EVALUATING AVIAN COMMUNITIES OF THE BLANCO RIVER VALLEY USING OCCUPANCY MODELING AND LANDOWNER CONDUCTED SURVEYS

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EVALUATING AVIAN COMMUNITIES OF THE BLANCO RIVER VALLEY USING OCCUPANCY MODELING AND LANDOWNER CONDUCTED SURVEYS

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DEDICATION

To my parents and older sister and brother. They did not always understand why I chose this path, but have finally come to realize my dreams are going to lead me to amazing places and adventures.

And they're invited to visit.

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ABSTRACT

EVALUATING AVIAN COMMUNITIES OF THE BLANCO RIVER VALLEY USING OCCUPANCY MODELING AND LANDOWNER CONDUCTED SURVEYS

by

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Abundance and distribution of species tend to be linked, so when outside forces cause changes in population size there is a change in the number of sites occupied. Presence-nonpresence surveys are a simple method for monitoring these changes and obtaining valuable information on avian assemblages facing development and are arguably more accurate than point counts. The need for reliable and cost-effective

surveys is a constant challenge for biologists. Non-governmental agencies, private organizations or "citizen scientists" may be an answer to this problem. Landowners in Texas may perform bird censuses as one of the requirements to maintain agricultural tax status by managing for wildlife. These data are public information and can be used to track broad-scale changes across a landscape through time. The study of animal distributions at a large spatial scale has benefited immensely from collaborative work with amateur ornithologists. Using the Coefficient of Jaccard, I found landowner surveys had a 51% similarity to my presence-nonpresence surveys conducted in all seasons and 56% similarity to spring and summer. These results do not show a strong similarity between the surveys. Common, year-round species such as Northern Cardinal [spring $\psi = 0.9958$ (SE = 0.0369), summer $\psi = 0.9110$ (SE = 0.0453), and winter $\psi = 0.8897$ (SE = 0.0546)] and Carolina Chickadee [$\psi = 1.00$ SE = 0.000), $p = 0.5580$ (SE = 0.0304)] had high occupancy and high probabilities of detection and were detected on landowner surveys. Secretive species, such as the Yellow-billed Cuckoo [$\psi = 1.00$ (SE = 0.000, $p = 0.1017$ (SE = 0.0227)], had low detection probabilities but were also detected by landowner surveys. Eleven species were equally detectable every season and considered year-round residents. Species whose occupancy varied seasonally ($n = 10$) declined from spring to winter, except for the Eastern Phoebe. Four species varied in occupancy and detectability seasonally, but only the Eastern Phoebe and Canyon Wren had detection probabilities increase from spring to winter. All but four of these species were detected on landowner surveys. Occupancy results suggest landowner and contractor surveys may have limited value for use by biologists but important changes such as larger sample size and additional seasons might increase value for wildlife biologists.

CHAPTER I

INTRODUCTION

Abundance and distribution of species tend to be linked such that changes in abundance also results in changes in sites occupied (Gaston et al. 2000). Simple bird survey methods can be used to monitor such changes and provide valuable information on avian assemblages impacted by development and changing land use practices. Generally, avian surveys are conducted using point counts or distance sampling techniques at the habitat scale or geographical region (Bohning-Gaese 1997). Bart and Klosiewski (1989) suggested using only presence-nonpresence surveys to increase sample size, delineate range, and measure changes in density. They argue that presence-nonpresence surveys might be more accurate if surveyors did not count all individuals, and in the case of Breeding Bird Surveys (BBS), surveyors could conduct more routes and increase the overall sample size. Presence-nonpresence surveys are a commonly used occupancy modeling method for monitoring broad-scale changes (Rhodes et al. 2006). Occupancy is defined as the fraction of sampling units in a landscape where a species is present (Mackenzie and Royal 2005).

Detectability of a species will affect the calculated occupancy and should be assessed to avoid biased results. To offset biases from imperfect detections, surveys should be replicated within a relatively short amount of time. Finding easily conducted surveys which provide reliable information is a constant challenge for applied biologists (Hui et al. 2006). Additionally, methods for estimating detection probabilities can be expensive in both time and effort (Royle and Nichols 2003). As an alternative to conducting surveys, biologists could utilize available databases. Many organizations and individuals, from local Audubon chapters to non-governmental agencies such as the Texas Ornithological Society and The Nature Conservancy, gather data on animal populations. The National Zoo's Conservation and Research Center in Front Royal, Virginia, makes use of nearly 100 volunteers in a scientific survey of mammals along parts of the Appalachian Trail. Citizen scientists position remote cameras along the trail and periodically check and re-position them as well as gather data and record observations. Both this survey and its larger counterpart, the MEGA-Transect depend heavily on these citizen scientists, says its director William McShea, and would likely not reach completion without them (Cohn 2008). Working with citizen scientists is not a new idea. The Audubon Society's annual Christmas Bird Count began in 1900 and now has around 80,000 volunteers across the United States (Cohn 2008). In Texas, a potential source of data is information filed by landowners to maintain open space agricultural valuation of their land by wildlife management practices instead of farming or ranching. In 1995, voters approved wildlife management practices as a legitimate land use for open space agricultural valuation (Combs 2002). To be eligible, the property must have been qualified and appraised as agricultural land prior to declaring wildlife management as agricultural use. Texas Tax Code (Section 23.51(2)) includes wildlife management in the definition of agricultural uses of land. Section 23.51(2) defines wildlife management as:

> "Actively using land that at the time the wildlife management began was appraised as qualified open space land under this subchapter in at least three of the following ways: to propagate a sustaining breeding, migrating, or wintering, population of indigenous wild animals for human use, including food, medicine, or recreation (Stevens 2008)."

