Bird and Vegetation Community Relationships in the Middle Rio Grande Bosque: 2010 Report

Submitted to:

U.S. Army Corps of Engineers
New Mexico Department of Game and Fish
(T-32-P-2, Project 10 final report)
Middle Rio Grande Conservancy District

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June 2011

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EXECUTIVE SUMMARY

Between December 2003 and August 2010, we monitored avian abundance and species richness at 64 transects representing 20 vegetation and community structure (C/S) types. Our study area encompassed the Middle Rio Grande bosque between the Bernalillo Bridge and the La Joya Game Management Area, New Mexico. During summer, C/S types supporting dense understory vegetation tended to support higher avian density and richness than C/S types with relatively sparse understory vegetation. Similarly, during winter, C/S types incorporating dense vegetation with standing water supported the highest densities and richness of birds. Among terrestrial C/S types, the highest winter avian densities and richness occurred in pure stands of Russian olive (*Elaeagnus angustifolia*) and stands incorporating extensive amounts of New Mexico olive (*Forestiera neomexicana*). These results suggest the value of Russian olive to wintering birds is greater than previously acknowledged. Currently, the mechanical removal of all non-native vegetation is a common management practice throughout much of the middle Rio Grande bosque. During all seasons, areas subjected to such treatment supported among the lowest avian densities and richness levels, at least over the short term. Continued monitoring is imperative in order to assess the longer-term impact of non-native vegetation removal, and the success of subsequent re-vegetation efforts.

INTRODUCTION

The riparian cottonwood forest that borders the Middle Rio Grande in central New Mexico, commonly referred to as “bosque,” provides important habitat for wildlife, including up to 280 species of birds that use the area for nesting, migrating, and wintering (Hink and Ohmart 1984). About 85 to 95 of these bird species breed in the Middle Rio Grande Valley, most of which are primarily associated with riparian shrub or forest habitats.

Several management issues, including the removal of exotic vegetation, fire prevention, water conservation, and development impact the bosque and adjacent lands. A variety of habitat restoration initiatives also might affect wildlife dependent upon this habitat over both the short and long term. Because of the potential conflict between avian conservation and management actions, it is important to monitor bird use of the bosque.

Since 2004, numerous habitat restoration initiatives have been conducted within the middle Rio Grande bosque. The primary goal of these projects is to remove non-native understory vegetation in order to reduce fuel loads, and thereby minimize the risk of fire. These projects have impacted vast areas of the middle Rio Grande. For example, just within the Rio Grande Valley State Park, over 2,000 acres were mechanically thinned in 2004 alone (USACE 2004). A secondary goal of these projects is to restore native vegetation, although re-vegetation efforts have not kept pace with thinning activities. Unfortunately, the removal of non-native understory vegetation, at least initially, has altered the vegetation structure to a type that has been shown to support fewer birds (Hink and Ohmart 1984). The functional role of native vegetation has been replaced by exotics along many rivers with altered hydrologic conditions (Howe and Knopf 1991, Poff et al. 1997), and the subsequent removal of this non-native vegetation can disrupt avian communities (Zavaleta et al. 2001).

Hawks Aloft, Inc., contracted by the U.S. Army Corps of Engineers, the Middle Rio Grande Conservancy District through the U.S. Forest Service Collaborative Forest Restoration Program, and the New Mexico Department of Game and Fish, is conducting a songbird monitoring study in the Middle Rio Grande bosque between the Bernalillo Bridge and the La Joya State Game Refuge, New Mexico. Surveys are being conducted along the Rio Grande on lands managed by the Middle Rio Grande Conservancy District, City of Albuquerque Open Space Division, the Village of Corrales, the City of Rio Rancho, and the New Mexico Department of Game and Fish.

This project is the first comprehensive replication of the avian and vegetative portions of the Middle Rio Grande Biological Survey (MRGBS; Hink and Ohmart 1984). We are sampling avian abundance and species richness relative to vegetation community and structure (C/S) types within the Middle Rio Grande bosque. One of the primary objectives is to collect long-term data (i.e. at least 10 years) comparing current avian abundance and species richness among current C/S types. These long-term data will document changes in C/S types and subsequent avian density and richness that occur over the length of the study, and provide baseline data for comparisons with future studies. This information is especially important given the extensive restoration efforts currently being undertaken by land managers throughout the middle Rio Grande. Through continuous monitoring, this study will provide up-to-date information to land managers regarding the short-term impact of restoration activities on avian populations. It also will provide land managers with avian density and richness information as replanted areas undergo successional growth of vegetation, thereby providing them with a measure to assess the effectiveness of restoration activities.

Another primary objective of this study is to collect long-term data on individual bird species in the bosque. These data will document the current status of individual species in the Middle Rio Grande bosque as a whole, as well as their status in specific C/S types. The collection of long-term data also will reveal any trends or change in status of specific species during the length of the study, and how species are impacted by restoration efforts over time. This knowledge is particularly important in regard to species of conservation concern that are dependent on the bosque at different times of year.

Other objectives of this study focus on changes in the bosque since the MRGBS in the early 1980’s. In collaboration with Natural Heritage New Mexico, we are currently incorporating the original MRGBS raw data into a database that will allow us to directly compare current avian and vegetation characteristics with those present in the early 1980's. Ultimately, we intend to provide a 25+ year comparison of (1) change in avian abundance and species richness, (2) change in vegetation communities and structure types, and (3) comparison of current avian abundance and species richness relative to C/S types present 25+ years ago.

This interim report documents monitoring efforts performed during the 2010 field season (December 2009 through August 2010), but also includes comparisons with data collected during the 2004-2009 field seasons (December 2003 through August 2009).

STUDY AREA AND METHODOLOGY

Study Area

The study area encompasses 79 river miles (127 km) between the Bernalillo Bridge in the north, and the La Joya State Game Refuge to the south (Appendices 1-13). Within this reach of the Rio Grande, we established 64 transects representing 20 vegetation community and structure (C/S) types. Transects were generally 700-800 m in length, although nine transects were limited to lengths shorter than 700 m due to significant changes in C/S type at both ends.

We duplicated 27 transects surveyed during the 1981-1982 Middle Rio Grande Biological Survey (MRGBS; Hink and Ohmart 1984), relocated seven transects surveyed during the MRGBS within their original stands, and included 30 additional transects established within the original survey area.

To name transects, we followed the protocol used in the MRGBS. The names of duplicated transects are the same as in the MRGBS (Appendix 14). We referred to transects established in stands that contained MRGBS transects, but not in the original location, as “alternate” transects. These transects were given the same names as the MRGBS transects they replaced, but with an “A” added to the end. The locations of these transects are not identical to MRGBS transects due to changes in habitat composition, habitat type, urban development, or to incorporate under-represented C/S types.

New transects that we established were given location names following MRGBS naming protocol (i.e. Interstate 40 was the demarcation between north and south and the Rio Grande was the demarcation between east and west). The specific numbers included in the names of these transects start with larger numbers than any used in MRGBS in the relevant location area. The exceptions to this protocol are Oxbow 1 and Oxbow 2, which were named as such because they occur in an area widely known as "the oxbows," and the KW transects (KW01 through KW05), which were original MRGBS transects. The names of new transects have an "N" added to the end.

Vegetation Community and Structure Types

Nomenclature for vegetation community and structure type generally follows that used in the MRGBS (Table 1). Vegetation stands were grouped into six structure types defined by overall vegetation height and amount of vegetation in the understory layers. Types 1, 3, and 5 had a significant amount of understory, whereas types 2, 4, and 6 contained relatively sparse understory.

Table 1. Key to plant species and community type abbreviations used in text, tables, figures, and appendices.

Abbreviation	Common name	Scientific name
C	Rio Grande cottonwood	*Populus fremonti*
CW	coyote willow	*Salix exigua*
MB	littleleaf mulberry	*Morus microphylla*
NMO	New Mexico olive	*Forestiera neomexicana*
RO	Russian olive	*Elaeagnus angustifolia*
SB	silver buffaloberry	*Shepherdia argentea*
SC	salt cedar	*Tamarix chinensis*
SE	Siberian elm	*Ulmus pumila*
TW	tree willow	*Salix amygdaloides* or *Salix gooddingii*
Non-species specific habitat abbreviations:		
BURN	burned habitat	
DR	drain	
MH	marsh habitat	
OP	open terrestrial habitat	
OW	open water	

We combined similar C/S types into groups we called analysis categories. We defined analysis category (Appendix 15) as transects of a particular C/S type, grouped for avian abundance and species richness calculations. For example, there were two C/S types that included a mature cottonwood (*Populus fremonti*) overstory with New Mexico olive (*Forestiera neomexicana*) as the most dominant understory species: cottonwood with a dense New Mexico olive understory (C/NMO 1) and cottonwood with a dense New Mexico olive and Russian olive (*Elaeagnus angustifolia*) understory (C/NMO-RO 1). These two C/S types were combined into a single analysis category: mature cottonwood overstory with a dense New Mexico olive understory (C/NMO 1). Transects in a specific analysis category may have contained different secondary vegetation species in their C/S type, but we found this did not result in significant differences in avian densities or species richness compared to other transects in the same analysis category. In general, these secondary species were present at all transects in a particular analysis category, but were not prominent enough to be included in the specific C/S type for some transects in the analysis category.

Structure type 1 had dense vegetation in all foliage layers, with a cottonwood overstory averaging at least 12 m in height. The C/S 1 types in this study (Table 2) were Cottonwood/coyote willow 1 (C/CW 1), Cottonwood/coyote willow-mulberry 1 (C/CW-MB 1), Cottonwood/mulberry-Siberian elm 1 (C/MB-SE 1), Cottonwood/mulberry-salt cedar 1 (C/MB-SC 1), Cottonwood/New Mexico olive 1 (C/NMO 1), Cottonwood/New Mexico olive-Russian olive 1 (C/NMO-RO 1), Cottonwood/Russian olive 1 (C/RO 1), and Cottonwood/Russian olive-salt cedar 1 (C/RO-SC 1). For our data analysis, we combined similar C/S types to increase sample size and because our data indicated that the secondary understory species listed were insignificant in terms of impact on bird density and species richness and overall habitat structure. Thus, we combined C/RO-SC 1 and C/RO 1 into C/RO 1 for analysis (see Appendix 15). Similarly, we combined C/CW-MB 1 and C/CW 1 into C/CW 1, C/MB-SE 1 and C/MB-SC 1 into C/MB 1, and C/NMO-RO 1 and C/NMO 1 into C/NMO 1 for analysis.

At one location, a bosque fire in late February, 2007 consumed over 90% of the standing vegetation. Prior to the fire, this transect had been classified as C/RO-SC 1. For field seasons after the fire (spring 2007, summer 2007, winter and summer 2008, 2009, and 2010), we classified this site as BURN 1, because the “skeletal remains” of the vegetation depicted the structure of a type 1 stand.

Type 2 areas were mature stands of cottonwood that averaged at least 12 m in height with a sparse and/or patchy understory. In contrast to MRGBS, we separated the type 2 stands into two C/S types: C-2 natural to represent stands with a naturally occurring sparse understory and C-2 artificial to represent stands with a mechanically thinned understory (Fig. 1). In C-2 artificial stands, all woody, non-native understory vegetation was removed within the census area sometime after August, 2003. During subsequent years of this study some C-2 artificial stands were reclassified as C-2 natural when understory vegetation re-established itself. Other C-2 artificial stands have not experienced any substantial understory vegetation re-establishment during the course of this study.

Prior to summer 2008, we established one transect in an area that had previously supported a mature cottonwood canopy and dense understory, but where a bosque fire in late February, 2007 consumed over 90% of the standing vegetation. Subsequent post-fire thinning efforts reduced non-native re-sprouts. We classified this site as BURN 2 because the "skeletal remains" of the cottonwoods and thinning of post-fire re-sprouts depicted the structure of a type 2 stand (Table 2). We re-classified this site as BURN OP (see below) prior to winter 2010 due to additional thinning and snag removal.

Prior to summer 2010, we established one transect in an area that had previously supported a mature cottonwood canopy and dense understory, but where a bosque fire in May, 2010 consumed a majority of the standing vegetation, with much of the understory vegetation completely consumed. We classified this site as BURN 2 for summer 2010 because the "skeletal remains" of the cottonwoods and understory vegetation depicted the structure of a type 2 stand.

Type 3 stands contained intermediate-age trees of 6-12 m in height with dense vegetation up to 9 m in height. The type 3 stands in this study were C-RO/CW 3 and RO 3 (Table 2).

Type 4 stands contained intermediate-aged trees of 6-12 m in height with a sparse understory. The majority of foliage in this C/S type was between 4.6 and 10 m in height. Through the 2010 field season we did not survey any type 4 stands.

Type 5 stands were dense stands with the majority of foliage occurring between 0 and 6 m. The type 5 stands in this study were CW 5, CW-RO 5, DR 5, MH 5-OW, NMO-RO 5, NMO-SB 5, RO 5, RO-CW 5, RO-SC 5, and SC 5 (Table 2). Due to structural and avian density similarities, we combined RO-CW 5, RO-SC 5, and RO 5 into RO 5; and CW 5 and CW-RO 5 into CW 5 for analysis (Appendix 15). We also combined NMO-SB 5 and NMO-RO 5 into NMO 5 for analysis.

Figure 1. In C-2 artificial stands (top), essentially all woody understory vegetation has been mechanically removed. In contrast, C-2 natural stands (bottom) support a naturally occurring sparse understory.

Type 6 stands had low, relatively sparse herbaceous and/or shrubby vegetation, with most of the foliage less than 1.5 m in height. The type 6 stands in this study were CW 6 and DR 6 (Table 2).

Table 2. Key to community and structure type abbreviations used in text, tables, figures, and appendices.

Abbreviation	C/S Type
BURN 1	at least 90% of present vegetation burned in an area that previously supported a cottonwood overstory w/ dense understory vegetation
BURN 2	at least 90% of present vegetation burned in an area that previously supported a cottonwood overstory w/ post-fire conditions resulting in a Type 2 stand structure
BURN OP	at least 90% of present vegetation burned in an area that previously supported a cottonwood overstory w/ post-fire restoration resulting in an OP structure
C/CW 1	cottonwood overstory w/ dense coyote willow dominated understory
C/CW-MB 1	cottonwood overstory w/ dense coyote willow and mulberry dominated understory
C/MB 1	cottonwood overstory w/ dense mulberry dominated understory
C/MB-SC 1	cottonwood overstory w/ dense mulberry and salt cedar dominated understory
C/MB-SE 1	cottonwood overstory w/ dense mulberry and Siberian elm dominated understory
C/NMO 1	cottonwood overstory w/ dense New Mexico olive dominated understory
C/NMO-RO 1	cottonwood overstory w/ dense New Mexico olive and Russian olive dominated understory
C/RO 1	cottonwood overstory w/ dense Russian olive dominated understory
C/RO-SC 1	cottonwood overstory w/ dense Russian olive and salt cedar dominated understory
C-2 natural	cottonwood overstory w/ naturally sparse understory vegetation
C-2 artificial	cottonwood overstory w/ mechanically cleared understory
C-RO/CW 3	intermediate-sized cottonwood and Russian olive overstory w/ coyote willow dominated understory
CW 5	coyote willow dominated vegetation >5 ft. tall
CW-RO 5	coyote willow w/ smaller amounts of Russian olive >5 ft. tall
CW 6	relatively sparse coyote willow dominated vegetation <5 ft. tall
DR 5	drain area w/ edge vegetation >5 ft. tall
DR 6	drain area w/ edge vegetation <5 ft. tall
MH 5-OW	marsh habitat >5 ft. tall w/ open water areas
NMO 5	New Mexico olive dominated vegetation >5 ft. tall
NMO-RO 5	New Mexico olive and Russian olive dominated vegetation >5 ft. tall
NMO-SB 5	New Mexico olive and silver buffaloberry dominated vegetation >5 ft. tall
OP	mechanically-thinned terrestrial open area w/ minimal woody vegetation <5 ft. tall
RO 3	Russian olive dominated vegetation 20-30 ft. tall
RO 5	Russian olive dominated vegetation >5 ft. tall
RO-CW 5	Russian olive with smaller amounts of coyote willow >5 ft. tall
RO-SC 5	Russian olive with smaller amounts of salt cedar >5 ft. tall
SC 5	salt cedar dominated vegetation >5 ft. tall

OP stands were mechanically thinned areas with no significant woody vegetation remaining. We re-classified a BURN 2 stand as BURN OP prior to winter 2010 because continued thinning of woody re-sprouts and the removal of most cottonwood snags at the site left a landscape best categorized as OP.

Original C/S types for duplicated transects were taken directly from the MRGBS (Appendix 15). For alternate and new transects, original C/S types were determined from 1983 U.S. Army Corps of Engineers vegetation maps that followed MRGBS C/S classifications. We field-checked current C/S types using MRGBS classifications. Hink and Ohmart (1984) found that transects on habitat edges supported greater avian density and species richness than transects in the interior of homogenous habitats. We defined edge transects as those which border a C/S change on the immediate opposite side of the transect line, and interior transects as those which are a contiguous C/S type on both sides of the transect line (Appendix 15). We do not differentiate between edge and interior transects in the data analyses presented in this interim report.

Avian Survey Methods

Bird surveys for the 2010 field season began in December, 2009. Each transect was surveyed three times monthly, with a minimum five-day waiting period between consecutive surveys at a site. Surveys were conducted within the first four hours after sunrise. Due to budgetary limitations, only 53 transects were surveyed during the winter field season (December through February). All 64 transects were surveyed during summer 2010 (June through August). We did not conduct any surveys during spring 2010 (March through May) or fall 2010 (September through November). Because we have not conducted fall surveys since 2007 and spring surveys since 2008, our 2008 interim report provided a comprehensive review of the fall data collected during this study, and our 2009 interim report provided a comprehensive review of the spring data collected during this study. Thus, we do not present any spring or fall data in this interim report.

To be consistent with the MRGBS, we followed the survey protocol and density estimate calculations described by Emlen (1971), and modified by Balph et al. (1977) and Anderson et al. (1977a). Observers slowly walked the length of each transect, recording all birds seen or heard within the transect strip. Observers recorded the lateral distance of the bird from the transect line using the following distance classes: <5 m, 5-15 m, 16-30 m, 31-45 m, 46-60 m, 61-80 m, and 81-122 m. Avian density estimates were calculated and expressed as the number of birds per 100 acres. In the MRGBS, the number of birds per 100 acres was calculated using observations within 15 m. In contrast, we calculated the number of birds per 100 acres based on our observations within 30 m of the transect line. Thirty m is an accepted distance for skilled observers to estimate distance to within approximately 10% of the actual distance; accuracy declines beyond 30 m (Emlen 1971, Verner and Ritter 1988, Rumble and Gobeille 2004). In addition, by analyzing data within 30 m of the transect line, we were able to double the analysis area without a significant reduction in our detection rates or distance accuracy. Beyond 30 m our ability to detect birds rapidly decreased, especially in dense C/S types. Since we analyzed abundance data based on modified Emlen count protocol (i.e. including both visual and auditory detections), we have presented relative avian densities and not absolute densities.

We present our species richness data in terms of the average number of species per transect at densities $\geq$1.5 individuals per 100 acres for each C/S type. In order to be consistent with our avian abundance methods, we included only species recorded within 30 m of the transect line when calculating species richness. Conversely, in the MRGBS, species richness was calculated as the total number of species present in a C/S type in densities $\geq$0.5 individuals per 100 acres within a season (Hink and Ohmart 1984). The MRGBS calculations were based on all sightings of a species regardless of distance from the transect line. By choosing $\geq$1.5 individuals per 100 acres as the density threshold for inclusion in species richness calculations, at least three individuals of a species had to be observed on a given transect for the season in question. Because some transects had relatively small census areas, using the 0.5 individuals per 100 acres threshold followed by Hink and Ohmart could have potentially been achieved by the observation of a single individual.

We defined census area (Appendix 14) as the size of the area at each transect for which we included observations used in our avian abundance and species richness calculations. This area was determined by multiplying the transect length by the transect width of 30m from each side of a two-sided transect. For transects with widths of less than 30m for one side, we multiplied the width by the length and added those areas together to determine the total census area.

Statistical analyses comparing avian density and species richness across C/S types and/or years were conducted using Tukey-Kramer tests. We set statistical significance for all comparisons at $\alpha \leq 0.05$. All statistical analyses were conducted using JMP 5.0 statistical software (SAS institute 2002).

Vegetation Sampling Methods

Natural Heritage New Mexico (NHNM) collaborated with Hawks Aloft, Inc. and conducted vegetation sampling during summer 2005 and summer 2006, following the methods described in the MRGBS. NHNM is in the process of analyzing the vegetation data, as well as the original vegetation data from the MRGBS. Tree and shrub density were estimated by counting the number of trees within a sample of 50 x 100 ft subplots of the transect strips. Density will be extrapolated as the number of trees and shrubs per acre. Percent foliage cover in the ground layer (0-2 ft) and shrub layer (2-15 ft) were visually estimated within 15 x 15 foot subplots of the survey transects**,** and percent canopy cover was measured using a spherical densiometer. Relative foliage density was estimated using the MacArthur board technique (MacArthur and MacArthur 1961). Ultimately, NHNM will conduct multivariate analyses of vegetative structure for each transect, using multivariate ordination and cluster analysis to develop transect models based on community and structure types. NHNM will also make comparisons between the current vegetation data and original MRGBS vegetation data.

RESULTS

Winter Avian Abundance

Russian olive (RO) 3 supported the highest avian density during winter 2010 (3745 birds/100 acres; Table 3), which was significantly higher than all other C/S types (Tukey-Kramer test; Appendix 16). No transects classified as RO 3 were surveyed during winter prior to 2010. BURN 1 (1536 birds/100 acres) and DR 5 (1213 birds/100 acres) were the only other C/S types to support avian densities greater than 1000 birds/100 acres during winter 2010. Cumulatively, during the winters of 2004-2009, C/NMO 1 (798 birds/100 acres) and RO 5 (758 birds/100 acres) supported the highest avian densities among terrestrial C/S types. The cumulative C/NMO 1 and RO 5 densities for 2004-2009 were significantly higher than all other terrestrial C/S types except for BURN 1, NMO 5, and BURN 2 (Tukey-Kramer test; Appendix 16).

Table 3. Comparison of winter avian abundance by C/S type for 2010 and 2004-2009 cumulatively. C/S types with N/A were not surveyed during those seasons.

C/S type	# Birds per 100 acres (2010)	# Birds per 100 acres (2004-09)
RO 3	3745	N/A
BURN 1	1536	712
DR 5	1213	1249
NMO 5	988	677
C/NMO 1	963	798
C-RO/CW 3	781	366
RO 5	726	758
DR 6	699	657
C/RO 1	624	300
CW 5	484	469
C-2 natural	474	330
BURN OP	456	N/A
C/CW 1	288	213
OP	223	329
C-2 artificial	117	77
MH 5-OW	N/A	1264
BURN 2	N/A	643
CW 6	N/A	258
C/MB 1	N/A	176
SC 5	N/A	111

C/S types incorporating standing water with dense vegetation (e.g. MH 5-OW and DR 5) supported the highest avian densities during all winters prior to 2010. We did not survey any MH 5-OW transects during winter 2010. Cumulatively, during winters 2004-2009, densities in MH 5-OW (1264 birds/100 acres) and DR 5 (1249 birds/100 acres) were significantly higher than all other C/S types (Tukey-Kramer test; Appendix 16).

In contrast, C-2 artificial stands supported the lowest winter densities during all seven years of this study (117 birds/100 acres in 2010 and 77 birds/100 acres cumulatively in 2004-2009; Table 3). The cumulative densities in C-2 artificial stands for 2004-2009 were significantly lower than all other C/S types except for SC 5, C/MB 1, C/CW 1, CW 6, and BURN 2 (Tukey-Kramer test; Appendix 16). C-2 artificial was the only C/S type that supported densities lower than 100 birds/100 acres cumulatively during winters 2004-2009, and was the only C/S type to support densities lower than 200 birds/100 acres during winter 2010.

Overall, bird densities were higher during winter 2010 than cumulatively for winters 2004-2009 in 10 of 13 C/S types where data were recorded during both periods (Table 3). The only significant changes in avian density within C/S types between 2009 and 2010 were the increases in BURN 1 and C-RO/CW 3 (Tukey-Kramer test; Appendix 17). Due to budgetary limitations, no MH 5-OW, C/MB 1, or SC 5 transects were surveyed during winter 2010. No established transects were classified as BURN 2 or CW 6 during winter 2010.

