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Managing Water in the West

2014 Monitoring Report for the Los Lunas Habitat Restoration Project

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Environmental Services Division
Fisheries and Wildlife Resources Group
Denver, Colorado

April 2015

Mission Statements

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

2014 Monitoring Report for the Los Lunas Habitat Restoration Project

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Cover Photo: Rio Grande looking upstream from the Los Lunas site, September 2014.
Photo by Gregory Reed.

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Introduction

Riparian cottonwood (*Populus* spp.) and willow (*Salix* spp.) forests are an important ecosystem in the Southwestern United States, providing fish and wildlife habitat, biodiversity, and watershed protection (Hultine et al. 2010). Native riparian habitat is used by a wide range of species and supports a greater diversity of vertebrate species than adjacent upland areas (Sprenger 1999). Along the Middle Rio Grande in central New Mexico, the endangered southwestern willow flycatcher (*Empidonax traillii extimus*; SWFL) and the threatened yellow-billed cuckoo (*Coccyzus americanus*) are species of particular concern that are dependent on riparian habitat. The destruction of riparian habitats has caused severe declines in these populations, which exist only in fragmented and scattered locations throughout their historic range (USFWS 1997, USFWS 2013).

Native riparian communities, although once abundant, are declining and now comprise <1 percent of the land area in the southwest (Sprenger 1999). Declines and degradation of native riparian habitat have been associated with a number of activities that have resulted in hydrologic changes. In the Middle Rio Grande Valley, reservoir construction, regulation of surface flow, groundwater pumping, and water diversions have interfered with hydrological processes such as overbank flooding, floodplain scouring, and sediment deposition within floodplains (Sprenger 1999). These flood control structures and flow management regimes have prevented natural flooding necessary for cottonwood and willow regeneration (Dreesen et al. 2002) and have also led to sections of the bosque being less hydrologically connected to the river than they were in the past, lowering the water table (Cartron et al. 2008). The reproductive biology of cottonwood and willow is strongly tied to fluvial processes (Stromberg 1993). In desert riparian areas, seedling establishment is dependent on late winter and early spring flood flows to deposit moist alluvium on sediment bars during the short period in early spring when native seeds are dispersed (Sprenger 1999, Muldavin et al. 2015). Seeds, which are only viable for several weeks, are reliant upon slowly receding flood flows and water tables so seedling roots can stay in contact with adequate soil moisture. Mature plants often become isolated on high floodplains some distance from the active channel, but continue to remain hydrologically dependent on a shallow riparian water table (Stromberg 1993). Mature tree growth and maintenance depends on groundwater remaining above a depth of about 10 feet (ft) in the bosque (Cartron et al. 2008). For the establishment and development of younger age classes (those typically occupied by SWFLs) the groundwater levels must remain much higher – perhaps less than 5 ft based on data collected in association with the Elephant Butte and Bosque del Apache Sediment Plug Studies (Siegle et al. 2013, Siegle et al. 2012).

In addition, large areas of the Middle Rio Grande that were historically cottonwood forests have been invaded by exotic woody species, primarily saltcedar (*Tamarix* spp.). Saltcedar, like cottonwood and willow, is dependent upon moist, bare substrates created by receding flood flows for initial germination and survival (Sprenger 1999). Unlike native species, however, saltcedar disperses seed throughout the growing season allowing greater opportunity to establish than native species. The establishment of exotics, along with a predominately dry floodplain that lacks scouring floods and slows decomposition, have magnified the potential of severe wildland fires because of the massive fuel loads produced (Dreesen et al. 2002, Cartron et al. 2008).

In April of 2000, an area of the bosque near Los Lunas, New Mexico suffered a severe fire that destroyed virtually all of the aboveground vegetation. This area thus presented a unique opportunity for native riparian forest restoration and was designated as the Los Lunas Habitat Restoration Project.

Project Background

Historically, the Los Lunas Habitat Restoration Project fulfilled requirements in one of eight reaches in which habitat restoration was to be conducted in accordance with Element J of the Reasonable and Prudent Alternative (RPA) within the June 2001 Biological Opinion (BO) issued by the U.S. Fish and Wildlife Service (USFWS 2001). Following the fire, the Los Lunas Restoration Site (LLRS) was selected as the first BO restoration area (Figure 1). The U.S. Bureau of Reclamation (Reclamation) Albuquerque Area Office and the U.S. Army Corps of Engineers Albuquerque District have acted as joint lead federal agencies on this project, and the Middle Rio Grande Conservancy District is the primary non-federal cooperator.

The primary objectives of the restoration project were to improve habitat conditions for the Rio Grande silvery minnow (*Hybognathus amarus*; minnow) and SWFL such that, in combination with other elements of the RPA, continued jeopardy to the two species could be avoided.

The design goals were to generate inundation of the project area at flows of greater than or equal to 2,500 cubic ft/second (cfs). For flows below 2,500 cfs, a variety of substrate elevations was integrated into the project design to allow for the inundation of certain regions at lower river stages. This included features such as a network of variable depth side and transverse channels designed to aid in minnow egg retention and provide shallow water/low velocity rearing habitat. In addition, the increased inundation frequency would begin the process of post-fire regeneration of high-value terrestrial habitats in portions within and adjacent to the restoration area to support the recovery of the SWFL.

In April 2002, the initial phase of work began by removing approximately 1,400 jetty jacks and establishing access routes and a staging area. When construction was initiated, the site was largely dominated by thick stands of herbaceous and exotic regrowth. Vegetation was cleared and mulched within the overbank area, access roads, staging area, and disturbance areas next to the levee and root-wad berm. With the removal of jetty jacks completed, crews from Reclamation’s Socorro Field Office began clearing, surveying, and excavating the flood plain. Specific areas within the site were revegetated using seed, potted shrubs, or cottonwood and willow poles.

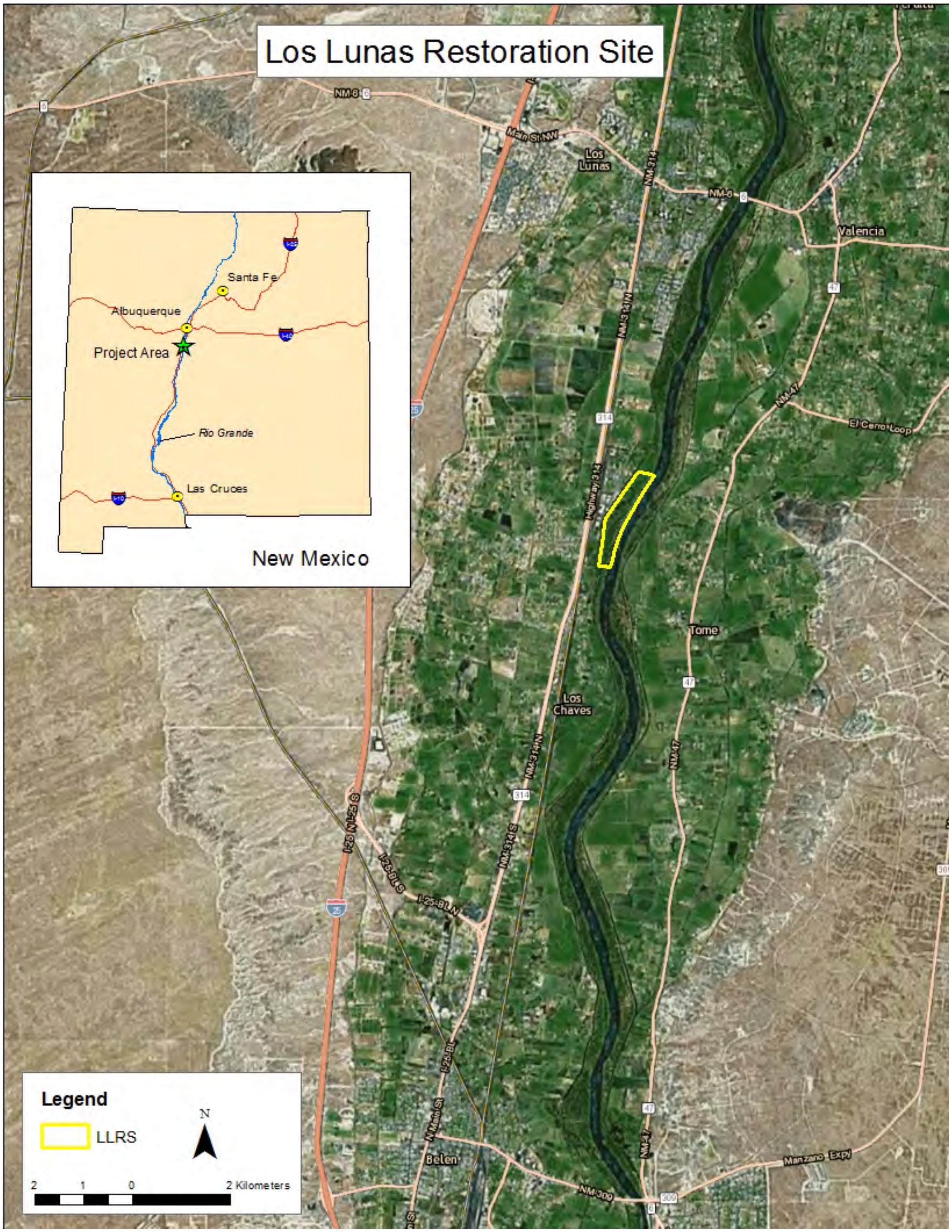


Figure 1.—Location of the Los Lunas Restoration Site (LLRS) project area.

Properly functioning riparian areas serve key roles in providing fish and wildlife habitat and preserving water quality and supply. Factors such as water table depth and fluctuation, soil texture, soil salinity, and browsing pressure from livestock and wildlife determine the success of restoration in creating a functioning riparian area (Dreesen et al. 2002). Reclamation’s Technical Service Center (TSC) in Denver, Colorado has conducted avian, vegetation, and groundwater monitoring at LLRS since 2003. Although requirements of the BO have been met, this study is being continued to provide information for an adaptive management approach to creating and monitoring potential SWFL habitat. Objectives of annual monitoring efforts are to:

- determine the success of restoration at the LLRS in establishing a productive cottonwood/willow riparian community, as well as characterizing factors that may have influenced the outcome;
- assess SWFL habitat suitability/sustainability and identify those variables which contribute to the development of SWFL habitat;
- establish a potential timeframe in which a restored site develops into suitable SWFL habitat under local environmental conditions; and
- provide data for the adaptive management of future restoration efforts in the Middle Rio Grande

Methods

This comprehensive study is comprised of various types of monitoring which include avian point counts and SWFL surveys, vegetation transects, ground water wells, and photo stations. Methods used for each type of monitoring are described below.

Avian Monitoring

Point Counts

Avian monitoring included 5-minute, 50-meter (m) fixed-radius point counts that were conducted 3 times/year during the peak breeding season (late-May to early-July). Point counts took place within 2 areas that were monitored over a 12-year study period from 2003 to 2014 (waypoint locations are listed in Appendix A). These areas – the Cleared/Overbank and Burned Areas – were located within the LLRS and are separated by a root-wad berm constructed during restoration activities. Only the Cleared/ Overbank Area was monitored for the duration of the study. Point counts were conducted in the Burned Area in 2003, 2004, and 2007 to 2014. The Cleared/Overbank and Burned Areas are described below:

Cleared/Overbank Area

This restoration area, adjacent to the active river channel, was cleared and excavated to allow overbank flooding with regrowth comprised of primarily native and mixed vegetation. Eight point counts were conducted at this site from 2003 to 2006; points were relocated and increased to 12 in 2007 so that: a) the points were more evenly distributed over the area; and b) all areas had the same sample size (Figure 2).

Burned Area

This cottonwood gallery, burned in 2000 and adjacent to the Cleared/Overbank Area, experienced regrowth of mixed vegetation. Point counts were conducted in 2003 and 2004, and after a two year hiatus, monitoring was resumed in 2007 to provide a comparison site. Seventeen point counts were conducted at this site in 2003 and 2004; points were relocated and decreased to 12 in 2007 so that: a) the points were more evenly distributed and were all within the restoration area; and b) all areas had the same sample size (Figure 2).

Data from the 12 years of monitoring were analyzed to evaluate any trends in relative abundance of pooled species guilds over time and statistical comparisons were made between areas. Pooled species guilds were categorized based predominately on nesting habitat and included canopy, cavity, dense shrub, edge, ground shrub, mid-story, open, and water birds. Migrants were also documented but were not included in statistical analysis. Table B-1 in Appendix B shows the groupings of individual bird species into guilds for analysis purposes as well as scientific names of the bird species.

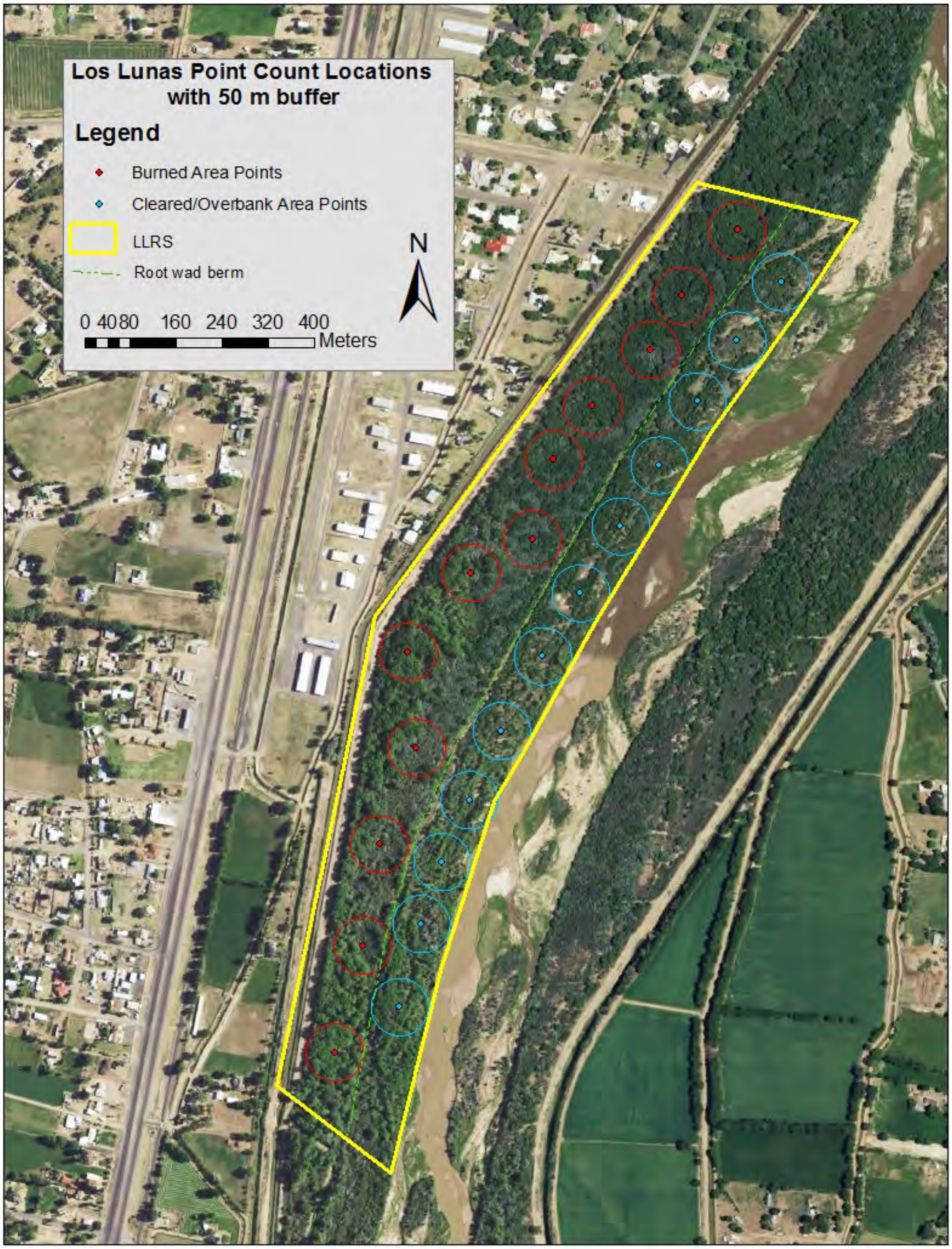


Figure 2.—Cleared/Overbank and Burned Area point count locations at LLRS (NAIP 2014 natural color photography). A root wad berm separates the 2 areas.

Statgraphics statistical software was used to conduct simple linear regressions to test for significant relationships between the abundance of birds and year (*i.e.*, time; Nur et al. 1999). To compare bird abundance between areas by year, the Student's t-test was used for normally distributed data and the Mann-Whitney nonparametric test of medians was used for data that were not normally distributed. Primer-e statistical software was used to generate Multi-dimensional Scaling (MDS) configurations which were used to examine species composition over time and between plots. MDS ordination ranks species similarities and the associated configuration can be interpreted in terms of relative similarity of samples to each other (Clarke et al. 2014).

Southwestern Willow Flycatcher Surveys

Three presence/absence surveys were conducted per year for the endangered SWFL within the LLRS from 2004 through 2014 in accordance with Sogge et al. (2010). Additional surveys were conducted within the same period on both sides of the river in adjacent sections of the Belen reach between the Los Lunas and Belen bridges. These surveys were part of Reclamation's annual SWFL monitoring program conducted at selected sites along the Rio Grande from Bandelier National Monument to Elephant Butte Reservoir (Moore and Ahlers 2015).

Vegetation Monitoring

Twelve 50-m permanent transects were established at the LLRS between the root-wad berm and the river (the site referred to as the Cleared/Overbank Area in avian monitoring) to document the natural establishment of vegetation in this area (waypoint locations are listed in Appendix A). The area where transects were placed was not revegetated using seed or potted shrubs as were some areas within the restoration site. All transects were evenly distributed in the disturbed area and were oriented perpendicular to the river (Figure 3).

Cover and species composition were measured every 0.5 m along the 50-m transect. For understory measurements, the point-intercept method was used, which entailed recording the first "hit" for herbaceous plant species and for woody species under 1 m tall. If a plant was not intercepted, then bare soil or litter was recorded. As of 2007, the line-intercept method was used for measuring overstory cover. Canopy cover was measured along each transect by noting the point along the tape where the canopy began and the point at which it ended for each woody species over a meter tall. Because species overlapped in some cases, the sum of the cover for all species did not necessarily reflect the actual percentage of overstory cover along the tape. The percentage of the tape covered by overstory was also calculated. The height of the tallest vegetation within each continuous stretch of the same species was measured.

The methodology used for cover measurements was revised in 2007 to include a separate overstory measure (woody species > 1 m in height). Prior to 2007, the method used to collect understory cover was applied to all vegetation cover measurements, so that if a woody species was intercepted first, then this species was recorded as understory. As

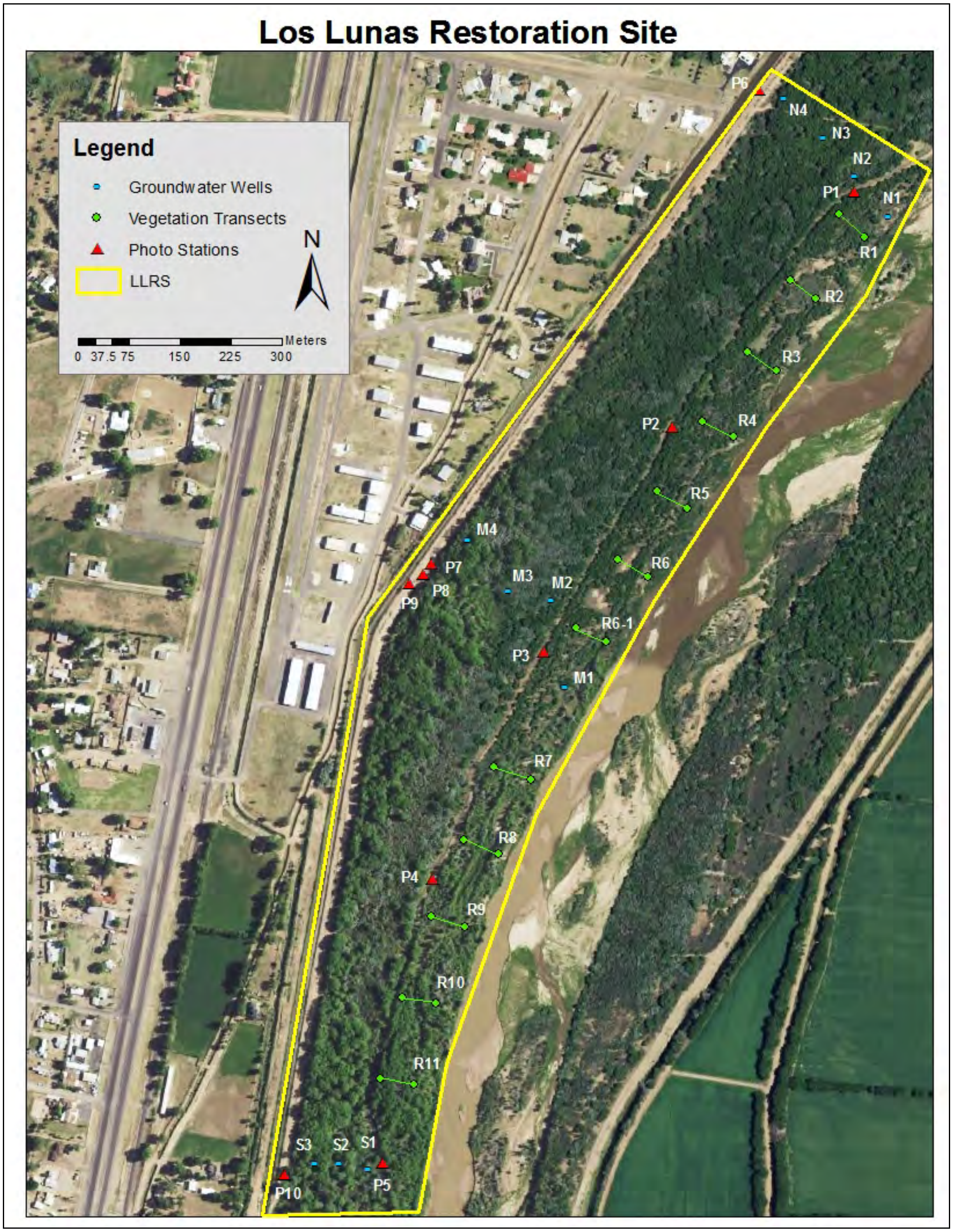


Figure 3.—Vegetation transect, well, and photo station locations at LLRS (NAIP 2014 natural photography).

vegetation grew in height, the original methodology did not account for overstory as a separate layer, and understory vegetation cover was not fully captured. This phenomenon was first noticed in 2006; therefore understory shrub data from that year is probably more comparable to overstory data from 2007 to 2014. Data were collected between mid-August and mid-September from 2003 through 2014.

Data from the 12 years of monitoring were compared to evaluate any statistically significant changes within vegetation types over time. The repeated measures analysis of variance (ANOVA) was applied to test for relationships between total cover and year, while Fisher's least significant difference (LSD) procedure was used as a multiple comparison test to evaluate statistically significant differences between years (alpha=0.05) utilizing StatGraphics statistical software. The Fisher’s LSD analysis is a post-test to the repeated measures ANOVA and provides a more focused analysis of individual years. Primer-e statistical software was used to generate MDS configurations to examine changes in plant species composition over time. MDS ordination ranks species similarities and the associated configuration can be interpreted in terms of relative similarity of samples to each other (Clarke et al. 2014).

Total percent cover (i.e., actual cover estimate) was statistically analyzed for understory and overstory vegetation. Relative percent cover was determined for understory life-forms (i.e., native or introduced shrubs <1 m in height, grasses and grass-like species, and forbs). Relative cover is cover of a species or life-form expressed as a percent of total vegetation.

Ground Water Monitoring

Eleven ground water monitoring wells were installed along 3 transects running perpendicular to the river: 4 wells on the northern end of the site, 4 in the center, and 3 on the southern end (Figure 3; waypoint locations are listed in Appendix A). All wells were installed using the Army Corps of Engineers (2000) methodology. Wells averaged 5.0 ft in depth, with the ground water depth at a range of 2.0 to 4.0 ft below the surface at the time of installation. Eight wells were installed in June 2003 and the remaining westernmost three were installed July 2004. The eleven wells were manually monitored every month from date of installment to 2010.

In June 2011, HOBO Water Level Loggers were installed in 9 of the wells and hydrologic measurements were discontinued in 2 of the westernmost wells. Loggers were attached to the well cap via a braided stainless steel wire and programmed to collect readings every 2 hours. Data from loggers provides a much more detailed record of groundwater fluctuations than the previous method of collecting data just once a month. Most importantly, the duration of water table depths at critical levels can be determined and correlations to surface flows can be derived.

Photo Stations

Ten photo stations were established throughout the study area with permanent numbered t-posts (Figure 3; waypoint locations are listed in Appendix A). Digital photographs were taken between mid-August and mid-September in 2003 through 2014 to visually document vegetation height, density, species composition, and overall site development. Annual photos were compared to evaluate visible changes over time.

Results

Avian Monitoring

Point Counts

Cleared/Overbank Area

Table C-1 in Appendix C provides data on the relative abundance of individual bird species for the Cleared/Overbank Area by year. The *% Plots* column shows the percentage of points in which the species was documented within this area. The *Mean* and *SD* columns represent the mean number and standard deviation of detections per point for the species.

There were 62 breeding bird species and 14 migrant species detected in the Cleared/Overbank Area during the point counts conducted from 2003 to 2014. The most abundant species (based on the mean number of detections per point) in 2003 were redwing blackbirds, turkey vultures, and blue grosbeaks. The most abundant species in 2014 were yellow-breasted chats, black-chinned hummingbirds, and spotted towhees.

Species composition was analyzed using a Bray-Curtis similarity matrix which examines species similarity between years. Statistical analysis found a significant difference in species composition over time ($P<0.001$) within the Cleared/Overbank Area. Pairwise testing identified the highest similarities between years 2003 and 2004 and between years 2012, 2013, and 2014. For the most part, these results are illustrated in the Multi-dimensional Scaling (MDS) configuration in Figure 4 (note that the configuration may not exactly represent statistical results because MDS analysis uses means, unlike pairwise testing, and therefore variances may differ). MDS ordination ranks similarities and the associated configuration can be interpreted in terms of relative similarity of samples to each other (Clarke et al. 2014). For example, in this case it can be interpreted that species composition in 2005 and 2006 was less similar than all other years of monitoring. Species composition followed a continual change over time and began to become more similar starting in 2010 or 2011. Stress is the measure of distortion in the configuration. A stress factor of <0.5 gives an excellent representation; MDS analysis of this data had a stress of 0.06. The length and change in direction of the line between years illustrates the degree and relative change in species composition each year (e.g., starting in 2003 and ending in 2014). Size of overlay circles associated with each year represent abundance of 4 species, each of which was a species detected in the 4 most common guilds. In this case, abundance of black-chinned humming birds increased with time while abundance of red-winged blackbirds decreased with time after peaking in 2005.

Means and totals by species guilds for the Cleared/Overbank Area are shown in Table 1. Totals for the numbers of species within each guild accounted for all species detected

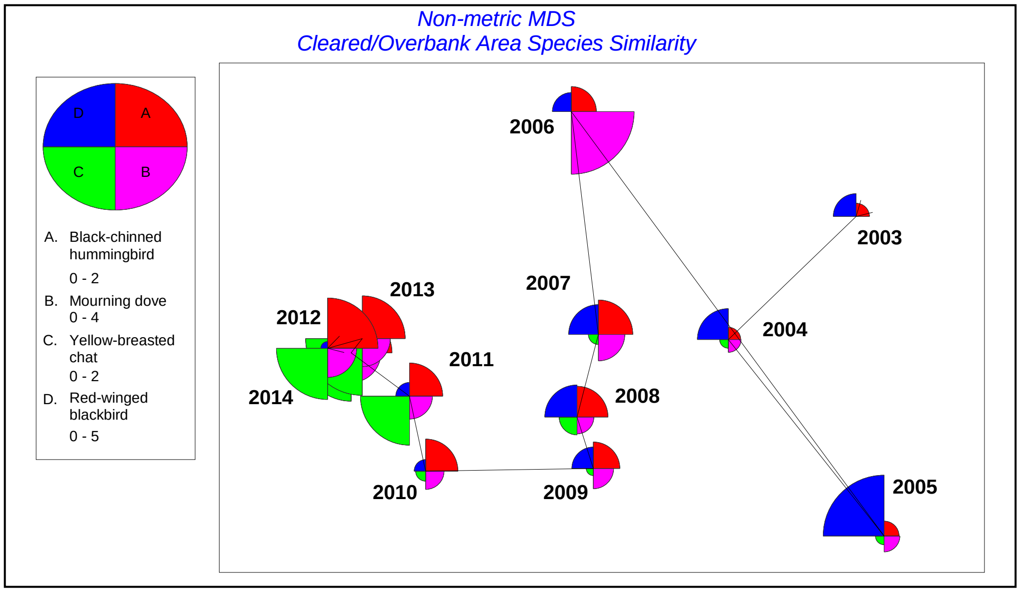


FIGURE 4.— MDS ordination of 12 years of species abundance data within the Cleared/Overbank Area based on Bray-Curtis similarities (stress=0.06). Overlay circles associated with each year represent abundance of 4 of the species detected.

Table 1.—Total, mean, and standard deviation by species guilds for the Cleared/Overbank Area from 2003 to 2008.

Guilds in the Cleared/overbank area	2003 8 points		2004 8 points		2005 8 points		2006 8 points		2007 12 points		2008 12 points	
	Total	Mean (SD)	Total	Mean (SD)	Total	Mean (SD)	Total	Mean (SD)	Total	Mean (SD)	Total	Mean (SD)
# Species	18	1.79 (1.25)	20	2.92 (1.61)	21	3.58 (1.35)	20	3.67 (2.04)	24	3.78 (1.66)	22	3.42 (1.71)
# Birds	22	2.75 (3.08)	37	4.58 (2.92)	77	9.67 (4.47)	70	8.79 (9.14)	79*	7.83 (11.21)	66	5.50 (3.26)
# Canopy spp.	1	0.04 (0.20)	0	0.00 (0.00)	1	0.04 (0.20)	0	0.00 (0.00)	1	0.03 (0.17)	0	0.00 (0.00)
# Canopy birds	3	0.42 (2.04)	0	0.00 (0.00)	1	0.04 (0.20)	0	0.00 (0.00)	1	0.03 (0.17)	0	0.00 (0.00)
# Cavity spp.	1	0.04 (0.20)	2	0.13 (0.45)	2	0.08 (0.28)	1	0.04 (0.20)	1	0.06 (0.23)	2	0.14 (0.49)
# Cavity birds	1	0.04 (0.20)	2	0.17 (0.56)	2	0.08 (0.28)	1	0.04 (0.20)	1	0.06 (0.23)	2	0.14 (0.49)
# Dense shrub spp.	0	0.00 (0.00)	1	0.13 (0.34)	1	0.17 (0.38)	1	0.17 (0.38)	1	0.61 (0.49)	1	0.36 (0.49)
# Dense shrub birds	0	0.00 (0.00)	1	0.13 (0.34)	2	0.21 (0.51)	1	0.17 (0.38)	10	0.81 (0.86)	5	0.42 (0.60)
# Edge spp.	5	0.38 (0.65)	5	0.46 (0.59)	2	0.29 (0.46)	4	1.00 (1.06)	3	0.58 (0.65)	2	0.36 (0.49)
# Edge birds	5	0.54 (1.02)	5	0.50 (0.66)	3	0.33 (0.56)	12	1.50 (1.84)	11*	2.19 (8.09)	6	0.50 (0.77)
# Ground shrub spp.	2	0.29 (0.46)	3	0.75 (0.79)	3	0.54 (0.59)	4	1.00 (0.83)	4	1.06 (0.89)	4	0.42 (0.60)
# Ground shrub birds	3	0.42 (0.72)	9	1.13 (1.54)	10	1.25 (1.62)	38	4.71 (7.80)	23	1.94 (2.40)	6	0.53 (0.84)
# Mid-story spp.	3	0.17 (0.38)	4	0.42 (0.78)	3	0.13 (0.45)	2	0.17 (0.48)	7	0.61 (0.73)	5	1.11 (0.95)
# Mid-story birds	3	0.17 (0.38)	5	0.67 (1.20)	3	0.21 (0.83)	2	0.29 (0.81)	12	1.00 (1.37)	23	1.92 (1.92)
# Open spp.	1	0.04 (0.20)	1	0.17 (0.38)	1	0.08 (0.28)	1	0.21 (0.41)	1	0.03 (0.17)	0	0.00 (0.00)
# Open birds	2	0.08 (0.41)	1	0.17 (0.38)	1	0.08 (0.28)	5	0.58 (1.32)	2	0.11 (0.67)	0	0.00 (0.00)
# Water spp.	5	0.83 (0.83)	4	0.88 (0.90)	8	2.33 (1.05)	7	1.08 (0.83)	7	0.83 (0.94)	8	1.03 (1.06)
# Water birds	9	1.08 (1.21)	15	1.83 (2.48)	59	7.46 (3.88)	12	1.50 (1.25)	20	1.69 (2.25)	24	2.00 (2.07)

*In 2007, 45 Brewer’s blackbirds were detected at one point during 1 of 3 monitoring periods. This data was omitted as an outlier for analysis purposes.

Table 1.(cont'd)—Total, mean, and standard deviation by species guilds for the Cleared/ Overbank Area from 2009 to 2014.