Landowners must complete three of the following practices: habitat control, erosion control, predator control, providing supplemental supplies of water, providing supplemental supplies of food, providing shelter, and making census counts to determine population. A portion of landowners receiving I-d-I open space land tax exemptions conduct bird censuses or employ environmental consulting organizations for that purpose. Such data might be useful for monitoring avian populations across a large geographical area such as a river basin, provided the data are accurate and reliable. Time and economic constraints often limit extensive field surveys by wildlife agency biologists especially over large areas. Using volunteers or "citizen scientists" allows wildlife biologists to gather data over a larger geographical area and over a longer time (Cohn

2008). Furthermore, gathering data at a larger scale may make the data of more value to biologists. Particularly at large scales and in a monitoring context, the proportion of sites within the region where a species is present can be used as a surrogate for population size (MacKenzie and Royle 2005). The study of distribution at large spatial and temporal scales has benefited hugely from collaborative work with amateur ornithologists (Greenwood 2007). Using data from a geographical scale may provide valuable insight into the avifauna population in the area, as well as its relationship to the vegetation and changing landscape that comes with development. As more people move from the cities to "ranchettes", especially in the Hill Country of Texas, it is important to track changes in animal populations. And since Texas is approximately 96% privately owned, landowners collecting data on their private land can increase study area for scientific studies. Strayer (1999) found that the willingness of volunteers to record presence-nonpresence data on mammals in their private gardens may have allowed for better monitoring of mammals in this habitat since population declines can be inferred from a decrease in the number of sites at which a species is detected. If landowner survey data are scientifically defensible, their use would be a significant contribution to wildlife management and conservation (Nupp and Swihart 2000).

My objectives were to monitor the avian assemblage of the Blanco River Valley using occupancy modeling, to compare landowner bird survey data to my presence-nonpresence data, and to assess the usefulness of landowner surveys in monitoring changes in avian populations.