Winter Species Richness

Species richness was highest on DR 5 transects during both winter 2010 (19.0 species/transect) and cumulatively during winters 2004-2009 (20.9 species/transect; Table 4). BURN 1 (18.0 species/transect) and C/NMO 1 (18.0 species/transect) supported the highest richness among entirely terrestrial transects during winter 2010, while C/NMO 1 (18.3 species/transect) and NMO 5 (17.5 species/transect) supported the highest richness cumulatively in 2004-2009. The cumulative richness (winter 2004-2009) for DR 5 was significantly higher than 11 other C/S types, and for C/NMO 1 was significantly higher than seven other C/S types (Tukey-Kramer test; Appendix 18).

In contrast, areas subjected to mechanical clearing (OP and C-2 artificial) supported the lowest richness numbers during winter 2009 (6.5 species/transect for each) and among the lowest richness cumulatively during 2004-2009 (7.5 and 5.5 species/transect respectively). SC 5 stands supported the lowest richness cumulatively during 2004-2009 (4.5 species/transect), but were not surveyed during winter 2010. Cumulatively, during winters 2004-2009, SC 5 and C-2 artificial supported significantly lower richness than 12 and 11 other C/S types respectively (Tukey-Kramer test; Appendix 18).

Table 4. Comparison of winter species richness by C/S type for 2010 and 2004-2009 cumulatively. C/S types with N/A were not surveyed during those seasons.

C/S type	# Species/transect (2010)	# Species/transect (2004-09)
DR 5	19.0	20.9
BURN 1	18.0	15.5
C/NMO 1	18.0	18.3
NMO 5	16.5	17.5
RO 3	16.0	N/A
C-RO/CW 3	15.5	14.4
CW 5	14.5	12.3
C-2 natural	14.1	12.5
RO 5	14.0	15.1
C/RO 1	14.0	11.0
C/CW 1	14.0	14.6
DR 6	10.7	11.6
BURN OP	7.0	N/A
OP	6.5	7.5
C-2 artificial	6.5	5.5
MH 5-OW	N/A	15.7
C/MB 1	N/A	13.0
CW 6	N/A	10.5
BURN 2	N/A	10.0
SC 5	N/A	4.5

Overall, species richness was lower during winter 2010 than cumulatively during winters 2004-2009 for seven of 13 C/S types where data were recorded during both periods (Table 4). 2010 was the third consecutive winter that species richness was lower than cumulative winters for a majority of C/S types. BURN OP was not surveyed during winter prior to 2010. Due to budgetary limitations, no MH 5-OW, C/MB 1, or SC 5 transects were surveyed during winter 2010. No established transects were classified as CW 6 or BURN 2 during winter 2010. There were no statistically significant differences in species richness between years within specific C/S types.

Summer Avian Abundance

BURN 1 supported the highest avian density during summer 2010 (1316 birds/100 acres; Table 5). MH 5-OW, and NMO 5 also supported densities greater than 1000 birds/100 acres during 2010 (1240 and 1108 birds/100 acres respectively). Cumulatively, MH 5-OW supported the highest bird densities during 2004-2009 (1692 birds/100 acres). NMO 5, BURN 1, and C/NMO 1 also supported bird densities greater than 1000 birds per 100 acres during 2004-2009 (1296, 1115, and 1064 birds/100 acres respectively).

In 2010, BURN 1 and MH 5-OW supported significantly higher avian densities than all other C/S types except for NMO 5 (Tukey-Kramer test; Appendix 19). Cumulatively in 2004-2009, MH 5-OW had a significantly higher density than all other C/S types, while NMO 5 had a significantly higher density than all remaining C/S types except for BURN 1 and RO 3 (Tukey-Kramer test; Appendix 20).

The lowest summer avian densities during all years occurred in SC 5 (242 birds/100 acres in 2010 and 192 birds/100 acres in 2004-2009), OP (299 birds/100 acres in 2010 and 254 birds/100 acres in 2004-2009), and C-2 artificial (353 birds/100 acres in 2010 and 363 birds/100 acres in 2004-2009; Table 5). DR 6 (335 birds/100 acres) also supported a particularly low summer avian density in 2010. The cumulative summer 2004-2009 avian densities for SC 5, OP, and C-2 artificial were significantly lower than all other C/S types except for BURN 2 (Tukey-Kramer test; Appendix 20).

Table 5. Comparison of summer avian abundance by C/S type for 2010 and 2004-2009 cumulatively. C/S types with N/A were not surveyed during those seasons.

C/S type	# Birds per 100 acres (2010)	# Birds per 100 acres (2004-09)
BURN 1	1316	1115
MH 5-OW	1240	1692
NMO 5	1108	1296
C/NMO 1	897	1064
C/MB 1	811	698
RO 3	794	937
C-RO/CW 3	768	852
CW 5	723	870
RO 5	712	833
C/CW 1	667	759
C/RO 1	625	827
C-2 natural	562	677
DR 5	558	722
CW 6	491	660
BURN OP	446	N/A
BURN 2	405	423
C-2 artificial	353	363
DR 6	335	514
OP	299	263
SC 5	201	192

Overall, 15 of 19 C/S types supported lower avian densities during 2010 than cumulatively in 2004-2009 (Table 5). Summer 2010 was the second consecutive year that avian density was lower than cumulative summers for a majority of C/S types where data were recorded during both periods. There were no statistically significant changes in summer avian density within C/S types between 2009 and 2010.

Summer Species Richness

During summer 2010, BURN 1 (30.0 species/transect) and C/MB 1 (29.0 species/transect) supported the highest avian species richness (Table 6). In contrast, DR 6 (12.0 species/transect) and C-2 artificial (13.3 species/transect) supported the lowest richness. DR 6 supported significantly lower richness during summer 2010 than seven other C/S types (Tukey-Kramer test; Appendix 21).

Table 6. Comparison of summer species richness by C/S type for 2010 and 2004-2009 cumulatively. C/S types with N/A were not surveyed during those seasons.

C/S type	# Species/transect (2010)	# Species/transect (2004-09)
BURN 1	30.0	27.7
C/MB 1	29.0	26.6
C/CW 1	27.0	27.3
CW 5	24.8	26.0
C/RO 1	23.0	24.1
MH 5-OW	22.7	25.7
NMO 5	21.5	27.3
C/NMO 1	20.4	24.8
C-2 natural	20.4	21.6
C-RO/CW 3	18.0	23.1
BURN OP	17.0	N/A
RO 5	17.0	21.1
CW 6	17.0	20.5
DR 5	16.2	20.6
RO 3	16.0	25.0
OP	15.3	11.4
BURN 2	14.5	20.5
SC 5	14.3	12.2
C-2 artificial	13.3	12.9
DR 6	12.0	13.9

Cumulatively during summers 2004-2009, BURN 1 (27.7 species/transect), NMO 5 (27.3 species/transect), and C/CW 1 (27.3 species/transect) supported the highest avian species richness (Table 6). Conversely, OP (11.4 species/transect), SC 5 (12.2 species/transect), C-2 artificial (12.9 species/transect), and DR 6 (13.9 species/transect) supported the lowest richness during summer 2004-2009. OP, SC 5, C-2 artificial and DR 6 supported significantly lower richness during 2004-2009 than 12 other C/S types (Tukey-Kramer test; Appendix 22).

Overall, species richness was lower during summer 2010 than cumulatively during 2004-2009 in 14 of 19 C/S types surveyed during both periods (Table 6). None of the changes in richness within C/S types between 2009 and 2010 were statistically significant.

Comparison of Avian Abundance and Richness by Land Management Entity

The 64 transects we surveyed occur on lands administered by five different entities. From north to south in our study area these entities are: the City of Rio Rancho, the Village of Corrales, the City of Albuquerque, the Middle Rio Grande Conservancy District (MRGCD), and the New Mexico Department of Game and Fish (NMGF). Because each of these entities adheres to their own land management strategy, we compared cumulative (2004-2010) avian density and richness by land manager to evaluate how the different management strategies employed may be impacting avian use.

Cumulative winter avian density during 2004-2010 was highest in Corrales (778 birds/100 acres) and lowest in Rio Rancho (304 birds/100 acres; Table 7). Avian density was significantly higher in Corrales than all other areas except for lands managed by NMGF (Tukey-Kramer test; Appendix 23). Winter avian density was significantly lower in Rio Rancho and Albuquerque than all other areas.

Cumulative winter avian richness during 2004-2010 was highest in Corrales (16.7 species/transect) and lowest in areas managed by NMGF (9.6 species/transect; Table 7).

Winter richness was significantly higher in Corrales than in all other management areas (Tukey-Kramer test; Appendix 23).

Table 7. Comparison of cumulative winter avian densities and species richness by land management entity, 2004-2010.

Land manager	# Transects	Mean # birds per 100 acres	Species richness
Corrales	18	778	16.7
NMGF	7	678	9.6
MRGCD	20	556	13.1
Albuquerque	16	439	10.4
Rio Rancho	3	304	10.2

Cumulatively during summer 2004-2010, avian density was highest in Corrales (858 birds/100 acres) and lowest on lands managed by NMGF (465 birds/100 acres; Table 8). Summer avian density was significantly higher in Corrales than all other areas (Tukey-Kramer test; Appendix 23). Summer avian density was significantly lower on NMGF lands and in Rio Rancho than all other areas.

Cumulatively during summer 2004-2010, Corrales (22.2 species/transect) supported the highest avian species richness, while NMGF lands (15.7 species/transect) supported the lowest richness (Table 8). Summer avian richness was significantly higher in Corrales than on NMGF lands and in Albuquerque (Tukey-Kramer test; Appendix 23).

Table 8. Comparison of cumulative summer avian densities and species richness by land management entity, 2004-2010.

Land manager	# Transects	Mean # birds per 100 acres	Species richness
Corrales	18	858	22.2
Albuquerque	16	725	19.3
MRGCD	20	662	20.8
Rio Rancho	3	552	19.6
NMGF	7	465	15.7

Single Site Comparison of Avian Abundance and Richness Before and After Restoration

We surveyed a single transect (SE31) during summer 2004 that was subsequently subjected to the mechanical removal of all non-native vegetation prior to summer 2005. Ultimately, the restoration of this site included the creation of two ponds. When we began surveying this transect in summer 2004, it was classified as C/MB 1. The data collected at this site during summer 2004 were compromised by spots of mechanical thinning prior to summer 2004. But, complete removal of non-native vegetation did not occur at this transect until after summer 2004. We initiated winter surveys at the site in December 2004 (winter 2005 survey season), after the mechanical removal of all non-native vegetation had occurred. By winter 2006 the ponds had been established and water was present, but vegetation recovery was minimal. By winter 2007, marsh habitat had been established and vegetation recovery was substantial.

The summer avian abundance at SE31 decreased from 515 birds/100 acres in 2004 to 442 birds/100 acres in 2005 (Table 9), but the decrease was not statistically significant. By summer 2006, the USACE established two ponds at this site, with water flowing out of the south pond to create a marsh near the south end of the transect. The summer avian densities at SE31 for 2006 (924 birds/100 acres), 2007 (907 birds/100 acres), 2008 (899 birds/100 acres), 2009 (1010 birds/100 acres), and 2010 (1062 birds/100 acres) were significantly higher than the summer 2004 pre-thin level and summer 2005 post-thin level (Tukey-Kramer test).

Avian richness during summer 2010 (30 species) was at its lowest level since 2006, and notably lower than summer 2009 (42 species; Table 9). Summer avian richness was substantially higher during all years after the establishment of the pond/marsh habitat than before and after thinning, but the changes were not statistically significant (Tukey-Kramer test).

Table 9. Comparison of summer avian densities and species richness at SE31 prior to mechanical thinning (summer 2004), after mechanical thinning (summer 2005), and after restoration to create a mixed habitat including ponds and marsh (summer 2006-2010).

C/S type	Mean # birds per 100 acres	Species richness
Pond/MH mix (2010)	1062	30.0
Pond/MH mix (2009)	1010	42.0
Pond/MH mix (2006)	924	30.0
Pond/MH mix (2007)	907	35.0
Pond/MH mix (2008)	899	35.0
C/MB 1 (2004)	515	17.0
C-2 artificial/OP mix (2005)	442	20.0

Winter avian abundance at SE31 increased every year from 2005 (56 birds/100 acres) to 2009 (2055 birds/100 acres; Table 10). Avian density in winter 2010 (1587 birds/100 acres) was lower than 2009, but higher than all previous years. Winter avian density during 2008, 2009 and 2010 was significantly higher than in 2005 and 2006 (Tukey-Kramer test). Winter avian density during 2009 and 2010 was also significantly higher than in 2007.

Table 10. Comparison of winter avian densities and species richness at SE31 after mechanical thinning (winter 2005 and 2006), and after restoration to create a mixed habitat including ponds and marsh (winter 2007-2010).

C/S type	Mean # birds per 100 acres	Species richness
Pond/MH mix (2010)	1587	20.0
Pond/MH mix (2009)	2055	22.0
Pond/MH mix (2008)	1244	18.0
Pond/MH mix (2007)	526	18.0
Pond/C-2 artificial mix (2006)	191	6.0
OP/C-2 artificial mix (2005)	56	4.0

Winter species richness also increased every year from 2005 (4 species) to 2009 (22 species; Table 10). Winter 2010 richness (20 species) was slightly lower than 2009, but higher than all other years. Winter richness during 2007-2010 was significantly higher than 2005 and 2006 (Tukey-Kramer test).

Comparison of Avian Abundance and Richness Before and After Catastrophic Fire

In late February 2007, a bosque fire near Belen consumed over 90 percent of the vegetation on one transect (SW27). Data collected during spring 2007 indicated that both avian density and species richness were reduced in the area after the fire (Table 10), but the reduction was modest and not statistically significant. Despite the loss of vegetation, spring 2007 avian use at the burn site (BURN 1) was higher than in mechanically-thinned stands (C-2 artificial and OP) surveyed during that same season. Avian density (608 birds/100 acres in BURN 1 vs. 205 and 142 birds/100 acres in C-2 artificial and OP respectively) was significantly higher. Species richness (19.0 species/transect in BURN 1 vs. 12.3 and 8.3 species/transect in C-2 artificial and OP respectively) was also higher. Due to budgetary limitations, we have not surveyed this transect during spring since 2007.

Data collected at the burn site during summer 2007 indicate that both avian density and species richness were higher in the area after the fire than prior to the burn (Table 10), although the differences were not significant. In comparison to mechanically-thinned areas, avian density (1108 birds/100 acres vs. 367 and 234 birds/100 acres in C-2 artificial and OP respectively) and species richness (23.0 species/transect vs. 14.0 and 10.8 species/transect in C-2 artificial and OP respectively) were both higher in the burn during summer 2007. This trend continued through summer 2010, when avian density was again significantly higher in the burn than in mechanically thinned C/S types (1316 birds/100 acres vs. 353 and 299 birds/100 acres in C-2 artificial and OP respectively). Species richness also was higher in the burn during summer 2010 than in mechanically thinned habitats (30.0 species/transect vs. 13.3 and 15.3 species/transect in C-2 artificial and OP respectively), although the difference was not statistically significant.

Table 11. Comparison of avian density and species richness at a single site for spring, summer, and winter before and after a catastrophic fire.

C/S type	Year	Season	Mean # birds/100 acres	Mean # species/transect
BURN 1	2007	Spring	608	19.0
C/RO 1	2004-06	Spring	710	23.5
BURN 1	2010	Summer	1316	30.0
BURN 1	2009	Summer	1154	29.0
BURN 1	2008	Summer	1083	31.0
BURN 1	2007	Summer	1108	23.0
C/RO 1	2004-06	Summer	856	21.0
BURN 1	2010	Winter	1536	18.0
BURN 1	2009	Winter	700	16.0
BURN 1	2008	Winter	725	15.0
C/RO 1	2004-07	Winter	437	12.0

Data collected at the burn site during winter in 2008 and 2009 also indicated that both avian density and species richness were higher in the area after the fire than they had been before (Table 10), although the differences were not statistically significant. Winter 2010 avian density (1536 birds/100 acres) was significantly higher than that recorded at the site during any previous winter (Tukey-Kramer test). Species richness during winter 2010 (18.0 species/transect) also was higher than that recorded at the site during any previous winter, but was not statistically significant.

Status of Selected Bird Species in the Middle Rio Grande Bosque

Mourning Dove (*Zenaida macroura*) - This dove is a New Mexico Species of Greatest Conservation Need (BISON-M 2011). Hink and Ohmart (1984) considered this dove to be an abundant summer resident throughout the middle Rio Grande bosque, with nests most commonly placed in Russian olive and cottonwood trees in dense vegetation. Although we consider this dove to be a fairly common year-round resident in the bosque, numbers have clearly decreased since the early 1980's. The majority of nests we documented were placed in Russian olive. The continued range expansion of White-winged Dove (*Zenaida asiatica*) and Eurasian Collared-Dove (*Streptopelia decaocto*) may be contributing to the decline in Mourning Dove numbers. But, we have noticed a decline in this species since the beginning of this study that pre-dates the arrival of these other doves in significant numbers in the middle Rio Grande bosque.

Yellow-billed Cuckoo (*Coccyzus americanus*) – New Mexico Partners in Flight (2008) lists this species at Biodiversity Conservation Level 1, it is a USFWS candidate species for listing under the Endangered Species Act, and a New Mexico Species of Greatest Conservation Need (BISON-M 2011). Hink and Ohmart (1984) considered this species to be an uncommon summer resident throughout the middle Rio Grande. We found cuckoos to be rare migrants during late spring/early summer and late summer/early fall, with no evidence of summering birds. All of our detections occurred in areas with dense vegetation from understory to canopy. We did not detect any cuckoos during summer 2010. The extensive removal of non-native vegetation throughout the middle Rio Grande has likely contributed to the local decline of this species, although it has also been declining globally (Sauer et al. 2005).

Black-chinned Hummingbird (*Archilochus alexandri*) – New Mexico Partners in Flight (2008) lists this hummingbird at Species Conservation Level 2. Hink and Ohmart (1984) considered this species to be an abundant migrant and summer resident. The most abundant avian breeder in the middle Rio Grande bosque, Black-chinned Hummingbird was abundant during summer in all C/S types surveyed except for mechanically thinned areas (C-2 artificial and OP; common) and pure stands of salt cedar (SC 5; uncommon).

Willow Flycatcher (*Empidonax traillii*) - The southwestern subspecies (*E. t. extimus*) is listed as endangered under the U.S. Endangered Species Act (USFWS 2002). It is nearly impossible to differentiate subspecies in the field, but any birds nesting in New Mexico are presumed to be of the southwestern subspecies. Hink and Ohmart (1984) considered Willow Flycatcher to be regular and fairly common in migration, and an uncommon breeder. We found this flycatcher to be rare during both spring and fall migration, and strictly occurring in densely vegetated C/S types near water. The only known breeding sites within our study area are on pueblo land (which we do not survey), and at Sevilleta NWR (D. Hill, USFWS, personal comm.).

Dusky Flycatcher (*Empidonax oberholseri*) – Hink and Ohmart (1984) considered this species to be common in migration throughout the study area. Based on the individuals we were able to definitively identify, we found Dusky Flycatcher to generally be an uncommon spring migrant throughout the study area, although it was the most common *Empidonax* in the bosque. The species is probably uncommon during fall migration, but difficult to differentiate from other *Empidonax* flycatchers due to a lack of vocalizations. The species was absent from open areas and pure stands of salt cedar.

Gray Flycatcher (*Empidonax wrightii*) – Hink and Ohmart (1984) considered this flycatcher to be a rare to uncommon regular migrant in cottonwood-dominated areas of the bosque. Based on the individuals were able to definitively identify, we found this flycatcher to be uncommon in pure stands of salt cedar during spring migration, but rare to uncommon in other habitats. The species was probably rare to very uncommon during fall migration, but was difficult to differentiate from other *Empidonax* flycatchers due to a lack of vocalizations. Overall, we found Gray Flycatcher to be the second-most common *Empidonax* in the bosque. The species was very rare or absent from mechanically-thinned areas.

Bell's Vireo (*Vireo bellii*) - New Mexico Partners in Flight (2008) lists this vireo at Species Conservation Level 1. It is also a USFWS Federal Species of Concern, and is listed as threatened in New Mexico (BISON-M 2011). The normal range of this vireo is south of our study area (e.g. Parmeter et al. 2002), and the single observation by Hink and Ohmart (1984) was the northernmost record in New Mexico at that time. In July 2009, we documented a singing individual in dense Russian olive/coyote willow habitat near the river bank in Belen (SW26).

Plumbeous Vireo (*Vireo plumbeus*) - New Mexico Partners in Flight (2008) lists this vireo at Species Conservation Level 2. Hink and Ohmart (1984) considered this species to be an uncommon, but regular migrant through mature cottonwood habitats. But, at that time, the species was not split from Cassin's Vireo (*Vireo cassinii*), which also migrates through the bosque. We found this species to be a rare to uncommon migrant in most mature cottonwood habitats (C/CW 1, C/NMO 1, C/RO 1, and C-2 natural), but virtually absent from C-2 artificial. Because this species does not consistently vocalize during migration and tends to stay in dense cover, it may have been under-documented. Our observations suggest that Cassin's Vireo, which does not breed in New Mexico, may be nearly as common a migrant through the bosque as Plumbeous Vireo.

Steller's Jay (*Cyanocitta stelleri*) – Hink and Ohmart (1984) considered this species to be a rare but regular visitor to the bosque. Prior to 2008, we had only recorded Steller's Jay as a rare fall visitor to the bosque. But, during winter 2008 the species was common in six C/S types (C/NMO 1, C/RO 1, C-2 natural, DR 5, DR 6, NMO 5), uncommon in RO 5, and absent elsewhere. It was frequently observed foraging on Russian olive and New Mexico olive berries. During spring 2008, the species was common in C/NMO 1, uncommon in DR 5 and NMO 5, and absent elsewhere. We now consider this species to be irruptive in the bosque during years of poor conifer cone crops at higher elevations, which appears to be what happened in 2008 (W. DeRagon, USACE, personal comm.).

Bushtit (*Psaltriparus minimus*) - Hink and Ohmart (1984) considered this species to be regular throughout the year, but only sporadic breeders within the bosque. We found

Bushtit to be common year-round and regular breeders in C/S types with significant amounts of coyote willow (C/CW 1 and CW 5), New Mexico olive (C/NMO 1 and NMO 5), and/or Russian olive (C/RO 1 and RO 5). But, the species was rare in C-2 artificial stands and uncommon in other C/S types. The majority of nests we located were built in either Russian olive or New Mexico olive.

Winter Wren (*Troglodytes troglodytes*) - Considered a rare, possibly regular migrant by Hink and Ohmart (1984). We found this species to be a rare migrant, but also a rare winter resident in densely vegetated areas adjacent to standing water. Because of its secretive nature and minimal vocalizations during winter, this species is easily overlooked. During winter 2005-2008, Winter Wren was uncommon, but regular along densely-vegetated drains (DR 5) in Corrales. We only recorded single individuals during winter 2009 and 2010.

Eastern Bluebird (*Sialia sialis*) - Considered uncommon and irregular during winter by Hink and Ohmart (1984). We found this species to be rare during winter in most bosque habitats, but common in pure stands of Russian olive (RO 5), where they exploited the abundant berry crops. This bluebird is now a year-round resident in the bosque. During summer 2006-2010, this species was a regular breeder in areas of the bosque with a mature cottonwood canopy and a relatively sparse understory (C-2 natural and C-2 artificial). In 2008, we also documented a nest in C/NMO 1.

Hermit Thrush (*Catharus guttatus*) - This thrush is a good indicator species in terms of the health of understory vegetation for wintering birds. Hink and Ohmart (1984) considered this thrush to be uncommon to fairly common locally in winter and in migration. We found this species to generally be an uncommon migrant and winter resident in the bosque, but common in stands with extensive Russian olive not under a cottonwood canopy (RO 5 and C-RO/CW 3) and in New Mexico olive (NMO 5) where it exploited berry crops of those two species. Hermit Thrush was absent from C-2 artificial and pure salt cedar stands (SC 5), and rare in thinned, open areas (OP).

