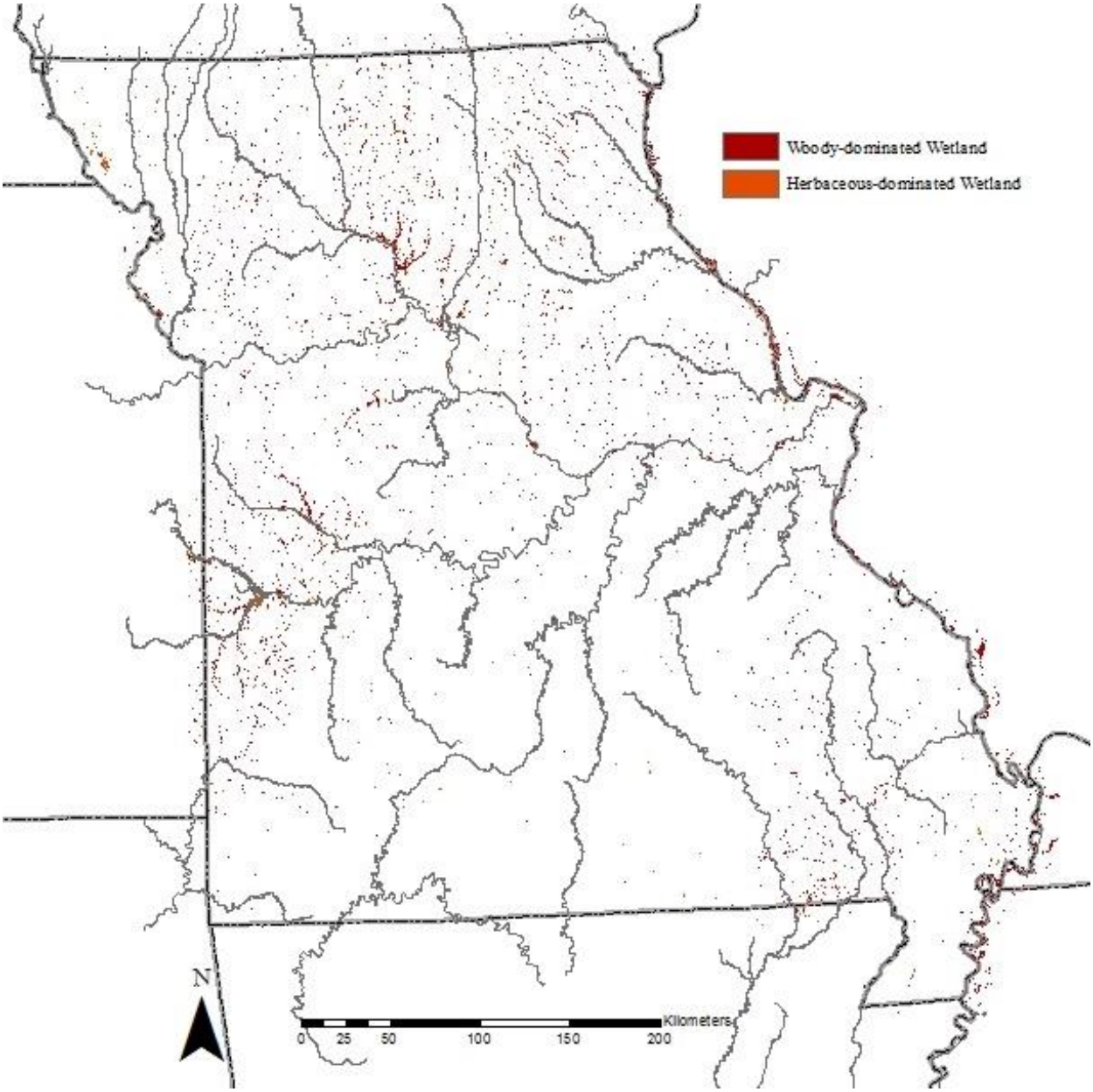

Figure 2.5: Suitable habitat available in Missouri, including woody-dominated and herbaceous-dominated wetlands and thirty-meter buffers around rivers and streams.

