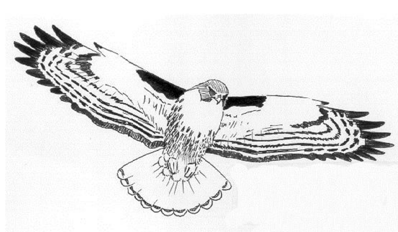
Bird and Vegetation Community Relationships in the Middle Rio Grande Bosque: 2013 Interim Report

Submitted To:

Ondrea Hummel
U.S. Army Corps of Engineers
Albuquerque District
4101 Jefferson Plaza NE
Albuquerque, New Mexico 87109
(505) 342-3375

Prepared By:

Hawks Aloft, Inc.
P.O. Box 10028
Albuquerque, New Mexico 87184
(505) 828-9455
Website: www.hawksaloft.org
e-mail contact: tfetz@hawksaloft.org



December 2014

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICIES

EXECUTIVE SUMMARY

Between December 2003 and August 2013, we monitored avian abundance and species richness at 78 transects, representing 22 vegetation and community structure (C/S) types. Our study area encompassed the Middle Rio Grande bosque between Rio Rancho 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. 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 avian densities and richness occurred in pure stands of Russian olive (*Elaeagnus angustifolia*) and stands incorporating extensive amounts of New Mexico olive (*Forestiera neomexicana*). Although density and richness trends in 2013 were consistent with previous years in terms of C/S types supporting the highest avian use, bird numbers were substantially lower during summer 2013 within specific C/S types relative to cumulative densities during 2004-2012. During summer, avian density was lower at 19 of 20 C/S types surveyed during both periods and species richness was lower at 13 of 20 C/S types in 2013 than cumulatively in 2004-2012, with density significantly lower at seven C/S types. The decrease in avian use across C/S types during summer was likely due to ongoing drought conditions. In contrast, winter avian density in 2013 was higher than cumulatively in 2004-2012 at 11 of 20 C/S types surveyed during both periods and richness was higher in 2013 at 12 of 20 C/S types. Continued monitoring is imperative in order to assess the longer-term impacts of the drought on individual species and the avian community as a whole, as well as the impacts of ongoing bosque restoration 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 in the bosque.

Since 2004, numerous habitat restoration initiatives have been conducted within the middle Rio Grande bosque. The primary goal of most 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 bosque. For example, just within the Rio Grande Valley State Park, over 2,000 acres were mechanically thinned in 2004 alone (USACE 2004). Fortunately, the pace of thinning activities has slowed over the past few years. But, non-native vegetation removal without corresponding re-vegetation using native plants remains a potential threat to the robustness of avian communities in the bosque.

The re-establishment of native vegetation has been a stated secondary goal of many thinning projects in the bosque, but re-vegetation efforts have not kept pace with thinning activities. Unfortunately, the removal of non-native, woody vegetation, at least initially, alters the vegetation structure to types that have 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), including the Rio Grande, and the subsequent removal of this non-native vegetation can disrupt avian communities (Zavaleta et al. 2001). The re-establishment of native vegetation in thinned areas may aid in the recovery of avian communities, but in too many instances re-vegetation efforts have either been very sparse or non-existent.

In contrast, the U.S. Army Corps of Engineers (USACE) began work in 2011 on an ambitious project to restore the Rio Grande corridor throughout the greater Albuquerque area. Known as the Middle Rio Grande Ecosystem Restoration Project, this project will ultimately restore about 916 acres at 18 different locations (USACE 2014). The goal of ecosystem restoration will be accomplished by improving native bosque habitat quantity and quality, reestablishing fluvial processes to more natural conditions, and restoring hydraulic processes between the bosque and river via overbank flows and increased groundwater recharge. An additional goal of this project is to protect, extend, and improve areas of potential habitat for listed species, including the endangered Southwestern Willow Flycatcher (*Empidonax traillii extimus*). Activities involved in this restoration project include removing select exotic vegetation and planting native vegetation, establishing shrub thickets and native canopy, and excavating backwater channels, seasonal high-flow channels, wetland swales, and an oxbow wetland.

Hawks Aloft, Inc., contracted by the USACE, has been conducting a songbird monitoring study in the Middle Rio Grande bosque between Rio Rancho and the La Joya Waterfowl Management Area, 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, the Pueblo of Sandia, and the New Mexico Department of Game and Fish.

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 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, as well as impacts to individual species 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.

A newer, additional objective is to document avian abundance and species richness in selected work areas of the USACE Middle Rio Grande Ecosystem Restoration Project. Although our objectives in these areas are the same as those listed above, because many of these work areas involve multiple C/S types, categorizing avian use by a specific C/S type will not be feasible. Instead, in these areas we will document avian abundance and richness before, during and after the completion of restoration work based on the given project area as a whole. Corresponding differences in analysis protocol, when applicable, are noted below.

This interim report documents monitoring efforts performed during the 2013 field season (December 2012 through August 2013), but also includes comparisons with data collected during the 2004-2012 field seasons (December 2003 through August 2012).

STUDY AREA AND METHODOLOGY

Study Area

The study area encompasses 79 river miles (127 km) between Rio Rancho in the north, and the La Joya Waterfowl Management Area to the south (Appendices 1-22). Within this reach of the Rio Grande, we established 78 transects representing 22 vegetation community and structure (C/S) types on lands administered by six different entities. From north to south in our study area these entities are: The City of Rio Rancho, the Village of Corrales, the Pueblo of Sandia, the City of Albuquerque, the Middle Rio Grande Conservancy District (MRGCD), and the New Mexico Department of Game and Fish (NMGF). Transects were generally 700-800 m in length, although 14 transects were limited to lengths shorter than 700 m due to significant changes in C/S type at both ends.

We duplicated 25 transects surveyed during the 1981-1982 Middle Rio Grande Biological Survey (MRGBS; Hink and Ohmart 1984), relocated nine transects established during the MRGBS within their original stands, and included 44 additional transects established within the original survey area.

To name transects, we followed the protocol used in the MRGBS. For this report, the names of duplicated transects and transects established in areas that contained MRGBS transects, but not following the same route (i.e "alternate" transects), retained the same name as in the MRGBS (Appendix 23). The locations of "alternate" 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 OXB01 and OXB02, which were named as such because they occur in an area widely known as "the oxbow".

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.

We combined similar C/S types into groups we called analysis categories. We defined analysis category (see Appendix 24) 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 deltoides*) overstory with a dense, New Mexico olive (*Forestiera neomexicana*)-dominated understory: 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 (*Salix exigua*) 1 (C/CW 1), Cottonwood/coyote willow-mulberry (*Morus microphylla*) 1 (C/CW-MB 1), Cottonwood/mulberry-Siberian elm (*Ulmus pumila*) 1 (C/MB-SE 1), Cottonwood/mulberry-salt cedar (*Tamarix chinensis*) 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 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/CW-MB 1 and C/CW 1 into C/CW 1 for analysis (see Appendix 24). Similarly, we combined C/MB-SE 1 and C/MB-SC 1 into C/MB 1, C/NMO-RO 1 and C/NMO 1 into C/NMO 1, and C/RO-SC 1 and C/RO 1 into C/RO 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. We re-classified this site into a different C/S type (RO 5 BURN) prior to winter 2011 due to vegetation development and composition changes. We did not survey any transects classified at BURN 1 in 2013.

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 (see 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. The transects comprising the C-2 natural analysis category during this study included the following C/S types: C/CW-NMO 2, C/CW-RO 2, C/NMO 2, C/RO 2, C/RO-CW 2, C/SE 2, and C/TW (*Salix gooddingii*) 2 (Table 2; Appendix 24).

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. In 2013, we surveyed three transects classified as BURN 2 due to their structure following the 2012 Romero Fire.

Type 3 stands contained intermediate-sized 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; Appendix 24).

Type 4 stands contained intermediate-sized 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. The only type 4 stand in this study was C-4 (Table 2; Appendix 24).

Type 5 stands were dense stands with the majority of foliage occurring between 0 and 6 m and no significant overstory canopy. The type 5 stands in this study were CW-RO 5, CW-RO-C 5, DR 5, MH 5-OW, NMO-RO 5, NMO-SB 5, RO 5, RO 5 BURN, RO-CW 5, RO-SC 5, and SC 5 (Table 2). Due to structural and avifaunal similarities, we combined CW-RO 5 and CW-RO-C 5 into CW-RO 5 for analysis; RO 5, RO 5 BURN, RO-CW 5, and RO-SC 5 into RO 5 for analysis; and NMO-SB 5 and NMO-RO 5 into NMO 5 for analysis (Appendix 24).

Type 6 stands had low, relatively sparse herbaceous and/or shrubby vegetation, with most of the foliage less than 1.5 m in height and no significant overstory canopy. The type 6 stands in this study were CW 6, DR 6, and RO 6 (Table 2; Appendix 24).

OP stands were mechanically thinned areas with minimal woody vegetation remaining (Table 2). We classified one transect subjected to catastrophic fire as BURN OP in 2013 (Appendix 24) because continued thinning of woody re-sprouts and the removal of most cottonwood snags at the sites left landscapes best categorized as OP. We did not group OP and BURN OP sites together for analysis because of differences in avian use, despite superficial landscape similarities between these areas.

Many transects established in 2011 and 2012 in work areas of the USACE Middle Rio Grande Ecosystem Restoration Project include more than one dominant C/S type over their lengths. We categorized these transects as "mixed" C/S types and included the dominant C/S types present in their C/S description (See Appendices 39 and 40).

Avian Survey Methods

Bird surveys for the 2013 field season began in December, 2012. 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. In 2013, we surveyed all 78 transects during both the winter (December through February) and summer (June through August) field seasons.

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. We calculated the number of birds per 100 acres based on our observations within 30 m of the transect line. We chose 30 m as our limit for density estimates because it is accepted that skilled observers can estimate out to that 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, our ability to detect birds rapidly decreased beyond 30 m, 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 ≥1.5 individuals per 100 acres for each C/S type. By choosing

≥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. In order to more accurately assess avian use within specific C/S types, we included only species recorded within 30 m of the transect line when calculating species richness at transects with a defined C/S type. But, at USACE restoration sites we calculated richness based on species recorded at all distances (i.e. potentially out to 122 m from the transect line) along a given transect. We altered our richness calculations for the USACE restoration sites because we are interested in assessing richness across the entire survey area and not relative to a specific C/S type. Additionally, a majority of the USACE restoration sites are comprised of multiple C/S types along the length of corresponding avian survey transects and cannot be assigned to a specific C/S type.

We defined census area (Appendix 23) as the size of the area at each transect for which we included observations used in our avian abundance and (except for USACE restoration transects) 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 post-hoc 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).

RESULTS

Winter Avian Abundance

Russian olive (RO) 3 supported the highest avian density during winter 2013 (1527 birds/100 acres; Table 3), which was significantly higher than all other C/S types except for DR 5 (1058 birds/100 acres) (Tukey-Kramer test; Appendix 25). RO 3 also supported the highest cumulative avian density (1660 birds/100 acres) during the winters of 2004-2012. Drain 5 (1151 birds/100 acres) and MH 5-OW (1076 birds/100 acres) were the only other C/S types to support cumulative avian densities greater than 1000 birds/100 acres. The cumulative RO 3 density for 2004-2012 was significantly higher than all other C/S types, while the cumulative densities for DR 5 and MH 5-OW were significantly higher than all remaining C/S types except for BURN 1 (Tukey-Kramer test; Appendix 26).

In contrast, OP (110 birds/100 acres), C/CW 1 (127 birds/100 acres), and C-2 artificial (131 birds/100 acres) supported the lowest winter densities in 2013 (Table 3), and were significantly lower than nine other C/S types (Tukey-Kramer test; Appendix 25). C-2 artificial stands have supported the lowest winter densities during eight of 10 years of this study. The cumulative density in C-2 artificial stands for 2004-2012 (90 birds/100 acres) was significantly lower than 13 other C/S types (Tukey-Kramer test; Appendix 26). C-2 artificial was the only C/S type that supported densities lower than 100 birds/100 acres cumulatively during winters 2004-2012.

Overall, bird densities were higher during winter 2013 than cumulatively for winters 2004-2012 in 11 of 20 C/S types where data were recorded during both periods (Table 3). Further, winter density in 2013 was higher than 2012 in 18 of 19 C/S types surveyed during both years, with the density significantly higher in four C/S types (Appendix 27). Avian density in 2013 was not significantly different than cumulatively during 2004-2012 within any C/S types (Tukey-Kramer test; Appendix 28).

Winter Species Richness

Avian species richness was highest in 2013 at MH 5-OW (20.3 species/transect), RO 3 (20.0 species/transect), and DR 5 (18.4 species/transect) (Table 4). Richness in 2013 was significantly higher at MH 5-OW than two other C/S types (Tukey-Kramer test; Appendix 29). Cumulative winter richness (2004-2012) was highest at DR 5 (19.2 species/transect), C/NMO 1 (17.7 species/transect) and BURN 1 (16.3 species/transect). The cumulative richness (winter 2004-2012) for DR 5 was significantly higher than 14 other C/S types, and for C/NMO 1 was significantly higher than 11 other C/S types (Tukey-Kramer test; Appendix 30).

In contrast, species richness was lowest in 2013 at OP (3.5 species/transect), SC 5 (7.3 species/transect), and C-2 artificial (9.4 species/transect) (Table 4). Cumulative richness in 2004-2012 was lowest at SC 5 (4.3 species/transect), C-4 (5.0 species/transect), and C-2 artificial (6.1 species/transect). Cumulative (2004-2012) richness at SC 5 was significantly lower than 14 other C/S types and C-2 artificial was significantly lower than 12 other C/S types (Tukey-Kramer test; Appendix 30).

Overall, species richness was higher during winter 2013 than cumulatively during winters 2004-2012 for 12 of 20 C/S types where data were recorded during both periods (Table 4). Winter 2013 was the first winter since 2007 that species richness was higher than cumulative winters for a majority of C/S types. There were no statistically significant differences in species richness between 2013 and cumulatively 2004-2012 within specific C/S types.

Summer Avian Abundance

RO 3 supported the highest avian density during summer 2013 (1145 birds/100 acres; Table 5). MH 5-OW (1063 birds/100 acres) and NMO 5 (1005 birds/100 acres) were the only other C/S types that supported densities greater than 1000 birds/100 acres during 2013. Cumulatively, MH 5-OW supported the highest bird density during 2004-2012 (1500 birds/100 acres). NMO 5 (1196 birds/100 acres) and BURN 1 (1165 birds/100 acres) were the only other C/S types to support cumulative densities greater than 1000 birds per 100 acres during 2004-2012.

In 2013, RO 3 and MH 5-OW supported significantly higher avian densities than 17 of the 18 other C/S types surveyed (Tukey-Kramer test; Appendix 31). In addition, NMO 5 supported significantly higher densities than 16 other C/S types, C/NMO 1 supported significantly higher densities than 14 other C/S types and RO 5 supported significantly higher densities than 13 other C/S types. Cumulatively in 2004-2012, MH 5-OW had a significantly higher density than all other C/S types, while NMO 5 had a significantly higher density than 18 other C/S types (Tukey-Kramer test; Appendix 32).

The lowest summer avian densities in 2013 occurred in OP (124 birds/100 acres), SC 5 (171 birds/100 acres), and C-2 artificial (200 birds/100 acres; Table 5). In 2013, avian density in OP was significantly lower than 13 other C/S types, while density in SC 5 was significantly lower than 11 other C/S types and C-2 artificial was significantly lower than 10 other C/S types (Tukey-Kramer test; Appendix 31). Cumulative summer avian density (2004-2012) was lowest at SC 5 (206 birds/100 acres), OP (234 birds/100 acres), and C-2 artificial (347 birds/100 acres). The cumulative summer density at SC 5 was significantly lower than 18 other C/S types while OP was significantly lower than 17 other C/S types (Tukey-Kramer test; Appendix 32).

Overall, 19 of 20 C/S types supported lower avian densities during summer 2013 than cumulatively in 2004-2012 (Table 5). Summer 2013 was the fifth consecutive year that avian density was lower than cumulative summers for a majority of C/S types where data were recorded during both periods. Summer avian density in 2013 was significantly lower than cumulatively during 2004-2012 at seven C/S types: MH 5-OW, DR 5, C/CW 1, C/RO 1, CW 6, C-2 natural and C/MB 1 (Tukey-Kramer test; Appendix 33).

Summer Species Richness

During summer 2013, RO 3 (32.0 species/transect), C/MB 1 (27.0 species/transect), and CW-RO 5 (26.7 species/transect) supported the highest avian species richness (Table 6). RO 3 supported significantly higher richness in summer 2013 than three other C/S types (Tukey-Kramer test; Appendix 34). In contrast, OP (5.5 species/transect), DR 6 (10.6 species/transect) and C-2 artificial (11.3 species/transect) supported the lowest richness. OP supported significantly lower richness during summer 2013 than five other C/S types.

Cumulatively during summers 2004-2012, CW-RO 5 (25.8 species/transect), C/CW 1 (25.6 species/transect), and C/MB 1 (25.6 species/transect) supported the highest avian species richness among C/S types that were also surveyed in 2013 (Table 6). CW-RO 5 supported significantly higher cumulative richness (2004-2012) than nine other C/S types (Tukey-Kramer test; Appendix 35). Conversely, OP (10.3 species/transect), SC 5 (12.1 species/transect), DR 6 (12.3 species/transect), and C-2 artificial (12.5 species/transect) supported the lowest cumulative richness during summer 2004-2012. OP supported significantly lower cumulative richness during 2004-2012 than 15 other C/S types, while SC 5, C-2 artificial and DR 6 supported significantly lower cumulative richness than 13 other C/S types.

Overall, species richness was lower during summer 2013 than cumulatively during 2004-2012 in 12 of 20 C/S types surveyed during both periods (Table 6). There were no statistically significant differences in species richness between years within specific C/S types.

Comparison of Avian Abundance and Richness by Land Management Entity

The 78 transects we surveyed occurred on lands administered by six different entities. From north to south in our study area these entities are: The City of Rio Rancho, the Village of Corrales, the Pueblo of Sandia, 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 (2004-2013) avian density and richness by land manager to evaluate how the different management strategies employed may be affecting avian use.

Cumulative winter avian density during 2004-2013 was highest in Corrales (688 birds/100 acres) and lowest in Rio Rancho (229 birds/100 acres; Table 7). Avian density was significantly higher in Corrales and on lands managed by NMGF than all other areas

(Tukey-Kramer test). Winter avian density was significantly lower in Rio Rancho than four of the five other areas.

Cumulative winter avian richness during 2004-2013 was highest in Corrales (15.5 species/transect) and lowest in Rio Rancho (9.0 species/transect; Table 8). Winter richness was significantly higher in Corrales than four of the five other management areas.

Cumulatively during summer 2004-2013, avian density was highest in Corrales (771 birds/100 acres) and lowest on lands managed by the Pueblo of Sandia (460 birds/100 acres; Table 9). Summer avian density was significantly higher in Corrales than all other areas (Tukey-Kramer test). Summer avian density was significantly lower on the Pueblo of Sandia, Rio Rancho, and NMGF lands than the three other areas.

Cumulative summer avian species richness during 2004-2013 was highest in Corrales (20.9 species/transect) and lowest on NMGF lands (14.7 species/transect; Table 10). Summer avian richness was significantly lower on NMGF lands managed by Corrales, MRGCD, and Albuquerque (Tukey-Kramer test).

Comparison of Avian Abundance and Richness Before and After Wetland Creation

We began surveying a single transect (SE31) in the Tingley Beach area of the Albuquerque bosque in the summer of 2004 to monitor the impact of wetland creation on avian abundance and species richness. Ultimately, the restoration of this site included the creation of two ponds by the USACE. Water flowing out of the south pond resulted in the creation of a cattail (*Typha* sp.)-dominated marsh with a substantial willow component along the edges. During the initial survey season in summer 2004 this site 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 summer 2005, the site consisted of open (OP) and C-2 artificial habitats. By winter 2006, the ponds had been established and water was present, but vegetation recovery was minimal. By summer 2006, 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 11), but the decrease was not statistically significant. By summer 2006, the establishment of pond and marsh habitat led to a substantial increase in avian use. The summer avian densities at SE31 for each year from 2006-2013 were significantly higher than 2005 and significantly higher than 2004 during all years except 2007, 2008, 2012, and 2013 (Tukey-Kramer test; Appendix 36).

As a USACE restoration site (see Avian Survey Methods above), we calculated avian species richness at this site based on all species documented at densities of $\geq$1.5 individuals per 100 acres within the entire survey area rather than just within 30 m of the transect line. This deviation allows us to meet our goal of documenting avian use across the entire project area. Avian richness during summer 2013 (37 species) was higher than all other summers except 2012 (43 species), 2009 (43 species) and 2008 (38 species; Table 11). Summer avian richness was substantially higher during all years after the establishment of the pond/marsh habitat than before, but the changes were not statistically significant (Tukey-Kramer test).

Winter avian abundance at SE31 increased every year from 2005 (56 birds/100 acres) to 2009 (2055 birds/100 acres; Table 12). Avian density in winter 2013 (1729 birds/100 acres) was lower than 2009, but higher than all other years. Winter avian density during all years since 2008 was significantly higher than in 2005 and 2006 (Tukey-Kramer test; Appendix 37). Winter avian density during all years since 2009 was also significantly higher than in 2007.

Winter species richness increased every year from 2005 (5 species) to 2007 (23 species; Table 12). Winter 2013 richness (43 species) was substantially higher than all other years. Winter richness during 2007-2013 was significantly higher than 2005 and 2006 (Tukey-Kramer test).

<u>Comparison of Avian Abundance and Richness at Current USACE Restoration Sites</u>

In 2011 and 2012, we established 15 new transects in areas where USACE planned to conduct extensive habitat restoration. The goal at these transects was to document both pre- and post-restoration avian use. A number of these transects traverse substantial habitat changes and cannot be assigned to a single, primary C/S type. Thus, we categorized these transects as “mixed” C/S types, but include the two or three most predominant C/S types in their “mixed” classification. Because we were interested in documenting avian use across the entire survey area of each transect, we calculated species richness based on all species documented at densities of $\geq$1.5 individuals per 100 acres within the entire survey area rather than just within 30 m of the transect line. But, avian density calculations are based only on observations within 30 m of the transect line (see Avian Survey Methods for explanation). Through summer 2013, restoration work had been initiated in the vicinity of 11 transects. Details regarding survey history and avian use at these 11 transects are provided below and in Appendix 39 (summer data) and Appendix 40 (winter data).

USACE project area 1B (NE14, NE16, NE17) - These transects were established to document avian use in areas of upland bosque restoration on the Pueblo of Sandia (see Appendix 4). In 2011, these transects were classified as C-2 natural with Russian olive being the predominant woody understory species. Exotic species reduction/removal occurred during the winter 2012 field season at NE14 and NE17, changing the C/S type at those transects to C-2 artificial. NE16 was not altered during the winter 2012 field season. In June 2012, all three transects were consumed by catastrophic wildfire (see Fig. 2). From the north, all of NE17 and NE16 and the north 630 m of NE14 burned. Consumption of woody vegetation by the fire approached 100% within 30 m of the transect line on both NE17 and NE16, while consumption of woody vegetation on the north 630 m of NE14 exceeded 90%. Some woody vegetation on the western periphery of all three transects (generally 60-120 m from the transect lines) survived the fire.

Summer avian density at all three transects during post-fire 2012 was higher than pre-fire 2012 (823, 430 and 359 birds/100 acres vs. 396, 283 and 281 birds/100 acres respectively at NE14, NE16 and NE17) and 2011 (719, 381 and 290 birds/100 acres respectively at NE14, NE16 and NE17) (Appendix 39). Post-fire 2012 species richness at all three transects was higher than pre-fire 2012 (22, 18 and 18 species/transect vs. 9, 10 and 8 species/transect respectively at NE14, NE16 and NE17) and similar to 2011 richness (19, 21 and 20 species/transect respectively at NE14, NE16 and NE17). Summer avian density at all three transects in 2013 (442, 277 and 274 birds/100 acres respectively at NE14, NE16 and NE17) was lower than post-fire 2012, but similar to 2011. Species richness in summer 2013 (22, 23 and 20 species/transect respectively at NE14, NE16 and NE17) was higher than or equal to richness during previous summers at all three transects. None of the differences in summer avian density and species richness between years at a particular transect were statistically significant.

Winter avian density in 2013 (post-fire; 558, 275 and 315 birds/100 acres respectively at NE14, NE16 and NE17) was higher at all three transects than the pre-fire winters of 2011 (277, 228 and 97 birds/100 acres respectively at NE14, NE16 and NE17) and 2012 (142 pre-thin and 105 post-thin birds/100 acres at NE14, 105 birds/100 acres at NE16, and 91 pre-thin and 78 post-thin birds/100 acres at NE17) (Appendix 40). Avian species richness at NE14 and NE17 in 2013 (15 and 16 species/transect respectively) was higher than 2011 (12 and 11 species/transect respectively) and 2012 (7 pre-thin and 5 post-thin and 6 species/transect pre- and post-thin respectively at NE14 and NE17). Winter avian richness was slightly higher at NE16 in 2013 (14 species/transect) than 2012 (13 species/transect) but slightly lower than 2011 (15 species/transect). None of the differences in summer avian density and species richness between years at a particular transect were statistically significant.

USACE project area 1E (NW16 S) - During winter 2012, USACE began bank terracing and swale construction in the south Corrales bosque that included the southernmost 340 m of the pre-existing NW16 transect (see Appendix 6). We began separating the data collected in the construction area as soon as work began (visit #8 in winter 2012). Prior to clearing for bank terracing, the habitat in that portion of NW16 was classified as RO-SC 5. The last two visits to NW16 S occurred after the site had been cleared for swale creation and were the first visits where we separated data from NW16 into two transects. We categorized the C/S type for the two winter visits at NW16 S as OP. By summer 2012, the swale and terrace that includes NW16 S had been planted and we re-categorized the C/S type for that transect as CW 6. Despite a substantial increase in floristic height and density between summer 2012 and 2013, avian density and richness at NW16 S were similar during both summers (436 birds/100 acres, 18 species/transect in 2012, and 403 birds/100 acres, 19 species/transect in 2013) (Appendix 39). Winter 2013 was the first full season we surveyed NW16 S as a distinct transect, with avian density at 529 birds/100 acres and richness at 14 species/transect (Appendix 40).

USACE project area 1G (NW30) - This transect was established prior to the winter 2011 field season to document avian use in areas of swale creation, bank terracing, and upland bosque restoration in south Corrales (see Appendix 7). No restoration activities were undertaken during 2011 and we categorized the C/S type at this transect as C/RO 1 when it was established. Construction began during the winter 2012 field season, with the first five surveys occurring before construction started and the last four after construction was underway. For the four visits conducted during construction we classified the C/S type as an OP/C-2 mix. Avian density during winter 2012 was slightly higher during the five pre-construction visits (531 birds/100 acres) than the four visits conducted during construction (415 birds/100 acres), but avian richness was similar during pre-construction (10 species/transect) and mid-construction (9 species/transect) visits (Appendix 40).

By summer 2012, construction and planting were complete and we classified the C/S type as a CW 6/C-2 mix (Appendix 39). Avian density and richness during summer

2012 (531 birds/100 acres and 19 species/transect) were similar to summer 2011 (534 birds/100 acres and 21 species/transect). Avian density during summer 2013 was slightly lower than previous summers (497 birds/100 acres), but richness was higher (24 species/transect). Avian density during winter 2013 (700 birds/100 acres) was higher than any previous winter, but richness was lower (14 species/transect) than winter 2011 (Appendix 40).

USACE project area 4B (SE34) - We established this transect prior to the summer 2005 field season in order to monitor the open (OP) C/S type created by City of Albuquerque thinning activities (see Appendix 12). Before USACE restoration activities began during winter 2012, we classified the C/S type at SE34 as either OP or an OP/SE-RO 6 mix, depending on the growth of woody vegetation and the results of additional thinning activities by the City of Albuquerque. During the summers of 2005-2011, avian density ranged from a low of 153 birds/100 acres in 2005 to a high of 385 birds/100 acres in 2011 (Appendix 39). Avian richness ranged from a low of 7 species/transect in summer 2006 to a high of 19 species/transect in 2010.

Winter surveys were conducted at SE34 in years prior to 2011 only when adequate funding was available. Winter avian density in years prior to USACE construction ranged from a low of 384 birds/100 acres in 2010 to a high of 746 birds/100 acres in 2006, while winter avian richness ranged from a low of 7 species/transect in 2010 to a high of 12 species/transect in 2006 and 2007 (Appendix 40).

By the beginning of the winter 2012 field season, USACE had completed construction of a large swale and bank terrace at the site. But, our first two visits during winter 2012 occurred before planting had begun. We classified the C/S type as OP during that time. With a lack of vegetation, avian density (16 birds/100 acres) and species richness (1 species/transect) were particularly low during those first two visits (Appendix 40). Planting was completed prior to our third visit in winter 2012 and we reclassified the C/S type to CW 6 from that point on. Avian density and richness remained low during the seven post-planting visits in winter 2012 (61 birds/100 acres and 4 species/transect). But, avian density and richness were substantially higher in winter 2013 (828 birds/100 acres and 12 species/transect). During the two post-planting summer field seasons, avian density and richness slightly increased from 388 birds/100 acres and 20 species/transect in 2012 to 426 birds/100 acres and 21 species/transect in 2013 (Appendix 39).

USACE project area 4C (SE35) - This transect was established prior to the winter 2011 field season to document avian use in areas of swale creation and upland bosque restoration in the Albuquerque South Valley (Appendix 13). In 2011, we classified the C/S type at this transect as an OP/C-2 mix. During winter 2011, avian density was 251 birds/100 acres and species richness was 14 species/transect (Appendix 40). The swales at the site were constructed and planted prior to our winter 2012 field season. At that time, we reclassified the C/S type as an OP/CW 6/C-2 mix. Although the swales had been planted by this time, the vegetation coverage was still very limited. Avian density during winter 2012 (134 birds/100 acres) was lower than in 2011, but species richness was slightly higher (15 species/transect). By summer 2012, vegetation growth had expanded in height and density, and we reclassified the C/S type as a CW 6/OP/C-2 mix. Both avian density and species richness were higher during winter 2013 (250 birds/100 acres and 20 species/transect) than winter 2012.