Guilds in the Cleared/overbank area	**2009 12 points**		**2010 12 points**		**2011 12 points**		**2012 12 points**		**2013 12 points**		**2014 12 points**	
	Total	**Mean (SD)**	**Total**	**Mean (SD)**	**Total**	**Mean (SD)**	**Total**	**Mean (SD)**	**Total**	**Mean (SD)**	**Total**	**Mean (SD)**
# Species	18	2.67 (1.45)	18	2.86 (1.53)	33	4.81 (1.01)	25	5.86 (1.07)	27	5.92 (1.00)	29	5.42 (1.40)
# Birds	40	3.36 (2.09)	48	4.03 (3.08)	82	6.89 (2.30)	109	9.05 (2.23)	106	8.81 (1.89)	99	8.31 (2.92)
# Canopy spp.	0	0.00 (0.00)	0	0.00 (0.00)	2	0.06 (0.23)	1	0.03 (0.17)	3	0.08 (0.28)	4	0.19 (0.47)
# Canopy birds	0	0.00 (0.00)	0	0.00 (0.00)	2	0.06 (0.23)	1	0.03 (0.17)	3	0.08 (0.28)	4	0.19 (0.47)
# Cavity spp.	0	0.00 (0.00)	2	0.17 (0.45)	4	0.31 (0.52)	4	0.28 (0.45)	4	0.19 (0.47)	4	0.25 (0.44)
# Cavity birds	0	0.00 (0.00)	7	0.19 (0.52)	4	0.36 (0.64)	5	0.39 (0.69)	4	0.22 (0.54)	4	0.31 (0.58)
# Dense shrub spp.	1	0.47 (0.51)	2	0.28 (0.45)	2	0.53 (0.51)	3	0.61 (0.60)	3	0.28 (0.45)	2	0.28 (0.45)
# Dense shrub birds	6	0.50 (0.56)	3	0.28 (0.45)	7	0.61 (0.64)	10	0.81 (0.82)	5	0.39 (0.69)	5	0.44 (0.94)
# Edge spp.	2	0.39 (0.55)	2	0.47 (0.56)	4	0.50 (0.56)	2	0.58 (0.50)	2	0.72 (0.51)	3	0.78 (0.48)
# Edge birds	6	0.47 (0.74)	7	0.56 (0.73)	7	0.64 (0.76)	10	0.86 (0.83)	12	1.03 (0.84)	16	1.33 (1.10)
# Ground shrub spp.	3	0.47 (0.70)	4	0.44 (0.69)	4	0.78 (0.64)	4	1.00 (0.68)	4	1.17 (0.85)	4	0.97 (0.65)
# Ground shrub birds	9	0.75 (1.23)	7	0.58 (1.00)	13	1.06 (1.09)	17	1.39 (0.96)	19	1.61 (1.32)	16	1.31 (1.01)
# Mid-story spp.	7	0.75 (0.73)	6	1.39 (0.99)	12	2.33 (0.93)	9	3.25 (0.87)	9	3.36 (0.90)	10	2.75 (1.05)
# Mid-story birds	11	0.89 (0.95)	24	2.03 (1.93)	42	3.50 (1.76)	64	5.36 (1.97)	63	5.22 (1.99)	52	4.36 (2.22)
# Open spp.	1	0.03 (0.17)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)
# Open birds	1	0.03 (0.17)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)
# Water spp.	4	0.56 (0.73)	2	0.11 (0.32)	5	0.31 (0.58)	2	0.11 (0.32)	2	0.11 (0.32)	2	0.11 (0.32)
# Water birds	8	0.75 (1.05)	5	0.39 (1.48)	8	0.67 (1.55)	3	0.22 (0.68)	3	0.25 (0.81)	4	0.36 (1.13)

during all three point count periods per year. Totals for the number of birds within each guild were calculated by averaging the number of birds detected at each point over the three point count periods and then summing all point averages. Note that sample sizes were sometimes different, so totals are not always equally comparable between areas or years. *Mean* and *SD* are the mean number and standard deviation of detections per point within each species guild.

The mean number of birds per point represents relative abundance (Nur et al. 1999), which is graphed by species guild over time in Figure 5. The total number of species detected during point counts represents species richness, graphed by guild over time in Figure 6. Since 2010, the most common species guilds based on relative abundance were midstory, ground shrub, and edge birds (Table 1 and Figure 4). There was an increase in both relative abundance and species richness among total birds over the monitoring period. Both of these variables increased in 2011 after a downward trend since around 2007. Relative abundance has continued to remain above 2011 levels while species richness has decreased since 2011 (but is still higher than when monitoring began).

In regression analysis examining the relationship between relative abundance of birds (average number of birds per point) and time (year), total, cavity, dense shrub, edge, mid-

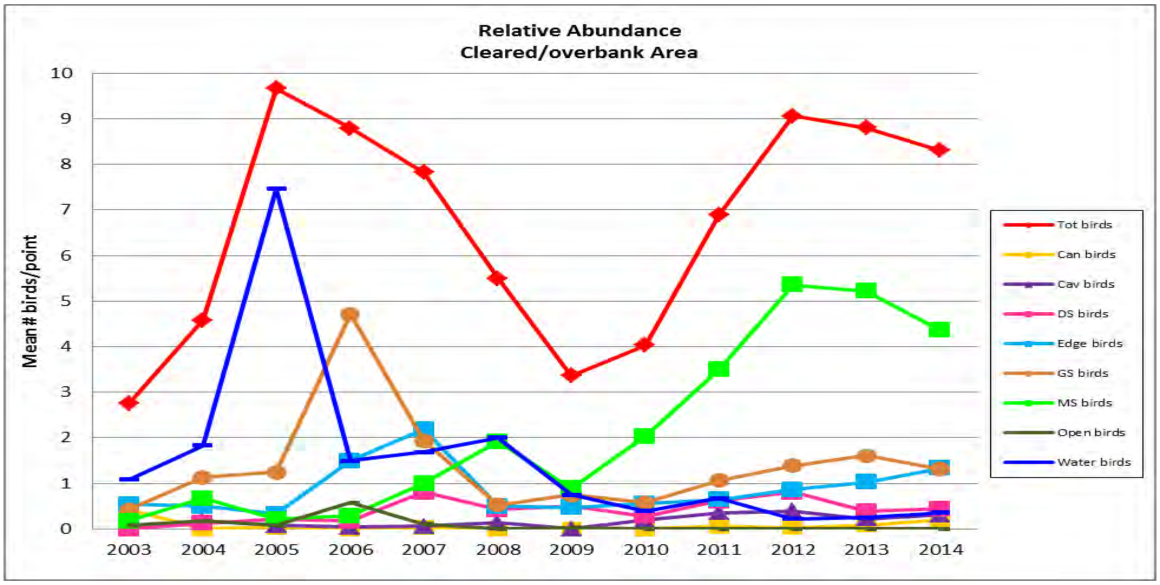


Figure 5.—Relative abundance by species guilds in the Cleared/Overbank Area over time.

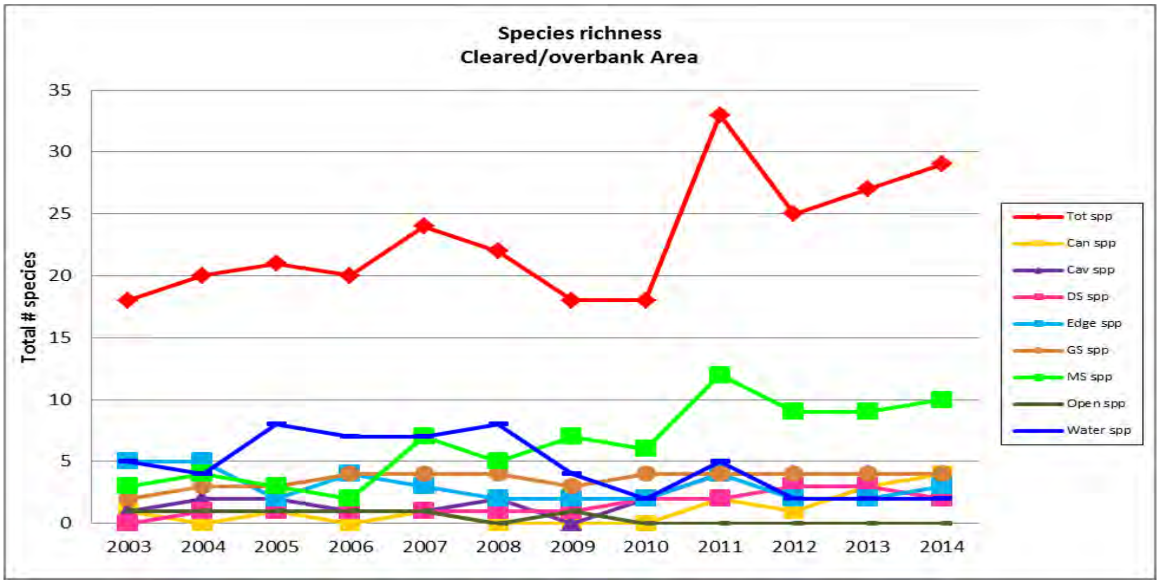


Figure 6.—Species richness by species guilds in the Cleared/Overbank Area over time.

story, open, and water bird guilds showed significance at the 95 percent confidence level (Table 2). In the total, cavity, dense shrub, edge, and mid-story guilds there was an increasing trend in the relative abundance of birds detected; among open and water birds there was a decreasing trend. Although the P-value identified a difference in abundance over time for almost all bird guilds, low R^2 values indicated that these differences were small for all but the mid-story bird guild (see linear trend in Figure 7). An R^2 value of 0.6477 (65 percent) indicated a moderately strong relationship between year and relative abundance among mid-story birds. Linear trends for the other 6 guilds in the Cleared/ Overbank Area that were found to be statistically significant are shown in Appendix D.

Table 2.— P and R^2 values for simple linear regression analysis between year and relative abundance by guild in the Cleared/Overbank Area. Alpha = 0.05.

Guilds	Cleared/overbank area 2003 to 2014	
	P	**R^2**
Total birds	>0.001	0.0900
Canopy birds	0.734	0.0009
Cavity birds	0.002	0.0763
Dense shrub birds	0.003	0.0702
Edge birds	0.008	0.0541
Ground shrub birds	0.589	0.0023
Mid-story birds	0.000	0.6477
Open birds	0.003	0.0689
Water birds	0.000	0.2374

Highlight = significant difference at the 95-percent confidence level

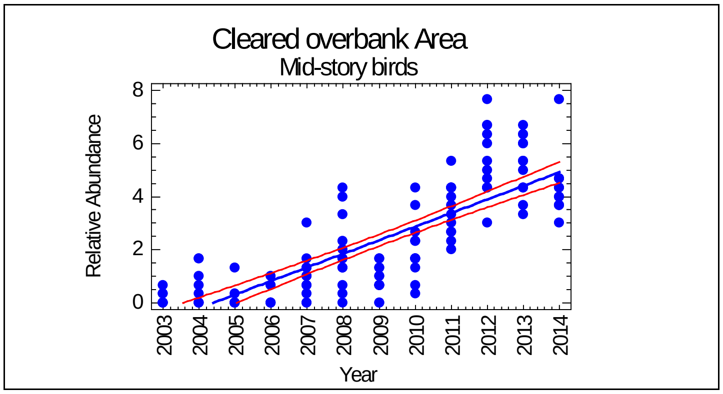


Figure 7.—Linear trend in average number of mid-story birds per point in relation to year (2003 to 2014) in the Cleared/Overbank Area. Points represent the average number of observations within 3 reps at each point in each year, straight blue line represents best-fitting trend, and red curving lines represent 95 percent confidence intervals.

Using a similarity matrix to examine changes in the proportion of species guilds between years identified a statistically significant difference over time ($P<0.001$) within the Cleared/Overbank Area. Pairwise testing identified the highest similarities of species guild abundance between years 2003 and 2004, and between years 2012, 2013, and 2014. In general, these results are illustrated in the MDS configuration in Figure 8. The composition of species guild abundance followed a continual change over time with 2005 and 2006 diverging and strong similarity beginning in approximately 2011. The MDS configuration had a stress factor of 0.07, which can be interpreted as an excellent representation. Each of the overlay circles represent abundance of 4 of the most common species guilds. Abundance of species within the midstory bird guild increased with time while abundance of water bird guild decreased with time after peaking in 2005. This analysis was the same done for species composition, which is described in more detail above.

Burned Area

Table C-2 (Appendix C) shows relative abundance of individual species for the Burned Area by year. A total of 56 breeding bird species and 7 migrant species were detected in this area in 2003, 2004, and 2007 through 2014. The most abundant species in 2003 were

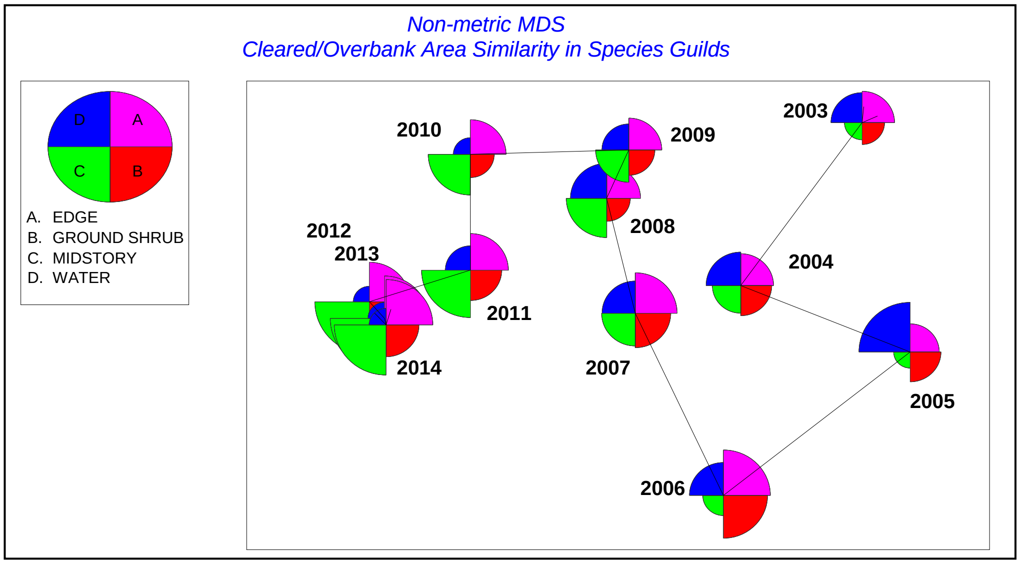


Figure 8.— MDS ordination based on 12 years of square root transformed species guild abundance data and Bray-Curtis similarities (stress=0.07). Overlay circles associated with each year represent abundance of species within 4 of the guilds.

the brown-headed cowbird, yellow-breasted chat, and spotted towhee. In 2014, the most common species included the black-chinned hummingbird, yellow-breasted chat, and spotted towhee.

Statistical analysis found a significant difference in species composition over time (P<0.001) within the Burned Area. Pairwise testing identified the highest species similarities between years 2009 and 2010; 2009 and 2012; 2011 and 2012; 2012 and 2013; and between years 2013 and 2014. These results are generally illustrated in the MDS configuration in Figure 9. The line between years illustrates relative change in

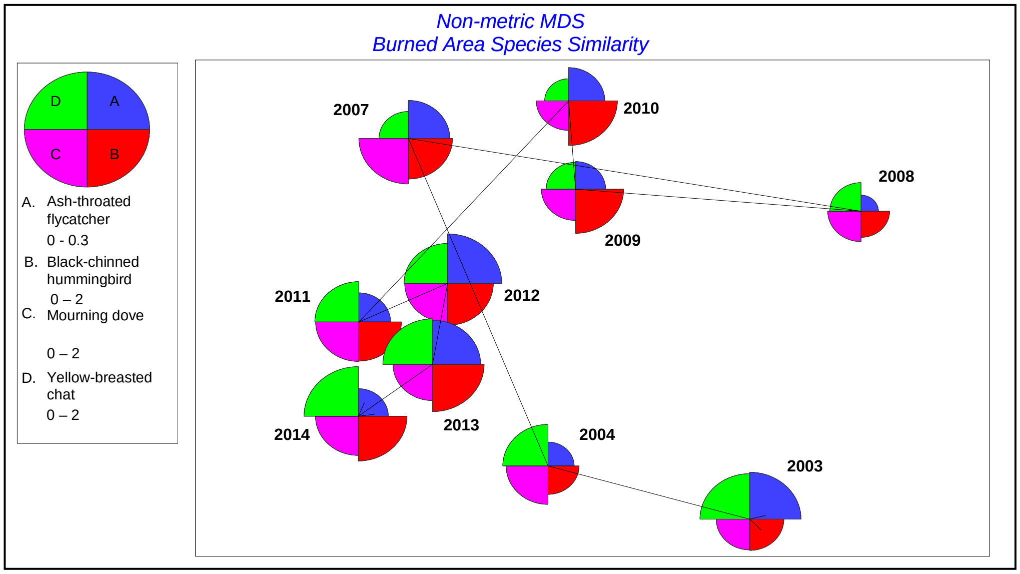


FIGURE 9.— MDS ordination of 10 years of species abundance data within the Burned Area based on Bray-Curtis similarities (stress=0.06). Overlay circles associated with each year represent abundance of 4 of the species detected.

species composition each year starting in 2003 and ending in 2014 with no data for years 2005 and 2006. In the Burned Area, MDS ordination shows that species similarity diverged somewhat from 2008 to 2010 and returned to a composition more similar to earlier years (2004 and 2007) from 2011 to 2014. This configuration had a stress of 0.06, which indicates an excellent representation. Size of overlay circles associated with each year represent abundance of 4 species, each of which was a species detected in the 4 most common guilds. Each of the overlay circles represent abundance of 4 of the most common species guilds. When comparing these species guilds from the first year of monitoring (2003) to the last (2014), abundance of ash-throated flycatchers decreased while abundance of black-chinned hummingbirds increased. Upon closer examination, it appeared that there was quite a bit of variability in the abundance of the 4 species throughout the monitoring period. Species similarity analysis was the same done for Cleared/overbank species composition, which is described in more detail above.

Means and totals by species guilds for the Burned Area are shown in Table 3. Relative abundance and species richness are graphed in Figures 10 and 11, respectively. There was an increase in relative abundance of edge birds and a decrease in canopy and cavity birds over the monitoring period; relative abundance in all other guilds did not show considerable change (Table 3, Figure 10). The total number of birds detected remained essentially the same at 8.45 birds/pt. in 2003 and 8.31 birds/pt. in 2014. Species richness did not show major changes in any bird guild over time.

In simple linear regression of abundance in relation to year, canopy, open, and edge bird guilds showed a significant relationship with $P<0.05$ (Table 4). Among the canopy and open guilds there was a statistically significant decreasing trend in the relative abundance of birds detected, while birds in the edge guild showed a significantly increasing trend. However, relatively low R^2 values indicated weak relationships between abundance and year for all of these species guilds. The linear trends for these three guilds within the Burned Area are plotted in Appendix D.

Using a similarity matrix to examine changes in the proportion of species guilds between years identified a statistically significant difference in the composition of guilds over time ($P<0.001$) within the Burned Area. In general, pairwise testing found years 2008 and 2010 to have the least similarities compared to the other years. It also appeared that composition of guilds in 2014 was more similar to the first years of monitoring than to the mid-years. For the most part, these results are illustrated in the MDS configuration in Figure 12, which had a stress factor of 0.07. When comparing these species guilds from the first year of monitoring (2003) to the last (2014), abundance of the water species guild decreased while abundance of ground shrub and edge species guilds increased. Abundance of the 4 species guilds varied, however, throughout the monitoring period. Species similarity analysis was the same done for Cleared/overbank species composition, which is described in more detail above.

Table 3.—Total, mean, and standard deviation by species guilds for the Burned Area for 2003, 2004, and 2007 to 2014.

Los Lunas Burned area	**2003 17 points**		**2004 17 points**		**2007 12 points**		**2008 12 points**		**2009 12 points**		**2010 12 points**		**2011 12 points**		**2012 12 points**		**2013 12 points**		**2014 12 points**	
	Total	**Mean (SD)**	**Total**	**Mean (SD)**	**Total**	**Mean (SD)**	**Total**	**Mean (SD)**	**Total**	**Mean (SD)**	**Total**	**Mean (SD)**	**Total**	**Mean (SD)**	**Total**	**Mean (SD)**	**Total**	**Mean (SD)**	**Total**	**Mean (SD)**
# Species	30	5.71 (1.66)	27	5.47 (1.40)	24	5.81 (2.23)	17	3.83 (1.54)	24	4.42 (1.44)	18	3.89 (1.53)	29	5.42 (0.84)	30	5.72 (0.74)	23	5.61 (0.87)	28	5.50 (1.21)
# Birds	146	8.45 (3.23)	118	7.34 (2.55)	107	8.89 (3.77)	65	5.42 (3.55)	75	6.28 (2.35)	66	5.50 (2.81)	96	8.00 (2.08)	96	7.97 (1.73)	102	8.53 (2.08)	100	8.31 (2.27)
# Canopy spp.	3	0.26 (0.50)	2	0.11 (0.31)	2	0.14 (0.35)	0	0.00 (0.00)	3	0.19 (0.40)	0	0.00 (0.00)	2	0.11 (0.32)	3	0.17 (0.38)	3	0.19 (0.47)	5	0.25 (0.50)
# Canopy birds	11	0.74 (1.80)	6	0.38 (1.28)	2	0.14 (0.35)	0	0.00 (0.00)	3	0.19 (0.40)	0	0.00 (0.00)	2	0.11 (0.32)	3	0.17 (0.38)	3	0.25 (0.65)	5	0.28 (0.57)
# Cavity spp.	5	0.57 (0.67)	6	0.43 (0.68)	5	0.81 (0.95)	3	0.14 (0.35)	4	0.36 (0.59)	4	0.39 (0.55)	3	0.33 (0.53)	6	0.58 (0.60)	4	0.39 (0.55)	4	0.22 (0.48)
# Cavity birds	12	0.62 (0.76)	7	0.43 (0.68)	12	1.03 (1.25)	3	0.14 (0.35)	5	0.39 (0.64)	6	0.47 (0.70)	5	0.47 (0.91)	9	0.78 (0.90)	6	0.47 (0.70)	4	0.25 (0.55)
# Dense shrub spp.	1	0.19 (1.40)	1	0.11 (0.31)	1	0.17 (0.38)	1	0.14 (0.35)	2	0.06 (0.23)	1	0.03 (0.17)	3	0.22 (0.48)	3	0.22 (0.42)	1	0.17 (0.38)	3	0.25 (0.44)
# Dense shrub birds	3	0.19 (1.40)	2	0.11 (0.31)	2	0.17 (0.38)	2	0.14 (0.35)	2	0.06 (0.23)	1	0.03 (0.17)	3	0.28 (0.66)	3	0.28 (0.57)	2	0.19 (0.47)	4	0.31 (0.58)
# Edge spp.	4	0.62 (0.58)	2	0.64 (0.61)	3	1.08 (0.65)	3	0.53 (0.70)	4	0.89 (0.46)	2	0.83 (0.51)	3	0.92 (0.44)	4	0.92 (0.50)	2	0.94 (0.33)	1	0.75 (0.44)
# Edge birds	15	0.83 (0.93)	12	0.70 (0.69)	20	1.69 (1.21)	6	0.53 (0.70)	17	1.44 (0.91)	17	1.39 (1.13)	13	1.08 (0.60)	15	1.25 (1.00)	18	1.53 (0.84)	16	1.31 (1.01)
# Ground shrub spp.	4	0.88 (0.80)	4	0.89 (0.70)	3	0.83 (0.61)	3	0.69 (0.71)	3	0.58 (0.60)	3	0.61 (0.65)	3	0.81 (0.58)	3	0.92 (0.60)	3	0.83 (0.70)	4	1.03 (0.70)
# Ground shrub birds	18	1.14 (1.26)	20	1.28 (1.04)	21	1.75 (1.73)	10	0.86 (1.05)	10	0.86 (1.13)	10	0.83 (0.94)	16	1.33 (1.15)	14	1.19 (0.89)	14	1.14 (1.10)	17	1.42 (1.11)
# Invasive spp.	1	0.02 (0.15)	1	0.02 (0.15)	1	0.03 (0.17)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)
# Invasive birds	1	0.02 (0.15)	1	0.02 (0.15)	1	0.06 (0.33)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)
# Mid-story spp.	8	2.98 (1.18)	7	3.15 (0.98)	8	2.58 (1.18)	6	2.22 (1.10)	7	2.22 (1.35)	7	1.97 (1.08)	12	2.83 (1.06)	10	2.78 (1.05)	9	2.94 (0.98)	9	2.89 (0.98)
# Mid-story birds	83	4.69 (2.28)	69	4.30 (1.94)	44	3.64 (1.96)	37	3.06 (1.82)	37	3.11 (2.14)	32	2.64 (1.89)	50	4.19 (1.83)	48	3.97 (1.76)	56	4.67 (2.01)	55	4.58 (1.79)
# Open spp.	1	0.02 (0.15)	1	0.02 (0.15)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)
# Open birds	1	0.02 (0.15)	1	0.02 (0.15)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)
# Water spp.	3	0.17 (0.38)	3	0.11 (0.31)	1	0.17 (0.38)	1	0.11 (0.32)	1	0.11 (0.32)	1	0.06 (0.23)	3	0.19 (0.47)	1	0.14 (0.35)	1	0.14 (0.35)	2	0.11 (0.40)
# Water birds	4	0.19 (0.45)	3	0.11 (0.31)	5	0.42 (1.16)	8	0.69 (2.36)	3	0.22 (0.76)	2	0.14 (0.68)	6	0.56 (1.52)	4	0.33 (0.93)	3	0.28 (0.74)	2	0.17 (0.61)

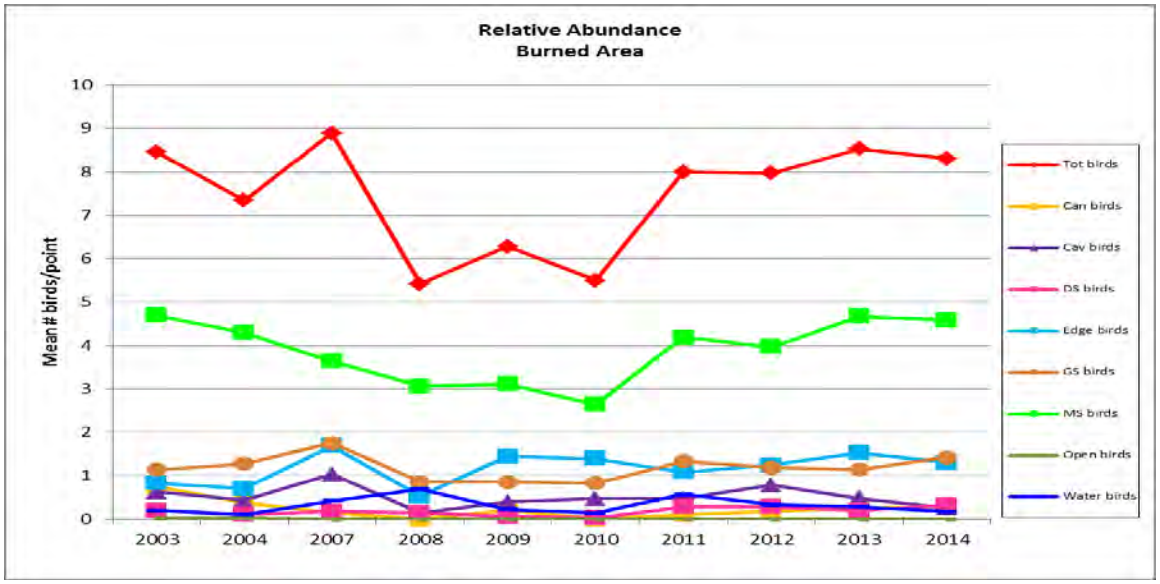


Figure 10.—Relative abundance by species guilds in the Burned Area over time.

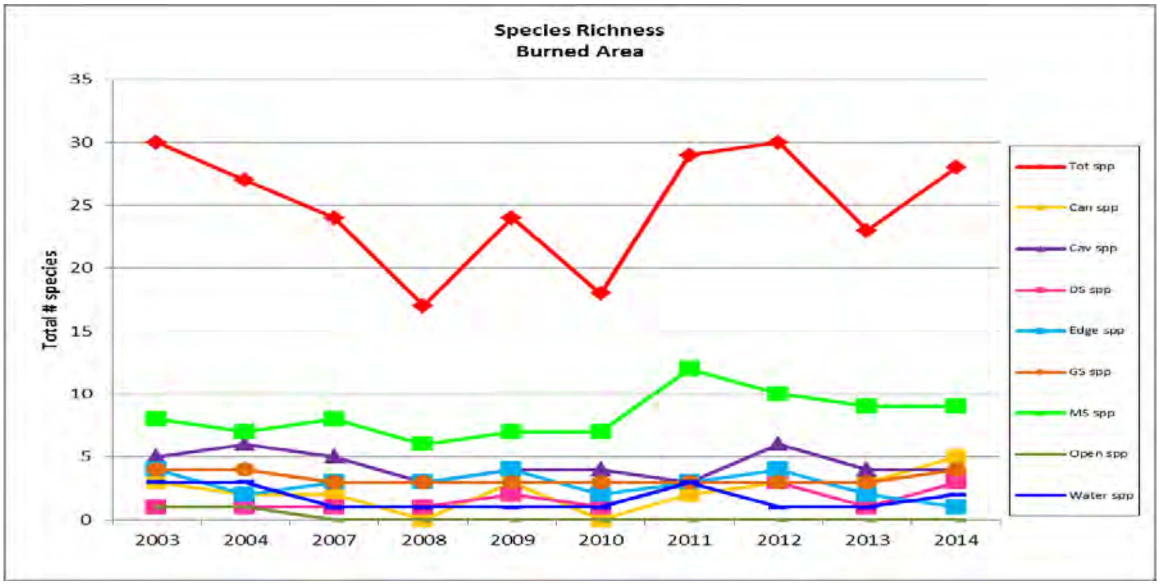


Figure 11.—Species richness by species guilds in the Burned Area over time.

Table 4.—P and R^2 values for simple linear regression analysis between year and relative abundance by guild in the Burned Area. Alpha = 0.05.

Guilds	Burned area 2003, 2004, 2007 - 2014	
	P	**R^2**
Total birds	0.980	0.0000
Canopy birds	0.012	0.0420
Cavity birds	0.234	0.0112
Dense shrub birds	0.093	0.0221
Edge birds	0.001	0.0785
Ground shrub birds	0.846	0.0003
Mid-story birds	0.476	0.0040
Open birds	0.043	0.0320
Water birds	0.888	0.0002

Highlight = significant difference at the 95-percent confidence level

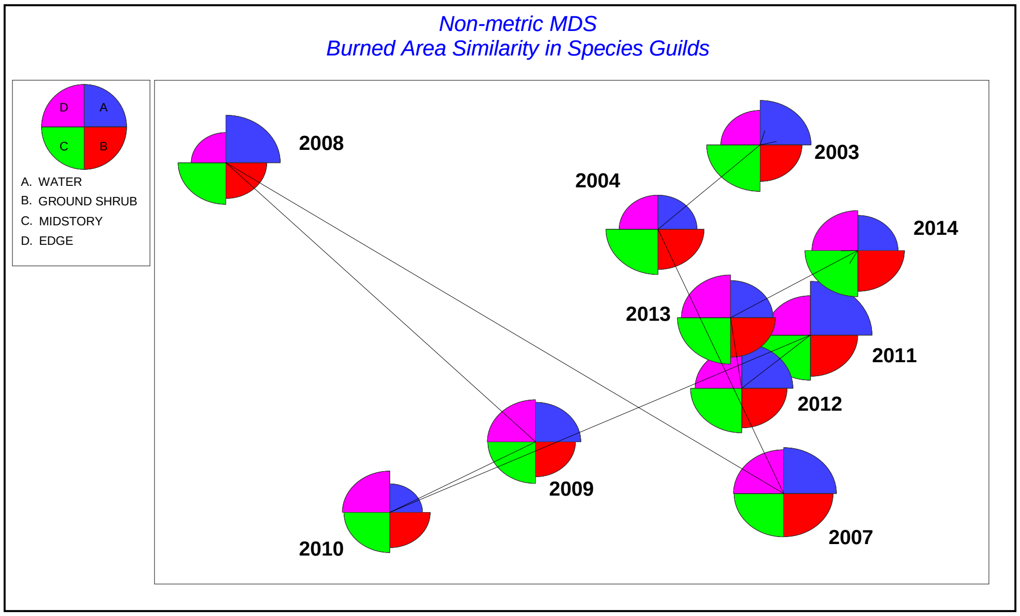


Figure 12.— MDS ordination based on 10 years of square root transformed species guild abundance data and Bray-Curtis similarities within the Burned Area (stress=0.07). Overlay circles associated with each year represent abundance of species within 4 of the guilds.

Comparisons between Monitoring Areas

MDS ordination of species similarity including both monitoring areas is shown in Figure 13. This perspective demonstrates that relative to the Cleared/Overbank Area, the Burned Area did not undergo large changes in species composition. The first years of

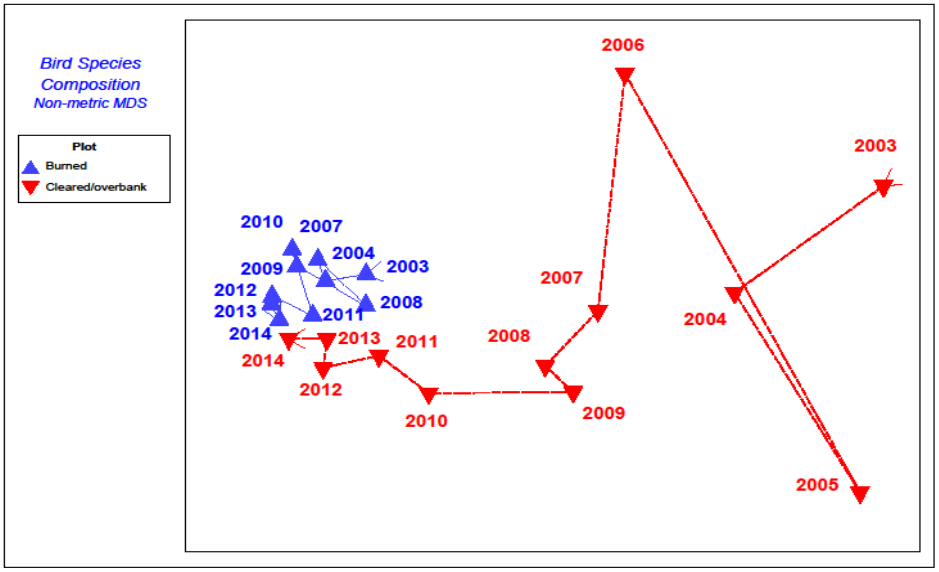


Figure 13.— MDS ordination based on 12 years of square root transformed species abundance data and Bray-Curtis similarities for both the Cleared/Overbank and Burned Areas (stress=0.07).

monitoring the two areas had very different species and with time, the Cleared/Overbank Area approached the Burned Area in species similarity.

Relative abundance was statistically compared between the two monitoring areas by years in which they were both sampled and by species guilds (see Table 5 for statistical results and P-values). In 2005 and 2006, the Cleared/ Overbank Area was the only site in which point counts were performed, therefore no comparisons between plots were made.

Statistical comparisons between Areas over time show that the Burned Area generally had a significantly greater number of total birds until 2012, when the Cleared/Overbank Area surpassed the Burned Area in relative abundance of total birds. In 2013 and 2014, total bird abundance in the two areas was statistically equal. In the early years of monitoring, the Burned Area usually had higher abundance of cavity, edge, and mid-story birds while the Cleared/Overbank Areas had higher abundance of dense shrub and water birds. By 2011, all guilds became statistically equal between areas with the exception of edge birds, which still had higher abundance in the Burned Area. There were no differences between areas in the abundance of birds in any guild in 2014.