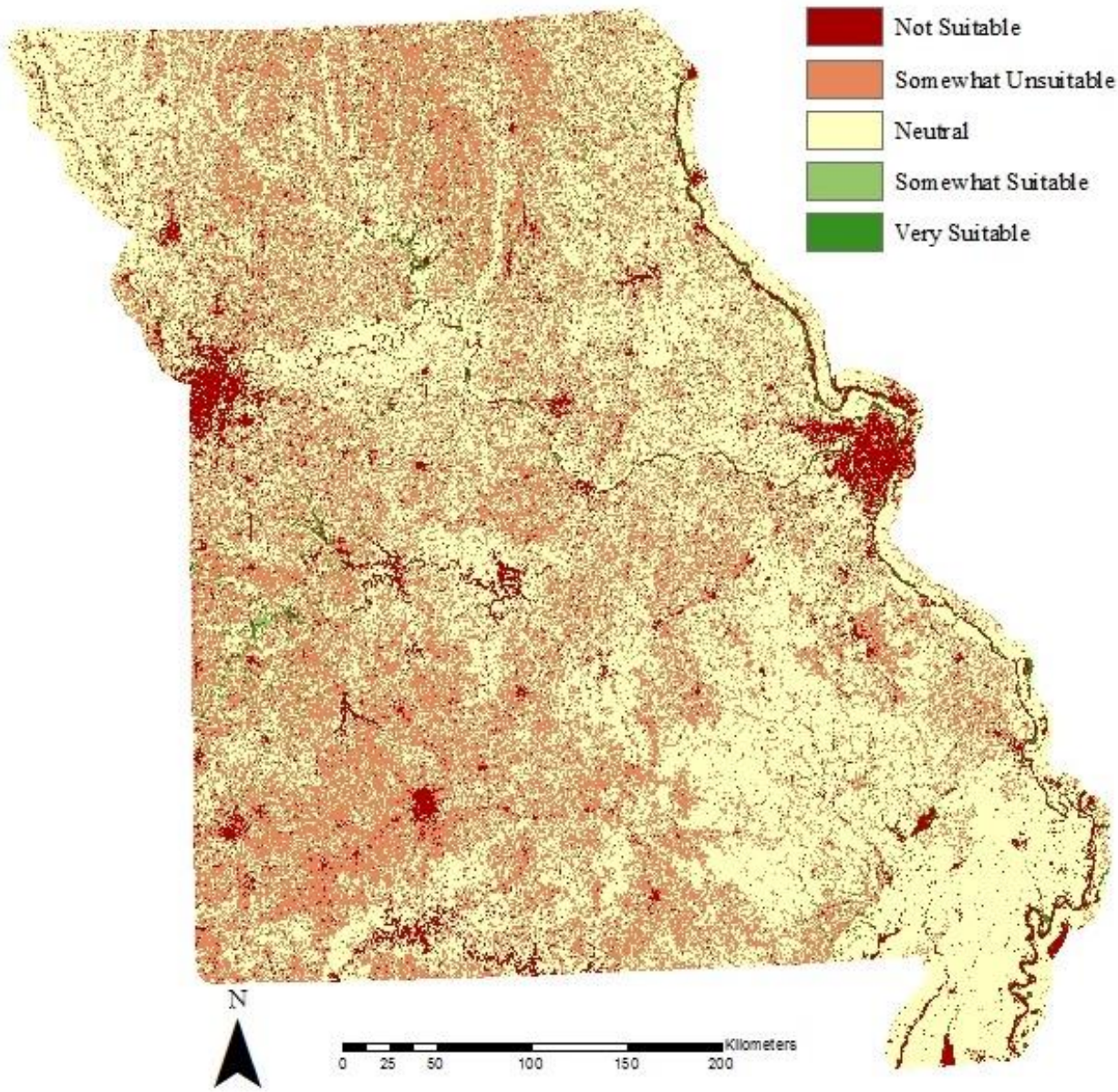

Figure 2.6: Ranking of suitable habitat available for Rusty Blackbirds in Missouri as defined by Avery (2013).