Phainopepla (*Phainopepla nitens*) – Hink and Ohmart (1984) only recorded this species once within the study area. Although we surveyed fewer transects in the southern part of the study area than Hink and Ohmart, we found this species to be rare from May through August in areas lacking a cottonwood canopy or near the edges of cottonwood stands as far north as Los Lunas. Based on our observations, this species may be expanding its range northward. But, we did not detect any Phainopepla in 2010.

Cedar Waxwing (*Bombycilla cedrorum*) - Hink and Ohmart (1984) considered this species to be uncommon to fairly common in migration and winter, with varying abundance between years, and occasional during the summer. We also found waxwings to vary in abundance between years. During fall and winter, the species was uncommon to common in habitats supporting significant amounts of Russian olive and/or New Mexico olive, with numbers much higher during years of large berry crops. Elsewhere, the species was generally rare during fall and winter, and was absent from mechanically-thinned areas. During spring, the species was common in pure stands of Russian olive, where berries often were still available, and uncommon in other stands with significant Russian olive and New Mexico olive. The species was absent from open areas, pure stands of salt cedar, and marsh habitat during the spring. The species was very rare during summer.

Gray Catbird (*Dumetella carolinensis*) - Considered a fairly common summer breeder in dense vegetation by Hink and Ohmart (1984). We found this species to be common in dense coyote willow (CW 5) and uncommon to fairly common in other densely-vegetated bosque habitats. The range of Gray Catbird in the bosque has been reduced by thinning operations, and we did not record the species in mechanically thinned C/S types (C-2 artificial and OP).

Northern Mockingbird (*Mimus polyglottos*) – Hink and Ohmart (1984) considered this species to be a fairly common summer resident in salt cedar habitat, but rare in summer and migration in other C/S types. This species was an uncommon to rare migrant during 2004 and 2005. This species had an eruption in spring 2006, when it was common in several C/S types (C/RO 1, C/NMO 1, CW 5, CW 6) and abundant in pure stands of salt cedar (SC 5). A similar eruption was recorded on other Hawks Aloft surveys throughout New Mexico outside the bosque during 2006 (M. Stake, pers. comm.). The numbers recorded in spring 2007-2009 were consistent with those recorded in 2004 and 2005. In summer 2010, Northern Mockingbird was common in SC 5 and RO 5 stands at La Joya, uncommon in BURN 1 and BURN 2 transects in Belen, and generally rare elsewhere.

Virginia's Warbler (*Vermivora virginiae*) - New Mexico Partners in Flight (2008) lists this warbler at Species Conservation Level 1. Hink and Ohmart (1984) considered this warbler to be common during both spring and fall migration. We found this species to be a fairly common to common migrant in most C/S types, but very uncommon to rare in mechanically thinned habitats (C-2 artificial and OP) and pure stands of salt cedar (SC 5). This species has experienced significant population declines throughout much of its breeding range (Sauer et al. 2005).

Yellow Warbler (*Dendroica petechia*) - New Mexico Species of Greatest Conservation Need (BISON-M 2010). Hink and Ohmart (1984) considered this warbler to be a common summer resident in the cottonwood bosque at San Ildefonso (north of our study area), and common during spring and fall migration, but uncommon as a summer resident south of San Ildefonso. Unfortunately, we do not know how far south of San Ildefonso Hink and Ohmart found this warbler as a summer resident. We found this species to be a regular but uncommon spring migrant and an uncommon to rare fall migrant, primarily in densely vegetated C/S types. We found no evidence of breeding within our study area.

Chestnut-sided Warbler (*Dendroica pensylvanica*) – Hink & Ohmart (1984) recorded this species once during their study. We recorded a territorial male in the Corrales bosque during June and July 2007, with a second bird (presumably a female) also present. We suspect, but could not confirm, that a nesting attempt was made in an area near the river edge dominated by dense Russian olive and New Mexico olive. The species was not recorded in 2008-2010.

Black-throated Gray Warbler (*Dendroica nigrescens*) - New Mexico Partners in Flight (2008) lists this warbler at Species Conservation Level 2, and it is a New Mexico Species of Greatest Conservation Need (BISON-M 2011). This species has experienced significant population declines in much of New Mexico, Arizona, Colorado, and Utah (Sauer et al. 2005). Hink and Ohmart (1984) considered this warbler an uncommon, but regular migrant. We found this warbler to be a rare to uncommon migrant in the bosque, occurring in most C/S types with a mature cottonwood canopy and densely vegetated areas without a significant cottonwood overstory (CW 5, RO 5, and SC 5). We did not record the species in mechanically-thinned habitats (C-2 artificial and OP).

MacGillivray's Warbler (*Oporornis tolmiei*) - This warbler was considered common in migration, especially in wet, densely vegetated areas by Hink and Ohmart (1984). We found this species to be uncommon during spring migration and fairly common during fall migration in densely vegetated areas. The species was absent during spring and rare during fall in C-2 artificial.

Common Yellowthroat (*Geothlypis trichas*) - Considered a common summer resident and migrant found primarily in moist, well-vegetated areas by Hink and Ohmart (1984). We found yellowthroats to be abundant in marsh habitat and common in dense areas of coyote willow and Russian olive (CW 5, RO 5 and C-RO/CW 3) during summer, and generally uncommon to rare in other densely vegetated areas. During migration, the species was common in marsh habitat and uncommon to rare in most other habitats, depending on the proximity to water. The species was rare in open habitat during spring migration, and otherwise absent from mechanically-thinned areas during migration and summer. Due to the loss of suitable habitat, it seems likely that yellowthroat numbers in the middle Rio Grande are lower now than during the early 1980's.

Wilson's Warbler (*Wilsonia pusilla*) - New Mexico Partners in Flight (2008) lists this warbler at Biodiversity Conservation Level 2. Hink and Ohmart (1984) considered the species abundant in spring and fall migration. During spring migration, we found the species to be uncommon to fairly common in most habitats, but rare in mechanically-thinned areas (C-2 artificial and OP) and pure stands of salt cedar. During fall migration, the species was common to abundant in all C/S types except for mechanically-thinned areas, where it was rare to uncommon.

Yellow-breasted Chat (*Icteria virens*) - Considered a common summer resident in moist, well vegetated areas by Hink and Ohmart (1984). We found chats to be abundant in New Mexico olive (NMO 5), and uncommon to common in most other C/S types with significant understory vegetation. But, in mechanically thinned areas chats were rare (OP) or absent (C-2 artificial).

Lazuli Bunting (*Passerina amoena*) - New Mexico Partners in Flight (2008) lists this bunting at Species Conservation Level 2. Hink and Ohmart (1984) considered Lazuli Bunting to be fairly common in migration and uncommon as a summer resident, mostly north of Albuquerque. Our detections of this species have steadily decreased over the course of the study. Initially, we found this species to be an uncommon migrant and summer resident in all C-1 habitats, along drains, and in dense New Mexico olive (NMO 5). In addition, it was uncommon during the summer in coyote willow (CW 5) and Russian olive (RO 5). The species was rare or absent in other C/S types. Since we have not conducted spring surveys since 2008 and fall surveys since 2007, we cannot assess this bunting's status during peak migration. But, the species was rare during summer in 2009 and 2010, with only six detections during 2010. It appears to regularly hybridize (T. Fetz, personal observation) with Indigo Bunting (*Passerina cyanea*) in the middle Rio Grande bosque, where the southern edge of its breeding range overlaps with the Indigo Bunting breeding range.

Indigo Bunting (*Passerina cyanea*) - Hink and Ohmart (1984) considered this bunting to be a fairly common migrant and summer resident. We found this species to be uncommon to rare during migration and summer. It was uncommon to very uncommon along drains (DR 5 and DR 6), and in areas with dense New Mexico olive (NMO 5 and C/NMO 1), Russian olive (RO 5, C/RO 1, and C-RO/CW 3), mulberry (C/MB 1), and coyote willow (CW 5). Elsewhere, the species was rare or absent. It seems likely that Indigo Bunting numbers in the middle Rio Grande bosque are lower now than during the early 1980’s.

Painted Bunting (*Passerina ciris*) - New Mexico Partners in Flight (2008) lists this bunting at Biodiversity Conservation Concern, Level 1, and it is a New Mexico Species of Greatest Conservation Need (BISON-M 2011). This bunting was not recorded by Hink and Ohmart (1984). It is considered casual in New Mexico outside of desert scrub and oases in the southeast and eastern plains (Parmeter et al. 2002). In August 2009, we documented a flock of five individuals in marsh habitat at the La Joya State Game Refuge (GS 20). We did not record this species during 2010.

Spotted Towhee (*Pipilo maculatus*) - The best indicator species in terms of the health of understory vegetation for resident birds. Hink and Ohmart (1984) considered this species to be a common resident. We found Spotted Towhee to be abundant in areas with dense New Mexico olive (NMO 5 and C/NMO 1), and generally common in all other C/S types with significant understory vegetation. It was rare in C-2 artificial and very uncommon in open areas.

Dark-eyed Junco (*Junco hyemalis*) – Hink and Ohmart (1984) considered this species to be abundant in the bosque during winter. They found the Oregon and pink-sided races to be the most common, the gray-headed race uncommon, and recorded a few birds from the slate-colored and white-winged races. The most abundant bird in the bosque during winter, juncos were common to abundant in nearly all C/S types, but were especially plentiful along drains. Juncos generally began arriving in the bosque during October and left by the end of April. Our data show that, similar to what Hink and Ohmart found, the Oregon and pink-sided races were the most common, with both present in large numbers. Birds of the gray-headed race were uncommon to rare and the slate-colored race was rare. We recorded only two individuals of the red-backed race and none from the white-winged race during 2004-2010.

Cassin's Finch (*Carpodacus cassinii*) – Hink and Ohmart (1984) recorded single individuals in the bosque during fall and winter. We received regular reports of Cassin's Finch sightings at feeders, especially in Corrales, during winter 2008 (J. Finley, pers. comm.), but did not record the species in the bosque prior to spring 2008. During that season the species was common in C/NMO 1, uncommon in DR 5, rare in C/RO 1, and absent elsewhere. We consider this species to be irruptive in the bosque during times when food is scarce at higher elevations, which appears to be what happened in winter 2008. A similar irruption was documented in 2008 on other Hawks Aloft studies outside the bosque at relatively low elevation sites where Cassin's Finch would not normally be expected (M. Stake, pers. comm.). We did not record this finch during 2010.

DISCUSSION

Winter Avian Abundance and Species Richness

During four of the first six winters of this study, stands of Russian olive not shaded by a cottonwood canopy (RO 5) supported the highest avian densities among terrestrial C/S types. The primary reason for the high densities in Russian olive stands is the presence of berries for foraging throughout the winter (see Fig. 2). Unlike other fruit-bearing plants in the bosque, Russian olive berries remain viable on the tree throughout winter, or until the crop is consumed (Borell 1971, Olsen 1974). The value of Russian olive to wintering birds is often underappreciated by land managers. Species such as Mountain Bluebird (*Sialia currucoides*) , Eastern Bluebird, Western Bluebird (*Sialia mexicana*), American Robin (*Turdus migratorius*), Cedar Waxwing, and Red-winged Blackbird (*Agelaius phoeniceus*) tend to be more common in pure stands of Russian olive than other terrestrial C/S types, especially during years the berry crop is particularly large. Other species common in Russian olive stands during winter included Northern Flicker (*Colaptes auratus*), Hermit Thrush, Bewick's Wren (*Thryomanes bewickii*), Yellow-rumped Warbler (*Dendroica coronata*), Spotted Towhee, White-crowned Sparrow (*Zonotrichia leucophrys*), Song Sparrow (*Melospiza melodia*), and Dark-eyed

Junco. Bewick's Wren is the only one of these species that does not regularly consume berries (Kennedy and White 1997). To date, we have recorded 35 species actively foraging on Russian olive berries, ranging in size from American Crow (*Corvus brachyrhynchos*) to Ruby-crowned Kinglet (*Regulus calendula*).

Prior to summer 2009, we reclassified one RO 5 transect as RO 3 due to the average overall height and structure of the trees at the site. In winter 2010, this RO 3 stand supported an exceptionally high avian density, averaging greater than 2200 birds per 100 acres more than the second highest C/S type. The exceptional avian density at this site was primarily due to huge numbers of American Robins and Mountain Bluebirds, although Cedar Waxwing, Red-winged Blackbird, and Yellow-rumped Warbler also were present at unusually high densities. All of these species were drawn to the massive berry crop produced during the 2009 growing season. Mature Russian olives produce larger, more consistent berry crops than younger trees (Olsen 1974), and berry production is higher on plants with access to direct sunlight (Shafroth et al. 1995). Thus, the maturity of the Russian olives at this site and the uninhibited access to direct sunlight create ideal conditions for the consistent production of large berry crops.

Although American Robin density was highest in RO 3 during winter 2010, the species was irruptive throughout the middle Rio Grande bosque. American Robin was a primary reason why avian densities were higher in 2010 than 2009 at 10 of 13 C/S types surveyed during both winters, and was the most common species at the five C/S types with the highest winter densities in 2010 (RO 3, BURN 1, DR 5, NMO 5, and C/NMO 1).

Figure 2. Russian olive is an important food source for many wintering and migrating birds, including Yellow-rumped Warbler (top) and Cedar Waxwing (bottom).

The high avian density and richness in BURN 1 was primarily a result of extensive woody and weedy re-growth. The winter 2008 survey season began about nine months after the fire, by which time the previous woody understory vegetation had significantly recovered (mostly Russian olive and salt cedar, along with smaller amounts of native vegetation). In addition, a large amount of weedy vegetation, including grasses and Russian thistle (*Salsola tragus*) was present. By winter 2010, woody vegetation re-growth covered most of the site, but dense patches of weedy vegetation were still present. The woody re-growth provided extensive cover, and the weedy vegetation provided forage for a number of species, especially sparrows. The most common species in BURN 1 during winter 2010 were American Robin, White-crowned Sparrow, Song Sparrow, Cedar Waxwing, Northern Flicker, Downy Woodpecker (*Picoides pubescens*), and Dark-eyed Junco. The sparrows predominantly foraged on seeds from the weedy vegetation, while Northern Flicker and Downy Woodpecker likely exploited insects in the burned cottonwood snags. Hairy Woodpecker (*Picoides villosus*) also were regular in the burn during winter 2010.

Overall, drains bordered by dense vegetation (DR 5) supported the highest avian density during four of the seven winters and the highest richness levels during all seven winters. The presence of standing water along with dense vegetation to provide both cover and forage explains the high bird use of this C/S type. Nearly all regularly recorded wintering songbirds were documented in these densely vegetated drains. The most common species in DR 5 during winter 2010 were American Robin, Dark-eyed Junco, White-crowned Sparrow, Song Sparrow, and Mallard (*Anas platyrhynchos*).

The importance of dense waterside vegetation to birds is illustrated by the differences in both avian density and richness between drains bordered by dense vegetation (DR 5) and drains with sparse edge vegetation (DR 6). Although DR 6 supported a relatively high avian density during all winters, density and species richness were low compared to DR 5. This difference in abundance and richness between drain C/S types can be attributed to the shorter stature and more patchy distribution of waterside vegetation at DR 6 locations. More secretive species such as Hermit Thrush, Winter Wren, and Lincoln's Sparrow (*Melospiza lincolnii*) were consistently documented in densely vegetated drains (DR 5), but rare or absent in more sparsely vegetated drains (DR 6). A similar trend is shown by wintering ducks: Mallard, Northern Shoveler (*Anas clypeata*), Wood Duck (*Aix sponsa*), American Wigeon (*Anas americana*), and Gadwall (*Anas strepera*) were all regularly recorded on DR 5 transects, but only Mallard was regularly recorded on DR 6 transects.

Mature cottonwood stands with a mechanically-thinned understory (C-2 artificial) supported the lowest densities and among the lowest richness levels during all seven winters. The low bird numbers in mechanically-thinned stands can be attributed to the absence of understory vegetation. The lack of understory shrubs and trees in these stands reduced cover and forage opportunities for birds. In addition, a high percentage of wintering birds in the southwest, especially sparrows, are granivores that feed on seeds from weedy annual plants (Pulliam and Brand 1975). Such weedy vegetation was minimal under the closed canopy of most C-2 artificial stands during the winter. As a result, the species composition in C-2 artificial stands was largely limited to canopy-dwelling species such as White-breasted Nuthatch (*Sitta carolinensis*), and Black-capped Chickadee (*Poecile atricapilla*).

Summer Avian Abundance and Species Richness

During summer 2010, BURN 1 supported both the highest avian density and species richness. A more thorough discussion of BURN 1 is provided below, but the diversity in vegetation composition and structure likely explains the high avian use. The numerous cottonwood snags provided breeding opportunities for cavity-nesting species such as Downy Woodpecker, White-breasted Nuthatch, Ash-throated Flycatcher (*Myiarchus cinerascens*), and Bewick's Wren, all of which were common. The snags also provided a desirable nesting substrate for Western Kingbird (*Tyrannus verticalis*), a species generally associated with open areas (Gamble and Bergin 1996), but common in BURN 1 in 2010. At the same time, the dense re-growth of woody vegetation (primarily Russian olive and salt cedar) provided nesting substrate for species such as Blue Grosbeak (*Guiraca caerulea*), Spotted Towhee, and Yellow-breasted Chat, all common in BURN 1 during 2010. Other common species in 2010 included Mourning Dove, Black-chinned Hummingbird, and American Robin.

Marsh Habitat incorporating open water (MH 5-OW) has consistently supported among the highest avian densities and richness levels during summer throughout this study. The large numbers of Common Yellowthroats and Red-winged Blackbirds present in marsh habitat during all seven summers of this study were major factors in the high density levels. Marsh habitat was also the only C/S type in which Pied-billed Grebe (*Podilymbus podiceps*), Wood Duck, and American Coot (*Fulica americana*) were common during the summer and the only C/S type where species such as American Bittern (*Botaurus lentiginosus*), Wilson’s Snipe (*Gallinago delicata*), Great Egret (*Ardea alba*), White-faced Ibis (*Plegadis chihi*), Lesser Yellowlegs (*Tringa flavipes*) and Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*) were recorded. Sora (*Porzana Carolina*) and Virginia Rail (*Rallus limicola*) also were recorded. But, because our survey protocol is not designed for the detection of secretive marsh birds such as rails (e.g. by the playing of tape recorded calls), these species are likely under-detected.

Among terrestrial C/S types, those dominated by dense native vegetation (e.g. NMO 5, C/NMO 1, C/CW 1, and CW 5) generally supported higher bird densities and species richness than C/S types with large amounts of introduced non-native vegetation and more sparsely vegetated C/S types; a finding that is consistent with other studies (Knopf and Olsen 1984; Brown 1990; Stoleson and Finch 2001). But, in contrast to previous studies, areas with extensive Russian olive (RO 3, RO 5, C/RO 1, C-RO/CW 3) supported densities and richness levels during all seven summers that were comparable to most predominantly native C/S types (especially C/CW 1 and CW 5).

One possible explanation for the relatively high avian use of areas with extensive Russian olive is easy access to food, as breeding birds prefer to nest in areas that are near reliable food sources. In general, habitats dominated by exotic vegetation, such as salt cedar and Russian olive, have been shown to harbor lower levels of insect prey than equivalent habitats dominated by native vegetation (e.g. Anderson et al. 1977b). But, although no formal data were collected, we incidentally noted high insect levels (specifically, but not limited to, mosquitoes) in areas with extensive Russian olive, especially RO 5 and C-RO/CW 3. This may be due to their proximity to standing water, as four of our five RO 5 transects and both C-RO/CW 3 transects are adjacent to the Rio Grande. In addition, Russian olive stands in the Middle Rio Grande bosque tend to occur in moister areas, as illustrated by the fact that coyote willow is generally the second-most common plant species in these stands. Because insect populations tend to be higher in moister areas (e.g. Janzen and Schoener 1968), their avian predators are likely to be more abundant as well.

Some support for this hypothesis comes from the fact that several bosque breeders that rely heavily on insects and other invertebrates for food are more common in Russian olive stands (especially RO 5 and C-RO/CW 3) than most other C/S types. Bushtit, Bewick's Wren, Common Yellowthroat, Yellow-breasted Chat, and Spotted Towhee are all common to abundant in Russian olive stands and rely primarily on insects and other invertebrates for food during the breeding season.

In addition to food availability, breeding birds also seek locations that provide the specific vegetative structure they find desirable for nesting. Locations with a desired vegetative structure have been shown to support higher avian abundance and species richness (Gutzwiller and Anderson 1987). Given that songbirds breeding in the bosque have evolved nesting habits based on the native vegetation historically present, it is reasonable to assume they prefer the vegetative structure provided by native vegetation to that of introduced non-natives.

But, it also has been suggested that breeding bird density in the southwest is correlated with vegetation volume (Mills et al. 1991). The importance of vegetation structure and density is illustrated by the fact that the two terrestrial C/S types with the most dense vegetation (NMO 5 and C/NMO 1), also are among the terrestrial C/S types that supported the highest avian densities and species richness levels during each summer. In contrast to other non-native vegetation in the bosque (e.g. salt cedar and Siberian elm), Russian olive provides a dense structure that is likely desirable to breeding birds. This is especially true for understory and sub-canopy nesters in C/RO 1 stands who rely on the Russian olive for nesting substrate, and is the most likely explanation for the relatively high summer density and richness levels in C/RO 1 stands.

Comparison of Avian Abundance and Richness by Land Management Entity

Cumulatively during the seven years of this study (2004-2010), both avian density and species richness during winter and summer have been higher at transects in Corrales than in areas managed by other entities. Both winter species richness and summer avian density have been significantly higher in Corrales than all other areas. Because each land management entity employs its own management strategy, these results suggest the Corrales bosque management strategy is the most beneficial to avifauna. Although, in general, we believe this to be true, land management strategy is not the only factor impacting avian use.

Vegetation composition and structure have a significant impact on avifauna (e.g. Rice et al. 1984). And, regardless of management strategy, different areas in the bosque support specific habitats of varying value to birds. A comparison of our transects in Corrales and at La Joya (managed by the New Mexico Department of Game and Fish) illustrates this. In both Corrales and La Joya, the areas we survey have been largely unaltered by thinning or restoration projects. But, despite the similarity in management between these two areas, avian density and richness have cumulatively been much higher in Corrales than at La Joya. Nearly all of our transects incorporating significant amounts of New Mexico olive (C/NMO 1 and NMO 5) occur in Corrales. Because New Mexico olive attracts large numbers of birds year-round, these transects increase the mean avian numbers for the Corrales bosque. In contrast, all three of our salt cedar transects (SC 5) are located at La Joya. In general, avian use of salt cedar has been found to be low (e.g. Anderson et al. 1977b, Hunter et al. 1988), a trend our data also have shown. Thus, the salt cedar decreases the mean avian numbers at La Joya and limits potential avian use.

So, when comparing avian numbers between management entities, it is important to consider the impact of differences in baseline vegetation composition.

Unequal sample sizes can also skew avian density and richness numbers. While we survey 16-20 transects each in Corrales, Albuquerque, and on Middle Rio Grande Conservancy District (MRGCD) lands, we have only seven transects at La Joya and three in Rio Rancho. The smaller sample sizes in Rio Rancho and La Joya magnify the avian trends in those areas. In addition, while our large sample sizes in Corrales, Albuquerque, and on MRGCD lands provided the opportunity to survey multiple C/S types of differing value to birds, the small sample sizes in Rio Rancho and La Joya resulted in a decreased diversity of C/S types surveyed in those areas.

Ultimately, management strategy can have either a positive or negative impact on avian use, regardless of vegetation composition or sample size. The Village of Corrales manages its bosque as a nature preserve. Thinning and restoration activities have therefore been limited in the Corrales bosque, in order to protect the integrity of the preserve and minimize the impact on wildlife. The resulting high avian use in Corrales is not coincidental.

In contrast, the City of Rio Rancho manages its bosque like a city park, with increased access for humans as the apparent goal. As a result, there has been almost constant alteration of the vegetation in the Rio Rancho bosque over the past few years, and subsequent decreases in bird numbers. The irony in Rio Rancho is the presence of numerous interpretive signs extolling the wildlife found in the bosque, while, at the same time their management practices decrease the habitat value and force wildlife out.

Although the area is small, the habitat potential for birds in the Rio Rancho bosque would be large if the ecosystem there were provided time to recover.