Comparisons of trendlines and R^2 values for relative abundance and species richness between both monitoring sites are shown in Figures 14 and 15, respectively. Note that the R^2 values listed here were based on one number – the average number of birds or species detected per year – unlike those analyzed within each area and each guild, in which data from all points were used. Therefore, R^2 values differ. The Cleared/Overbank Area showed an increasing trendline for relative abundance (an increase that was determined to be statistically significant at $P<0.001$) and species richness over time while the Burned Area showed almost no slope (i.e., no change).

As can be seen on the graphs, in terms of actual values the Burned Area had consistently higher numbers of birds than the Cleared/Overbank Area. For example, in 2003 the relative abundance of total birds was 8.45 in the Burned Area compared to 2.75 in the Cleared/Overbank Area. This trend continued through 2011; in 2014 the Cleared/Overbank Area was equal to the Burned Area with both areas having an average relative abundance of 8.31 (Tables 1 and 3).

Table 5.—Statistical comparisons of relative abundance between Areas by year and guild. Alpha =0.05.

Year	Species Guilds								
	Total birds	Canopy birds	Cavity birds	Dense shrub birds	Edge birds	Ground shrub birds	Mid-story birds	Open birds	Water birds
2003	P<0.001[1] Cleared<Burned	P=0.275[2]	P=0.006[2] Cleared<Burned	No dense shrub spp. in Cleared	P=0.329[2]	P=0.057[1]	P<0.001[2] Cleared<Burned	P=0.578[2]	P<0.001[2] Cleared>Burned
2004	P=0.004[1] Cleared<Burned	No canopy spp. in Cleared	P=0.045[2] Cleared<Burned	P=0.938[2]	P=0.346[1]	P=0.660[1]	P<0.001[2] Cleared<Burned	P=0.059[2]	P<0.001[2] Cleared>Burned
2007	P=0.032[2] Cleared<Burned	P=0.071[2]	P<0.002[2] Cleared<Burned	P=0.005[2] Cleared>Burned	P=0.016[1] Cleared<Burned	P=1.00[2]	P<0.001[1] Cleared<Burned	No open spp. in Burned plot	P=0.006[2] Cleared>Burned
2008	P=0.953[2]	No canopy spp. in Cleared	P=1.00[2]	P=0.015[1] Cleared>Burned	P=0.879[1]	P=0.119[1]	P=0.019[1] Cleared<Burned	No open spp. in any plot	P<0.001[2] Cleared>Burned
2009	P=0.001[2] Cleared<Burned	No canopy spp. in Cleared	No cavity spp. in Cleared	P<0.001[2] Cleared>Burned	P<0.001[1] Cleared<Burned	P=0.704[1]	P<0.001[1] Cleared<Burned	No open spp. in Burned plot	P=0.004[2] Cleared>Burned
2010	P=0.033[1] Cleared<Burned	No canopy spp. in any plot	P=0.105[2]	P=0.010[2] Cleared>Burned	P=0.003[2] Cleared<Burned	P=0.309[1]	P=0.130[1]	No open spp. in any plot	P=0.328[2]
2011	P=0.061[1]	P=0.596[2]	P=0.668[2]	P=0.053[1]	P=0.017[1] Cleared<Burned	P=0.153[1]	P=0.098[1]	No open spp. in any plot	P=0.171[2]
2012	P=0.039[1] Cleared>Burned	P=0.031[2] Cleared<Burned	P=0.063[1]	P=0.009[2] Cleared>Burned	P=0.090[1]	P=0.405[1]	P=0.007[1] Cleared>Burned	No open spp. in any plot	P=0.829[2]
2013	P=0.601[1]	P=0.313[2]	P=0.133[2]	P=0.567[2]	P=0.024[1] Cleared<Burned	P=0.156[1]	P=0.293[1]	No open spp. in any plot	P=0.614[2]
2014	P=1.00[1]	P=0.493	P=0.672[1]	P=0.668[2]	P=0.920[1]	P=0.708[1]	P=0.170[2]	No open spp. in any plot	P=0.569[2]

1=Student's t-test; 2=Mann-Whitney test of medians

Highlighted boxes = significant difference at the 95-percent confidence level

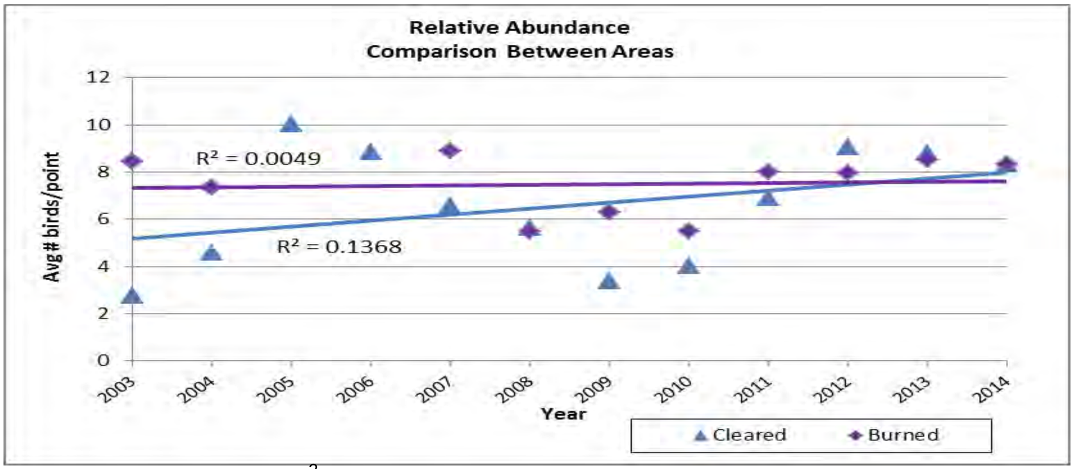


Figure 14.—Trendlines and R^2 values for relative abundance over time in the Cleared/Overbank Area (2003-2013) and Burned Area (2003, 2004, 2007-2014).

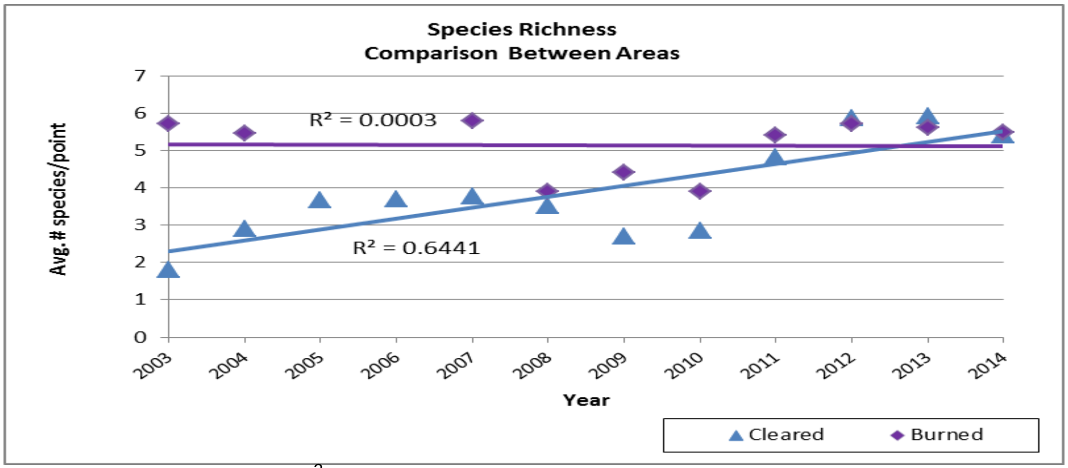


Figure 15.—Trendlines and R^2 values for species richness over time in the Cleared/Overbank Area (2003-2014) and Burned Area (2003, 2004, 2007-2014).

Southwestern Willow Flycatcher Surveys

Willow flycatcher survey forms and maps are shown in Appendix E. In 2014, one migrant WIFL was detected within the boundaries of the LLRS. There was a total of 16 WIFLs detected at areas adjacent to the LLRS between the Los Lunas and Belen bridges (Figure 16) within Reclamation's Belen survey site; all were determined to be migrants. Figure 16 also shows SWFL habitat suitability based on a model created for the Middle Rio Grande using 2012 vegetation maps (Siegle et al. 2013). As can be seen, most of the area between bridges is categorized as *Unsuitable* SWFL habitat including the entire LLRS.

Vegetation Monitoring

Of the two areas included in avian point count monitoring, the Cleared/Overbank Area was the only area where vegetation monitoring was conducted throughout the entire

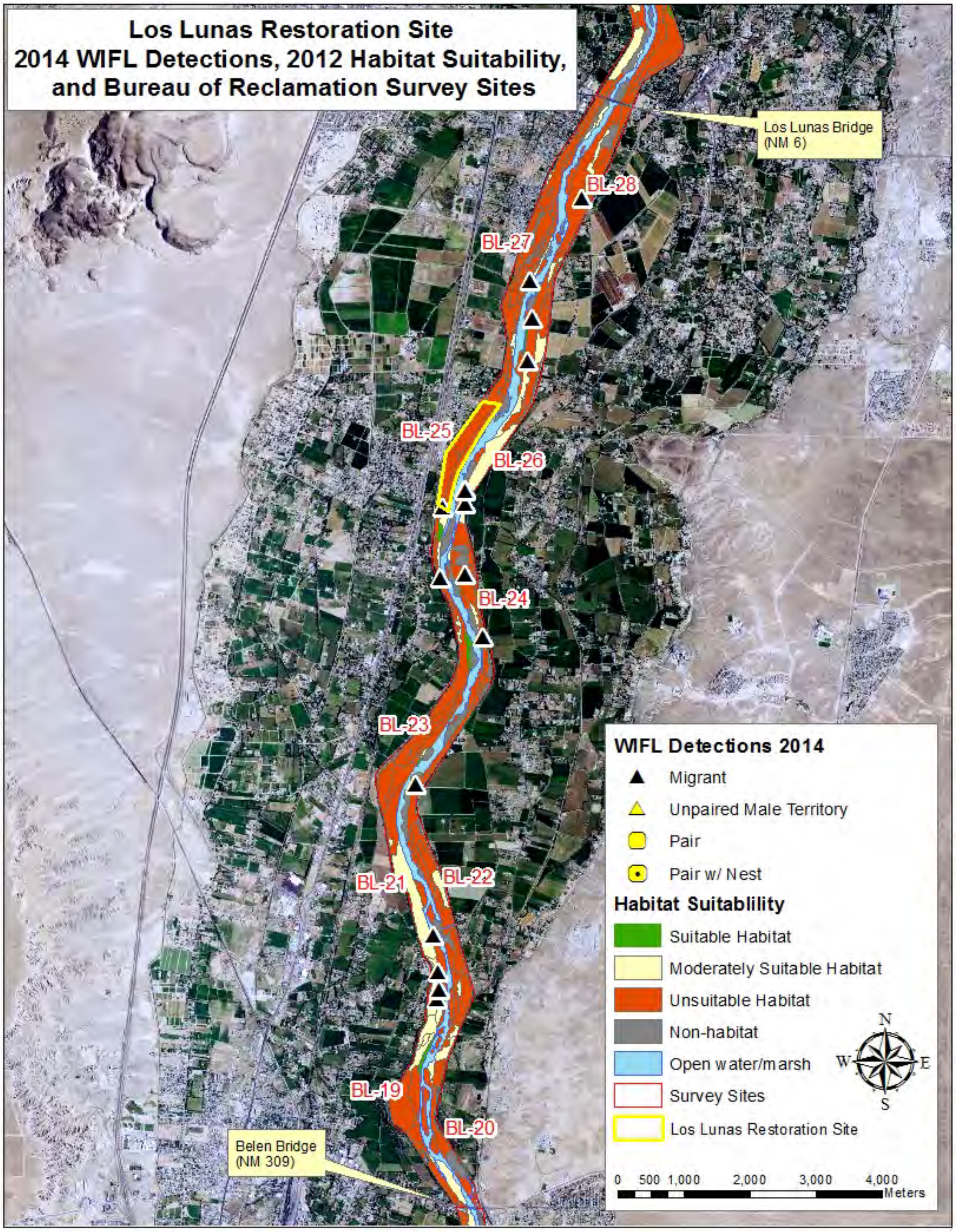


Figure 16.—WIFL detections and habitat suitability in the vicinity of LLRS within the Belen survey site (NAIP 2014 natural color photography).

study. As such, no comparisons were made between areas; only between years. In 2005 and 2006, survivorship of mixed shrub and cottonwood pole plantings were monitored in areas throughout the LLRS. Monitoring of mixed shrub and cottonwood pole plantings was discontinued once mortality/survivorship was documented. Fifty-four percent of the 160 mixed shrubs originally counted in 2005 at this site had survived by 2006 (Siegle 2007). New Mexico olive and Goodding's willow were the most successful species among the transplanted shrubs. The vast majority of cottonwood poles located within monitoring plots died (72 percent mortality). Based on recent observation, however, enough cottonwood poles were planted within the site to result in long-term success of some trees.

Seventy-eight annual and perennial species were detected in under- and overstory measurements during 12 years of vegetation monitoring. These species are listed in Table F-1 in Appendix F. Species richness at the site increased from 18 species detected in 2003 to 36 in 2014 and peaked at 44 in 2010 (Figure 17).

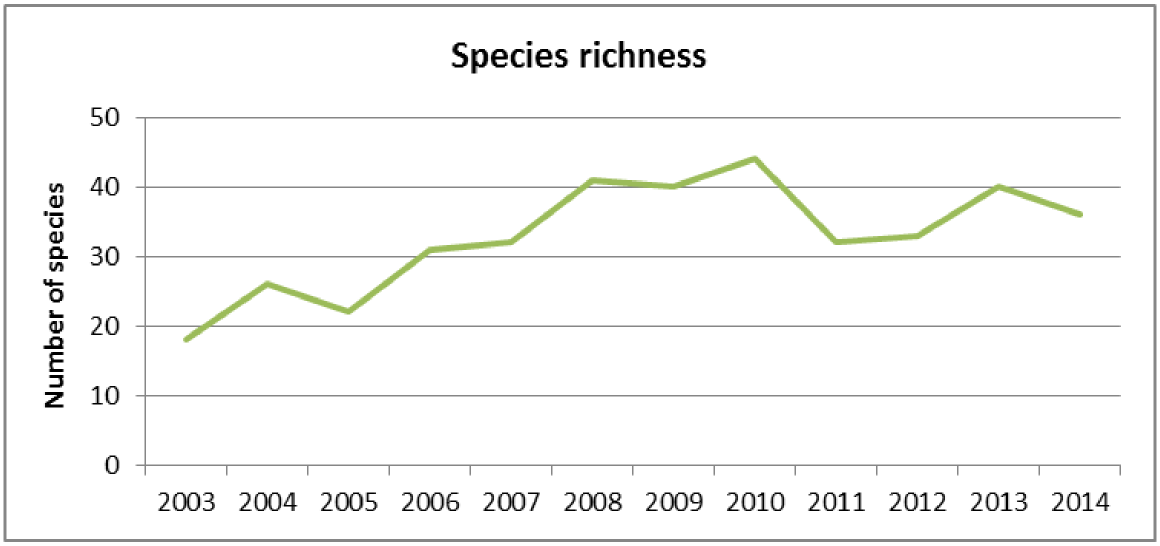


Figure 17.—Plant species richness from 2003 to 2014.

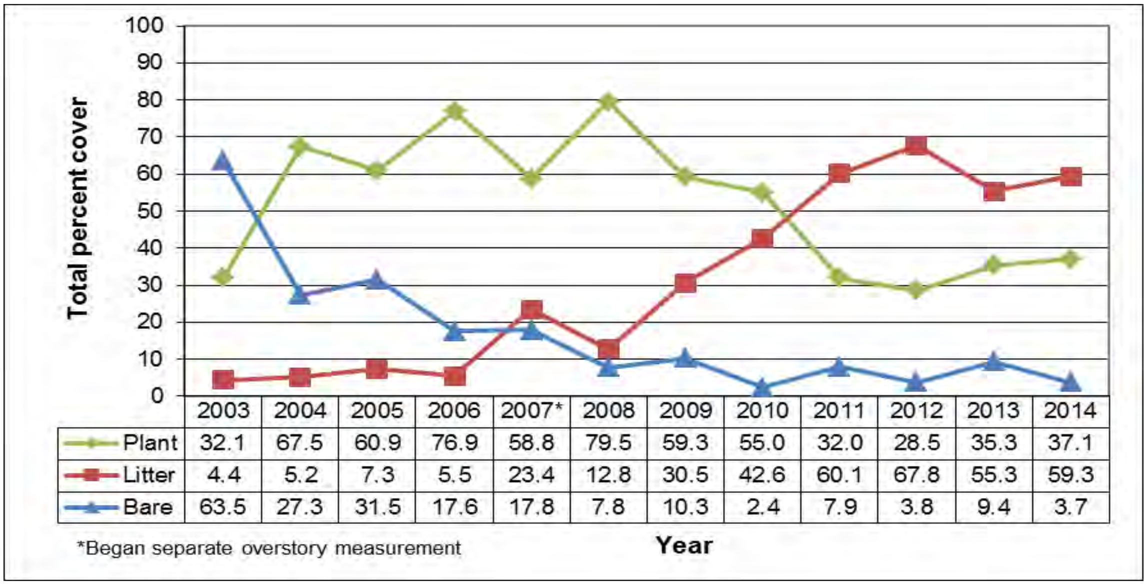
Total percent cover by individual species, life-form (i.e., native or introduced shrubs < 1m, grasses, and forbs) and cover type (i.e., plants, litter, bare ground) of those species found in the understory layer are shown in Table F-2 in Appendix F.

Total plant cover in the understory layer was variable over the course of monitoring, reaching a high of 79.5 percent in 2008 (Figure 18). From 2011-2014, total plant cover significantly decreased to levels comparable to those observed when monitoring began in 2003, which resulted in no change over the course of monitoring from 2003 to 2013 (Figure 19). Total cover of plant litter was 4.4 percent in 2003 and remained relatively stable until 2007. Since 2008 litter cover has generally increased and peaked at 67.8 percent cover in 2012. Total litter cover was significantly less in the early years than in the later years (approximately 2009 to 2014) of monitoring. Total cover of bare ground decreased significantly over the monitoring period, from 63.5 percent in 2003 to 3.7 percent in 2014; bare ground was significantly higher in 2003 than in all other years (Figures 18 and 19).

Relative plant cover by life-form in the understory from 2003 to 2014 is shown in Figure 20. Native and introduced forbs and native grasses have been the predominant life-forms throughout monitoring with some shift in proportions from year to year.

Understory shrub cover in 2006 (the year before measuring overstory as a separate layer) was higher than other years (Figure 20 and Table F-2). Shrubs over 1 m tall were still recorded in the understory yet this was the point that shrubs began reaching greater heights. All size classes of shrubs were included in 2006, which most likely led to higher values for understory shrubs than was truly representative. The regeneration of woody species, as represented by shrub cover in the understory layer, has remained stable over time with coyote willow and saltcedar typically the most common shrub species detected. Native and introduced shrub species were relatively close in cover values, with native species generally having slightly higher cover in the understory layer. Native woody species (particularly coyote willow and cottonwood) have been more successful in maturing to the overstory layer.

Native grasses have sustained as a relatively high proportion of the understory composition throughout monitoring (Figure 20) and have apparently been successful in outcompeting introduced grasses at the LLRS. Native forbs have also sustained as a dominant lifeform at the site. Introduced forb cover was particularly high immediately after restoration activities and has remained one of the principal life-forms.



	2003	2004	2005	2006	2007*	2008	2009	2010	2011	2012	2013	2014
Plant	32.1	67.5	60.9	76.9	58.8	79.5	59.3	55.0	32.0	28.5	35.3	37.1
Litter	4.4	5.2	7.3	5.5	23.4	12.8	30.5	42.6	60.1	67.8	55.3	59.3
Bare	63.5	27.3	31.5	17.6	17.8	7.8	10.3	2.4	7.9	3.8	9.4	3.7

*Began separate overstory measurement

Figure 18.—Total plant, litter, and bare ground cover in the understory layer from 2003 to 2014.

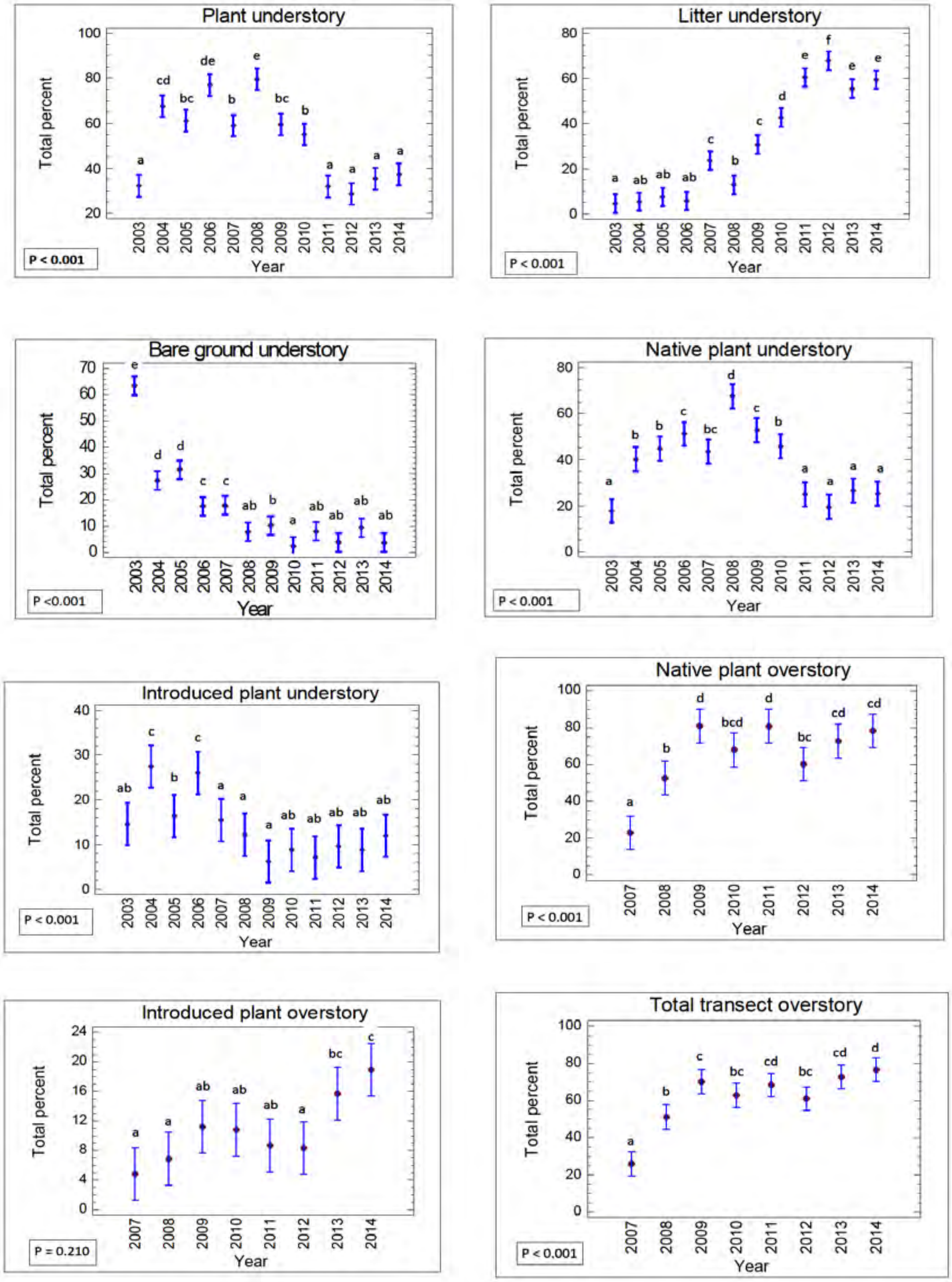
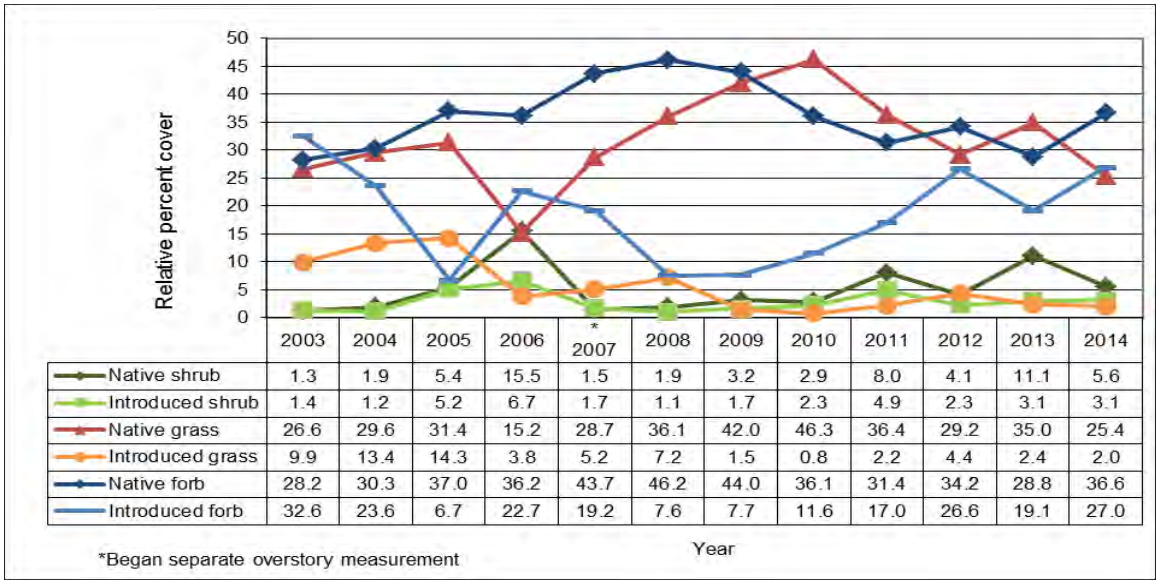


FIGURE 19— Statistical results analyzing total vegetative cover over time for various parameters. Red points represent the mean; blue bars represent least significant difference intervals. Bars with the same letter indicate no significant differences while those with dissimilar letters indicate a significant difference in total cover between years (Alpha = 0.05).



	2003	2004	2005	2006	* 2007	2008	2009	2010	2011	2012	2013	2014
Native shrub	1.3	1.9	5.4	15.5	1.5	1.9	3.2	2.9	8.0	4.1	11.1	5.6
Introduced shrub	1.4	1.2	5.2	6.7	1.7	1.1	1.7	2.3	4.9	2.3	3.1	3.1
Native grass	26.6	29.6	31.4	15.2	28.7	36.1	42.0	46.3	36.4	29.2	35.0	25.4
Introduced grass	9.9	13.4	14.3	3.8	5.2	7.2	1.5	0.8	2.2	4.4	2.4	2.0
Native forb	28.2	30.3	37.0	36.2	43.7	46.2	44.0	36.1	31.4	34.2	28.8	36.6
Introduced forb	32.6	23.6	6.7	22.7	19.2	7.6	7.7	11.6	17.0	26.6	19.1	27.0

*Began separate overstory measurement

Figure 20.—Relative percent cover of life-forms in the understory layer from 2003 to 2014.

Total percent cover and average height of overstory species (woody species > 1 m in height) are shown in Table 6. Rio Grande cottonwood has continued to be the dominant woody species in the overstory canopy followed by coyote willow. Height estimates were gathered by measuring the tallest plants within the continual stretch of a species, therefore do not represent average heights of the stand but provide a consistent comparison from year to year.

The total cover of native overstory species significantly increased over time, expanding from 22.7 percent in 2007 to 78.2 percent in 2014, despite a significant drop from 80.9 percent in 2011 (Table 6 and Figure 19). There were no significant changes in total cover of introduced woody species over time, which ranged from 4.9 percent to 19.0 percent. The overall transect canopy cover when accounting for overlap of species significantly increased from 2007 and 2008 to later years, peaking in 2014. Total canopy cover has followed a similar pattern to native overstory species since native species make up the majority of overstory canopy.

Since the onset of vegetation monitoring, the majority of plant species have been composed of native species relative to introduced in both the understory and overstory layers (Table 7). Relative cover of native understory species increased from 56 to 68 over the monitoring period while introduced species decreased from 44 to 32. Changes in relative cover of overstory species were not as drastic, with little variation over the monitoring period.

Table 6.—Total percent cover and average height of woody overstory species (>1 m) from 2007 to 2014.

	2007		2008		2009		2010		2011		2012		2013		2014	
Overstory plant species	**Tot % cover**	**Avg ht (m)**	**Tot % cover**	**Avg ht (m)**	**Tot % cover**	**Avg ht (m)**	**Tot % cover**	**Avg ht (m)**	**Tot % cover**	**Avg ht (m)**	**Tot % cover**	**Avg ht (m)**	**Tot % cover**	**Avg ht (m)**	**Tot % cover**	**Avg ht (m)**
Coyote willow	7.4	1.6	23.9	2.1	35.8	2.4	25.4	2.3	25.7	2.2	14.2	2.3	22.2	2.4	23.1	2.4
Goodding willow	0.3	1.6	0.9	2.4	1.5	2.9	1.0	3.3	1.0	3.4	0.2	2.4	0.5	2.7	1.1	3.0
Rio Grande Cottonwood	15.0	2.3	27.7	3.1	43.4	4.6	41.5	4.9	53.9	5.1	45.4	6.4	49.9	6.4	53.8	7.1
Narrowleaf cottonwood	0.0		0.0		0.0		0.0		0.3	5.3	0.3	3.3	0.0		0.0	
Seep willow	0.0		0.0		0.0		0.0		0.0		0.2	1.9	0.0		0.0	
Virgin's bower (vine)	0.0		0.0		0.0		0.0		0.0		0		0.0		0.2	2.5
Total native woody spp	**22.7**		**52.5**		**80.7**		**67.9**		**80.9**		**60.3**		**72.6**		**78.2**	
Saltcedar	4.3	2.3	5.8	2.2	9.7	2.8	8.9	2.8	6.5	2.6	5.7	2.7	9.2	3.3	9.6	3.0
Russian olive	0.6	2.9	1.1	3.4	1.6	3.9	1.9	5.2	2.5	4.7	3.5	4.9	5.5	4.8	9.1	4.9
Siberian elm	0.0		0.0		0.0		0.0		0.0		0.2	2.8	0.2	2.9	0.3	3.7
Total introduced woody spp	**4.9**		**6.9**		**11.3**		**10.8**		**9.0**		**9.4**		**14.9**		**19.0**	
Total transect cover (accounting for overlap)	**25.9**		**51.1**		**70.0**		**62.7**		**68.3**		**60.8**		**72.6**		**76.5**	

Table 7.—Proportion of native and introduced species in the understory and overstory layers by year.

	Relative Percent Cover			
	Understory layer		**Overstory layer**	
Year	**Native spp**	**Introduced spp**	**Native spp**	**Introduced spp**
2003	56	44	NA	NA
2004	62	38	NA	NA
2005	74	26	NA	NA
2006	67	33	NA	NA
2007	74	26	83	17
2008	84	16	89	12
2009	89	11	88	12
2010	85	15	86	14
2011	76	24	90	10
2012	71	29	87	13
2013	75	25	83	17
2014	68	32	80	20

Analysis using a Bray-Curtis similarity matrix to compare plant species composition found a significant difference in species similarity between years (P<0.001). Pairwise testing identified the highest similarities between years 2011, 2012, 2013, and 2014. In general, these results are illustrated in the MDS configuration in Figure 21 (note that the configuration may not exactly represent statistical results because MDS analysis uses means, unlike pairwise testing, and therefore variances may differ). MDS ordination ranks similarities and the associated configuration can be interpreted in terms of relative similarity of samples to each other (Clarke and Warwick 2001). For example, in this case it can be interpreted that species composition in 2005 was less similar than that of all other years of monitoring. There was also a large difference in species composition from when monitoring began to the present. Stress is the measure of distortion in the configuration. A stress factor of <0.5 gives an excellent representation; MDS analysis of this data had a stress of 0.03. The line between years illustrates the degree and relative change in species composition each year (i.e., a very continual progression from 2003 to 2014 with species composition becoming more similar beginning around 2009). Size of overlay circles associated with each year represent average percent cover of the 3

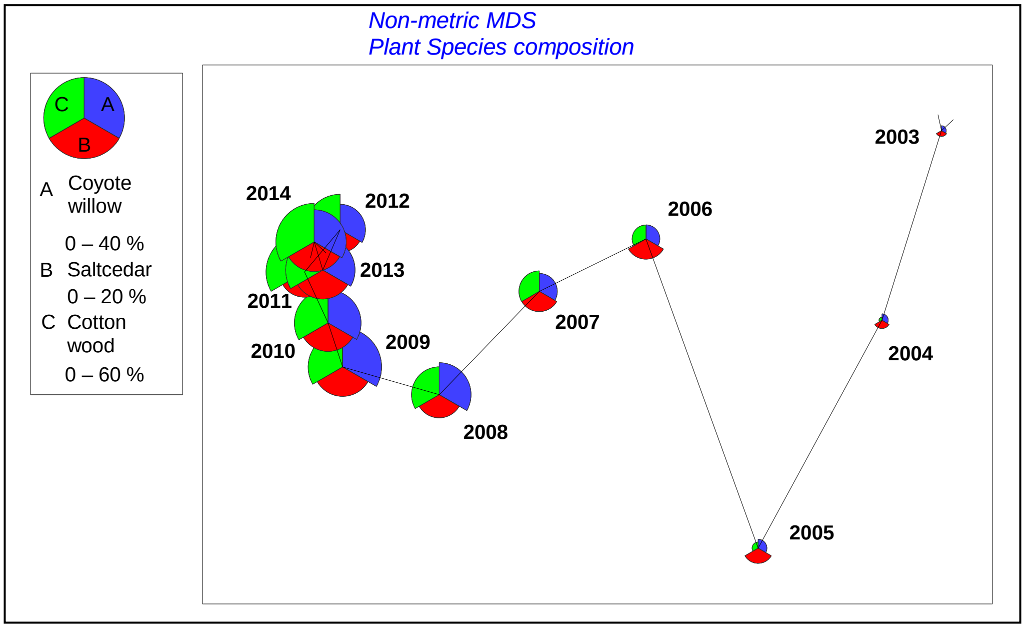


FIGURE 21.— MDS ordination of 12 years of plant species cover data based on Bray-Curtis similarities (stress=0.03). Overlay circles associated with each year represent percent cover of the 3 dominant overstory species.

dominant overstory species each year. Total cover of the 3 species has increased with time, with larger increases in cottonwood and coyote willow.