CHAPTER II

MATERIALS AND METHODS

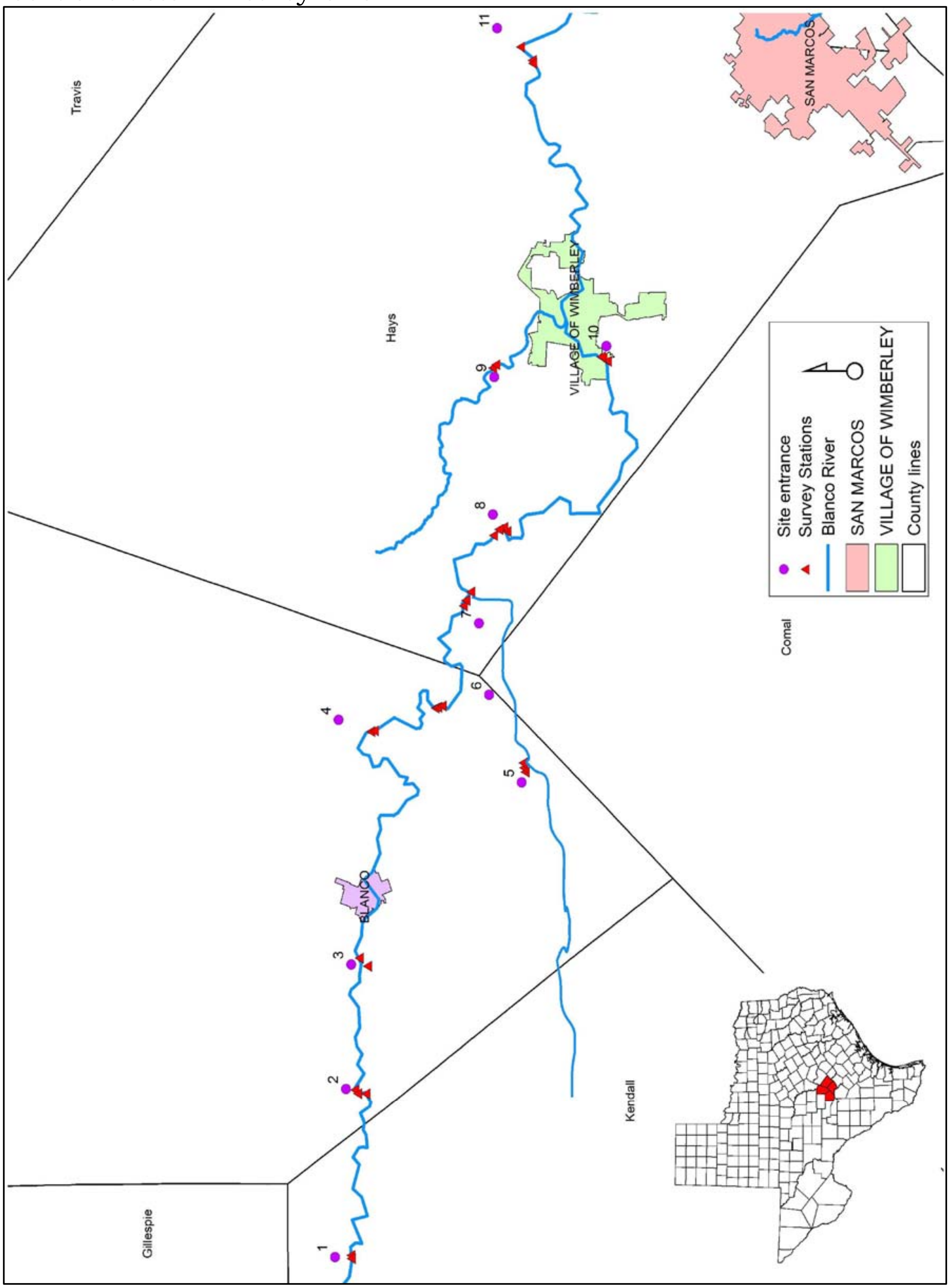
Study Area

The Blanco River begins as a spring in northwestern Kendall County. The river flows for approximately 140 km, through Kendall, Blanco, Comal, and Hays counties to a confluence with the San Marcos River southeast of the City of San Marcos (Texas Parks and Wildlife Department 2007). Topographic features of the river valley consist of limestone ledges and cliff faces covered with herbaceous vegetation and ashe juniper (*Juniperus ashei*) and oak (*Quercus* sp.) trees, as well as streambanks dominated by bald cypress (*Taxodium distichum*), pecan (*Carya illinoinensis*), and elm (*Ulmus* sp.) (Texas Parks and Wildlife Department 2007). Most of the property through which the river flows is privately owned ranch land, although some substantial residential development can be found in and near Wimberley, Texas. With the assistance of The Nature Conservancy personnel, I selected 11 privately own ranches along the Blanco River from near the headwaters in Kendall County, through Blanco and Comal counties to the last site in Hays County. Each site contained two to four survey stations (depending on river frontage), with a total of 30 survey stations for all sites (Fig. 1). Stations were spaced at least 250 m apart to minimize the probability of double detection (Ralph and Scott 1981), and located with a Garmin eTrex Legend (Garmin™, Olathe, Kansas) GPS unit.

Presence-nonpresence Surveys

Because seasonal changes can affect detectability, I sampled multiple seasons (Best and Peterson 1985). Each bird survey station was visited three times seasonally: spring, summer and winter. I surveyed spring stations (n = 30) from 13 April 2007 to 2 June 2007, summer stations (n = 29) from 5 August 2007 to 4 September 2007, and winter stations (n = 30) from 20 December 2007 to 26 January 2008. When possible, I visited all sites within a four-week period. Occasionally weather or landowner availability extended the survey period but never past the season. Surveys were conducted from sunrise to approximately 1030 h in all seasons, as well as varying afternoon time periods. Afternoon spring surveys were conducted from 1530 h to sunset, summer surveys from 1630 h to sunset, and winter surveys from 1430 h to sunset. Afternoon start times varied due to changes in temperature and seasonal changes in sunset. Procedurally, I approached each site quietly and waited 5 min to allow birds to acclimate to my presence. I collected data for 10 min, during which time I recorded all species

Figure 1. Map of the Blanco River Valley with major tributaries, study area, survey sites and number of stations. See Appendix 5 for specific locations determined by GPS.



detected aurally and visually. I also recorded data during the 5 min rest period, but did not include these data in occupancy analysis.

Landowner Data

I obtained landowner survey records for properties declaring wildlife management as agricultural use from County Appraisal District offices in Hays (Contact, Kay Beth Williams), and Blanco counties (Contact, Amy Hulburt). I used data only from properties adjacent to the Blanco River. These surveys were landowner conducted surveys or surveys done by environmental consulting firms. I used only the presence of species on landowner surveys for comparison to my data.

Statistical Tests

I analyzed presence-nonpresence of bird species on surveys using occupancy modeling in the program PRESENCE (MacKenzie et al. 2006). I examined 3 models (Table 1): a single season model with occupancy (ψ) and probability of detection (p) held constant, a multi-season model with colonization (γ), extinction (ε) and probability of detection (p) held constant but allowing for changes in occupancy (ψ) by season, and a multi-season model with colonization (γ), and extinction (ε) held constant but allowing occupancy (ψ), and probability of detection (p) to vary by season.

Table 1. Occupancy models examined for spring, summer and winter surveys.

Name	**Model**
Single-season constant	$\psi(.),p(.)$
Multi-season constant	$\psi(.),\gamma(.),\varepsilon(.),p(.)$
Multi-season variable detection	$\psi(.),\gamma(.),\varepsilon(.),p(\text{season})$

Since presence-nonpresence information is binary data, I used the Coefficient of Jaccard to compare my species richness data collected from presence-nonpresence surveys to landowner species richness data (Krebs 1999). Landowner surveys were only conducted in spring and summer, therefore, Jaccard's index was calculated comparing landowner data to all my yearly data, as well as comparing landowner data to only spring and summer data. Jaccard's index measures similarity where 0 is no similarity and 1 is identical.

CHAPTER III

RESULTS

I observed a total of 98 bird species during my study (Appendix 1). Forty species were unique to my surveys. Seventy-three bird species were identified on spring and summer landowner surveys (Appendix 2). Fifty-eight bird species were common to both surveys. Based on the Coeffiecient of Jaccard these surveys had a similarity of 0.51. During spring and summer, I detected 74 species, with 21 species being unique. A comparison of spring and summer bird species was slightly higher (0.56).

A total of 267 presence-nonpresence surveys from stations surveyed 3 times seasonally provided occupancy and detection probability results. Many common and year-round bird species [i.e Northern Cardinal (*Cardinalis cardinalis*), Black-crested Titmouse (*Baeolophus atricristatus*), *n* = 11, Lockwood 2005] to the area had 75-100% occupancy and high probabilities of detection (*n* = 6, Table 2). The majority of these species (*n* = 9) were also detected on landowner surveys (Appendix 2). The Brown-headed Cowbird (*Molothrus ater*), considered a nuisance species, was present at 100% of my stations in spring then declined during summer and winter. It had consistently low detections in all seasons [spring ψ = 1.0000 (SE = 0.0000), summer ψ = 0.2064 (SE = 0.1343), winter ψ = 0.0426 (SE = 0.0554), all seasons p = 0.0897 (SE = 0.0295)]. Neotropical migrants such as the Indigo Bunting (*Passerina cyanea*) [ψ = 0.5728 (SE = 0.1455), p = 0.2098 (SE = 0.0592)] and Yellow-billed Cuckoo (*Coccyzus americanus*) [ψ = 1.000 (SE = 0.000), p = 0.1017 (SE = 0.0227)] had low detectability. Yellow-billed Cuckoos occupied 100% of sites and were detected on landowner surveys, while Indigo Buntings occupied 57% of sites and were not detected by landowners.