The MRGCD has adopted a third, mosaic-type management strategy. Although extensive areas of the bosque managed by MRGCD have been mechanically thinned, there are large patches of habitat that also have been left unaltered. A concern about fuel load, and thereby fire danger, appears to be the driving force behind much of the MRGCD thinning. But, by leaving extensive patches of habitat unaltered, they have maintained important areas for birds and other wildlife.

The City of Albuquerque seems to have adopted a similar strategy. During the first few years of our study, wholesale mechanical thinning of the Albuquerque bosque was the norm, presumably to reduce fire danger. But, thinning operations have substantially decreased over the past few years, and the vegetation in certain areas of the Albuquerque bosque is now being allowed to recover. This change in management in Albuquerque has been reflected in the bird numbers there, as cumulative avian use has been increasing since 2008.

In summary, although multiple factors need to be considered when comparing avian density and richness between land management entities, the management strategies employed by the different entities have the greatest impact on avian use. The bird numbers in Corrales, where habitat alteration has been minimal, have consistently remained high. Bird numbers in Rio Rancho, where human use appears to be the priority, have been among the lowest and continue to decline. Bird numbers in Albuquerque and on MRGCD lands where habitat alteration has occurred in a mosaic manner, are generally somewhere in the middle.

Single Site Comparison of Abundance and Richness Before and After Restoration

In fall 2004, the USACE mechanically thinned a site in the Tingley Beach area of the Albuquerque bosque (SE31) that had previously supported a mature cottonwood overstory and mulberry (*Morus microphylla*) dominated understory (C/MB 1). The ultimate goal of this project was to establish ponds and a marsh at this location. The summer pre- and post-thinning data for SE31 (we did not initiate winter surveys at the site until after thinning) indicated only a slight decrease in avian density between summer 2004 and 2005, with a slight increase in species richness. But, this transect was subjected to some mechanical thinning in May 2004, just prior to the start of our summer surveys. This thinning altered about 25% of the survey area, negatively impacting bird numbers. When the summer 2004 data from this transect is compared with that of a second, undisturbed C/MB 1 transect (SE30), the impact of the disturbance on bird numbers is clear. Both avian density (515 birds/100 acres vs. 764 birds/100 acres in the undisturbed stand) and species richness (17 species/transect vs. 28 species/transect in the undisturbed stand) were lower in the disturbed C/MB 1 stand during summer 2004, although the differences were not statistically significant. The density and richness numbers for the undisturbed C/MB 1 stand remained consistent over the following six years (750 birds/100 acres and 28.2 species/transect on average for 2005-2010), suggesting that the pre-thin data for the C/MB 1 transect do not provide a true indication of avian use prior to disturbance.

Figure 3. The establishment of ponds and a marsh at SE31 created valuable wildlife habitat.

What can be concluded is that the establishment of ponds and marsh habitat by the USACE at this site (see Fig. 3) has positively impacted bird density and diversity. Since 2007, SE31 has consistently supported among the highest avian densities and richness of any transects we survey during both summer and winter. The ponds and marsh provide habitat that is severely lacking throughout the middle Rio Grande. In addition to significantly increasing bird densities and richness from both pre and post-thinning levels, this project has created habitat for species such as Snowy Egret (*Egretta thula*), Green Heron (*Butorides virescens*), and Sora. In summer 2010, Virginia Rail, Black-crowned Night-Heron (*Nycticorax nycticorax*), and Common Moorhen (*Gallinula chloropus*) were all recorded at the sight for the first time. In addition, both Snowy Egret and Green Heron were common in 2010. All of these species are generally rare or absent elsewhere in the middle Rio Grande bosque. During winter, the ponds attract a large variety of waterfowl. In winter 2010, we recorded 11 duck species in the ponds: Ring-necked Duck (*Aythya collaris*), American Wigeon, Mallard, Canvasback (*Aythya valisineria*), Wood Duck, Bufflehead (*Bucephala albeola*), Common Merganser (*Mergus merganser*), Redhead (*Aythya americana*), Gadwall, Green-winged Teal (*Anas crecca*), and Northern Shoveler. In addition, Pied-billed Grebe was common in the ponds and Marsh Wren (*Cistothorus palustris*) was common in the marsh.

Comparison of Avian Abundance and Richness Before and After a Catastrophic Fire

The February 2007 Belen bosque fire burned 90-95% of the vegetation on one of our previously-established transects (SW27), and provided us with the opportunity to document the impact of a catastrophic fire on bird numbers. During the first month of the spring 2007 survey season (March) the burned area was devoid of all vegetation (see Fig. 4). By the end of the spring survey season (May), annual vegetation was re-established, and woody species were beginning to re-sprout. Given the nearly complete loss of vegetation in the fire, we anticipated decreases in both avian density and species richness from levels recorded during spring and summer survey seasons prior to the fire. But, the decrease during spring 2007 was much smaller than expected and not statistically significant. Unfortunately, due to a lack of funding, we were unable to survey this site during subsequent springs. Perhaps more surprising, avian density and richness were higher during all four post-fire summers (2007-2010) than during pre-fire summers (2004-2006). Avian density and species richness were also higher during all post-fire winters (2008-2010) than during pre-fire winters (2004-2007).

Figure 4. Photos of the south end of SW27. The top photo was taken one month after the Belen fire (late March 2007), and the bottom photo was taken in July 2010.

Figure 5. Photos of SW27 during July 2007 (top; five months after the Belen fire) and July 2010 (bottom).

By summer 2007, woody vegetation such as Russian olive, salt cedar, coyote willow, and cottonwood had well-established re-sprouts, and many annual and weedy species were present (see Fig. 5). By summer 2010, many woody re-sprouts (primarily

Russian olive and salt cedar, but also cottonwood and tree willow) had reached or passed 2 m in height. Areas between woody vegetation were covered with a dense layer of weedy vegetation. A comparison of summer bird composition between pre and post-burn years indicates nearly all regularly-occurring species present before the fire were still present after the fire. The only species common before the fire that was absent in summer 2007 was Yellow-breasted Chat. By 2009, Yellow-breasted Chat was once again common. Black-capped Chickadee, which was uncommon before the fire, was the only regularly recorded pre-fire species to be absent during all four post-fire summers.

In summer 2007, decreases were documented for Spotted Towhee (although still common), Summer Tanager (*Piranga rubra*), Ash-throated Flycatcher, Bushtit, and Wilson's Warbler (a late summer migrant). All of those species were regular during summer before the fire. In 2010, Spotted Towhee (abundant), Ash-throated Flycatcher (common), Bushtit (common), and Wilson's Warbler (common) were all at least as common as they had been during pre-fire summers. Only Summer Tanager (regular), was still present in smaller numbers than during pre-fire summers. Of the 21 most predominant species during pre-fire summers, numbers actually increased for 11 of those during summer 2007, and for 14 during 2008, 2009, and 2010. Among the species increasing post-fire were Mourning Dove, Black-chinned Hummingbird, Northern Flicker, Downy Woodpecker, Western Kingbird (*Tyrannus verticalis*), White-breasted Nuthatch, Bewick's Wren, American Robin, MacGillivray's Warbler, Bullock's Oriole (*Icterus bullockii*), and Blue Grosbeak. Several species not regularly recorded in the summers before the fire were regular in 2010, including Gambel's Quail (*Callipepla* *gambelii*), American Kestrel (*Falco sparverius*), Hairy Woodpecker, Northern Mockingbird, and Yellow Warbler.

Data from winter 2008-2010 also indicate that bird numbers increased post fire. Avian density in both 2008 and 2009 was higher than any of the four pre-fire years, and species richness was higher in 2008 and 2009 than for all previous years except 2005. In 2010, winter avian density was significantly higher than any previous year. Species richness was also higher in 2010 than any previous winter. Of the 13 regularly occurring wintering species prior to the fire, eight were more common after the fire, including Downy Woodpecker, Northern Flicker, American Robin, Yellow-rumped Warbler, White-crowned Sparrow, Song Sparrow, and Spotted Towhee. Black-capped Chickadee (uncommon) was the only pre-fire species not recorded in 2010. The extensive growth of weedy vegetation following the fire attracted large numbers of seed-eating birds in winter 2010, especially sparrows. White-crowned Sparrow and Song Sparrow were abundant in 2010, and Dark-eyed Junco was common.

Perhaps a more important comparison can be made between bird numbers in the burned area and bird numbers in mechanically-thinned cottonwood stands (C-2 artificial). Avian density was significantly higher in the burn area during all post-fire seasons (spring 2007 and 2008, summer 2007-2010, and winter 2008-2010), and species richness, although not statistically significant, was also higher during all seasons. Obviously, we are not advocating burning the bosque. But, our data suggest that avian populations recover much more rapidly following a fire, even in the event of a catastrophic fire that consumes nearly all vegetation, than from mechanical thinning.

RECOMMENDATIONS

Since we began this study in December, 2003, land managers throughout the Middle Rio Grande have generally become more aware of the biological impacts of non-native vegetation removal and the value some of these species have to avian populations. Russian olive (see Smith et al. 2009, Shafroth et al. 2010), and to a lesser extent, mulberry, have significant value to bird and other wildlife populations. In some cases, land managers are acknowledging the benefits of these non-native species. Work done by the U.S. Army Corps of Engineers provides perhaps the best example of accomplishing thinning goals while showing sensitivity to the bosque ecosystem and acknowledging the value of certain non-native vegetation. Unfortunately, in other cases this knowledge either has been ignored, or has not necessarily been reaching the field crews conducting thinning operations. Although some land managers profess to be sensitive in their thinning activities, in too many cases field crews continue to remove as much vegetation as possible with impunity.

Even in management areas where a premium has been placed on maintaining a healthy bosque ecosystem (e.g. Corrales), thinning activities have resulted in the removal of non-target vegetation. It is clear that there needs to be more direct control over, and specific instructions given to thinning crews before and during their activities. We have several recommendations that might help alleviate the current gap between proposed activities and what actually occurs on the ground.

First, everyone from land managers, down the chain of authority to field crew leaders, need to have a clear understanding of when it is appropriate to conduct thinning activities and knowledge of applicable laws (including, but not limited, to the Migratory

Bird Treaty Act of 1918). We suggest that all thinning activities be conducted prior to the onset of nesting (as early as mid-February for Great Horned Owls) or after August 31, when most birds have completed nesting activities for the year. Certainly, no thinning activities should occur after April 1, by which time most resident birds have initiated breeding activities. The avoidance of vegetation treatments during the breeding season should include not only thinning activities, but also the mowing of vegetation (e.g. along drains and of weedy open areas). Land managers should schedule vegetation treatments for times of year when the impact on avian and other wildlife populations in the bosque will be lowest. If it is necessary to perform vegetation treatments during the breeding season, it is imperative that pre-treatment nest searches be conducted in the impacted area by an independent, qualified entity. This is a requirement of the Migratory Bird Treaty Act. Given the extensive vegetation removal that has already occurred, we also suggest that future thinning activities in previously untreated areas be staggered over several years to allow time for the establishment of new vegetation to provide habitat for birds and other wildlife in previously thinned areas.

Second, land managers need to provide clear, concise instructions to crew leaders in the field, and monitor the results more closely to prevent misinterpretation of actual instructions. These instructions need to include information regarding not only which species to remove, but also areas to avoid (e.g. due to the presence of ongoing research projects, biologically sensitive areas, etc.). Training should be provided for field crews so they have the skills to identify woody vegetation and accurately differentiate between species to be removed and those to be left undisturbed. One way to assist field crews in minimizing the loss of desirable vegetation would be to flag either the vegetation to be removed, or the vegetation to be avoided, depending on which represents the larger amount of the vegetation present. These steps may be logistically challenging in some cases, but will help to ensure that thinning activities do not exceed the scope of what is appropriate and envisioned by the land managers.

Third, the use of heavy equipment (i.e. Franklin machines, etc.) should be avoided whenever possible. Given the extensive thinning that has already occurred in many areas, the need to clear large, densely vegetated areas rarely should be necessary. In addition, this type of equipment has limited precision, increasing the likelihood that non-target areas and species will be impacted. This equipment not only destroys the target species, but all other vegetation it passes over as well, leaving a longer-term impact on the area. Because most vegetation-removal activities at this point are focused on controlling re-sprouts in previously thinned areas, the use of heavy equipment is inappropriate. This equipment continues to disturb the soil, thereby favoring the germination of annual weeds such as kochia (*Kochia scoparia*) and Russian thistle that thrive in such situations. These noxious weeds often out-compete hand-planted seedlings, shrubs, and whips in areas where restoration activities have been initiated. Therefore, hand crews using chain saws and/or spraying re-sprouts are more appropriate. By taking a proactive and diligent approach to treating the stumps and subsequent re-sprouts after treatment, the need for more heavy-handed re-treatments can be minimized.

The primary goal of most thinning activities has been to reduce fuel load, and thereby decrease fire danger in the bosque. But, while reducing fuel loads may decrease the intensity of a fire, it does not necessarily reduce the likelihood of a fire starting. Several bosque fires over the past few years have started in previously thinned areas.

Given that all bosque fires in the middle Rio Grande since at least 2003 have been human caused (USACE 2007), we suggest that land managers follow the protocol used by the Corrales Bosque Commission and the Village of Corrales. The cornerstone of this strategy is to close the bosque to public access during times of extreme fire danger, thereby minimizing the likelihood of a human-caused fire. The closure is enforced by regular police and fire patrols and by enlisting the help of volunteers from the community. Because it is unrealistic to expect police to continuously monitor activities in the bosque, the use of community volunteers to monitor activity in the bosque is essential. Although this strategy may be more logistically challenging in high use areas such as Albuquerque, there also are many private citizens who likely are willing to volunteer their time to patrol the bosque.

Our data from the first seven years of this study showed drastically reduced avian use of areas that have been subject to the mechanical removal of non-native vegetation. We still do not know, however, the longer-term impacts of this management practice on birds, especially in areas where re-vegetation activities are undertaken. The effect of bosque restoration efforts, particularly in areas that are re-vegetated with native plants, may benefit birds in the long-term, as shrub vegetation matures. Unfortunately, re-vegetation efforts have occurred in only a small fraction of the areas that have been thinned.

If no re-vegetation efforts are undertaken, non-native vegetation will simply re-grow where it was removed. In some areas where mechanical thinning has occurred without subsequent re-vegetation efforts, invasive species (especially salt cedar, tree of heaven [*Ailanthus altissima*] and Siberian elm) have fully re-established within a year.

Thus, there is the potential for a continuous cycle of mechanical thinning followed by the re-establishment of non-native vegetation. Under this scenario, bird life will undoubtedly be negatively impacted over the long term. Following a management strategy of removing non-natives without restoring native vegetation, then repeating the same process every few years is not only detrimental to avian and other wildlife populations, it is also prohibitively expensive.

In order for re-vegetation efforts to be successful, careful planning is essential. One of the most important factors to successful re-vegetation is an adequate water supply to support native plants (Shafroth et al. 2010). The main reason introduced species such as Russian olive and salt cedar can out-compete native species is that they are better adapted to survive low levels of water (Horton 1977). By engaging in practices such as monitoring the water table to determine the depth at which to plant and selecting plants appropriate for given soil salinity and moisture levels, the successful re-growth of native vegetation can be achieved (Fenchel 2006, Shafroth et al. 2010).

It also is important for re-vegetation efforts to include a mosaic of native understory species, including New Mexico olive, coyote willow, tree willow (*Salix amygdaloides* and/or *S. gooddingii*), and silver buffaloberry in addition to young cottonwood shoots. Avian richness and abundance have been shown to increase with increased floristic diversity (Strong and Bock 1990, Powell and Steidl 2000). Thus, establishing a diversity of native vegetation will provide habitat for a greater diversity and density of avian life.

Although the replacement of non-native vegetation with native plants could benefit avian densities and species richness in the long term, the importance of Russian olive to wintering birds should not be overlooked. During six of seven winters during this study, Russian olive stands exposed to direct sunlight (i.e. not under a cottonwood canopy; RO 3 and RO 5) have supported among the highest avian densities of all terrestrial C/S types because Russian olive produces larger berry crops when provided with direct sunlight (Shafroth et al. 1995), and the berries remain viable on the tree for up to three years, or until the crop is consumed (Borell 1971, Olsen 1974). Our data also have shown variability in avian use of these stands, depending on berry crop size. Therefore, it is imperative to continue data gathering over the coming years to acquire more definitive information regarding the importance of Russian olive to wintering birds. Based on our preliminary data, we suggest that thinning activities to remove non-native vegetation should avoid areas where Russian olive is established and not blocked from direct sunlight by a cottonwood overstory. In addition, we recommend that healthy, berry-producing Russian olive plants be retained for the benefit of wildlife regardless of the accompanying vegetation present.

Data for the first seven years of this study have suggested certain trends in avian use of the bosque. The most pronounced of these trends include: 1) a preference by breeding birds for C/S types supporting dense vegetation dominated by either native plants, Russian olive, or a combination of the two; 2) the importance of Russian olive stands not under a cottonwood canopy to wintering birds; 3) the reduced avian use of areas recently subjected to the mechanical removal of non-native vegetation. But, due to the relatively short-term nature of our data set, these trends are preliminary. In addition, the impact and effectiveness of restoration activities on avifauna have not yet been established, and cannot be sufficiently determined without continuous, long-term data collection. Thus, in order to determine the ultimate effects of restoration activities and to properly understand avian use of the bosque, it is essential to continue monitoring avian populations in the Middle Rio Grande bosque long term.

In addition, recent funding shortfalls have minimized the number of transects we have been able to survey during certain seasons. Our data for 2010 illustrate this, as we were only able to survey 53 of our 64 established transects during winter 2010. This emphasizes the need for adequate funding to ensure a full set of surveys for both winter and summer. An ongoing lack of complete winter data sets will greatly impact our ability to conduct meaningful analyses of changes in different C/S types, particularly as they relate to land management.

ACKNOWLEDGMENTS

The U.S. Army Corps of Engineers, the Middle Rio Grande Conservancy District through the U.S. Forest Service Collaborative Forest Restoration Program, the New Mexico Department of Game and Fish Share With Wildlife Program, and Hawks Aloft, Inc. funded this study. HAI staff that participated in this study included Erik Andersen, Kathi Borgmann, Trevor Fetz, Gail Garber, Ron Kellermueller, Jenny Lisignoli, Kristin Madden, Adam Ringia, Sandy Skeba, Mike Stake, and John Stanek. This report was written by Trevor Fetz and reviewed by Gail Garber. Cover photo by David Powell. All other photos by Trevor Fetz.

We extend our sincere thanks to William DeRagon, Ondrea Hummel, and Patricia Phillips, U.S. Army Corps of Engineers, for their technical expertise and overall support. We also thank Yasmeen Najmi and Jake Grandy, Middle Rio Grande Conservancy

District, and Chuck Hayes, New Mexico Department of Game and Fish, for their overall support.

We thank the government agencies, other organizations, and individuals that contributed to this study by allowing access to the bosque, including providing the necessary permits and keys to gates. They are: City of Albuquerque Open Space Division, City of Rio Rancho Department of Parks and Recreation, Corrales Bosque Commission, Middle Rio Grande Conservancy District, New Mexico Department of Game and Fish, the Village of Corrales Administration, Corrales Mayor Phil Gasteyer, Jack Burgess, Anthony Martinez, Karen Murray, and Matt Schmader.