Perennial pepperweed – a noxious weed – was documented at the site in 2003 and 2004, but inundation appeared to eradicate the species in 2005. In 2009, a patch of pepperweed was discovered between transect posts 3B and 4B and spotty occurrences of the weed were detected on the berm west of the river between transects 2 and 5. In 2010, perennial pepperweed total cover within transects peaked at 2.3 percent — up from minor detections in previous years (Table F-2). A patch was detected between transects 2 and 3 (about 1 acre) and pepperweed fell within transect 3. The patch between transects 3 and 4 had grown to approximately 2 acres in size. From 2011 to 2014, the cover of pepperweed within transects decreased, however occurrence of the species was noted in additional locations (between transects 1 and 2, on either side of mid-transect 6, at transect 5). Perennial pepperweed appears to be confined to the north section of the site.

Ground Water Monitoring

Monthly Well Monitoring

Regular monthly well monitoring began in September 2004. The depth (in inches) below the ground surface to water at each well for each reading from June 2004 to October 2010 is summarized in Table G-1 in Appendix G. Data were used to create hydrographs that also included river discharge at the Rio Grande floodway in San Acacia, New Mexico (2003 to 2007) and at the Bosque Farms gauge (2008 to 2010; Figure G-1 in Appendix

G). Discharge data collected near Los Lunas show flows in the Rio Grande are typically highest around April and May and lowest from July to September.

Within each transect (North, Middle, South as shown in Figure 3) groundwater levels varied. All wells were at surface level when discharges peaked around 4,600 cfs in May and June 2005. Wells along the South transect showed the largest differences in groundwater depth between wells compared to the Middle and North transects. The well nearest to the river (S1) was the shallowest, and during monthly monitoring was only dry in September of 2003, 2004, and 2010 (Table G-1 in Appendix G). Groundwater at this well was less than 10 inches from the surface when discharges were greater than around 3,100 cfs and groundwater more than 50 inches from the surface when discharge fell below about 400 cfs. Well S2 (Figure 3) was typically dry at 61.5 inches during summer months (July-September) when river levels generally drop below 400 cfs.

The water table along the Middle transect was the shallowest measured, with Wells M1 – M3 only dry during September 2003 and 2004 (M1 was also dry September 2010) during monthly monitoring. The two wells nearest the river (M1 and M2) reached surface level when discharge was above approximately 3,200 cfs. The three wells nearest the river (M1-3) were relatively similar in ground water depth, with groundwater at 15 inches or less from the surface when discharges were between 2,000 and 2,500 cfs. These wells only fell to more than 50 inches from the surface when the river was essentially dry.

Unlike the South and Middle transects, groundwater in the two wells nearest the river along the North transect where soils were sandy (N1 and N2) was generally deeper than in the two westernmost wells (N3 and N4). Clay soils at wells N3 and N4 most likely created shallow water table conditions and Well N3 was only dry in September 2003 and 2004 during monthly monitoring. When river discharge was between 3,200 and 3,500 cfs, groundwater depth was <10 inches from the surface in the shallower wells while the deeper wells were between 12 and 17 inchesfrom the surface. The 2 shallower wells – N3 and N4 – only fell below 42 inches from the surface when the river was essentially dry.

Data Logger Well Monitoring

In June 2011, HOBO data loggers were installed. Groundwater data and river discharge at the gauge near Bosque Farms from June 2012 to September of 2014 are graphed and included in Appendix H. Conditions were much dryer from 2011 to 2013 in the region, with peak flows only reaching about 1,700 cfs in April 2012. Flows rarely exceeded 750 cfs and the water table never reached the surface during this period.

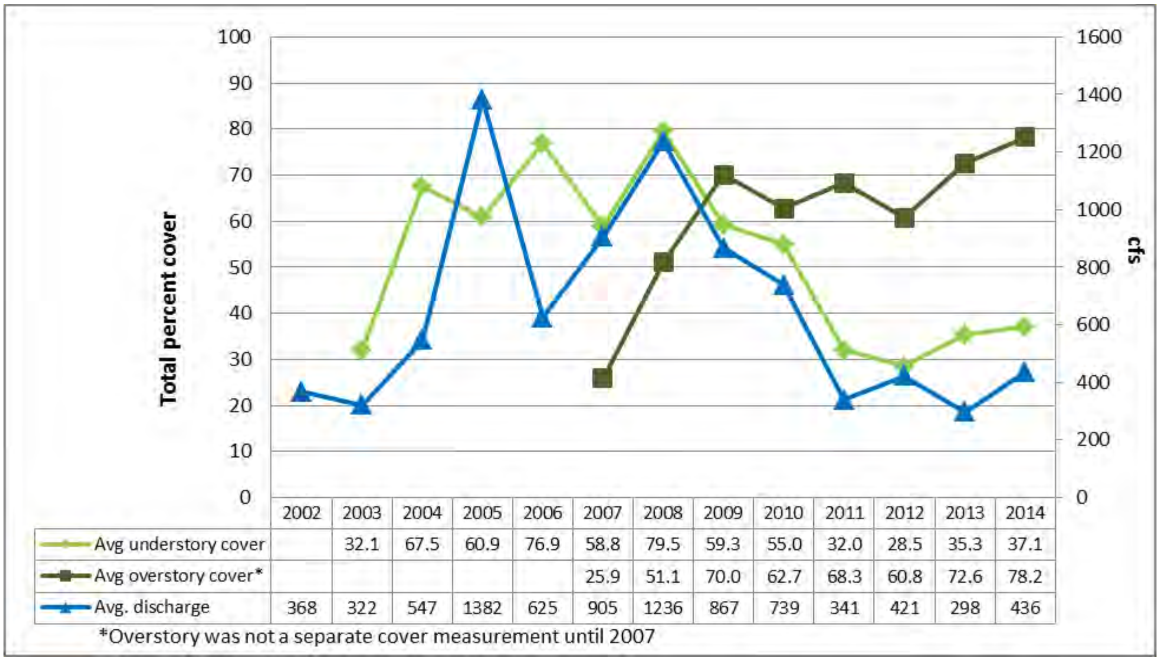
Wells showed similar patterns in relative groundwater depth when comparing data from HOBO water level loggers with monthly data. Ground water continued to be deepest at Wells S2, N1 and N2 with wells dry when river levels dropped below about 100 cfs. Well S2 was dry for most of the September 2012 to September 2013 period. All wells were dry from approximately August to November 2012. In July 2013, monsoons and associated increases in river discharge led to responses in groundwater level in all wells, though depths to ground water and the length of time wells held water varied. Flows were much more consistent in 2014, with several peaks between 750 and 1000 cfs. The river was never dry and all wells held water throughout the year with the exception of Well S2 (groundwater present only when flows peaked) and Well N2 (rarely dry during summer months). A missing HOBO logger in Well N1 resulted in no data from September 2012 to September 2014.

The level of ground water at the LLRS correlates closely with flows in the river, indicating a hydrologic regime influenced by the riverine system at the site (Appendices G and H). River discharge (which represents groundwater levels because the two are so closely linked) and vegetative cover are graphed in Figure 22).

Data loggers provided enough detail to discern diurnal fluctuations in the water table. Groundwater fluctuated anywhere from 0.01 to 18.0 in/day over approximately 3 years at Well M2 (Figure 23). This well was dry in September and October 2012 and therefore no fluctuations were observed or graphed.

Photo Stations

Photos taken from 2003 through 2014 are shown for comparison purposes in Appendix I.



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Avg understory cover		32.1	67.5	60.9	76.9	58.8	79.5	59.3	55.0	32.0	28.5	35.3	37.1
Avg overstory cover*						25.9	51.1	70.0	62.7	68.3	60.8	72.6	78.2
Avg. discharge	368	322	547	1382	625	905	1236	867	739	341	421	298	436

*Overstory was not a separate cover measurement until 2007

Figure 22.—Hydrologic year (October – September) average discharge (cfs) in the Rio Grande at San Acacia (2002-2007) and at Bosque Farms (2008-2014), and the average total percent plant cover in transects at the LLRS, New Mexico. Restoration occurred in 2002; vegetation monitoring began in 2003.

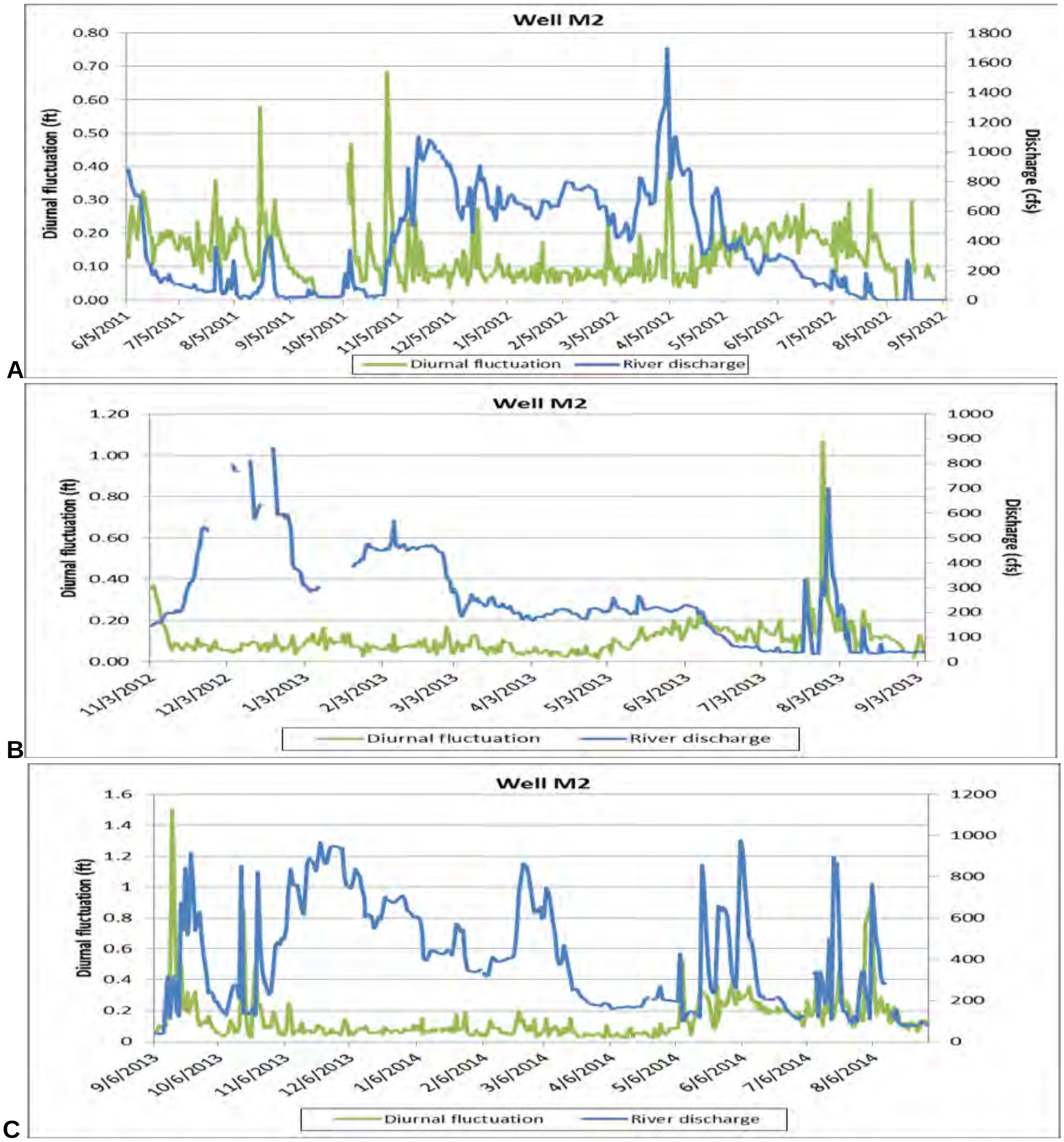


Figure 23.— Diurnal fluctuation (ft) within Well M2 and average discharge (cfs) in the Rio Grande at Bosque Farms, New Mexico from June 2011 through August 2012 (A); from November 2012 to September 2013 (B); and from October 2013 through August 2014 (C).

Discussion

Avian Monitoring

Point Counts

Cleared/Overbank Area

Using the Burned Area for comparison, it appeared that desirable bird habitat developed over time within the Cleared/Overbank Area. By 2007, the Cleared/Overbank Area had higher numbers of dense shrub birds than the reference area, which was 5 years following restoration activities. In 2008 – 6 years after restoration – relative abundance became either statistically equal or greater than the Burned Area within all guilds except the mid-story guild, which had consistently greater abundance in the Burned Area. By 2010, relative abundance of mid-story species was equal between the two areas but total birds were greater in the Burned Area due to a significantly higher number of edge birds detected. From 2011– 9 years following restoration – to 2014, the two areas were essentially the same in relative abundance of most birds, although edge birds remained greater in the Burned Area. Species composition also became very similar between the two areas beginning in 2011 (Figure 13).

Increasing trends in relative abundance and species richness for cavity, dense shrub, and mid-story species guilds were consistent with the development of vegetation within the Cleared/Overbank Area, *i.e.*, as the cover and height of vegetation have increased (see Figure 24), so have the number and types of birds. Decreasing trends for opening and water birds are also consistent with habitat development patterns for these guilds; as the more open habitat required for these species has been replaced with denser vegetation, numbers of these birds have decreased.

Although most of the bird guilds in the Cleared/Overbank Area showed significant changes during the monitoring period, only the mid-story guild was found to show a strong statistically significant relationship with time at an R^2 of 65 percent, increasing from 2003 to 2014 (Table 2). The brown-headed cowbird was the most abundant species detected among mid-story birds until 2009, when the mean number of cowbirds detected per point dropped considerably. The brown-headed cowbird is not the most desirable of species because the cowbird uses brood parasitism as a breeding strategy, which can reduce the productivity of host nests. Therefore, its decline may have been beneficial to other avian host species. Abundance of this species increased again from 2010 to 2014, however, other mid-story species (e.g., black-headed grosbeaks, spotted towhees, and yellow-breasted chats) also increased during this period so that brown-headed cowbirds were not the dominant species. From 2003 to 2014, relative abundance of mid-story species increased from 0.17 to 4.36 birds/point and species richness increased from 3 to 10 (Table 1), which are favorable trends for this site. The mid-story bird guild is an important indicator for the SWFL, which uses mid-story nesting habitat; therefore the increasing trend in mid-story species is an indication that the LLRS has potentially developed suitable habitat for SWFLs.

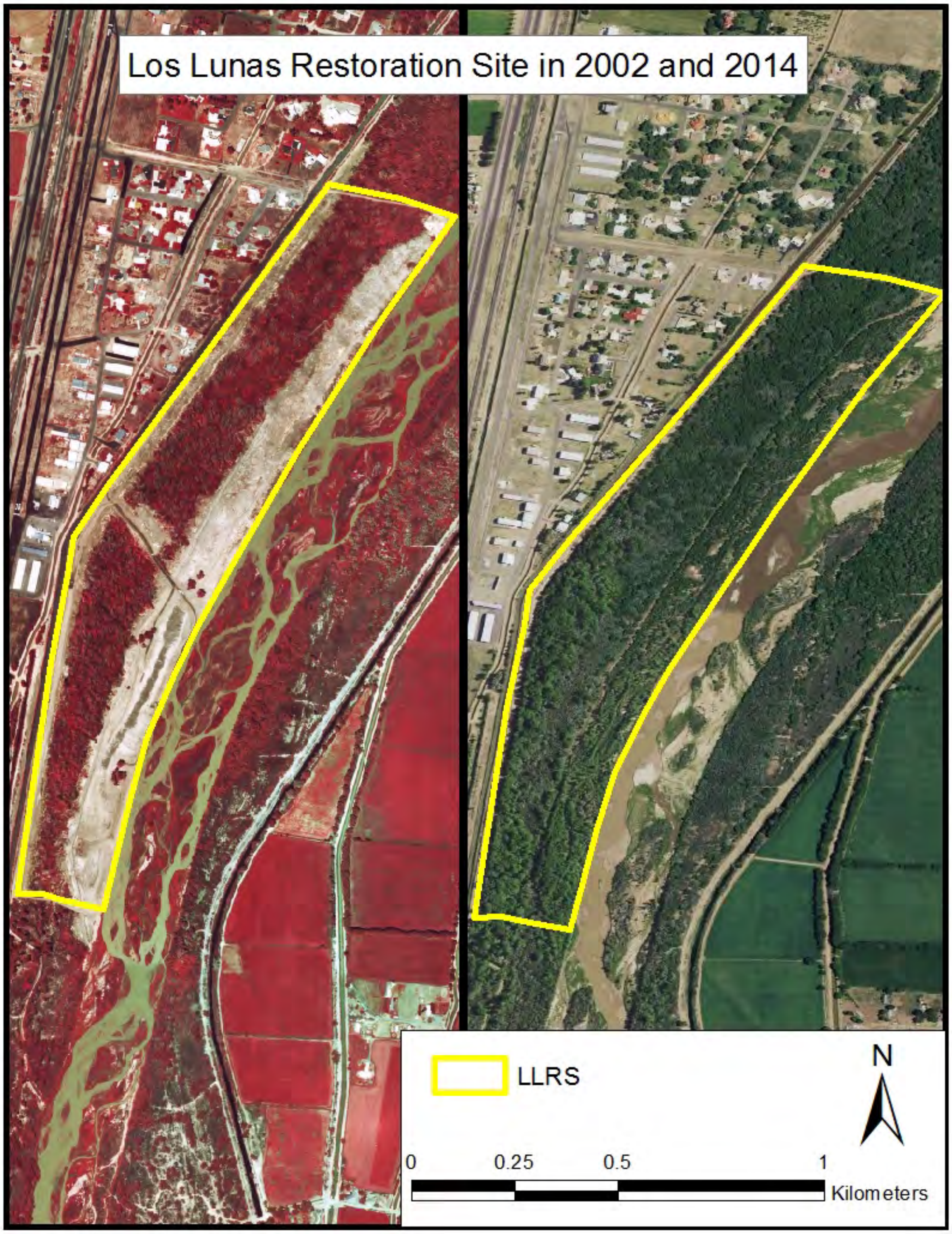


Figure 24.—Development of vegetation at the LLRS as seen in 2002 immediately after the site was cleared (IR photography left) and in 2014 (NAIP natural color photography right).

While the total number of birds in the Cleared/Overbank Area increased significantly from 2.75 birds/point in 2003 to 8.31 birds/point in 2014, only a weak linear relationship (R^2 of 9 percent) was identified due to changing habitat and variable bird abundance. Relative abundance both increased and decreased over the study period as some habitat types declined while others became more developed. The number of total birds was closely linked to the number of water birds in this Area until approximately 2009 (Figure 5). For example, the number of water birds peaked in 2005, when the LLRS was flooded, as did total number of birds. As vegetation in this Area developed, habitat was less conducive to water birds. From 2009 to 2014, relative abundance of total birds closely correlated with the trend in mid-story birds (Figure 5). Further monitoring will determine if total birds continue to be more closely linked to mid-story birds with the development of this habitat type.

Burned Area

Results for the Burned Area were variable, indicating increasing and decreasing trends in both relative abundance and species richness among bird guilds, although none of the guilds showed exceptionally strong statistically significant relationships between abundance and year. This suggested that changes in bird populations may not have been strictly temporal and could have been caused by other factors affecting the site. A number of cottonwood snags have fallen since point counts were initiated, which changed the habitat somewhat and could be related to decreases in canopy and cavity birds. The average number of mid-story birds detected per point consistently decreased through 2010 (Table 3 and Figure 10). Relative abundance has increased since that time and numbers have rebounded to those observed when monitoring began. The reason for the decreasing trend in mid-story birds is unknown. Relative abundance of mid-story birds was relatively high (4.69 birds/pt) in 2003, 3 years after the fire. This site rejuvenated earlier than the Cleared/Overbank Area, where vegetation was completely removed in 2002. It is possible that mid-story birds migrated from the Burned Area into the Cleared/Overbank Area as better habitat developed there. More recently, the relatively high abundance of birds in this guild within both areas could be related to the development of habitat within the entire project area that is attracting more mid-story species in general.

Southwestern Willow Flycatcher Surveys

Some portions of the Cleared/Overbank and Burned Areas appeared to have developed riparian vegetation of suitable height, density, and structure to provide breeding habitat for the SWFL. Based on both avian and vegetation monitoring, the area has been productive in terms of developing native overstory habitat, and SWFLs could potentially occupy the LLRS in time if the current trend continues. It appears that suitable habitat currently exists within adjacent sites between the Los Lunas and Belen bridges based on the occurrence of one SWFL territory in 2011, 2012, and 2013 (Moore and Ahlers 2015). Associated nests were successful in producing fledglings in 2012 and 2013. Much of the riparian habitat in the Belen survey reach is suitable as stopover habitat for migrating SWFLs as confirmed by presence/absence surveys; the number of territories detected within the reach has increased from 0 in 2009 to 17 in 2014. The 17 territories were found 15 miles downstream of Belen, NM, which is the closest breeding population that could serve as a source for SWFL dispersal into the Los Lunas site.

Unfortunately, it is difficult to accurately assess the habitat suitability of a site for breeding SWFLs based solely on visual observations since the factors that appear to influence site selection are numerous and variable. Based on vegetation transect monitoring data, the site appeared to develop into potentially suitable SWFL habitat by about 2012, 12 years after the fire and 10 years after restoration work began, although data was not specifically designed to quantify SWFL habitat suitability. This estimate is based on total overstory cover values which have remained relatively stable since 2012 (increasing from 61 to 77 percent) despite prolonged drought (Table 6), which could be an indication that overstory species have become well established. Around this time, two layers of overstory began to develop (i.e. 3 m and 5-6 m heights; note that these heights represent the tallest of the species, not the average), which provides structure to the stand. By this point, there were certainly small patches of vegetation that could be assessed as suitable based on observation. However, habitat suitability modeling in 2012 determined the site to be *Unsuitable* based on Hink and Ohmart (1984) vegetation classification (Siegle et al. 2013). The Cleared/Overbank Area was characterized as a coyote willow/cottonwood stand of the same height class (5-15 ft average). The cottonwood component renders this vegetation type as unsuitable because the species does not provide the structural diversity often associated with optimal SWFL habitat, particularly within this size class. Furthermore, based on established mapping techniques, vegetation types less than 1 acre in size were not mapped, so although patches of suitable habitat may have existed, they probably weren’t large enough to map.

In 2007, vegetation data from 3 selected sites within the Burned Area of LLRS were compared to similar data collected from sites downstream where SWFL nests were known to occur (Moore 2009). At that time, vegetation at the Los Lunas site was found to be more dense, and of a younger age-class than sites where SWFL breeding took place. It was determined that the Los Lunas site would more closely approximate occupied SWFL breeding habitat in “a few growing seasons.” Based on visual observation, small isolated patches of vegetation likely reached structural suitability around 2010 within the Burned Area.

Based on avian point count data, mid-story bird species (the guild in which SWFLs are categorized) began an increasing trend in 2010 in the Cleared/Overbank Area (8 years after restoration), which is an indication of the time frame that it took similar species to occupy the area. This data supports the assumption that small patches of habitat within the LLRS may have reached suitability for breeding SWFLs sometime in the past few years. However, in the absence of site specific quantifiable data it is not possible to state with certainty that the habitat within the Burned or Cleared/Overbank Areas of the LLRS has reached suitability for breeding SWFLs.

Vegetation Monitoring

A number of factors are important to the success of cottonwood/willow riparian forest restoration. These factors include soil conditions, such as salinity levels and texture, availability of native seed source, timing of high flows and flooding, and ground water depth.

Alluvium texture is of primary importance in determining which plant species will succeed (Dressen et al. 2002). Lotic systems are characterized by fast moving water that deposits coarse alluvium of low fertility and high aeration. In contrast, lentic systems deposit fine alluvium (silts and clays) with higher fertility and less aeration. In general, lotic systems are conducive to the establishment of woody riparian trees and shrubs, while lentic systems are suitable for herbaceous wetland and marsh plants. The LLRS is a lotic system, as is the Middle Rio Grande bosque in general, although there are microsites where herbaceous wetland plants have established in depressions where silts and clays have deposited. In a restoration project on the Bosque del Apache National Wildlife Refuge (BDANWR), downstream of the LLRS, there was virtually no cottonwood germination in areas dominated by clay soils (> 65% clay), while regeneration of native species was greatest in sand deposits resulting from secondary channel development (Sprenger 1999) symptomatic of lotic systems.

Native species dominate the LLRS, particularly in the overstory, with cottonwood, coyote willow, and Goodding’s willow present in the forest canopy. In the monitoring area, these species naturally re-established, indicating that a sufficient seed source was available on site. These species continue to regenerate, as is represented by shrub cover in the understory layer. Saltcedar and Russian olive (*Eleagnus angustifolia*) are also re-establishing at the site, although appear to be outcompeted by native willows and cottonwood. This is a very positive outcome considering that saltcedar dominated the site when it was cleared, meaning there was an abundant seed source and resprouting potential for this species. The total percent cover of saltcedar after 12 years of monitoring was 1.1 percent in the understory (an indicator of the rate of regeneration) and 9.6 percent in the overstory, which is very low compared to other areas adjacent to the site. Evidence of *Diorhabda* was detected in and around the LLRS in 2014 (Figure 25). This beetle was released at several sites across the Southwest as a biological control for saltcedar and is spreading into areas beyond its predicted extent, including the Middle Rio Grande. The effects from *Diorhabda* could potentially reduce saltcedar, an outcome that monitoring would detect. Saltcedar that fell within the vegetation transects did not show signs of beetle forage in 2014.

Of course, although a local natural seed source is important to successful restoration, it must be combined with hydrologic conditions optimum for cottonwood and willow regeneration and establishment. A restoration site in the urban Albuquerque reach of the Middle Rio Grande used a design similar to the one implemented at LLRS by incorporating natural hydrologic processes; 10,000 cottonwoods/ha established at this site following overbank flooding as compared to a higher site out of reach of the flood in which no trees established following the same event (Muldavin et al. 2015). Not only is

Figure 25.—Evidence of *Diorhabda*, a biological control beetle released in the Southwest to manage saltcedar, was observed in the LLRS in 2014.

overbank flooding necessary, it must be timed with germination of willow and cottonwood seedlings. Investigations at the BDANWR proved that natural recruitment of willow and cottonwood was possible subsequent to over-bank flooding during peak river flows in late May and early June (Sprenger 1999). Flooding conditions at LLRS were apparently conducive to natural recruitment of native species, especially from 2005 to 2009 when average annual discharge rates were relatively high compared to other years (Figure 22). The rate of stream stage decline should not exceed 2.5 cm per day for seedling survival (USDA, NRCS 1998), a criterion that was presumably met. Cottonwood and willow seedlings were detected early in the study, starting in 2003 which was the first year of vegetation monitoring. Establishment of woody species, however, was especially evident during the2006 growing season, the year after extremely high river flows and prolonged flooding on site. The length of inundation from flooding also affects the ability of plants to germinate and sustain. Mortality of cottonwoods submerged for over 32 days was 100 percent in studies by Sprenger (1999) and Hosner (1958 as cited by Sprenger 1999). Coyote willow, on the other hand, was found to survive after 2 months of inundation in New Mexico (USDA, NRCS 1998). Monthly groundwater well data collected in this study did not provide enough detail to determine how long flooded conditions persisted at the LLRS. From 2011 to 2014, when more complete groundwater data was collected with HOBO logger instruments, no flooding occurred. Hydraulic modeling of the LLRS determined that discharge of 2,500 cfs (design goal) would cause extensive inundation of the site (Kissock 2010), a level that has not been reached since HOBO loggers were installed (Appendix H).

Depth to ground water plays a key role in determining which riparian species will succeed in a restored site. The primary rooting zone for obligate riparian plants is the capillary fringe above the water (Dressen et al. 2002). The thickness of the capillary fringe is controlled by soil texture, with finer textured alluvium having a broad zone of unsaturated soil with high moisture content. A thicker capillary fringe zone has a greater water content however it also has lower aeration resulting from less air-filled pores. Because woody riparian species generally require highly aerated soils, suitable restoration sites generally have a thin capillary fringe with lower water content but more air filled pores. Groundwater conditions at the LLRS are discussed in the Ground Water Monitoring section below.

Ground Water Monitoring

Ground water depth at the LLRS correlated closely to Rio Grande flows (Appendices G and H), indicating that connectivity between the shallow aquifer and the river is still functioning despite management activities that could potentially impact hydrologic processes. Because flows influenced the water table depth, total percent plant cover also correlated with river discharge rates (Figure 22), particularly shallow-rooted understory plant species. There were shifts in understory vegetation composition (see 2005 and 2006 in Figure 20) as well as noticeable increases in growth in 2006 following the extended period of inundation in 2005. Flooded conditions led to germination and establishment of riparian plants (especially coyote willow and cottonwood as demonstrated in Table F-2, Appendix F). The relatively high discharge rates in 2008 did not lead to long periods of inundation, but did result in a high water table. These conditions provided plant available water and allowed for increased plant cover that year. Yearly discharge rates have decreased since 2008, as has understory vegetative cover. Overstory cover remained somewhat stable from 2009 to 2013 despite decreasing discharge rates. This would suggest that by 2009, cottonwood and willow had developed a deep enough root system to sustain declines in the water table. Regardless, based on well monitoring data, it is unlikely that groundwater at the site has fallen below the crucial depth of around 10 ft necessary to sustain woody riparian species (Cartron et al. 2008). Most wells, which average around 5 ft in depth, were only occasionally dry, which indicates that the water table is relatively shallow at the site. On the other hand, vegetation did appear to be affected by prolonged dry conditions at the site. From 2010 to 2012, overstory foliage was observed to be rather sparse and leaves were dropping earlier than expected. This is supported by overstory cover values, which did not notably increase from 2009 to 2012.

The three wells nearest to the river and within (or near) the vegetation monitoring site show that groundwater is deeper in the northern section of the site. Groundwater depth did not appear to have a direct correlation with overstory vegetation cover, which was relatively consistent throughout transects. Nor did it seem to affect species composition as there were no large differences in the percent cover of each species throughout the monitoring area. These results imply that although the water table falls below well depth more frequently in the north, differences in ground water depth are probably not significantly different between areas since there does not appear to be varying responses in vegetation.

Data from the HOBO water level loggers were collected every 2 hr from June 2011 to September 2014, which captured diurnal fluctuations in the water table (Figure 22). Diurnal fluctuation in shallow water tables is attributed to ground water consumption by phreatophytes such as willow and cottonwood (Shah et al. 2007). The significant evapotranspiration (ET) consumption of phreatophytic plants influences the behavior of interconnected surface and ground water systems. The water table, which declines rapidly during daylight due to ET, partially recovers at night. The recovery in the evening and night hours is attributed to lateral and vertical ground water flow to the discharge area (Shah et al. 2007). As Figure 23 shows, in many cases a spike in river discharge also caused a spike in diurnal fluctuation, indicating that river flows were controlling fluctuations in well depth. In general, diurnal fluctuations were highest during the growing season (approximately May through September), which is a representation of plant ET at the site.

The ET of surrounding plant species influences diurnal fluctuations in association with ground water depths. Transpiration by cottonwood is unaffected as long as the water table is within 3 m of the surface (Cleverly et al. 2006). When groundwater is drawn down deeper, transpiration declines with increasing crown dieback. Goodding’s willow is found in habitats similar to those of cottonwood; therefore Goodding’s willow ET is expected to respond to groundwater depth in the same manner as cottonwood (Cleverly et al. 2006). Conversely, coyote willow can tolerate dryer conditions, much like saltcedar, and ET from coyote willow is expected to respond more like saltcedar. Saltcedar transpiration is not restricted by depth to groundwater as it is in cottonwood (Cleverly et al. 2006). Even though saltcedar ET is not dependent upon depth to the water table, it does respond to changes in water table depth, increasing while the groundwater is falling.

Data collected at LLRS is not specific enough to correlate individual wells with surrounding plant species. Another limitation is that wells do not go to depths that are found to inhibit ET of cottonwood and Goodding’s willow. Nonetheless, patterns in diurnal fluctuations are apparent. There is an increase in diurnal fluctuation while river levels fall, which could indicate coyote willow ET responding to a deepening water table, or it could simply be a seasonal pattern (i.e summer months are the growing season and also when river flows decline).

Photo Stations

Photos taken at Stations 1 through 5, which are located along the berm and face east toward the river in the Cleared/Overbank Area where vegetation transects are located, show considerable and steady growth in regenerating willow and cottonwood. In 2006, following flooded conditions in 2005, the establishment of woody species appears stable. By 2009, a definite overstory has developed. From about 2010 through 2012, foliage is noticeably affected by dry conditions and there is not an obvious growth in overstory species. In photos taken at Stations 6 – 10, which are located along the road and face east toward the Burned Area, the density of standing dead cottonwoods in the burned forest has noticeably decreased over the years as the growth of regenerating understory has increased. This is the area in which cottonwood poles were planted in 2004, and a healthy stand of cottonwoods is developing in this area. Saltcedar is also evident in many of the photos.

From 2010 to 2012, it was observed that leaves were already turning yellow and beginning to fall from the vegetation during monitoring in early to mid-September, which may have been due to an extended period of low precipitation (Figure 22). This condition is apparent in photos from these years. By 2013, despite continued drought, foliage is fuller and greener (which was supported by data which showed an increase in overstory cover this year).

Conclusion and Recommendations

Avian Monitoring

Conclusions

Avian relative abundance and species richness data have been collected for a 12 year study period at the LLRS in riparian habitat along the Middle Rio Grande. Monitoring has tracked the development of the avian population and of SWFL habitat suitability in the Cleared/Overbank restoration area where established stands of riparian vegetation bordering high flow channels is the desired future condition.

Despite decreasing trends in relative abundance of total birds in both avian monitoring areas from approximately 2005 to 2009, bird detections have either maintained (i.e., Burned Area) or increased (i.e., Cleared/Overbank Area) from 2003 to 2014. These results are similar for species richness in each monitoring area as well. The reasons for decreases mid-study are unknown, but regardless, riparian habitat in the LLRS currently appears to be supporting diverse avian populations.

The abundance and diversity of breeding cavity, dense shrub, edge, and mid-story bird species in the Cleared/Overbank Area have increased during monitoring, resulting in an overall increase in total bird abundance. The mid-story guild serves as an indicator for SWFL habitat. Since 2010, the number of mid-story species detections per point in the Cleared/Overbank has been either statistically equal to or greater than the Burned Area. Both areas (restored and burned) appear to show promising potential for providing SWFL habitat. As woody riparian plants develop height and density suitable for nesting substrate and cover in the Cleared/Overbank and Burned Areas, mid-story habitat vital to SWFLs should continue to increase.