Twenty species fit the simplest, constant single season model (Table 2). Northern Cardinal, Turkey Vulture (*Cathartes aura*), Brown-headed Cowbird, Carolina Wren (*Thryothorus ludovicianus*), Field Sparrow (*Spizella pusilla*) and Downy Woodpecker *(Picoides pubescens)* fit the multi-season model (n = 6). Northern Cardinal occupancy decreased from spring to winter [spring ψ = 0.9958 (SE = 0.0369), summer ψ = 0.9110 (SE = 0.0453), and winter ψ = 0.8897 (SE = 0.0546)]. Turkey Vulture occupancy was high in spring [ψ = 0.7649, (SE = 0.1644)], but declined in summer [ψ = 0.2037 (SE = 0.1068)] and winter [ψ = 0.1085 (SE = 0.0594)]. Carolina Wren, Field Sparrow, Brown-headed Cowbird and Downy Woodpecker occupancy also decreased from spring to winter (Table 2).

Four species [Black-crested Titmouse, Painted Bunting (*Passerina ciris*), Eastern Phoebe (*Sayornis phoebe*) and Canyon Wren (*Catherpes mexicanus*)] fit the multi-season model that allowed for variation in seasonal occupancy results and detectability. Black-crested Titmouse and Painted Bunting had consistent 100% occupancy at all stations (Table 2). Black-crested Titmouse detection declined from spring to summer then increased in winter [spring p = 0.6222 (SE = 0.0510), summer p = 0.3448 (SE = 0.0509), winter p = 0.4333 (SE = 0.0521)]. Painted Bunting detection declined from spring to summer [spring p = 0.4667 (SE = 0.0526), summer p = 0.2753 (SE = 0.1068)]. The Eastern Phoebe was the only species to have occupancy and detection increase from spring [ψ = 0.8459 (SE = 0.1337)], to summer [ψ = 0.8980 (SE = 0.0772)], and winter [ψ = 0.9256 (SE = 0.0868)]. The Canyon Wren had occupancy decline from spring to winter [spring ψ = 0.6080 (SE = 0.1270), summer ψ = 0.4417 (SE = 0.0880), winter ψ = 0.3208 (SE = 0.0929)], and was the only other species besides the Eastern Phoebe to have probability of detection increase from spring to winter [spring p = 0.1828 (SE = 0.0589), summer p = 0.4169 (SE = 0.0903), winter p = 0.5084 (SE = 0.1071)]. Sixty-eight species lacked sufficient detections (n = 9) to be analyzed in PRESENCE (Appendix 3).

Table 2. Occupancy (ψ), probability of detection (*p*), standard error (SE), model selected, AIC weight (ω), and number of parameters (k) by species. Some species had sufficient data for seasonal comparisons of data.

Species	**ψ**	**SE**	***p***	**SE**	**Model selected**	**ω**	**k**
Black-crested Titmouse					ψ(1),γ(.5),ε(.),*p*(season)	0.8747	4
Spring	1.0000	0.0000	0.6222	0.0510			
Summer	1.0000	0.0000	0.3448	0.0509			
Winter	1.0000	0.0000	0.4333	0.0521			
Carolina Chickadee	1.0000	0.0000	0.5580	0.0304	ψ(.),*p*(.)	0.0071*	2
Painted Bunting					ψ(1),γ(.5),ε(.),*p*(season)	0.8026	4
Spring	1.0000	0.0000	0.4667	0.0526			
Summer	1.0000	0.0000	0.2753	0.1068			
Winter	-	-	-	-			
Yellow-billed Cuckoo	1.0000	0.0000	0.1017	0.0227	ψ(.),*p*(.)	0.7555	2
Northern Cardinal					ψ(.),γ(.),ε(.),*p*(.)	0.7786	4
Spring	0.9958	0.0369	0.7229	0.0321			
Summer	0.9110	0.0453	0.7229	0.0321			
Winter	0.8897	0.0546	0.7229	0.0321			
Eastern Phoebe					ψ(.),γ(.),ε(.),*p*(season)	0.9987	6
Spring	0.8459	0.1337	0.3809	0.0764			
Summer	0.8980	0.0772	0.1809	0.0464			
Winter	0.9256	0.0868	0.5138	0.0674			

Table 2 continued.

Summer Tanager	0.8319	0.1126	0.2774	0.0468	ψ(.),*p*(.)	0.4993	2
Golden-fronted Woodpecker	0.8125	0.4917	0.0506	0.0337	ψ(.),*p*(.)	0.5992	2
White-eyed Vireo	0.8056	0.0948	0.3309	0.0471	ψ(.),*p*(.)	0.7693	2
American Goldfinch**	0.8056	0.2157	0.3034	0.0937	ψ(.),*p*(.)	1.0000	2
Turkey Vulture					ψ(.),γ(.),ε(.),*p*(.)	0.8231	4
Spring	0.7649	0.1644	0.2870	0.0689			
Summer	0.2037	0.1068	0.2870	0.0689			
Winter	0.1085	0.0594	0.2870	0.0689			
Mourning Dove	0.6864	0.1401	0.1536	0.0369	ψ(.),*p*(.)	0.8539	2
Brown-headed Cowbird					ψ(.),γ(.),ε(.),*p*(.)	0.3316*	4
Spring	1.0000	0.0000	0.0897	0.0295			
Summer	0.2064	0.1343	0.0897	0.0295			
Winter	0.0426	0.0554	0.0897	0.0295			
Belted Kingfisher	0.6620	0.3966	0.0565	0.0372	ψ(.),*p*(.)	0.5007	2
Bewick's Wren	0.6620	0.3966	0.0565	0.0372	ψ(.),*p*(.)	0.5681	2
Canyon Wren					ψ(.),γ(.),ε(.),*p*(season)	0.6733	6
Spring	0.6080	0.1270	0.1828	0.0589			
Summer	0.4417	0.0880	0.4169	0.0903			
Winter	0.3208	0.0929	0.5084	0.1071			

Table 2 continued.