During summer 2011, avian density was 280 birds/100 acres and richness was 24 species/transect (Appendix 39). Summer 2012 was the first post-construction summer field season and both avian density (315 birds/100 acres) and richness (31 species/transect) were higher. During summer 2013, avian density was slightly lower (301 birds/100 acres) but richness was higher (33 species/transect).

USACE project area 5B (SE36) - This transect was established prior to the 2011 winter field season to document avian use in areas of upland bosque restoration and swale creation in the Albuquerque South Valley (Appendix 13). But, because the swale construction occurred on the western periphery of our survey area we were primarily documenting avian use in upland bosque through 2013. Although some upland vegetation was planted following the winter 2012 field season, due to very limited growth and expansion we classified the C/S type at this transect as C-2 artificial during all years. Avian density and species richness were very low during all three winter field seasons (27 birds/100 acres and 8 species/transect in 2011, 54 birds/100 acres and 9 species/transect in 2012, 55 birds/100 acres and 9 species/transect in 2013) (Appendix 40). Avian density was also low during all three summer field seasons (292 birds/100 acres in 2011, 295 birds/100 acres in 2012, 283 birds/100 acres in 2013) (Appendix 39). But, avian richness was relatively high during all three summers (22 species/transect in 2011, 23 species/transect in 2012, 21 species/transect in 2013).

USACE project area 5C (SE37) - This transect was established prior to the winter 2011 field season to document avian use in areas of swale creation and upland bosque restoration in the Albuquerque South Valley (Appendix 14). Much of this transect was consumed by fire in the early 2000's and woody vegetation was very limited when we began surveying. We classified the C/S type as OP from winter 2011 through winter 2012. Willow swales were constructed during the winter 2012 field season, but no vegetation was planted until after that field season. During winter 2011, avian density was relatively low (215 birds/100 acres) but richness was relatively high (22 species/transect) (Appendix 40). Due to the removal of most weedy vegetation prior to swale construction, both avian density (90 birds/100 acres) and richness (12 species/transect) were low during winter 2012. Vegetation in the swales and upland areas was still small during winter 2013 and both avian density (187 birds/100 acres) and richness (11 species/transect) remained low.

Summer avian density in 2011 was relatively low (323 birds/100 acres) but richness was relatively high (26 species/transect) (Appendix 39). Planting occurred prior to the 2012 summer field season and we classified the C/S type as a CW 6/OP mix from that point on. Still, there was little change in summer avian density during 2012 (326 birds/100 acres) and 2013 (313 birds/100 acres). In contrast, avian richness was higher in 2012 (33 species/transect) and 2013 (30 species/transect).

USACE project area 5D (SW39) - This transect was established prior to the winter 2011 field season to document avian use in areas of swale creation, bank terracing and upland bosque restoration in the Albuquerque South Valley (Appendix 14). This site also burned during the early 2000's and we classified the C/S type as BURN OP from winter 2011 through winter 2012. In winter 2011, avian density was 259 birds/100 acres and richness was 16 species/transect (Appendix 40). Limited planting occurred during winter 2012 and both avian density and richness increased (393 birds/100 acres and 17 species/transect). Due to vegetation growth and expansion we classified the C/S type during winter 2013 as a CW 6/C 6 mix. Both avian density and richness were higher during winter 2013 (863 birds/100 acres and 23 species/transect).

Avian density during summer 2011 was 290 birds/100 acres and richness was 22 species/transect (Appendix 39). Due to planting, we reclassified the C/S type at the site to a CW 6/C 6/OP mix for summer 2012. Both avian density and richness were higher during summer 2012 (394 birds/100 acres and 34 species/transect). But, despite continued vegetation growth in 2013, both avian density and richness decreased (221 birds/100 acres and 28 species/transect).

USACE project area 5A (SW40) - This transect was established prior to the 2012 winter field season to document avian response to upland bosque restoration in the Albuquerque South Valley (Appendix 13). Much of the survey area had been thinned prior to transect establishment and we classified the C/S type at this site as C-2 artificial. Avian density during winter 2012 was 150 birds/100 acres and richness was 14 species/transect (Appendix 40). Planting at the site occurred during the winter 2013 field season, and we reclassified the C/S type to a C-2 mix. Avian density was lower during winter 2013 (117 birds/100 acres) but richness was slightly higher (15 species/transect). Avian density and richness during summer 2012 (pre-planting) was higher than the post-planting summer of 2013 (364 birds/100 acres and 24 species/transect in 2012 vs. 164 birds/100 acres and 22 species/transect in 2013) (Appendix 39).

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 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, the decline in this species since the early 1980’s pre-dates the arrival of significant numbers of these other dove species to the middle Rio Grande bosque.

Yellow-billed Cuckoo (*Coccyzus americanus*) - New Mexico Partners in Flight (2008) listed this species at Biodiversity Conservation Level 1 and it is a New Mexico Species of Greatest Conservation Need (BISON-M 2011). The western population of this cuckoo is a USFWS candidate species for listing as “threatened” under the Endangered Species Act. Hink and Ohmart (1984) considered this species to be an uncommon summer resident throughout the middle Rio Grande. We found cuckoos to be very rare migrants during late spring/early summer and late summer/early fall, with no clear evidence of summering birds. The extensive removal of non-native vegetation throughout the middle Rio Grande may have contributed to the local decline of this species, although it also has been declining globally (Sauer et al. 2012). We documented a single individual during summer 2013.

Black-chinned Hummingbird (*Archilochus alexandri*) - New Mexico Partners in Flight (2008) listed 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). Despite its continued abundance, this species has noticeably decreased in the bosque since 2010; the ongoing drought conditions likely are having a negative impact.

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 (Sogge et al. 2010). 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 almost exclusively occurring in densely vegetated C/S types near water. We documented an active territory in 2012 on a CW-RO 5 transect south of Belen and the site was later confirmed to be an active nest by Bureau of Reclamation surveyors (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.

Gray Flycatcher (*Empidonax wrightii*) - Hink and Ohmart (1984) considered this flycatcher to be a rare to uncommon, but regular migrant in cottonwood-dominated areas of the bosque. Based on the individuals we 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) listed 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) listed 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, is a much less common migrant through the bosque than 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.

Bewick's Wren (*Thryomanes bewickii*) - Hink and Ohmart (1984) considered this species to be fairly common during migration and winter, but did not document them breeding in the bosque south of Cochiti Pueblo. We found this wren to be uncommon to common year-round in most C/S types and a regular breeder in areas where cavities were available for nesting.

Winter Wren/Pacific Wren (*Troglodytes hiemalis/T. pacificus*) - Considered a rare, possibly regular migrant by Hink and Ohmart (1984). In 2010, Winter Wren was split into two species in North America: Winter Wren in the east and Pacific Wren in the west (Chesser et al. 2010). We have documented both species since the 2010 split, with Pacific Wren being less frequent. Cumulatively, we found these species to be rare migrants, but also rare winter residents in densely vegetated areas adjacent to standing water. Because of their secretive nature and limited vocalizations during winter, these species are easily overlooked. We most frequently encountered these species along densely-vegetated drains (DR 5) in Corrales.

Western Bluebird (*Sialia mexicana*) - New Mexico Partners in Flight (2008) listed this bluebird at Species Conservation Level 2. Hink and Ohmart (1984) considered this species a rare visitor to the bosque between late September and late March and did not document it during other times of year. We found this species to be uncommon in most habitat types during winter, with higher densities occurring in areas with substantial New Mexico olive and Russian olive berry crops. Western Bluebird has been present in small numbers as a breeder each year since 2011, primarily in mature cottonwood stands with relatively sparse understory vegetation (i.e. C-2 natural and C-2 artificial) and snags in burned habitat (BURN 2). We did not document this species during summer in 2004-2010.

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 it exploited abundant berry crops. This bluebird is now a year-round resident in the bosque. During summer 2006-2013, 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).

Varied Thrush (*Ixoreus naevius*) - Resident in moist forests in the Pacific Northwest (George 2000), this thrush is considered a casual visitor to New Mexico during late fall and winter, with fewer than 20 documented reports (Parmeter et al. 2002). We documented a single male during winter 2011 over several surveys at a RO 3 transect south of Belen. The bird was generally observed foraging on Russian olive berries in association with American Robins.

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 (RO 3, RO 5, C/RO 1 and C-RO/CW 3) and New Mexico olive (C/NMO 1, NMO 5) where it exploited berry crops of those two species. This thrush was rare in mechanically thinned areas (C-2 artificial and OP) and pure salt cedar stands (SC 5). We documented a steady, substantial decrease in Hermit Thrush numbers in 2011 and 2012, but the numbers rebounded slightly in winter 2013.

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 a rare migrant or post-breeding wanderer to the middle Rio Grande bosque.

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 among 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. Cedar Waxwing was documented sporadically during summer during all years of this study except for 2005.

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-RO 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 the species was essentially absent from mechanically thinned C/S types (C-2 artificial and OP). A single bird wintered in the Corrales bosque during 2011. Our detections have steadily decreased since peaking in 2008, but in 2013 abundance rebounded to its highest level since 2010.

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. We found this species to be an uncommon to rare migrant during all years of the study except for 2006, 2008, 2009, 2011 and 2013, when numbers were particularly high. Northern Mockingbird was common in SC 5 stands at La Joya in 2006, 2010, 2011, and 2013, but generally uncommon during other years. We documented breeding during some years in SC 5 and BURN 1 C/S types. The species was less abundant in 2012 than any previous year since 2007. But, abundance was higher during 2013 than all previous years except for 2006, 2008, 2009 and 2011.

Virginia's Warbler (*Vermivora virginiae*) - New Mexico Partners in Flight (2008) listed this warbler at Species Conservation Level 1, and it has experienced significant population declines throughout much of its breeding range (Sauer et al. 2012). 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). We documented particularly low numbers of this warbler in 2010 and 2011. Although there was a slight rebound in 2012, abundance in 2013 was lower than all previous years except for 2010 and 2011.

Yellow Warbler (*Dendroica petechia*) - This warbler is a New Mexico Species of Greatest Conservation Need (BISON-M 2011). 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. We found this species to be a regular, but uncommon spring and fall migrant, primarily in densely vegetated C/S types. We have documented several summering individuals, but 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. This species was not recorded in 2008-2012, but we documented a single individual during June 2013.

Black-throated Gray Warbler (*Dendroica nigrescens*) - New Mexico Partners in Flight (2008) listed 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 the southwest (Sauer et al. 2012). Hink and Ohmart (1984) considered this warbler an uncommon, but regular migrant. We found this warbler to be a rare 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 have not documented 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, especially near water. We documented substantially lower numbers in 2010 and 2011 than earlier years of this study. But, a strong rebound occurred in 2012, when the species density was higher than all previous years of the study except 2009. Abundance dropped in 2013, but was still higher than in 2010 and 2011.

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-RO 5, RO 5 and C-RO/CW 3) during summer, and generally uncommon to rare in other densely vegetated areas. The species was very rare in mechanically thinned areas (OP, C-2 artificial). Due to the loss of suitable habitat, it seems likely that yellowthroat numbers throughout the middle Rio Grande are lower now than during the early 1980's. We recorded this species at lower densities in 2011 than any other year of our study, but densities were higher in 2013 than all years except for 2005 and 2007-2010.

Wilson's Warbler (*Wilsonia pusilla*) - New Mexico Partners in Flight (2008) listed this warbler at Biodiversity Conservation Level 2. Hink and Ohmart (1984) considered the species abundant in spring and fall migration. We found the species to be substantially more common as a fall migrant than a spring migrant. We have documented large fluctuations in this species as a migrant during the summer field season over the course of this study. Abundance of this warbler was relatively high in 2012, but was lower in 2013 than any previous year of this study.

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 stands of New Mexico olive (NMO 3, NMO 5), and uncommon to common in most other C/S types with significant understory vegetation. The species was rare in mechanically thinned areas (OP and C-2 artificial).

Lazuli Bunting (*Passerina amoena*) - New Mexico Partners in Flight (2008) listed 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 generally decreased over the course of the study. In early years, 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-RO 5) and Russian olive (RO 5). The species was rare or absent in other C/S types. But, our detections steadily declined every year from 2007-2010. Our detections increased slightly in 2011 and 2012, but dropped in 2013 to a level lower than all other years of the study except for 2010 and 2011. We now consider the species to be rare to very uncommon as a migrant and summer resident. We have documented occasional hybridization with Indigo Bunting (*Passerina cyanea*) in the middle Rio Grande bosque, where the breeding ranges of the two species overlap.

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-RO 5). Elsewhere, the species was rare or absent. Indigo Bunting numbers were particularly low in 2010 and 2011, but rebounded slightly in 2012 and 2013. Indigo Bunting has been more prevalent during the summer than the closely-related Lazuli Bunting in all years since 2009.

Painted Bunting (*Passerina ciris*) - New Mexico Partners in Flight (2008) listed 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 Waterfowl Management Area (GS 20). We did not record this species during 2010-2013.

Spotted Towhee (*Pipilo maculatus*) - This species is the best indicator in terms of the health of understory vegetation for resident birds in the middle Rio Grande bosque. 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. But, it was rare to very uncommon in C-2 artificial and open areas. Abundance has steadily decreased during winter since 2008 and during summer since 2009, although 2013 abundance was slightly higher than 2012 during both seasons. Ongoing drought conditions are likely having a negative impact on this species.

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 very rare. We have recorded only two individuals of the red-backed race and none from the white-winged race during this study. Since peaking in winter 2008, junco numbers have steadily decreased, with numbers in 2012 lower than all other years of this study; but, numbers rebounded in 2013 to their highest level since 2010.

Summer Tanager (*Piranga rubra*) - Hink and Ohmart (1984) found this species to be fairly common at Bernardo, but rare to uncommon north of the Bosque Bridge in southern Valencia County. The regular range of this tanager has clearly expanded north since the early 1980's, as we found the species to be an uncommon to fairly common summer resident in areas with mature cottonwoods throughout our study area. Abundance of this species has been relatively consistent during all years of our study. But, abundance during 2013 was lower than all other years of this study except for 2005.

Western Tanager (*Piranga ludoviciana*) - Hink and Ohmart (1984) found this species to be a common spring and fall migrant. Current numbers are likely lower than the early

1980's, as we found this tanager to be an uncommon to fairly common migrant. Although Western Tanager does not breed within our study area, we have documented individuals throughout the summer, with the species being more common during June and August. Detection rates for this species have varied throughout the course of our study; the species was more abundant in summer 2012 than all other years, but less abundant in 2013 than all other years except for 2008 and 2011.

Black-headed Grosbeak (*Pheucticus melanocephalus*) - Hink and Ohmart (1984) found this species to be one of the most numerous birds in the bosque during the breeding season and considered it a very abundant summer resident and migrant. We found this species to be a common summer resident and migrant, but numbers appear to be much lower now than in the early 1980's. In addition, we have documented a reduction in the abundance of this species since 2009, with a lower abundance in 2013 than all other years.

Blue Grosbeak (*Passerina caerulea*) - Hink and Ohmart (1984) considered this species to be a common summer resident and fairly common migrant. We found Blue Grosbeak to be a fairly common to common migrant and summer resident, although numbers have decreased in recent years. Summer abundance of this species in 2013 was lower than any other year of this study.

Cassin's Finch (*Carpodacus cassinii*) - Hink and Ohmart (1984) recorded single individuals in the bosque during fall and winter. There were regular reports of Cassin's Finch sightings at feeders, especially in Corrales, during winter 2008 (J. Finley, pers. comm.), but we 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. We documented a small flock of this species during a single visit to a BURN OP site in 2013.

DISCUSSION

Winter Avian Abundance and Species Richness

In winter 2013, avian density and richness were higher in RO 3 than any other entirely terrestrial C/S type. This was consistent with previous winters, as stands of Russian olive not shaded by a cottonwood canopy (RO 3 and RO 5) have supported the highest avian densities among entirely terrestrial C/S types during eight of the 10 winters of this study. The primary reason for the high densities in Russian olive stands is the presence of berries for foraging throughout the winter (see Fig. 3). 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). In fact, we have documented year-old berries being consumed by a variety of species through the following summer (T. Fetz, pers. obs.). In addition to the long-term viability of Russian olive berries, berry production is higher on plants with access to direct sunlight (Shafroth et al. 1995). Thus, stands of Russian olive with uninhibited access to direct sunlight produce larger, more consistent berry crops, which attract large numbers of wintering birds.

Historically, the value of Russian olive to wintering birds has been underappreciated by land managers. Species such as Mountain Bluebird (*Sialia currucoides*), Eastern Bluebird, Western Bluebird, 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 when the berry crop is particularly large. Other species common in Russian olive stands during winter include Northern Flicker (*Colaptes auratus*), Hermit Thrush, Yellow-rumped Warbler (*Dendroica coronata*), Spotted Towhee, White-crowned Sparrow (*Zonotrichia leucophrys*), Song Sparrow (*Melospiza melodia*), and Dark-eyed Junco. All of these species regularly consume berries. To date, we have recorded 45 bird species actively foraging on Russian olive berries (see Appendix 38), ranging in size from American Crow (*Corvus brachyrhynchos*) to Ruby-crowned Kinglet (*Regulus calendula*).

Winter avian density was substantially higher in 2013 than in 2012. In fact, winter density was higher in 2013 than 2012 at 18 of 19 C/S types surveyed during both years. Overall, avian density was higher during winter 2013 than cumulatively for winters 2004-2012 at 11 of 20 C/S types where data were recorded during both periods.

Although there are likely multiple factors that influenced the increase in avian use during winter 2013, the most obvious factor was a modest relaxation of drought conditions throughout the middle Rio Grande region and across New Mexico in general. Precipitation levels in the middle Rio Grande region (designated as New Mexico Climate Division 5 by NOAA) during the most recent water year leading up to the winter 2013 field season (September 2011-August 2012) were 5.9 cm below average, the 24th driest water year on record for the region (NOAA National Climatic Data Center 2014). But, this was a substantial improvement from the water year leading up the winter 2012 field season (September 2010-August 2011), when precipitation levels in the middle Rio Grande region were 13.8 cm below average, the driest water year on record. Similarly, the statewide precipitation levels for the 2011 water year leading up to the winter 2012 field season were 15.8 cm below average, also the driest water year on record. The statewide conditions improved during the 2012 water year leading up to the winter 2013 field season, with precipitation levels 7.5 cm below normal, the 23rd driest on record.

Resident bosque species are certain to have suffered more during the 2011 water year than 2012. And, because many of the species that winter in the bosque breed elsewhere in New Mexico (and beyond), the statewide improvement of drought conditions during the 2012 breeding season may be at least as important as local conditions in terms of wintering bosque bird numbers during the winter 2013 field season. Given that the 2011 water year was the driest on record both for the middle Rio Grande region and across New Mexico as a whole, breeding success statewide in 2011 was likely very low. Drought has been associated with reduced reproductive effort (Christman 2002) and success (Li and Brown 1999), as well as higher mortality (Mooij et al. 2002). Such impacts likely resulted in fewer wintering birds being present in the bosque during winter 2012. The statewide improvement in drought conditions during the 2012 water year likely resulted in improved (but less than ideal) breeding conditions and breeding success during summer 2012. This would have resulted in more birds being present in the bosque during winter 2013.

The relatively high avian density at RO 3 during winter 2013 was primarily due to substantial numbers of American Robin, Spotted Towhee, Mountain Bluebird, White-crowned Sparrow, and Yellow-rumped Warbler. Other species common during winter 2013 in RO 3 included Song Sparrow, Dark-eyed Junco, Northern Flicker, Red-winged Blackbird, Cedar Waxwing and Hermit Thrush. All of these species forage on Russian olive berries during winter. And, despite the ongoing drought conditions, RO 3 supported a strong berry crop during winter 2013, likely attracting large numbers of the above-mentioned species to this C/S type.

Aside from RO 3, drains bordered by dense vegetation (DR 5) and marsh habitat (MH 5-OW) also supported winter densities greater than 900 birds per 100 acres in 2013. The presence of standing water along with dense vegetation to provide both cover and forage explains the relatively high bird use of these C/S types. Dark-eyed Junco, Mallard (*Anas platyrhynchos*), Song Sparrow, White-crowned Sparrow, and American Wigeon (*Anas americana*) were the most common species in DR 5 during winter 2013, while

Red-winged Blackbird, American Coot (*Fulica americana*), Song Sparrow, White-crowned Sparrow, and Mallard were the most common in MH 5-OW. Similar to RO 3, although the winter 2013 avian densities in these two C/S types were substantially higher than winter 2012, they remained lower than cumulatively in 2004-2012.

Although the C/S types supporting the three highest avian densities during winter 2013 remained at lower densities than cumulatively during 2004-2012, densities were higher in 2013 than cumulatively in 2004-2012 at 11 of the other 17 C/S types surveyed during both periods. The extremely low number of birds present in the bosque during winter 2012 was one factor that negatively impacted the cumulative densities in these other C/S types. Overall, 22 of the 25 most common wintering species were present at lower than normal densities in 2012. A second factor was the greater coverage of some C/S types and the bosque in general due to the increased number of transects surveyed in 2013 relative to earlier years of the study. Due to lower initial funding levels, we surveyed fewer transects during the first winters of this project (e.g. 22 in 2004 and 42 in 2005 vs. 78 in 2013). Thus, some C/S types were either not surveyed or were under-represented during those years. In addition, a higher percentage of transects surveyed in the early years of this study, especially 2004 and 2005, were in C/S types that have historically supported lower avian use (e.g. C-2 artificial, OP, SC 5). And, decreases in thinning activity in recent years, as well as the gradual recovery of vegetation in areas mechanically thinned in 2004 and 2005 have led to improved vegetative conditions for birds.

These factors help explain why the numbers among common wintering bosque species were generally higher in 2013 than both 2012 and cumulatively in 2004-2012.

White-crowned Sparrow was the most common wintering species in 2013 and was present at a higher density in 2013 than any other year. Dark-eyed Junco, the most common wintering species in the bosque throughout this study, was present at a higher density in 2013 than either 2012 or 2011. But, junco density was still lower in 2013 than all years prior to 2011 except for 2004. Among the six most common wintering species (consistent across all years of this study), two others (American Robin, Spotted Towhee) were present at lower densities in 2013 than cumulatively in 2004-2012. Although American Robin was present at a lower density in 2013 than cumulatively, the 2013 density was actually higher than all other winters except for 2007 and 2010. Robins are somewhat irruptive in the bosque during winter depending on Russian olive and New Mexico olive berry crop size, and numbers in 2007 and 2010 were extremely high. Spotted Towhee density was lower in 2013 than all other winters except for 2004-2006 and 2012. Song Sparrow and American Crow were present at higher densities in 2013 than cumulatively. Song Sparrow density was higher in 2013 than 2004, 2005, 2011 and 2012, but lower than 2006-2010. American Crow density was higher in 2013 than all other winters except for 2006, 2008, 2011 and 2012.

Overall, 25 of the 30 most common wintering species were present at higher densities in 2013 than 2012. Only American Crow, American Coot, Black-capped Chickadee (*Poecile atricapillus*), Bewick’s Wren and Eastern Bluebird were present at lower densities in 2013 than 2012. Similarly, 22 of the 30 most common wintering species were more common in 2013 than cumulatively in 2004-2012. Only Dark-eyed Junco, American Robin, Spotted Towhee, Black-capped Chickadee, Yellow-rumped Warbler, Bewick’s Wren, Ruby-crowned Kinglet, and Eastern Bluebird were present at lower than normal densities in 2013. In order of abundance, White-crowned Sparrow, Song Sparrow, Mallard, House Finch (*Carpodacus mexicanus*), Red-winged Blackbird, Northern Flicker, American Goldfinch (*Spinus tristis*), White-breasted Nuthatch (*Sitta carolinensis*), European Starling (*Sturnus vulgaris*), Mourning Dove, Bushtit, White-winged Dove, Hermit Thrush, Pine Siskin (*Spinus pinus*), Downy Woodpecker (*Picoides pubescens*), Western Bluebird, Northern Shoveler (*Anas clypeata*), Canada Goose (*Branta canadensis*), Great-tailed Grackle (*Quiscalus mexicanus*), and Lesser Goldfinch (*Spinus psaltria*) were all present at higher densities during winter 2013 than either 2012 or cumulatively in 2004-2012.

Overall, drains bordered by dense vegetation (DR 5) supported the highest avian density during five of the 10 winters of this study and the highest richness levels during eight winters. Nearly all regularly recorded wintering songbirds were documented in these densely vegetated drains. The importance of dense waterside vegetation to wintering birds is illustrated by the differences in both avian density and richness between drains bordered by dense vegetation on at least one side (DR 5) and drains with sparse edge vegetation on both sides (DR 6). Although DR 6 supported a relatively high avian density during all winters, density was significantly lower than DR 5 during winter 2013 and both density and richness were significantly lower than DR 5 cumulatively during winter 2004-2012. 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, which provide less cover and reduced foraging opportunities relative to DR 5. The situation is even more extreme at DR 6 locations where both sides of the drain have been mechanically cleared. At these locations land birds were virtually absent due to the lack of any cover and common wintering ducks such as Mallard and American Wigeon comprised nearly all avian detections.

Mature cottonwood stands with a mechanically-thinned understory (C-2 artificial) supported among the lowest densities and lowest richness levels during all 10 winters of this study. The low bird numbers in mechanically-thinned stands can be attributed to the absence of woody 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 Black-capped Chickadee, and woodpeckers.

Summer Avian Abundance and Species Richness

During summer 2013, mature Russian olive (RO 3) supported the highest avian density and species richness among all C/S types. Marsh habitat incorporating open water (MH 5-OW) and NMO 5 were the only other C/S types in 2013 to support densities greater than 1000 birds/100 acres. Although summer avian density at RO 3 in 2013 was higher than cumulatively in 2004-2012, all 19 other C/S types surveyed during both periods supported lower avian densities in 2013 than in 2004-2012. After RO 3, C/MB 1 and CW-RO 5 supported the next highest avian richness levels in 2013. Similar to density, summer avian richness was lower in 2013 than cumulatively in 2004-2012 in 13 of 20 C/S types surveyed during both periods. On the positive side, the five C/S types supporting the highest summer avian richness in 2013 were at higher levels in 2013 than cumulatively in 2004-2012.

Drought can reduce abundance and species richness in avian communities (Albright et al. 2010a), with the negative impacts becoming increasingly pronounced during long-term drought (George et al. 1992, Bock and Bock 1999). Thus, the ongoing drought conditions were likely the biggest factor in lower than normal avian use throughout much of the bosque during summer 2013. Birds are most susceptible to drought conditions during the breeding and post-fledging seasons (i.e. March through August in the bosque) (Albright et al. 2010b). Precipitation levels in the middle Rio Grande region between March 2013 and August 2013 (the breeding and post-fledging period relevant to our 2013 survey season) were 1.7 cm below normal, representing the 45th driest year for that 6-month period on record (NOAA National Climatic Data Center 2014). This was a vast improvement from the same period during the previous two years, but still below normal and represented the third consecutive year of breeding season drought conditions. Precipitation levels in the middle Rio Grande region between March 2012 and August 2012 were 6.4 cm below average, the eighth driest for that 6-month time period on record and between March 2011 and August 2011 were 8.0 cm below average, the second driest for that 6-month time period on record.

Relatively low abundance was the norm for most species, regardless of guild, during summer 2013. Among the 30 most common summering species during the 10 years of this study, 26 were present at lower abundance levels in 2013 than cumulatively in 2004-2012. Similarly, 22 of the 30 most common species were present at lower abundances in 2013 than in 2012. Among the 30 most common species, only Yellow-breasted Chat, House Finch, Bushtit, and Western Wood-Pewee (*Contopus sordidulus*) were present at higher abundances in 2013 than cumulatively in 2004-2012. Similarly, only Spotted Towhee, Lesser Goldfinch, House Finch, Ash-throated Flycatcher (*Myiarchus cinerascens*), Brown-headed Cowbird (*Molothrus ater*), Common Yellowthroat, Gray Catbird, and Western Wood-Pewee were present at higher densities in summer 2013 than 2012.

The generally low numbers across most species and guilds during summer 2013 suggests that the ongoing drought conditions had a negative impact community-wide during the breeding season. This stands in contrast to winter 2013, when the vast majority of the most common species were present at higher abundances than previous years. Albright et al. (2010a) found that migrants, especially Neotropical migrants, demonstrate the strongest negative response to severe drought. While Neotropical migrants are, by definition, absent from the bosque during winter, they comprise 13 of the 30 most common species during summer. In addition, many of the wintering bosque birds breed in locations outside of New Mexico where drought conditions during 2011 and 2012 less severe than in New Mexico. For example, just within the southwest region (as defined by the National Climatic Data Center), breeding season precipitation was near normal in Colorado in 2011 and Arizona in 2012, and was higher than normal in Utah in 2011 (NOAA National Climatic Data Center 2014). Farther afield (e.g the west, northwest and northern Rockies regions), breeding season conditions were generally normal to wetter than normal in 2011 and 2012. Beyond drought, there may well be other undocumented factors that negatively impacted summer avian abundance in the bosque during 2013.

Despite supporting a significantly lower summer density in 2013 than cumulatively in 2004-2012, 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 10 summers of this study were major factors in the high density levels. This also was the only C/S type in which Pied-billed Grebe (*Podilymbus podiceps*) and American Coot were common during the summer and the only C/S type in which Snowy Egret, Virginia Rail (*Rallus limicola*), and Blue-winged Teal (*Anas discors*) were regularly documented. In addition, it was 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*), Sora (*Porzana Carolina*), and Lesser Yellowlegs (*Tringa flavipes*) were recorded.

Among terrestrial C/S types, those dominated by dense native vegetation (e.g. NMO 5, C/NMO 1, and C/CW 1) 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, and CW-RO 5) supported densities and richness levels during all ten summers that were comparable to or exceeded most predominantly native C/S types. During summer 2013, four of the six entirely terrestrial C/S types supporting the highest avian densities included Russian olive as a substantial component. RO 3 supported the highest density among all C/S types while RO 5 supported a higher density than all remaining terrestrial

C/S types except for NMO 5 and C/NMO 1. Cumulatively from 2004-2012, only terrestrial C/S types incorporating dense New Mexico olive (NMO 5, C/NMO 1) supported higher densities than the five dense C/S types incorporating substantial Russian olive.