Based on avian data collected in this study, mid-story habitat – potentially suitable for SWFL breeding - became established by approximately 2010. Using the LLRS as a reference, it appears that it is possible for SWFL habitat to develop within 8 years following restoration activities in the Middle Rio Grande. These results are dependent on environmental conditions that are favorable for successful restoration, as were present during development of this site. Using hydraulic and geospatial analysis, Kissock (2010) determined that the LLRS is “sustainable by continuing to provide habitat to endangered species targeted for habitat restoration.”

Over the past several years, SWFLs have established territories in closer proximity to the LLRS, increasing the likelihood that they may occupy the site in the near future.

Recommendations

TSC recommends continuing avian monitoring in accordance with the initial monitoring requirements of the BO and to provide information for adaptive management of flycatcher restoration projects. Further monitoring will help to determine if the Cleared/Overbank Area can sustain habitat for most bird guilds, especially for mid-story species that include the SWFL. It is also important to document occurrence of breeding SWFLs at the LLRS to determine if suitable habitat has in fact developed, which was one of the objectives for restoration of this site.

Vegetation Monitoring

Conclusions

Vegetation monitoring data are being used to document:

1) the natural establishment of riparian vegetation in the disturbed areas
2) the establishment of wetland vegetation in depression areas
3) the possible establishment of noxious weeds and recolonization of exotics
4) rates of vegetation development for future SWFL restoration efforts.

Success of riparian restoration at the LLRS could also potentially be used for comparison at other restoration sites along the middle Rio Grande.

Riparian vegetation has successfully established in the Cleared/Overbank Area. Native species dominated the overstory and included coyote willow, Goodding’s willow, and Rio Grande cottonwood. The wetland indicator status of both willows is “facultative wetland” (i.e., usually occur in wetlands but may occur in nonwetlands) based on the National Wetland Plant List for the Arid West (USDA NRCS 2014). In the understory layer, native species also dominated the vegetation, although were not necessarily considered riparian plants. The native grass vine mesquite, for example, was the most common understory species detected at the site and is in the “upland” wetland indicator category. Plant species found in depressions, however, were categorized as “obligate wetland” (i.e. almost always occurs in wetlands, e.g., common spikerush) or as “facultative wetland” (e.g., fragrant flatsedge, Baltic rush, common reed, and sword-leaved rush). Saltcedar, although present at the site, had relatively low cover values (<10 percent) over the monitoring period and did not appear to be competitive with native overstory species.

Prichard et al. (1998 as cited in Dressen et al. 2002) developed a comprehensive assessment of criteria useful in judging riparian area condition and attributes that constitute a proper functioning condition for lotic areas. The vegetation attributes of a proper functioning riparian system include:

1) the age class distribution of the riparian plant community indicates the recruitment of young individuals and the maintenance of older individuals;
2) the species composition of the riparian area is diverse;
3) the characteristic soil moisture of a riparian-wetland area is indicated by the species present;
4) species with root masses capable of protecting against high flow events are present on the streambanks;

5) the condition of the riparian plant community is healthy and robust;
6) vegetative cover is sufficient to protect streambanks and dissipate energy during high flow events; and,
7) the riparian plant community can provide sufficient large woody debris to act as an agent to modify the hydrology if necessary for proper functioning.

When evaluating the LLRS using these attributes, most of these criteria appear to have been met. Tree and shrub species detected in the understory layer are an indication that woody species are regenerating at the site and have been throughout monitoring. A diverse composition of riparian species, including willow, cottonwood, sedges, and rushes, are present. The condition of vegetation appears healthy. Even during drought conditions, canopy cover maintained at a stable rate, which also indicates that woody vegetation has reached rooting depths that can sustain a deeper and fluctuating water table. Woody debris is present in the form of downed cottonwood as a result of the fire in 2000. High energy flows have not been present in recent years, although the site appeared to withstand very high flows in 2005.

Conditions that are important to the success of riparian restoration, which include ground water depth, timing of high flows and flooding, native seed source, competition from exotics, and soil conditions (i.e., texture and salinity levels) have all been conducive to development of healthy, native riparian habitat. In conjunction with favorable conditions, the techniques used for restoring the site can also be deemed successful thus far. The success of restoration at this site can largely be attributed to a design that integrated natural hydrologic processes; banks were lowered to allow for overbank flooding and channels created to slow flood waters and encourage sediment deposition (Muldavin et al. 2015). Kissock (2010) predicted that the LLRS would require maintenance in the future due to greater than critical sheer stress values, resulting in a tendency towards erosion. At this point in the study, erosion does not appear to be problematic.

Recommendations

Monitoring should be continued at the established vegetation transects in accordance with the initial monitoring requirements of the BO and to provide information for adaptive management of flycatcher restoration projects. Long-term monitoring will help to determine if vegetation at the site can continue to regenerate and sustain varying conditions.

In an attempt to specifically evaluate the site for SWFL habitat suitability, TSC recommends conducting nest site quantification studies in 2015, which would involve comparing vegetation within the Burned and Cleared/Overbank Areas of LLRS to that of known breeding SWFL territories. This would provide more accurate estimates of habitat conditions for the species.

As of 2010, large patches of perennial pepperweed were detected within the LLRS. The occurrence of this noxious weed has expanded from previous years. Control of this species may be warranted.

Ground Water Monitoring

Conclusions

Data from monitoring wells were used to correlate the development and extent of wetland/riparian type vegetation at the restoration site. These data have been instrumental in interpreting long-term development of plant communities at the LLRS. The depth of the water table has a large effect on the continued success of cottonwood and willow. For example, Hultine et al. (2010) found that cottonwood has a greater sensitivity to interannual reductions in water availability, while willow is more sensitive to longer periods of soil water depletion.

It appears that the water table at the LLRS is relatively shallow, which has been important in recruiting and establishing stands of cottonwood and willow. Most of the wells, all of which averaged around 5 ft in depth, held water throughout the majority of the year. Based on groundwater data and on the development of healthy native vegetation, it is unlikely that that the water table falls to depths that are detrimental to the success of woody riparian species. Vegetation did, however, appear to show stress from dry conditions in recent years.

Recommendations

Data from water level loggers is useful in determining groundwater effects on developing vegetation and associated wildlife habitat at the site, as well as evaluating the connectivity of groundwater and surface water flows. Ground water monitoring should be continued for the duration of the study, particularly in light of dry conditions that have occurred in recent years.

Photo Stations

Conclusions

Shifts in plant composition and growth stages of regenerating willow and cottonwood have been observed over the12 years of monitoring. Photos have provided an important record of the changing vegetation, including the timing of certain stages in development. Of all the methods of data collection used, photographic documentation has probably presented the clearest account of the changes at the LLRS.

Recommendations

Trends in the vegetation should continue to be captured through photos for the duration of the study.

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Appendix A

Waypoint Locations for Avian Point Counts, Vegetation Transects, Groundwater Monitoring Wells, and Photo Stations

All coordinates are in NAD83, Zone 13

Avian Point Count Waypoints

Point	Easting (X)	Northing (Y)
LL1-01	340970	3848075
LL1-02	340874	3847961
LL1-03	340818	3847867
LL1-04	340717	3847768
LL1-05	340649	3847675
LL1-06	340612	3847536
LL1-07	340505	3847477
LL1-08	340395	3847340
LL1-09	340410	3847172
LL1-10	340345	3847004
LL1-11	340316	3846827
LL1-12	340267	3846641
LL2-01	341046	3847985
LL2-02	340969	3847883
LL2-03	340900	3847777
LL2-04	340833	3847665
LL2-05	340766	3847559
LL2-06	340696	3847442
LL2-07	340630	3847332
LL2-08	340558	3847202
LL2-09	340502	3847081
LL2-10	340454	3846973
LL2-11	340418	3846865
LL2-12	340380	3846720

Vegetation Transect Waypoints

Transect	x	y
R1A	341053	3847958
R1B	341015	3847992
R2A	340981	3847867
R2B	340943	3847895
R3A	340923	3847761
R3B	340880	3847789
R4A	340860	3847665
R4B	340814	3847687
R5A	340793	3847560
R5B	340749	3847584
R6A	340734	3847459
R6B	340691	3847484
R6-1A	340674	3847363
R6-1B	340630	3847384
R7A	340563	3847162
R7B	340508	3847180
R8A	340516	3847052
R8B	340465	3847073
R9A	340466	3846945
R9B	340417	3846961
R10A	340424	3846834
R10B	340374	3846842
R11A	340392	3846715
R11B	340342	3846723

Groundwater Well Waypoints

Well	x	y
N1	341087	3847987
N2	341037	3848047
N3	340992	3848103
N4	340933	3848162
M1	340613	3847298
M2	340592	3847425
M3	340529	3847439
M4	340469	3847513
S1	340324	3846590
S2	340280	3846598
S3	340245	3846598

Photo Station Waypoints

Photo Station	x	y
P-1	341038	3848023
P-2	340771	3847679
P-3	340582	3847349
P-4	340419	3847015
P-5	340345	3846598
P-6	340898	3848173
P-7	340416	3847477
P-8	340404	3847462
P-9	340384	3847449
P-10	340200	3846582

Appendix B

Bird Species Detected During Point Counts and Associated Habitat Guilds

Table B-1—Bird species detected during point counts and associated habitat guilds.

SPECIES	Scientific name	Canopy	Cavity	Dense shrub	Edge	Ground shrub	Invasive	Mid-story	Opening	Water	Migrant
American avocet	*Recurvirostra americana*									X	
American crow	*Corvus brachyrhynchos*				X						
American kestrel	*Falco sparverius sparverius*		X								
American robin	*Turdus migratorius*							X			
Ash-throated flycatcher	*Myiarchus cinerascens*		X								
Barn swallow	*Hirundo rustica*								X		
Bank swallow	*Riparia riparia*									X	
Bewick's wren	*Thryomanes bewickii*		X								
Black phoebe	*Sayornis nigricans*									X	
Black-capped chickadee	*Poecile atricapillus*		X								
Black-chinned hummingbird	*Archilochus alexandri*				X						
Black-crowned night heron	*Nycticorax nycticorax*									X	
Black-headed grosbeak	*Pheucticus melanocephalus*							X			
Black-necked stilt	*Himantopus mexicanus*									X	
Blue grosbeak	*Guiraca caerulea*					X					
Blue-gray gnatcatcher	*Polioptila caerulea*							X			
Blue-winged teal	*Anas discors*									X	
Brewer's blackbird	*Euphagus cyanocephalus*				X						
Broadtailed hummingbird	*Selasphorus platycercus*										X
Brown-headed cowbird	*Molothrus ater*							X			
Bullock's oriole	*Icterus bullockii*	X									
Bushtit	*Psaltriparus minimus*							X			
Canada goose	*Branta canadensis*									X	
Cassin's finch	*Carpodacus cassinii*										X
Cassin's vireo	*Vireo cassinii*										X
Cattle egret	*Bubulcus ibis*										X
Cliff swallow	*Petrochelidon pyrrhonota*									X	
Common grackle	*Quiscalus quiscula*				X						
Common yellowthroat	*Geothlypis trichas*			X							
Cooper's hawk	*Accipiter cooperii*	X									
Downy woodpecker	*Picoides pubescens*		X								
Dusky flycatcher	*Empidonax oberholseri*										X

SPECIES	Scientific name	Canopy	Cavity	Dense shrub	Edge	Ground shrub	Inva-sive	Mid-story	Open-ing	Water	Migrant
European starling	*Sturnus vulgaris*						X				
Gadwall	*Anas strepera*										X
Gambel's quail	*Callipepla gambelii*					X					
Gray catbird	*Dumetella carolinensis*							X			
Great egret	*Ardea alba*										X
Great-blue heron	*Ardea herodias*									X	
Great-horned owl	*Bubo virginianus*				X						
Great-tailed grackel	*Quiscalus mexicanus*	X									
Green heron	*Butorides virescens*										X
Hairy woodpecker	*Picoides villosus*		X								
House finch	*Carpodacus mexicanus*							X			
Indigo bunting	*Passerina cyanea*				X						
Killdeer	*Charadrius vociferus*					X					
Ladder-backed woodpecker	*Picoides scalaris*		X								
Lazuli bunting	*Passerina amoena*										X
Lesser goldfinch	*Carduelis psaltria*							X			
Little blue heron	*Egretta caerulea*										X
Loggerhead shrike	*Lanius ludovicianus*				X						
Lucy's warbler	*Vermivora luciae*										X
MacGillivray's warbler	*Ardea alba*										X
Mallard	*Anas platyrhynchos*									X	
Mountain chickadee	*Poecile gambeli*		X								
Mourning dove	*Zenaida macroura*					X					
Northern flicker	*Colaptes auratus*		X								
Northern mockingbird	*Mimus polyglottos*				X						
Northern rough-winged swallow	*Stelgidopteryx serripennis*									X	
Orange-crowned warbler	*Vermivora celata*			X							
Phainopepla	*Phainopepla nitens*										X
Plumbeous vireo	*Vireo plumbeus*							X			
Red-tailed hawk	*Buteo jamaicensis*	X									
Red-winged blackbird	*Agelaius phoeniceus*									X	
Ring-necked pheasant	*Phasianus colchicus*					X					
Say's phoebe	*Sayornis saya*				X						

SPECIES	Scientific name	Canopy	Cavity	Dense shrub	Edge	Ground shrub	Invasive	Mid-story	Opening	Water	Migrant
Snowy egret	*Egretta thula*									X	
Southwestern willow flycatcher	*Empidonax traillii*							X			
Spotted sandpiper	*Actitis macularia*									X	
Spotted towhee	*Pipilo maculatus*							X			
Summer tanager	*Piranga rubra*	X									
Swainson's hawk	*Buteo swainsoni*	X									
Turkey vulture	*Cathartes aura*	X									
Townsend's warbler	*Dendroica townsendi*										X
Unidentified swallow										X	
Violet-green swallow	*Tachycineta thalassina*									X	
Western kingbird	*Tyrannus verticalis*				X						
Western screech owl	*Otus kennicottii*		X								
Western tanager	*Piranga ludoviciana*	X									
Western wood pewee	*Contopus sordidulus*	X									
White-breasted nuthatch	*Sitta carolinensis*		X								
White-winged dove	*Zenaida asiatica*							X			
Wilson's warbler	*Wilsonia pusilla*										X
Yellow warbler	*Dendroica petechia*			X							
Yellow-breasted chat	*Icteria virens*							X			
Yellow-rumped warbler	*Dendroica coronata*							X			

Appendix C

Relative Abundance of Individual Bird Species by Area

Table C-1.—Relative abundance of individual bird species in the Cleared/overbank area.

Cleared/overbank area	2003 n=24		2004 n=24		2005 n=24		2006 n=24		2007 n=36		2008 n=36	
Species	% Plots	Mean (SD)	% Plots	Mean (SD)	% Plots	Mean (SD)	% Plots	Mean (SD)	% Plots	Mean (SD)	% Plots	Mean (SD)
Canopy birds												
Bullock's oriole	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Cooper's hawk	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Great-tailed grackle	0.0	0.00 (0.00)	0.0	0.00 (0.00)	4.2	0.04 (0.20)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)
Summer tanager	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Swainson's hawk	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Turkey vulture	4.2	0.42 (2.04)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Western tanager	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Western wood pewee	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Cavity birds												
American kestrel	4.2	0.04 (0.20)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Ash-throated flycatcher	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	4.2	0.04 (0.20)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Bewick's wren	0.0	0.00 (0.00)	8.3	0.13 (0.45)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Black-capped chickadee	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Downy woodpecker	0.0	0.00 (0.00)	0.0	0.00 (0.00)	4.2	0.04 (0.20)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Mountain chickadee	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Northern flicker	0.0	0.00 (0.00)	4.2	0.04 (0.20)	4.2	0.04 (0.20)	0.0	0.00 (0.00)	5.6	0.06 (0.23)	5.6	0.06 (0.23)
Western screech-owl	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
White-breasted nuthatch	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	8.3	0.08 (0.28)
Dense shrub birds												
Common yellowthroat	0.0	0.00 (0.00)	12.5	0.13 (0.34)	16.7	0.21 (0.51)	16.7	0.17 (0.38)	61.1	0.81 (0.86)	36.1	0.42 (0.60)
Orange-crowned warbler	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.00	0.00 (0.00)	0.00	0.00 (0.00)	0.00	0.00 (0.00)
Yellow warbler	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.00	0.00 (0.00)	0.00	0.00 (0.00)	0.00	0.00 (0.00)
Edge birds												
American crow	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	4.2	0.21 (1.02)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Black-chinned hummingbird	4.2	0.08 (0.41)	8.3	0.08 (0.28)	12.5	0.13 (0.34)	29.2	0.33 (0.56)	38.9	0.58 (0.84)	33.3	0.47 (0.77)
Brewer's blackbird	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.00	0.00 (0.00)	0.00	0.00 (0.00)	2.8	1.25 (7.50)	0.0	0.00 (0.00)
Indigo bunting	8.3	0.08 (0.28)	4.2	0.04 (0.20)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Loggerhead shrike	4.2	0.04 (0.20)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Northern mockingbird	0.0	0.00 (0.00)	4.2	0.04 (0.20)	0.0	0.00 (0.00)	29.2	0.38 (0.71)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Say's phoebe	8.3	0.13 (0.45)	4.2	0.04 (0.20)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Western kingbird	12.5	0.21 (0.59)	25.0	0.29 (0.55)	16.7	0.21 (0.51)	37.5	0.58 (0.88)	16.7	0.36 (0.90)	2.8	0.03 (0.17)
Ground shrub birds												
Blue grosbeak	20.8	0.33 (0.70)	2.1	0.29 (0.62)	4.2	0.04 (0.20)	25.0	0.46 (0.93)	44.4	0.69 (0.89)	13.9	0.14 (0.35)
Killdeer	8.3	0.08 (0.28)	37.5	0.67 (1.20)	37.5	0.96 (1.60)	20.8	0.25 (0.53)	22.2	0.42 (0.94)	5.6	0.08 (0.37)

Cleared/overbank area	**2003 n=24**		**2004 n=24**		**2005 n=24**		**2006 n=24**		**2007 n=36**		**2008 n=36**	
Species	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**
Mourning dove	0.0	0.00 (0.00)	16.7	0.17 (0.38)	12.5	0.25 (0.74)	45.8	3.92 (7.63)	25.0	0.69 (2.08)	19.4	0.28 (0.66)
Ring-necked pheasant	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	8.3	0.08 (0.28)	14.9	0.14 (0.35)	2.8	0.03 (0.17)
Midstory birds												
American robin	0.0	0.00 (0.00)	4.2	0.04 (0.20)	4.2	0.04 (0.20)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Black-headed grosbeak	4.2	0.04 (0.20)	4.2	0.04 (0.20)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	5.6	0.06 (0.23)	19.4	0.28 (0.61)
Blue-gray gnatcatcher	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Brown-headed cowbird	8.3	0.08 (0.28)	29.2	0.54 (0.98)	0.0	0.00 (0.00)	12.5	0.25 (0.68)	25.0	0.50 (1.00)	50.0	1.17 (1.75)
Bushtit	0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.00	0.00 (0.00)	2.8	0.11 (0.67)	0.0	0.00 (0.00)
Gray catbird	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	4.2	0.04 (0.20)	2.8	0.03 (0.17)	2.8	0.03 (0.17)
House finch	0.0	0.00 (0.00)	0.0	0.00 (0.00)	4.2	0.13 (0.61)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Lesser goldfinch	4.2	0.04 (0.20)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Plumbeous vireo	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Spotted towhee	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.00	0.00 (0.00)	16.7	0.19 (0.47)	25.0	0.28 (0.51)
Southwestern willow flycatcher	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
White-winged dove	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.00	0.00 (0.00)	2.8	0.06 (0.33)	0.0	0.00 (0.00)
Yellow-breasted chat	0.0	0.00 (0.00)	4.2	0.04 (0.20)	4.2	0.04 (0.20)	0.0	0.00 (0.00)	5.6	0.06 (0.23)	13.9	0.17 (0.45)
Yellow-rumped warbler	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Open birds												
Barn swallow	4.2	0.08 (0.41)	16.7	0.17 (0.38)	8.3	0.08 (0.28)	2.1	0.58 (1.32)	2.8	0.11 (0.67)	0.0	0.00 (0.00)
Water birds												
American avocet	0.0	0.00 (0.00)	0.0	0.00 (0.00)	4.2	0.04 (0.20)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Bank swallow	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Black-crowned night heron	4.2	0.04 (0.20)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	4.2	0.04 (0.20)	0.0	0.00 (0.00)	8.3	0.11 (0.40)
Black-necked stilt	0.0	0.00 (0.00)	4.2	0.17 (0.82)	25.0	0.42 (0.83)	8.3	0.13 (0.45)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Blue-winged teal	0.0	0.00 (0.00)	0.0	0.00 (0.00)	12.5	0.21 (0.66)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Canada goose	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Cliff swallow	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	8.3	0.17 (0.61)
Great-blue heron	0.0	0.00 (0.00)	0.0	0.00 (0.00)	4.2	0.04 (0.20)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Mallard	0.0	0.00 (0.00)	0.0	0.00 (0.00)	33.3	1.46 (3.16)	4.2	0.04 (0.20)	5.6	0.11 (0.52)	8.3	0.11 (0.40)
Northern rough-winged swallow	12.5	0.13 (0.34)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	8.3	0.17 (0.61)	2.8	0.03 (0.17)
Red-winged blackbird	4.2	0.67 (1.13)	50.0	1.21 (1.50)	95.8	4.63 (1.79)	33.3	0.46 (0.78)	47.2	1.11 (1.69)	55.6	1.28 (1.60)
Snowy egret	12.5	0.13 (0.34)	20.8	0.29 (0.62)	12.5	0.21 (0.59)	0.0	0.00 (0.00)	8.3	0.11 (0.40)	5.6	0.06 (0.23)
Spotted sandpiper	12.5	0.13 (0.34)	12.5	0.17 (0.48)	37.5	0.46 (0.66)	8.3	0.13 (0.45)	8.3	0.08 (0.28)	5.6	0.08 (0.37)
Unidentified swallow	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	25.0	0.33 (0.64)	2.8	0.08 (0.50)	0.0	0.00 (0.00)
Violet-green swallow	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	25.0	0.38 (0.71)	2.8	0.03 (0.17)	8.3	0.17 (0.61)

Cleared/overbank area	**2003 n=24**		**2004 n=24**		**2005 n=24**		**2006 n=24**		**2007 n=36**		**2008 n=36**	
Species	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**
Migrants												
Broadtailed hummingbird	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Cassin's finch	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	4.2	0.04 (0.20)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Cassin's vireo	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Cattle egret	0.0	0.00 (0.00)	0.0	0.00 (0.00)	4.2	0.25 (1.22)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Dusky flycatcher	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Gadwall	0.0	0.00 (0.00)	0.0	0.00 (0.00)	4.2	0.13 (0.61)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Great egret	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Green heron	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Lazuli bunting	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	8.3	0.11 (0.40)
Little blue heron	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Lucy's warbler	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)
MacGillivray's warbler	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Phainopepla	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Wilson's warbler	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)

Table C-1.(cont'd)—Relative abundance of individual bird species in the Cleared/overbank area.

Cleared/overbank area	**2009 n=36**		**2010 n=36**		**2011 n=36**		**2012 n=36**		**2013 n=36**		**2014 n=36**	
Species	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**
Canopy birds												
Bullock's oriole	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Cooper's hawk	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	2.8	0.03 (0.17)
Great-tailed grackle	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Summer tanager	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	5.6	0.06 (0.23)
Swainson's hawk	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	5.6	0.06 (0.23)
Turkey vulture	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Western tanager	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)
Western wood pewee	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.03 (0.17)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	5.6	0.06 (0.23)
Cavity birds												
American kestrel	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Ash-throated flycatcher	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	5.6	0.08 (0.37)	2.8	0.03 (0.17)	13.9	0.14 (0.35)
Bewick's wren	0.0	0.00 (0.00)	0.0	0.00 (0.00)	16.7	0.22 (0.54)	2.8	0.03 (0.17)	8.3	0.08 (0.28)	2.8	0.06 (0.33)
Black-capped chickadee	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	5.6	0.06 (0.23)
Downy woodpecker	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	13.9	0.22 (0.59)	2.8	0.06 (0.33)	2.8	0.06 (0.33)
Mountain chickadee	0.0	0.00 (0.00)	8.3	0.11 (0.40)	8.3	0.08 (0.28)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Northern flicker	0.0	0.00 (0.00)	8.3	0.08 (0.28)	2.8	0.03 (0.17)	5.6	0.06 (0.23)	5.6	0.06 (0.23)	0.0	0.00 (0.00)

Cleared/overbank area	2009 n=36		2010 n=36		2011 n=36		2012 n=36		2013 n=36		2014 n=36	
Species	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**
Western screech-owl	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
White-breasted nuthatch	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Dense shrub birds												
Common yellowthroat	47.2	0.50 (0.56)	25.0	0.25 (0.44)	47.2	0.56 (0.65)	41.7	0.58 (0.77)	11.1	0.11 (0.32)	22.2	0.28 (0.57)
Orange-crowned warbler	0.00	0.00 (0.00)	0.00	0.00 (0.00)	0.00	0.00 (0.00)	13.9	0.17 (0.45)	13.9	0.25 (0.65)	11.1	0.14 (0.42)
Yellow warbler	0.00	0.00 (0.00)	2.8	0.03 (0.17)	5.5	0.06 (0.23)	5.6	0.06 (0.23)	2.8	0.03 (0.17)	0.0	0.00 (0.00)
Edge birds												
American crow	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Black-chinned hummingbird	33.3	0.36 (0.54)	44.4	0.53 (0.65)	41.7	0.56 (0.73)	55.6	0.83 (0.85)	66.7	0.92 (0.77)	72.2	1.28 (1.11)
Brewer's blackbird	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Indigo bunting	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Loggerhead shrike	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Northern mockingbird	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	2.8	0.03 (0.17)
Say's phoebe	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	5.6	0.11 (0.46)	2.8	0.03 (0.17)
Western kingbird	5.5	0.11 (0.46)	2.8	0.03 (0.17)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Ground shrub birds												
Blue grosbeak	13.9	0.17 (0.45)	11.1	0.11 (0.32)	25.0	0.33 (0.63)	13.9	0.22 (0.59)	22.2	0.33 (0.72)	19.4	0.25 (0.55)
Killdeer	8.3	0.17 (0.56)	5.6	0.11 (0.52)	8.3	0.11 (0.40)	8.3	0.08 (0.28)	19.4	0.31 (0.71)	5.6	0.06 (0.23)
Mourning dove	25.0	0.42 (0.87)	25.0	0.33 (0.63)	36.1	0.53 (0.84)	55.6	0.86 (0.87)	55.6	0.78 (0.80)	55.6	0.83 (0.88)
Ring-necked pheasant	0.0	0.00 (0.00)	2.8	0.03 (0.17)	8.3	0.08 (0.28)	22.2	0.22 (0.42)	19.4	0.19 (0.40)	16.7	0.17 (0.38)
Midstory birds												
American robin	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.06 (0.33)
Black-headed grosbeak	22.2	0.22 (0.42)	33.3	0.50 (0.81)	38.9	0.50 (0.70)	66.7	0.92 (0.77)	61.1	0.75 (0.69)	50.0	0.64 (0.72)
Blue-gray gnatcatcher	0.0	0.00 (0.00)	0.0	0.00 (0.00)	5.5	0.08 (0.37)	5.6	0.08 (0.37)	2.8	0.03 (0.17)	0.0	0.00 (0.00)
Brown-headed cowbird	8.3	0.17 (0.61)	36.1	0.61 (0.96)	41.7	0.78 (1.07)	66.7	1.28 (1.21)	58.3	1.03 (1.16)	41.7	0.67 (0.93)
Bushtit	0.0	0.00 (0.00)	2.8	0.17 (1.00)	5.5	0.14 (0.59)	8.3	0.25 (0.84)	11.1	0.25 (0.77)	5.6	0.17 (0.74)
Gray catbird	2.8	0.03 (0.17)	5.6	0.06 (0.23)	2.8	0.03 (0.17)	5.6	0.06 (0.23)	5.6	0.06 (0.23)	11.1	0.14 (0.42)
House finch	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	5.6	0.08 (0.37)	2.8	0.03 (0.17)	8.3	0.17 (0.56)
Lesser goldfinch	0.0	0.00 (0.00)	0.0	0.00 (0.00)	5.5	0.14)0.59)	25.0	0.47 (0.88)	8.3	0.17 (0.56)	8.3	0.14 (0.54)
Plumbeous vireo	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Spotted towhee	33.3	0.39 (0.60)	55.6	0.64 (0.64)	41.7	0.50 (0.65)	66.7	1.06 (0.89)	94.4	1.31 (0.58)	69.4	1.03 (0.84)
Southwestern willow flycatcher	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
White-winged dove	2.8	0.03 (0.17)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Yellow-breasted chat	2.8	0.03 (0.17)	5.6	0.06 (0.23)	80.5	1.19 (0.79)	75.0	1.17 (0.85)	91.7	1.61 (0.80)	75.0	1.31 (0.95)
Yellow-rumped warbler	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.06 (0.33)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.06 (0.33)

Cleared/overbank area	**2009 n=36**		**2010 n=36**		**2011 n=36**		**2012 n=36**		**2013 n=36**		**2014 n=36**	
Species	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**
Open birds												
Barn swallow	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Water birds												
American avocet	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Bank swallow	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.08 (0.50)	0.0	0.00 (0.00)	2.8	0.11 (0.67)	0.0	0.00 (0.00)
Black-crowned night heron	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Black-necked stilt	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Blue-winged teal	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Canada goose	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	8.3	0.31 (1.09)
Cliff swallow	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Great-blue heron	5.5	0.06 (0.23)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Mallard	5.5	0.06 (0.23)	2.8	0.22 (1.33)	11.1	0.31 (1.09)	5.6	0.08 (0.37)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Northern rough-winged swallow	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Red-winged blackbird	41.7	0.58 (0.81)	8.3	0.17 (0.70)	11.1	0.22 (0.64)	5.6	0.14 (0.59)	8.3	0.14 (0.49)	2.8	0.06 (0.33)
Snowy egret	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Spotted sandpiper	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Unidentified swallow	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Violet-green swallow	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Migrants												
Broadtailed hummingbird	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)
Cassin's finch	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Cassin's vireo	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Cattle egret	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Dusky flycatcher	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Gadwall	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Great egret	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	2.8	0.03 (0.17)	2.8	0.03 (0.17)	0.0	0.00 (0.00)
Green heron	0.0	0.00 (0.00)	0.0	0.00 (0.00)	5.5	0.06 (0.23)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	2.8	0.03 (0.17)
Lazuli bunting	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Little blue heron	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Lucy's warbler	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
MacGillivray's warbler	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)
Phainopepla	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Wilson's warbler	0.0	0.00 (0.00)	0.0	0.00 (0.00)	8.3	0.08 (0.28)	11.1	0.11 (0.32)	8.3	0.11 (0.40)	8.3	0.11 (0.40)

Table C-2.—Relative abundance of individual bird species in the Burned area.