Indigo Bunting	0.5728	0.1455	0.2098	0.0592	ψ(.),*p*(.)	0.3591	2
Red-eyed Vireo	0.5602	0.0964	0.4189	0.0543	ψ(.),*p*(.)	0.7388	2
Rio Grande Turkey	0.5336	0.1893	0.1049	0.0413	ψ(.),*p*(.)	0.0349*	2
Red-shouldered Hawk	0.5206	0.1550	0.1289	0.0418	ψ(.),*p*(.)	0.5901	2
Ladder-backed Woodpecker	0.5034	0.2939	0.1007	0.0640	ψ(.),*p*(.)	0.0310*	2
Ruby-crowned Kinglet**	0.4864	0.1717	0.3198	0.1188	ψ(.),*p*(.)	1.0000	2
Blue-gray Gnatcatcher	0.4830	0.2236	0.1282	0.0647	ψ(.),*p*(.)	0.6641	2
Carolina Wren					ψ(.),γ(.),ε(.),*p*(.)	0.9612	4
Spring	0.3534	0.1570	0.3247	0.1100			
Summer	0.1739	0.0737	0.3247	0.1100			
Winter	0.1520	0.0712	0.3247	0.1100			
Acadian Flycatcher	0.2078	0.0925	0.2426	0.0946	ψ(.),*p*(.)	0.4504	2
Chimney Swift	0.2078	0.0925	0.2426	0.0946	ψ(.),*p*(.)	0.5455	2
Eastern Wood-Pewee	0.2078	0.0925	0.2426	0.0946	ψ(.),*p*(.)	0.4902	2
Field Sparrow					ψ(.),γ(.),ε(.),*p*(.)	0.4361	4
Spring	0.1365	0.0636	0.6464	0.1213			
Summer	0.0699	0.0480	0.6464	0.1213			
Winter	-	-	-	-			
Black Vulture	0.0668	0.0457	0.4989	0.1189	ψ(.),*p*(.)	0.1031*	2

Table 2 continued.

Downy Woodpecker					ψ(.),γ(.),ε(.),*p*(.),	0.6757	4
Spring	0.0526	0.0540	0.2650	0.1230			
Summer	0.2078	0.0914	0.2650	0.1230			
Winter	0.2631	0.1379	0.2650	0.1230			

* Model with highest AIC weight (ω) estimated nonsensical parameters. Next highest model was selected.

- No estimates.

** Present in winter only. Model ψ(.),*p*(.) selected.

CHAPTER IV

DISCUSSION

The primary objective of my study was to use occupancy modeling to describe the avian communities of the Blanco River Valley. Secondly, I evaluated whether "citizen science" in the form of landowner bird surveys is a viable tool for applied biologists to track population changes over large areas.

Species expected to be detected by even novice birders did appear on landowner surveys. Common, year-round residents (Northern Cardinal, Carolina Chickadee (*Poecile carolinensis*), Carolina Wren, etc.) had high occupancy and were easily detectable by both presence-nonpresence surveys and landowner surveys. Of the 30 species capable of being analyzed in PRESENCE, the majority did not have occupancy and detectibility affected by season (n = 20). In theory this should mean that the species is detectable no matter the time of the year. Of these 20 species, 4 were not detected on landowner surveys. Those that were affected by seasonal changes were common species (n = 10), and detected on landowner surveys. This might indicate that landowners did not have difficulty detecting species in different seasons (i.e. spring and summer).

All but one seasonally affected species had occupancy and probability of detection decline from spring to winter. Many birds vocalize less outside the breeding season, making detection more difficult. This might explain the decline. The only two species to have probability of detection increase from spring to winter was the Eastern Phoebe and the Canyon Wren. The Eastern Phoebe is a flycatcher, a Genus which frequents areas where water is found, such as along rivers. All my stations were only located on the Blanco River, which could have made it easier for me to detect species that rely on waterways. The Eastern Phoebe is also known for vocalizing often and in any season, increasing detection. The Canyon Wren is a year-round resident which nests on cliff faces and rocky outcrops which are a common topographic feature of the Blanco River and my stations, making them a permanent resident of my survey stations and quite detectable in every season.

Four species unique to my surveys were Acadian Flycatcher (*Empidonax virescen*), Indigo Bunting, Belted Kingfisher (*Megaceryle alcyon*) and American Goldfinch (*Carduelis tristis*). The Acadian Flycatcher had both low occupancy [ψ = 0.2078 (SE = 0.0925)] and detection probabilities [p = 0.2426 (SE = 0.0946)]. Furthermore, the Genus *Empidonax* is known for their difficulty in identification, even amongst professionals. All are small and of similar color and markings, and usually detected by song rather than by sight. The Indigo Bunting is a migratory species, but easily identified by sight. It occupies much of the same habitat as the Painted Bunting (*Passerina ciris*) which had 100% occupancy and relatively high detection in spring [p = 0.4667 (SE = 0.0526)] and was detected by landowners. The Indigo Bunting occupied approximately 57% [ψ = 0.5728 (SE = 0.1455)] of my sites and was detected 21% [ψ = 0.2098 (SE = 0.0592)] of the time. The species has a similar song to Painted Bunting, which may explain why they were not detected by landowners and were also not as easily detected on presence-nonpresence surveys. The female Indigo Bunting is a drab brownish color, very similar to that of the drab olive-yellow color of the female Painted Bunting, which could have furthered complicated detection by the landowner. The Belted Kingfisher is almost entirely encountered near water. Landowners did not focus on riparian areas, which may explain why they did not detect this species. And lastly, the American Goldfinch would not likely be detected, because it is a winter resident to this area and landowner surveys were not typically conducted in spring and summer.