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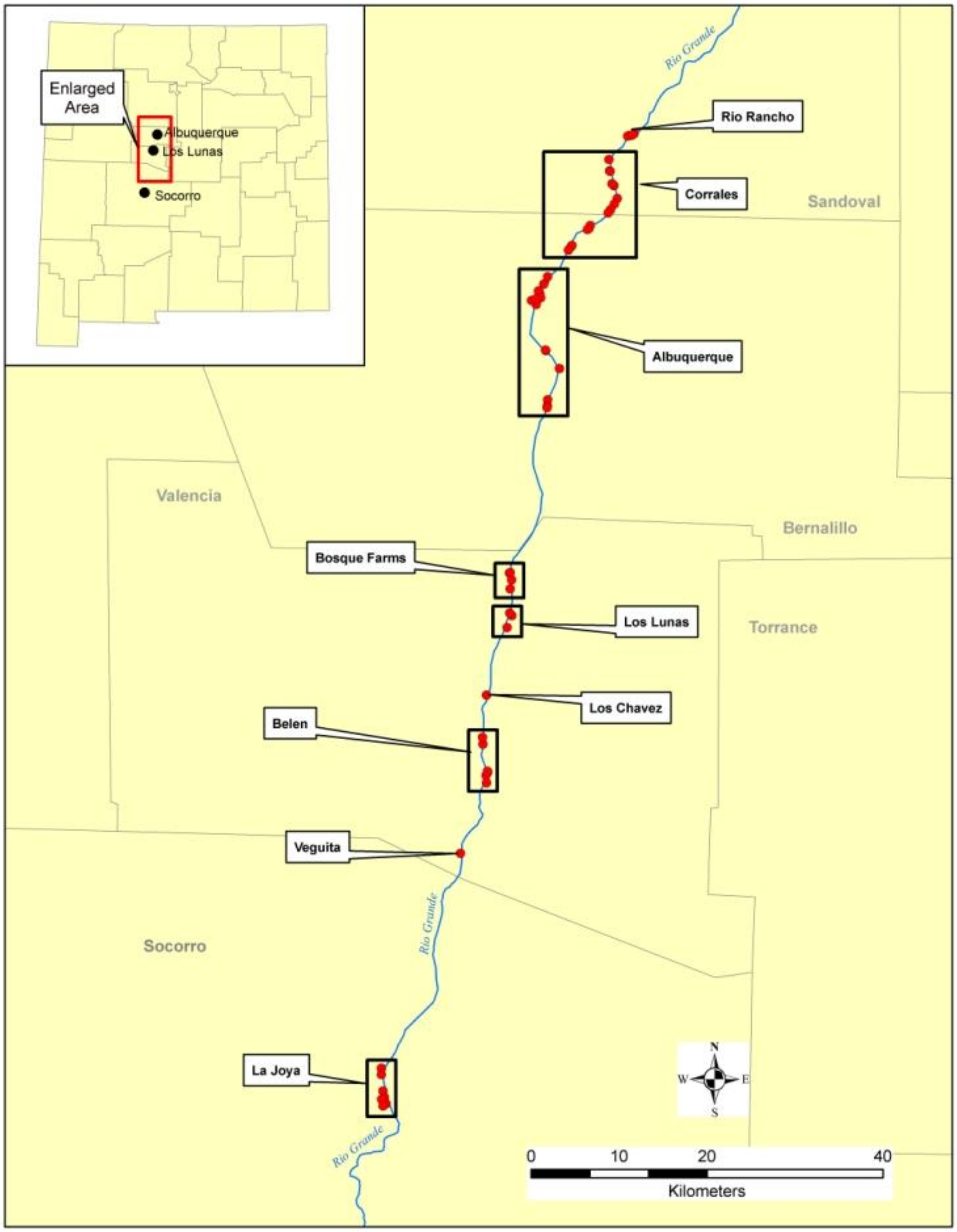
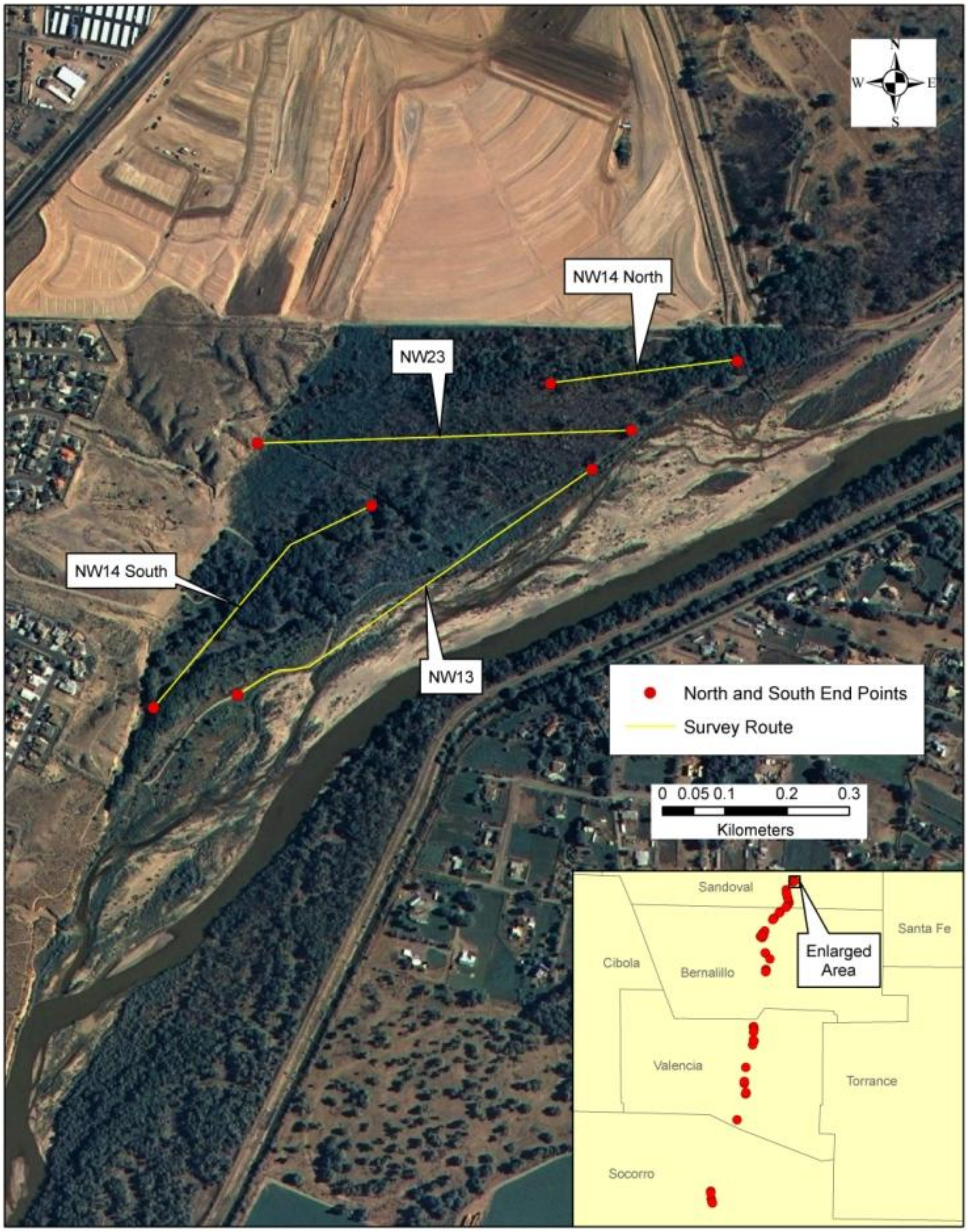
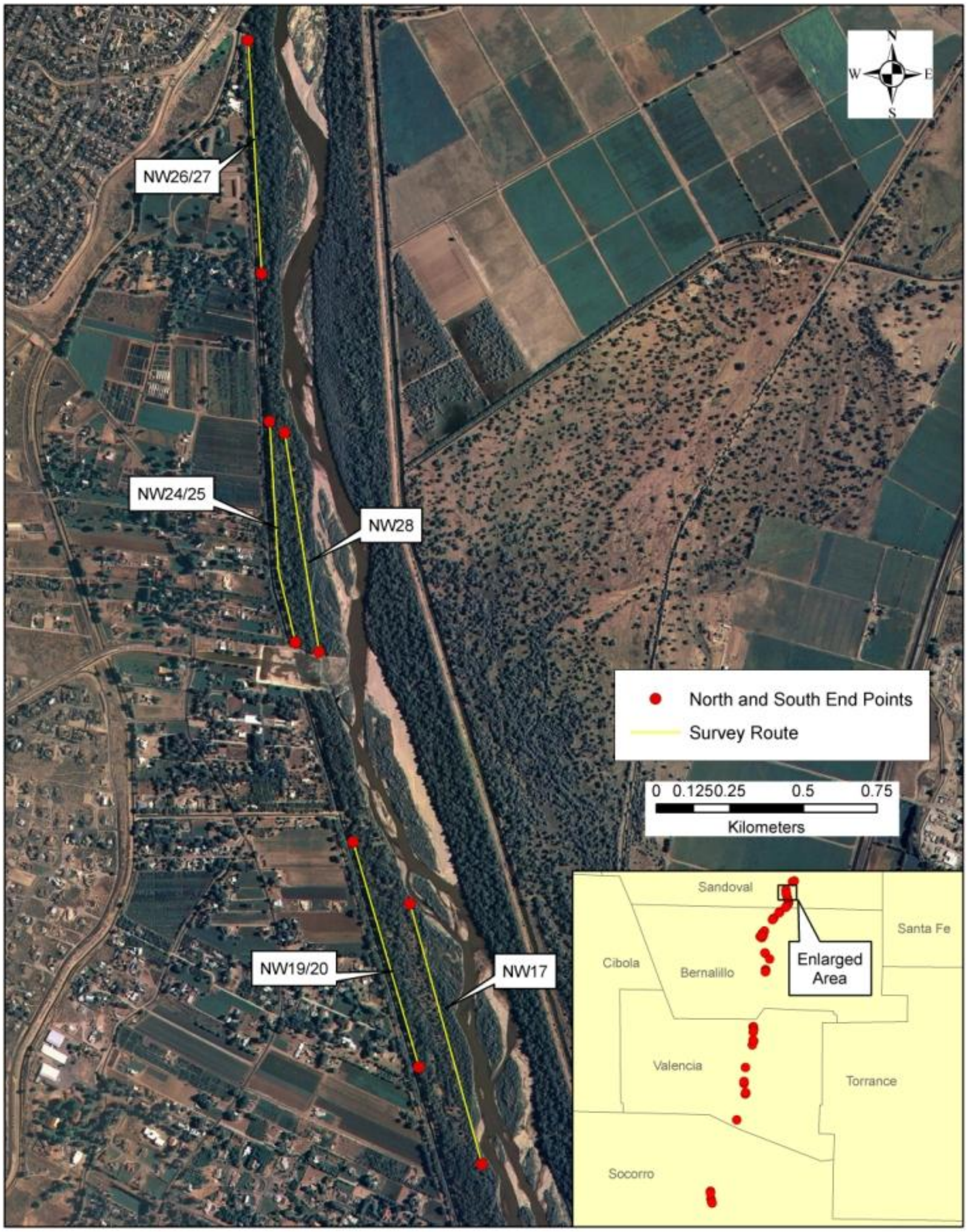
Appendix 1. Map of the Middle Rio Grande songbird study area. Red dots represent transect locations from Rio Rancho to La Joya State Game Refuge, New Mexico. Area Names correspond to individual maps in appendix 2-13.



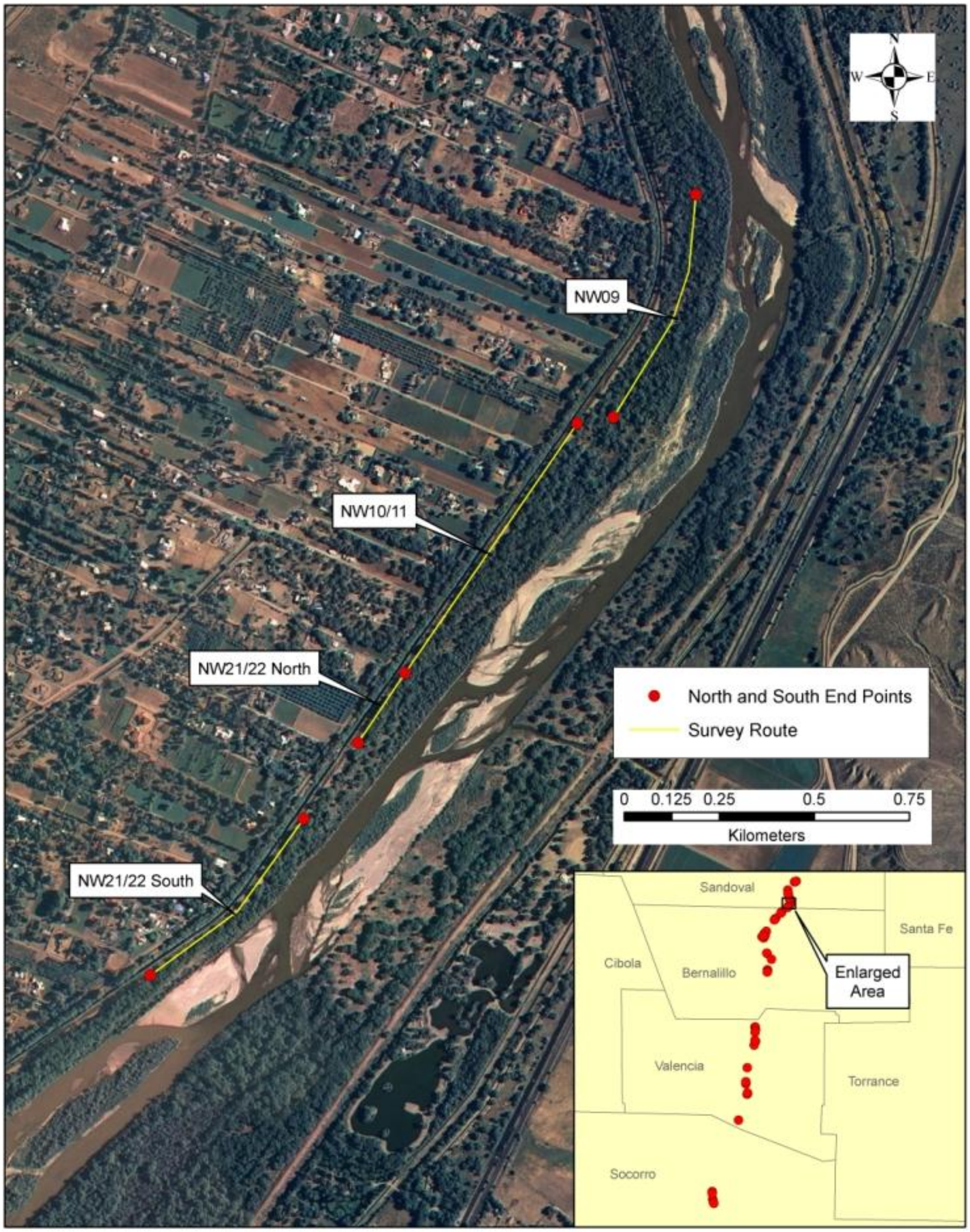
Appendix 2. Map of transects located in Rio Rancho, New Mexico.



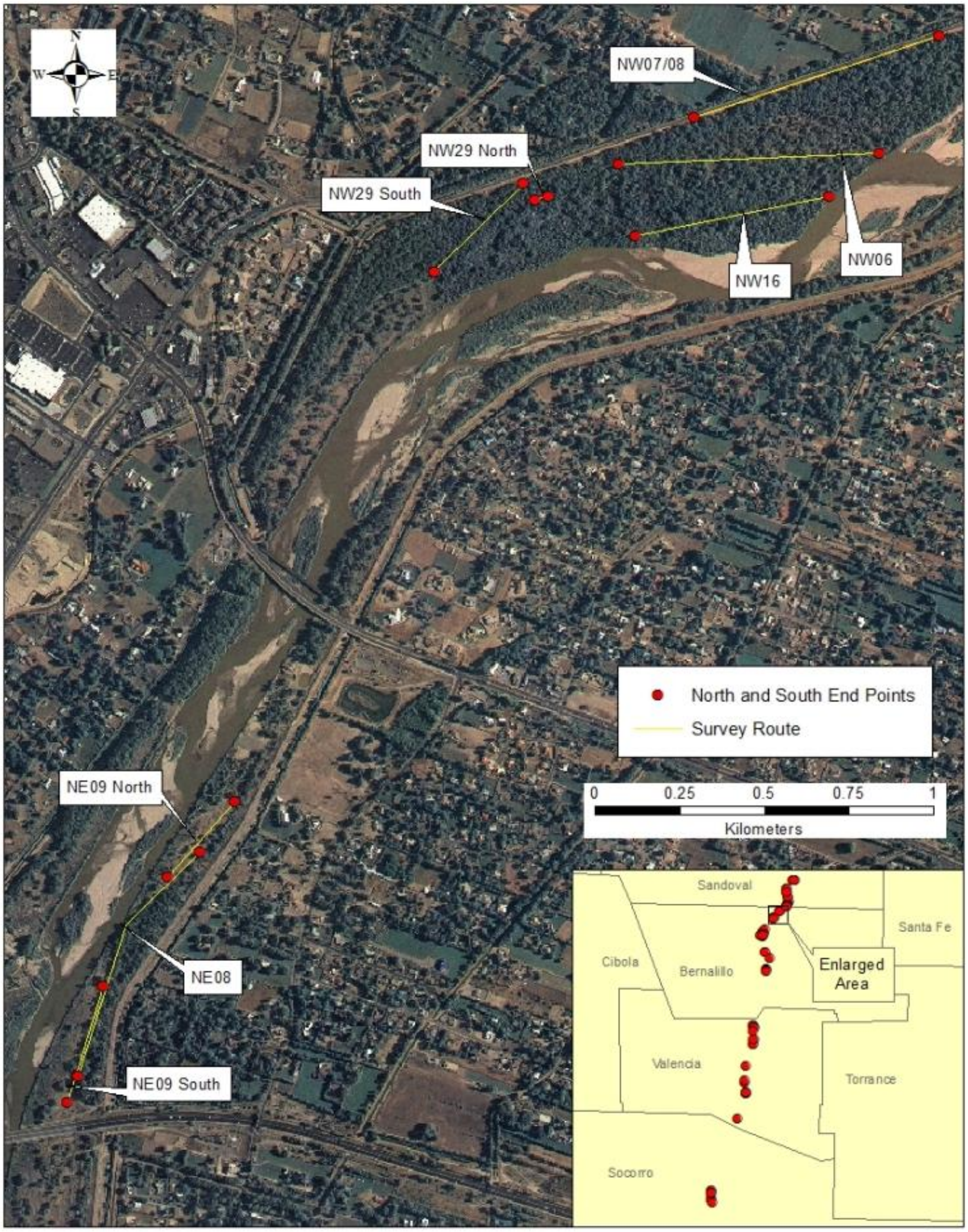
Appendix 3. Map of transects located in north Corrales, New Mexico.



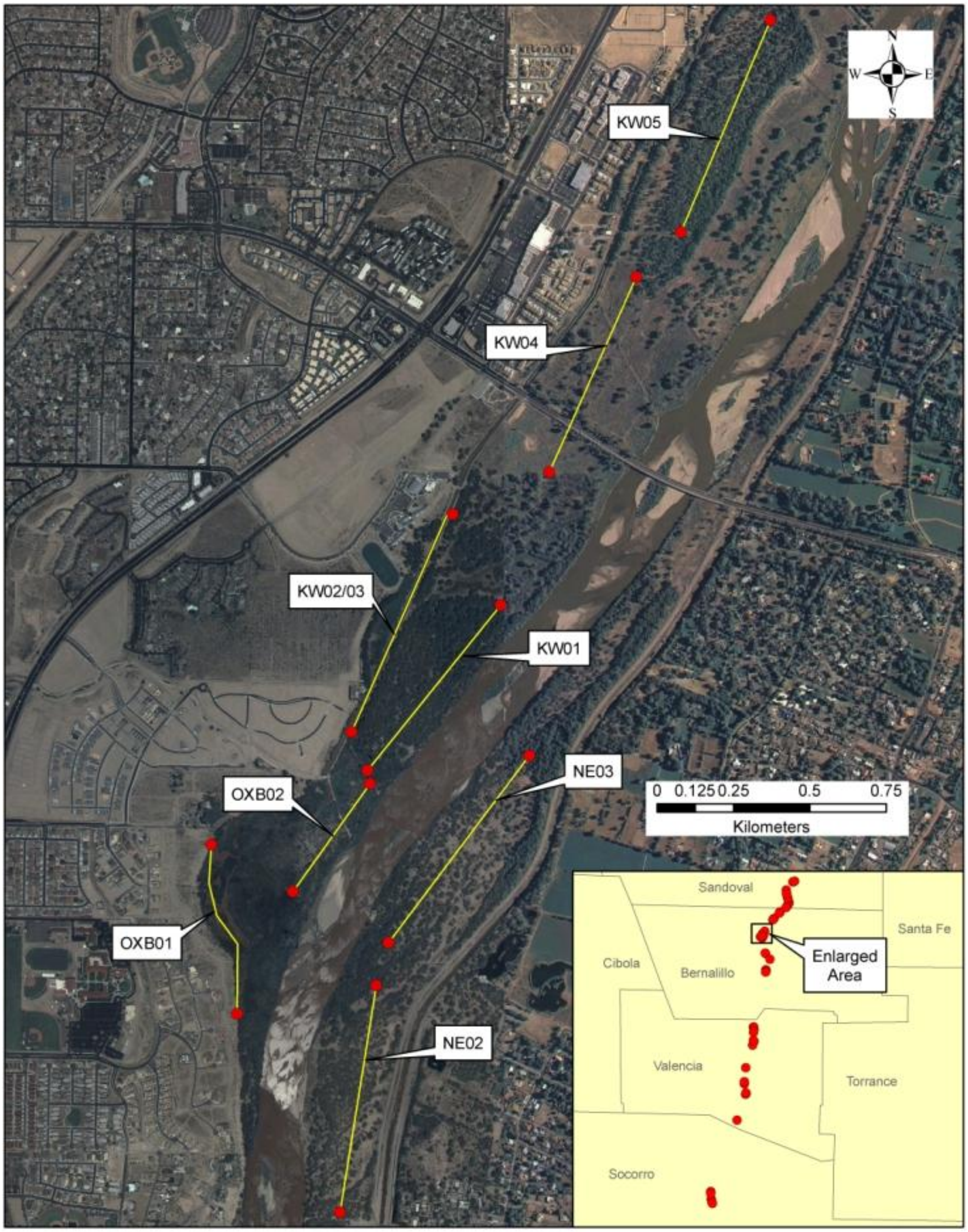
Appendix 4. Map of transects located in mid Corrales, New Mexico.



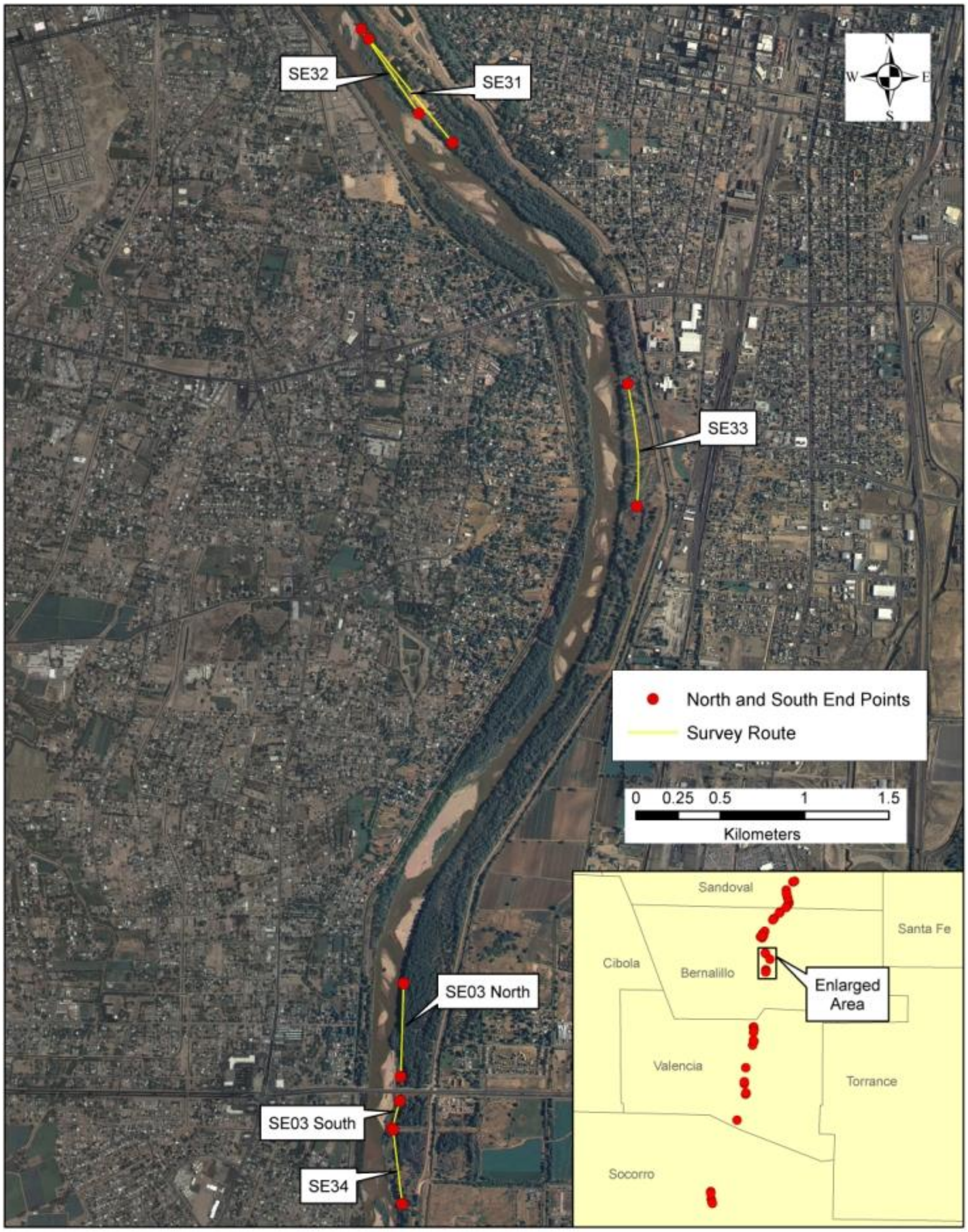
Appendix 5. Map of transects located in south Corrales and Alameda, New Mexico.



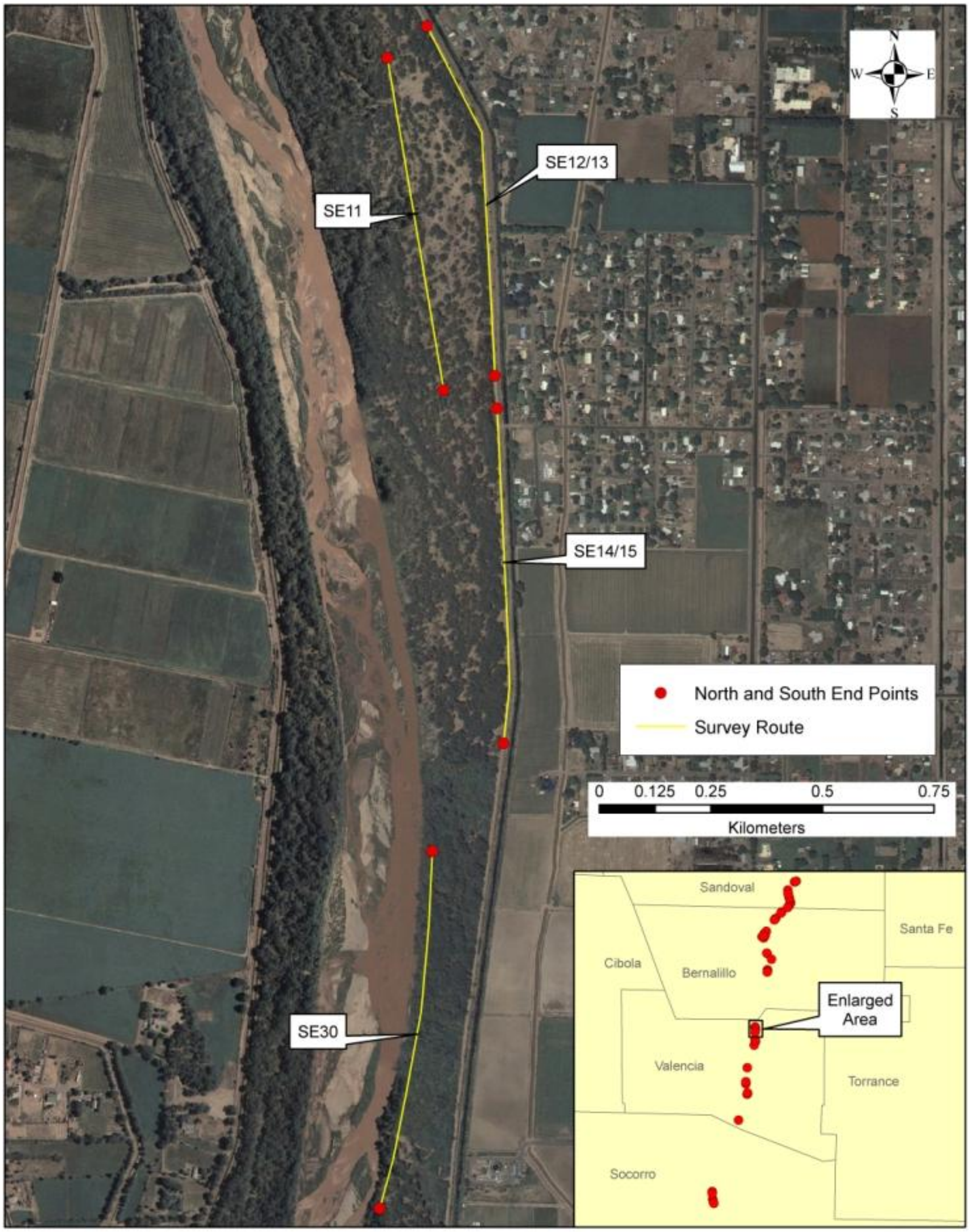
Appendix 6. Map of transects located in north Albuquerque, New Mexico.