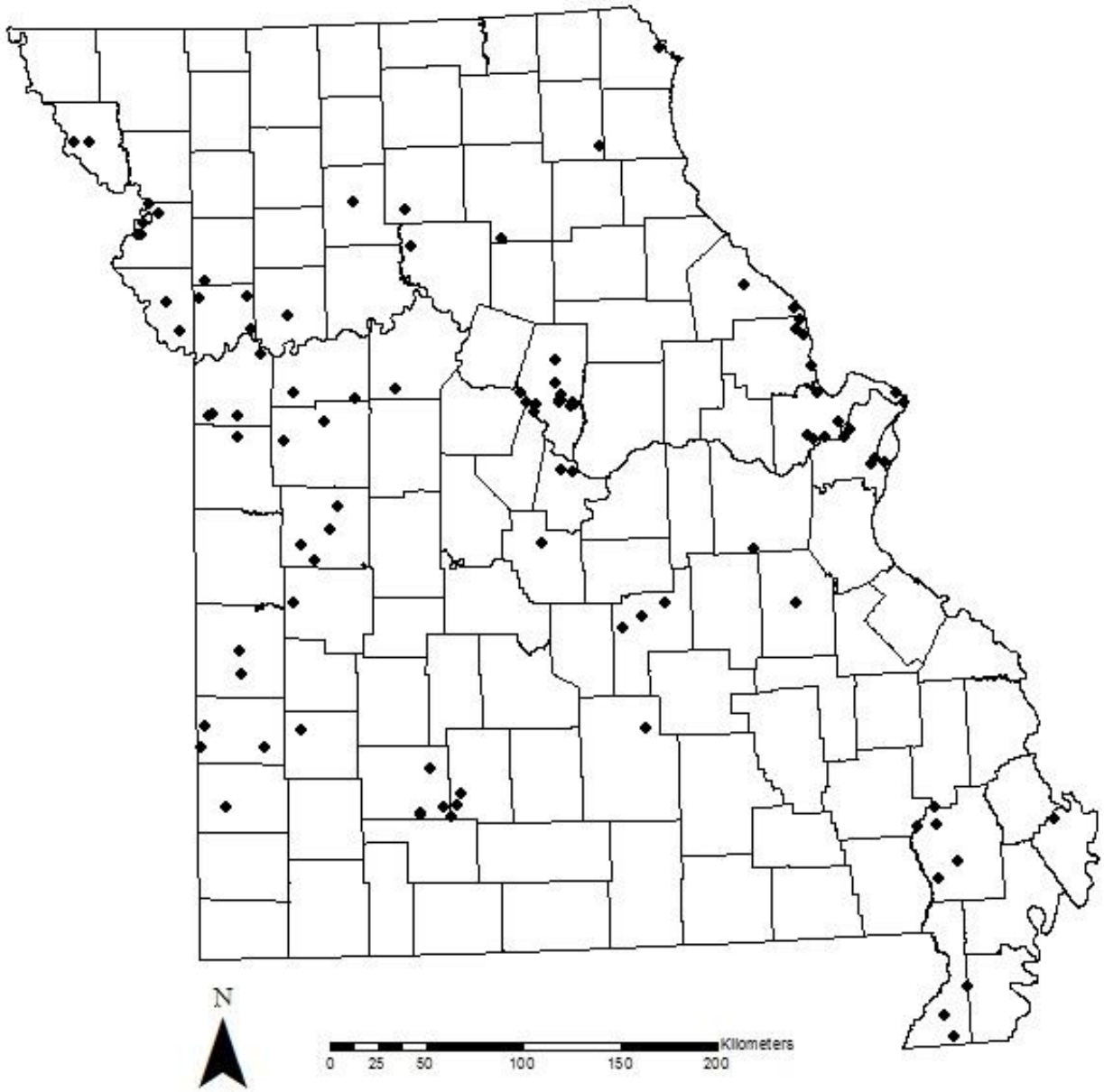

Figure 2.7: Rusty Blackbird detections reported to eBird during fall migration 1999-2013.