Coefficient of Jaccard did not indicate a close similarity between my species list and landowner species list. An index of 0.90 must be obtained to claim similarity (Krebs 1999). Landowner surveys detected slightly more than 50% of the species on my presence-nonpresence surveys. I found that the majority of the 40 species unique to my surveys were either winter only residents (43%), migratory (30%) or wading or water-foraging birds (17.5%). The landowner data were primarily breeding bird surveys, so winter resident species were largely absent. Some early landowner surveys could detect late departing winter residents, but they did not detect this group of birds as well as my surveys. Comparing only my spring and summer data to landowners' surveys, produced an increase from 0.51 to 0.56 in Jaccard's Coefficient of similarity. Thirty percent of species not detected by landowners were migratory, so were uncommon or only in the area for a short time. This would make them difficult to detect on a survey, especially for a novice birder or for surveys only conducted once per year.

Species that I found difficult to detect such as the Eastern Wood-Pewee (*Contopus virens*) [$\psi = 0.2078$ (SE = 0.0925), $p = 0.2426$ (SE = 0.0946)] and Downy Woodpecker [spring $\psi = 0.0526$ (SE = 0.0540), $p = 0.2650$ (SE = 0.1230); summer $\psi = 0.2078$ (SE = 0.0914), $p = 0.2426$ (SE = 0.0946); winter $\psi = 0.2631$ (SE = 0.1379), $p = 0.2426$ (SE = 0.0946)] were also present on landowner surveys, which may indicate landowner data may have limited usefulness for biologists. Many of the species detected by landowners and absent from my surveys were not found in the riparian zone such as Greater Roadrunner (*Geococcyx californianus*) and domesticated species of ducks such as Mallard Duck (*Anas platyrhynchos*) and Muscovy Duck (*Cairina moschata*) that might occur on man-made ponds and tanks near residential areas of the properties. Furthermore, 68 species detected on presence-nonpresence surveys had insufficient detections to run in PRESENCE. Had the data been analyzed it may have provided more insights into the similarities between presence-nonpresence surveys and landowner surveys.

In order for this free data to be a viable tool for biologists, I would suggest several modifications. Perhaps most importantly is contacting environmental consulting firms and landowners to orchestrate year-round surveys. Conducting at least one survey a season would record the avifauna from not only breeding and migration, but summer and winter residents. Survey replicates would also serve to increase sample size and potentially decrease error. Additionally, if their property adjoins a significant riparian area they should locate survey stations in that habitat. After these changes, it would be important to re-analyze my study area to see if the similarity index has increased and also to see if species with low occupancy or detection probabilities had been recorded on landowner surveys.

Many agencies have personnel and time restraints. If these survey data could be updated with the changes outlined above, the database could potentially be of great use in wildlife management across many landscapes and geographical areas, as well as in conserving bird populations in fragile riparian areas.

APPENDIX

Bird species list recorded from 5 minute and 10 minute periods.

Acadian Flycatcher	Fox Sparrow	Red-eyed Vireo
American Crow	Golden-cheeked Warbler	Red-shouldered Hawk
American Goldfinch	Golden-fronted Woodpecker	Red-tailed Hawk
American Redstart	Grasshopper Sparrow	Ring-necked Pheasant
American Robin	Great Blue Heron	Rio Grande Turkey
Barn Swallow	Great Horned Owl	Rough-winged Swallow
Belted Kingfisher	Great-tailed Grackle	Ruby-crowned Kinglet
Bewick's Wren	Green Heron	Ruby-throated Hummingbird
Black and White Warbler	Green Kingfisher	Rufous-crowned Sparrow
Black Vulture	House Finch	Savannah Sparrow
Black-chinned Hummingbird	House Sparrow	Scarlet Tanager
Black-crested Titmouse	House Wren	Scissor-tailed Flycatcher
Black-throated Green Warbler	Indigo Bunting	Scrub Jay
Blue Grosbeak	Ladder-backed Woodpecker	Song Sparrow
Blue Jay	Lark Sparrow	Spotted Sandpiper
Blue-gray gnatcatcher	Least Flycatcher	Spotted Towhee
Brown-headed Cowbird	Lesser Goldfinch	Summer Tanager
Canyon Wren	Lesser Scaup	Turkey Vulture
Carolina Chickadee	Lincoln's Sparrow	Vermillion Flycatcher
Carolina Wren	Louisiana Waterthrush	Western Kingbird
Cedar Waxwing	Mourning Dove	White-crowned Sparrow
Chimney Swift	Nashville Warbler	White-eyed Vireo
Chipping Sparrow	Northern Cardinal	White-throated Sparrow
Common Nighthawk	Northern Flicker	White-winged Dove
Common Raven	Northern Mockingbird	Wood Duck
Cooper's Hawk	Northern Pintail	Yellow-billed Cuckoo

Bird species list recorded from 5 minute and 10 minute periods continued.