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 have consistently noted high insect levels (specifically, but not limited to, mosquitoes) in areas with extensive Russian olive, especially RO 3, RO 5, C-RO/CW 3 and CW-RO 5. This may be due to their proximity to standing water or damp soil, as all of our RO 3, RO 5, C-RO/CW 3 and CW-RO 5 transects are either adjacent to the Rio Grande or in areas with a particularly high water table. 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 primarily reside in dense sub-canopy and/or understory vegetation and rely heavily on insects and other invertebrates for food are more common in C/S types with a substantial Russian olive component than most other C/S types. Bushtit, Bewick's Wren, Gray Catbird, Common Yellowthroat, Yellow-breasted Chat, and Spotted Towhee are all common to abundant in dense habitats incorporating substantial Russian olive 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). 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 volume is illustrated by the fact that the two terrestrial C/S types with the densest vegetation structure (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) and native coyote willow, Russian olive also provides a relatively dense structure that is likely desirable to breeding birds. Thus, Russian olive is especially important as a nesting and foraging substrate for understory and sub-canopy species in areas that lack a substantial component of native understory vegetation.

Comparison of Avian Abundance and Richness by Land Management Entity

Cumulatively during the 10 years of this study (2004-2013), both avian density and species richness during winter and summer have been higher at transects in Corrales than in areas managed by other entities. Summer avian density was significantly higher in Corrales than all other areas, while winter avian density and winter species richness were significantly higher than all but one other area. 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 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 surveyed were largely unaltered by thinning or restoration projects. But, despite the superficial similarity in management between these two areas during the course of our study, summer avian density and both winter and summer richness were cumulatively 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) occurred in Corrales. Because New Mexico olive attracted large numbers of birds year-round, these transects increased the mean avian numbers for the Corrales bosque. In contrast, all three of our salt cedar transects (SC 5) were 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 community structure showed decreased mean avian numbers at La Joya and limited 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 also can skew avian density and richness numbers. While we surveyed 19-24 transects each in Corrales, Albuquerque, and on Middle Rio Grande Conservancy District (MRGCD) lands, we had only seven transects at La Joya, five at the Pueblo of Sandia, and three in Rio Rancho. The smaller sample sizes in Rio Rancho, Sandia, and La Joya magnified the avian trends on specific transects 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 at La Joya, Rio Rancho, and Sandia and limited the 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 to wildlife. The resulting high avian use in Corrales is not coincidental.

In contrast, the City of Rio Rancho manages its Willow Creek bosque like a city park, with increased access for humans as the apparent goal. The establishment of wide, gravel paths (as well as smaller, dirt paths) throughout the area has resulted in increased human use. This directly resulted in increased disturbance to the avian community, especially understory birds, leading to subsequent decreases in bird numbers. In addition, there has been almost constant alteration of the vegetation in the Rio Rancho bosque over the past few years, especially the annual (or sometimes biannual) mowing of non-native, herbaceous vegetation. Mowing of herbaceous vegetation has been shown to reduce avian abundance and species richness (e.g. Blank et al. 2011), and the use of this management technique in the Willow Creek bosque has likely been an important factor in the reduced avian use we have documented there in recent years. 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 habitat value and force wildlife out. Although the area is small, the habitat potential for birds in the Rio Rancho bosque would be greater if the ecosystem there were provided time to recover.

The MRGCD has generally adopted a third, mosaic-type management strategy. Although extensive areas of the bosque managed by MRGCD were mechanically thinned, large patches of habitat were left unaltered. A concern about fuel loads, and thereby fire danger, appears to have been the driving force behind much of the MRGCD thinning. But, by leaving extensive patches of unaltered habitat, they have maintained important areas for birds and other wildlife. Many transects on MRGCD land were located in more remote areas with limited human use, and those that were not subjected thinning activities generally supported robust avian communities.

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 has been 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.

We initiated surveys at five transects on the Pueblo of Sandia in 2011, so the sample size for that area was quite small. All transects on the Pueblo were in areas of current or planned restoration efforts in conjunction with USACE. In addition, the June 2012 Romero Fire consumed nearly all vegetation within our survey area on two transects and on the north 630 m of a third transect. With three of the five transects we survey on the Pueblo having been altered by catastrophic fire, avian use has been heavily impacted and management strategy adjusted. Thus, additional years of data collection will be required before a clear assessment of avian use on the Pueblo can be made.

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 vegetation alteration has generally been limited and/or aimed at improving wildlife habitat, 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 and has been reduced in recent years, are generally somewhere in the middle and increasing.

Comparison of Avian Abundance and Richness Before and After Wetland Creation

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 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. The basins for the two ponds were constructed by October 2005, and the ponds held water by December 2005. But, avian use in winter 2006 remained low and the marsh habitat was not well established until June 2006.

Ultimately, the establishment of open water and marsh habitat by the USACE at this site (see Fig. 4) had a significant positive impact on avian use. Since 2007, this site has consistently supported among the highest avian densities and richness of any transects we surveyed during both summer and winter. The ponds and marsh provided habitat that remains sorely lacking throughout the middle Rio Grande. These areas have been heavily utilized by a variety of bird species over the past seven years. Although the avian density and richness at the site since the establishment of both open water and marsh habitat illustrates the overall value of the area to birds, it is especially important for relatively rare species that are dependent on these habitats. Among breeding birds, perhaps the biggest beneficiary has been Pied-billed Grebe. Because these grebes require slow-moving or stagnant water for nesting (Muller and Storer 1999), the areas throughout the middle Rio Grande where they can successfully breed are very limited. But, grebes have bred annually at the Tingley site for at least the past six years. Other relatively rare species that utilize the habitat created at Tingley include Virginia Rail and Sora. Because marsh habitat is limited to a few locations in the middle Rio Grande, both species are rarely encountered. But, we have documented both species during summer and winter at Tingley. We did not document breeding by either species at the site, but future breeding is certainly possible.

Winter bird use at Tingley was greatly enhanced by high waterfowl numbers. The middle Rio Grande, in general, supports large numbers of wintering waterfowl, but the diversity of these species is limited in most areas. And, many of the areas where some of the less common species occur are subject to hunting. But, since 2007, the ponds at Tingley have become a haven for many of these less common species. Green-winged

Teal (*Anas crecca*), Wood Duck (*Aix sponsa*), Cackling Goose (*Branta hutchinsii*), Northern Pintail (*Anas acuta*), Common Goldeneye (*Bucephala clangula*), Ruddy Duck (*Oxyura jamaicensis*), and Gadwall and were among the less-common waterfowl encountered at the site during winter 2013, while species such as Mallard, Northern Shoveler, Canada Goose (*Branta canadensis*), Ring-necked Duck (*Aythya collaris*), Canvasback (*Aythya valisineria*), Lesser Scaup (*Aythya affinis*), Common Merganser (*Mergus merganser*), American Wigeon, and Redhead (*Aythya americana*) were common. The ponds provided these birds with viable wintering habitat that is safe from the pressures of hunting. In addition, Marsh Wren (*Cistothorus palustris*), another species limited by suitable habitat throughout the middle Rio Grande, was common in the marsh and Swamp Sparrow (*Melospiza georgiana*) was recorded several times during winter 2013.

Comparison of Avian Abundance and Richness at Current USACE Restoration Sites

In 2011 and 2012, we established 15 new transects in areas where USACE planned to conduct extensive habitat restoration as part of their Middle Rio Grande Ecosystem Restoration Project. The purpose of these transects was to document both pre- and post-restoration avian use. These restoration areas include the establishment of swales (see Fig. 5) and bank terracing along the river bank and in low-lying areas that are likely to be inundated during years of normal spring run-off, and the planting of native vegetation in more upland areas. Although the ground disturbance in these project areas has been substantial, especially in the low-lying project areas, the retention of beneficial non-native vegetation (primarily Russian olive) has been incorporated, where feasible.

Re-vegetation activities at these USACE sites have involved a mosaic of native species. Avian species richness and abundance have been shown to increase with increased floristic diversity (Strong and Bock 1990, Powell and Steidl 2000). Thus, assuming the plantings are successful and continue to grow, this work should ultimately enhance avian use of these areas by providing habitat for a greater diversity and density of avian life. Coyote willow has been the primary plant reintroduced in the swale and bank terracing areas. But, coyote willow unto itself provides limited value to birds in terms of forage and cover, especially during winter. Thus, it has been extensively supplemented with several other species, most notably Gooddings willow, cottonwood, and desert false indigo (*Amorpha fruticosa*). In upland areas, the most common plants being established include New Mexico olive, baccharis (*Baccharis* sp.), silver buffaloberry, golden currant (*Ribes aureum*), and 3-leaf sumac (*Rhus trilobata*). Additionally, this project has included two years of manual watering for newly planted vegetation, thereby substantially improving the likelihood of successful establishment of newly planted vegetation.

The bird data we have collected at these sites through summer 2013 is preliminary and the new vegetation is still establishing itself. Thus, bird use has generally remained modest in most areas and it is not yet possible to determine the ultimate impact on the avian community. Additionally, through 2013, restoration work had only been initiated at 11 of the 15 new transects. But, winter bird use has already increased in some of the areas where swales and bank terracing occurred, including NW30 (Area 1G), SE34 (Area 4B), and SW39 (Area 5D). We expect avian use to increase in other areas during the coming years and we are optimistic that this restoration work will ultimately benefit the avian community.

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. But, the goals and applications of thinning/restoration projects in the bosque still vary widely among land management entities. We urge all bosque land managers to execute any work in the bosque with a mind towards accomplishing their goals while also showing sensitivity to the bosque ecosystem and acknowledging the value of certain non-native vegetation. To that end, we recommend that management activities focus on actual restoration (i.e. the planting of native vegetation in treated areas), as opposed to simply conducting thinning operations to reduce fuel loads. Our data indicate that fuel reduction without a true restoration component (e.g. C-2 artificial and OP sites) has a significant negative impact on the avian community. In contrast, projects that include the retention of at least some non-native vegetation that is beneficial to avifauna (e.g. Russian olive) and incorporate the planting of native vegetation can maintain or benefit the avian community. We believe that well-planned projects can simultaneously reduce the risk of fire in the bosque while also benefitting the avian community and bosque ecosystem as a whole.

Work currently being undertaken by USACE with the Middle Rio Grande Ecosystem Restoration Project provides perhaps the best example of accomplishing project goals while showing sensitivity to the bosque ecosystem, re-establishing native vegetation and acknowledging the value of certain non-native vegetation. Although the scale of the ongoing USACE restoration projects is likely beyond the scope of projects under consideration by other land managers both in terms of size and financial commitment, we believe they provide a blueprint that can be adapted by other land managers that seek to reduce fire danger (or other goals) while also maintaining or enhancing the bosque ecosystem.

First, we recommend that healthy, berry-producing Russian olive plants be retained for the benefit of wildlife. We also 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. Russian olive produces larger berry crops when provided with direct sunlight (Shafroth et al. 1995), and avian use of these areas is particularly robust, especially during the winter when many species forage on the berries. Second, we recommend the planting of a mosaic of native species following thinning operations. If no re-vegetation efforts are undertaken, non-native vegetation will simply re-grow where it was removed. In some areas where 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-beneficial, exotic 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 expensive. In addition to planting native vegetation, the conscientious treatment of non-native stumps and cuttings to prevent regrowth is an important step to slow and minimize the re-establishment of unwanted non-natives.

We have several additional recommendations that will benefit bosque avifauna and also help ensure compliance with current regulations. 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 projects involving vegetation alteration 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 to 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. We also have observed that the quality of work and attention to detail varies widely among contractors. Thus, it falls on the land managers to assure work is conducted to meet the specifications of the project.

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. Heavy equipment disturbs the soil, thereby favoring the germination of annual weeds such as kochia (*Kochia scoparia*) and Russian thistle (*Salsola tragus*) 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. Additionally, by taking a proactive and diligent approach to spraying 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 or spreading through an area. Several bosque fires over the past few years have either started in previously thinned areas or burned through thinned areas after starting elsewhere. For example, the 2012 Romero Fire started in an area of relatively dense vegetation in Corrales. The fire was quickly controlled in Corrales, but jumped the river to the Pueblo of Sandia and raced through a bosque landscape that has recently been thinned. Despite thinning, nearly all of the vegetation in the path of the fire was consumed.

Given that all bosque fires in the middle Rio Grande since at least 2003 have been human caused (USACE 2007, Hawks Aloft unpublished data), we believe the decisions by most land managers over the past few years to close the bosque to public access during times of extreme fire danger is beneficial. These closures minimize the likelihood of human-caused fires during times when the bosque is most susceptible and are more effective at preventing fires (and less detrimental to the ecosystem) than thinning operations.

Data for the first ten 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 shaded by a cottonwood canopy to wintering birds; and 3) the reduced avian use of areas recently subjected to the mechanical removal of non-native vegetation. But, the ongoing drought conditions in New Mexico have complicated issues in the bosque and it is not yet clear how much and for how long the drought will impact individual species, the avian community, or the bosque ecosystem as a whole. In addition, the impacts and effectiveness of ongoing 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.

ACKNOWLEDGMENTS

The U.S. Army Corps of Engineers and Hawks Aloft, Inc. funded this study in 2013. HAI staff that participated in this study during 2013 included Trevor Fetz, Gail Garber, Erin Greenlee, Michael Hilchey, Jason Kitting, Kieran Sullivan, and Raymond VanBuskirk. This report was written by Trevor Fetz and reviewed by Gail Garber. The cover photo was taken by Doug Brown. All other photos were taken by Trevor Fetz. All maps were created by Mike Hill.

We extend our sincere thanks to Ondrea Hummel, U.S. Army Corps of Engineers, for her technical expertise and 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, Pueblo of Sandia, the Village of Corrales Administration, Corrales Mayor Phil Gasteyer, Lara Aho, Jay Hart, Anthony Martinez, Yasmeen Najmi, Matt Schmader, and Michael Scialdone.

LITERATURE CITED

Albright, T.P., A.M. Pidgeon, C.D. Rittenhouse, M.K. Clayton, C.H. Flather, P.D. Culbert, B.D. Wardlow, and V.C. Radeloff. 2010a. Effects of drought on avian community structure. Global Change Biology 16:2158–2170.

Albright, T.P., A.M. Pidgeon, C.D. Rittenhouse, M.K. Clayton, B.D. Wardlow, C.H. Flather, P.D. Culbert, and V.C. Radeloff. 2010b. Combined effects of heat waves and droughts on avian communities across the conterminous United States. Ecosphere 1:1-22.

Anderson, B.W., R.W. Engel-Wilson, D. Wells, and R.D. Ohmart. 1977a. Ecological study of southwest riparian habitats: Techniques and data applicability. Pp. 146-155 *in* Importance, Preservation, and Management of Riparian Habitat. USDA Forest Service General Technical Report RM-43, Fort Collins, Colorado.

Anderson, B.W., A. Higgins, and R.D. Ohmart. 1977b. Avian use of salt cedar communities in the Lower Colorado River Valley. Pp. 128-136 *in* Importance, Preservation, and Management of Riparian Habitat. USDA Forest Service General Technical Report RM-43, Fort Collins, Colorado.

Balph, M.H., L.C. Stoddard, and D.F. Balph. 1977. A simple technique for analyzing bird transect counts. Auk 94:606-607.

[BISON-M] Biota Information System of New Mexico. 2011. BISON-M home page. http://www.bison-m.org. Accessed 10 June 2013.

Blank, P.J., J.R. Parks, and G.P. Dively. 2011. Wintering bird response to fall mowing of herbaceous buffers. The Wilson Journal of Ornithology 123:59-64.

Bock, C.E., and J.H. Bock. 1999. Response of winter birds to drought and short duration grazing in southeastern Arizona. Conservation Biology 13:1117-1123.

Borell, A.E. 1971. Russian olive for wildlife and other conservation uses. Leaflet 292. Washington DC: United States Department of Agriculture. 8 p.

Brown, C.R. 1990. Avian use of native and exotic riparian habitats on the Snake River, Idaho: M.Sc. thesis, Colorado State Univ., Fort Collins, Colorado.

Chesser, R.T., et al. 2010. Fifty-first supplement to the American Ornithologists' Union check-list of North American birds. Auk 127:726-744.

Christman, B.J. 2002. Extreme between-year variation in productivity of a bridled titmouse (*Baeolophus wollweberi*) population. Auk 119:1149-1154.

Emlen, J.T. 1971. Population densities derived from transect counts. Auk 88:323-342.

George, T.L. 2000. Varied Thrush (*Ixoreus naevius*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/541

George, T.L., A.C. Fowler, R.L. Knight, and L.C. McEwen. 1992. Impacts of a severe drought on grassland birds in western North Dakota. Ecological Applications 2:275-284.

Gutzwiller, K.J. and S.H. Anderson. 1987. Multiscale associations between cavity-nesting birds and features of Wyoming streamside woodlands. Condor 89:534-548.

Hink, V.C., and R.D. Ohmart. 1984. Middle Rio Grande biological survey. Final report under Contract No. DACW47- 81-C-0015 with the U.S. Army Corps of Engineers, Albuquerque District. Center for Environmental Studies, Arizona State University, Tempe. 193 pp. + appendices.

Howe, W.H., and F.L. Knopf. 1991. On the imminent decline of Rio Grande cottonwoods in central New Mexico. The Southwestern Naturalist 36: 218-224.

Hunter, W.C, R.D. Ohmart, and B.W. Anderson. 1988. Use of exotic salt cedar (*Tamarix chinensis*) by birds in arid riparian systems. Condor 90:113-123.

Janzen, D.H. and T.W. Schoener. 1968. Differences in insect abundance and diversity between wetter and drier sites during a tropical dry season. Ecology 49:96-110.

Knopf, F.L., and T.E. Olson. 1984. Naturalization of Russian-olive: implications to Rocky Mountain wildlife. Wildlife Society Bulletin 12:289-298.

Li, S.H., and J.L. Brown. 1999. Influence of climate on reproductive success in Mexican Jays. Auk 116:924–936.

Mills, G.S., J.B. Dunning, and J.M. Bates. 1991. The relationship between breeding bird density and vegetation volume. Wilson Bulletin 103:468-479.

Mooij, W.M., R. . Bennetts, W.M. Kitchens, and D.L. DeAngelis. 2002. Exploring the effect of drought extent and interval on the Florida snail kite: interplay between spatial and temporal scales. Ecological Modelling 149:25-39.

Muller, M.J. and R.W. Storer. 1999. Pied-billed Grebe (*Podilymbus podiceps*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/410

New Mexico Partners in Flight. 2008. Website: http://www.nmpartnersinflight.org.

Olson, D.F., Jr. 1974. Elaeagnus *L. elaeagnus*. In: Schopmeyer, C.S., technical coordinator. Seeds of woody plants in the United States. Agric. Handb. 450. Washington, D.C: U.S. Department of Agriculture, Forest Service: 376-479.

Parmeter, J., B. Neville, and D. Emkalns. 2002. New Mexico Bird Finding Guide. New Mexico Ornithological Society, Albuquerque, NM.

Poff, L.N., J.D. Allan, M.B. Bain, J.R. Karr, K.L. Prestegaard, B.D. Richter, R.E. Sparks, and J.C. Stromberg. 1997. The Natural Flow Regime: A paradigm for river conservation and restoration. Bioscience 47:769-784.

Powell, B.F. and R.J. Steidl. 2000. Nesting habitat and reproductive success of southwestern riparian birds. Condor 102:823-831.

Pulliam, H.R. and M.R. Brand. 1975. The production and utilization of seeds in plains grassland of southeastern Arizona. Ecology 56:1158-1166.

Rice, J., B.W. Anderson, and R.D. Ohmart. 1984. Comparison of the importance of different habitat attributes to avian community organization. Journal of Wildlife Management 48:895-911.

Rumble, M.A. and J.E. Gobeille. 2004. Avian Use of Successional Cottonwood (*Populus deltoides*) Woodlands along the Middle Missouri River. American Midland Naturalist 152:165-177.

SAS Institute. 2002. JMP user's guide. 5th ed. SAS Institute, Cary, N.C.

Sauer, J.R., J.E. Hines, J.E. Fallon, K.L. Pardieck, D.J. Ziolkowski, Jr., and W.A. Link. 2012. The North American Breeding Bird Survey, Results and Analysis 1966 - 2011. Version 07.03.2013 USGS Patuxent Wildlife Research Center, Laurel, MD.

Shafroth, P.B., Auble, G.T., and M.L. Scott. 1995. Germination and establishment of the native plains cottonwood (*Populus deltoides* subsp. *monilifera*) and the exotic Russian-olive *(Elaeagnus angustifolia* L.). Conservation Biology 9:1169-1175.

Shafroth, P.B., Brown, C.A., and Merritt, D.M., eds., 2010, Saltcedar and Russian olive control demonstration act science assessment: U.S. Geological Survey Scientific Investigations Report 2009–5247, 143 p.

Sogge, M.K., D. Ahlers, and S.J. Sferra. 2010. A natural history summary and survey protocol for the Southwestern Willow Flycatcher. U.S. Geological Survey Methods and Techniques 2A-10, 38p.

Smith, D.M., D.M. Finch, and D.L. Hawksworth. 2009. Black-chinned Hummingbird nest site selection and nest survival in response to fuel reduction in a southwestern riparian forest. Condor 111:641-652.

Stoleson, S.H. and D.M. Finch. 2001. Breeding bird use of and nesting success in exotic Russian olive in New Mexico. Wilson Bulletin 113:452-455.

Strong, T.R. and C.E. Bock. 1990. Bird species distribution patterns in riparian habitats in southeastern Arizona. Condor 92:866-885.

United States Army Corps of Engineers. 2004. Environmental assessment for the bosque wildfire project, Bernalillo and Sandoval counties, New Mexico. Albuquerque, New Mexico.

United States Army Corps of Engineers. 2007. Bosque Wildfire Meeting, Albuquerque, NM, March 21, 2007.

United States Army Corps of Engineers. 2014. Middle Rio Grande Ecosystem Recreation Project, New Mexico. Online: http://www.spa.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/2135/Article/479099/middle-rio-grande-ecosystem-restoration-project-new-mexico.aspx

United States Fish and Wildlife Service. 2002. Southwestern Willow Flycatcher Recovery Plan. Albuquerque, New Mexico. I-IX + 210 pp., Appendices A-O.

Verner, J. and L.V. Ritter. 1988. A comparison of transects and spot mapping in oak-pine woodlands of California. Condor, 90:401-419.

Zavaleta, E.S., R.J. Hobbs, and H.A. Mooney. 2001. Viewing invasive species removal in a whole-ecosystem context. Trends in Ecology and Evolution 16:454-459.

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 deltoides*
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:

Abbreviation	Explanation
BURN	burned habitat
DR	drain
MH	marsh habitat
OP	open terrestrial habitat
OW	open water

Table 2. Key to community and structure (C/S) type abbreviations used in text, tables, figures, and appendices.

Abbreviation	Habitat Description
BURN 1	≥ 90% burned vegetation in area previously supporting mature cottonwood overstory w/ dense understory vegetation
BURN 2	≥ 90% burned vegetation in area previously supporting mature cottonwood overstory w/ post-fire conditions resulting in a Type 2 stand structure
BURN OP	≥ 90% burned vegetation in area w/ post-fire restoration resulting in an OP structure
C/CW 1	mature cottonwood overstory w/ dense coyote willow dominated understory
C/CW-MB 1	mature cottonwood overstory w/ dense coyote willow & mulberry dominated understory
C/MB 1	mature cottonwood overstory w/ dense mulberry dominated understory
C/MB-SC 1	mature cottonwood overstory w/ dense mulberry & salt cedar dominated understory
C/MB-SE 1	mature cottonwood overstory w/ dense mulberry & Siberian elm dominated understory
C/NMO 1	mature cottonwood overstory w/ dense New Mexico olive dominated understory
C/NMO-RO 1	mature cottonwood overstory w/ dense New Mexico olive & Russian olive dominated understory
C/RO 1	mature cottonwood overstory w/ dense Russian olive dominated understory
C/RO-SC 1	mature cottonwood overstory w/ dense Russian olive & salt cedar dominated understory
C-2 natural	mature cottonwood overstory w/ naturally sparse understory vegetation
C-2 artificial	mature cottonwood overstory w/ mechanically cleared understory
C/CW-NMO 2	mature cottonwood overstory w/ sparse coyote willow & New Mexico olive understory
C/CW-RO 2	mature cottonwood overstory w/ sparse coyote willow & Russian olive understory
C/NMO 2	mature cottonwood overstory w/ sparse New Mexico olive understory
C/RO 2	mature cottonwood overstory w/ sparse Russian olive understory
C/RO-CW 2	mature cottonwood overstory w/ sparse Russian olive & coyote willow understory
C/SE 2	mature cottonwood overstory w/ sparse Siberian elm understory
C/TW 2	mature cottonwood overstory w/ sparse tree willow understory
C-4	20-30 ft. tall cottonwood overstory w/ sparse understory
C-RO/CW 3	20-30 ft. tall cottonwood & Russian olive overstory w/ dense coyote willow dominated understory
CW-RO 5	coyote willow w/ smaller component of Russian olive >5 ft. tall
CW-RO-C 5	coyote willow w/ smaller components of Russian olive & cottonwood >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 & Russian olive dominated vegetation >5 ft. tall
NMO-SB 5	New Mexico olive & silver buffaloberry dominated vegetation >5 ft. tall
OP	mechanically-thinned terrestrial open area w/ minimal woody vegetation
RO 3	20-30 ft. tall Russian olive dominated vegetation
RO 5	5-20 ft. tall Russian olive dominated vegetation
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
RO 6	relatively sparse Russian olive dominated vegetation <5 ft. tall
SC 5	salt cedar dominated vegetation >5 ft. tall

Table 3. Comparison of winter avian abundance by C/S type for 2013 and 2004-2012 cumulatively. C/S types with N/A were not surveyed in 2013.

C/S Type	# Birds/100 Acres (2013)	# Birds/100 Acres (2004-2012)
RO 3	1527	1660
DR 5	1058	1151
MH 5-OW	914	1076
RO 5	735	681
C/NMO 1	671	749
DR 6	648	584
C/MB 1	614	218
BURN OP	605	425
CW 6	463	271
CW-RO 5	417	392
BURN 2	405	643
C-2 natural	359	313
NMO 5	352	637
C/RO 1	348	328
C-RO/CW 3	335	384
C-4	306	161
SC 5	165	112
C-2 artificial	131	90
C/CW 1	127	203
OP	110	245
BURN 1	N/A	987
RO 6	N/A	217

Table 4. Comparison of winter species richness by C/S type for 2013 and 2004-2012 cumulatively. Species richness is based on the number of species per transect at densities $\geq$ 1.5 birds per 100 acres within 30 m of the transect line. C/S types with N/A were not surveyed 2013.

C/S Type	# Species/Transect (2013)	# Species/Transect (2004-2012)
MH 5-OW	20.3	14.3
RO 3	20.0	15.0
DR 5	18.4	19.2
C/NMO 1	17.8	17.7
C/RO 1	16.7	11.4
C/MB 1	15.0	12.8
C-4	14.0	5.0
C-2 natural	13.6	12.1
DR 6	13.6	10.2
RO 5	13.4	13.9
BURN 2	13.3	10.0
C-RO/CW 3	12.5	13.4
CW-RO 5	12.0	12.4
NMO 5	11.0	15.9
C/CW 1	10.5	13.6
CW 6	10.4	8.0
BURN OP	10.0	10.3
C-2 artificial	9.4	6.1
SC 5	7.3	4.3
OP	3.5	6.9
BURN 1	N/A	16.3
RO 6	N/A	10.0

Table 5. Comparison of summer avian abundance by C/S type for 2013 and 2004-2012 cumulatively. C/S types with N/A were not surveyed in 2013.

C/S Type	# Birds/100 Acres (2013)	# Birds/100 Acres (2004-2012)
RO 3	1145	914
MH 5-OW	1063	1500
NMO 5	1005	1196
C/NMO 1	830	995
RO 5	803	829
C-RO/CW 3	669	817
CW-RO 5	650	818
DR 5	486	674
CW 6	399	633
C/CW 1	387	701
C/RO 1	351	752
C-2 natural	345	608
BURN 2	316	501
DR 6	312	434
C/MB 1	292	698
C-4	291	441
BURN OP	220	373
C-2 artificial	200	347
SC 5	171	206
OP	124	234
BURN 1	N/A	1165
RO 6	N/A	350

Table 6. Comparison of summer species richness by C/S type for 2013 and 2004-2012 cumulatively. Species richness is based on the number of species per transect at densities $\geq$ 1.5 birds per 100 acres within 30 m of the transect line. C/S types with N/A were not surveyed during 2013.

C/S Type	# Species/Transect (2013)	# Species/Transect (2004-2012)
RO 3	32.0	21.5
C/MB 1	27.0	25.6
CW-RO 5	26.7	25.8
BURN OP	24.0	19.4
MH 5-OW	23.3	22.6
C/CW 1	23.0	25.6
C-RO/CW 3	22.5	22.2
C/NMO 1	21.6	23.0
NMO 5	21.5	24.8
C/RO 1	18.8	23.1
RO 5	18.6	20.2
C-2 natural	18.6	20.0
DR 5	18.2	19.1
C-4	18.0	17.0
CW 6	15.6	18.3
SC 5	14.0	12.1
BURN 2	14.0	16.7
C-2 artificial	11.3	12.5
DR 6	10.6	12.3
OP	5.5	10.3
BURN 1	N/A	27.7
RO 6	N/A	17.7

Table 7. Comparison of cumulative winter avian densities by land management entity, 2004-2013. Comparisons were made using a Tukey-Kramer test. Areas not connected by the same letter are significantly different.

Land Manager	# Transects					# Birds/100 Acres
Corrales	19	A				688
NMGF	7	A				601
MRGCD	20		B			499
Albuquerque	24			C		411
Pueblo of Sandia	5		B	C	D	403
Rio Rancho	3				D	229

Table 8. Comparison of cumulative winter avian species richness by land management entity, 2004-2013. Species richness is based on the number of species per transect at densities $\geq$ 1.5 birds per 100 acres within 30 m of the transect line. Comparisons were made using a Tukey-Kramer test. Areas not connected by the same letter are significantly different.

Land Manager	# Transects				# Species/Transect
Corrales	19	A			15.5
MRGCD	20		B		12.8
Pueblo of Sandia	5	A	B	C	12.7
Albuquerque	24			C	10.9
NMGF	7			C	10.1
Rio Rancho	3			C	9.0

Table 9. Comparison of cumulative summer avian densities by land management entity, 2004-2013. Comparisons were made using a Tukey-Kramer test. Areas not connected by the same letter are significantly different.