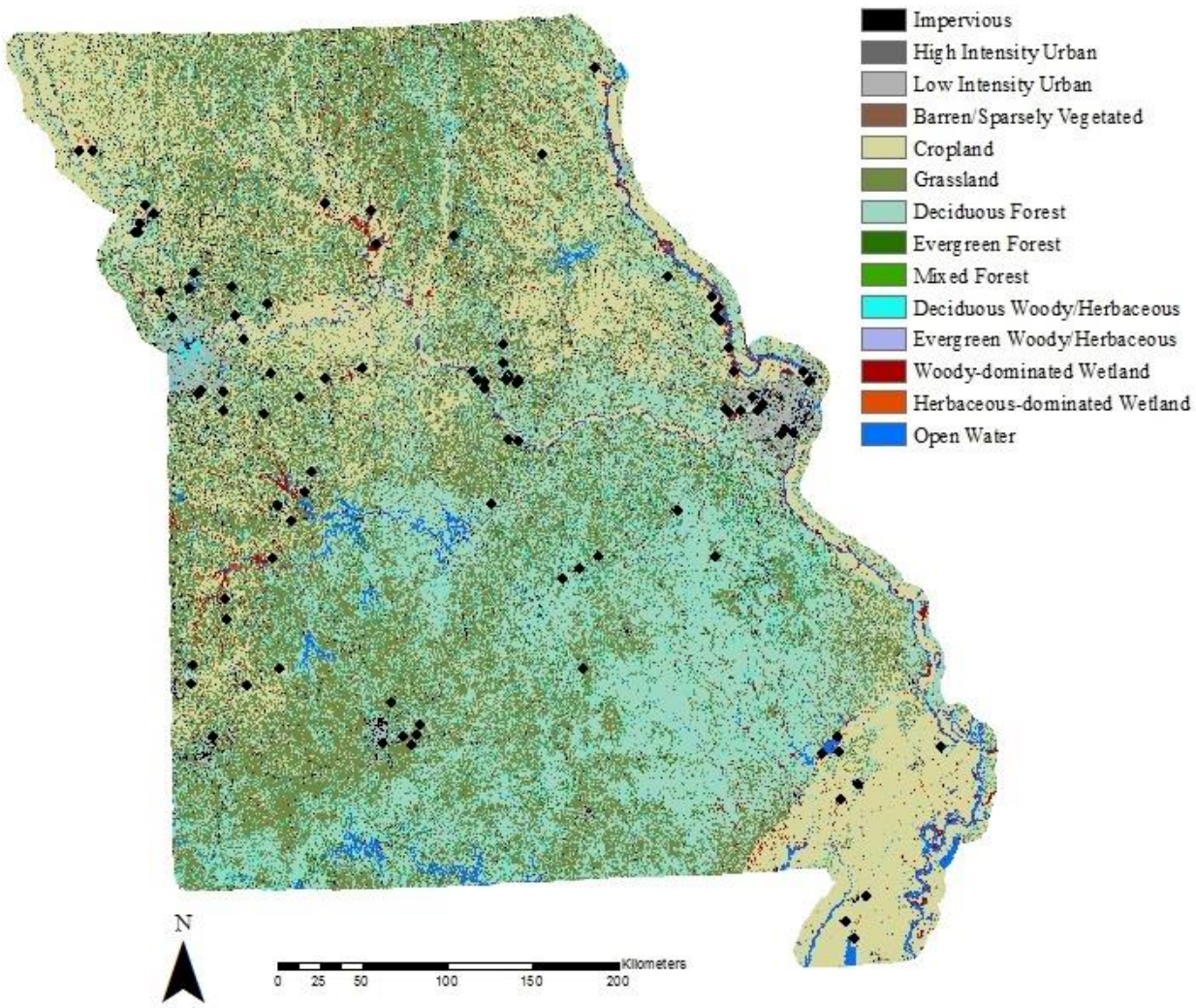

Figure 2.8: Rusty Blackbird eBird detections during migration from 1999-2013 over land use categories in Missouri.