Crested Caracara	Northern Shoveler	Yellow-rumped Warbler
Dark-eyed Junco	Orange-crowned Sparrow	
Dickcissel	Orchard Oriole	
Downy Woodpecker	Ovenbird	
Eastern Bluebird	Painted Bunting	
Eastern Phoebe	Prothonotary Warbler	
Eastern Wood-Pewee	Purple Martin	
Field Sparrow	Red-breasted Nuthatch	

Bird species detected by landowner or contractor surveys.

American Crow
American Robin
Ash-throated Flycatcher
Barn Swallow
Bewick's Wren
Black Vulture
Black-and-white Warbler
Black-bellied Whistling Duck
Black-chinned Hummingbird
Black-crested Titmouse
Black-throated Green Warbler
Blue Grosbeak
Blue Jay
Blue-gray Gnatcatcher
Broad-winged Hawk
Brown-headed Cowbird
Canyon Wren
Carolina Chickadee
Carolina Wren
Chimney Swift
Chuck-will's-Widow
Common Nighthawk
Common Raven
Common Grackle
Dickcissel
Downy Woodpecker
Eastern Phoebe
Eastern Wood-Pewee
Field Sparrow
Golden-cheeked Warbler
Golden-fronted Woodpecker
Gray Catbird
Great Blue Heron
Great Flycatcher
Greater Roadrunner
Great-tailed Grackle
House Finch
House Sparrow
Inca Dove
Ladder-backed Woodpecker
Lark Sparrow
Lesser Goldfinch
Mallard
Mourning Dove
Muscovy Duck
Nashville Warbler
Northern Bobwhite
Northern Cardinal
Northern Mockingbird
Northern Parula
Northern Rough-winged Swallow
Painted Bunting
Purple Martin
Red-eyed Vireo
Red-shouldered Hawk
Red-tailed Hawk
Rio Grande Turkey
Ruby-crowned Kinglet
Ruby-throated Hummingbird
Rufous-crowned Sparrow
Scissor-tailed Flycatcher
Scott's Oriole
Sharp-shinned Hawk
Spotted Sandpiper
Summer Tanager
Turkey Vulture
Upland Sandpiper
Western Scrub Jay
White-crowned Sparrow
White-eyed Vireo
White-winged Dove
Yellow-billed Cuckoo
Yellow-rumped Warbler

Bird species with insufficient detections to run in PRESENCE.

Species	**No. of detections**
American Crow	2
American Redstart	1
American Robin	1
Barn Swallow	2
Black-and-white Warbler	1
Black-chinned Hummingbird	5
Black-throated Green Warbler	2
Blue Grosbeak	2
Cedar Waxwing	1
Chipping Sparrow	3
Common Nighthawk	4
Common Raven	3
Common Yellowthroat	1
Cooper's Hawk	1
Crested Caracara	1
Dark-eyed Junco	5
Dickcissel	4
Eastern Bluebird	2
Fox Sparrow	2
Golden-cheeked Warbler	2
Grasshopper Sparrow	1
Great Blue Heron	6
Great Horned Owl	2
Great-tailed Grackle	1
Green Heron	3
Green Kingfisher	1
House Finch	2
House Sparrow	1 (5 min period only)
House Wren	4
Least Flycatcher	5
Lesser Goldfinch	1 (5 min period only)
Lesser Scaup	3 (5 min period only)

Bird species with insufficient detections to run in PRESENCE continued.

Lincoln's Sparrow	3
Louisiana Waterthrush	1
Nashville Warbler	1
Northern Flicker	2
Northern Mockingbird	8
Northern Parula	2
Northern Pintail	1
Northern Rough-winged Swallow	5
Northern Shoveler	1
Orange-crowned Warbler	1
Orchard Oriole	1
Ovenbird	2
Prothonotary Warbler	2
Purple Martin	9
Red-breasted Nuthatch	1
Red-tailed Hawk	1
Ring-necked Pheasant	1
Ruby-throated Hummingbird	2
Rufous-crowned Sparrow	2
Savannah Sparrow	6
Scarlet Tanager	2
Scissor-tailed Flycatcher	3
Song Sparrow	3
Spotted Sandpiper	4
Spotted Towhee	1
Vermillion Flycatcher	1
Western Kingbird	1 (5 min period only)
Western Scrub Jay	6
White-crowned Sparrow	1
White-throated Sparrow	2
White-winged Dove	6
Wood Duck	1
Yellow Warbler	2
Yellow-bellied Flycatcher	1
Yellow-bellied Sapsucker	5
Yellow-rumped Warbler	7

Bird species list by season.

Spring

Acadian Flycatcher
American Redstart
Barn Swallow
Belted Kingfisher
Bewick's Wren
Black Vulture
Black-chinned Hummingbird
Black-crested Titmouse
Black-throated Green Warbler
Blue Grosbeak
Blue Jay
Blue-gray Gnatcatcher
Brown-headed Cowbird
Canyon Wren
Carolina Chickadee
Carolina Wren
Cedar Waxwing
Chimney Swift
Common Yellowthroat
Common Nighthawk
Cooper's Hawk
Dickcissel
Downy Woodpecker
Eastern Bluebird
Eastern Phoebe
Eastern Wood-Pewee
Field Sparrow
Golden-cheeked Warbler
Golden-fronted Woodpecker
Grasshopper Sparrow
Great Blue Heron
Great Horned Owl
Great-tailed Grackle
Green Heron
House Finch
House Sparrow
Indigo Bunting
Ladder-backed Woodpecker
Lark Sparrow
Lesser Goldfinch
Louisiana Waterthrush
Mourning Dove
Nashville Warbler
Northern Cardinal
Northern Mockingbird
Northern Parula
Northern Rough-winged Swallow
Painted Bunting
Purple Martin
Red-shouldered Hawk
Rio Grande Turkey
Rough-winged Swallow
Ruby-throated Hummingbird
Scarlet Tanager
Scissor-tailed Flycatcher
Spotted Sandpiper
Summer Tanager
Turkey Vulture
Vermillion Flycatcher
Western Kingbird
Western Scrub Jay
White-eyed Vireo
White-throated Sparrow
White-winged Dove
Yellow-bellied Flycatcher
Yellow-billed Cuckoo
Yellow-rumped Warbler

Bird species list by season continued.