Burned area	**2003 n=42**		**2004 n=47**		**2007 n=36**		**2008 n=36**		**2009 n=36**		**2010 n=36**		**2011 n=36**		**2012 n=36**		**2013 n=36**		**2014 n=36**	
Species	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**
Canopy birds																				
Bullock's oriole	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.7	0.03 (0.17)	11.1	0.03 (0.17)
Cooper's hawk	0.0	0.00 (0.00)	0.0	0.00 (0.00)	8.3	0.08 (0.28)	0.0	0.00 (0.00)	5.6	0.06 (0.23)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	5.6	0.06 (0.23)	8.3	0.11 (0.40)	2.8	0.03 (0.17)
Red-tailed hawk	4.8	0.05 (0.22)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Summer tanager	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	8.3	0.08 (0.28)	0.0	0.00 (0.00)	5.5	0.06 (0.23)	8.3	0.08 (0.28)	8.3	0.11 (0.40)	5.6	0.06 (0.23)
Swainson's hawk	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.06 (0.33)
Turkey vulture	19.0	0.67 (1.72)	8.5	0.36 (1.28)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Western tanager	2.4	0.02 (0.15)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Western wood pewee	0.0	0.00 (0.00)	2.1	0.02 (0.15)	5.6	0.06 (0.23)	0.0	0.00 (0.00)	5.6	0.06 (0.23)	0.0	0.00 (0.00)	5.5	0.06 (0.23)	2.8	0.03 (0.17)	0.0	0.03 (0.17)	2.8	0.03 (0.17)
Cavity birds																				
American kestrel	7.1	0.10 (0.37)	2.1	0.02 (0.15)	13.9	0.17 (0.45)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	5.6	0.08 (0.37)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Ash-throated flycatcher	19.0	0.19 (0.40)	6.4	0.06 (0.25)	11.1	0.14 (0.42)	2.8	0.03 (0.17)	8.3	0.08 (0.28)	11.1	0.11 (0.32)	8.3	0.08 0.28	22.2	0.25 (0.50)	16.7	0.19 (0.47)	8.3	0.08 (0.28)
Bewick's wren	4.8	0.05 (0.22)	0.0	0.00 (0.00)	25.0	0.39 (0.80	5.6	0.06 (0.23)	8.3	0.08 (0.28)	13.9	0.17 (0.45)	13.9	0.25 (0.73)	19.4	0.33 (0.76)	11.1	0.11 (0.32)	2.8	0.03 (0.17)
Black-capped chickadee	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	5.6	0.08 (0.37)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Downy woodpecker	0.0	0.00 (0.00)	2.1	0.02 (0.15)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	5.6	0.06 (0.23)	8.3	0.14 (0.49)	8.3	0.11 (0.40)
Hairy woodpecker	0.0	0.00 (0.00)	4.3	0.04 (0.20)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Ladder-backed woodpecker	0.0	0.00 (0.00)	0.0	0.00 (0.00)	8.3	0.08 (0.28)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Mountain chickadee	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	11.1	0.14 (0.42)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Northern flicker	19.0	0.21 (0.47)	10.6	0.11 (0.31)	22.2	0.25 (0.50)	5.6	0.06 (0.23)	16.7	0.19 (0.37)	8.3	0.11 (0.40)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	2.8	0.03 (0.17)	2.8	0.03 (0.17)
White-breasted nuthatch	7.1	0.07 (0.26)	17.0	0.17 (0.38)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)

Burned area	2003 n=42		2004 n=47		2007 n=36		2008 n=36		2009 n=36		2010 n=36		2011 n=36		2012 n=36		2013 n=36		2014 n=36	
Species	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**
Dense shrub birds																				
Common yellowthroat	19.0	0.19 (0.40)	10.6	0.11 (0.31)	16.7	0.17 (0.38)	13.9	0.14 (0.35)	2.8	0.03 (0.17)	2.8	0.03 (0.17)	13.9	0.17 (0.45)	8.3	0.14 (0.49)	0.0	0.00 (0.00)	19.4	0.22 (0.48)
Orange-crowned warbler	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.06 (0.33)	8.3	0.08 (0.28)	16.7	0.19 (0.47)	2.8	0.06 (0.33)
Yellow warbler	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	5.5	0.06 (0.23)	5.6	0.06 (0.23)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Edge birds																				
American crow	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.06 (0.33)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Black-chinned hummingbird	45.2	0.57 (0.74)	46.8	0.51 (0.59)	75.0	1.08 (0.81)	44.4	0.44 (0.50)	77.8	1.28 (0.88)	77.8	1.31 (1.09)	83.3	1.00 (0.59)	83.3	1.14 (0.76)	91.7	1.47 (0.74)	75.0	1.31 (1.01)
Common grackle	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.06 (0.33)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Great-horned owl	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Indigo bunting	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Northern mockingbird	2.4	0.05 (0.31)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	5.5	0.06 (0.23)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Say's phoebe	2.4	0.02 (0.15)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Western kingbird	11.9	0.19 (0.59)	17.0	0.19 (0.45)	30.6	0.56 (0.91)	5.6	0.06 (0.23)	5.6	0.11 (0.46)	5.6	0.08 (0.37)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	2.8	0.06 (0.33)	0.0	0.00 (0.00)
Ground shrub birds																				
Blue grosbeak	33.3	0.40 (0.63)	21.3	0.26 (0.53)	8.3	0.11 (0.40)	11.1	0.11 (0.32)	2.8	0.06 (0.33)	2.8	0.03 (0.17)	19.4	0.25 (0.55)	2.8	0.03 (0.17)	22.2	0.25 (0.50)	16.7	0.25 (0.60)
Gambel's quail	0.0	0.00 (0.00)	2.1	0.02 (0.15)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Killdeer	2.4	0.02 (0.15)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Mourning dove	4.8	0.67 (0.90)	61.7	0.96 (0.88)	58.3	1.36 (1.64)	44.4	0.61 (0.80)	38.9	0.64 (0.99)	38.9	0.58 (0.81	55.5	1.03 (1.08)	72.2	1.00 (0.79)	58.3	0.86 (0.87)	69.4	1.00 (0.86)
Ring-necked pheasant	4.8	0.05 (0.22)	4.2	0.04 (0.20)	16.7	0.28 (0.78)	13.9	0.14 (0.35)	16.7	0.17 (0.38)	19.4	0.22 (0.48)	5.5	0.06 (0.23)	16.7	0.17 (0.38)	2.8	0.03 (0.17)	13.9	0.14 (0.35)
Invasive birds																				

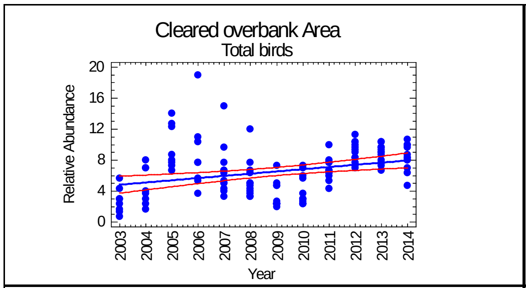
Burned area	**2003 n=42**		**2004 n=47**		**2007 n=36**		**2008 n=36**		**2009 n=36**		**2010 n=36**		**2011 n=36**		**2012 n=36**		**2013 n=36**		**2014 n=36**	
Species	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**
European starling	2.4	0.02 (0.15)	2.1	0.02 (0.15)	2.8	0.06 (0.33)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Midstory birds																				
American robin	4.8	0.05 (0.22)	14.9	0.21 (0.59)	8.3	0.08 (0.28)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	5.6	0.08 (0.37)	2.8	0.06 (0.33)	8.3	0.08 (0.28)	13.9	0.14 (0.35)	0.0	0.00 (0.00)
Black-headed grosbeak	69.0	1.00 (0.88)	61.7	0.74 (0.67)	44.4	0.56 (0.81)	58.3	0.83 (0.85)	47.2	0.69 (0.89)	41.7	0.53 (0.70)	36.1	0.47 (0.70)	55.6	0.75 (0.77)	38.9	0.58 (0.81)	47.2	0.69 (0.82)
Blue-gray gnatcatcher	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.06 (0.33)	0.0	0.00 (0.00)	5.5	0.06 (0.23)	2.8	0.03 (0.17)	2.8	0.03 (0.17)	0.0	0.00 (0.00)
Brown-headed cowbird	66.7	1.36 (1.43)	36.2	0.66 (1.13)	58.3	0.86 (0.96)	55.6	0.92 (1.34)	36.1	0.64 (0.99)	27.8	0.53 (1.03)	44.4	0.69 (0.92)	25.0	0.42 (0.77)	27.8	0.64 (1.17)	25.0	0.33 (0.63)
Bushtit	0.0	0.00 (0.00)	2.1	0.11 (0.73)	5.6	0.17 (0.85)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	11.1	0.22 (0.68)	5.6	0.08 (0.37)	11.1	0.31 (0.92)	11.1	0.25 (0.81)
Gray catbird	26.2	0.26 (0.45)	48.9	0.53 (0.58)	36.1	0.50 (0.74)	22.2	0.28 (0.57)	50.0	0.77 (0.76)	44.4	0.56 (0.69)	41.7	0.53 (0.70)	47.2	0.67 (0.79)	44.4	0.61 (0.77)	27.8	0.42 (0.73)
House finch	2.4	0.02 (0.15)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.06 (0.33)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	5.5	0.17 (0.70)	2.8	0.06 (0.33)	0.0	0.00 (0.00)	2.8	0.06 (0.33)
Lesser goldfinch	2.4	0.05 (0.31)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	13.9	0.25 (69)	5.6	0.08 (0.37)	5.6	0.06 (0.23)	5.6	0.06 (0.23)
Plumbeous vireo	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Spotted towhee	50.0	0.69 (0.84)	80.8	0.91 (0.54)	61.1	0.94 (0.89)	41.7	0.44 (0.56)	41.7	0.56 (0.73)	44.4	0.58 (0.77)	44.4	0.64 (0.80)	55.6	0.78 (0.80)	69.4	0.94 (0.75)	75.0	1.06 (0.79)
White-winged dove	0.0	0.00 (0.00)	0.0	0.00 (0.00)	5.6	0.06 (0.23)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Yellow-breasted chat	76.2	1.26 (0.91)	70.2	1.13 (1.03)	38.9	0.47 (0.70)	41.7	0.44 (0.56)	41.7	0.47 (0.61)	30.6	0.33 (0.53)	72.2	1.06 (0.79)	69.4	1.03 (0.81)	80.6	1.36 (0.87)	88.9	1.61 (0.80)
Yellow-rumped warbler	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	5.6	0.11 (0.46)
Open birds																				
Barn swallow	2.4	0.02 (0.15)	2.1	0.02 (0.15)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)		0.00 (0.00)		0.00 (0.00)
Water birds																				
Black phoebe	0.0	0.00 (0.00)	2.1	0.02 (0.15)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Black-necked stilt	2.4	0.02 (0.15)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Great-blue heron	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)

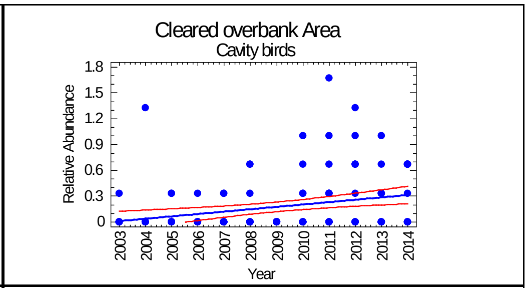
Burned area	2003 n=42		2004 n=47		2007 n=36		2008 n=36		2009 n=36		2010 n=36		2011 n=36		2012 n=36		2013 n=36		2014 n=36	
Species	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**
Mallard	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	5.5	0.22 1.05	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Red-winged blackbird	9.5	0.12 (0.40)	6.4	0.06 (0.25)	16.7	0.42 (1.16)	11.1	0.69 (2.36)	11.1	0.22 (0.76)	5.5	0.14 (0.68)	11.1	0.28 (0.81)	13.9	0.33 (0.93)	13.9	0.28 (0.74)	8.3	0.14 (0.49)
Snowy egret	0.0	0.00 (0.00)	2.1	0.02 (0.15)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Spotted sandpiper	4.8	0.05 (0.22)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Migrants																				
Cassin's vireo	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Cattle egret	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)
Dusky flycatcher	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	5.6	0.08 (0.37)
Lazuli bunting	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	5.6	0.08 (0.37)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
MacGillivray's warbler	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Townsend's warbler	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	5.6	0.06 (0.23)
Wilson's warbler	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.03 (0.17)	13.9	0.14 (0.34)	0.0	0.00 (0.00)	2.8	0.03 (0.17)

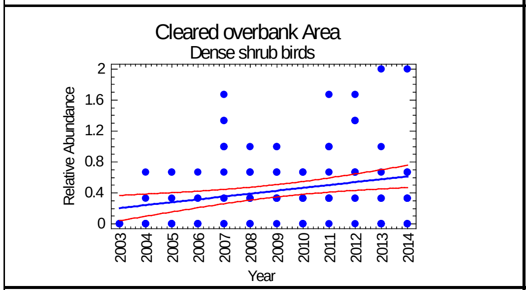
Appendix D

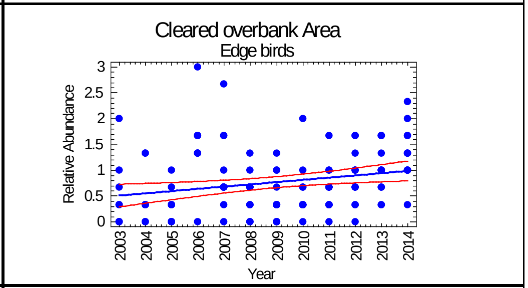
Linear Trend Graphs for Bird Guilds in which Statistically Significant Trends were Detected in the Cleared/Overbank and Burned Areas

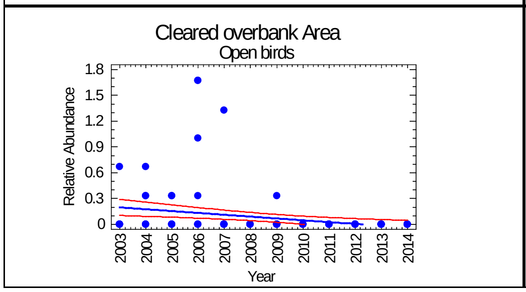
Cleared/overbank Area

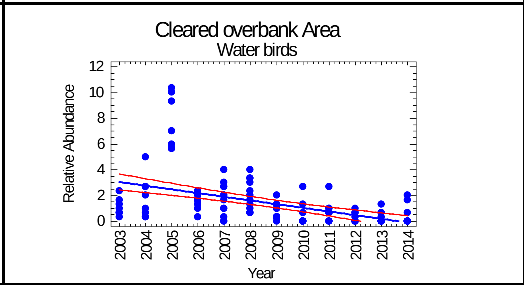




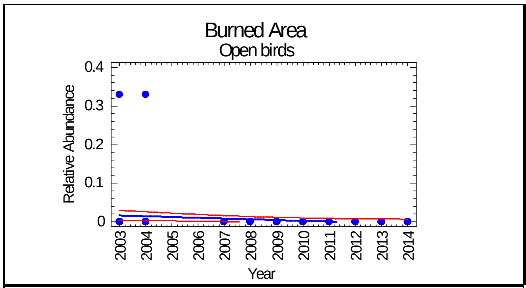


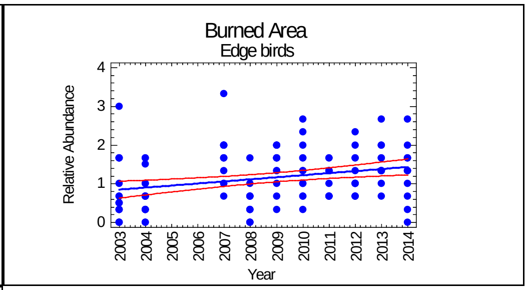


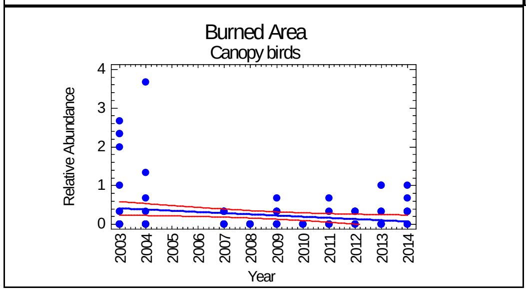




Burned Area







Appendix E

Southwestern Willow Flycatcher
Survey Forms and Maps
2014

Willow Flycatcher (WIFL) Survey and Detection Form (revised April, 2010)

Site Name: **BL-25** State: **New Mexico** County: **Valencia**

USGS Quad Name: **Tome, Los Lunas** Elevation: **1,469** (meters)

Creek, River, or Lake Name: **Rio Grande**

Is copy of USGS map marked with survey area and WIFL sightings attached (as required)? ***Ye*** **X** ***No***

Survey Coordinates: Start: E **341,191** N **3,848,584** UTM Datum: **NAD83** (See instructions)

Stop: E **340,201** N **3,845,501** UTM Zone: **13**

If survey coordinates changed between visits, enter coordinates for each survey in comments section on back of this page.

*****Fill in additional site information on back of this page*****

Survey # Observer(s) (Full Name)	Date (m/d/y) Survey Time	Number of Adult WIFLs	Estimated Number of Pairs	Estimated Number of Territories	Nest(s) Found? Y or N If Yes, number of nests	Comments (e.g., bird behavior; evidence of pairs or breeding; potential threats [livestock, cowbirds, *Diorhabda* spp.]). If *Diorhabda* found, contact USFWS and State WIFL coordinator.	GPS Coordinates for WIFL Detections (this is an optional column for documenting individuals, pairs, or groups of birds found on each survey). Include additional sheets if necessary.			
Survey # 1	Date:	0	0	0	N	Cowbirds detected.	# Birds	Sex	UTM E	UTM N
Observer(s):	5/19/201									
K> Betone	Start:									
	6:00									
	Stop:									
	10:15									
	Total hrs:									
	4.3									
Survey # 2	Date:	1	0	1	N	Cowbirds detected.	# Birds	Sex	UTM E	UTM N
Observer(s):	6/4/201						1	M	340,290	3,846,543
S. Muise	Start:									
	6:30									
	Stop:									
	10:30									
	Total hrs:									
	4.0									
Survey # 3	Date:	0	0	0	N	Some good habitat near river. Cowbirds detected.	# Birds	Sex	UTM E	UTM N
Observer(s):	7/8/201									
J. Felt	Start:									
	6:00									
	Stop:									
	10:30									
	Total hrs:									
	4.5									
Survey # 4	Date:						# Birds	Sex	UTM E	UTM N
Observer(s):										
	Start:									
	Stop:									
	Total hrs:									
Survey # 5	Date:						# Birds	Sex	UTM E	UTM N
Observer(s):										
	Start:									
	Stop:									
	Total hrs:									

Overall Site Summary	Total Adult Residents	Total Pairs	Total Territories	Total Nests				
Totals do not equal the sum of each column. Include only resident adults. Do not include migrants, nestlings, and fledglings.					Were any WIFLs color-banded?	Yes	No	X
Be careful not to double count individuals.	0	0	0	0	If yes, report color combination(s) in the comments section on back of form and report to USFWS.			
Total survey hrs: 12.8								

Reporting Individual: **Darrell Ahlers** Date Report Completed: **10/14/2014**

US Fish & Wildlife Service Permit #: **TE819475-4** State Wildlife Agency Permit #: **N/A**

Submit form to USFWS and State Wildlife Agency by September 1st. Retain a copy for your records.

Fill in the following information completely. <u>Submit</u> form by September 1st. Retain a copy for your records.

Reporting Individual **Darrell Ahlers** Phone # **(303) 445-2233**

Affiliation **Bureau of Reclamation** E-mail dahlers@usbr.gov

Site Name **BL-25** Date report Completed **10/14/2014**

Was this site surveyed in a previous year? Yes__X__ No____ Unknown____

Did you verify that this site name is consistent with that used in previous yrs? Yes **X** No ____ Not Applicable ____

If name is different, what name(s) was used in the past? **N/A**

If site was surveyed last year, did you survey the same general area this year? Yes **X** No ____ If no, summarize below.

Did you survey the same general area during each visit to this site this year? Yes **X** No ____ If no, summarize below.

Management Authority for Survey Area: Federal ____ Municipal/County ____ State ____ Tribal ____ Private **X**

Name of Management Entity or Owner (e.g., Tonto National Forest) **MRGCD**

Length of area surveyed: **3.3** (km)

Vegetation Characteristics: Check (only one) category that best describes the predominant tree/shrub foliar layer at this site:

____ Native broadleaf plants (entirely or almost entirely, > 90% native)

X Mixed native and exotic plants (mostly native, 50 - 90% native)

____ Mixed native and exotic plants (mostly exotic, 50 - 90% exotic)

____ Exotic/introduced plants (entirely or almost entirely, > 90% exotic)

Identify the 2-3 predominant tree/shrub species in order of dominance. Use scientific name.

Salix exigua, Eleagnus angustifolia, Populus sp.

Average height of canopy (Do not include a range): **15** (meters)

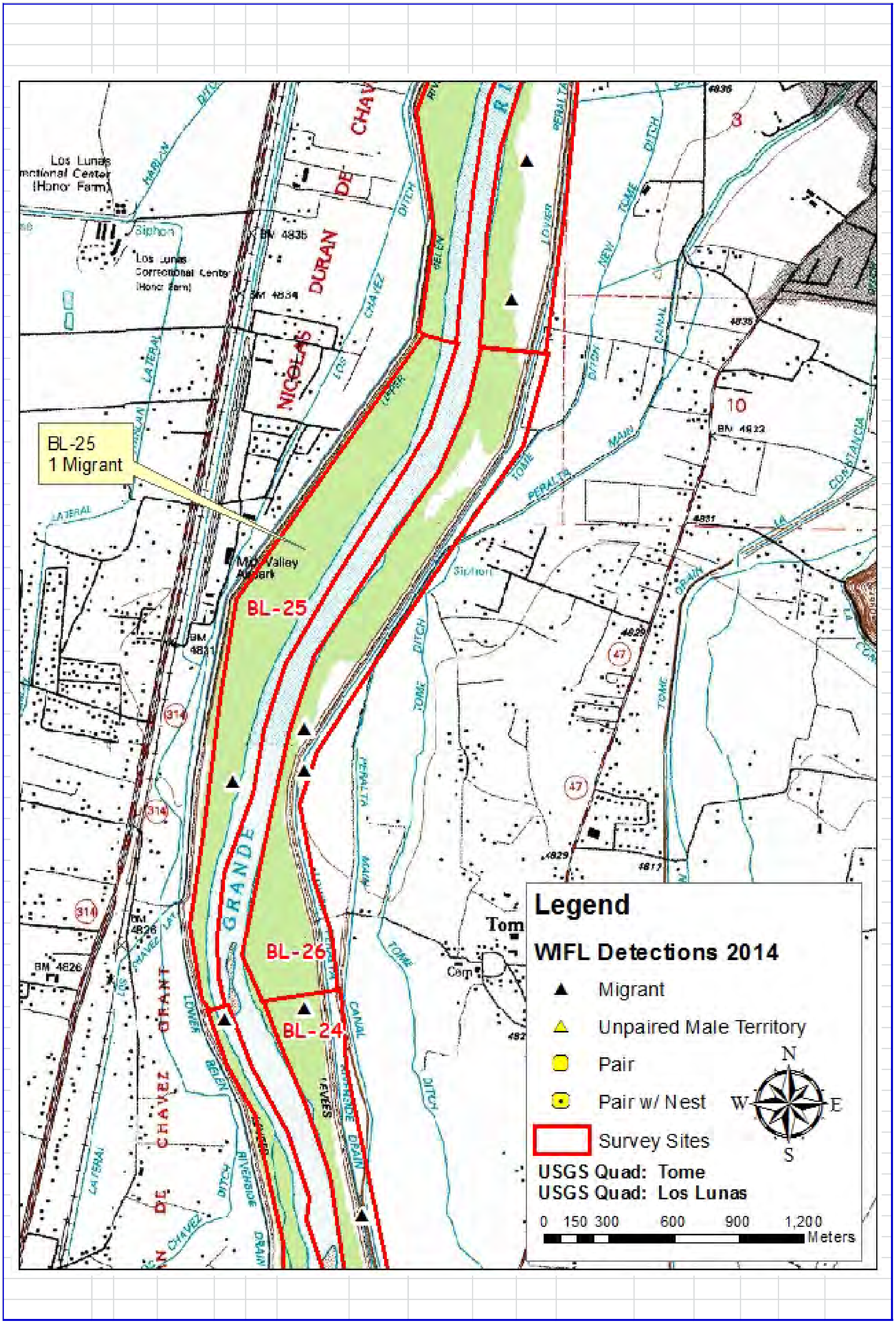
Attach the following: 1) copy of USGS quad/topographical map (REQUIRED) of survey area, outlining survey site and location of WIFL detections;
2) sketch or aerial photo showing site location, patch shape, survey route, location of any detected WIFLs or their nests;
3) photos of the interior of the patch, exterior of the patch, and overall site. Describe any unique habitat features in Comments.

<u>Comments (such as start and end coordinates of survey area if changed among surveys, supplemental visits to sites, unique habitat features. Attach additional sheets if necessary.</u>

Territory Summary Table. Provide the following information for each verified territory at your site.

Territory Number	All Dates Detected	UTM E	UTM N	Pair Confirmed? Y or N	Nest Found? Y or N	Description of How You Confirmed Territory and Breeding Status (e.g., vocalization type, pair interactions, nesting attempts, behavior)

Attach additional sheets if necessary


BL-25
1 Migrant
BL-25
BL-26
BL-24
Los Lunas Correctional Center (Honor Farm)
Mid Valley Airpark
Siphon
GRANDE
Tome
Cem
Legend
WIFL Detections 2014
▲ Migrant
▲ Unpaired Male Territory
● Pair
⊙ Pair w/ Nest
▭ Survey Sites
USGS Quad: Tome
USGS Quad: Los Lunas
0 150 300 600 900 1,200
Meters
N
S
E
W

Appendix F

Plant list
and
Total Percent Cover of Plants Detected in the Understory Layer by Individual Species, Life-form, and Cover Type
2003 to 2014

Table F-1.—Plant list of species detected from 2003 to 2014.

	Code	Scientific name	Common name	Lifeform
Trees/shrubs	BASA	*Baccharis salicifolia*	Seep willow	NS
	ELAN	*Eleagnus angustifolia*	Russian olive	IT
	POAN	*Populus angustifolia*	Narrowleaf cottonwood	NT
	PODE	*Populus deltoides*	Rio Grande cottonwood	NT
	SAEX	*Salix exigua*	Coyote willow	NT/S
	SAGO	*Salix gooddingii*	Gooddings willow	NT
	TARA	*Tamarix ramosissima*	Saltcedar	IT/S
	ULPU	*Ulmus pumila*	Siberian elm	IT
Grasses/grass-like	BOBA	*Bothriochloa barbinodis*	Cane bluestem	NG
	BRIN	*Bromus inermis*	Smooth brome	IG
	BRJA	*Bromus japonicus*	Japonese brome	IG
	CASP	*Carex* sp.	Sedge	NG
	COSE	*Cortaderia selloana*	Pampas grass	IG
	CYOD	*Cyperus odoratus*	Fragrant flatsedge	NG
	DISP	*Distichlis spicata*	Saltgrass	NG
	ECCR	*Echinochloa crus-galli*	Barnyard grass	IG
	ELPA	*Eleocharis palustris*	Common spikerush	NG
	ELEL	*Elymus elymoides*	Squirreltail	NG
	ELTR	*Elymus trachycaulus*	Slender wheatgrass	NG
	ERHY	*Eragrostis hypnoides*	Teal lovegrass	NG
	FEAR	*Festuca arundinacea*	Tall fescue	IG
	HOJU	*Hordeum jubatum*	Barley foxtail	NG
	JUBA	*Juncus balticus*	Baltic rush	NG
	JUEN	*Juncus ensifolius*	Sword-leaved rush	NG
	LEOR	*Leersia oryzoides*	Rice cutgrass	NG
	LEFU	*Leptochloa fusca*	Mexican sprangletop	NG
	MUAS	*Muhlenbergia asperifolia*	Scratchgrass	NG
	MURA	*Muhlenbergia racemosa*	Muhly	NG
	PACA	*Panicum capillare*	Witchgrass	NG
	PAOB	*Panicum obtusum*	Vine mesquite	NG
	PHAU	*Phragmites australis*	Common reed	NG
	POPA	*Poa pratensis*	Kentucky bluegrass	NG
	POMO	*Polypogon monspeliensis*	Rabbitfoot grass	IG
	SCAC	*Schoenplectus acutis*	Hardstem bulrush	NG
	SCAM	*Schoenplectus americanus*	American threesquare	NG
	SPCR	*Sporobolus cryptandrus*	Sand dropseed	NG
Forbs	AGPA	*Agastache pallidiflora ssp neomexicana*	New Mexico giant hyssop	NF
	AMBL	*Amaranthus blitoides*	Prostrate amaranth	IF
	AMPS	*Ambrosia psilostachya*	Western ragweed	NF
	APCA	*Apocynum cannabinum*	Clasping-leaf dogbane	NF
	ARAB	*Artemisia absinthium*	Wormwood	IF
	ARAN	*Argentina anserina*	Silverweed cinquefoil	NF
	ASSU	*Asclepias subverticillata*	Horsetail milkweed	NF
	ASSP	*Astragalus* sp.	Milkvetch	NF
	BIFR	*Bidens frondosa*	Beggarstick	NF
	CHAL	*Chenopodium album*	Lambsquarters	IF
	CHSE	*Chamaesyce serpyllifolia*	Thymeleaf spurge	NF
	CLLI	*Clematis ligusticifolia*	Virgin's bower	NF
	COAR	*Convolvulus arvensis*	Field bindweed	IF
	COCA	*Conyza canadensis*	Horseweed	NF
	CUSP	*Cuscuta* sp.	Dodder	NF
Forbs, con't.	DALE	*Dalea leporina*	Foxtail dalea	NF
	DEIL	*Desmanthus illinoensis*	Bundleflower	NF
	EQLA	*Equisetum laevigatum*	Smooth scouringrush	NF

	Code	Scientific name	Common name	Lifeform
	EUOC	*Euthamia occidentalis*	Western goldentop	NF
	GAPA	*Gaura parviflora*	Small-flowered gaura	NF
	GRSQ	*Grindelia squarrosa*	Curlycup gumweed	NF
	HEAN	*Helianthus annuus*	Common sunflower	NF
	KOSC	*Kochia scoparia*	Kochia	IF
	LASP	*Lactuca serriola*	Prickly lettuce	IF
	LELA	*Lepidium latifolium*	Perrenial pepperweed	IF
	MEAL	*Melilotus albus*	White sweetclover	IF
	OEEL	*Oenothera elata*	Hooker's evening primrose	NF
	PESP	*Penstemon* sp.	Penstemon	NF
	PLLA	*Plantago lanceolata*	Narrowleaf plantain	IF
	PLMA	*Plantago major*	Common plantain	IF
	POLA	*Polygonum lapathifolium*	Pale smartweed	NF
	PSST	*Pseudognaphalium stramineum*	Cottonbatting cudweed	NF
	RATA	*Ratibida tagetes*	Short-rayed coneflower	NF
	RUCR	*Rumex crispis*	Curly dock	IF
	SAIB	*Salsola iberica*	Russian thistle	IF
	SOAR	*Sonchus arvensis*	Field sowthistle	IF
	SOCA	*Solidago canadensis*	Golden rod	NF
	SYER	*Symphyotrichum ericoides*	White heath aster	NF
	TAOF	*Taraxacum officinale*	Dandelion	IF
	TRTE	*Tribulus terrestris*	Goats head	IF
	XAST	*Xanthium strumarium*	Common cocklebur	NF

*NT/S=Native tree/shrub; IT/S=Introduced tree/shrub; NG=Native grass; IG=Introduced grass; NF-Native forb; IF=Introduced forb

Table F-2.— Total percent cover of by individual species, life-form and cover type in the understory layer.

Understory layer	**Total Percent Cover**											
Species	**2003**	**2004**	**2005**	**2006**	**2007 ***	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Coyote willow	0.6	1.0	1.9	4.7	0.5	1.0	1.3	1.1	2.2	0.8	3.4	1.9
Cottonwood	0.0	0.4	1.3	7.1	0.3	0.5	0.3	0.1	0.4	0.3	0.5	0.1
Gooddings willow	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0
Total native shrubs	0.6	1.4	3.2	11.9	0.9	1.5	1.7	1.2	2.7	1.1	3.9	2.0
Saltcedar	0.4	0.8	2.8	5.0	1.0	0.8	0.8	1.1	1.3	0.7	1.1	1.1
Russian olive	0.0	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Total introduced shrubs	0.4	0.8	2.8	5.2	1.0	0.9	0.8	1.1	1.3	0.7	1.1	1.2
Fragrant flatsedge	1.7	3.5	8.4	0.5	2.1	4.4	1.0	0.1	0.0	0.0	0.0	0.0
Baltic rush	1.3	0.0	0.0	0.0	0.0	0.0	1.1	0.7	0.3	0.2	0.0	0.1
Muhly	1.3	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Witchgrass	1.1	5.2	4.4	0.8	0.4	1.7	0.4	0.4	0.3	0.0	0.3	0.0
Vine mesquite	0.4	0.4	1.6	4.7	7.6	12.2	16.9	15.7	9.2	4.5	6.7	6.7
Common spikerush	0.0	0.2	0.0	0.0	0.2	0.4	0.5	0.4	0.0	0.0	0.0	0.0
Saltgrass	0.0	0.1	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	1.0	0.0
Kentucky bluegrass	0.0	0.2	0.6	0.3	0.1	0.0	0.0	0.4	0.0	0.1	0.0	0.4
Sedge	0.0	0.1	0.0	0.0	0.1	0.6	0.1	0.7	0.6	0.8	0.5	0.3
Mexican sprangletop	2.2	6.7	1.1	2.5	0.1	0.7	0.4	0.2	0.0	0.0	0.1	0.0
Teal lovegrass	0.0	0.0	2.6	0.0	0.3	0.2	0.2	0.0	0.0	0.0	0.1	0.0
Barley foxtail	0.0	0.0	0.0	2.8	3.6	7.3	2.5	4.2	0.4	0.0	0.1	0.0
Squirreltail	0.0	0.0	0.0	0.0	1.7	0.1	0.1	0.0	0.0	0.3	0.0	0.4
Common reed	0.0	0.0	0.0	0.0	0.8	0.4	0.6	0.7	0.7	1.0	0.5	0.3
Sword-leaved rush	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.0	0.0	0.0	0.0

Understory layer	**Total Percent Cover**											
Species	**2003**	**2004**	**2005**	**2006**	**2007 ***	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Rice cutgrass	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.2	0.0	0.0	0.0	0.0
Hardstem bulrush	0.0	0.0	0.0	0.0	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.0
American threesquare	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.2	0.1	0.0	0.0	0.0
Scratchgrass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.9	1.8	0.3
Sand dropseed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.1	0.8
Slender wheatgrass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.2	0.0	0.0
Cane bluestem	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1
Total native grasses	8.0	19.1	18.7	11.6	17.0	28.8	25.4	24.7	12.4	8.1	12.4	9.4
Barnyard grass	1.3	4.3	6.0	2.8	1.0	1.1	0.4	0.1	0.0	0.0	0.0	0.0
Rabbitfoot grass	1.6	4.5	2.8	0.1	2.0	3.2	0.2	0.0	0.0	0.0	0.0	0.0
Smooth brome	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0
Tall fescue	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.4	0.5	0.6	0.4	0.6
Japanese brome	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.5	0.3	0.2
Pampas grass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.2	0.2	0.0
Total introduced grasses	2.9	8.8	8.8	2.9	3.0	5.7	0.9	1.3	0.5	1.3	0.9	0.8
Horseweed	0.2	0.0	0.0	4.3	7.7	0.0	0.0	0.7	0.3	0.6	0.4	4.1
Common sunflower	7.9	13.9	0.3	3.9	1.1	1.9	0.0	1.0	0.0	0.8	0.2	0.3
Pale smartweed	0.8	1.2	0.2	5.9	1.0	0.2	0.1	0.1	0.0	0.0	0.0	0.0
Common cocklebur	0.3	3.3	17.9	8.1	10.3	19.4	11.8	3.8	0.1	0.2	1.2	1.2
Beggarstick	0.0	0.9	3.4	0.5	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.0
Western goldentop	0.0	0.3	0.8	1.7	2.9	11.9	9.2	7.3	3.4	2.8	2.3	2.6
Clasping-leaf dogbane	0.0	0.0	0.3	0.2	0.9	1.5	1.5	1.4	1.5	1.3	1.3	1.5
Milkvetch	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cottonbatting cudweed	0.0	0.0	0.0	1.2	0.6	0.0	0.2	0.1	0.3	0.0	0.0	0.0
Hooker's evening primrose	0.0	0.0	0.0	1.2	0.0	0.2	0.1	0.7	0.4	0.0	0.1	0.2
Dodder	0.0	0.0	0.0	0.1	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
Bundleflower	0.0	0.0	0.0	0.0	0.5	0.2	0.7	1.3	0.2	0.0	0.0	0.0
Western ragweed	0.0	0.0	0.0	0.2	0.4	0.8	1.3	2.0	2.5	2.7	2.5	2.3
Silverweed cinquefoil	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Penstemon	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0
Smooth scouringrush	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.8	0.7	1.0	0.4	0.4
New Mexico giant hyssop	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.2	0.1	0.1	0.0	0.0
Curlycup gumweed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Thymeleaf spurge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.1	0.8	0.0
Small-flowered gaura	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.3
Foxtail dalea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.3	0.0
Golden rod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2
Short-rayed coneflower	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.1
Horsetail milkweed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
Vigin's bower	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
White heath aster	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Total native forbs	9.2	19.6	22.9	27.5	25.5	37.0	26.1	19.7	9.8	10.0	10.3	13.7
Lambsquarters	6.2	5.2	0.3	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0
Kochia	0.5	3.6	3.8	4.2	2.8	2.7	2.7	3.3	0.0	3.0	2.1	1.8
Prickly lettuce	0.1	0.8	0.0	6.0	2.3	0.9	0.0	0.2	0.1	0.6	0.1	0.2

Understory layer	**Total Percent Cover**											
Species	**2003**	**2004**	**2005**	**2006**	**2007 ***	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
White sweetclover	4.2	7.1	0.4	6.8	4.7	1.7	1.5	1.2	4.4	2.7	3.5	7.3
Russian thistle	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Perrenial pepperweed	0.0	0.2	0.0	0.0	0.0	0.0	0.1	2.3	0.3	1.0	0.3	0.1
Wormwood	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Curly dock	0.0	0.0	0.1	0.5	1.6	0.1	0.0	0.1	0.3	0.0	0.1	0.0
Prostrate amaranth	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Goats head	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Field bindweed	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.5	0.3
Narrowleaf plantain	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Dandelion	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Common plantain	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Field sowthistle	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Total Introduced forbs	11.0	17.8	4.8	17.8	11.4	5.7	4.4	7.0	5.3	7.3	6.7	10.0
Total understory vegetation	32.1	67.5	61.2	76.9	58.8	79.6	59.3	55.0	32.0	28.5	35.3	37.1
Litter	4.4	5.2	7.3	5.5	23.4	12.7	30.5	42.6	60.1	67.8	55.3	59.3
Bare soil	63.5	27.3	31.5	17.6	17.8	7.7	10.2	2.4	7.9	3.7	9.4	3.7
Total cover	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.1

Appendix G

Groundwater Monitoring Wells
Monthly Data
June 2003 – October 2010

Table G-1.—Depth (in inches) below the ground surface to water at each well for each monthly reading from June 2004 to October 2010.