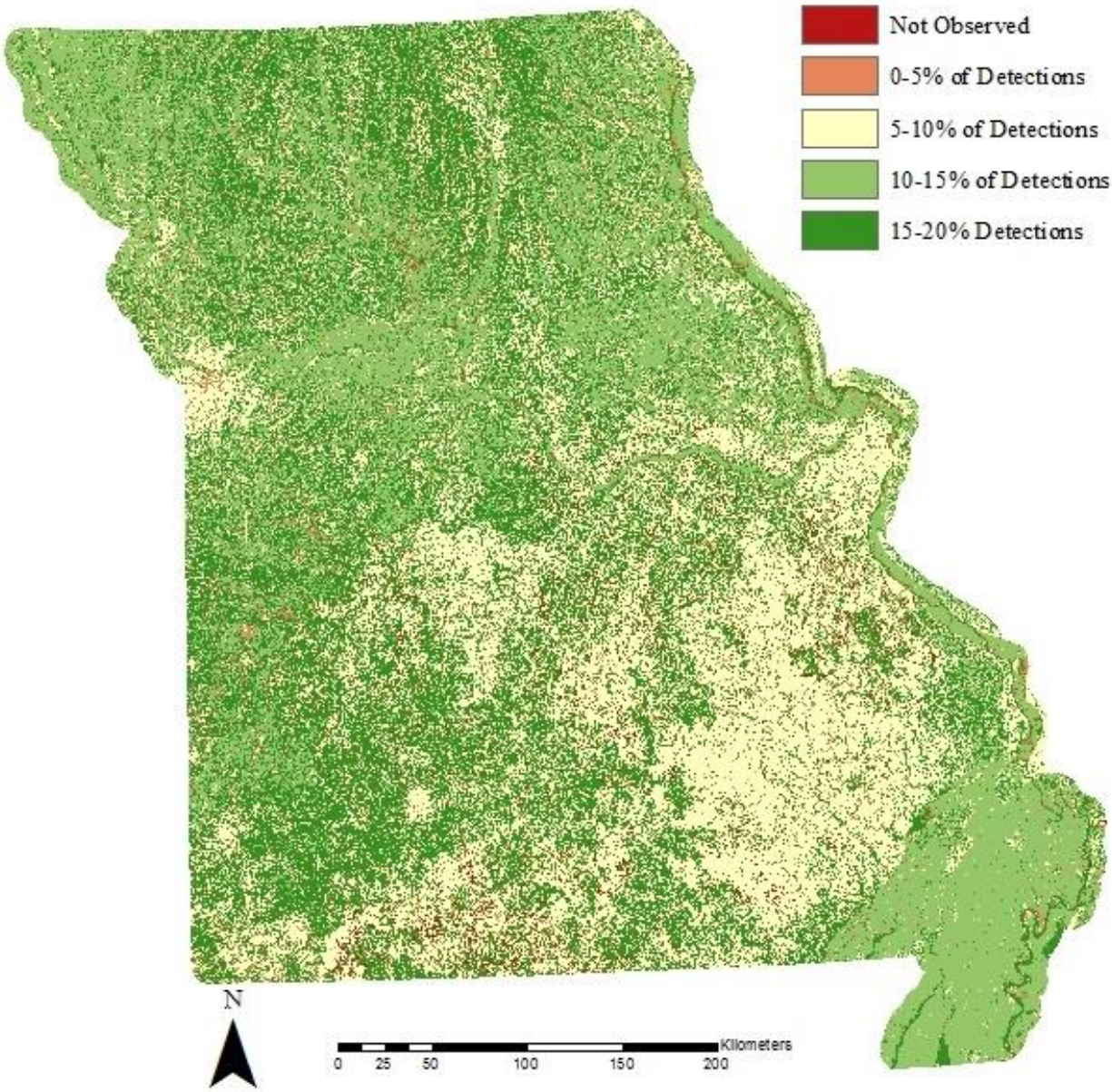

Figure 2.9: Land cover rankings by the percentage of Rusty Blackbird detections in fall from 1999-2013.