Summer

Acadian Flycatcher
American Crow
Belted Kingfisher
Bewick's Wren
Black-and-white Warbler
Black Vulture
Black-chinned Hummingbird
Black-crested Titmouse
Blue Grosbeak
Blue Jay
Blue-gray Gnatcatcher
Brown-headed Cowbird
Canyon Wren
Carolina Chickadee
Carolina Wren
Chimney Swift
Downy Woodpecker
Eastern Phoebe
Eastern Wood-Pewee
Field Sparrow
Golden-fronted Woodpecker
Great Blue Heron
Great Horned Owl
Great-tailed Grackle
Green Heron
Indigo Bunting
Ladder-backed Woodpecker
Mourning Dove
Northern Cardinal
Northern Rough-winged Swallow
Orchard Oriole
Painted Bunting
Prothonotary Warbler
Purple Martin
Red-eyed Vireo
Red-shouldered Hawk
Rio Grande Turkey
Ruby-throated Hummingbird
Spotted Sandpiper
Summer Tanager
Turkey Vulture
White-eyed Vireo
Wood Duck
Yellow Warbler
Yellow-billed Cuckoo

Bird species list by season continued.

Winter

American Crow
American Goldfinch
American Robin
Belted Kingfisher
Bewick's Wren
Black Vulture
Black-crested Titmouse
Blue Jay
Brown-headed Cowbird
Carolina Chickadee
Carolina Wren
Cedar Waxwing
Chipping Sparrow
Common Nighthawk
Common Raven
Cooper's Hawk
Crested Caracara
Dark-eyed Junco
Downy Woodpecker
Eastern Bluebird
Eastern Wood-Pewee
Fox Sparrow
Golden-fronted Woodpecker
Great Blue Heron
Great-tailed Grackle
Green Kingfisher
House Finch
House Wren
Ladder-backed Woodpecker
Lark Sparrow
Lesser Scaup
Lincoln's Sparrow
Mourning Dove
Nashville Warbler
Northern Cardinal
Northern Flicker
Northern Mockingbird
Northern Pintail
Northern Shoveler
Orange-crowned Sparrow
Ovenbird
Painted Bunting
Red-breasted Nuthatch
Red-eyed Vireo
Red-shouldered Hawk
Red-tailed Hawk
Ring-necked Pheasant
Rio Grande Turkey
Ruby-crowned Kinglet
Savannah Sparrow
Song Sparrow
Spotted Sandpiper
Spotted Towhee
Turkey Vulture
Western Scrub Jay
White-crowned Sparrow
White-throated Sparrow
White-winged Dove
Yellow-bellied Sapsucker
Yellow-rumped Warbler

Study sites and stations locations.

Site/Station ID	Latitude	Longitude
1	30.11082734	-98.63021672
1-1	30.10643799	-98.62935447
1-2	30.10631394	-98.62995487
2	30.10260712	-98.53258473
2-1	30.10381646	-98.53403388
2-2	30.10236413	-98.53612675
2-3	30.09811954	-98.53627863
3	30.09910458	-98.46207842
3-1	30.10173650	-98.45857018
3-2	30.09704992	-98.46325055
4	30.01428902	-98.35458269
4-1	30.01447711	-98.35269844
4-2	30.01507206	-98.35027423
4-3	30.01544656	-98.34753871
5	30.03279400	-98.30836505
5-1	30.06095636	-98.31568832
5-2	30.05968633	-98.31522195
5-3	30.05743244	-98.31463370
6	30.03784812	-98.26753856
6-1	30.04668172	-98.25747583
6-2	30.04473226	-98.25430286
6-3	30.04216790	-98.24951981
7	30.11121383	-98.32215831
7-1	30.09463702	-98.32889241
7-2	30.09265848	-98.32852981
8	30.02576854	-98.21553136
8-1	30.02450304	-98.21636058
8-2	30.02517921	-98.21386621
8-3	30.02729430	-98.21377829
8-4	30.03004767	-98.21723959
9	30.02904310	-98.12229325
9-1	30.03001012	-98.12152522
9-2	30.02817021	-98.11967282
10	29.97273406	-98.11392291
10-1	29.97077680	-98.11829978
10-2	29.97243759	-98.11628686
10-3	29.97334233	-98.11568529
11	30.02604372	-97.92749589
11-1	30.01408651	-97.93835859
11-2	30.00817836	-97.94607723
11-3	30.00776530	-97.94785428

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VITA

Jennifer Marie Korn was born in Garland, Texas, on July 24, 1978. She is the third child to John Michael Korn and Hella Della Goulding Korn, sister to Michele Valentine and Jason Korn. She received her Bachelor of Science in Biology, minor in Anthropology at the University of Texas at Arlington (UTA), Arlington, Texas in May 2003. In January 2006, she entered the Wildlife Ecology graduate program at Texas State University-San Marcos. During her graduate years she worked as an instructional assistant in freshman Biology, and upper level Mammalogy and Techniques in Wildlife Management labs. She also worked for the Texas Forest Service as a Certified Wildland Firefighter and fire and vegetation research. She was president of the Student Chapter of the Wildlife Society at Texas State in 2007, and president of Tri-Beta Biological Society in 2008.

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