Land Manager	# Transects				# Birds/100 Acres
Corrales	19	A			771
MRGCD	20		B		627
Albuquerque	24		B		625
NMGF	7			C	481
Rio Rancho	3			C	463
Pueblo of Sandia	5			C	460

Table 10. Comparison of cumulative summer avian species richness by land management entity, 2004-2013. Species richness is based on the number of species per transect at densities $\geq$ 1.5 birds per 100 acres within 30 m of the transect line. Comparisons were made using a Tukey-Kramer test. Areas not connected by the same letter are significantly different.

Land Manager	# Transects			# Species/Transect
Corrales	19	A		20.9
MRGCD	20	A		20.2
Albuquerque	24	A		18.8
Pueblo of Sandia	5	A	B	18.7
Rio Rancho	3	A	B	17.3
NMGF	7		B	14.7

Table 11. Comparison of summer avian density and species richness by year at SE31.

C/S Type	Year	# Birds/100 Acres	# Species/Transect
OW/MH/C-2 mix	2013	854	37
OW/MH/C-2 mix	2012	899	43
OW/MH/C-2 mix	2011	946	34
OW/MH/C-2 mix	2010	1062	30
OW/MH/C-2 mix	2009	1010	43
OW/MH/C-2 mix	2008	899	38
OW/MH/C-2 mix	2007	907	36
OW/MH/C-2 mix	2006	924	32
C-2 artificial/OP mix	2005	442	20
C/MB 1	2004	515	20

Table 12. Comparison of winter avian density and species richness by year at SE31.

C/S Type	Year	# Birds/100 Acres	# Species/Transect
OW/MH/C-2 mix	2013	1729	43
OW/MH/C-2 mix	2012	1720	33
OW/MH/C-2 mix	2011	1705	31
OW/MH/C-2 mix	2010	1587	24
OW/MH/C-2 mix	2009	2055	25
OW/MH/C-2 mix	2008	1244	21
OW/MH/C-2 mix	2007	526	23
OW/C-2 artificial mix	2006	191	9
C-2 artificial/OP mix	2005	56	5

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

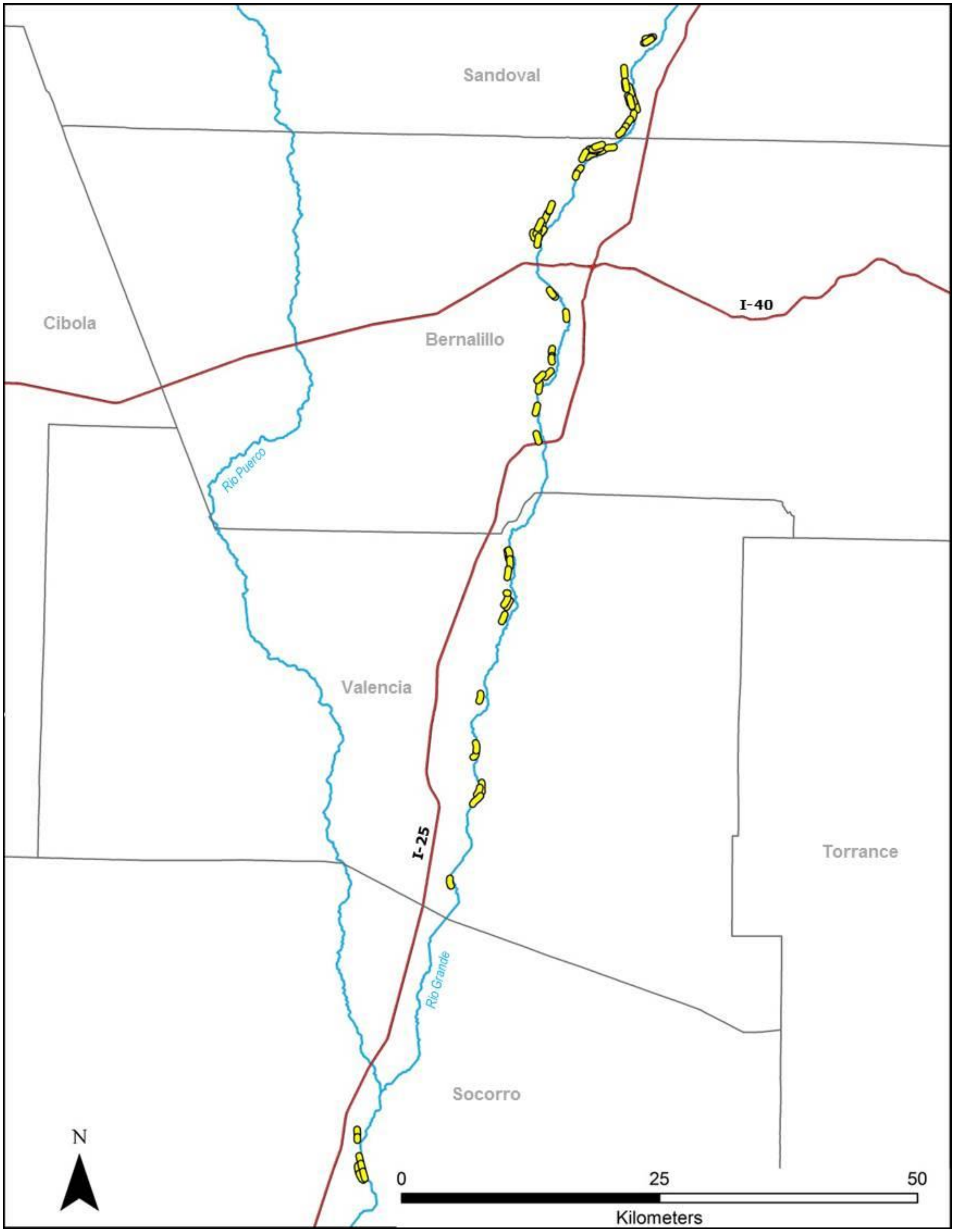
Figure 2. The June 2012 Romero Fire consumed three transects at the Pueblo of Sandia. Shown here is the south end of NE16 in July 2011 (top) and August 2013 (bottom).

Figure 3. Russian olive is an important food source for many wintering and migrating birds, including Yellow-rumped Warbler (top) and Cedar Waxwing (bottom).

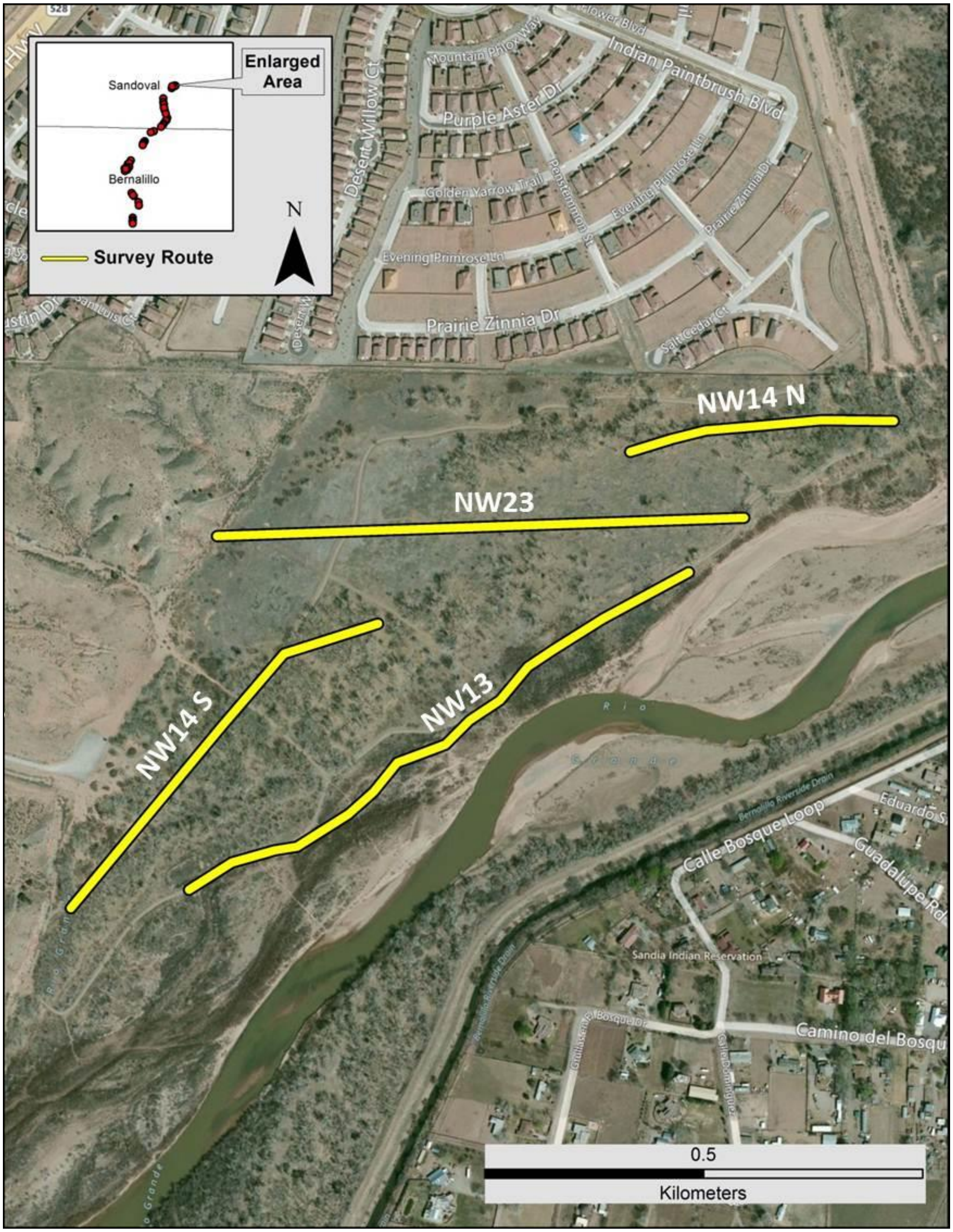
Figure 4. The establishment of ponds and a marsh at SE31 created valuable wildlife habitat.

Figure 5. Swale creation has enhanced wildlife habitat. Pictured is SE37 in December 2011 before construction (top) and the same location in August 2013, 18 months after construction (bottom).

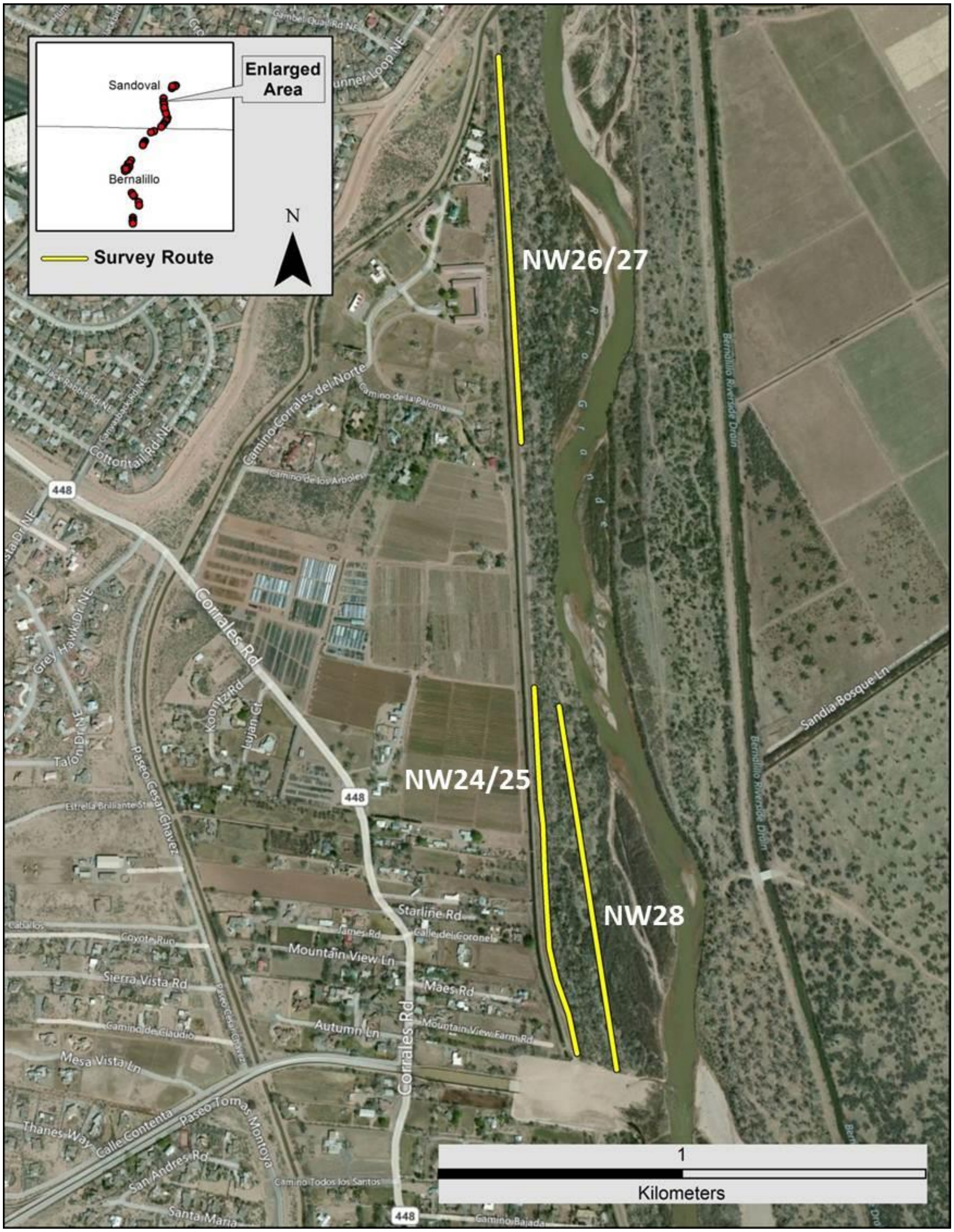
Appendix 1. Map of the Middle Rio Grande songbird study area. Yellow dots represent transect locations from Rio Rancho to La Joya State Game Refuge, New Mexico.



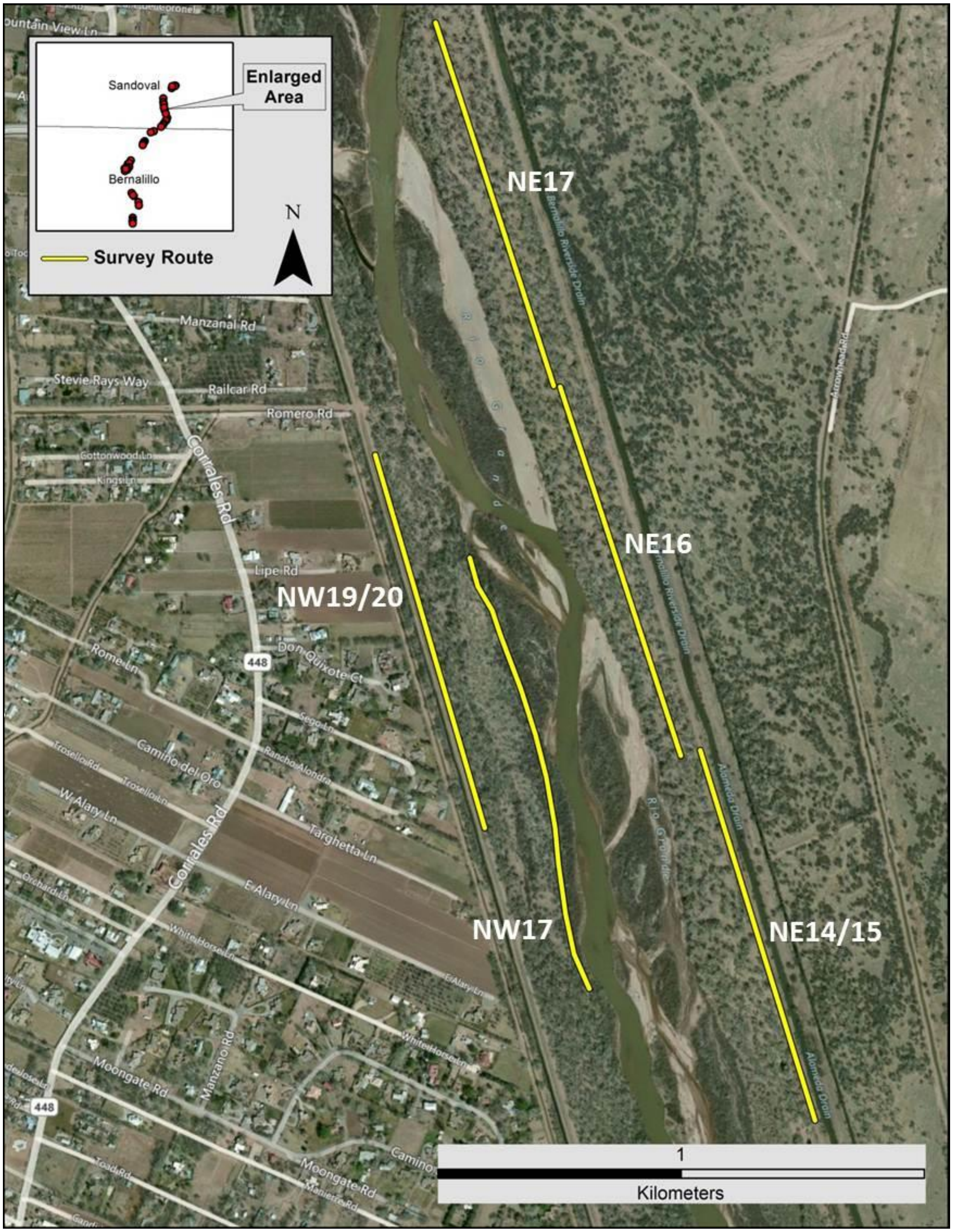
Appendix 2. Locations of transects in Rio Rancho, New Mexico.



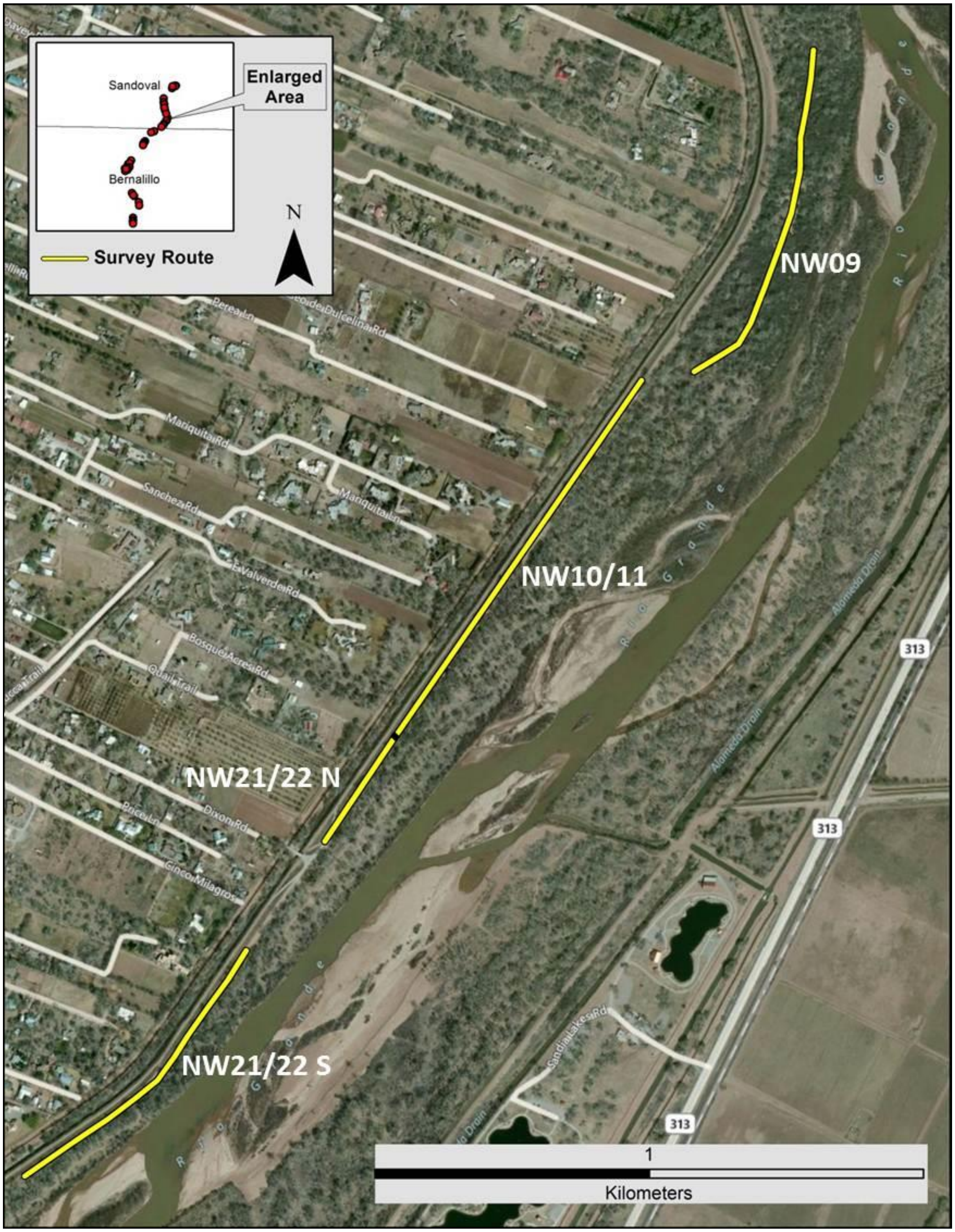
Appendix 3. Locations of transects in north Corrales, New Mexico.



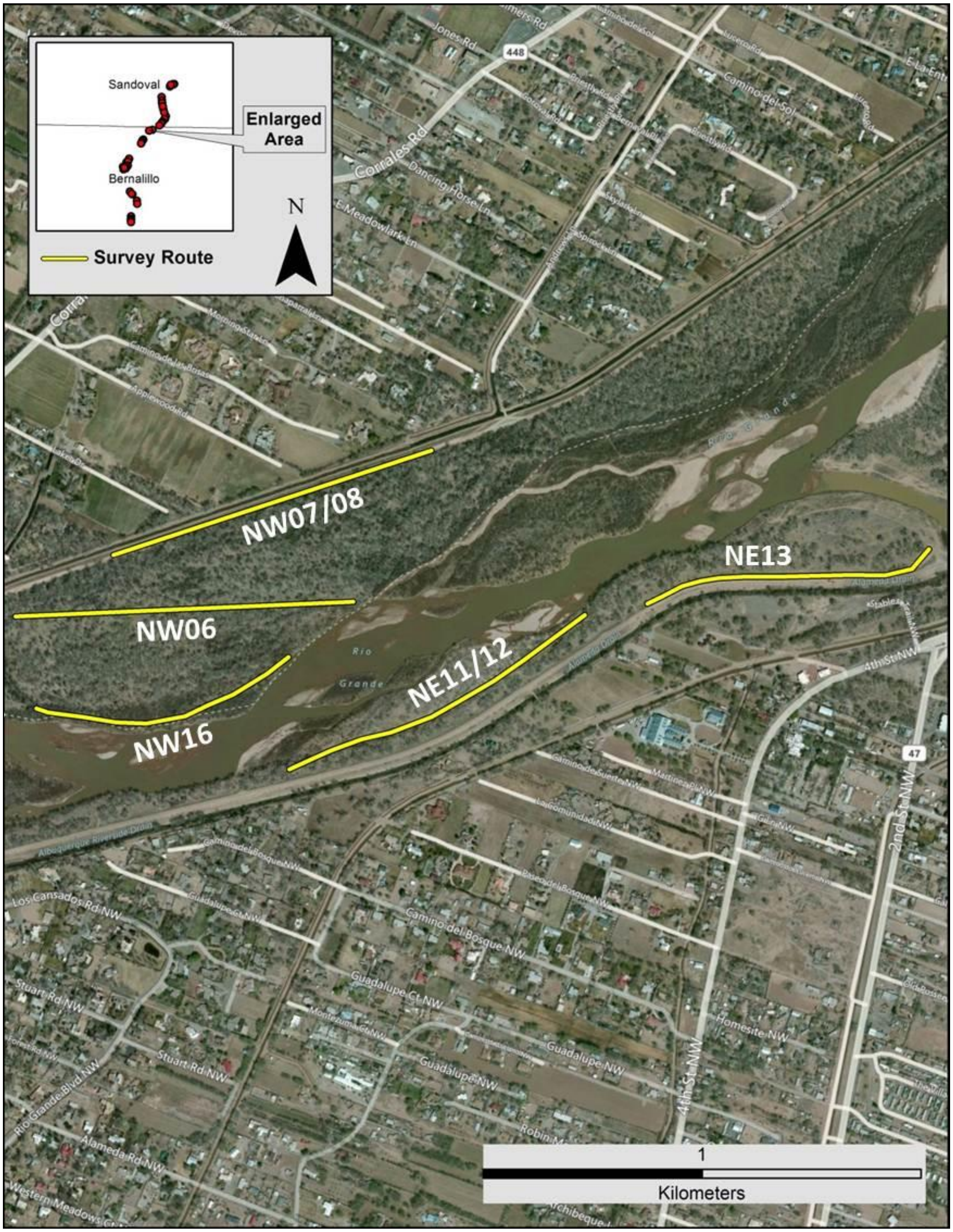
Appendix 4. Locations of transects on the Pueblo of Sandia and near Romero Road, Corrales, New Mexico.



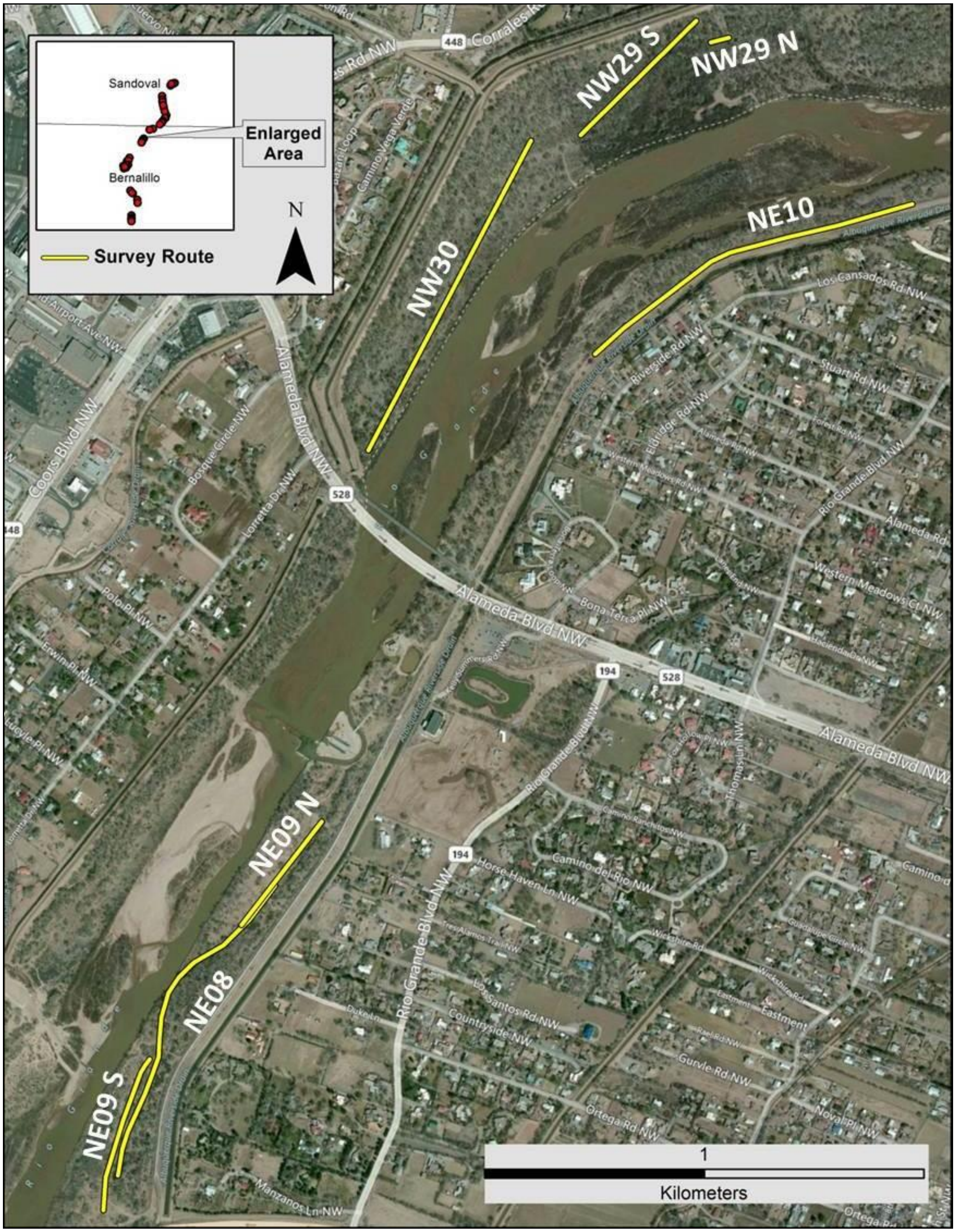
Appendix 5. Locations of transects in mid Corrales, New Mexico.