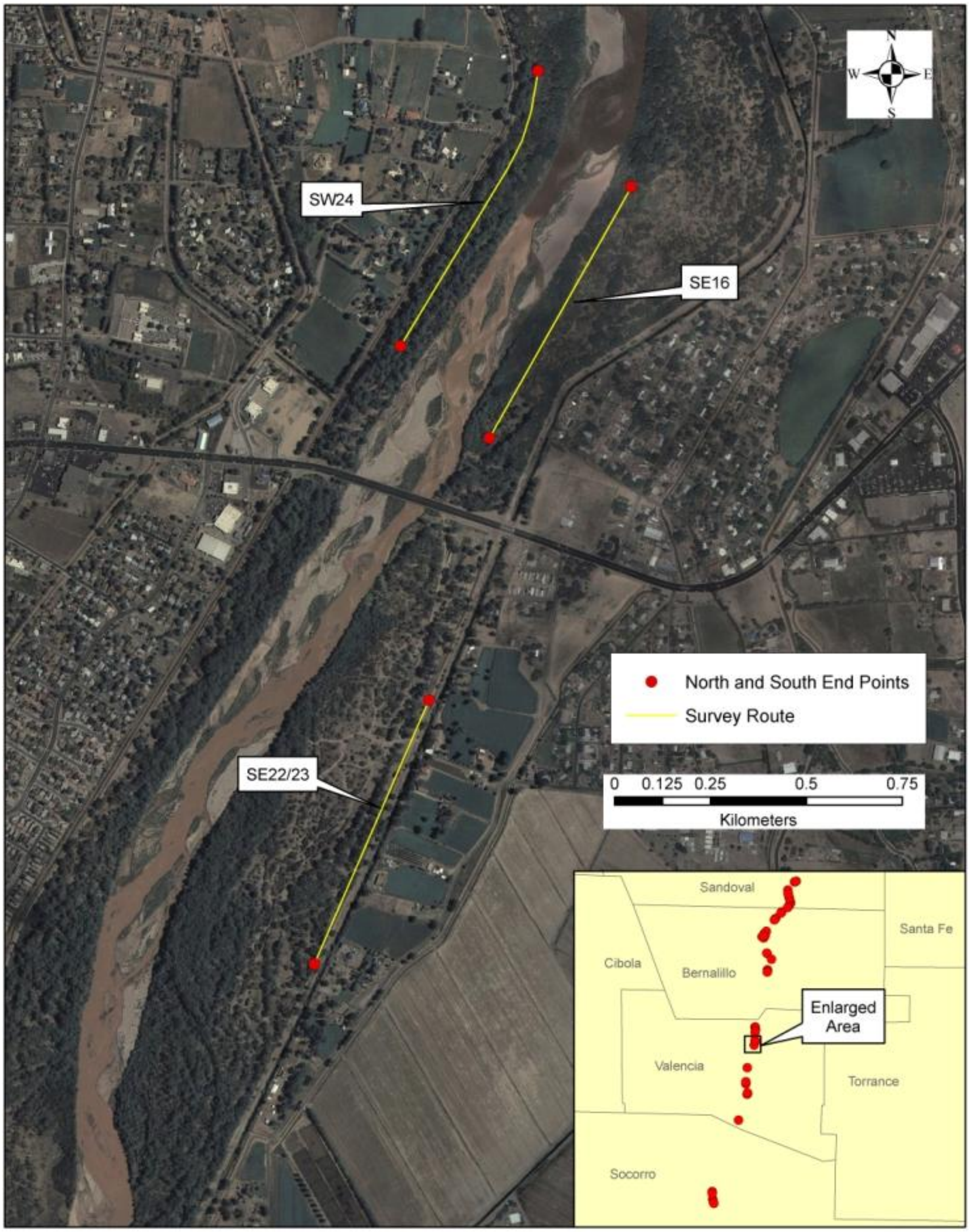
Appendix 7. Map of transects located in south Albuquerque, New Mexico.



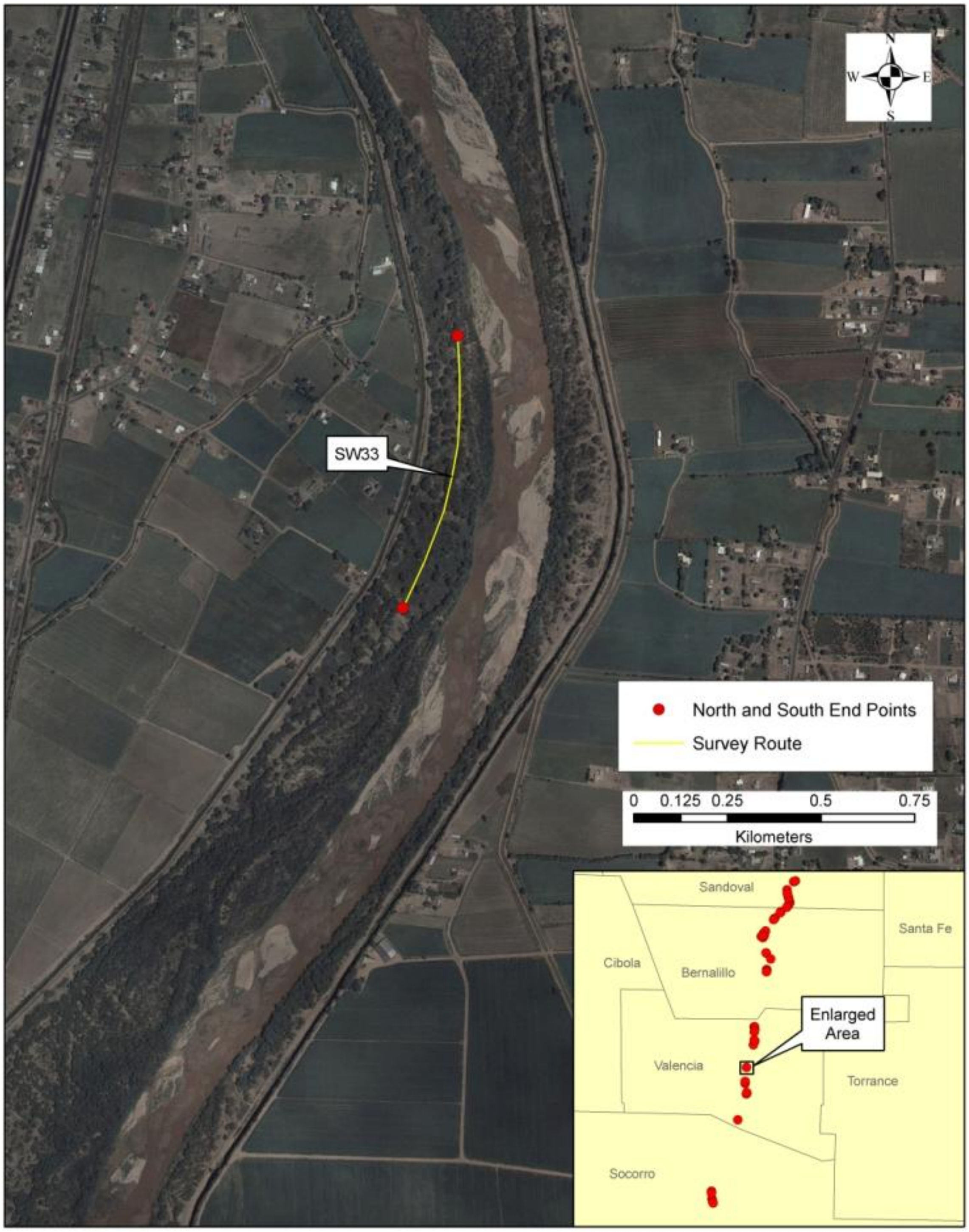
Appendix 8. Map of transects located in Bosque Farms, New Mexico.



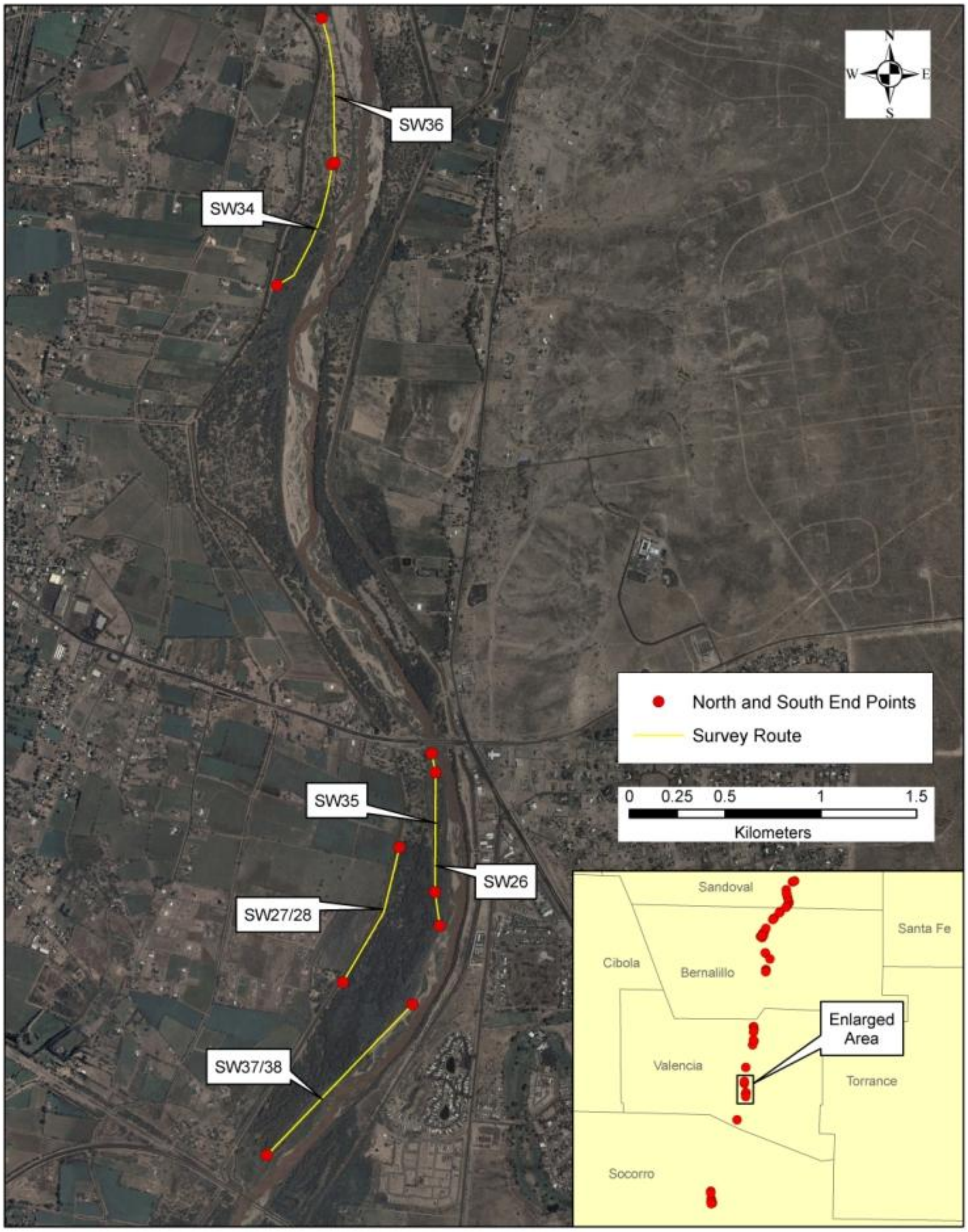
Appendix 9. Map of transects located in Los Lunas, New Mexico.



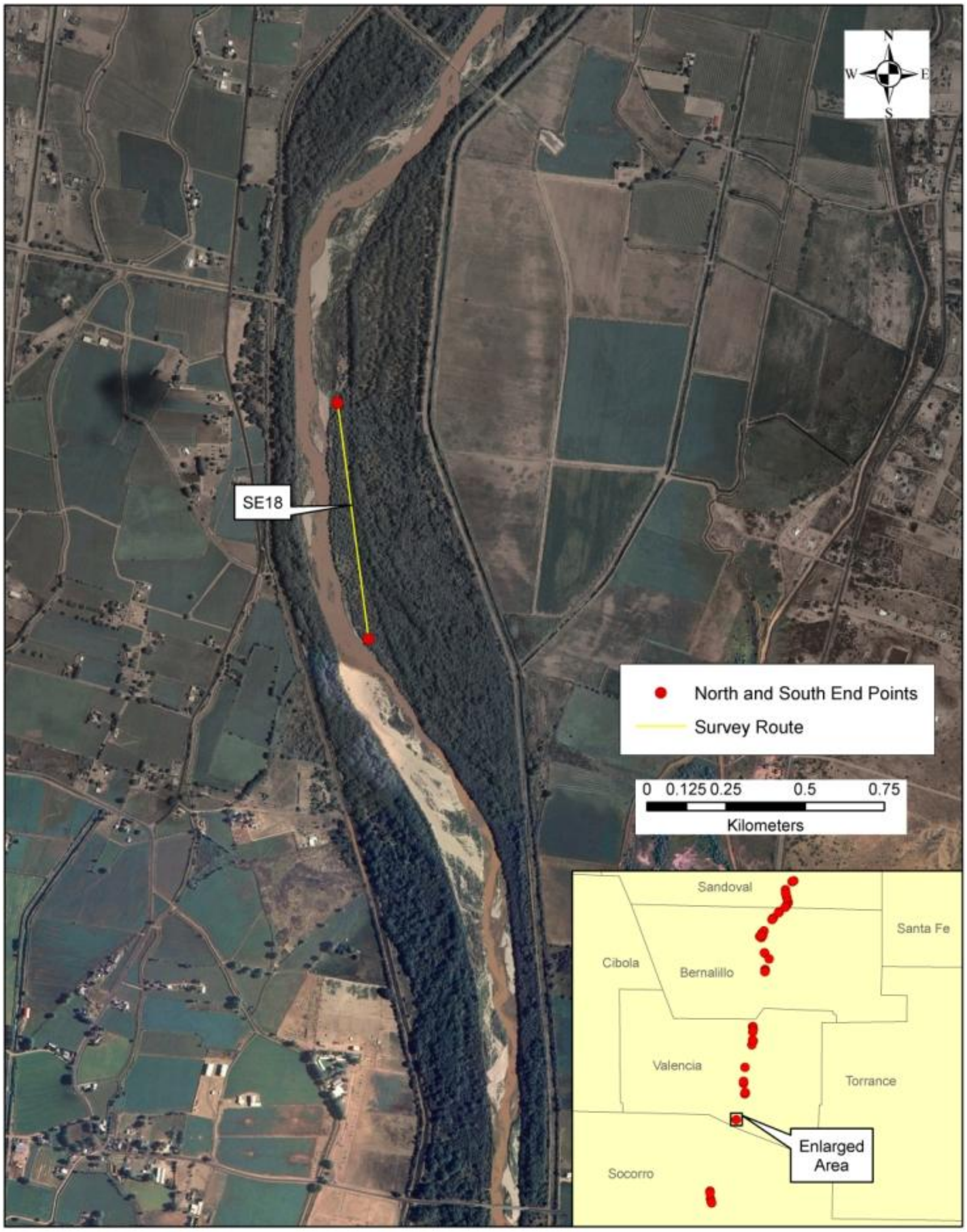
Appendix 10. Map of transect located near Los Chaves, New Mexico.



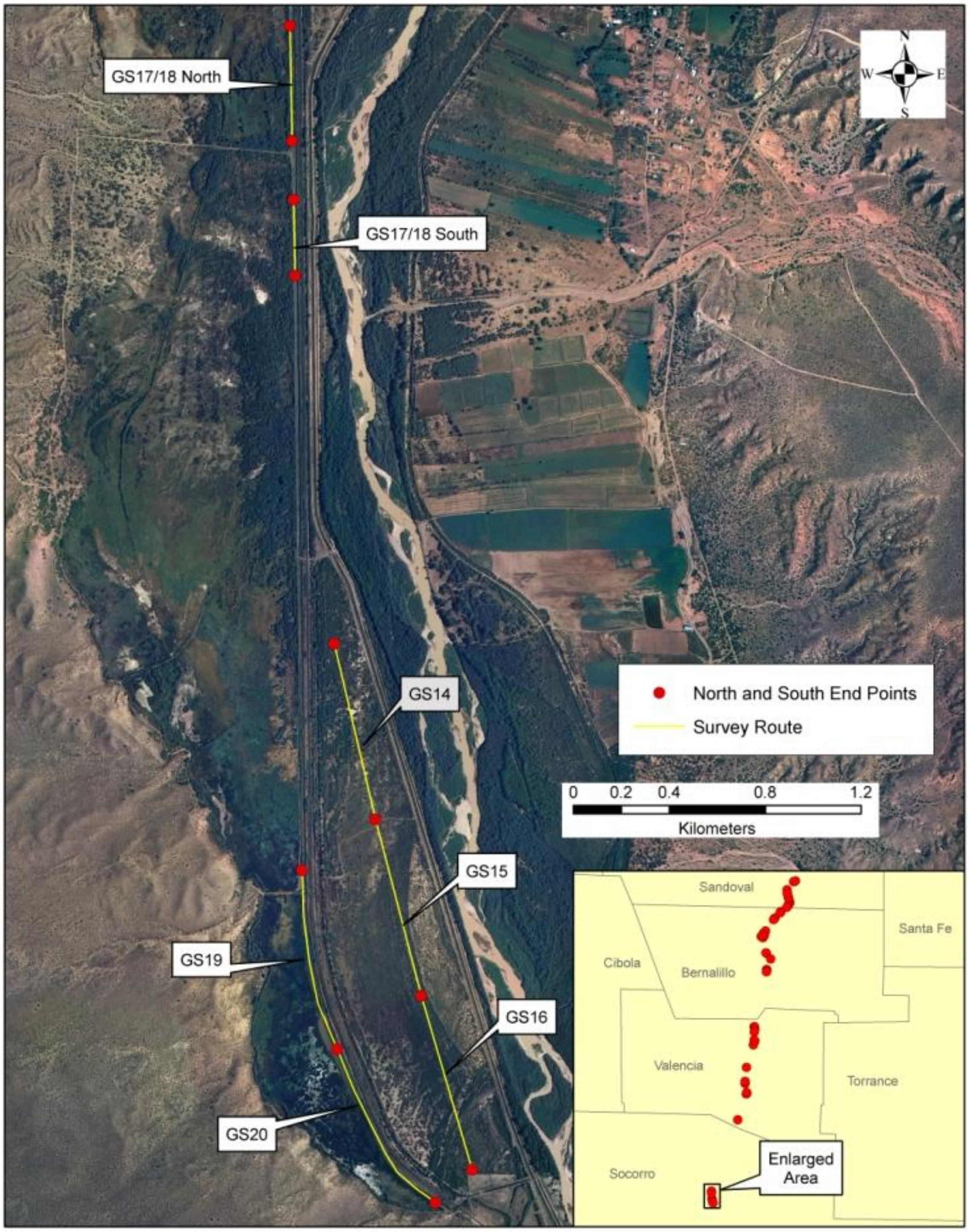
Appendix 11. Map of transect locations near Belen, New Mexico.



Appendix 12. Map of transect located near Veguita, New Mexico.



Appendix 13. Map of transects located at the La Joya Game Management Area, New Mexico.



Appendix 14. Location, length and area data for middle Rio Grande songbird transects.

Transect name	USGS quad	Original MRGBS transect?	Total length (m)	Current census area (acres)	Notes
GS14	La Joya	yes	760	11.27	
GS15	La Joya	yes	760	11.27	
GS16	La Joya	yes	760	11.27	
GS17N	La Joya	no	800	5.93	one-sided transect paired w/ GS18
GS18N	La Joya	no	800	5.93	one-sided transect paired w/ GS17
GS19N	La Joya	no	760	5.63	one-sided transect to the west
GS20N	La Joya	no	760	5.63	one-sided transect to the west
KW01	Los Griegos	yes	700	10.38	
KW02	Los Griegos	yes	790	5.86	one-sided transect paired w/ KW03; full mechanical thin 12/06
KW03	Los Griegos	yes	790	3.90	one-sided transect paired w/ KW02
KW04A	Los Griegos	yes*	700	10.38	transect moved 200m north of MRGBS location to maximize OP habitat
KW05	Los Griegos	yes	760	11.27	
NE02	Los Griegos & ABQ West	yes	760	9.04	only the 610m in mechanically thinned area included in census area
NE03	Los Griegos	yes	770	11.42	
NE08N	Los Griegos	no	760	5.63	one-sided transect partially paired w/ NE09N
NE09N	Los Griegos	no	660	4.89	one-sided transect partially paired w/ NE08N; divided into 2 sections
NW06	Alameda & Los Griegos	yes	770	11.42	
NW07	Alameda & Los Griegos	yes	760	5.63	one-sided transect paired w/ NW08
NW08	Alameda & Los Griegos	yes	760	5.63	one-sided transect paired w/ NW07
NW09A	Alameda	yes*	630	9.34	transect runs 90m west of MRGBS NW09 north
NW10A	Alameda	yes*	800	5.93	one-sided transect paired w/ NW11A and moved 700m south from MRGBS location to avoid overlapping with NW09A
NW11A	Alameda	yes*	800	5.93	one-sided transect moved 700m south from original location due to being paired w/ NW10A
NW13	Bernalillo	yes	680	10.08	
NW14A	Bernalillo	yes*	780	10.50	transect split into 2 sections with route change to avoid open areas
NW16	Alameda & Los Griegos	yes	590	8.40	shorter than original transect due to change in river course
NW17	Bernalillo & Alameda	yes	920	12.60	
NW19N	Bernalillo & Alameda	no	800	5.93	one-sided transect paired w/ NW20N
NW20N	Bernalillo & Alameda	no	800	5.93	one-sided transect paired w/ NW19N
NW21N	Alameda	no	800	5.93	one-sided transect paired w/ NW22N; split into 2 sections to avoid C/S change

Appendix 14 (continued).