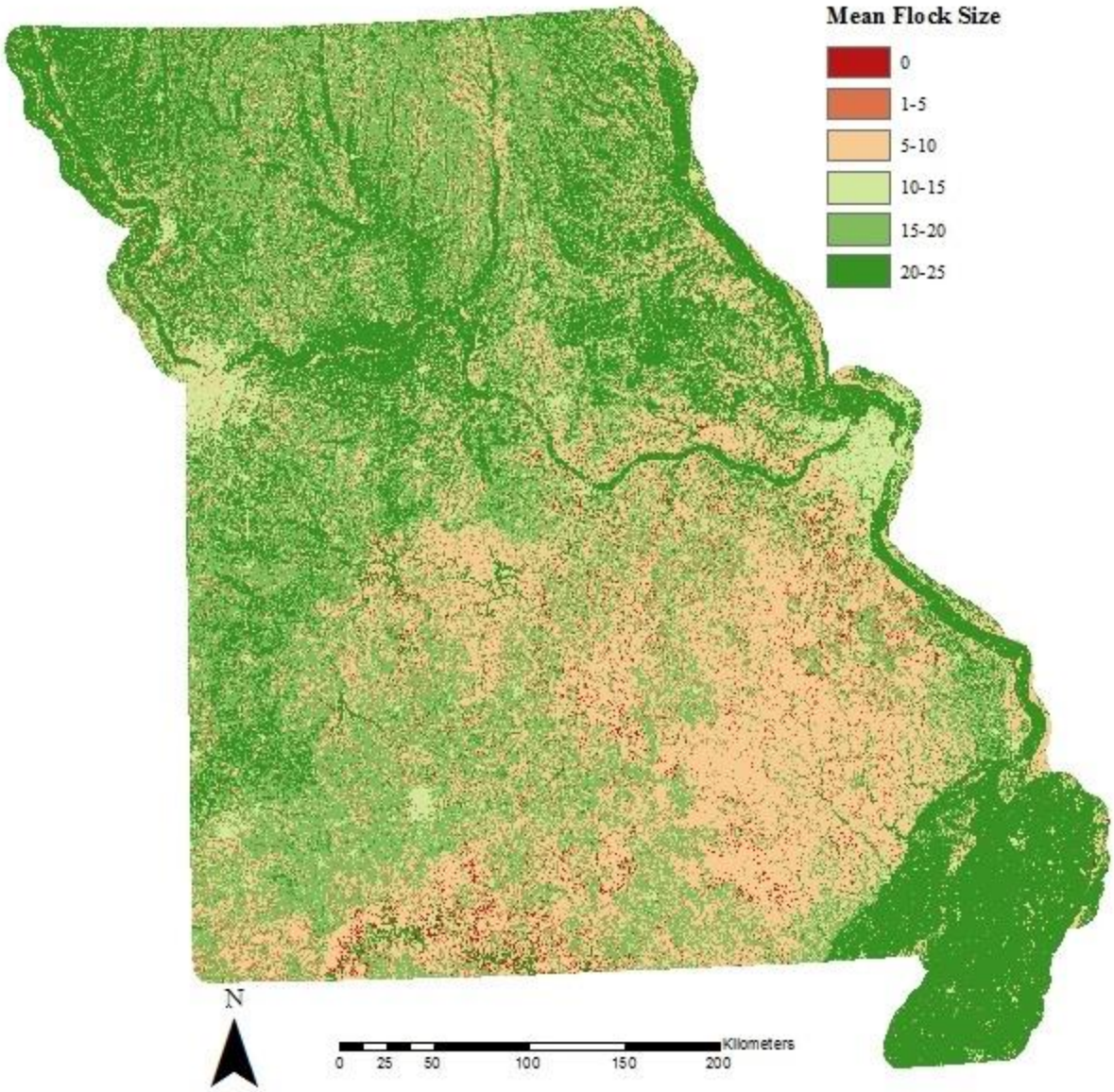

Figure 2.10: Land cover rankings by the mean Rusty Blackbird flock sizes reported to eBird in fall from 1999-2013.

