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Managing Water in the West

2010 Monitoring Report for the Los Lunas Habitat Restoration Site

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

May 2011

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

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.

2010 Monitoring Report for the Los Lunas Habitat Restoration Site

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Introduction

The Los Lunas Habitat Restoration Project is intended to fulfill requirements in one of eight reaches in which habitat restoration must 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; USFWS 2001). The U.S. Bureau of Reclamation (Reclamation) Albuquerque Area Office and the U.S. Army Corps of Engineers (Corps) Albuquerque District have acted as joint lead federal agencies on this project, and the Middle Rio Grande Conservancy District (MRGCD) is the primary non-federal cooperator.

In April of 2000, an area of the bosque that included the entirety of the Los Lunas Restoration Site (LLRS) suffered a severe fire that destroyed virtually all of the aboveground vegetation. This area thus presented a unique opportunity for restoration and was subsequently selected as the first BO restoration project.

The primary objectives of the restoration project were to improve habitat conditions for the Rio Grande silvery minnow (*Hybognathus amarus*; minnow) and southwestern willow flycatcher (*Empidonax traillii extimus*; 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 feet/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 existing and revegetated 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. Upon the initiation of construction, 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.

To fulfill requirements of the BO, monitoring of SWFL habitat suitability/sustainability is being conducted. Reclamation's Technical Service Center (TSC) in Denver, Colorado,

has conducted avian, vegetation, and ground water monitoring at the restoration site since 2003.

Methods

Avian Monitoring

Point Counts

Avian monitoring included 5-minute, 50-meter (m) fixed-radius point counts that were conducted three times/year during the peak breeding seasons (late-May to early-July). Point counts took place within 3 areas and were monitored over an 8-year study period from 2003 to 2010. Two of these areas – the Cleared/Overbank and Burned Areas – were located within the LLRS, and one area – the Desired Future Conditions Area – was located south of the restoration site. 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 2010 and in the Desired Future Conditions Area from 2006 to 2010. The three areas are described below:

Cleared/Overbank Area

This area, located within the LLRS, bordered the active river channel and was cleared and excavated to allow overbank flooding with regrowth comprised of primarily native 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 (Figure1).

Burned Area

A previously burned cottonwood gallery adjacent to the Cleared/Overbank Area within the LLRS experienced regrowth of mixed vegetation. After a 2 year hiatus, monitoring was resumed in 2007 to serve as a reference site for comparison purposes. 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 1).

Desired Future Conditions Area

This area was located south of the LLRS on seasonally flooded sandbars that consisted of young stands of mixed willow and cottonwood and was chosen as a reference site for comparison purposes; 12 point counts were conducted at this site from 2006 to 2010 (Figure 2).