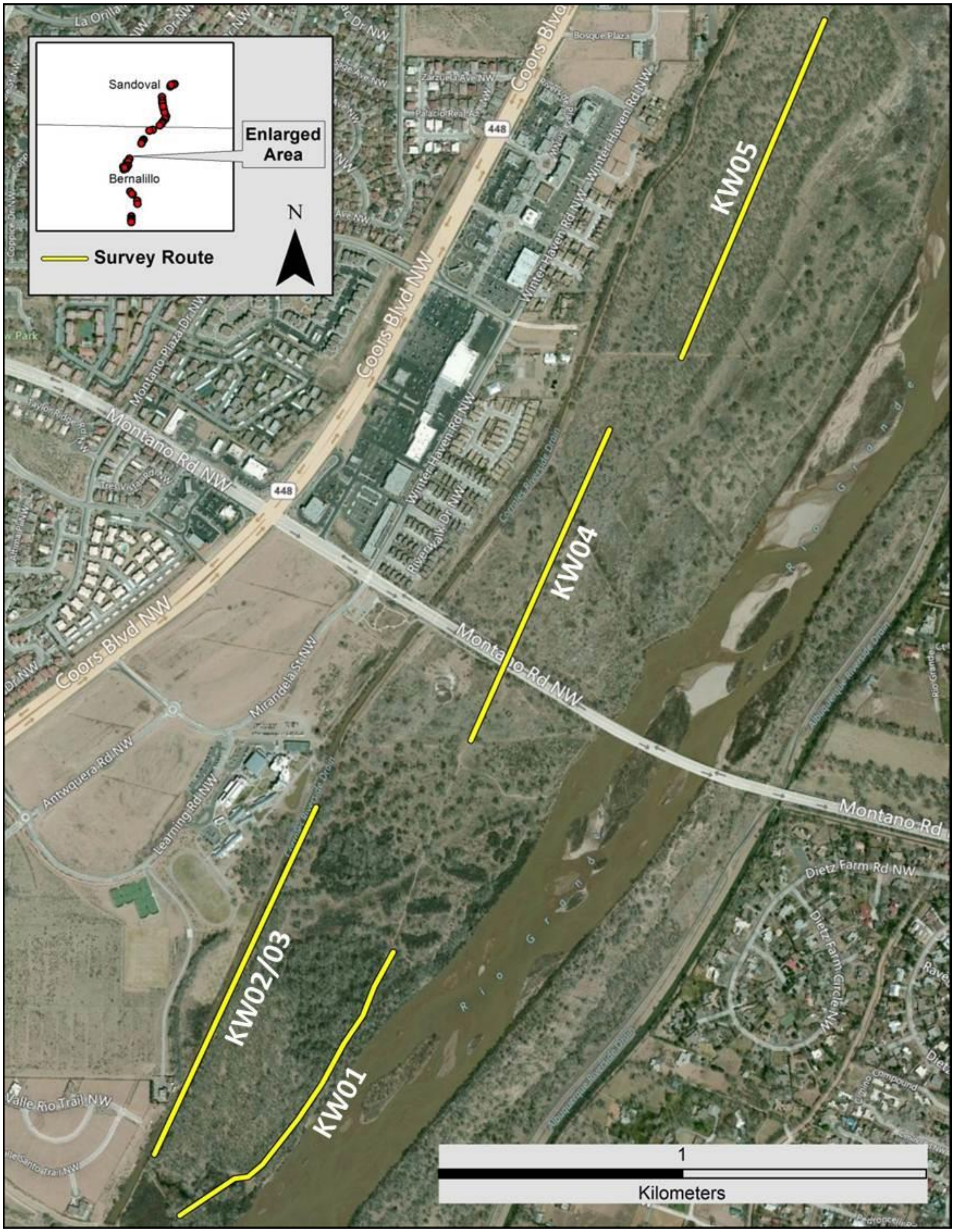
Appendix 6. Locations of transects in south Corrales, north Albuquerque and the south end of the Pueblo of Sandia, New Mexico.



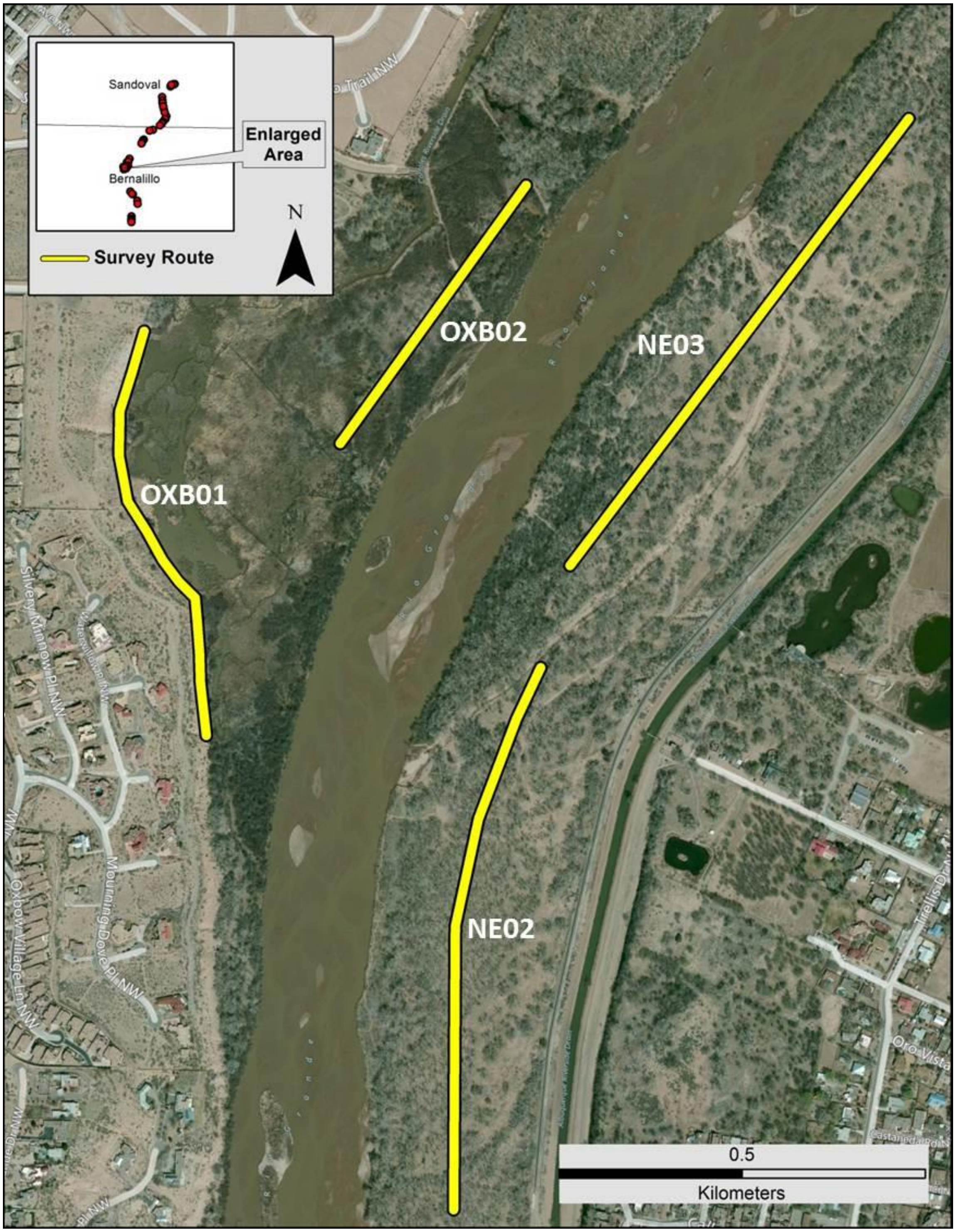
Appendix 7. Locations of transects near Alameda Boulevard, Albuquerque, New Mexico.



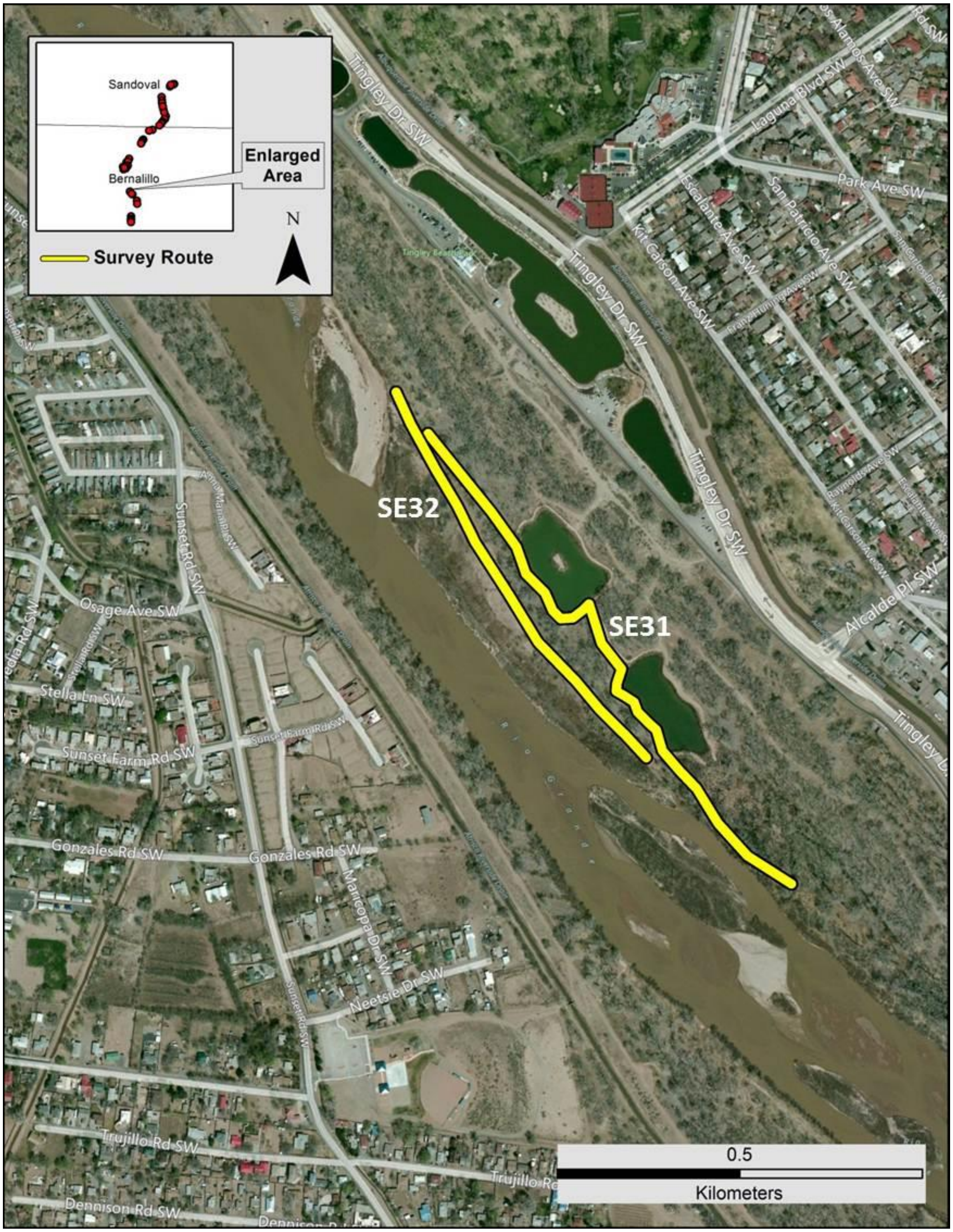
Appendix 8. Locations of transects near Montano Road, Albuquerque, New Mexico.



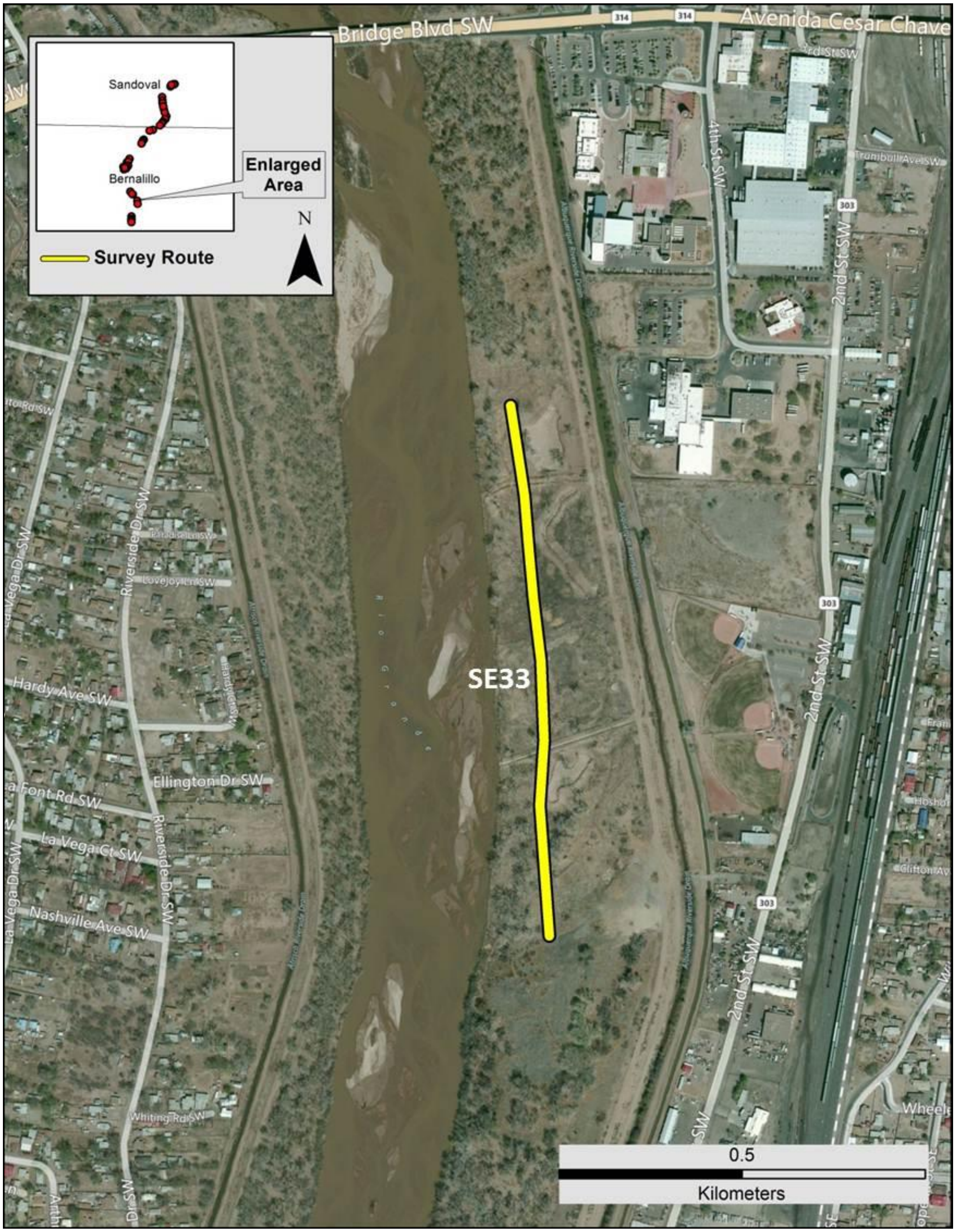
Appendix 9. Locations of transects near the Rio Grande Nature Center, Albuquerque, New Mexico.



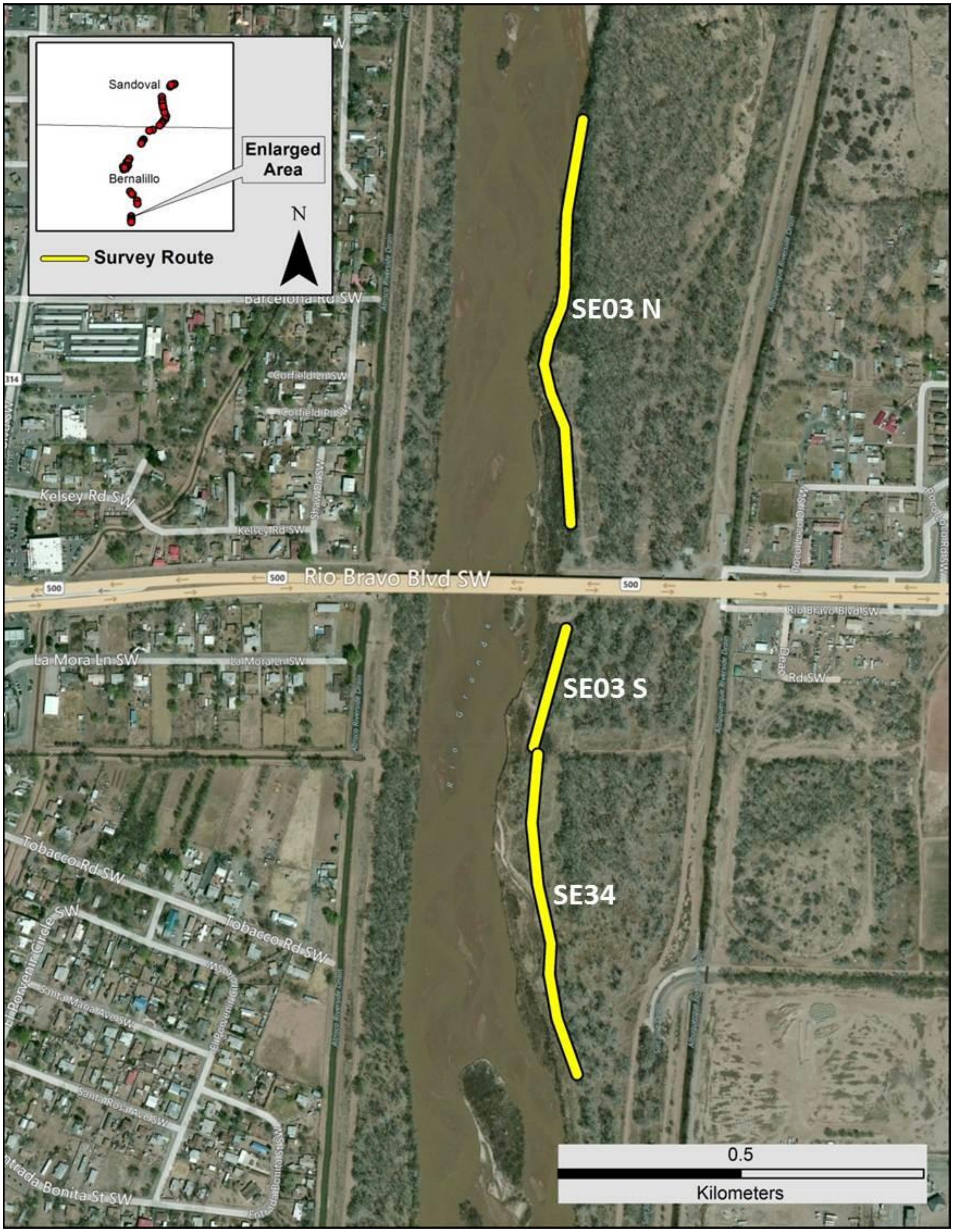
Appendix 10. Locations of transects in the Tingley Beach area, Albuquerque, New Mexico.



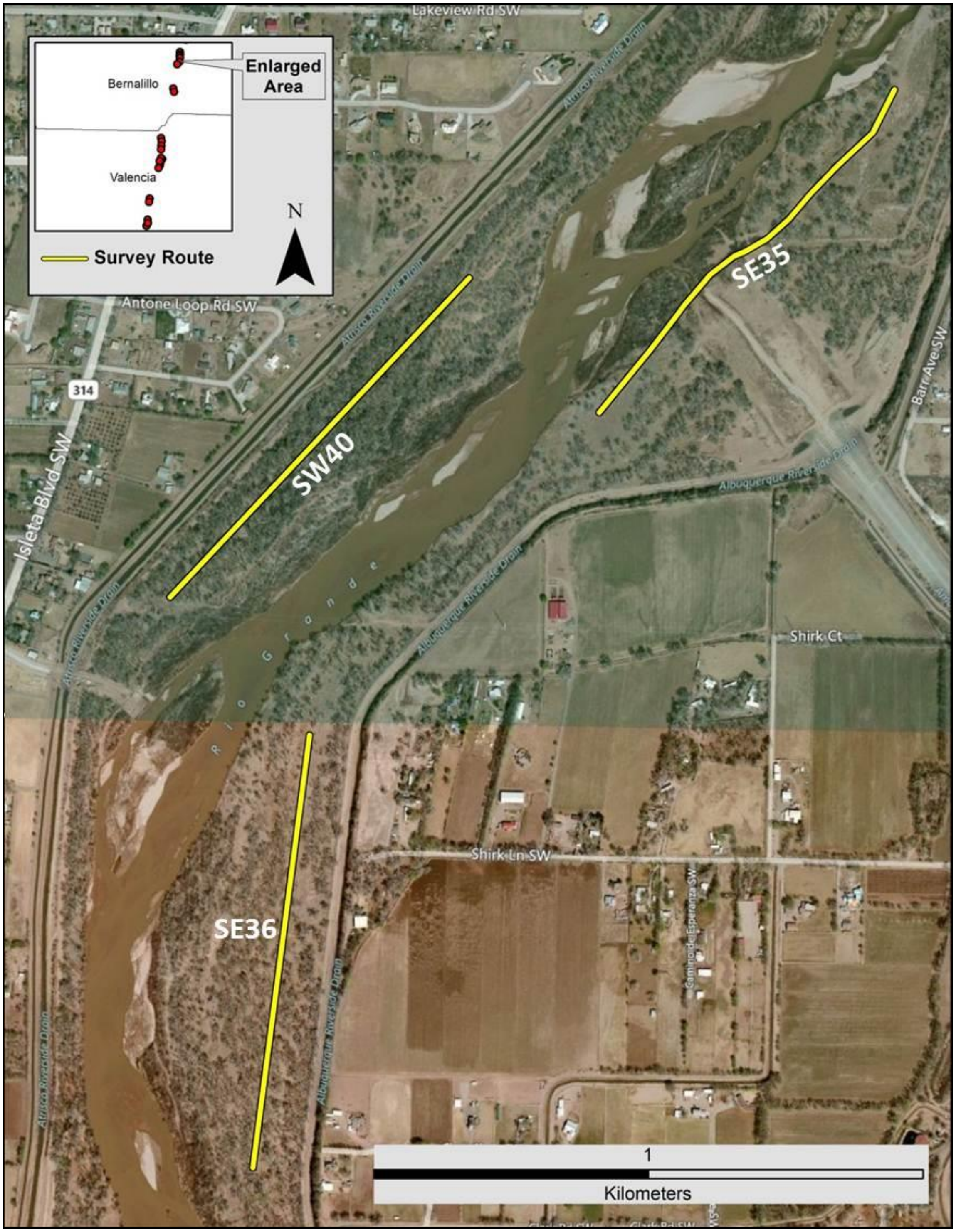
Appendix 11. Location of transect near Bridge Boulevard, Albuquerque, New Mexico.



Appendix 12. Locations of transects near Rio Bravo Boulevard, Albuquerque, New Mexico.

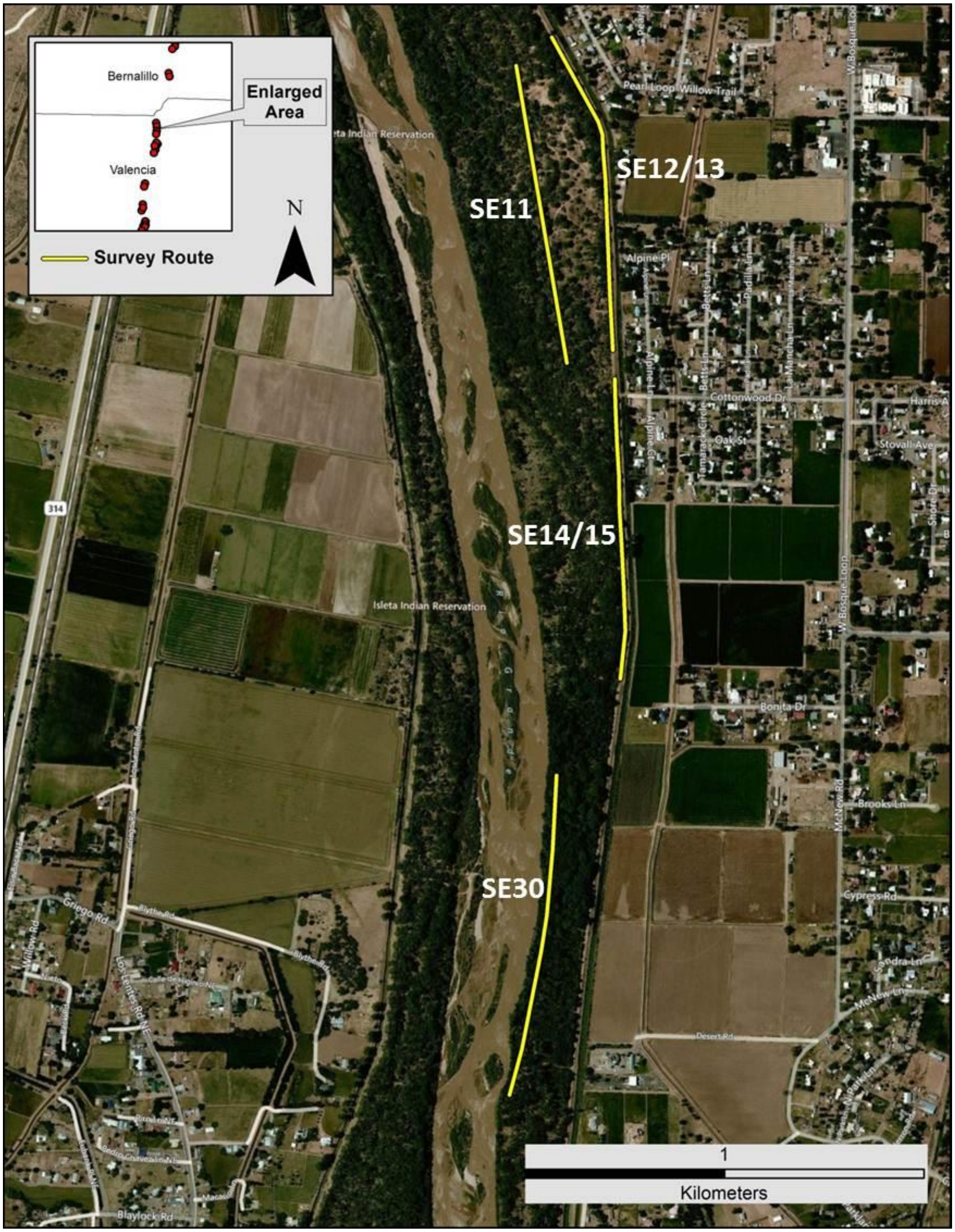


Appendix 13. Locations of transects in the South Valley, Albuquerque, New Mexico.

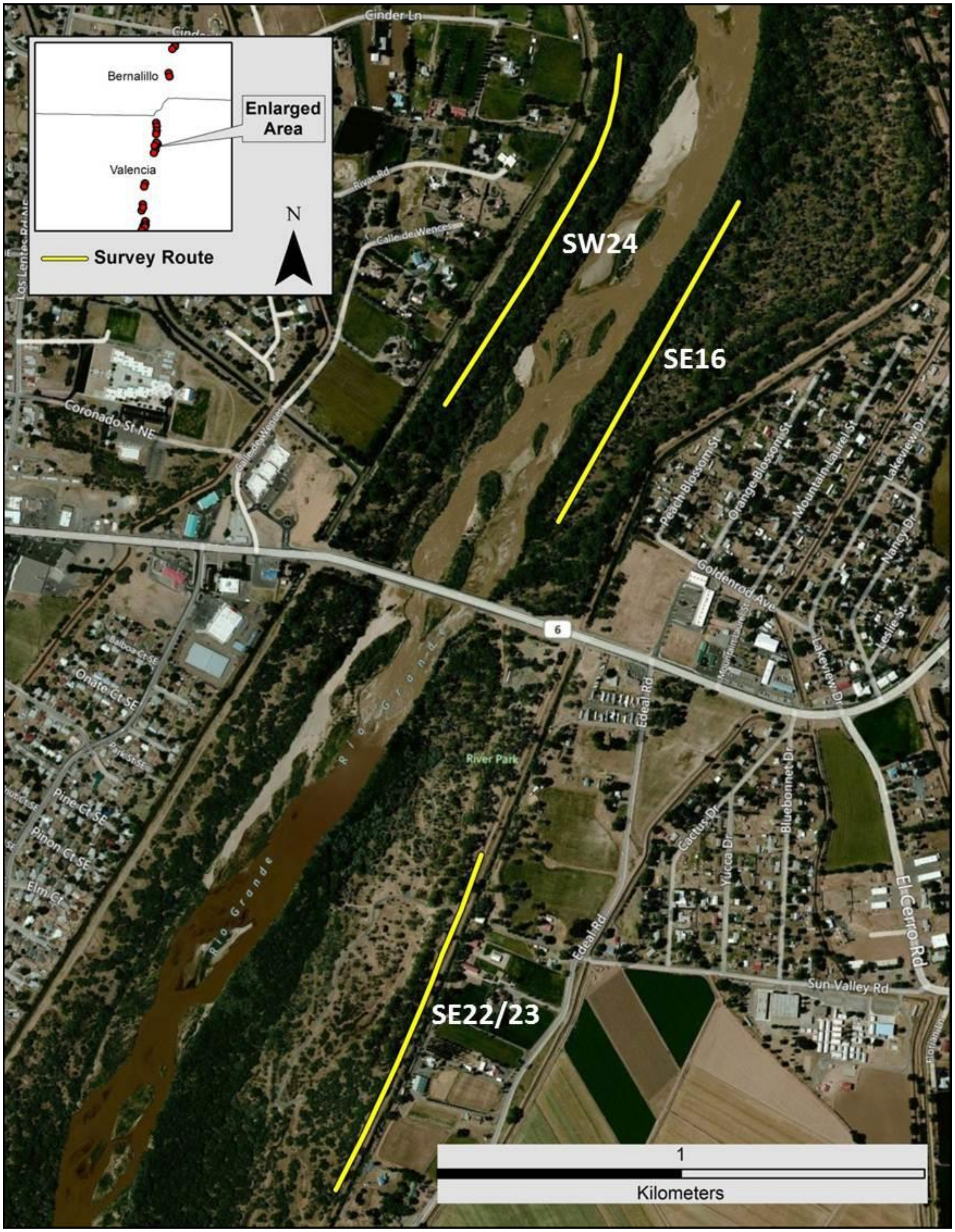


Appendix 14. Locations of transects north of the I-25 bridge, Albuquerque, New Mexico.