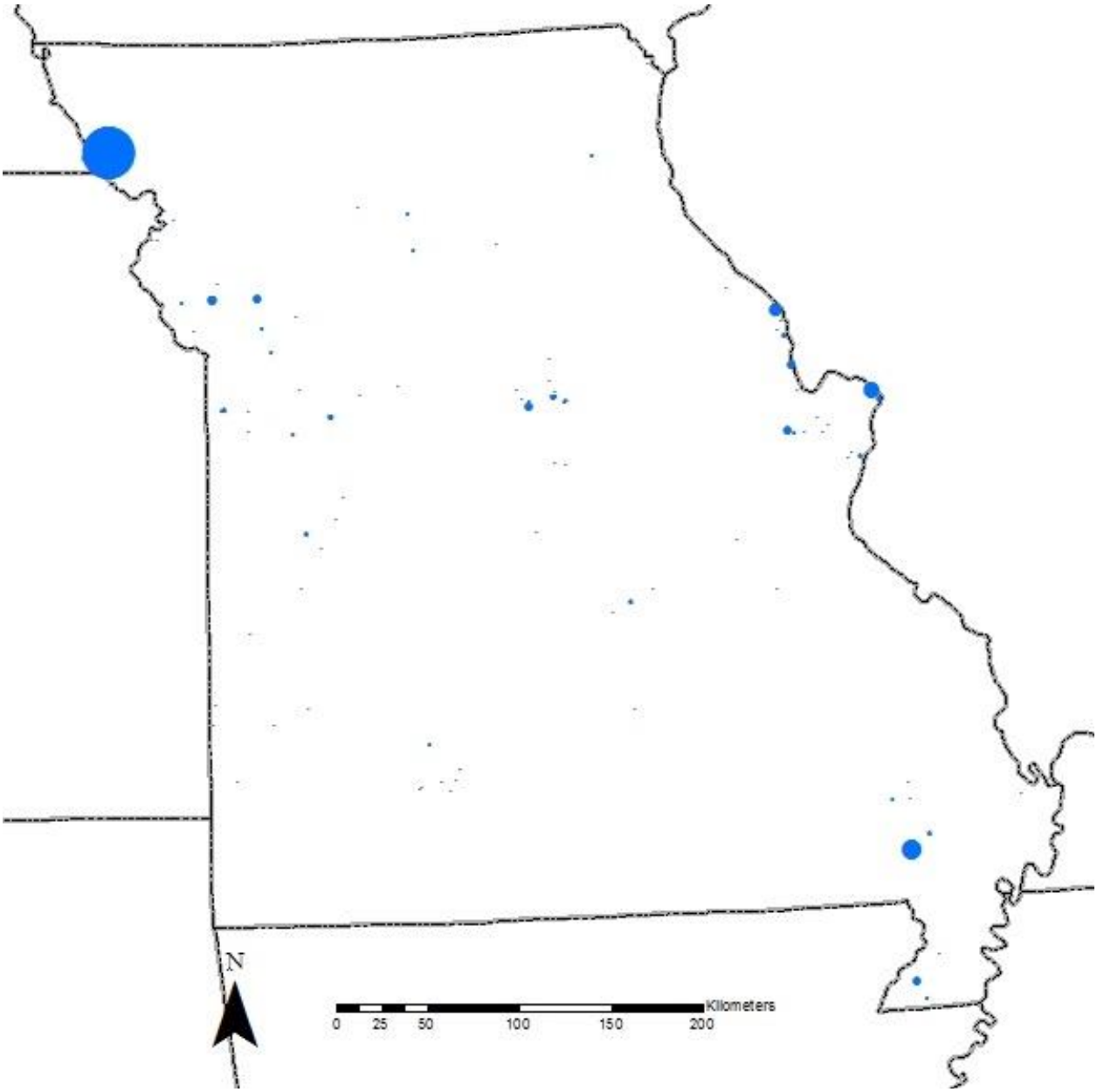

Figure 2.11: Rusty Blackbird fall eBird detections from 1999-2013. The size of the detection marker corresponds with the number of detections reported at the location over the 15 year time period.

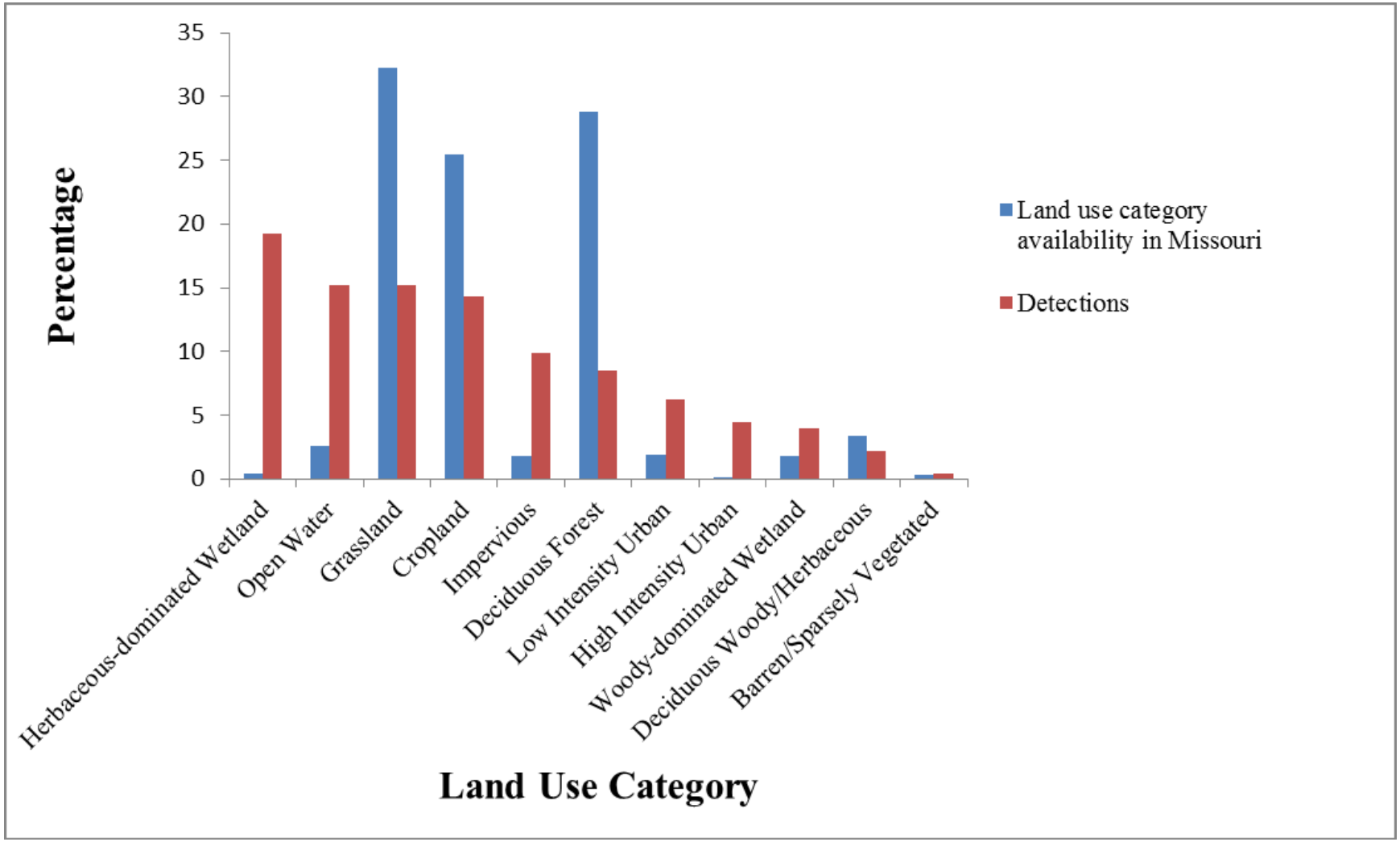

Figure 2.12: Percentage of Rusty Blackbird detections in each land use category compared to the percentage of land available in Missouri.