	Well number (depth of well)										
Date	**N1 (62)**	**N2 (62)**	**N3 (60.5)**	**N4 (64)**	**M1 (59)**	**M2 (61)**	**M3 (59)**	**M4 (61)**	**S1 (56)**	**S2 (61.5)**	**S3 (69)**
06/04/03	44.0	41.0	29.0	No well	30.0	29.0	28.0	No well	34.0	49.0	No well
09/04/03	dry	dry	dry	No well	dry	dry	dry	No well	dry	dry	No well
10/30/03	45.0	41.0	31.0	No well	32.0	32.5	36.5	No well	40.0	dry	No well
11/27/03	36.0	41.0	37.0	No well	20.0	19.0	22.5	No well	28.5	51.0	No well
12/21/03	37.0	33.0	25.0	No well	20.0	20.0	21.5	No well	30.5	53.0	No well
01/24/04	38.0	33.0	23.0	No well	20.5	19.5	20.5	No well	31.0	53.0	No well
03/11/04	38.5	33.5	23.5	No well	21.5	20.5	20.5	No well	32.0	54.0	No well
04/01/04	32.0	27.5	18.5	No well	15.5	15.5	18.0	No well	27.5	50.5	No well
04/30/04	42.0	37.0	26.0	No well	26.5	25.5	25.5	No well	37.5	60.0	No well
05/30/04	35.5	33.0	24.0	No well	19.5	20.5	21.5	No well	31.5	55.5	No well
06/29/04	53.5	47.5	35.0	No well	39.5	37.0	36.5	No well	48.5	dry	No well
08/05/04	57.0	53.0	46.0	42.0	31.0	41.0	41.5	dry	39.5	dry	65.0
09/02/04	dry	dry	dry	58.0	dry	dry	dry	dry	56.0	dry	66.0
10/05/04	54.0	49.0	37.0	39.5	41.5	42.0	46.5	dry	50.5	dry	64.0
11/05/04	42.0	37.0	26.0	31.0	28.0	No well	29.5	41.0	35.5	58.0	49.0
12/04/04	36.5	30.0	19.0	23.5	20.0	No well	17.5	28.0	27.5	48.5	41.0
01/07/05	36.5	32.0	23.5	30.0	19.0	20.0	21.0	36.5	29.5	51.0	45.0
02/04/05	36.5	32.0	23.0	29.5	19.0	16.0	20.0	34.5	29.5	51.0	44.0
03/03/05	30.0	27.0	19.0	27.5	13.0	11.0	16.0	33.0	23.0	45.5	39.5
04/02/05	26.5	24.0	16.0	26.0	10.0	8.5	13.0	32.0	19.0	42.0	37.0
05/06/05	0.0	14.5	8.5	19.0	0.0	0.0	5.5	25.5	11.0	36.0	32.5
06/06/05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
07/31/05	dry	57.5	43.0	40.5	47.0	39.5	42.0	49.5	52.0	dry	61.5
08/30/05	dry	59.0	40.0	34.0	48.0	40.0	37.5	52.0	52.5	dry	63.0
09/30/05	56.0	47.0	34.0	35.5	26.0	26.0	34.5	47.0	39.5	dry	56.0
10/31/05	52.0	43.5	31.0	34.0	28.0	24.5	29.0	43.5	34.5	56.5	48.5
11/29/05	45.5	38.0	27.0	32.0	22.5	20.0	25.0	40.0	30.0	52.0	45.5
12/30/05	42.5	35.0	23.5	28.0	21.0	17.0	21.5	33.0	29.0	50.0	43.5
01/31/06	46.5	39.0	27.5	32.5	24.0	21.0	25.0	38.0	34.0	54.5	46.5
02/28/06	48.0	40.0	28.5	32.5	26.5	22.5	25.0	38.5	36.5	56.5	49.0
03/31/06	59.5	49.5	35.0	36.0	39.5	32.5	34.5	44.5	46.0	dry	55.5
04/28/06	57.5	48.5	36.0	37.0	38.0	32.0	35.5	47.0	43.0	dry	54.5
05/29/06	53.5	46.5	36.0	38.0	32.0	29.0	34.5	47.5	39.0	dry	53.0
06/30/06	54.0	45.0	32.0	33.5	37.0	31.0	33.0	42.5	40.5	60.0	50.0
07/26/06	dry	55.0	39.5	36.0	52.0	43.5	43.5	49.0	55.5	dry	60.5
08/28/06	55.5	46.5	33.0	33.5	39.0	32.5	33.5	43.0	42.0	dry	52.5
09/21/06	dry	53.5	38.5	38.0	48.0	40.0	41.5	50.0	52.0	dry	60.5
10/31/06	42.0	35.0	36.0	29.5	19.0	17.0	22.5	36.5	26.5	49.5	43.0
11/30/06	41.5	36.0	29.5	24.5	15.0	13.0	17.5	33.0	23.5	46.5	40.5
01/27/06	43.5	36.5	26.0	31.5	21.5	18.5	22.0	36.5	31.5	53.0	45.5
02/26/07	43.0	36.0	25.5	31.0	21.0	18.0	21.5	36.0	31.0	52.5	45.0
03/28/07	29.0	24.0	15.0	22.5	9.5	7.5	12.0	28.0	20.0	42.0	36.0
04/29/07	46.5	37.5	25.5	28.5	29.5	24.0	26.0	37.5	36.0	56.5	47.0
05/31/07	27.5	21.5	17.5	25.0	10.5	9.5	14.5	32.5	20.0	56.5	38.0

	Well number (depth of well)										
Date	**N1 (62)**	**N2 (62)**	**N3 (60.5)**	**N4 (64)**	**M1 (59)**	**M2 (61)**	**M3 (59)**	**M4 (61)**	**S1 (56)**	**S2 (61.5)**	**S3 (69)**
06/29/07	50.0	41.5	28.0	29.0	37.5	32.5	34.5	43.0	42.5	dry	51.5
07/31/07	51.5	44.0	31.5	33.0	36.5	32.0	35.5	46.0	41.5	dry	53.5
08/31/07	56.0	47.0	33.0	31.0	42.0	36.0	38.5	45.5	47.0	dry	54.0
09/28/07	57.5	47.0	34.5	35.0	42.5	36.5	38.5	47.5	47.5	dry	56.5
10/30/07	51.0	44.0	31.0	34.5	34.0	33.0	39.5	50.0	43.0	dry	54.5
11/30/07	46.5	40.5	29.0	33.5	30.5	30.5	33.5	46.5	38.5	58.0	51.5
12/28/07	40.0	34.0	25.0	30.5	22.5	19.0	22.5	37.5	31.5	53.0	46.0
01/29/08	37.5	32.5	23.0	29.5	19.5	17.5	22.0	37.5	29.5	51.5	44.5
02/29/08	29.0	26.0	18.0	26.0	11.0	10.0	16.0	33.0	20.5	43.0	38.0
03/31/08	17.0	14.0	6.0	15.0	1.0	0.0	6.5	22.0	9.5	33.0	28.0
04/28/08	14.0	10.5	3.5	14.0	-4.0	-2.5	5.0	21.5	6.5	30.5	26.0
05/28/08	12.0	12.0	2.0	13.5	-5.0	-3.5	4.5	21.5	5.5	32.0	26.5
06/30/08	35.0	30.0	19.0	22.0	24.0	18.5	10.0	31.5	28.5	50.5	40.5
07/28/08	49.0	41.5	28.0	28.5	36.0	29.5	32.0	38.5	40.0	dry	51.5
08/27/08	59.0	49.0	34.0	35.0	42.0	36.0	37.5	46.0	45.5	dry	55.0
09/27/08	58.0	48.0	32.5	32.0	41.0	34.5	36.5	44.0	45.5	dry	56.0
10/31/09	52.5	44.0	30.0	32.5	33.5	28.5	32.0	42.5	39.5	dry	51.5
11/29/08	43.0	36.5	25.5	30.0	28.0	23.5	26.5	39.0	34.5	56.5	48.0
12/30/08	43.0	36.0	25.0	29.5	25.5	22.0	25.5	38.0	33.5	55.5	47.5
01/31/09	43.5	36.0	25.0	29.5	26.0	22.0	25.0	38.0	33.5	55.0	47.0
02/28/09	38.0	31.0	19.0	22.5	23.0	18.5	22.5	34.0	31.0	52.0	44.5
03/30/09	35.0	28.5	17.0	21.0	19.5	16.0	21.0	33.0	28.0	50.0	42.0
04/27/09	19.0	17.5	10.0	17.5	1.5	2.0	10.5	25.5	9.5	35.5	29.5
05/25/09	6.5	17.0	8.0	17.0	-0.5	0.5	6.5	23.5	9.0	34.5	30.0
07/02/09	36.0	32.0	19.5	24.5	24.0	20.5	25.0	37.0	35.1	50.5	42.0
09/07/09	dry	dry	36.0	34.5	45.5	38.0	39.5	47.5	44.5	dry	52.5
10/09/09	dry	dry	37.0	36.0	46.5	38.5	40.0	47.5	45.5	dry	54.0
11/02/09	55.5	45.0	31.5	32.5	35.0	29.0	32.0	41.5	37.5	58.5	49.0
12/02/09	50.5	42.0	30.0	33.5	27.5	23.0	26.5	39.5	31.5	53.5	44.5
01/04/10	48.5	40.5	29.5	33.5	26.5	22.5	26.0	40.0	32.0	53.0	44.0
02/08/10	45.0	38.0	27.0	31.5	25.0	21.5	25.0	39.0	32.0	52.5	44.0
03/05/10	46.5	38.0	27.0	30.5	26.0	22.0	24.5	38.0	32.0	52.0	43.0
04/05/10	38.5	31.0	20.5	24.5	22.5	18.5	22.0	33.0	30.0	50.0	41.5
05/03/10	27.0	22.5	17.5	22.5	10.0	10.5	13.5	29.5	20.5	42.0	36.0
05/30/10	24.5	19.0	13.5	18.5	10.0	9.0	13.5	32.0	17.5	42.0	35.5
06/30/10	56.0	46.0	32.5	32.0	41.5	36.0	38.5	46.5	41.0	dry	51.0
07/31/10	49.0	41.5	30.0	31.0	33.0	29.0	33.5	44.0	35.0	58.0	47.5
08/30/10	dry	dry	41.0	dry	54.5	45.0	45.5	48.0	dry	dry	62.0
9/22/2010	dry	dry	50.0	43.0	dry	60.0	57.5	58.0	dry	dry	dry

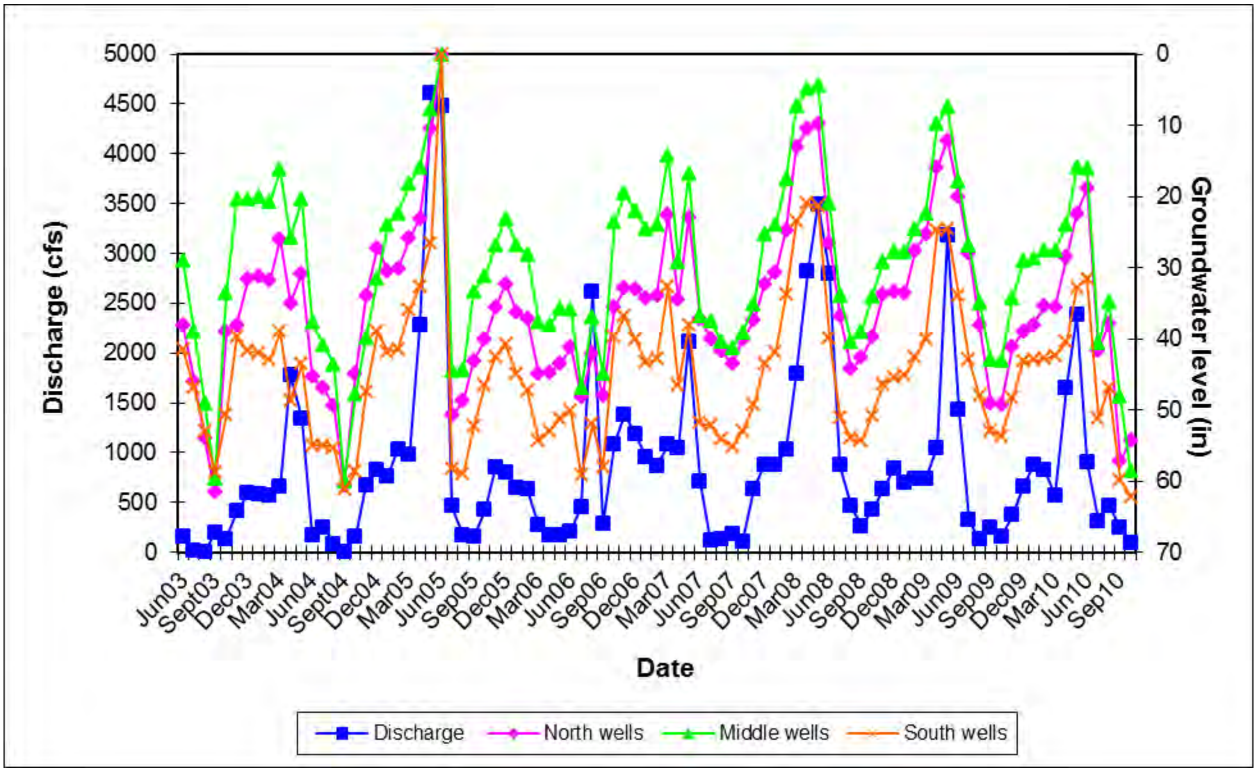


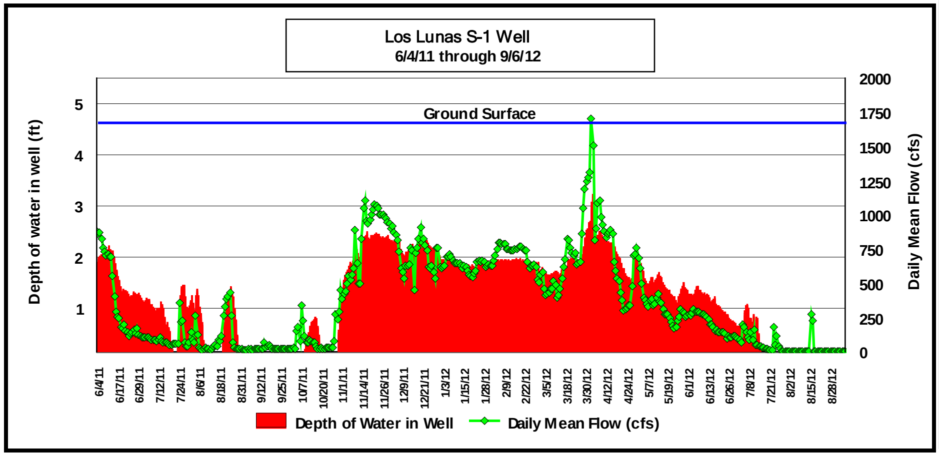
Figure G-1.—Discharge (cfs) of the Rio Grande at San Acacia, New Mexico, and average ground water levels (inches from the surface) in wells along the South, Middle, and North transects at the LLRS, June 2003 to Oct. 2010.

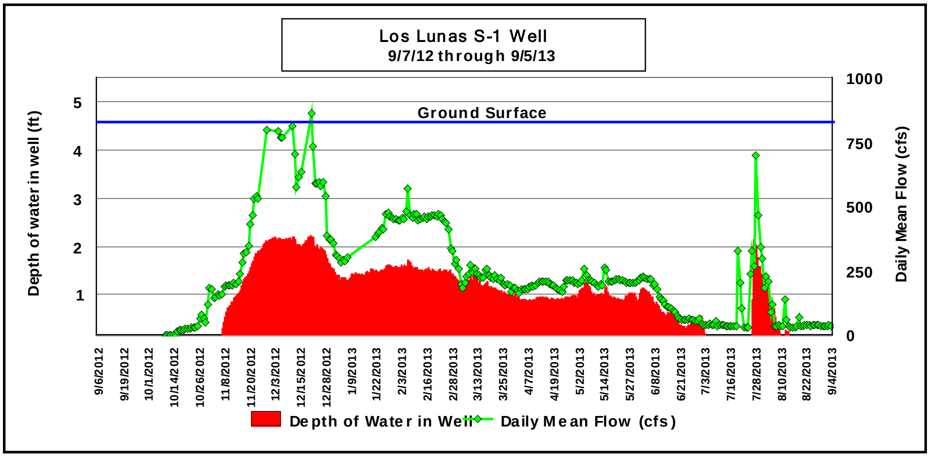
Appendix H

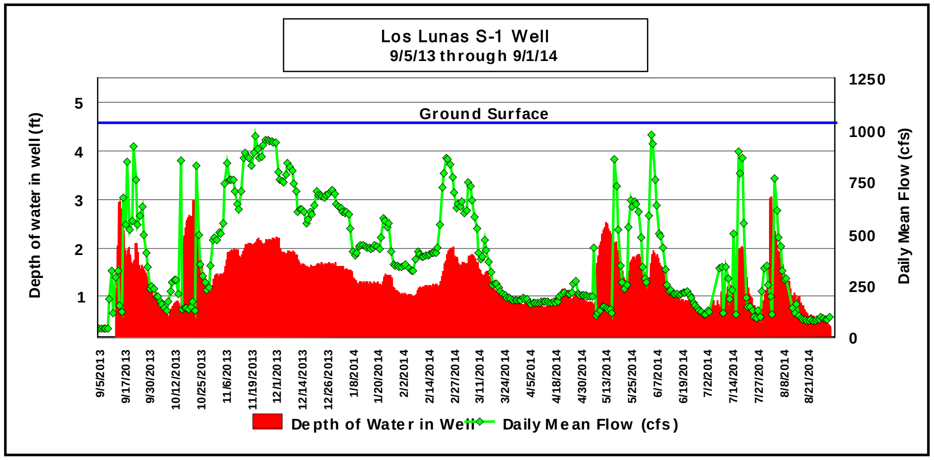
Groundwater Monitoring Wells
HOBO Water Level Logger Data
June 2012 – September 2014

South Transect

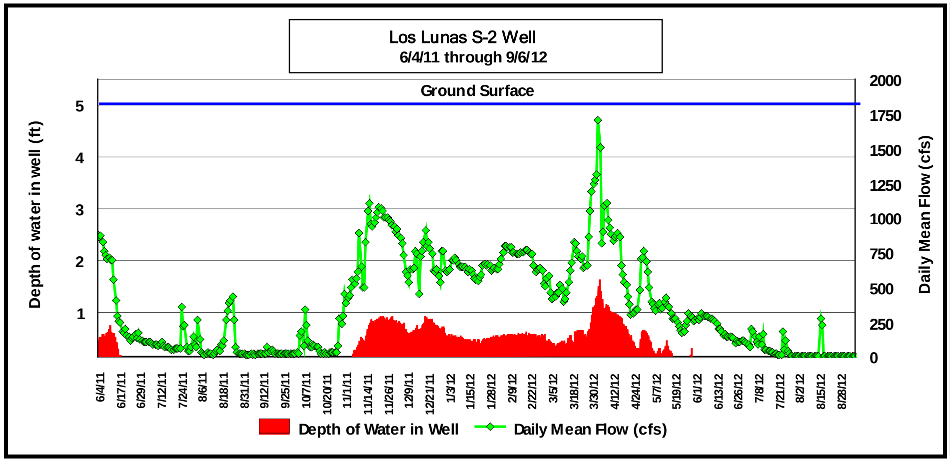
Well S1

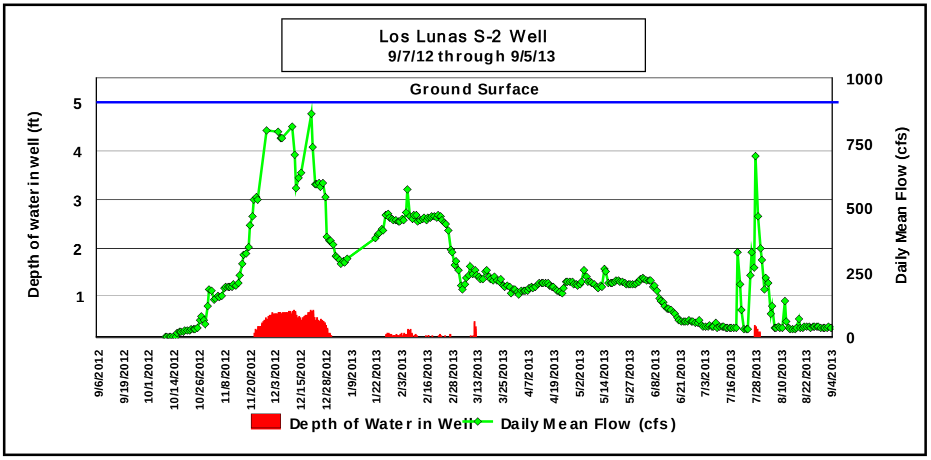


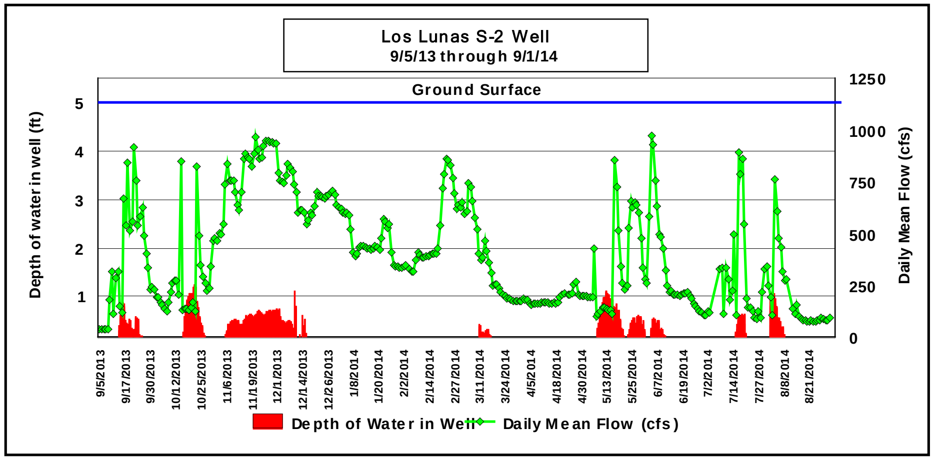




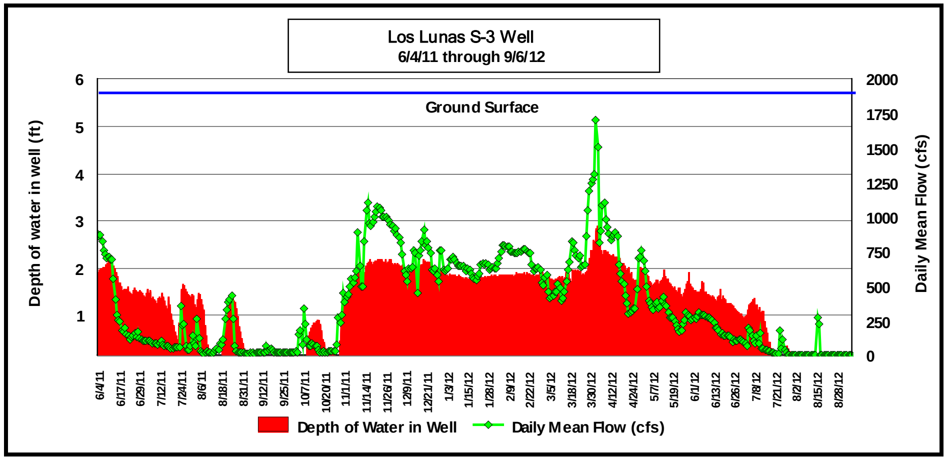
Well S2


Los Lunas S-2 Well
6/4/11 through 9/6/12
Ground Surface
Depth of water in well (ft)
5
4
3
2
1
2000
1750
1500
1250
1000
750
500
250
0
Daily Mean Flow (cfs)
6/4/11
6/17/11
6/29/11
7/12/11
7/24/11
8/6/11
8/18/11
8/31/11
9/12/11
9/25/11
10/7/11
10/20/11
11/1/11
11/14/11
11/26/11
12/9/11
12/21/11
1/3/12
1/15/12
1/28/12
2/9/12
2/22/12
3/5/12
3/18/12
3/30/12
4/12/12
4/24/12
5/7/12
5/19/12
6/1/12
6/13/12
6/26/12
7/8/12
7/21/12
8/2/12
8/15/12
8/28/12
Depth of Water in Well
Daily Mean Flow (cfs)

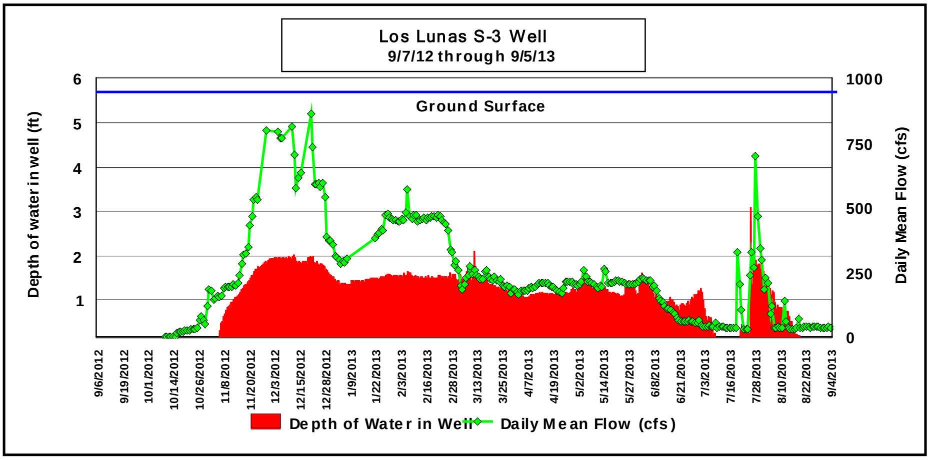

Los Lunas S-2 Well
9/7/12 through 9/5/13
Ground Surface
Depth of water in well (ft)
5
4
3
2
1
1000
750
500
250
0
Daily Mean Flow (cfs)
9/6/2012
9/19/2012
10/1/2012
10/14/2012
10/26/2012
11/8/2012
11/20/2012
12/3/2012
12/15/2012
12/28/2012
1/9/2013
1/22/2013
2/3/2013
2/16/2013
2/28/2013
3/13/2013
3/25/2013
4/7/2013
4/19/2013
5/2/2013
5/14/2013
5/27/2013
6/8/2013
6/21/2013
7/3/2013
7/16/2013
7/28/2013
8/10/2013
8/22/2013
9/4/2013
Depth of Water in Well
Daily Mean Flow (cfs)


Los Lunas S-2 Well
9/5/13 through 9/1/14
Ground Surface
Depth of water in well (ft)
5
4
3
2
1
1250
1000
750
500
250
0
Daily Mean Flow (cfs)
9/5/2013
9/17/2013
9/30/2013
10/12/2013
10/25/2013
11/6/2013
11/19/2013
12/1/2013
12/14/2013
12/26/2013
1/8/2014
1/20/2014
2/2/2014
2/14/2014
2/27/2014
3/11/2014
3/24/2014
4/5/2014
4/18/2014
4/30/2014
5/13/2014
5/25/2014
6/7/2014
6/19/2014
7/2/2014
7/14/2014
7/27/2014
8/8/2014
8/21/2014
Depth of Water in Well
Daily Mean Flow (cfs)

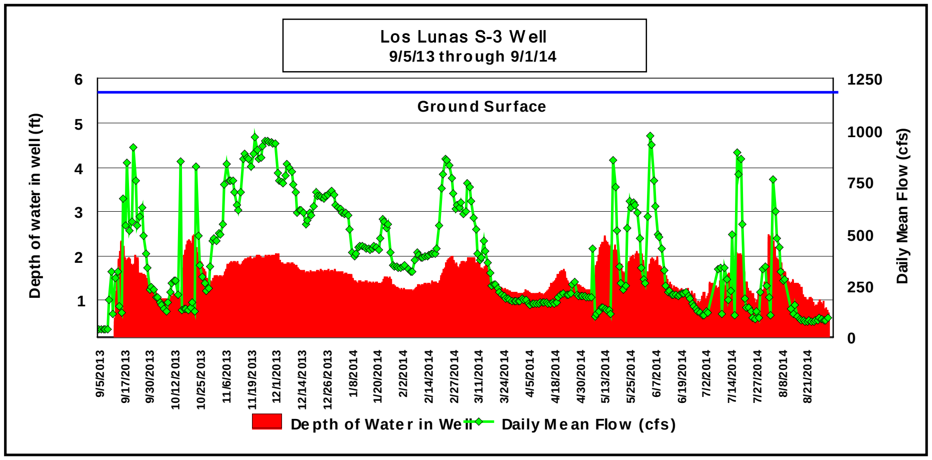
Well S3



Los Lunas S-3 Well
6/4/11 through 9/6/12
Ground Surface
Depth of water in well (ft)
Daily Mean Flow (cfs)
6
5
4
3
2
1
2000
1750
1500
1250
1000
750
500
250
0
6/4/11
6/17/11
6/29/11
7/12/11
7/24/11
8/6/11
8/18/11
8/31/11
9/12/11
9/25/11
10/7/11
10/20/11
11/1/11
11/14/11
11/26/11
12/9/11
12/21/11
1/3/12
1/15/12
1/28/12
2/9/12
2/22/12
3/5/12
3/18/12
3/30/12
4/12/12
4/24/12
5/7/12
5/19/12
6/1/12
6/13/12
6/26/12
7/8/12
7/21/12
8/2/12
8/15/12
8/28/12
Depth of Water in Well
Daily Mean Flow (cfs)



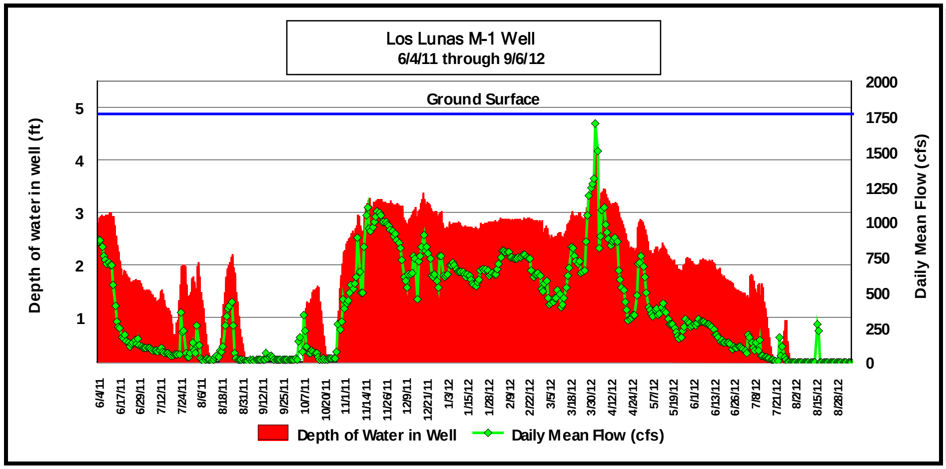
Los Lunas S-3 Well
9/7/12 through 9/5/13
Ground Surface
Depth of water in well (ft)
Daily Mean Flow (cfs)
6
5
4
3
2
1
1000
750
500
250
0
9/6/2012
9/19/2012
10/1/2012
10/14/2012
10/26/2012
11/8/2012
11/20/2012
12/3/2012
12/15/2012
12/28/2012
1/9/2013
1/22/2013
2/3/2013
2/16/2013
2/28/2013
3/13/2013
3/25/2013
4/7/2013
4/19/2013
5/2/2013
5/14/2013
5/27/2013
6/8/2013
6/21/2013
7/3/2013
7/16/2013
7/28/2013
8/10/2013
8/22/2013
9/4/2013
Depth of Water in Well
Daily Mean Flow (cfs)