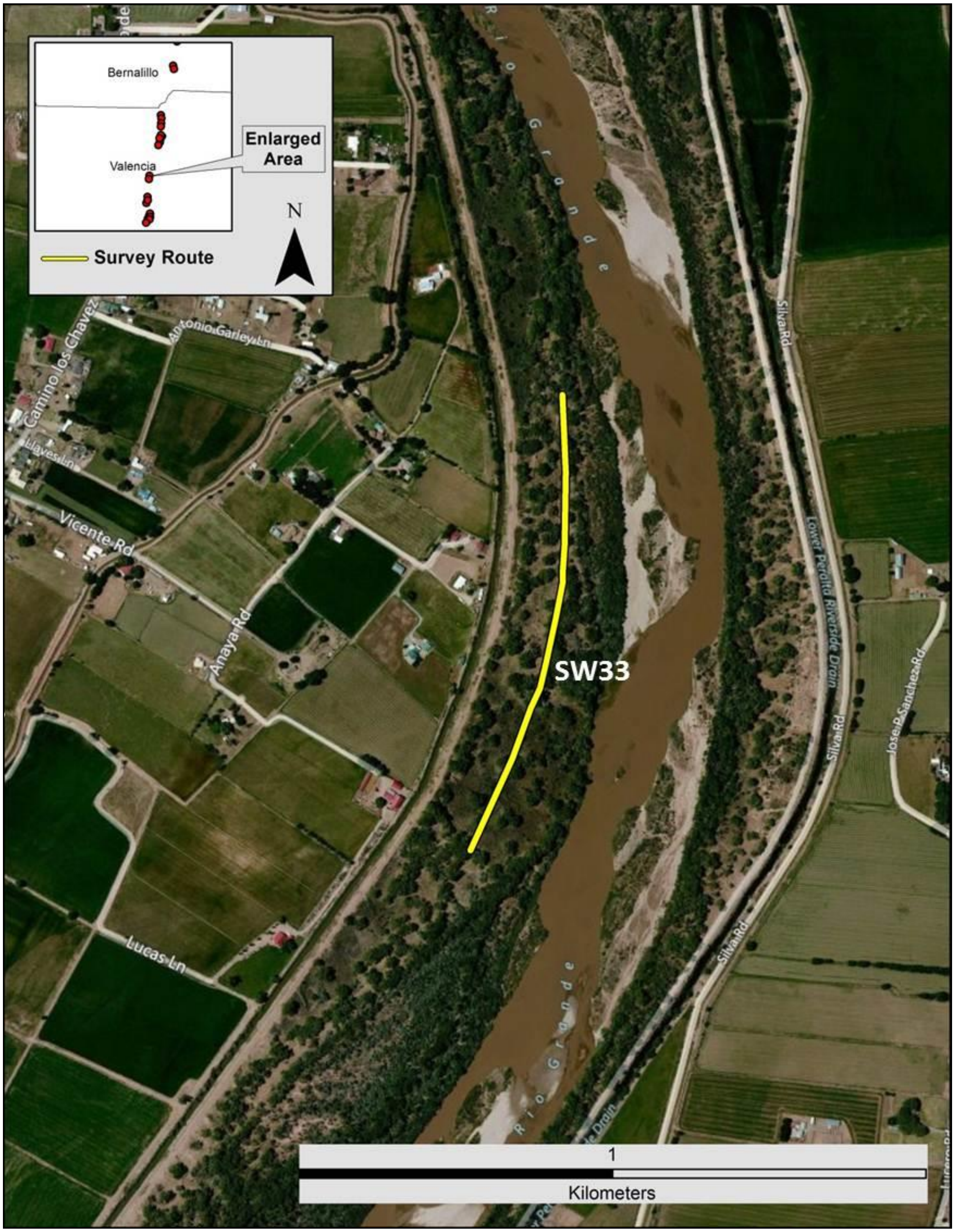
Appendix 15. Locations of transects in Bosque Farms, New Mexico.



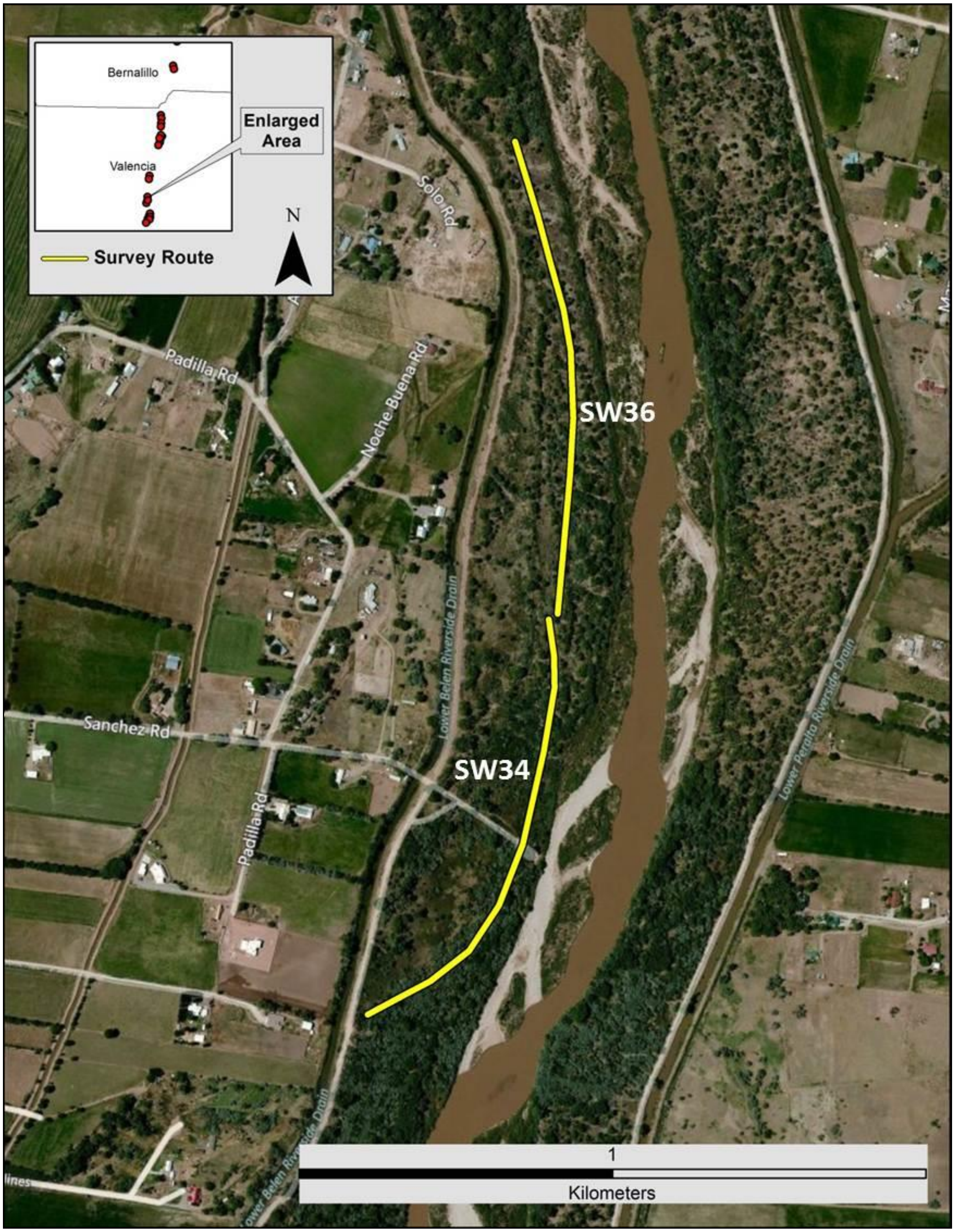
Appendix 16. Locations of transects in Los Lunas, New Mexico.



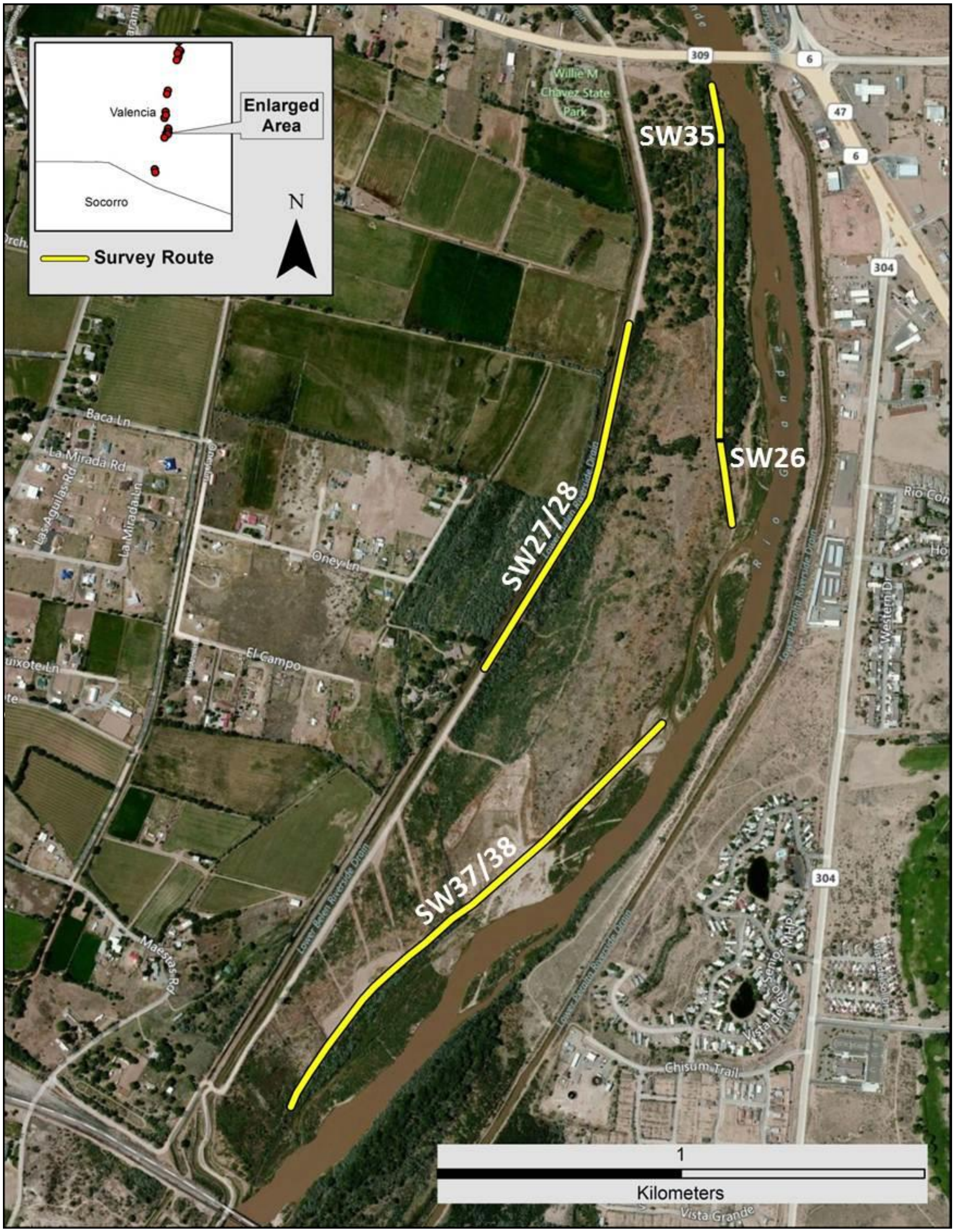
Appendix 17. Location of transect near Los Chavez, New Mexico.



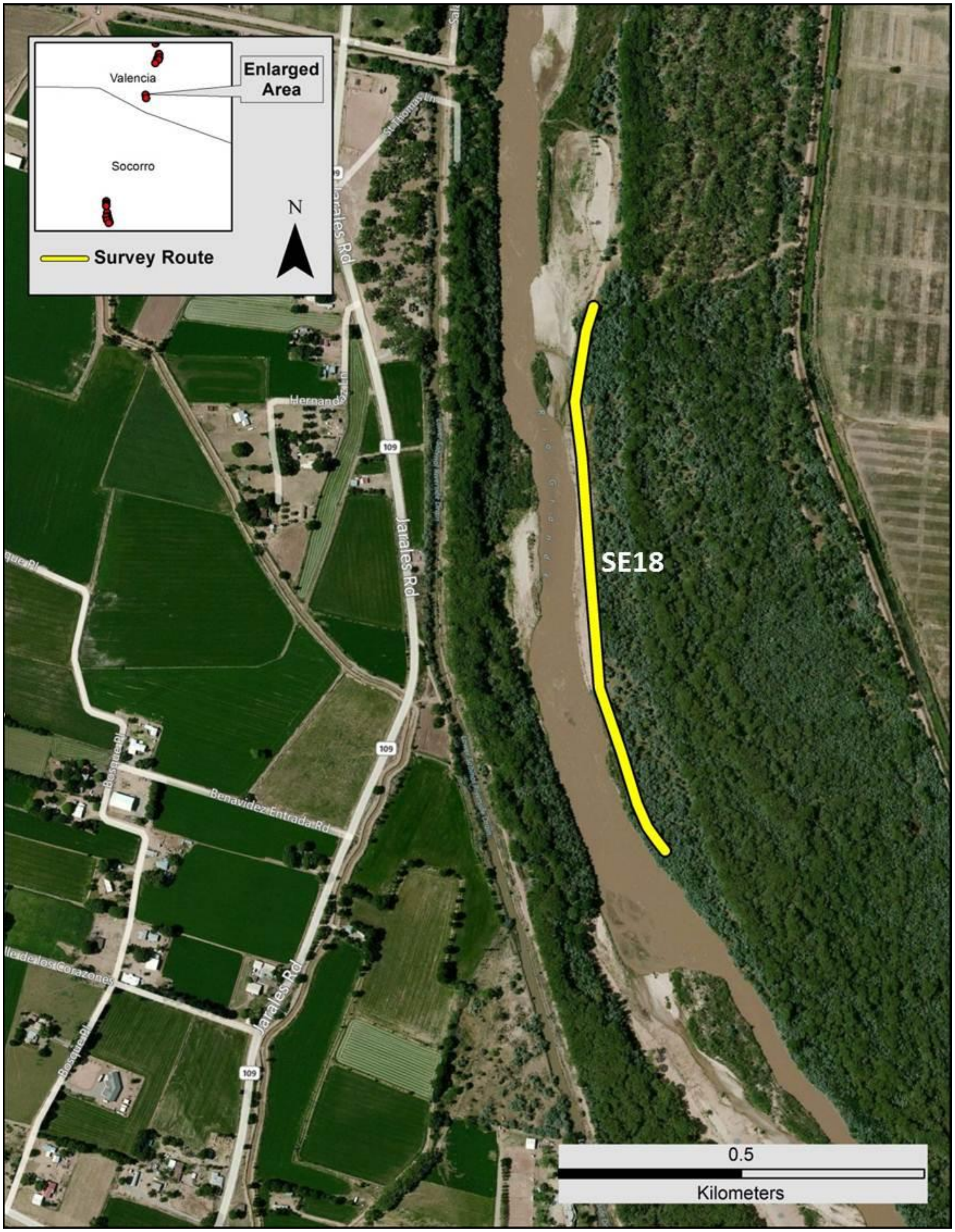
Appendix 18. Locations of transects near north Belen, New Mexico.



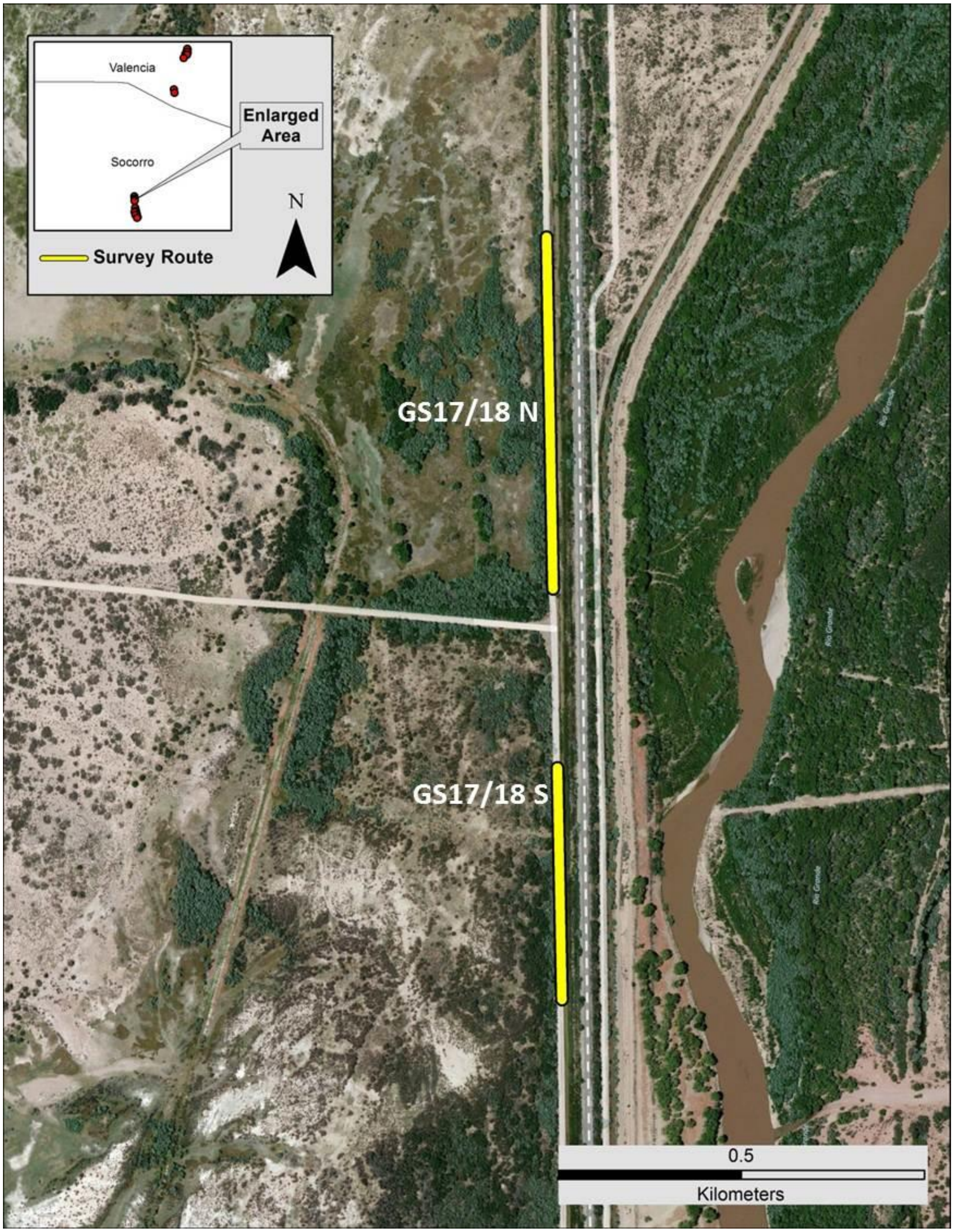
Appendix 19. Locations of transects near south Belen, New Mexico.



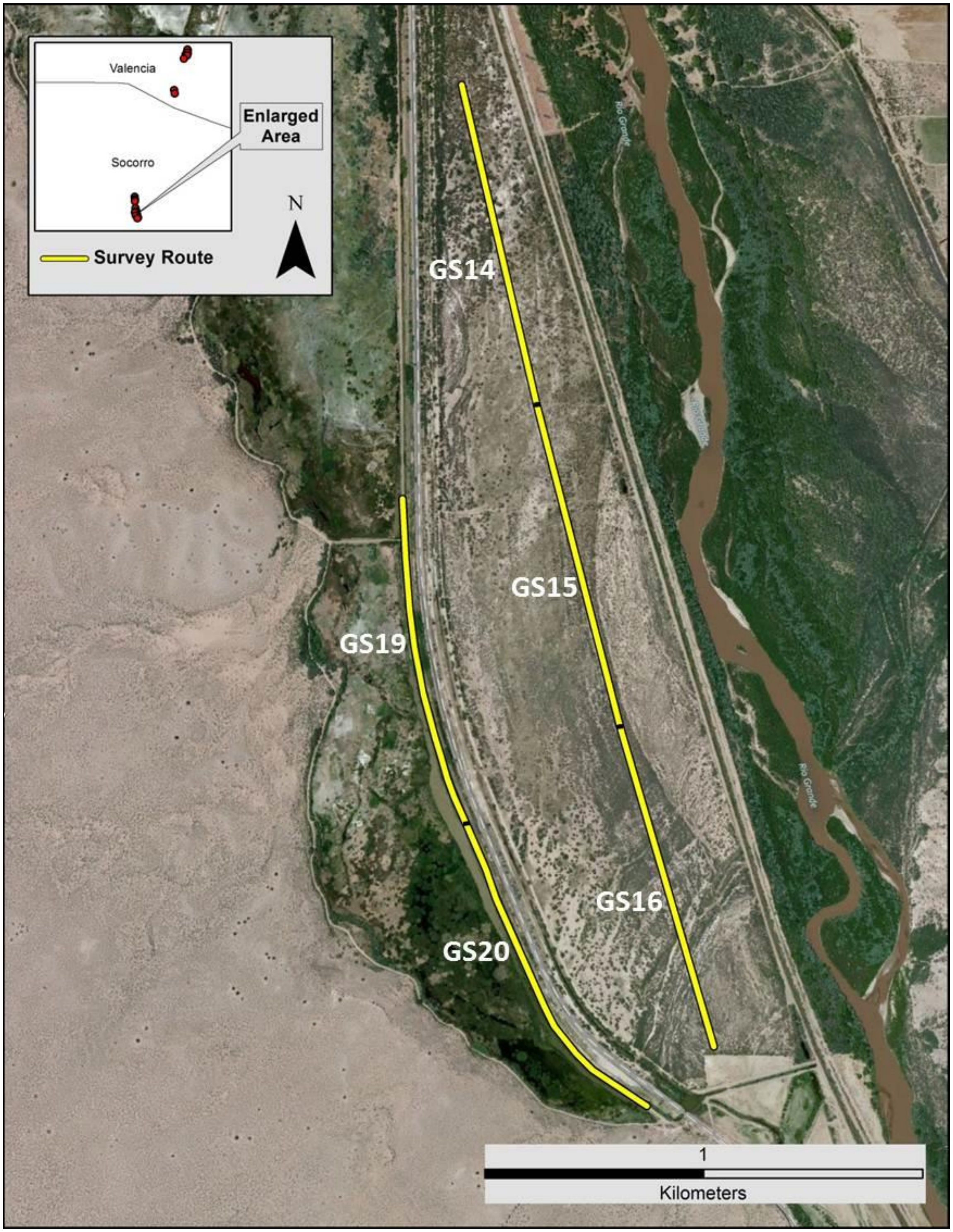
Appendix 20. Location of transect near Veguita, New Mexico.



Appendix 21: Location of transect near the north end of the La Joya Waterfowl Management Area, New Mexico.



Appendix 22. Locations of transects near the south end of the La Joya Waterfowl Management Area, New Mexico.



Appendix 23. Transect location, length and area data. Original MRGBS transects are marked with one asterisk (*). Transects in the same area as original MRGBS transects, but that do not follow the same survey route are marked with two asterisks (**).

Transect	USGS quad	Length (m)	Census area (acres)	Notes
GS14*	La Joya	760	11.27	
GS15*	La Joya	760	11.27	
GS16*	La Joya	760	11.27	
GS17 (N)	La Joya	480	3.56	one-sided, paired w/ GS18; split from south section 6/13
GS17 (S)	La Joya	320	2.37	one-sided, paired w/ GS18; split from north section after veg clearing prior to 6/13
GS18	La Joya	800	5.93	one-sided, paired w/ GS17; two sections
GS19	La Joya	760	5.63	one-sided
GS20	La Joya	760	5.63	one-sided
KW01**	Los Griegos	700	10.38	
KW02*	Los Griegos	790	5.86	one-sided, paired w/ KW03
KW03*	Los Griegos	790	3.90	one-sided, paired w/ KW02
KW04**	Los Griegos	700	10.38	transect offset 200m north from MRGBS KW04
KW05*	Los Griegos	760	11.27	
NE02*	Los Griegos	760	11.27	
NE03*	Los Griegos	770	11.42	
NE08	Los Griegos	760	5.63	one-sided, partially paired w/ NE09
NE09	Los Griegos	660	4.89	one-sided, partially paired w/ NE08; two sections
NE10	Los Griegos	800	5.93	established winter 2011; one-sided
NE11	Alameda	760	5.34	established winter 2011; one-sided, paired w/NE12
NE12	Alameda	760	5.63	established winter 2011; one-sided, paired w/NE11
NE13	Alameda	660	4.89	established winter 2011; one-sided
NE14	Alameda	800	4.67	established winter 2011; one-sided, paired w/NE15; only burned south 630m included in census area
NE15	Alameda	800	5.93	established winter 2011; one-sided, paired w/NE14
NE16	Bernalillo	800	11.86	established winter 2011
NE17	Bernalillo	800	11.86	established winter 2011
NW06*	Los Griegos	770	11.42	
NW07*	Alameda & Los Griegos	760	5.63	one-sided, paired w/ NW08
NW08*	Alameda & Los Griegos	760	5.63	one-sided, paired w/ NW07
NW09**	Alameda	630	9.34	transect runs 90m west of MRGBS NW09 north
NW10**	Alameda	800	5.93	one-sided, paired w/ NW11; moved 700m south from MRGBS NW10 to avoid overlapping with NW09
NW11**	Alameda	800	5.93	one-sided, paired w/ NW10; moved 700m south from MRGBS NW11
NW13*	Bernalillo	680	10.08	
NW14**	Bernalillo	780	10.50	split into 2 sections to maintain consistent C/S type
NW16 (N)*	Alameda	250	3.36	split from south section 2/12
NW16 (S)*	Los Griegos	340	5.04	split after establishment of willow swale during 2/12
NW17*	Bernalillo & Alameda	920	12.60	

Appendix 23 (continued).

Transect	USGS quad	Length (m)	Census area (acres)	Notes
NW19	Bernalillo	800	5.93	one-sided, paired w/ NW20
NW20	Bernalillo	800	5.93	one-sided, paired w/ NW19
NW21	Alameda	800	5.93	one-sided, paired w/ NW22; in 2 sections to avoid C/S change
NW22	Alameda	800	5.93	one-sided, paired w/ NW21; 2 sections
NW23	Bernalillo	600	8.90	establish spring 2006
NW24	Bernalillo	760	5.63	one-sided, paired w/ NW25; established fall 2006
NW25	Bernalillo	760	5.63	one-sided, paired w/ NW24; established fall 2006
NW26	Bernalillo	800	5.93	one-sided, paired w/ NW27; established fall 2006
NW27	Bernalillo	800	5.93	one-sided, paired w/ NW26; established fall 2006
NW28	Bernalillo	760	5.63	one-sided, established fall 2006
NW29	Los Griegos	410	5.78	establish summer 2010; split into 2 sections
NW30	Los Griegos	800	11.86	established winter 2011
OXB01	Los Griegos	560	4.15	one-sided
OXB02	Los Griegos	440	6.52	
SE03 (N)	ABQ West	560	4.70	Split into two sections due to C/S change, Rio Bravo Bridge
SE03 (S)	ABQ West	170	2.29	Split into two sections due to C/S change, Rio Bravo Bridge
SE11*	Los Lunas	760	11.27	
SE12*	Los Lunas	800	5.93	one-sided, paired w/ SE13
SE13*	Los Lunas	800	5.93	one-sided, paired w/ SE12
SE14*	Los Lunas	760	5.63	one-sided, paired w/ SE15
SE15*	Los Lunas	760	5.63	one-sided, paired w/ SE14
SE16*	Los Lunas	760	11.10	
SE18*	Veguita	760	7.77	
SE22*	Los Lunas	750	5.56	one-sided, paired w/ SE23
SE23*	Los Lunas	750	5.56	one-sided, paired w/ SE22
SE30	Los Lunas	800	8.80	
SE31	ABQ West	800	5.93	one-sided
SE32	ABQ West	610	4.42	one-sided
SE33	ABQ West	730	10.82	
SE34	ABQ West	440	6.52	
SE35	ABQ West	800	11.86	established winter 2011
SE36	ABQ West	800	11.86	established winter 2011
SE37	Isleta	760	11.27	established winter 2011
SW24**	Los Lunas	800	11.86	offset 100m northwest of MRGBS SW24
SW26**	Tome	800	5.04	one-sided, paritally paired w/ SW35; only the north 680 m (unburned & unthinned) included in census area
SW27*	Tome	770	5.71	one-sided, paired w/ SW28
SW28*	Tome	770	5.71	one-sided, paired w/ SW27
SW33	Tome	750	11.12	
SW34	Tome	700	10.38	
SW35	Tome	730	3.63	one-sided, partially paired w/ SW26; only north 490 m (untreated) included in census area
SW36	Tome	760	11.27	
SW37	Tome	1100	8.16	established summer 2008; one-sided, paired w/ SW38
SW38	Tome	1100	8.16	established summer 2008; one-sided, paired w/ SW37
SW39	Isleta	800	11.86	established winter 2011
SW40	ABQ West	800	11.86	established winter 2012

Appendix 24. Habitat characteristics of 2013 middle Rio Grande songbird transects.

Transect	C/S type	Analysis category	Notes
GS14	SC 5	SC 5	
GS15	SC 5	SC 5	
GS16	SC 5	SC 5	
GS17 (N)	RO-SC 5	RO 5	
GS17 (S)	OP	OP	south section completely cleared prior to 6/13
GS18	DR 5	DR 5	
GS19	MH 5-OW	MH 5-OW	
GS20	MH 5-OW	MH 5-OW	
KW01	C/RO 1	C/RO 1	partial mechanical thin beyond 30m 6/04
KW02	C-2 artificial	C-2 artificial	full mechanical thin 12/06; mostly SE regrowth in understory since then
KW03	DR 6	DR 6	much of transect annually mowed
KW04	Mixed	N/A	mechanically thinned annually 2004-2008; mix of OP, SC 5, CW 6
KW05	C-2 artificial	C-2 artificial	mechanically thinned in 2004, mowed occasionally since then
NE02	C/NMO 2	C-2 natural	re-classified from C-2 artificial to C-2 natural due to regrowth 6/13
NE03	C/RO 2	C-2 natural	
NE08	C/NMO 1	C/NMO 1	
NE09	OP	OP	mechanically thinned during fall 2004
NE10	C/TW 2	C-2 natural	
NE11	C-4	C-4	
NE12	C/SE 2	C-2 natural	
NE13	C/SE 2	C-2 natural	
NE14	BURN 2	BURN 2	north 630m burned in 6/12 fire; previously C-2 artificial
NE15	DR 5	DR 5	
NE16	BURN 2	BURN 2	entire transect burned in 6/12 fire; previously C-2 artificial
NE17	BURN 2	BURN 2	entire transect burned in 6/12 fire; previously C-2 artificial
NW06	C/RO 2	C-2 natural	
NW07	C/RO 1	C/RO 1	
NW08	DR 6	DR 6	mechanically thinned 11/05, annually mowed since then
NW09	NMO-SB 5	NMO 5	
NW10	C/NMO-RO 1	C/NMO 1	
NW11	DR 5	DR 5	
NW13	CW 6	CW 6	continual vegetation alteration since 2009
NW14	C/CW-NMO 2	C-2 natural	re-classified from C-2 artificial to C-2 natural due to regrowth 6/08
NW16 (N)	RO-SC 5	RO 5	
NW16 (S)	CW 6	CW 6	swale encompassing all of south section established 2/12
NW17	C-RO/CW 3	C-RO/CW 3	
NW19	C/NMO 2	C-2 natural	
NW20	DR 5	DR 5	
NW21	C/NMO-RO 1	C/NMO 1	
NW22	DR 5	DR 5	
NW23	OP	OP	mechanically thinned 12/05, 11/10; mowed in fall 2011 and 2012
NW24	C/NMO-RO 1	C/NMO 1	
NW25	DR 6	DR 6	mechanically cleared 1/11; now annually mowed
NW26	C/NMO-RO 1	C/NMO 1	
NW27	DR 6	DR 6	mechanically cleared 1/11; now annually mowed
NW28	NMO-RO 5	NMO 5	

Appendix 24 (continued).