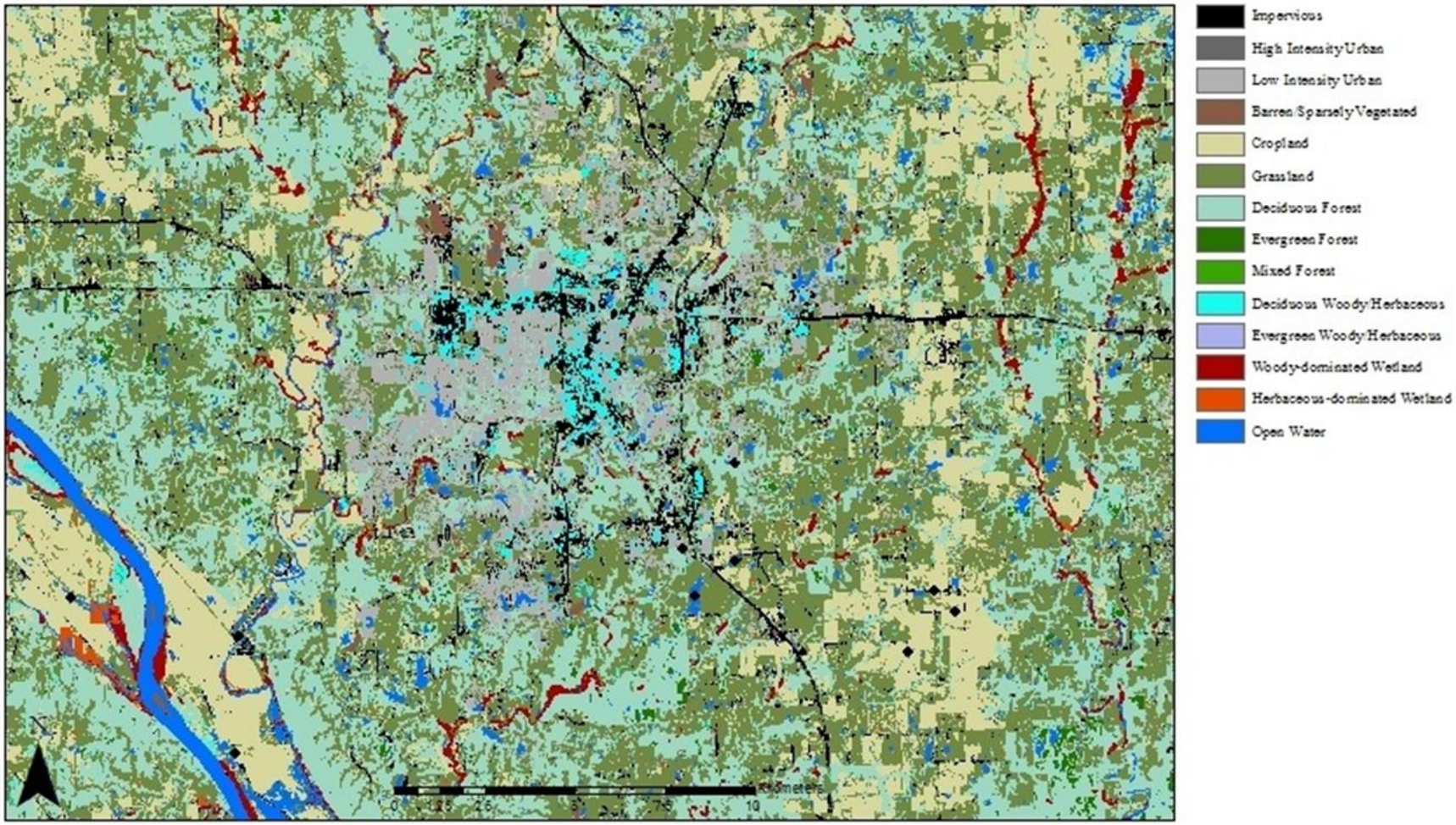

Figure 2.13: The land use layer over Columbia, Missouri, with Rusty Blackbird detections.