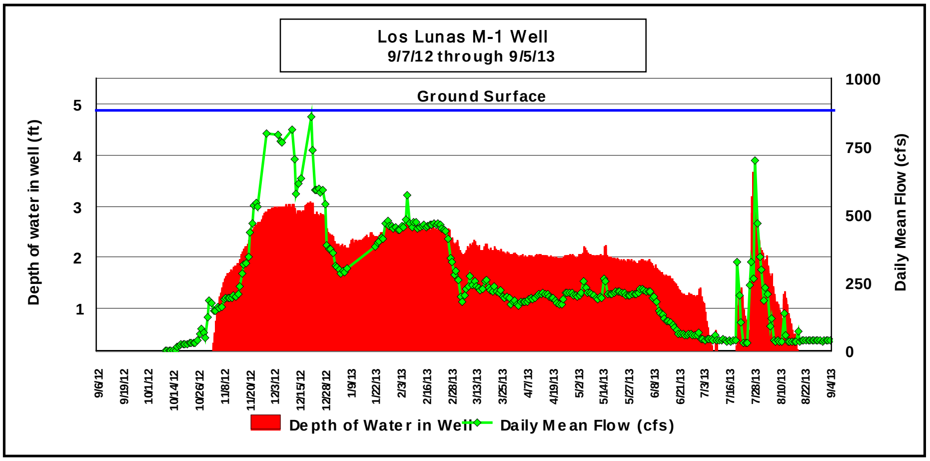


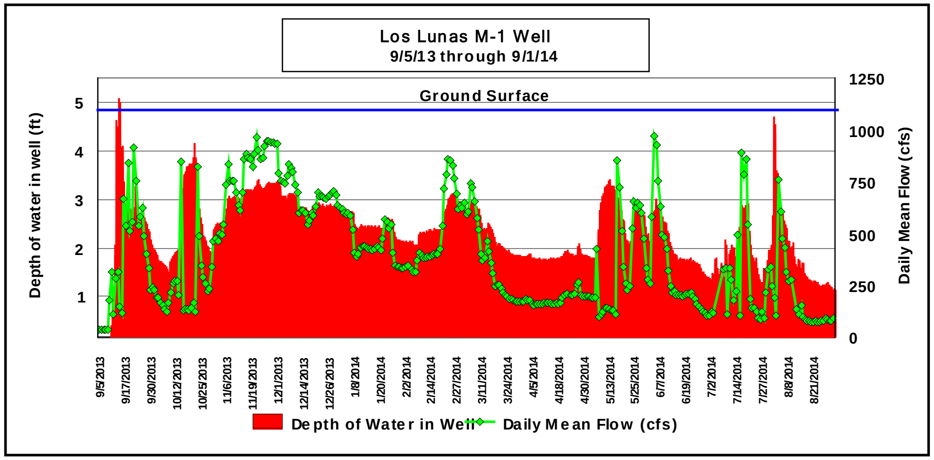
Los Lunas S-3 Well
9/5/13 through 9/1/14
Ground Surface
Depth of water in well (ft)
Daily Mean Flow (cfs)
6
5
4
3
2
1
1250
1000
750
500
250
0
9/5/2013
9/17/2013
9/30/2013
10/12/2013
10/25/2013
11/6/2013
11/19/2013
12/1/2013
12/14/2013
12/26/2013
1/8/2014
1/20/2014
2/2/2014
2/14/2014
2/27/2014
3/11/2014
3/24/2014
4/5/2014
4/18/2014
4/30/2014
5/13/2014
5/25/2014
6/7/2014
6/19/2014
7/2/2014
7/14/2014
7/27/2014
8/8/2014
8/21/2014
Depth of Water in Well
Daily Mean Flow (cfs)

Middle Transect

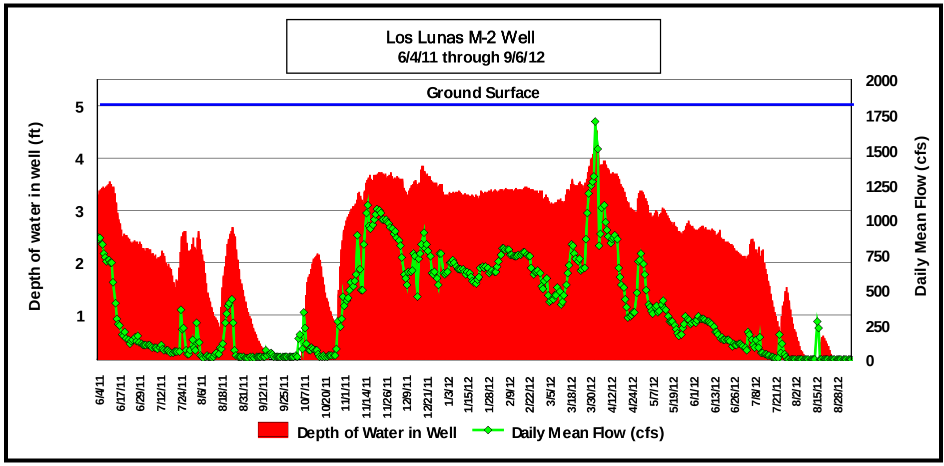
Well M1

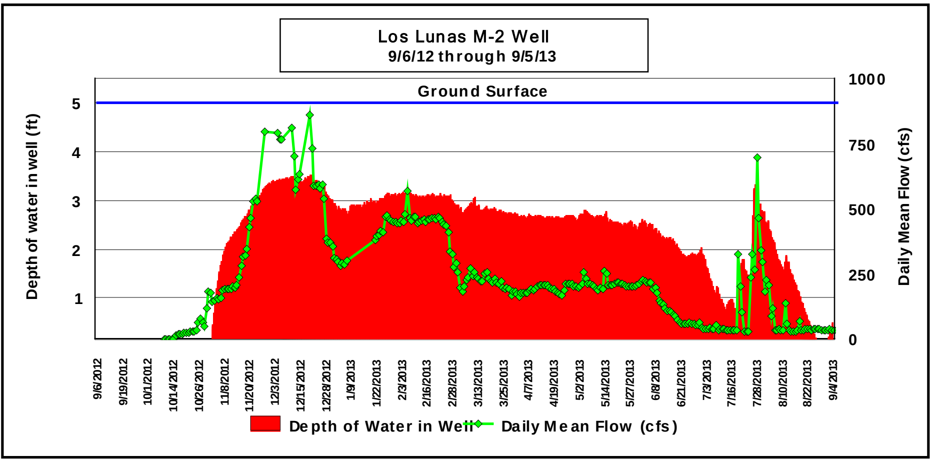


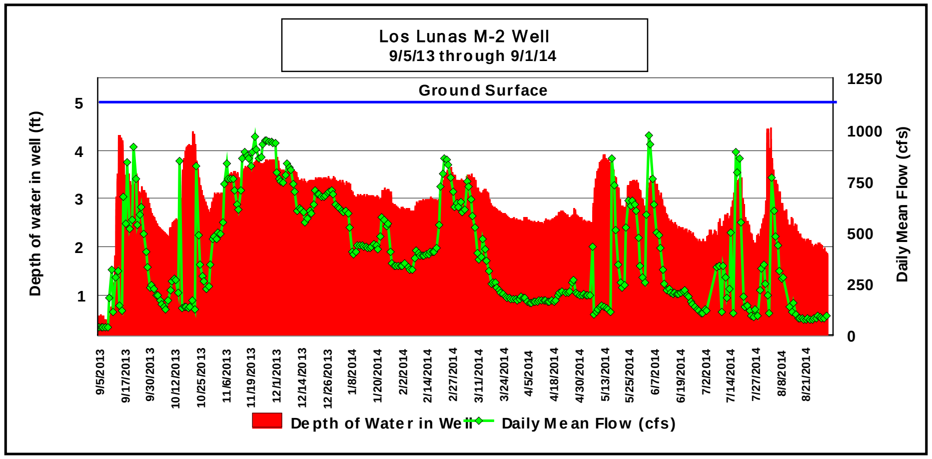




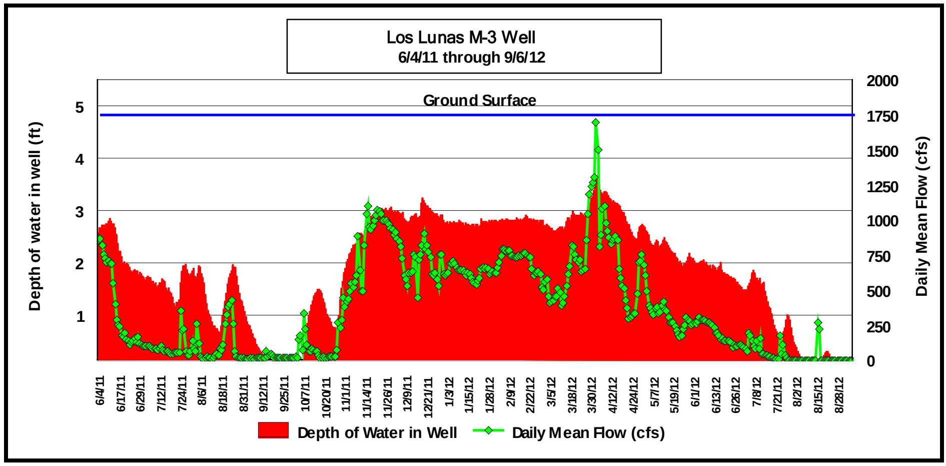
Well M2


Los Lunas M-2 Well
6/4/11 through 9/6/12
Ground Surface
Depth of water in well (ft)
5
4
3
2
1
Daily Mean Flow (cfs)
2000
1750
1500
1250
1000
750
500
250
0
6/4/11
6/17/11
6/29/11
7/12/11
7/24/11
8/6/11
8/18/11
8/31/11
9/12/11
9/25/11
10/7/11
10/20/11
11/1/11
11/14/11
11/26/11
12/9/11
12/21/11
1/3/12
1/15/12
1/28/12
2/9/12
2/22/12
3/5/12
3/18/12
3/30/12
4/12/12
4/24/12
5/7/12
5/19/12
6/1/12
6/13/12
6/26/12
7/8/12
7/21/12
8/2/12
8/15/12
8/28/12
Depth of Water in Well
Daily Mean Flow (cfs)

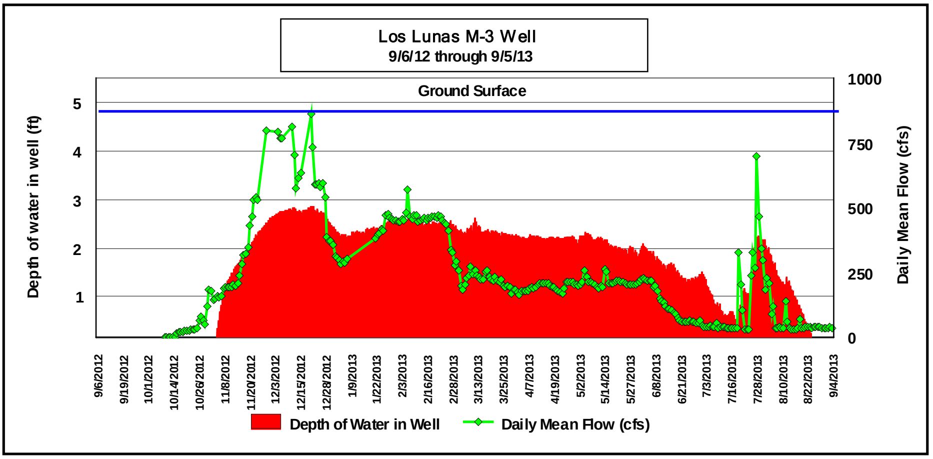

Los Lunas M-2 Well
9/6/12 through 9/5/13
Ground Surface
Depth of water in well (ft)
5
4
3
2
1
Daily Mean Flow (cfs)
1000
750
500
250
0
9/6/2012
9/19/2012
10/1/2012
10/14/2012
10/26/2012
11/8/2012
11/20/2012
12/3/2012
12/15/2012
12/28/2012
1/9/2013
1/22/2013
2/3/2013
2/16/2013
2/28/2013
3/13/2013
3/25/2013
4/7/2013
4/19/2013
5/2/2013
5/14/2013
5/27/2013
6/8/2013
6/21/2013
7/3/2013
7/16/2013
7/28/2013
8/10/2013
8/22/2013
9/4/2013
Depth of Water in Well
Daily Mean Flow (cfs)


Los Lunas M-2 Well
9/5/13 through 9/1/14
Ground Surface
Depth of water in well (ft)
5
4
3
2
1
Daily Mean Flow (cfs)
1250
1000
750
500
250
0
9/5/2013
9/17/2013
9/30/2013
10/12/2013
10/25/2013
11/6/2013
11/19/2013
12/1/2013
12/14/2013
12/26/2013
1/8/2014
1/20/2014
2/2/2014
2/14/2014
2/27/2014
3/11/2014
3/24/2014
4/5/2014
4/18/2014
4/30/2014
5/13/2014
5/25/2014
6/7/2014
6/19/2014
7/2/2014
7/14/2014
7/27/2014
8/8/2014
8/21/2014
Depth of Water in Well
Daily Mean Flow (cfs)

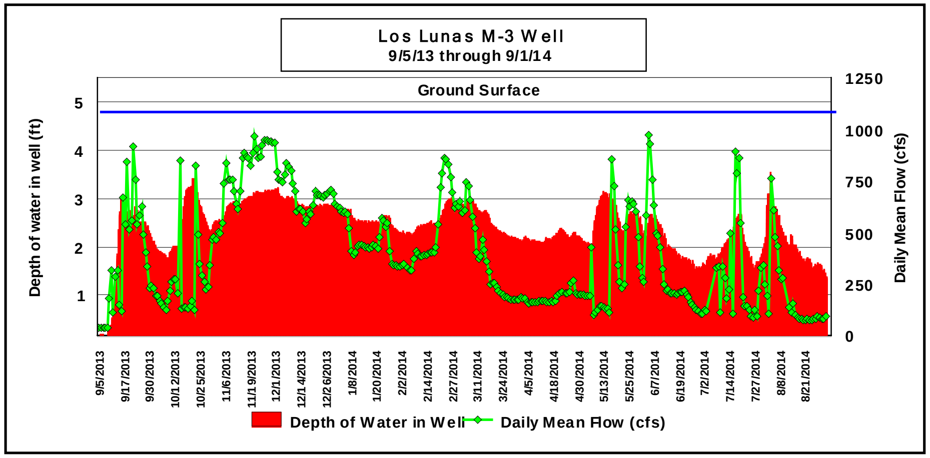
Well M3



Los Lunas M-3 Well
6/4/11 through 9/6/12
Ground Surface
Depth of water in well (ft)
5
4
3
2
1
Daily Mean Flow (cfs)
2000
1750
1500
1250
1000
750
500
250
0
6/4/11
6/17/11
6/29/11
7/12/11
7/24/11
8/6/11
8/18/11
8/31/11
9/12/11
9/25/11
10/7/11
10/20/11
11/1/11
11/14/11
11/26/11
12/9/11
12/21/11
1/3/12
1/15/12
1/28/12
2/9/12
2/22/12
3/5/12
3/18/12
3/30/12
4/12/12
4/24/12
5/7/12
5/19/12
6/1/12
6/13/12
6/26/12
7/8/12
7/21/12
8/2/12
8/15/12
8/28/12
Depth of Water in Well
Daily Mean Flow (cfs)



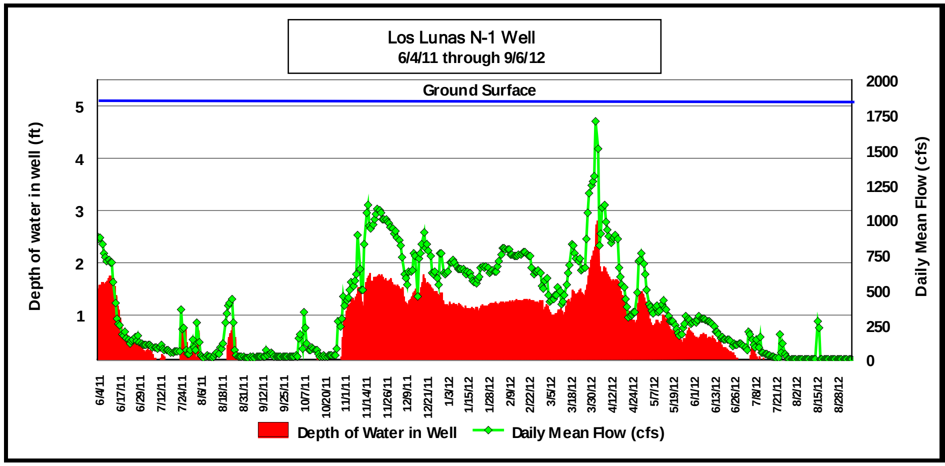
Los Lunas M-3 Well
9/6/12 through 9/5/13
Ground Surface
Depth of water in well (ft)
5
4
3
2
1
Daily Mean Flow (cfs)
1000
750
500
250
0
9/6/2012
9/19/2012
10/1/2012
10/14/2012
10/26/2012
11/8/2012
11/20/2012
12/3/2012
12/15/2012
12/28/2012
1/9/2013
1/22/2013
2/3/2013
2/16/2013
2/28/2013
3/13/2013
3/25/2013
4/7/2013
4/19/2013
5/2/2013
5/14/2013
5/27/2013
6/8/2013
6/21/2013
7/3/2013
7/16/2013
7/28/2013
8/10/2013
8/22/2013
9/4/2013
Depth of Water in Well
Daily Mean Flow (cfs)

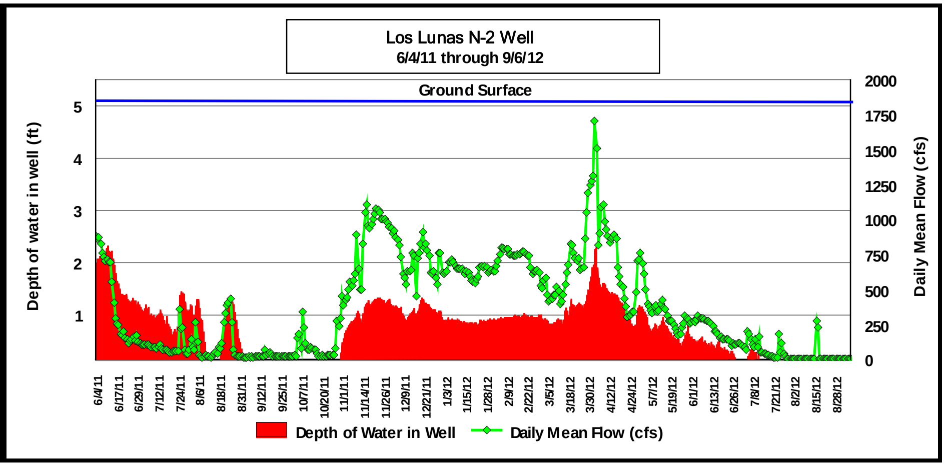


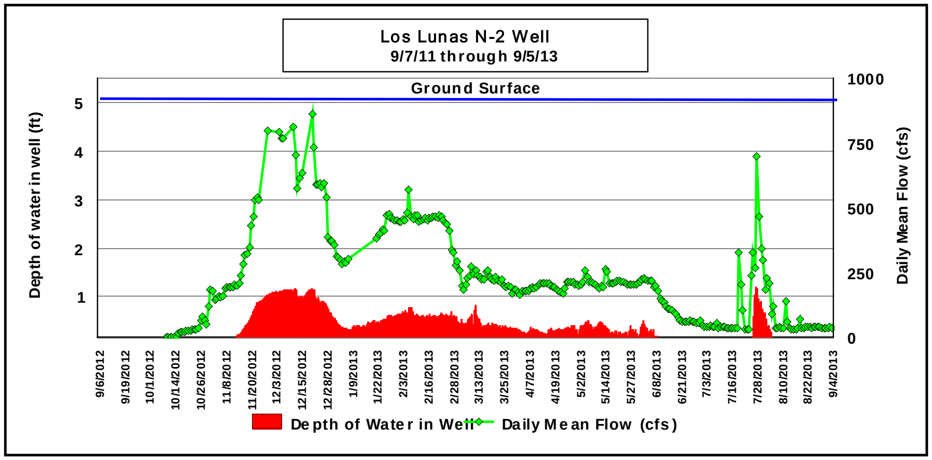
Los Lunas M-3 Well
9/5/13 through 9/1/14
Ground Surface
Depth of water in well (ft)
5
4
3
2
1
Daily Mean Flow (cfs)
1250
1000
750
500
250
0
9/5/2013
9/17/2013
9/30/2013
10/12/2013
10/25/2013
11/6/2013
11/19/2013
12/1/2013
12/14/2013
12/26/2013
1/8/2014
1/20/2014
2/2/2014
2/14/2014
2/27/2014
3/11/2014
3/24/2014
4/5/2014
4/18/2014
4/30/2014
5/13/2014
5/25/2014
6/7/2014
6/19/2014
7/2/2014
7/14/2014
7/27/2014
8/8/2014
8/21/2014
Depth of Water in Well
Daily Mean Flow (cfs)

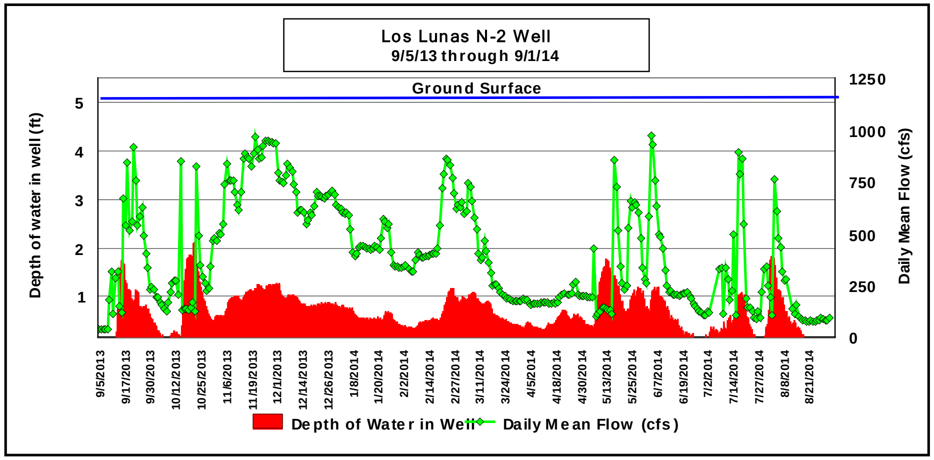
North Transect

Well N1 (Missing data from 9/12 to 9/14)**Well N2**

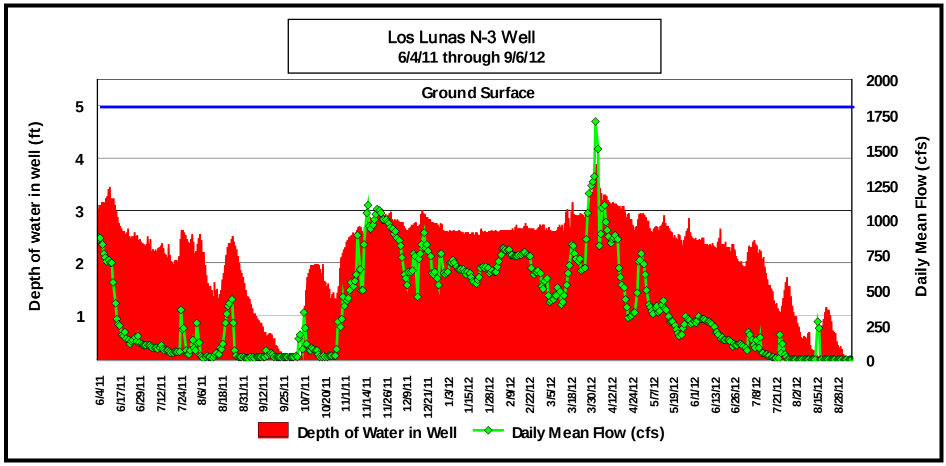


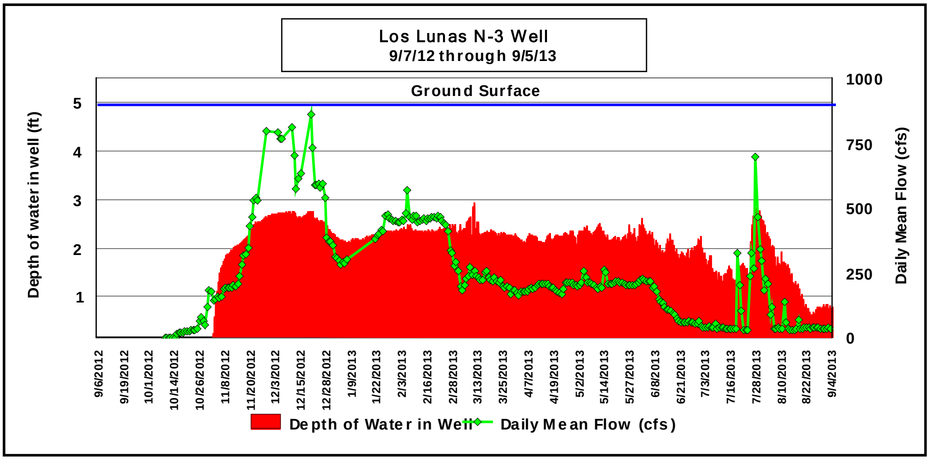


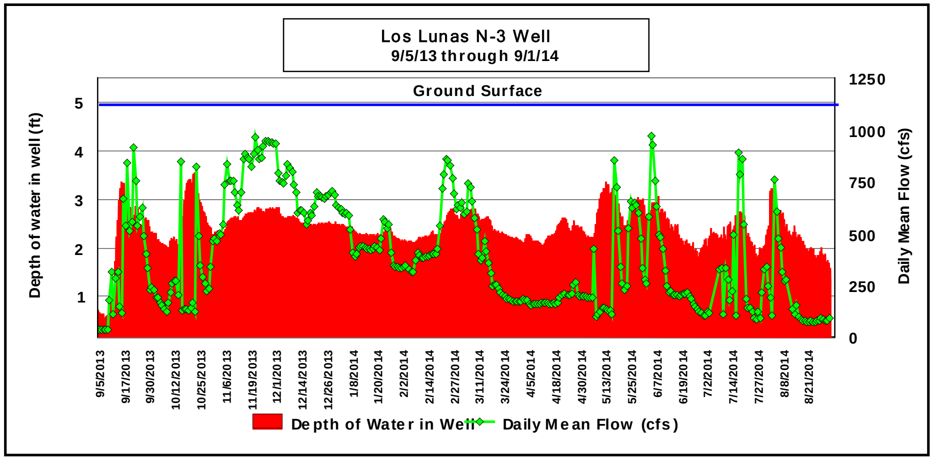




Well N3


Los Lunas N-3 Well
6/4/11 through 9/6/12
Ground Surface
Depth of water in well (ft)
Daily Mean Flow (cfs)
5
4
3
2
1
2000
1750
1500
1250
1000
750
500
250
0
6/4/11
6/17/11
6/29/11
7/12/11
7/24/11
8/6/11
8/18/11
8/31/11
9/12/11
9/25/11
10/7/11
10/20/11
11/1/11
11/14/11
11/26/11
12/9/11
12/21/11
1/3/12
1/15/12
1/28/12
2/9/12
2/22/12
3/5/12
3/18/12
3/30/12
4/12/12
4/24/12
5/7/12
5/19/12
6/1/12
6/13/12
6/26/12
7/8/12
7/21/12
8/2/12
8/15/12
8/28/12
Depth of Water in Well
Daily Mean Flow (cfs)


Los Lunas N-3 Well
9/7/12 through 9/5/13
Ground Surface
Depth of water in well (ft)
Daily Mean Flow (cfs)
5
4
3
2
1
1000
750
500
250
0
9/6/2012
9/19/2012
10/1/2012
10/14/2012
10/26/2012
11/8/2012
11/20/2012
12/3/2012
12/15/2012
12/28/2012
1/9/2013
1/22/2013
2/3/2013
2/16/2013
2/28/2013
3/13/2013
3/25/2013
4/7/2013
4/19/2013
5/2/2013
5/14/2013
5/27/2013
6/8/2013
6/21/2013
7/3/2013
7/16/2013
7/28/2013
8/10/2013
8/22/2013
9/4/2013
Depth of Water in Well
Daily Mean Flow (cfs)


Los Lunas N-3 Well
9/5/13 through 9/1/14
Ground Surface
Depth of water in well (ft)
Daily Mean Flow (cfs)
5
4
3
2
1
1250
1000
750
500
250
0
9/5/2013
9/17/2013
9/30/2013
10/12/2013
10/25/2013
11/6/2013
11/19/2013
12/1/2013
12/14/2013
12/26/2013
1/8/2014
1/20/2014
2/2/2014
2/14/2014
2/27/2014
3/11/2014
3/24/2014
4/5/2014
4/18/2014
4/30/2014
5/13/2014
5/25/2014
6/7/2014
6/19/2014
7/2/2014
7/14/2014
7/27/2014
8/8/2014
8/21/2014
Depth of Water in Well
Daily Mean Flow (cfs)

Appendix I

Photo Stations
2003 - 2014

Photo Station 1 - Facing North




2003 2004 2005 2006

2007

2008

2009

2010

2011

2012


2013 2014

Photo Station 1 – Facing River

No photo

2003 **2004** **2005** **2006**

2007 **2008** **2009** **2010**

2011 **2012** **2013** **2014**

Photo Station 1 – Facing South


2003


2004


2005


2006


2007




2008 2009 2010


2011




2012 2013 2014

Photo Station 2 – Facing North

2003

2004

2005

2006

2007

2008 2009

2010

2011 2012 2013 2014

Photo Station 2 – Facing River

2003

No photo

2004

2005

2006

2007 2008 2009 2010

2011 2012 2013 2014

Photo Station 2 – Facing South

2003

2004

2005

2006

2007

2008

2009 2010

2011 2012 2013 2014

Photo Station 3 – Facing North

2003

2004

2005

2006

2007

2008

2009

2010

2011

2012 2013 2014

Photo Station 3 - Facing South

2003

2004

2005

2006

2007

2008

2009

2010

2011

2012

2013 2014

Photo Station 4 – Facing North

2003

2004

2005

2006

2007

2008

2009

2010

2011

2012 2013 2014

Photo Station 4 – Facing South

2003

2004

2005

2006

2007

2008

2009

2010

2011

2012 2013 2014

Photo Station 5 – Facing North

2003

2004

2005

2006

2007

2008

2009

2010

2011

2012 2013 2014

Photo Station 5 – Facing South


2003


2004


2005


2006


2007


2008


2009


2010


2011


2012 2013 2014

Photo Station 6 – Facing North

No photo

2003

2004

2005

2006

2007

2008

2009

2010

2011

2012 2013 2014

Photo Station 6 – Facing South

2003

2004

2005

2006

2007

2008

2009

2010

2011

2012 2013 2014

Photo Station 7 – Facing North


2003


2004


2005


2006


2007


2008


2009


2010


2011

2012 2013 2014

Photo Station 8 – Pond

2003

2004

2005

2006

2007

2008

2009

2010

2011

2012 2013 2014

Photo Station 9 – Facing South

2003

2004

2005

2006

2007

2008

2009 2010

2011

2012 2013 2014

Photo Station 10 – Facing North


2003


2004


2005


2006


2007


2008


2009

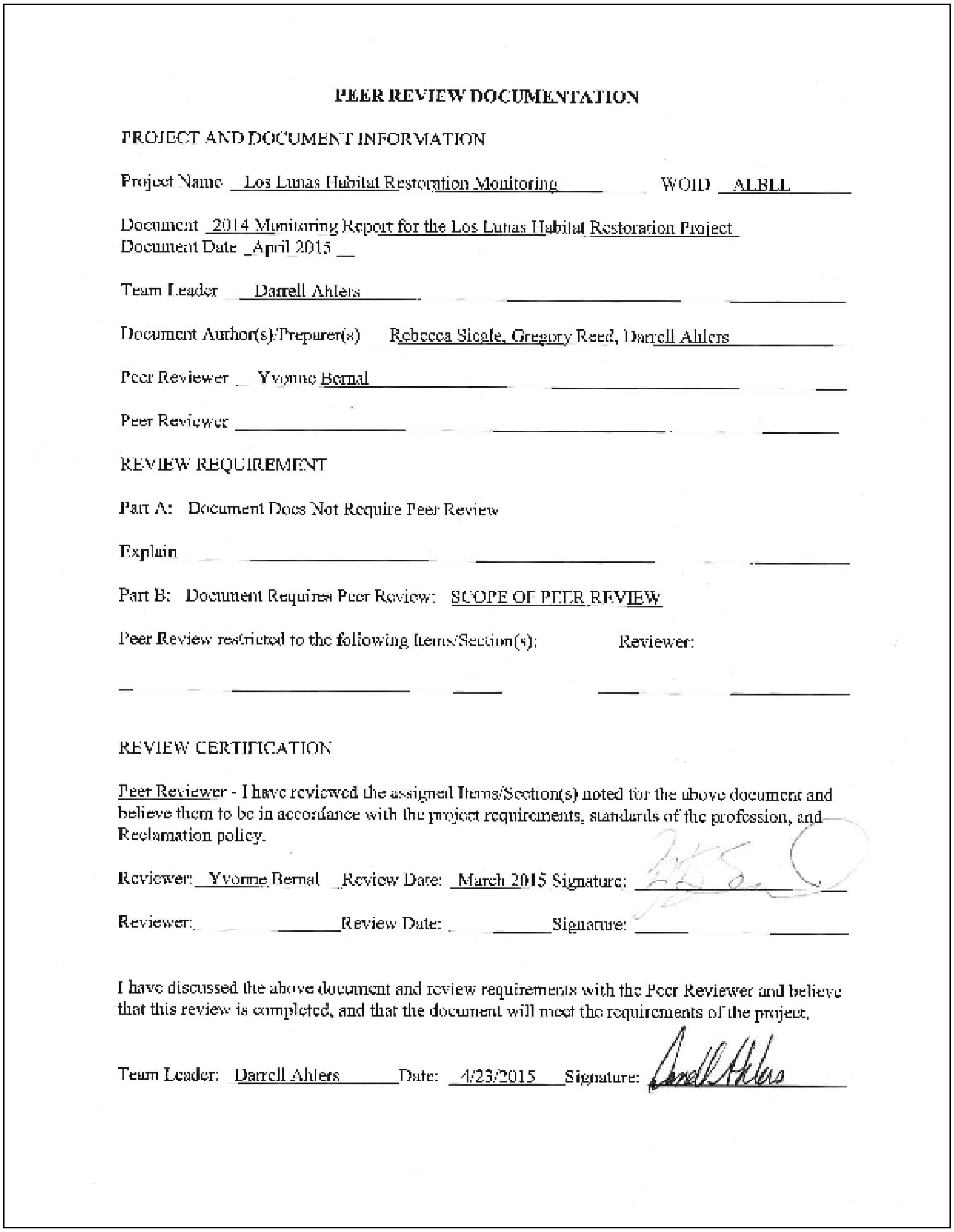

2010


2011


2012


2013


2014



PEER REVIEW DOCUMENTATION

PROJECT AND DOCUMENT INFORMATION

Project Name Los Lunas Habitat Restoration Monitoring WOID ALBLL

Document 2014 Monitoring Report for the Los Lunas Habitat Restoration Project

Document Date April 2015

Team Leader Darrell Ahlers

Document Author(s)/Preparer(s) Rebecca Siegle, Gregory Reed, Darrell Ahlers

Peer Reviewer Yvonne Bernal

Peer Reviewer

REVIEW REQUIREMENT

Part A: Document Does Not Require Peer Review

Explain

Part B: Document Requires Peer Review: SCOPE OF PEER REVIEW

Peer Review restricted to the following Items/Section(s): Reviewer:

REVIEW CERTIFICATION

Peer Reviewer - I have reviewed the assigned Items/Section(s) noted for the above document and believe them to be in accordance with the project requirements, standards of the profession, and Reclamation policy.

Reviewer: Yvonne Bernal Review Date: March 2015 Signature:

Reviewer: Review Date: Signature:

I have discussed the above document and review requirements with the Peer Reviewer and believe that this review is completed, and that the document will meet the requirements of the project.

Team Leader: Darrell Ahlers Date: 4/23/2015 Signature: Darrell Ahlers