Transect	C/S type	Analysis category	Notes
NW29	BURN Mix	N/A	mix of burned habitat (<5% to >90%) established after 5/10 fire
NW30	Mixed	N/A	mix of CW 6, C/RO 1, C/NMO 2
OXB01	MH 5-OW	MH 5-OW	
OXB02	Mixed	N/A	mix of CW 5 and MH
SE03 (N)	RO-CW 5	RO 5	
SE03 (S)	CW 6	CW 6	
SE11	C/RO-CW 2	C-2 natural	
SE12	C/CW-RO 2	C-2 natural	
SE13	DR 6	DR 6	annually mowed
SE14	C/SC 2	C-2 natural	re-classified from C-2 artificial to C-2 natural due to regrowth 12/12
SE15	DR 6	DR 6	annually mowed
SE16	C/RO-SC 1	C/RO 1	
SE18	RO 3	RO 3	reclassified from RO 5 to RO 3 prior to 6/09
SE22	C/RO 2	C-2 natural	
SE23	DR 6	DR 6	
SE30	C/MB-SC 1	C/MB 1	
SE31	Mixed	N/A	mix of MH, OW, C/SE 2
SE32	CW 6	CW 6	CW 5 through 2/07; mechanically thinned 3/07 &10/09
SE33	BURN OP	BURN OP	transect partially burned 6/23/04; complete mechanical thin 10/04 & 10/07; N 620m burned 4/10; annual mowing since then
SE34	CW 6	CW 6	swales established 12/11
SE35	Mixed	N/A	swales established 12/11; mix of CW 6, OP, C-2 natural
SE36	C-2 artificial	C-2 artificial	swales established on periphery of survey area 12/11
SE37	Mixed	N/A	swales established 2/12; mix of CW 6, OP, C-2 artificial
SW24	C/CW-MB 1	C/CW 1	
SW26	C-RO/CW 3	C-RO/CW 3	S 120m burned 3/07, thinned 2/10, excluded from analysis
SW27	RO 5 BURN	RO 5	95% of transect burned 2/07; reclassified from BURN 1 to RO 5 12/11
SW28	DR 6	DR 6	annually mowed
SW33	C/CW 1	C/CW 1	
SW34	CW-RO 5	CW-RO 5	
SW35	RO 5	RO 5	S 80m burned 3/07; S 240 m thinned 2/10, excluded from analysis
SW36	CW-RO 5	CW-RO 5	mechanically thinned 2/06; re-classified from CW 6 to CW 5 6/07
SW37	Mixed	N/A	entire area burned 3/07, thinned prior to transect establishment in 6/08; re-classified as BURN OP 12/09; now mix of CW 6, CW 5, OP
SW38	CW-RO-C 5	CW-RO 5	partially burned 3/07, veg recovered by transect establishment in 6/08
SW39	Mixed	N/A	burned in 2007 fire; swales established 3/12, now CW 6-OP mix
SW40	C-2 mix	N/A	

Appendix 25. Statistical significance table for avian abundance by C/S type during winter 2013. Comparisons were made using a Tukey-Kramer test. C/S types not connected by the same letter are significantly different.

C/S Type							# Birds/100 Acres
RO 3	A						1527
DR 5	A	B					1058
MH 5-OW		B	C				914
RO 5			C	D			735
C/NMO 1			C	D			671
DR 6			C	D			648
C/MB 1			C	D	E		614
BURN OP			C	D	E		605
CW 6				D	E		463
CW-RO 5				D	E	F	417
BURN 2				D	E	F	405
C-2 natural					E	F	359
NMO 5				D	E	F	352
C/RO 1					E	F	348
C-RO/CW 3					E	F	335
C-4				D	E	F	306
SC 5						F	165
C-2 artificial						F	131
C/CW 1						F	127
OP						F	110

Appendix 26. Statistical significance table for cumulative avian abundance by C/S type during winter 2004-2012. Comparisons were made using a Tukey-Kramer test. C/S types not connected by the same letter are significantly different.

C/S type									# Birds/100 Acres
RO 3	A								1660
DR 5		B							1151
MH 5-OW		B							1076
BURN 1		B	C						987
C/NMO 1			C						749
RO 5			C	D					681
BURN 2			C	D	E	F	G	H	643
NMO 5			C	D	E				637
DR 6				D	E				584
BURN OP					E	F			425
CW-RO 5						F			392
C-RO/CW 3						F			384
C/RO 1						F			328
C-2 natural						F			313
CW 6						F	G	H	271
OP						F	G	H	245
C/MB 1						F	G	H	218
RO 6						F	G	H	217
C/CW 1						F	G	H	203
C-4						F	G	H	161
SC 5							G	H	112
C-2 artificial								H	90

Appendix 27. Statistical significance table for avian abundance by C/S type during winter 2012 and winter 2013. Comparisons were made using a Tukey-Kramer test. C/S types not connected by the same letter are significantly different.

C/S Type and Year															# Birds/100 Acres
RO 3 2013	A	B													1527
DR 5 2013		B	C												1058
MH 5-OW 2013			C	D											914
RO 3 2012			C	D	E	F	G	H		J					786
RO 5 2013				D	E										735
DR 5 2012				D	E			H							712
C/NMO 1 2013				D	E	F		H		J					671
DR 6 2013				D	E	F		H		J					648
MH 5-OW 2012				D	E	F	G	H		J	K				627
C/MB 1 2013			C	D	E	F	G	H	I	J	K	L	M		614
BURN OP 2013			C	D	E	F	G	H	I	J	K	L	M		605
C/NMO 1 2012					E	F	G	H	I	J	K	L			479
CW 6 2013					E	F	G	H	I	J	K	L			463
DR 6 2012						F	G		I	J	K	L			423
CW-RO 5 2013					E	F	G	H	I	J	K	L	M		417
RO 5 2012						F	G		I	J	K	L	M		415
BURN 2 2013					E	F	G	H	I	J	K	L	M	N	405
BURN OP 2012						F	G	H	I	J	K	L	M	N	381
C-2 natural 2013							G		I		K	L	M		359
NMO 5 2013						F	G	H	I	J	K	L	M	N	352
C/MB 1 2012					E	F	G	H	I	J	K	L	M	N	351
C/RO 1 2013						F	G		I	J	K	L	M	N	348
NMO 5 2012						F	G	H	I	J	K	L	M	N	339
C-RO/CW 3 2013						F	G	H	I	J	K	L	M	N	335
C-4 2013					E	F	G	H	I	J	K	L	M	N	306
C/RO 1 2012									I			L	M	N	244
C-2 natural 2012												L	M	N	236
CW-RO 5 2012									I			L	M	N	229
C-RO/CW 3 2012												L	M	N	182
SC 5 2013												L	M	N	165
C/CW 1 2012												L	M	N	152
C-2 artificial 2013													M	N	131
C/CW 1 2013												L	M	N	127
C-4 2012									I		K	L	M	N	114
SC 5 2012													M	N	114
OP 2013													M	N	110
C-2 artificial 2012														N	98
OP 2012														N	76
CW 6 2012														N	67

Appendix 28. Statistical significance table for avian abundance by C/S type during cumulative winters 2004-2012 and winter 2013. Comparisons were made using a Tukey-Kramer test. C/S types not connected by the same letter are significantly different.

C/S Type and Year														# Birds/100 Acres
RO 3 04-12	A													1660
RO 3 2013	A	B												1527
DR 5 04-12		B	C											1151
MH 5-OW 04-12		B	C											1076
DR 5 2013		B	C	D										1058
BURN 1 04-12		B	C	D	E									987
MH 5-OW 2013		B	C	D	E	F	G							914
C/NMO 1 04-12					E		G		I					749
RO 5 2013				D	E	F	G	H	I					735
RO 5 04-12					E	F	G		I					679
C/NMO 1 2013					E	F	G	H	I	J				671
DR 6 2013					E	F	G	H	I					648
BURN 2 04-12			C	D	E	F	G	H	I	J	K	L	M	643
NMO 5 04-12					E	F	G	H	I					637
C/MB 1 2013			C	D	E	F	G	H	I	J	K	L	M	614
BURN OP 2013			C	D	E	F	G	H	I	J	K	L	M	605
DR 6 04-12						F		H					M	584
CW 6 2013						F	G	H	I	J	K		M	528
BURN OP 04-12								H		J	K		M	425
CW-RO 5 2013								H	I	J	K	L	M	417
BURN 2 2013								H	I	J	K	L	M	405
CW-RO 5 04-12										J	K			392
C-RO/CW 3 04-12										J	K			384
C-2 natural 2013										J	K			359
NMO 5 2013								H	I	J	K	L	M	352
C/RO 1 2013								H		J	K	L	M	348
C-RO/CW 3 2013								H	I	J	K	L	M	335
C/RO 1 04-12											K			328
C-2 natural 04-12											K			311
C-4 2013					E	F	G	H	I	J	K	L	M	306
CW 6 04-12											K	L		271
OP 04-12											K	L		246
C/MB 1 04-12											K	L		218
RO 6 04-12								H	I	J	K	L	M	217
C/CW 1 04-12											K	L		203
SC 5 2013											K	L		165
C-4 04-12											K	L	M	161
C-2 artificial 2013											K	L		131
C/CW 1 2013											K	L		127
SC 5 04-12												L		112
OP 2013											K	L		110
C-2 artificial 04-12												L		87

Appendix 29. Statistical significance tables for species richness by C/S type during winter 2013. Comparisons were made using a Tukey-Kramer test. C/S types not connected by the same letter are significantly different.

C/S Type				# Species/Transect
MH 5-OW	A			20.3
RO 3	A	B		20.0
DR 5	A	B		18.4
C/NMO 1	A	B		17.8
C/RO 1	A	B	C	16.7
C/MB 1	A	B	C	15.0
C-4	A	B	C	14.0
C-2 natural	A	B	C	13.6
DR 6	A	B	C	13.6
RO 5	A	B	C	13.4
BURN 2	A	B	C	13.3
C-RO/CW 3	A	B	C	12.5
CW-RO 5	A	B	C	12.0
NMO 5	A	B	C	11.0
C/CW 1	A	B	C	10.5
CW 6	A	B	C	10.4
BURN OP	A	B	C	10.0
C-2 artificial	A	B	C	9.4
SC 5		B	C	7.3
OP			C	3.5

Appendix 30. Statistical significance tables for species richness by C/S type during winter 2004-2012. Comparisons were made using a Tukey-Kramer test. C/S types not connected by the same letter are significantly different.

C/S Type										# Species/Transect
DR 5	A									19.2
C/NMO 1	A	B								17.7
BURN 1	A	B	C	D	E	F	G			16.3
NMO 5	A	B	C	D						15.9
RO 3	A	B	C	D	E	F	G	H		15.0
MH 5-OW		B	C	D	E	F				14.3
RO 5			C	D		F				13.9
C/CW 1		B	C	D	E	F				13.6
C-RO/CW 3		B	C	D	E	F				13.4
C/MB 1	A	B	C	D	E	F	G	H		12.8
CW-RO 5			C	D	E	F				12.4
C-2 natural				D	E	F				12.1
C/RO 1				D	E	F				11.4
BURN OP				D	E	F	G	H	I	10.3
DR 6					E		G			10.2
RO 6	A	B	C	D	E	F	G	H	I	10.0
BURN 2	A	B	C	D	E	F	G	H	I	10.0
CW 6					E		G	H	I	8.0
OP							G	H	I	6.9
C-2 artificial								H	I	6.1
C-4				D	E	F	G	H	I	5.0
SC 5									I	4.3

Appendix 31. Statistical significance table for avian abundance by C/S type during summer 2013. Comparisons were made using a Tukey-Kramer test. C/S types not connected by the same letter are significantly different.

C/S Type												# Birds/100 Acres
RO 3	A											1145
MH 5-OW	A											1063
NMO 5	A	B										1005
C/NMO 1		B	C									830
RO 5			C	D								803
C-RO/CW 3			C	D	E							669
CW-RO 5				D	E							650
DR 5					E	F						486
CW 6						F	G	H				399
C/CW 1						F	G	H	I			387
C/RO 1						F	G	H	I	J		351
C-2 natural							G	H				345
BURN 2							G	H	I	J	K	316
DR 6								H	I	J		312
C/MB 1						F	G	H	I	J	K	292
C-4						F	G	H	I	J	K	291
BURN OP								H	I	J	K	220
C-2 artificial									I	J	K	200
SC 5										J	K	171
OP											K	124

Appendix 32. Statistical significance table for avian abundance by C/S type during summer 2004-2012. Comparisons were made using a Tukey-Kramer test. C/S types not connected by the same letter are significantly different.

C/S Type													# Birds/100 Acres
MH 5-OW	A												1500
NMO 5		B											1196
BURN 1		B	C										1165
C/NMO 1			C										995
RO 3			C	D	E								914
RO 5				D	E								829
CW-RO 5				D	E								818
C-RO/CW 3				D	E								817
C/RO 1					E	F							752
C/CW 1						F	G						701
C/MB 1					E	F	G						698
DR 5						F	G						674
CW 6							G						633
C-2 natural							G						608
BURN 2							G	H	I	J			501
C-4							G	H	I	J	K	L	441
DR 6								H	I				434
BURN OP									I	J	K		373
RO 6									I	J	K	L	350
C-2 artificial										J			347
OP											K	L	234
SC 5												L	206

Appendix 33. Statistical significance table for avian abundance by C/S type for cumulative summers 2004-2012 and summer 2013. Comparisons were made using a Tukey-Kramer test. C/S types not connected by the same letter are significantly different.

C/S Type																				# Birds/100 Acres
MH 5-OW 04-12	A																			1500
NMO 5 04-12		B																		1196
BURN 1 04-12		B	C																	1165
RO 3 2013	A	B	C	D	E	F														1145
MH 5-OW 2013		B	C	D	E															1063
NMO 5 2013		B	C	D	E	F	G													1005
C/NMO 1 04-12			C	D																995
RO 3 04-12			C	D	E	F	G	H	I											914
C/NMO 1 2013				D	E	F	G	H	I											856
RO 5 04-12						F	G		I											829
CW-RO 5 04-12						F	G	H	I											818
C-RO/CW 3 04-12						F	G	H	I											817
RO 5 2013					E	F	G	H	I	J	K									803
C/RO 1 04-12							G	H	I	J										752
C/CW 1 04-12								H		J	K	L								701
C/MB 1 04-12								H	I	J	K	L								698
DR 5 04-12										J	K	L								674
C-RO/CW 3 2013							G	H	I	J	K	L	M	N						669
CW-RO 5 2013								H	I	J	K	L	M	N						650
CW 6 04-12											K	L	M							633
C-2 natural 04-12												L	M							608
BURN 2 04-12												L	M	N	O	P				501
DR 5 2013													M	N	O	P				486
C-4 04-12												L	M	N	O	P	Q	R	S	441
DR 6 04-12														N	O					434
C/CW 1 2013													M	N	O	P	Q	R	S	387
BURN OP 04-12															O	P	Q		S	373
CW 6 2013														N	O	P	Q	R	S	368
C-2 natural 2013															O	P	Q		S	365
C/RO 1 2013														N	O	P	Q	R	S	351
C-2 artificial 04-12																P			S	347
BURN 2 2013															O	P	Q	R	S	323
DR 6 2013															O	P	Q	R	S	312
C/MB 1 2013													M	N	O	P	Q	R	S	292
C-4 2013													M	N	O	P	Q	R	S	276
OP 04-12																	Q	R		234
BURN OP 2013															O	P	Q	R	S	220
SC 5 04-12																		R		206
C-2 artificial 2013																	Q	R	S	200
SC 5 2013																	Q	R	S	171
OP 2013																	Q	R	S	112

Appendix 34. Statistical significance table for species richness by C/S type for summer 2013. Comparisons were made using a Tukey-Kramer test. C/S types not connected by the same letter are significantly different.

C/S Type					# Species/Transect
RO 3	A				32.0
C/MB 1	A	B	C	D	27.0
CW-RO 5	A				26.7
BURN OP	A				24.0
MH 5-OW	A	B			23.3
C/CW 1	A	B	C	D	23.0
C-RO/CW 3	A	B	C	D	22.5
C/NMO 1	A	B			21.6
NMO 5	A	B	C	D	21.5
C/RO 1	A	B	C	D	18.8
RO 5	A	B	C	D	18.6
C-2 natural	A	B	C	D	18.6
DR 5	A	B	C	D	18.2
C-4	A	B	C	D	18.0
CW 6	A	B	C	D	15.6
SC 5	A	B	C	D	14.0
BURN 2	A	B	C	D	14.0
C-2 artificial		B	C	D	11.3
DR 6			C	D	10.6
OP				D	5.5

Appendix 35. Statistical significance table for species richness by C/S type during summer 2004-2012. Comparisons were made using a Tukey-Kramer test. C/S types not connected by the same letter are significantly different.

C/S Type							# Species/Transect
BURN 1	A	B	C	D			27.7
CW-RO 5	A	B					25.8
C/CW 1	A	B	C				25.6
C/MB 1	A	B	C	D			25.6
NMO 5	A	B	C	D			24.8
C/RO 1		B	C	D			23.1
C/NMO 1		B	C	D			23.0
MH 5-OW		B	C	D			22.6
C-RO/CW 3		B	C	D			22.2
RO 3	A	B	C	D	E		21.5
RO 5			C	D			20.2
C-2 natural				D			20.0
BURN OP		B	C	D	E		19.4
DR 5				D			19.1
CW 6				D			18.3
RO 6		B	C	D	E	F	17.7
C-4		B	C	D	E	F	17.0
BURN 2			C	D	E	F	16.7
C-2 artificial					E	F	12.5
DR 6					E	F	12.3
SC 5					E	F	12.1
OP						F	10.3

Appendix 36. Statistical significance table for summer avian density by year at SE31. Comparisons were made using a Tukey-Kramer test. Years types not connected by the same letter are significantly different.

C/S Type	Year				# Birds/100 Acres
OW/MH/C-2 mix	2010	A			1062
OW/MH/C-2 mix	2009	A			1010
OW/MH/C-2 mix	2011	A			946
OW/MH/C-2 mix	2006	A			924
OW/MH/C-2 mix	2007	A	B		907
OW/MH/C-2 mix	2012	A	B		899
OW/MH/C-2 mix	2008	A	B		899
OW/MH/C-2 mix	2013	A	B		854
C/MB 1	2004		B	C	515
C-2 artificial/OP mix	2005			C	442

Appendix 37. Statistical significance table for winter avian density by year at SE31. Comparisons were made using a Tukey-Kramer test. Years types not connected by the same letter are significantly different.

C/S Type	Year				# Birds/100 Acres
OW/MH/C-2 mix	2009	A			2055
OW/MH/C-2 mix	2013	A			1729
OW/MH/C-2 mix	2012	A			1720
OW/MH/C-2 mix	2011	A			1705
OW/MH/C-2 mix	2010	A			1587
OW/MH/C-2 mix	2008	A	B		1244
OW/MH/C-2 mix	2007		B	C	526
OW/C-2 artificial mix	2006			C	191
C-2 artificial/OP mix	2005			C	56

Appendix 38. Alphabetical list of 45 bird species observed foraging on Russian olive berries.

American Crow	Mountain Bluebird
American Goldfinch	Mountain Chickadee
American Robin	Northern Flicker
Ash-throated Flycatcher	Northern Mockingbird
Black-capped Chickadee	Pine Siskin
Black-headed Grosbeak	Red-winged Blackbird
Blue Grosbeak	Ruby-crowned Kinglet
Brown Thrasher	Say's Phoebe
Bullock's Oriole	Song Sparrow
Cedar Waxwing	Spotted Towhee
Chipping Sparrow	Steller's Jay
Crissal Thrasher	Summer Tanager
Curve-billed Thrasher	Varied Thrush
Dark-eyed Junco	Verdin
Downy Woodpecker	Western Bluebird
Eastern Bluebird	Western Kingbird
Eurasian Collared-Dove	Western Scrub-Jay
European Starling	Western Tanager
Gray Catbird	White-breasted Nuthatch
Great-tailed Grackle	White-crowned Sparrow
Green-tailed Towhee	White-throated Sparrow
Hermit Thrush	Yellow-rumped Warbler
House Finch	

Appendix 39. Summer avian density, species richness and site details at transects in USACE restoration project areas, 2011-2013. Transects with data prior to 2011 were pre-existing. The area column refers to the name of the USACE project area where the transect is located.

Transect & Year	Area	C/S Type	# Birds/100 Acres	# Species/Transect	Notes
NE14 2011	1B	C-2 natural	719	19	
NE14 (pre-fire) 2012	1B	C-2 artificial	396	9	2 visits before fire
NE14 (burn) 2012	1B	BURN 2	823	12	7 visits; north 630 m burned
NE14 (all post-fire) 2012	1B	BURN 2/C-2 mix	836	22	7 visits; all 800 m
NE14 (burn) 2013	1B	BURN 2	419	20	north 630 m
NE14 (all) 2013	1B	BURN 2/C-2 mix	442	22	all 800 m
NE16 2011	1B	C-2 natural	381	21	
NE16 (pre-fire) 2012	1B	C-2 artificial	283	10	first 2 visits before fire
NE16 (post-fire) 2012	1B	BURN 2	430	18	last 7 visits; entire site burned
NE16 2013	1B	BURN 2	277	23	
NE17 2011	1B	C-2 natural	290	20	
NE17 (pre-fire) 2012	1B	C-2 artificial	181	8	first 2 visits before fire
NE17 (post-fire) 2012	1B	BURN 2	359	18	last 7 visits; entire site burned
NE17 2013	1B	BURN 2	274	20	
NW16 (S) 2012	1E	CW 6	436	18	
NW16 (S) 2013	1E	CW 6	403	19	
NW30 2011	1G	C/RO 1	534	21	
NW30 2012	1G	CW 6/C-2 mix	531	19	
NW30 2013	1G	CW 6/C-2 mix	497	24	
SE34 2005	4B	OP	153	8	
SE34 2006	4B	OP	215	7	
SE34 2007	4B	OP	260	13	
SE34 2008	4B	OP/SE-RO 6 mix	330	11	
SE34 2009	4B	OP	263	13	
SE34 2010	4B	OP/SE-RO 6 mix	321	19	
SE34 2011	4B	OP/SE-RO 6 mix	385	18	
SE34 2012	4B	CW 6	388	20	
SE34 2013	4B	CW 6	426	21	
SE35 2011	4C	OP/C-2 mix	280	24	
SE35 2012	4C	CW 6/OP/C-2 mix	315	31	
SE35 2013	4C	CW 6/OP/C-2 mix	301	33	
SE36 2011	5B	C-2 artificial	292	22	
SE36 2012	5B	C-2 artificial	295	23	
SE36 2013	5B	C-2 artificial	283	21	
SE37 2011	5C	OP	323	26	
SE37 2012	5C	CW 6/OP mix	326	33	
SE37 2013	5C	CW 6/OP mix	313	30	
SW39 2011	5D	BURN OP	290	22	
SW39 2012	5D	CW 6/C 6/OP mix	394	34	
SW39 2013	5D	CW 6/C 6 mix	221	28	
SW40 2012	5A	C-2 artificial	364	24	
SW40 2013	5A	C-2 mix	164	22	

Appendix 40. Winter avian density, species richness and site details at transects in USACE restoration project areas 2011-2013. Transects with data prior to 2011 were pre-existing. The area column refers to the name of the USACE project area where the transect is located.

Transect & Year	Area	C/S Type	# Birds/100 Acres	# Species/Transect	Notes
NE14 2011	1B	C-2 natural	277	12	
NE14 (pre-thin) 2012	1B	C-2 natural	142	7	5 pre-thinning visits
NE14 (post-thin) 2012	1B	C-2 artificial	105	5	4 post-thinning visits
NE14 (burn) 2013	1B	BURN 2	626	16	north 630 m of transect
NE14 (all) 2013	1B	BURN 2/C-2 mix	558	15	all 800 m of transect
NE16 2011	1B	C-2 natural	228	15	
NE16 2012	1B	C-2 natural	105	13	
NE16 2013	1B	BURN 2	275	14	
NE17 2011	1B	C-2 natural	97	11	
NE17 (pre-thin) 2012	1B	C-2 natural	91	6	5 pre-thinning visits
NE17 (post-thin) 2012	1B	C-2 artificial	78	6	4 post-thinning visits
NE17 2013	1B	BURN 2	315	16	
NW16 (S) 2012	1E	OP	198	2	2 post-clearing visits only
NW16 (S) 2013	1E	CW 6	529	14	
NW30 2011	1G	C/RO 1	700	20	
NW30 (pre-thin) 2012	1G	C/RO 1	531	10	5 pre-construction visits
NW30 (post-thin) 2012	1G	OP/C-2 mix	415	9	4 post-construction visits
NW30 2013	1G	CW 6/C-2 mix	752	14	
SE34 2006	4B	OP	746	12	
SE34 2007	4B	OP	703	12	
SE34 2010	4B	OP	384	7	
SE34 2011	4B	OP/SE-RO 6 mix	730	11	large sunflower crop
SE34 (pre-planting) 2012	4B	OP	16	1	2 pre-planting visits
SE34 (post-planting) 2012	4B	CW 6	61	4	7 post-planting visits
SE34 2013	4B	CW 6	828	12	large sunflower crop
SE35 2011	4C	OP/C-2 mix	251	14	
SE35 2012	4C	OP/CW 6/C-2 mix	134	15	swale construction & planting
SE35 2013	4C	CW 6/OP/C-2 mix	250	20	
SE36 2011	5B	C-2 artificial	27	8	
SE36 2012	5B	C-2 artificial	54	9	swale construction
SE36 2013	5B	C-2 artificial	55	9	
SE37 2011	5C	OP	215	22	
SE37 2012	5C	OP	90	12	swale construction
SE37 2013	5C	CW 6/OP mix	187	11	
SW39 2011	5D	BURN OP	259	16	
SW39 2012	5D	BURN OP	393	17	limited planting during season
SW39 2013	5D	CW 6/C 6 mix	863	23	
SW40 2012	5A	C-2 artificial	150	14	
SW40 2013	5A	C-2 mix	117	15	planting during season

Appendix 41. Alphabetical list of bird species detected by C/S type during surveys in winter 2004-2013. 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-4	C-RO/CW 3	CW-RO 5	CW 6	DR 5	DR 6	MH 5-OW	NMO 5	OP	RO 3	RO 5	RO 6	SC 5
American Coot	*	*	*	*	*	*	*	*	*	*	*	*	*	U	R	C	*	*	*	R	*	*
American Crow	R	U	C	R	U	U	C	R	U	C	U	U	U	R	R	R	U	C	*	U	*	R
American Goldfinch	U	U	R	R	R	U	U	U	U	R	U	C	U	U	U	R	U	C	U	U	*	R
American Kestrel	R	R	U	R	R	R	R	R	R	*	*	R	R	*	R	R	*	R	*	R	*	*
American Pipit	*	*	*	*	*	R	*	*	R	*	R	R	R	R	R	*	*	*	*	R	*	R
American Robin	C	U	U	U	R	C	C	U	C	R	C	C	R	C	C	R	C	U	C	C	R	R
American Wigeon	*	*	*	*	*	*	*	*	*	*	*	*	*	C	U	U	*	*	*	*	*	*
Bald Eagle	*	*	R	R	R	R	R	R	R	*	R	*	R	*	*	*	R	R	*	R	*	*
Barn Owl	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*
Belted Kingfisher	*	*	*	*	R	*	R	*	R	*	R	*	R	U	U	R	*	*	*	R	*	*
Bewick's Wren	U	R	R	U	U	U	U	R	U	R	C	U	U	U	U	U	U	U	U	C	R	U
Black Phoebe	*	*	*	R	*	R	R	*	R	*	R	*	*	U	R	R	R	R	R	R	*	*
Black-billed Magpie	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*
Black-capped Chickadee	*	*	*	U	U	C	C	U	C	R	U	U	R	U	U	R	U	R	R	U	*	*
Black-crowned Night-Heron	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	R	*	*
Blue-gray Gnatcatcher	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*
Blue-winged Teal	*	*	*	*	*	*	*	*	*	*	*	*	*	R	R	*	*	*	*	*	*	*
Brewer's Blackbird	*	*	*	*	*	*	*	*	*	*	*	*	R	R	*	*	*	*	*	R	*	*
Brown Creeper	*	*	R	U	R	U	U	U	U	R	R	*	R	R	R	R	R	R	*	R	*	*
Brown Thrasher	*	*	*	*	*	*	*	*	*	*	R	R	*	*	*	*	R	*	R	R	*	*
Brown-headed Cowbird	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*
Bufflehead	*	*	*	*	*	*	*	*	*	*	*	*	*	R	R	R	*	*	*	*	*	*
Bushtit	*	R	R	U	R	U	U	R	U	R	U	U	U	C	U	U	U	R	U	U	*	U
Canada Goose	*	*	*	*	*	*	R	*	*	*	*	*	*	R	R	U	*	R	*	R	*	*
Canvasback	*	*	*	*	*	*	*	*	*	*	*	*	*	R	R	U	*	*	*	*	*	*
Canyon Towhee	*	*	*	*	*	*	*	*	*	*	R	*	R	*	*	*	*	R	*	*	*	*
Cassin's Finch	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Cedar Waxwing	U	R	*	R	R	U	U	*	R	*	U	U	*	U	U	*	U	*	C	U	*	*
Chipping Sparrow	R	*	*	R	*	R	*	*	R	*	*	R	R	R	*	*	*	R	*	R	*	R
Cinnamon Teal	*	*	*	*	*	*	*	*	*	*	*	*	*	R	R	U	*	*	*	*	*	*
Common Goldeneye	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Common Grackle	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	R	*	*	*	*	*	*
Common Merganser	*	*	*	*	*	*	*	*	*	*	*	*	*	R	R	R	*	*	*	*	*	*
Common Raven	*	*	*	*	*	R	R	R	R	*	R	*	R	R	R	*	R	R	*	R	R	R
Cooper's Hawk	R	R	R	R	R	U	U	R	U	*	R	R	R	R	R	R	R	R	R	U	*	R
Crissal Thrasher	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	R	*	*
Curve-billed Thrasher	*	*	*	*	*	R	*	*	R	*	*	R	*	*	*	R	R	*	*	R	*	*
Dark-eyed Junco	U	U	U	C	U	C	C	U	C	U	C	C	C	C	C	U	C	C	C	C	U	C
Downy Woodpecker	C	U	R	U	U	U	U	U	C	R	U	U	U	U	U	R	U	U	R	U	R	R
Eastern Bluebird	R	R	R	U	*	U	R	U	U	R	U	U	U	U	U	*	U	R	R	C	R	*
Eastern Meadowlark	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	R