Transect name	USGS quad	Original MRGBS transect?	Total length (m)	Current census area (acres)	Notes
NW22N	Alameda	no	800	5.93	one-sided transect paired w/ NW21N; 2 sections
NW23N	Bernalillo	no	600	8.90	establish spring 2006
NW24N	Bernalillo	no	760	5.63	one-sided transect paired w/ NW25; established fall 2006
NW25N	Bernalillo	no	760	5.63	one-sided transect paired w/ NW24; established fall 2006
NW26N	Bernalillo	no	800	5.93	one-sided transect paired w/ NW27; established fall 2006
NW27N	Bernalillo	no	800	5.93	one-sided transect paired w/ NW26; established fall 2006
NW28N	Bernalillo	no	760	5.63	one-sided transect established fall 2006
NW29N	Los Griegos	no	410	5.78	establish summer 2010; split into 2 sections
Oxbow 01N	Los Griegos	no	560	4.15	one-sided transect
Oxbow 02N	Los Griegos	no	440	6.52	
SE03A	ABQ West	no	730	6.98	overlaps w/ original transect, but extended north & split into two sections to avoid Rio Bravo Bridge
SE11	Los Lunas	yes	760	11.27	
SE12	Los Lunas	yes	800	5.93	one-sided transect paired w/ SE13
SE13	Los Lunas	yes	800	5.93	one-sided transect paired w/ SE12
SE14	Los Lunas	yes	760	5.63	one-sided transect paired w/ SE15
SE15	Los Lunas	yes	760	5.63	one-sided transect paired w/ SE14
SE16	Los Lunas	yes	760	11.27	
SE18	Veguita	yes	760	7.77	
SE22	Los Lunas	yes	750	5.56	one-sided transect paired w/ SE23
SE23	Los Lunas	yes	750	5.56	one-sided transect paired w/ SE22
SE30N	Los Lunas	no	800	8.80	
SE31N	ABQ West	no	800	5.93	one-sided transect
SE32N	ABQ West	no	610	4.23	one-sided transect
SE33N	ABQ West	no	730	10.82	for summer 2010 only the burned area (620 m, 9.19 acres) included in census area
SE34N	ABQ West	no	440	6.17	
SW24A	Los Lunas	yes*	800	11.86	offset 100m northwest of original SW24
SW26	Tome	yes	800	5.04	one-sided transect; only the north 680 m (unburned) included in census area
SW27	Tome	yes	770	5.34	one-sided transect paired w/ SW28; only south 720 m (burned) included in census area
SW28	Tome	yes	770	5.71	one-sided transect paired w/ SW27
SW33N	Tome	no	750	11.12	
SW34N	Tome	no	700	10.38	
SW35N	Tome	no	730	3.63	one-sided transect partially paired w/ SW26; only north 490 m (untreated) included in census area
SW36N	Tome	no	760	11.27	
SW37N	Tome	no	1100	8.16	one-sided transect paired w/ SW38; est. 6/08
SW38N	Tome	no	1100	8.16	one-sided transect paired w/ SW37; est. 6/08

Appendix 15. Habitat characteristics of middle Rio Grande songbird transects.

Transect	Original C/S type	Current C/S type	Analysis category	Edge/interior	Habitat notes
GS14	SC 6	SC 5	SC 5	interior	
GS15	SC 6	SC 5	SC 5	interior	
GS16	SC 6	SC 5	SC 5	interior	
GS17N	RO 5	RO-SC 5	RO 5	edge	
GS18N	DR 5	DR 5	DR 5	edge	
GS19N	MH 5-OW	MH 5-OW	MH 5-OW	edge	
GS20N	MH 5-OW	MH 5-OW	MH 5-OW	edge	
KW01	C/RO 2	C/RO 1	C/RO 1	interior	partial mechanical thin beyond 30m 6/04
KW02	C/CW 1	C-2 artificial	C-2 artificial	edge	full mechanical thin 12/06; C/RO 1 C/S type prior to summer 2005
KW03	DR 5	DR 6	DR 6	edge	mechanically thinned 12/05
KW04A	C/RO 1	OP	OP	interior	mechanically thinned after summer 2003 fire
KW05	C/CW-RO 4	C-2 artificial	C-2 artificial	interior	mechanically thinned in 2004
NE02	C/CW 4	C-2 artificial	C-2 artificial	interior	mechanically thinned area 610m long (thinned 12/03)
NE03	C/CW 4	C-2 natural	C-2 natural	interior	
NE08N	C/CW-NMO 1	C/NMO 1	C/NMO 1	edge	
NE09N	C/SC 5	OP	OP	edge	mechanically thinned during fall 2004
NW06	C/CW 5	C-2 natural	C-2 natural	interior	
NW07	C/RO 1	C/RO 1	C/RO 1	edge	
NW08	DR 6	DR 6	DR 6	edge	mechanically thinned 11/05, 11/07
NW09A	C-TW/CW-SB 5	NMO-SB 5	NMO 5	interior	
NW10A	C/RO-SC 1	C/NMO-RO 1	C/NMO 1	edge	
NW11A	DR 6	DR 5	DR 5	edge	
NW13	C/CW 6	CW 6 to CW 5	CW 5	interior	south 100m mechanically thinned 12/04; north 150m mechanically thinned 10/05
NW14A	C/CW 1	C-2 natural	C-2 natural	interior	south section mechanically thinned 12/04; north section mechanically thinned 2/05; C/S type was C/RO 1 prior to thinning operations. Re-classified from C-2 artificial to C-2 natural due to regrowth 6/08
NW16	C/CW 6	RO-SC 5	RO 5	interior	shorter than original transect due to change in river course
NW17	C/CW 6	C-RO/CW 3	C-RO/CW 3	interior	
NW19N	C/CW-RO-SC 1	C-2 natural	C-2 natural	edge	~70% C-2 natural, ~30% C/RO-NMO 1
NW20N	DR 6	DR 5	DR 5	edge	
NW21N	C/RO-SC 1	C/NMO-RO 1	C/NMO 1	edge	
NW22N	DR 6	DR 5	DR 5	edge	
NW23N	C/CW-RO 1	OP	OP	interior	mechanically thinned 12/05
NW24N	C/CW-NMO-RO 1	C/NMO-RO 1	C/NMO 1	edge	partially thinned winter 2008
NW25N	DR 6	DR 5	DR 5	edge	
NW26N	C-TW/NMO-RO 1	C/NMO-RO 1	C/NMO 1	edge	partially thinned winter 2008
NW27N	DR 6	DR 5	DR 5	edge	
NW28N	RO-SC 5	NMO-RO 5	NMO 5	edge	
NW29N	C/RO 3	BURN 2	BURN 2	interior	established after 5/10 fire

Appendix 15 (continued).

Transect	Original C/S type	Current C/S type	Analysis category	Edge/interior	Habitat notes
Oxbow 01N	MH 5-OW	MH 5-OW	MH 5-OW	edge	
Oxbow 02N	MH 5-OW	CW 5, OP, MH mix	N/A	interior	
SE03A	RO 5	RO-CW 5	RO 5	interior	North section: north 410m RO 5, south 150m RO-CW-SE 5; South section: disturbed area dominated by CW and weeds w/ minimal RO
SE11	C/CW 1	C-2 natural	C-2 natural	interior	
SE12	C/CW 1	C-2 natural	C-2 natural	edge	~70% C-2 natural, ~30% C/SC-CW 1
SE13	DR 6	DR 6	DR 6	edge	
SE14	C/CW 3	C-2 artificial	C-2 artificial	edge	mechanically thinned in 2003
SE15	DR 6	DR 6	DR 6	edge	
SE16	C/CW 5	C/RO-SC 1	C/RO 1	interior	
SE18	RO 6	RO 3	RO 3	interior	reclassified from RO 5 to RO 3 prior to 6/09
SE22	C/CW 2	C-2 natural	C-2 natural	edge	
SE23	DR 6	DR 6	DR 6	edge	
SE30N	C/SC-CW 1	C/MB-SC 1	C/MB 1	interior	
SE31N	C/RO-SC 1	Pond, MH, C-2 artificial mix	N/A	edge	sporadic mechanical thinning 6/04; complete thin 9/04; C/S type was C/MB 1 for Summer 2004; ponds established fall 2005
SE32N	CW-SC-RO 5	CW 6	CW 6	edge	CW 5 through 2/07; mechanically thinned 3/07; re-classified from CW 6 to CW 5 6/08; mechanically thinned fall '09, re-classified as OP for winter '10, CW 6 for summer '10
SE33N	C/RO-SC 1	BURN OP	BURN OP	interior	transect partially burned 6/23/04; complete mechanical thin 10/04 & 10/07; N 620m burned 4/10; original C/S type was C/MB 1 for 6/04
SE34N	OP & C/RO-TW 5	OP	OP	interior	mechanically thinned 2/05
SW24A	C/CW 1	C/CW-MB 1	C/CW 1	interior	
SW26	RO 5	C-RO/CW 3	C-RO/CW 3	edge	S 120m burned 3/07
SW27	C/RO 1	BURN 1	BURN 1	edge	over 90% of transect burned 2/07; previous C/S type was C/RO-SC 1
SW28	DR 6	DR 6	DR 6	edge	
SW33N	C/CW 1	C/CW 1	C/CW 1	interior	
SW34N	C/CW-RO 5	CW-RO 5	CW 5	interior	
SW35N	RO 6	RO 5	RO 5	edge	S 80m burned 3/07; S 240 m thinned 2/10, excluded from analysis
SW36N	C/CW-RO 5	CW-RO 5	CW 5	interior	mechanically thinned 2/06; re-classified from CW 6 to CW 5 6/07
SW37N	C/RO-SC 1	BURN OP	BURN OP	edge	entire area burned 3/07, thinned prior to transect establishment in 6/08; re-classified as BURN OP 12/09
SW38N	C/RO-SC 3	CW-RO 5	CW 5	edge	partially burned 3/07, vegetation recovered by transect establishment in 6/08

Appendix 16. Statistical significance tables for avian abundance by C/S type for winter 2010 and winter 2004-2009. Comparisons were made using Tukey-Kramer tests. C/S types not connected by the same letter are significantly different.

Winter 2010

C/S type								Mean # birds per 100 acres
RO 3	A							3745
BURN 1		B						1536
DR 5		B	C					1213
NMO 5		B	C	D				988
C/NMO 1			C	D				963
C-RO/CW 3			C	D	E			781
RO 5				D	E			726
DR 6				D	E			699
C/RO 1				D	E			624
CW 5					E	F		484
C-2 natural					E	F		474
BURN OP				D	E	F	G	456
C/CW 1					E	F	G	288
OP						F	G	223
C-2 artificial							G	117

Winter 2004-2009

C/S type								Mean # birds per 100 acres
MH 5-OW	A							1264
DR 5	A							1249
C/NMO 1		B						798
RO 5		B						758
BURN 1		B	C	D				712
NMO 5		B	C					677
DR 6		B	C					657
BURN 2		B	C	D	E	F	G	643
CW 5			C	D	E			469
C-RO/CW 3				D	E			366
C-2 natural				D	E			330
OP				D	E	F		329
C/RO 1				D	E	F		300
CW 6			C	D	E	F	G	258
C/CW 1					E	F	G	213
C/MB 1					E	F	G	176
SC 5						F	G	111
C-2 artificial							G	77

Appendix 17. Statistical significance table for avian abundance by C/S type comparing winter 2010 and winter 2009. Comparisons were made using a Tukey-Kramer test. C/S types not connected by the same letter are significantly different.

C/S type											Mean # birds per 100 acres
RO 3 2010	A										3745
BURN 1 2010		B									1536
DR 5 2010		B	C								1213
DR 5 2009		B	C	D							1156
NMO 5 2010		B	C	D	E						988
C/NMO 1 2010			C	D	E						963
C-RO/CW 3 2010				D	E	F	G				781
C/NMO 1 2009					E	F					759
RO 5 2010					E	F	G				726
BURN 1 2009			C	D	E	F	G	H	I		700
DR 6 2010					E	F	G				699
BURN 2 2009				D	E	F	G	H	I	J	643
C/RO 1 2010					E	F	G	H			624
NMO 5 2009					E	F	G	H	I		607
DR 6 2009						F	G	H	I		500
CW 5 2010						F	G	H	I		484
BURN OP 2010					F	F	G	H	I	J	456
C-2 natural 2010							G	H	I		435
CW 5 2009							G	H	I	J	399
RO 5 2009							G	H	I	J	345
C-2 natural 2009								H	I	J	340
C/RO 1 2009								H	I	J	339
C/CW 1 2010							H	H	I	J	288
C-RO/CW 3 2009								H	I	J	245
C/CW 1 2009								H	I	J	223
OP 2010									I	J	223
OP 2009								H	I	J	145
C-2 artificial 2010										J	97
C-2 artificial 2009										J	92

Appendix 18. Statistical significance tables for species richness by C/S type for winter 2010 and winter 2004-2009. Comparisons were made using Tukey-Kramer tests. C/S types not connected by the same letter are significantly different.

Winter 2010

C/S type				Mean # species per transect
DR 5	A			19.0
BURN 1	A	B	C	18.0
C/NMO 1	A			18.0
NMO 5	A	B	C	16.5
RO 3	A	B	C	16.0
C-RO/CW 3	A	B	C	15.5
CW 5	A	B	C	14.5
C-2 natural	A	B		14.1
RO 5	A	B	C	14.0
C/RO 1	A	B	C	14.0
C/CW 1	A	B	C	14.0
DR 6		B	C	10.7
BURN OP	A	B	C	7.0
C-2 artificial			C	6.5
OP			C	6.5

Winter 2004-2009

C/S type								Mean # species per transect
DR 5	A							20.9
C/NMO 1	A	B						18.3
NMO 5	A	B	C					17.5
MH 5-OW	A	B	C	D				15.7
BURN 1	A	B	C	D	E	F		15.5
RO 5		B	C	D				15.1
C/CW 1		B	C	D				14.6
C-RO/CW 3		B	C	D				14.4
C/MB 1	A	B	C	D	E	F	G	13.0
C-2 natural			C	D				12.5
CW 5			C	D	E			12.3
DR 6				D	E			11.6
C/RO 1				D	E			11.0
CW 6		B	C	D	E	F	G	10.5
BURN 2	A	B	C	D	E	F	G	10.0
OP					E	F	G	7.5
C-2 artificial						F	G	5.5
SC 5							G	4.5

Appendix 19. Statistical significance table for avian abundance by C/S type for summer 2010. Comparisons were made using a Tukey-Kramer test. C/S types not connected by the same letter are significantly different.

C/S type								Mean # birds per 100 acres
BURN 1	A							1316
MH 5-OW	A							1240
NMO 5	A	B						1108
C/NMO 1		B	C					897
C/MB 1		B	C	D				811
RO 3		B	C	D				794
C-RO/CW 3			C	D				768
CW 5			C	D				723
RO 5			C	D				712
C/CW 1			C	D				667
C/RO 1				D				625
C-2 natural				D				562
DR 5				D	E			558
CW 6				D	E	F	G	491
BURN OP				D	E	F	G	446
BURN 2				D	E	F	G	405
C-2 artificial					E	F	G	353
DR 6						F	G	335
OP							G	299
SC 5							G	201

Appendix 20. Statistical significance table for avian abundance by C/S type for summer 2004-2009. Comparisons were made using a Tukey-Kramer test. C/S types not connected by the same letter are significantly different.

C/S type											Mean # birds per 100 acres
MH 5-OW	A										1692
NMO 5		B									1296
BURN 1		B	C								1115
C/NMO 1			C								1064
RO 3		B	C	D	E	F					937
CW 5				D							870
C-RO/CW 3				D	E						852
RO 5				D	E						833
C/RO 1				D	E						827
C/CW 1				D	E	F					759
DR 5						F					722
C/MB 1					E	F	G				698
C-2 natural						F	G				677
CW 6				D	E	F	G	H			660
DR 6								H			514
BURN 2							G	H	I	J	423
C-2 artificial									I		363
OP									I	J	263
SC 5										J	192

Appendix 21. Statistical significance table for species richness by C/S type for summer 2010. Comparisons were made using a Tukey-Kramer test. C/S types not connected by the same letter are significantly different.

C/S type				Mean # species per transect
BURN 1	A			30.0
C/MB 1	A	B		29.0
C/CW 1	A			27.0
CW 5	A			24.8
C/RO 1	A	B		23.0
MH 5-OW	A	B		22.7
NMO 5	A	B	C	21.5
C-2 natural	A	B		20.4
C/NMO 1	A	B	C	20.4
C-RO/CW 3	A	B	C	18.0
BURN OP	A	B	C	17.0
RO 5	A	B	C	17.0
CW 6	A	B	C	17.0
DR 5	A	B	C	16.2
RO 3	A	B	C	16.0
OP	A	B	C	15.3
BURN 2	A	B	C	14.5
SC 5	A	B	C	14.3
C-2 artificial		B	C	13.3
DR 6			C	12.0

Appendix 22. Statistical significance table for species richness by C/S type for summer 2004-2009. Comparisons were made using a Tukey-Kramer test. C/S types not connected by the same letter are significantly different.

C/S type				Mean # species per transect
BURN 1	A	B		27.7
NMO 5	A			27.3
C/CW 1	A			27.3
C/MB 1	A	B		26.6
CW 5	A			26.0
MH 5-OW	A	B		25.7
RO 3	A	B	C	25.0
C/NMO 1	A	B		24.8
C/RO 1	A	B		24.1
C-RO/CW 3	A	B		23.1
C-2 natural	A	B		21.6
RO 5	A	B		21.4
DR 5		B		20.6
BURN 2	A	B	C	20.5
CW 6	A	B	C	20.5
DR 6			C	13.9
C-2 artificial			C	12.9
SC 5			C	12.2
OP			C	11.4

Appendix 23. Statistical significance tables for avian density and species richness by land management entity for winter and summer 2004-2010. Comparisons were made using Tukey-Kramer tests. C/S types not connected by the same letter are significantly different.

Winter 2004-2010 avian density

Land Manager				Mean # birds per 100 acres
Corrales	A			778
NMGF	A	B		678
MRGCD		B		556
Albuquerque			C	439
Rio Rancho			C	304

Winter 2004-2010 species richness

Land Manager				Mean # species per transect
Corrales	A			16.7
MRGCD		B		13.1
Albuquerque			C	10.4
Rio Rancho		B	C	10.2
NMGF			C	9.6

Summer 2004-2010 avian density

Land Manager					Mean # birds per 100 acres
Corrales	A				858
Albuquerque		B			725
MRGCD			C		662
Rio Rancho				D	552
NMGF				D	465

Summer 2004-2010 species richness

Land Manager				Mean # species per transect
Corrales	A			22.2
MRGCD	A	B		20.8
Rio Rancho	A	B	C	19.6
Albuquerque		B		19.3
NMGF			C	15.7

Appendix 24. Alphabetical list of bird species detected by C/S type during surveys in winter 2004-2010. Flyovers (e.g. swallows) and detections beyond 30 m from transect routes are not included. C = common; species detected on nearly all visits in moderate to large numbers. U = uncommon; species detected regularly, but in small numbers. R = rare; species on average detected no more than once or twice a season in very small numbers. Asterisks (*) indicate the species was not recorded in a given C/S type.

Species	BURN 1	BURN 2	BURN OP	C/CW 1	C/MB 1	C/NMO 1	C/RO 1	C-2 ART	C-2 NAT	C-RO/CW 3	CW 5	CW 6	DR 5	DR 6	MH 5-OW	NMO 5	OP	RO 3	RO 5	SC 5
American Coot	*	*	*	*	*	*	*	*	*	*	*	*	R	*	U	*	*	*	R	*
American Crow	R	*	*	R	R	U	U	R	U	U	*	*	R	R	R	U	C	*	R	R
American Goldfinch	U	U	R	R	R	U	U	U	U	U	C	U	U	U	R	U	C	*	U	R
American Kestrel	U	R	R	R	R	R	R	R	R	*	R	R	*	R	*	*	R	*	R	*
American Pipit	*	*	*	*	*	R	*	*	R	R	R	*	R	R	*	*	*	*	R	*
American Robin	C	*	U	U	*	C	C	U	C	C	U	U	C	U	R	C	U	C	C	R
American Wigeon	*	*	*	*	*	*	*	*	*	*	*	*	C	U	U	*	*	*	*	*
Bald Eagle	*	*	*	R	R	R	R	*	R	*	*	*	*	*	*	*	R	*	*	*
Barn Owl	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*
Belted Kingfisher	*	*	*	*	R	*	R	*	R	*	*	*	R	R	R	*	*	*	R	*
Bewick's Wren	U	U	R	U	U	U	C	R	U	C	U	U	U	U	U	U	U	U	C	U
Black Phoebe	*	*	*	R	*	*	R	*	*	*	*	*	U	R	*	R	R	*	R	*
Black-capped Chickadee	*	*	*	U	U	C	C	U	C	U	U	R	U	U	R	U	R	R	U	*
Black-crowned Night-Heron	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*
Blue-gray Gnatcatcher	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	R	*
Brewer's Blackbird	*	*	*	*	*	*	*	*	*	*	R	*	R	*	*	*	*	*	R	*
Brown Creeper	*	*	*	U	U	U	U	U	U	R	R	*	R	R	R	R	*	*	R	*
Brown Thrasher	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	R	*	*	*	*
Bufflehead	*	*	*	*	*	*	*	*	*	*	*	*	R	*	R	*	*	*	*	*
Bushtit	*	U	*	U	R	U	U	R	U	C	U	*	U	U	U	C	*	*	U	U
Canada Goose	*	*	*	*	*	*	R	*	*	*	*	*	*	R	U	*	R	*	R	*
Canvasback	*	*	*	*	*	*	*	*	*	*	*	*	R	R	U	*	*	*	*	*
Canyon Towhee	*	*	*	*	*	*	*	*	*	R	R	*	*	*	*	*	R	*	*	*
Cedar Waxwing	U	*	*	*	R	U	U	*	R	U	R	*	U	R	*	U	*	C	U	*
Chipping Sparrow	*	*	*	R	*	R	*	*	R	*	R	R	R	*	*	*	R	*	R	R
Cinnamon Teal	*	*	*	*	*	*	*	*	*	*	*	*	R	R	U	*	*	*	*	*
Common Goldeneye	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
Common Grackle	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
Common Merganser	*	*	*	*	*	*	*	*	*	*	*	*	R	R	*	*	*	*	*	*
Common Raven	R	*	*	*	*	R	*	R	R	*	R	*	R	*	*	*	R	*	*	*
Cooper's Hawk	R	*	*	R	R	R	R	R	U	R	R	*	R	R	R	R	R	R	R	*
Crissal Thrasher	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	R	*
Curve-billed Thrasher	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	R	*
Dark-eyed Junco	C	C	U	C	U	C	C	U	C	C	C	C	C	C	C	C	C	C	C	C
Downy Woodpecker	C	*	*	C	R	C	U	U	C	U	U	R	U	R	R	U	R	*	U	*
Eastern Bluebird	*	*	*	U	*	U	R	U	U	U	U	U	U	U	*	U	R	*	C	*
Eastern Phoebe	*	*	*	*	*	R	*	*	*	*	*	*	R	*	*	*	*	*	*	*
Eurasian Collared-Dove	R	*	R	R	R	*	*	*	R	*	*	*	R	R	*	*	*	*	R	*
European Starling	C	*	*	U	R	U	R	R	U	R	U	U	U	U	*	U	R	C	U	*
Fox Sparrow	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*
Gadwall	*	*	*	*	*	*	*	*	*	*	*	*	U	R	U	*	*	*	R	*
Gambel's Quail	U	R	*	*	*	*	*	*	*	*	R	*	R	*	R	*	*	*	U	R
Golden-crowned Kinglet	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Great Blue Heron	*	*	*	R	R	U	U	*	R	*	R	*	U	R	U	R	*	*	R	*

Appendix 24 (continued).

Species	BURN 1	BURN 2	BURN OP	C/CW 1	C/MB 1	C/NMO 1	C/RO 1	C-2 ART	C-2 NAT	C-RO/CW 3	CW 5	CW 6	DR 5	DR 6	MH 5-OW	NMO 5	OP	RO 3	RO 5	SC 5
Great Egret	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*
Great Horned Owl	*	*	*	R	*	*	*	R	R	*	R	*	*	*	*	*	*	*	R	*
Greater Roadrunner	*	R	*	*	*	*	*	R	R	*	R	*	R	R	*	*	R	*	R	*
Great-tailed Grackle	*	*	*	*	*	*	R	*	*	*	*	*	*	*	R	*	*	*	R	*
Green-tailed Towhee	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*
Green-winged Teal	*	*	*	*	*	*	*	*	*	*	*	*	U	R	R	*	*	*	*	*
Hairy Woodpecker	U	*	*	R	R	U	U	R	U	*	*	*	R	R	R	*	R	*	R	R
Harris' Sparrow	*	*	*	*	*	*	R	*	*	*	R	*	R	*	*	*	*	*	*	R
Hermit Thrush	U	*	*	U	U	C	U	*	U	C	U	*	U	R	R	C	R	C	C	*
House Finch	C	*	R	U	*	C	U	U	C	U	U	R	C	C	C	U	C	*	U	R
House Sparrow	*	*	*	*	*	R	*	*	R	*	*	*	U	U	*	*	*	*	R	*
House Wren	R	*	*	*	R	R	*	*	*	R	*	*	R	R	*	*	*	*	R	*
Killdeer	*	*	*	*	*	*	*	*	*	*	*	*	R	R	*	*	*	*	*	*
Ladder-backed Woodpecker	*	*	*	R	*	U	R	*	R	R	R	R	R	*	R	R	R	*	*	*
Lesser Goldfinch	*	R	*	*	*	U	R	R	U	U	U	U	U	R	*	R	R	*	U	*
Lesser Scaup	*	*	*	*	*	*	*	*	*	*	*	*	*	R	U	*	*	*	*	*
Lincoln's Sparrow	R	U	R	*	R	R	*	*	*	R	R	*	R	R	R	R	R	*	U	*
Loggerhead Shrike	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	R
Mallard	*	*	*	*	*	R	U	*	*	*	*	*	C	C	U	*	*	U	U	*
Marsh Wren	*	*	*	R	*	*	*	*	*	*	*	*	R	R	C	*	*	*	R	*
Merlin	*	*	R	*	*	*	*	*	R	*	R	*	R	*	*	*	*	*	R	*
Mountain Bluebird	*	*	*	*	R	R	U	*	*	R	R	*	R	U	R	*	R	C	U	U
Mountain Chickadee	U	*	*	U	*	U	U	R	U	U	R	*	U	R	R	U	*	U	U	*
Mourning Dove	U	U	U	C	*	U	U	U	C	R	U	R	U	U	*	U	U	*	U	R
Northern Flicker	C	R	U	C	U	U	C	U	C	C	C	U	U	U	R	U	U	C	C	U
Northern Goshawk	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*
Northern Harrier	*	*	*	*	*	*	*	*	*	*	*	R	*	R	R	*	*	R	R	R
Northern Pintail	*	*	*	*	*	*	*	*	*	*	*	*	R	R	U	*	*	*	*	*
Northern Shoveler	*	*	*	*	*	*	*	*	*	*	*	*	U	*	R	*	*	*	*	*
Pied-billed Grebe	*	*	*	*	*	*	*	*	*	*	*	*	*	R	U	*	*	*	*	*
Pine Siskin	U	C	*	R	*	U	R	R	R	R	U	*	U	R	*	R	U	*	R	*
Redhead	*	*	*	*	*	*	*	*	*	*	*	*	R	R	U	*	*	*	*	*
Red-breasted Nuthatch	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	R	*
Red-tailed Hawk	R	*	R	R	U	R	R	R	R	*	R	*	R	R	*	R	R	R	R	R
Red-winged Blackbird	*	*	*	R	R	R	R	*	R	R	U	U	U	R	C	R	R	C	C	R
Ring-necked Duck	*	*	*	*	*	*	*	*	*	*	*	*	R	*	R	*	*	*	*	*
Ring-necked Pheasant	*	*	*	R	R	R	R	*	R	U	R	R	R	R	R	R	R	R	U	R
Rock Pigeon	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Ruby-crowned Kinglet	R	R	*	U	U	U	U	R	U	U	U	R	U	R	U	U	R	R	U	U
Ruddy Duck	*	*	*	*	*	*	*	*	*	*	*	*	R	*	R	*	*	*	*	*
Sandhill Crane	*	*	R	*	*	*	*	*	*	*	*	R	*	R	*	*	R	*	R	*
Savannah Sparrow	*	*	*	*	*	*	*	R	*	*	*	*	*	R	*	*	*	*	*	R
Say's Phoebe	*	*	*	*	*	*	R	R	R	R	R	*	R	R	R	*	R	R	R	*
Sharp-shinned Hawk	*	*	*	*	R	R	R	R	R	R	R	*	R	R	R	R	*	*	R	R
Snow Goose	*	*	*	*	R	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Song Sparrow	C	C	C	U	U	U	U	R	U	C	C	U	C	C	C	U	C	C	C	U
Sora	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
Spotted Sandpiper	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Spotted Towhee	C	C	U	C	C	C	C	R	C	C	C	U	C	U	U	C	U	C	C	U
Steller's Jay	*	*	*	*	*	R	R	*	R	*	*	*	R	R	*	R	*	*	R	*

Appendix 24 (continued).

Species	BURN 1	BURN 2	BURN OP	C/CW 1	C/MB 1	C/NMO 1	C/RO 1	C-2 ART	C-2 NAT	C-RO/CW 3	CW 5	CW 6	DR 5	DR 6	MH 5-OW	NMO 5	OP	RO 3	RO 5	SC 5
Swamp Sparrow	*	*	*	*	*	*	*	*	*	*	R	*	R	*	R	*	*	*	R	*
Townsend's Solitaire	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*
Verdin	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*
Virginia Rail	*	*	*	*	*	*	*	*	*	*	*	*	R	*	R	*	*	*	*	*
Western Bluebird	*	*	*	R	R	U	U	*	U	U	U	R	U	U	*	U	U	U	U	*
Western Meadowlark	*	*	*	*	R	*	*	*	*	*	*	*	R	*	*	*	R	*	R	U
Western Screech-Owl	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	R	*
Western Scrub-Jay	R	*	R	*	*	R	R	*	*	R	R	*	R	*	R	*	*	*	R	*
White-breasted Nuthatch	U	*	R	C	U	C	C	U	C	U	U	R	U	U	R	U	U	R	U	*
White-crowned Sparrow	C	C	C	C	U	C	U	R	C	U	C	U	C	C	C	C	C	C	C	C
White-throated Sparrow	*	R	R	*	*	U	R	*	R	R	R	R	U	R	*	U	*	U	U	*
White-winged Dove	*	R	R	U	R	U	R	R	C	*	R	*	R	R	*	R	*	*	R	*
Wilson's Snipe	*	*	*	*	*	*	*	*	*	*	*	*	R	R	*	*	*	*	*	*
Winter Wren	*	*	*	*	R	*	R	*	*	*	*	*	U	*	*	R	R	*	R	*
Wood Duck	*	*	*	*	*	*	R	*	R	*	*	*	U	R	R	*	*	*	R	*
Yellow-rumped Warbler	U	*	*	U	U	U	U	R	U	C	U	*	C	C	U	U	R	C	C	U

Appendix 25. Alphabetical list of bird species detected by C/S type during surveys in summer 2004-2010. Flyovers (e.g. swallows) and detections beyond 30 m from transect routes are not included. C = common; species detected on nearly all visits in moderate to large numbers. U = uncommon; species detected regularly, but in small numbers. R = rare; species on average detected no more than once or twice a season in very small numbers. Asterisks (*) indicate the species was not recorded in a given C/S type.

Species	BURN 1	BURN 2	BURN OP	C/CW 1	C/MB 1	C/NMO 1	C/RO 1	C-2 ART	C-2 NAT	C-RO/CW 3	CW 5	CW 6	DR 5	DR 6	MH 5-OW	NMO 5	OP	RO 3	RO 5	SC 5
American Bittern	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
American Coot	*	*	*	*	*	*	*	*	*	*	*	*	R	*	C	*	*	*	*	*
American Crow	R	*	R	R	R	U	R	R	U	R	R	*	R	R	*	R	R	*	R	R
American Goldfinch	*	*	R	R	*	R	R	*	R	R	R	*	*	*	R	*	*	*	R	*
American Kestrel	R	U	C	R	U	R	R	R	U	R	U	U	*	R	*	R	U	*	*	R
American Robin	C	R	U	C	C	U	U	U	U	U	U	U	R	U	R	U	R	R	U	*
American Wigeon	*	*	*	*	*	*	*	*	*	*	*	*	*	*	U	*	*	*	*	*
Ash-throated Flycatcher	C	U	R	C	U	C	C	U	C	U	U	R	U	U	U	U	U	R	U	U
Bank Swallow	*	*	*	*	*	R	*	*	*	*	R	R	R	*	R	*	R	*	*	R
Barn Owl	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*
Barn Swallow	*	*	R	R	*	R	R	R	R	R	R	R	U	U	U	R	R	*	U	U
Belted Kingfisher	*	*	*	*	*	*	R	*	*	*	R	*	R	R	R	*	*	*	R	*
Bewick's Wren	U	U	U	C	C	C	C	U	C	C	C	U	C	U	U	C	U	U	C	U
Black Phoebe	R	*	*	R	R	R	R	R	R	*	R	*	C	U	U	R	R	R	R	R
Black-and-white Warbler	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*
Black-capped Chickadee	*	U	*	C	C	C	C	U	C	C	U	U	U	R	R	U	U	U	U	*
Black-chinned Hummingbird	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	U
Black-crowned Night-Heron	*	*	*	R	R	R	U	*	R	*	R	*	R	R	U	*	*	R	U	*
Black-headed Grosbeak	U	R	U	C	C	C	C	U	C	C	C	U	U	U	U	C	U	C	C	U
Black-throated Gray Warbler	*	*	*	R	R	R	R	*	R	*	R	*	*	R	*	*	*	*	R	R
Black-throated Sparrow	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R
Blue Grosbeak	U	U	C	C	C	C	C	U	C	C	C	C	C	C	U	U	C	C	C	C
Blue-gray Gnatcatcher	*	*	*	R	R	R	R	R	U	R	R	*	R	R	*	R	*	*	R	R
Blue-winged Teal	*	*	*	*	*	*	*	*	*	*	*	*	*	*	U	*	*	*	*	*
Brewer's Blackbird	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*
Brewer's Sparrow	*	*	*	*	*	*	*	R	*	*	*	*	*	*	R	*	*	*	*	U
Broad-tailed Hummingbird	R	R	R	U	U	U	U	R	U	U	U	R	U	U	R	U	R	*	U	R
Brown Creeper	*	*	*	*	*	*	R	R	*	*	*	*	*	*	*	*	R	*	*	*
Brown-headed Cowbird	U	U	U	C	C	U	C	U	U	C	C	U	U	U	U	C	R	C	C	U
Bullock's Oriole	U	R	U	U	U	U	U	R	U	U	U	R	R	U	R	U	R	C	U	R
Bushtit	U	U	R	C	C	C	C	R	C	C	C	U	C	U	U	C	U	*	C	U
Calliope Hummingbird	R	R	*	R	R	U	R	R	U	U	U	R	R	R	R	R	R	*	R	*
Canada Goose	*	*	*	*	*	*	*	*	*	*	*	*	*	*	U	*	*	*	*	*
Canyon Towhee	*	*	*	*	*	R	R	*	*	*	*	*	*	R	*	*	*	*	*	*
Carolina Wren	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Cassin's Kingbird	*	*	*	R	*	*	*	*	*	*	R	*	*	*	R	*	*	*	*	R
Cassin's Sparrow	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	U
Cassin's Vireo	*	*	*	*	*	*	R	R	*	*	R	*	*	*	*	*	*	*	*	*
Cattle Egret	*	*	*	*	R	*	*	*	*	*	*	*	*	*	U	*	*	*	R	R
Cedar Waxwing	*	*	*	R	R	U	R	*	R	R	R	*	R	*	*	R	*	*	*	*
Chestnut-sided Warbler	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	R	*	*	*	*
Chipping Sparrow	U	U	*	U	R	U	U	U	U	U	U	U	U	U	U	U	C	R	U	C

Appendix 25 (continued).

Species	BURN 1	BURN 2	BURN OP	C/CW 1	C/MB 1	C/NMO 1	C/RO 1	C-2 ART	C-2 NAT	C-RO/CW 3	CW 5	CW 6	DR 5	DR 6	MH 5-OW	NMO 5	OP	RO 3	RO 5	SC 5
Cinnamon Teal	*	*	*	*	*	*	*	*	*	*	*	*	R	*	U	*	*	*	*	*
Clay-colored Sparrow	*	*	*	*	*	R	*	R	R	*	U	R	R	*	*	*	R	*	R	U
Cliff Swallow	R	R	*	*	*	R	*	*	R	R	U	R	R	R	U	*	R	*	U	U
Common Black-Hawk	*	*	*	*	*	*	*	*	R	*	*	*	*	R	*	*	*	*	*	*
Common Grackle	*	U	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
Common Merganser	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Common Moorhen	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
Common Nighthawk	R	*	*	R	*	*	R	R	R	*	R	R	R	R	*	*	*	R	*	*
Common Poorwill	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Common Raven	*	*	*	R	*	R	R	R	U	*	R	*	*	R	R	*	R	*	*	*
Common Yellowthroat	U	U	R	U	U	R	U	*	R	C	C	U	U	U	C	R	*	U	C	R
Cooper's Hawk	U	R	R	R	U	U	C	U	U	U	U	R	R	U	U	U	U	R	U	*
Cordilleran Flycatcher	R	*	*	R	*	R	*	*	R	*	*	*	R	*	*	*	*	*	*	R
Crissal Thrasher	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*
Curve-billed Thrasher	*	*	*	*	*	*	*	*	R	R	R	*	*	*	*	*	*	*	*	R
Double-crested Cormorant	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
Downy Woodpecker	U	U	U	C	U	C	C	U	C	U	U	U	U	U	R	U	U	*	U	R
Dusky Flycatcher	*	*	*	*	*	*	R	*	R	*	R	*	R	*	*	R	*	*	*	*
Eastern Bluebird	*	*	*	R	*	R	R	U	U	*	R	*	R	R	*	R	U	*	*	*
Eastern Phoebe	*	*	*	*	*	*	*	*	R	*	*	*	R	*	*	*	*	*	*	*
Eastern Wood-Pewee	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*
Empidonax spp.	*	*	*	R	R	R	U	R	U	R	R	*	U	U	R	R	*	*	U	U
Eurasian Collared-Dove	R	R	R	R	*	R	R	*	R	*	R	*	R	R	*	*	R	*	*	*
European Starling	U	*	U	R	*	U	R	R	U	*	R	*	R	U	*	R	R	*	R	*
Gadwall	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
Gambel's Quail	R	*	*	R	R	U	R	*	*	R	R	*	R	*	U	R	*	*	U	U
Gray Catbird	R	U	U	U	U	U	U	*	R	U	C	U	R	R	U	U	*	U	U	R
Gray Flycatcher	R	*	*	R	*	*	*	*	R	*	R	*	*	*	R	R	R	*	R	R
Great Blue Heron	*	*	*	R	R	R	R	R	R	*	R	R	R	R	U	*	*	*	R	*
Great Egret	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
Great Horned Owl	R	*	*	U	*	R	R	U	R	*	R	*	R	R	*	R	*	*	*	*
Greater Roadrunner	R	R	*	R	R	R	R	R	U	R	U	R	R	U	R	R	R	*	R	R
Great-tailed Grackle	*	*	R	*	*	*	*	*	R	*	*	*	*	*	R	*	*	*	*	*
Green Heron	*	*	*	*	R	R	*	*	*	*	R	*	R	R	U	*	*	*	R	R
Green-tailed Towhee	*	*	*	R	*	R	R	*	*	R	R	*	R	R	*	R	R	*	R	R
Green-winged Teal	*	*	*	*	*	*	R	*	*	*	*	*	*	*	R	*	*	*	*	*
Hairy Woodpecker	R	*	R	R	R	R	U	R	U	*	R	*	R	R	R	R	R	*	R	*
Hermit Thrush	*	*	*	*	*	*	R	*	*	*	*	*	*	R	*	*	*	*	*	*
Hermit Warbler	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R
Hooded Warbler	*	*	*	R	*	R	*	*	*	*	*	*	*	*	*	R	*	*	*	*
House Finch	C	U	C	U	U	U	C	U	U	U	C	U	U	U	C	U	U	R	U	U
House Sparrow	*	*	R	R	*	R	R	R	R	*	*	*	U	U	*	*	R	*	U	R
House Wren	*	*	*	R	*	R	R	*	*	R	R	*	R	R	*	R	*	*	R	R
Inca Dove	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Indigo Bunting	R	R	R	U	U	U	U	R	R	U	U	*	U	U	*	U	*	*	U	R
Killdeer	*	R	R	*	*	*	*	*	*	*	R	*	R	*	U	*	*	*	*	*
Ladder-backed Woodpecker	*	*	R	R	R	R	R	R	U	R	*	*	R	R	*	R	*	*	*	*
Lark Bunting	*	*	*	*	*	R	*	*	*	*	*	*	*	*	R	*	R	*	R	*
Lark Sparrow	R	R	R	R	R	U	R	R	R	R	U	R	U	R	U	R	U	*	R	C
Lazuli Bunting	R	R	*	R	R	R	R	R	R	R	R	*	R	R	R	R	R	*	R	R

Appendix 25 (continued).

Species	BURN 1	BURN 2	BURN OP	C/CW 1	C/MB 1	C/NMO 1	C/RO 1	C-2 ART	C-2 NAT	C-RO/CW 3	CW 5	CW 6	DR 5	DR 6	MH 5-OW	NMO 5	OP	RO 3	RO 5	SC 5
Least Bittern	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
Least Sandpiper	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
Lesser Goldfinch	C	U	R	C	U	C	C	C	C	C	C	U	C	U	U	C	U	U	C	U
Lesser Yellowlegs	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
Loggerhead Shrike	*	*	*	*	*	*	*	*	*	*	R	R	*	*	*	*	*	*	*	R
Lucy's Warbler	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
MacGillivray's Warbler	U	R	R	U	U	U	U	R	U	U	U	U	U	U	R	U	U	R	U	U
Mallard	*	*	*	*	R	*	U	R	U	*	U	R	C	C	C	*	R	*	U	R
Marsh Wren	*	*	*	*	R	*	*	*	*	*	*	*	*	*	R	*	*	*	R	*
Merlin	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*
Mississippi Kite	*	R	*	*	*	*	R	*	R	*	R	*	*	R	*	*	*	*	*	*
Mountain Chickadee	*	*	*	U	U	R	U	R	R	R	R	R	R	*	*	R	*	*	*	*
Mourning Dove	C	C	C	C	C	C	C	C	C	C	C	U	U	C	U	U	C	C	C	C
Nashville Warbler	*	*	*	*	*	*	*	*	*	R	R	*	R	*	*	*	*	*	R	*
Northern Flicker	U	U	U	U	U	U	U	U	U	U	U	U	R	R	R	U	R	R	U	R
Northern Harrier	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	R
Northern Mockingbird	U	R	R	R	R	R	R	*	R	*	U	U	U	R	R	R	R	*	U	C
Northern Parula	*	*	*	*	*	*	R	*	*	*	R	*	*	*	*	*	*	*	*	*
Northern Pintail	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
Northern Rough-winged Swallow	*	*	*	*	*	*	R	*	R	*	U	*	R	U	U	R	R	*	R	R
Northern Shoveler	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
Northern Waterthrush	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Olive-sided Flycatcher	R	*	*	R	R	R	R	R	R	R	R	*	R	*	R	R	*	*	*	R
Orange-crowned Warbler	*	*	*	R	R	R	R	R	R	R	U	*	R	R	R	R	R	*	R	*
Osprey	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Painted Bunting	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
Palm Warbler	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*
Peregrine Falcon	*	R	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*
Phainopepla	*	*	*	R	*	*	*	*	*	*	*	*	*	R	*	*	*	*	R	R
Pied-billed Grebe	*	*	*	*	*	*	*	*	*	*	*	*	R	*	C	*	*	*	*	*
Pine Siskin	*	*	*	*	R	*	R	R	R	R	U	*	*	*	*	*	*	*	*	R
Plumbeous Vireo	*	*	*	R	R	*	R	*	R	R	*	*	R	*	R	R	R	*	R	*
Prothonotary Warbler	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*
Red-breasted Nuthatch	R	*	*	R	R	R	R	R	R	R	R	*	R	*	*	R	*	*	R	*
Red Crossbill	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Redhead	*	*	*	*	*	*	*	*	*	*	*	*	*	R	R	*	*	*	*	*
Red-headed Woodpecker	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Red-tailed Hawk	*	*	R	*	*	R	*	*	R	*	*	*	*	*	*	*	R	*	*	*
Red-winged Blackbird	R	U	*	R	R	*	*	*	R	*	U	R	U	R	C	*	*	R	U	U
Ring-necked Pheasant	R	R	R	U	U	R	U	R	U	U	U	U	*	R	R	R	U	*	U	R
Rock Pigeon	*	*	*	*	*	*	*	*	R	*	*	*	*	R	*	*	R	*	R	*
Rose-breasted Grosbeak	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Ruby-crowned Kinglet	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*
Ruddy Duck	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
Rufous Hummingbird	R	*	R	U	U	U	U	U	U	U	U	*	U	U	R	U	R	R	U	R
Rufous-crowned Sparrow	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R
Savannah Sparrow	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*
Say's Phoebe	*	*	*	R	R	R	R	R	R	*	U	*	R	R	R	R	U	*	R	R
Scaled Quail	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	R
Snowy Egret	*	*	*	*	*	*	R	*	*	*	R	*	*	R	U	*	*	*	R	*

Appendix 25 (continued).

Species	BURN 1	BURN 2	BURN OP	C/CW 1	C/MB 1	C/NMO 1	C/RO 1	C-2 ART	C-2 NAT	C-RO/CW 3	CW 5	CW 6	DR 5	DR 6	MH 5-OW	NMO 5	OP	RO 3	RO 5	SC 5
Song Sparrow	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*
Sora	*	*	*	*	*	*	*	*	*	*	*	*	*	*	U	*	*	*	*	*
Spotted Sandpiper	*	*	*	*	*	*	*	*	*	R	R	*	*	R	R	*	*	*	R	*
Spotted Towhee	C	C	U	C	C	C	C	U	C	C	C	U	C	U	U	C	U	C	C	C
Summer Tanager	U	*	R	C	U	U	C	U	C	U	U	R	U	U	R	U	U	*	U	U
Swainson's Hawk	U	*	R	R	R	*	R	*	R	*	R	R	*	R	R	*	R	*	*	R
Townsend's Warbler	*	*	*	R	*	R	R	*	R	R	R	*	R	R	*	R	R	*	R	R
Tree Swallow	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*
Turkey Vulture	R	*	*	R	R	*	R	R	R	*	R	*	*	*	*	R	*	*	R	*
Vesper Sparrow	*	*	*	R	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	R
Violet-green Swallow	*	*	*	R	*	*	*	*	R	*	R	*	*	*	U	*	R	*	R	R
Virginia Rail	*	*	*	*	*	*	*	*	*	*	*	*	R	*	U	*	*	*	R	*
Virginia's Warbler	U	R	R	U	U	U	U	U	U	C	C	*	U	U	R	U	R	R	U	U
Warbling Vireo	*	*	*	R	R	U	U	R	U	U	R	R	U	R	R	R	*	*	U	U
Western Bluebird	*	*	*	*	*	*	R	R	*	*	R	*	*	*	*	*	*	*	*	*
Western Kingbird	U	*	C	U	U	R	U	R	U	R	U	U	U	U	U	R	U	R	U	R
Western Meadowlark	*	*	*	*	*	*	*	*	R	*	R	*	*	*	R	*	*	*	R	*
Western Screech-Owl	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	R	*
Western Scrub-Jay	*	*	*	*	*	*	R	*	R	R	*	*	*	*	*	*	*	*	R	*
Western Tanager	R	*	*	U	U	U	U	R	U	U	U	R	U	U	R	U	R	R	U	R
Western Wood-Pewee	R	R	R	U	U	U	U	U	U	U	U	*	U	R	R	U	R	*	U	R
White-breasted Nuthatch	U	U	U	C	U	C	C	C	C	U	U	R	U	U	R	U	U	*	U	*
White-crowned Sparrow	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*
White-eyed Vireo	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*
White-faced Ibis	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
White-winged Dove	U	U	R	R	R	U	R	R	U	R	R	R	R	R	R	*	R	*	R	U
Willow Flycatcher	*	*	*	*	*	*	R	*	R	R	*	R	R	*	*	R	*	*	R	*
Wilson's Snipe	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
Wilson's Warbler	C	*	U	U	U	U	C	U	U	U	U	R	C	U	R	U	U	U	U	U
Wood Duck	*	*	*	R	R	R	R	*	R	R	R	*	U	U	C	*	R	*	R	*
Yellow Warbler	U	*	U	R	U	U	R	R	R	U	U	*	U	R	R	U	R	R	U	R
Yellow-billed Cuckoo	*	*	*	R	R	*	*	*	R	R	*	*	*	*	*	*	*	*	*	*
Yellow-breasted Chat	U	U	U	C	C	C	C	*	U	C	C	U	U	U	U	C	R	C	C	U
Yellow-headed Blackbird	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
Yellow-rumped Warbler	*	*	*	R	R	*	R	R	R	*	*	*	R	*	*	R	*	*	R	*