Appendix 41 (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-4	C-RO/CW 3	CW-RO 5	CW 6	DR 5	DR 6	MH 5-OW	NMO 5	OP	RO 3	RO 5	RO 6	SC 5
Eastern Phoebe	*	*	*	*	*	R	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*
Eurasian Collared-Dove	R	*	R	U	R	R	R	R	U	*	*	R	*	R	R	*	*	*	*	R	*	*
European Starling	U	U	C	U	U	U	U	R	U	*	R	U	U	U	U	R	U	U	U	U	*	*
Fox Sparrow	R	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	R	*	*
Gadwall	*	*	*	*	*	*	*	*	*	*	*	*	*	U	U	U	*	*	*	R	*	*
Gambel's Quail	U	R	*	*	R	R	*	*	R	*	*	R	*	R	R	R	*	*	*	U	*	R
Golden-crowned Kinglet	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Gray Catbird	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*
Great Blue Heron	R	*	R	R	R	U	U	*	R	*	*	R	R	U	U	U	R	R	*	U	*	*
Great Egret	*	*	*	*	*	*	*	*	*	*	*	*	*	R	R	*	*	*	*	*	*	*
Great Horned Owl	*	*	*	R	*	*	R	R	R	*	R	R	*	*	*	*	*	*	*	R	*	*
Greater Roadrunner	*	R	*	*	R	R	R	R	R	*	*	R	R	R	R	R	*	R	R	R	*	*
Great-tailed Grackle	*	*	U	*	*	*	R	*	R	*	*	*	*	*	*	R	*	R	*	R	*	*
Green-tailed Towhee	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Green-winged Teal	*	*	*	*	*	*	*	*	*	*	*	*	*	U	U	U	*	*	*	*	*	*
Hairy Woodpecker	U	*	R	R	R	U	U	R	U	*	*	R	*	R	R	R	*	R	R	R	*	R
Harris' Sparrow	*	*	*	*	*	*	R	*	*	*	*	*	R	R	*	*	*	*	*	*	*	R
Hermit Thrush	U	*	*	U	U	C	C	R	U	R	C	U	R	U	R	R	C	R	C	C	*	R
Hooded Merganser	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Horned Lark	*	*	*	*	R	*	R	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*
House Finch	U	*	U	U	R	C	U	U	C	R	U	U	U	C	C	U	U	C	R	U	U	R
House Sparrow	*	*	*	*	*	R	*	*	R	*	*	*	*	U	U	R	*	*	*	R	*	*
House Wren	R	*	*	*	R	R	*	*	*	*	R	*	*	R	R	*	*	*	*	R	*	*
Killdeer	*	*	R	*	*	*	R	*	*	*	*	*	*	R	R	R	*	*	*	*	*	*
Ladder-backed Woodpecker	*	*	R	R	*	U	R	R	R	*	R	R	R	R	*	R	R	R	R	R	*	*
Lesser Goldfinch	R	R	U	*	*	U	R	R	U	R	U	U	U	U	R	U	U	R	R	U	R	*
Lesser Scaup	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	U	*	*	*	*	*	*
Lincoln's Sparrow	R	R	R	*	R	R	*	*	R	*	R	R	R	U	R	R	R	R	R	U	*	*
Loggerhead Shrike	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	R
Mallard	*	*	*	*	*	R	U	*	*	*	*	R	*	C	C	C	*	*	R	U	*	*
Marsh Wren	*	*	*	R	*	*	*	*	*	*	*	R	*	U	U	C	*	*	R	R	*	*
Merlin	*	*	R	*	*	R	R	*	R	*	*	*	R	R	*	*	*	*	*	R	*	*
Mountain Bluebird	*	R	*	*	R	R	U	*	*	*	R	R	*	R	U	R	R	*	U	U	U	U
Mountain Chickadee	R	*	*	U	R	U	U	R	U	*	U	R	R	U	R	R	U	*	R	U	*	*
Mourning Dove	U	U	U	C	R	U	U	U	C	U	U	U	U	U	U	R	U	U	*	U	R	R
Northern Flicker	C	R	U	C	U	U	C	U	C	U	U	U	U	U	U	U	U	U	C	C	U	U
Northern Goshawk	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*
Northern Harrier	*	*	*	R	*	*	*	*	*	*	R	R	R	R	R	R	*	*	R	R	*	R
Northern Pintail	*	*	*	*	*	*	*	*	*	*	*	*	*	R	R	U	*	*	*	*	*	*
Northern Shoveler	*	*	*	*	*	*	*	*	*	*	*	*	*	U	R	U	*	*	*	*	*	*
Osprey	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Pacific Wren	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*
Peregrine Falcon	*	*	R	*	*	R	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*
Pied-billed Grebe	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	U	*	*	*	*	*	*
Pine Siskin	U	U	R	U	R	U	U	U	U	*	U	U	U	U	R	*	R	U	U	U	*	*

Appendix 41 (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-4	C-RO/CW 3	CW-RO 5	CW 6	DR 5	DR 6	MH 5-OW	NMO 5	OP	RO 3	RO 5	RO 6	SC 5
Prairie Falcon	*	*	*	*	*	*	*	*	R	*	*	*	R	*	*	*	*	*	*	R	*	*
Pygmy Nuthatch	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*
Redhead	*	*	*	*	*	*	*	*	*	*	*	*	*	R	R	U	*	*	*	*	*	*
Red-breasted Nuthatch	*	*	*	*	*	*	R	R	*	*	*	R	*	*	*	*	*	*	*	R	*	*
Red-naped Sapsucker	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Red-tailed Hawk	R	*	R	U	R	U	U	U	U	R	*	U	R	R	R	R	R	R	R	U	*	R
Red-winged Blackbird	*	*	R	R	R	U	R	*	R	R	R	U	U	C	R	C	R	R	U	U	*	R
Ring-necked Duck	*	*	*	*	*	*	*	*	*	*	*	*	*	R	R	U	*	*	*	*	*	*
Ring-necked Pheasant	*	*	R	U	R	R	U	*	U	R	U	U	R	R	R	R	R	R	R	U	*	R
Rock Pigeon	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Ruby-crowned Kinglet	R	R	R	U	U	U	U	R	U	R	U	U	U	U	U	U	U	R	R	U	*	U
Ruddy Duck	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	R	*	*	*	*	*	*
Sandhill Crane	*	*	U	*	*	*	*	*	R	*	*	R	R	*	R	*	*	R	*	R	*	*
Savannah Sparrow	*	*	*	*	*	*	*	R	*	*	*	*	R	R	R	R	*	*	*	*	*	R
Say's Phoebe	*	*	R	*	*	R	R	R	R	*	R	R	*	R	R	R	R	R	R	R	R	*
Scaled Quail	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*
Sharp-shinned Hawk	*	*	*	*	R	R	R	R	R	*	R	R	R	R	R	R	R	*	R	U	*	R
Snow Goose	*	*	*	*	R	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*
Solitary Sandpiper	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*
Song Sparrow	C	C	C	U	U	C	U	U	U	U	C	C	C	C	C	C	U	C	C	C	C	U
Sora	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Spotted Sandpiper	*	*	*	*	*	*	*	*	*	*	*	*	*	R	R	*	*	*	*	*	*	*
Spotted Towhee	C	C	U	C	U	C	C	R	C	R	C	C	U	C	U	U	C	U	C	C	R	U
Steller's Jay	*	*	*	*	*	R	R	*	R	*	*	*	*	R	R	*	R	*	*	R	*	*
Swamp Sparrow	*	*	*	*	*	*	*	*	*	*	*	*	R	R	R	R	*	*	R	R	*	*
Townsend's Solitaire	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*
Varied Thrush	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*
Verdin	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*
Virginia Rail	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	R	*	*	*	*	*	*
Western Bluebird	*	U	*	R	R	U	U	U	U	*	U	U	U	U	U	R	U	U	U	U	U	*
Western Meadowlark	*	*	*	*	R	*	*	*	*	*	*	R	*	R	R	R	*	R	*	R	*	U
Western Screech-Owl	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*
Western Scrub-Jay	R	*	R	*	*	U	R	*	R	*	U	U	R	U	R	R	R	*	R	R	*	*
White-breasted Nuthatch	U	U	U	C	C	C	C	C	C	R	U	U	U	U	U	R	U	U	R	U	R	*
White-crowned Sparrow	C	C	C	U	U	C	U	U	C	U	U	C	U	C	C	C	C	C	C	C	*	C
White-throated Sparrow	R	R	R	*	U	U	R	*	R	*	R	R	R	U	U	*	U	*	U	U	*	R
White-winged Dove	R	R	R	U	R	U	U	U	C	*	R	R	R	U	U	*	R	R	*	R	*	*
Wild Turkey	*	*	*	*	*	*	*	*	R	*	*	*	*	R	*	*	*	*	*	*	*	*
Wilson's Snipe	*	*	*	*	*	*	*	*	*	*	*	*	*	U	U	R	*	*	*	*	*	*
Winter Wren	*	*	*	*	R	*	R	*	*	R	*	R	*	U	R	*	R	R	*	R	*	*
Wood Duck	*	*	*	*	*	*	R	*	R	*	R	*	*	U	U	U	*	*	*	U	*	*
Yellow-rumped Warbler	U	R	R	U	U	U	U	U	U	U	U	U	R	C	C	U	U	R	C	C	R	U

Appendix 42. Alphabetical list of bird species detected by C/S type during surveys in summer 2004-2013. 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-4	C-RO/CW 3	CW-RO 5	CW 6	DR 5	DR 6	MH 5-OW	NMO 5	OP	RO 3	RO 5	RO 6	SC 5
American Bittern	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
American Coot	*	*	*	*	*	*	*	*	*	*	*	*	*	R	R	C	*	*	*	*	*	*
American Crow	R	*	R	R	R	U	R	R	U	R	R	R	R	R	R	R	R	R	*	R	R	R
American Goldfinch	*	*	R	R	*	R	R	*	R	*	R	R	R	R	R	R	*	*	*	R	*	R
American Kestrel	R	U	C	R	U	R	R	R	U	*	R	U	U	*	U	R	R	U	*	U	U	R
American Robin	C	R	U	C	C	U	U	U	U	U	U	U	U	R	U	R	U	R	R	U	*	R
American Wigeon	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Ash-throated Flycatcher	C	U	R	C	U	C	C	U	C	U	U	U	R	U	U	U	U	U	R	U	U	U
Bank Swallow	*	*	*	*	*	R	R	*	*	*	R	*	R	R	*	R	*	R	*	R	*	R
Barn Owl	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	R	*	*
Barn Swallow	R	R	R	R	R	R	R	R	U	R	R	U	R	U	U	U	R	R	U	U	U	U
Bell's Vireo	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*
Belted Kingfisher	*	*	*	*	*	*	R	*	*	*	R	R	*	R	R	R	*	*	*	R	*	*
Bewick's Wren	U	U	U	C	C	C	C	U	C	U	C	C	R	C	U	U	C	U	U	C	U	U
Black Phoebe	R	R	*	R	R	R	R	R	R	R	R	R	R	C	U	U	R	R	R	R	*	R
Black-and-white Warbler	*	*	*	R	*	*	*	*	*	*	*	R	*	*	*	*	R	*	*	*	*	*
Black-capped Chickadee	*	U	R	C	C	C	C	U	C	U	C	U	U	U	R	R	U	R	U	U	R	*
Black-chinned Hummingbird	C	C	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	R	R	U	*	R	R	U	*	*
Black-headed Grosbeak	U	R	U	C	C	C	C	U	C	U	C	C	U	U	U	U	C	U	C	C	U	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	C	U	C	C	C	C	C	C
Blue-gray Gnatcatcher	R	R	R	R	R	R	R	R	U	R	R	R	R	R	R	*	R	R	R	R	R	R
Blue-winged Teal	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	U	*	*	*	*	*	*
Blue-winged Warbler	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Brewer's Blackbird	*	*	*	*	*	*	*	R	*	*	*	*	*	*	R	*	*	R	*	*	*	R
Brewer's Sparrow	*	*	R	*	*	*	*	R	R	R	*	*	R	R	*	R	*	R	*	*	*	U
Broad-tailed Hummingbird	R	R	R	U	U	U	U	R	U	R	U	U	R	U	U	R	U	R	*	U	R	R
Brown Creeper	*	*	*	*	*	*	R	R	R	*	*	*	*	*	*	*	*	R	*	*	*	*
Brown Thrasher	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Brown-headed Cowbird	U	U	U	C	C	U	C	U	U	U	C	C	U	U	U	U	C	R	C	C	U	U
Bullock's Oriole	U	R	U	U	U	U	U	R	U	R	U	U	R	R	U	R	R	R	C	U	R	R
Bushtit	U	U	R	C	U	C	C	R	C	U	C	C	U	C	U	U	C	U	U	C	R	U
Calliope Hummingbird	R	R	R	R	R	U	R	R	U	*	U	U	R	R	R	R	R	R	*	R	R	*
Canada Goose	*	*	*	*	*	*	*	*	*	*	*	R	*	R	R	U	*	*	*	*	*	*
Canvasback	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Canyon Towhee	*	*	*	*	*	R	R	*	*	*	*	*	*	*	R	*	*	*	*	*	*	R

Appendix 42 (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-4	C-RO/CW 3	CW-RO 5	CW 6	DR 5	DR 6	MH 5-OW	NMO 5	OP	RO 3	RO 5	RO 6	SC 5
Carolina Wren	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*
Cassin's Kingbird	*	*	R	R	R	*	R	*	*	*	*	R	*	R	*	R	*	R	R	R	*	R
Cassin's Sparrow	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	U
Cassin's Vireo	*	*	*	*	*	*	R	R	R	*	*	R	*	*	*	*	*	*	*	*	*	*
Cattle Egret	*	*	*	*	R	*	*	*	*	*	*	*	*	*	R	R	*	R	*	R	*	R
Cedar Waxwing	*	*	*	R	R	U	R	*	R	*	R	R	R	R	*	*	R	*	*	R	*	*
Chestnut-sided Warbler	*	*	*	*	*	*	*	R	*	*	*	*	*	R	*	*	R	*	*	*	*	*
Chipping Sparrow	U	U	U	U	R	U	R	U	U	R	U	U	R	U	U	R	U	C	R	R	U	C
Cinnamon Teal	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	U	*	*	*	*	*	*
Clay-colored Sparrow	R	*	R	R	*	R	R	R	R	*	R	R	R	R	R	R	*	R	*	R	*	U
Cliff Swallow	R	R	R	R	*	R	R	*	R	*	R	U	R	R	R	U	*	R	R	U	*	R
Common Black-Hawk	*	*	*	*	*	*	*	*	R	*	*	*	*	*	R	*	*	*	*	*	*	*
Common Gallinule	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Common Grackle	R	R	*	*	*	*	*	*	*	*	*	R	*	*	*	R	*	*	*	*	*	*
Common Merganser	*	*	*	*	*	*	*	*	*	*	*	*	*	R	R	*	*	*	*	*	*	*
Common Nighthawk	R	*	*	R	*	R	R	R	R	*	*	R	R	R	R	R	R	R	R	R	*	R
Common Poorwill	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	R
Common Raven	R	R	R	R	R	R	R	R	U	*	*	R	*	R	R	R	R	R	R	*	R	R
Common Yellowthroat	U	U	R	U	U	R	U	R	R	R	C	C	U	U	U	C	R	R	U	C	*	R
Cooper's Hawk	U	R	R	R	U	U	C	U	U	R	U	U	R	R	R	U	U	U	R	U	R	R
Cordilleran Flycatcher	R	*	*	R	*	R	*	*	R	*	*	R	*	R	*	*	R	*	R	R	*	R
Crissal Thrasher	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*
Curve-billed Thrasher	*	*	*	*	*	*	*	*	R	*	R	*	R	*	*	R	*	*	*	*	*	R
Double-crested Cormorant	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Downy Woodpecker	U	U	U	C	U	C	C	U	C	U	U	U	U	U	U	R	U	U	R	U	U	R
Dusky Flycatcher	*	*	*	R	R	R	R	R	R	*	R	R	*	R	R	R	R	*	R	R	*	R
Eastern Bluebird	*	R	R	R	*	R	R	U	U	R	*	*	R	R	R	*	R	R	R	*	R	*
Eastern Phoebe	*	*	*	*	*	*	*	*	R	*	*	*	R	R	*	*	*	*	*	*	*	*
Eastern Wood-Pewee	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*
Empidonax spp.	*	R	R	R	R	R	U	R	U	*	R	R	R	U	U	R	R	R	R	R	R	R
Eurasian Collared-Dove	R	R	R	R	*	R	R	R	R	*	*	R	*	R	R	R	*	R	*	R	*	*
European Starling	U	R	U	R	*	U	R	R	U	*	R	R	*	R	R	*	R	*	R	R	*	*
Gadwall	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	U	*	*	*	*	*	*
Gambel's Quail	R	*	*	R	R	R	R	*	R	R	R	R	*	R	R	U	R	*	*	U	*	U
Gray Catbird	R	U	U	U	U	U	U	R	R	*	U	C	U	R	R	U	U	*	U	U	*	R
Gray Flycatcher	R	*	R	R	*	R	R	*	R	*	R	R	R	*	R	R	R	R	R	R	*	R
Gray Vireo	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*
Great Blue Heron	*	*	R	R	R	R	R	R	R	*	R	R	R	R	R	U	*	R	*	R	*	R
Great Egret	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	U	*	*	*	*	*	*
Great Horned Owl	R	R	*	U	*	R	R	U	U	*	*	R	*	R	R	*	R	*	R	*	*	*
Greater Roadrunner	R	R	R	R	R	R	R	R	U	*	R	U	R	R	U	R	R	R	R	R	*	R
Great-tailed Grackle	*	*	R	*	*	*	*	*	R	*	*	*	R	R	R	R	*	*	*	*	*	*
Green Heron	R	*	R	*	R	R	*	R	*	*	*	R	*	R	R	U	*	*	*	R	*	R
Green-tailed Towhee	*	*	R	R	R	R	R	R	*	*	R	R	R	R	R	*	R	R	*	R	*	R
Green-winged Teal	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Hairy Woodpecker	R	R	R	R	R	R	U	R	U	*	*	R	R	R	R	R	R	R	R	R	R	*

Appendix 42 (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-4	C-RO/CW 3	CW-RO 5	CW 6	DR 5	DR 6	MH 5-OW	NMO 5	OP	RO 3	RO 5	RO 6	SC 5
Hepatic Tanager	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*
Hermit Thrush	*	*	*	*	R	*	R	*	R	*	*	*	*	*	R	*	*	*	*	*	*	*
Hermit Warbler	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R
Hooded Warbler	*	*	*	R	*	R	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
House Finch	C	U	C	U	U	U	C	U	U	U	U	C	U	U	U	C	U	U	R	U	R	U
House Sparrow	*	*	R	R	R	R	R	R	R	*	*	*	*	U	U	R	*	R	*	U	*	R
House Wren	R	*	*	R	R	R	R	*	R	*	R	R	R	R	R	R	R	*	*	R	*	R
Inca Dove	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Indigo Bunting	R	R	R	R	R	U	U	R	R	U	U	U	R	U	U	*	U	R	R	U	*	R
Killdeer	*	R	R	*	*	*	*	*	*	R	*	R	*	R	R	U	*	*	*	*	R	*
Ladder-backed Woodpecker	R	R	R	R	R	R	R	R	U	*	R	R	*	R	R	R	R	R	R	R	*	*
Lark Bunting	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	R	*	R	*	R	*	*
Lark Sparrow	R	R	R	R	R	U	R	R	R	*	R	R	R	U	R	U	R	U	R	R	R	C
Lazuli Bunting	R	R	*	R	R	R	R	R	R	*	R	R	R	R	R	R	R	R	R	R	*	R
Least Bittern	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Least Sandpiper	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Lesser Goldfinch	C	U	R	C	U	C	C	C	C	R	C	C	R	C	U	U	C	U	U	C	C	R
Lesser Yellow legs	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Lew is's Woodpecker	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Loggerhead Shrike	*	*	*	*	*	*	*	*	*	*	*	R	R	*	*	R	*	*	*	*	*	R
Long-eared Ow l	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*
Lucy's Warbler	*	*	*	R	R	*	*	R	R	*	*	*	*	R	R	*	*	*	*	R	*	R
MacGillivray's Warbler	U	R	R	U	U	U	U	R	U	R	U	U	U	U	U	R	U	U	R	U	R	U
Mallard	*	*	R	R	R	R	U	R	U	*	*	U	R	C	C	U	*	R	*	U	*	R
Marsh Wren	*	*	*	*	R	*	*	*	*	*	*	*	*	R	*	R	*	*	*	R	*	*
Merlin	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*
Mississippi Kite	*	R	*	R	*	R	R	R	R	*	R	R	*	R	R	*	R	*	*	*	*	*
Mountain Chickadee	*	*	*	R	R	R	U	R	R	*	R	R	*	R	R	*	R	R	*	R	*	*
Mourning Dove	C	C	C	C	C	C	C	C	C	U	C	C	C	U	C	U	U	C	C	C	C	C
Mute Sw an	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Nashville Warbler	*	*	*	*	*	*	R	*	*	*	R	R	*	R	*	*	*	*	*	R	*	*
Northern Flicker	U	U	U	U	U	U	U	U	U	R	U	U	U	R	R	R	U	R	R	U	U	R
Northern Harrier	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	R	*	*	*	R	*	R
Northern Mockingbird	U	R	R	R	R	R	R	*	R	*	R	U	U	R	R	R	R	R	*	R	R	C
Northern Parula	*	*	*	*	*	*	R	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*
Northern Pintail	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
N. Rough-w inged Sw allow	*	*	R	*	*	R	*	R	R	*	R	U	R	R	U	U	R	R	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	*	*	R	*	R
Orange-crow ned Warbler	R	*	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	*	R
Osprey	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Ovenbird	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
Painted Bunting	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*

Appendix 42 (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-4	C-RO/CW 3	CW-RO 5	CW 6	DR 5	DR 6	MH 5-OW	NMO 5	OP	RO 3	RO 5	RO 6	SC 5
Palm Warbler	*	*	*	*	*	*	R	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*
Peregrine Falcon	*	R	R	R	*	*	*	*	R	*	*	R	*	*	R	*	*	R	*	*	*	*
Phainopepla	*	*	*	R	*	*	*	*	*	*	*	R	*	*	R	*	*	*	*	R	*	R
Pied-billed Grebe	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	C	*	*	*	*	*	*
Pine Siskin	*	R	*	*	R	*	R	R	R	*	R	R	*	R	*	*	*	*	*	*	*	R
Pinyon Jay	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
Plumbeous Vireo	*	*	*	R	*	*	R	*	R	*	R	*	*	R	*	R	R	R	*	R	*	*
Prothonotary Warbler	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*
Purple Martin	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Red Crossbill	*	*	*	*	*	R	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*
Redhead	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	R	*	*	*	*	*	*
Red-breasted Nuthatch	R	*	*	R	R	R	R	R	R	*	R	R	R	R	*	*	R	*	*	R	*	*
Red-eyed Vireo	*	*	*	*	*	*	*	*	R	*	*	R	*	*	*	*	R	*	*	*	*	*
Red-headed Woodpecker	*	*	R	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Red-tailed Hawk	*	R	R	*	*	R	*	*	R	R	*	R	*	*	*	*	*	R	*	*	*	*
Red-winged Blackbird	R	U	R	R	R	R	R	*	R	*	*	U	R	U	R	C	R	R	R	U	*	U
Ring-necked Duck	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Ring-necked Pheasant	R	R	R	U	U	R	U	R	U	R	U	U	U	R	R	R	R	U	*	U	*	R
Rock Pigeon	*	*	*	*	*	*	*	*	R	*	*	*	*	*	R	*	*	R	*	R	*	*
Rose-breasted Grosbeak	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Ruby-crowned Kinglet	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*
Ruddy Duck	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Rufous Hummingbird	R	R	R	U	U	U	U	U	U	R	U	U	U	U	U	R	U	R	R	U	R	R
Rufous-crowned Sparrow	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	R	*	*	*	R	*	R
Savannah Sparrow	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	R	*	*	*	*
Say's Phoebe	*	*	R	R	R	R	R	R	R	*	R	R	R	R	R	R	R	U	*	R	R	R
Scaled Quail	*	*	*	*	*	R	*	*	R	*	*	*	R	*	*	*	*	*	*	*	R	R
Snowy Egret	*	*	R	*	R	*	R	*	R	*	*	R	*	R	R	U	*	R	R	R	*	*
Solitary Sandpiper	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	R	*	*	*	*	*	*
Song Sparrow	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*
Sora	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Spotted Sandpiper	*	*	*	*	*	*	R	*	R	R	R	R	R	*	R	R	*	*	R	R	*	*
Spotted Towhee	C	C	U	C	C	C	C	U	C	U	C	C	C	C	U	U	C	U	C	C	U	C
Summer Tanager	U	U	R	C	U	U	C	U	C	U	U	U	R	U	U	R	U	R	R	U	U	R
Swainson's Hawk	R	R	R	R	R	R	R	R	R	*	*	R	R	*	R	R	*	R	R	R	*	R
Townsend's Solitaire	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	R	*	*	*	*	*
Townsend's Warbler	*	*	*	R	*	R	R	*	R	*	R	R	*	R	R	*	R	R	*	R	*	R
Tree Swallow	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	R	*	*	*	*	*	*
Turkey Vulture	R	R	*	R	R	*	R	R	R	R	*	R	*	*	R	*	R	*	*	R	*	*
Vesper Sparrow	*	*	*	R	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R
Violet-green Swallow	*	R	*	R	*	R	R	*	R	*	*	R	*	R	*	U	*	R	*	R	*	R
Virdin	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Virginia Rail	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	U	*	*	*	R	*	*

Appendix 42 (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-4	C-RO/CW 3	CW-RO 5	CW 6	DR 5	DR 6	MH 5-OW	NMO 5	OP	RO 3	RO 5	RO 6	SC 5
Virginia's Warbler	U	R	R	U	U	U	U	U	U	R	C	C	U	U	U	R	U	R	R	C	*	U
Warbling Vireo	*	*	R	R	R	U	U	R	U	R	U	R	R	U	R	R	R	R	R	U	*	R
Western Bluebird	*	R	*	R	*	*	R	R	R	*	*	*	R	*	*	*	*	*	*	*	*	R
Warbling Vireo	*	*	R	R	R	U	U	R	U	R	U	R	R	U	R	R	R	R	R	U	*	R
Western Bluebird	*	R	*	R	*	*	R	R	R	*	*	*	R	*	*	*	*	*	*	*	*	R
Western Kingbird	U	R	C	U	U	R	U	R	U	*	R	U	U	U	U	U	R	U	R	U	U	R
Western Meadow lark	*	*	R	*	*	*	*	*	R	*	*	R	*	*	R	R	*	*	*	R	R	R
Western Screech-Ow l	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	R	*	*	R	*	*
Western Scrub-Jay	*	*	*	*	*	R	R	*	R	*	R	R	*	*	R	*	*	R	*	R	*	*
Western Tanager	R	R	R	U	U	U	U	R	U	R	U	U	R	U	U	R	U	R	R	U	R	R
Western Wood-Pew ee	R	R	R	U	U	U	U	U	U	R	R	U	R	U	R	R	U	R	R	U	R	R
White-breasted Nuthatch	U	U	U	C	U	C	C	C	C	U	U	U	R	C	U	R	U	U	R	U	U	*
White-crow ned Sparrow	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	R	*	*	R	*	*
White-eyed Vireo	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*
White-faced Ibis	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
White-w inged Dove	U	U	R	R	R	R	R	R	U	*	R	R	R	R	R	R	R	R	R	R	*	U
Wild Turkey	*	R	*	*	*	*	*	*	R	*	*	*	*	*	*	*	*	*	*	*	*	*
Willow Flycatcher	*	*	*	*	*	*	R	*	R	*	R	R	R	R	R	*	R	R	*	R	*	R
Wilson's Snipe	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	*
Wilson's Warbler	C	*	U	U	U	U	C	U	U	U	U	U	U	C	U	R	U	U	U	U	R	U
Wood Duck	*	R	*	R	U	R	R	*	R	R	R	R	R	C	U	C	*	R	*	R	*	*
Yellow Warbler	U	R	U	R	U	U	R	R	R	R	U	U	R	U	U	R	U	R	R	U	*	R
Yellow -billed Cuckoo	*	*	*	R	R	*	*	*	R	*	R	*	*	*	*	*	*	*	*	R	*	*
Yellow -breasted Chat	U	U	U	C	C	C	C	R	U	C	C	C	U	C	U	U	C	R	C	C	R	U
Yellow -headed Blackbird	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	R	*	*	*	*	*	R
Yellow -rumped Warbler	*	*	R	R	R	R	R	R	R	*	*	R	R	R	R	R	R	*	*	R	R	R