Data from the 8 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

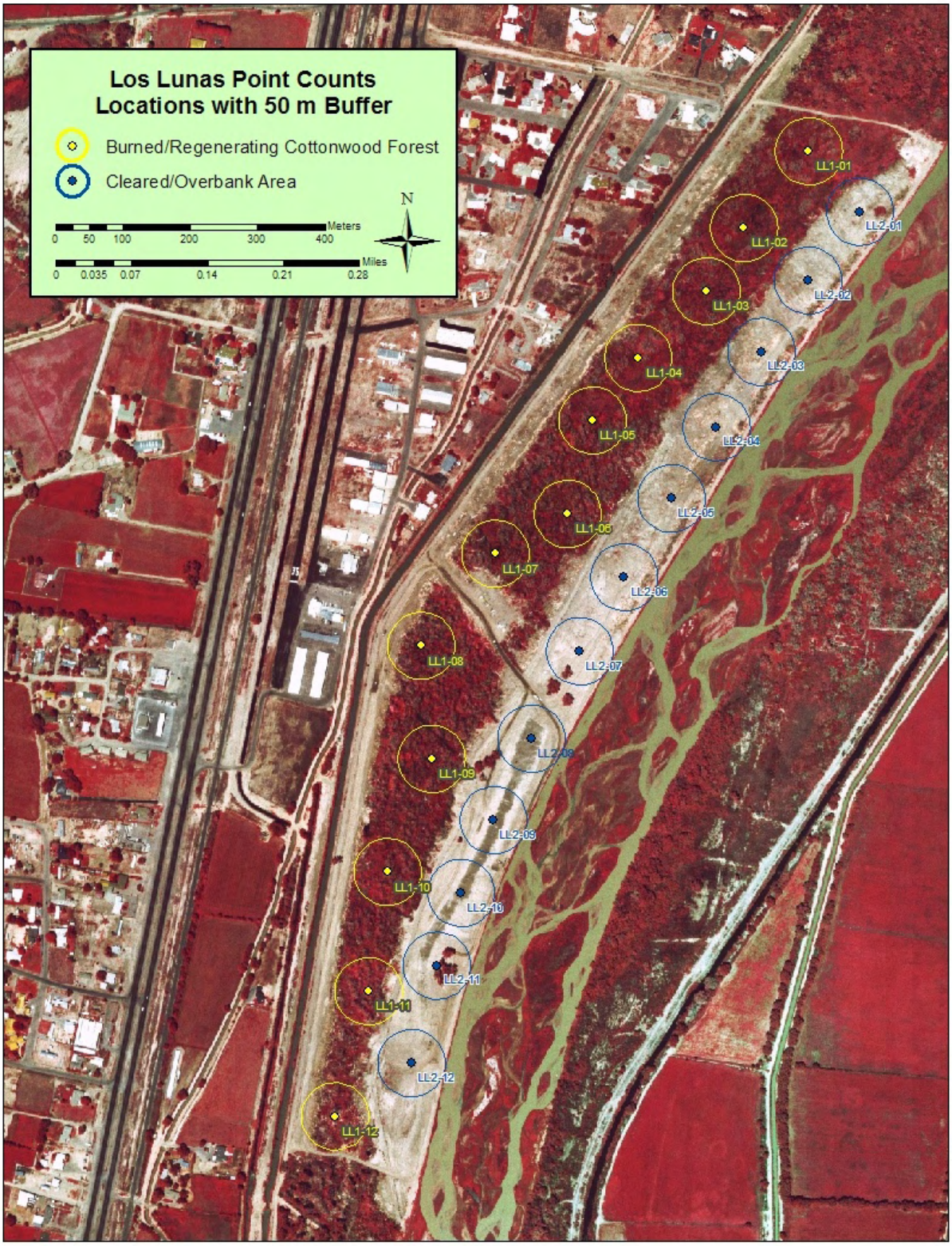


Figure 1.—Cleared/Overbank and Burned Area point count locations at LLRS.

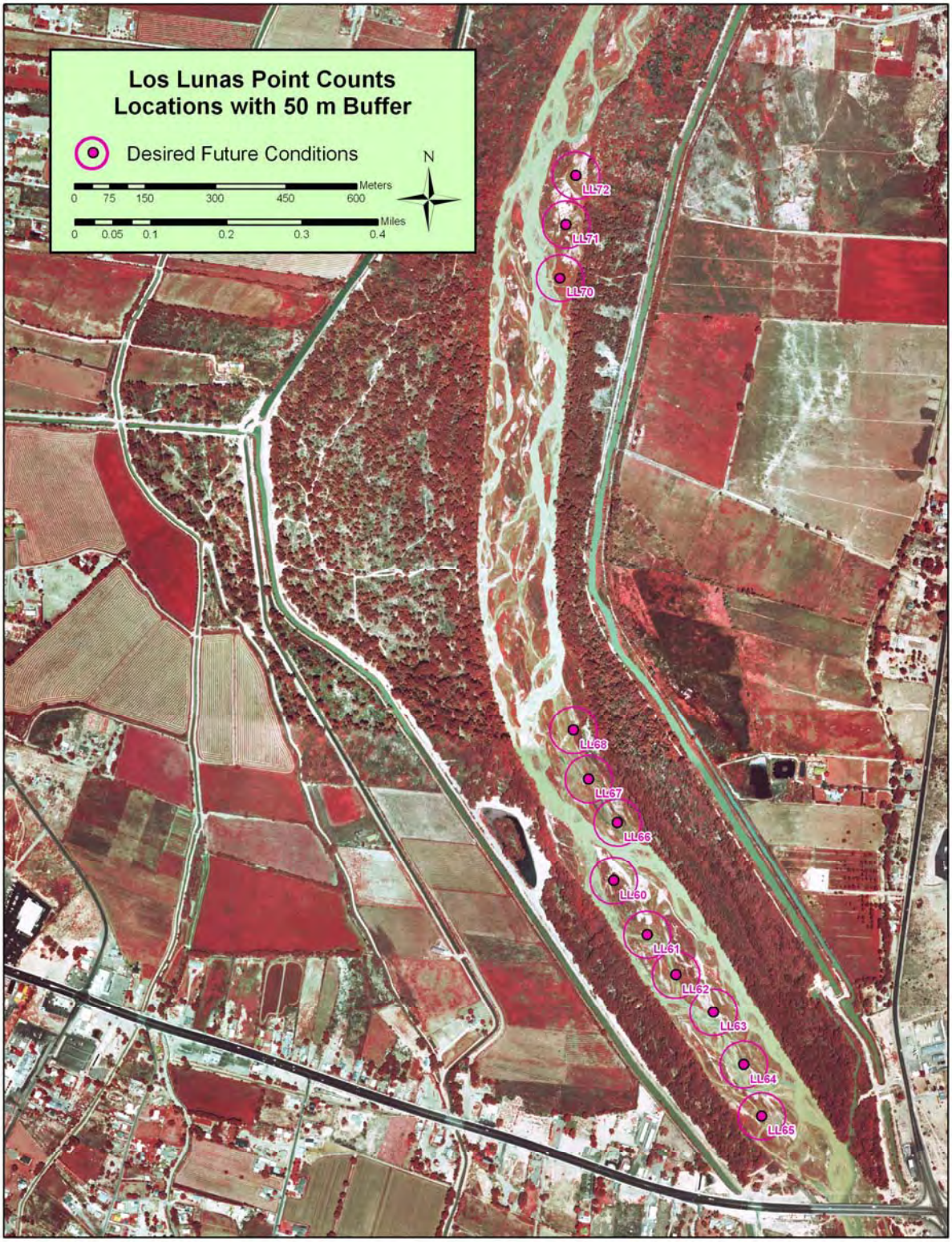


Figure 2.—Desired Future Conditions Area point count locations downstream of LLRS.

habitat and included canopy, cavity, dense shrub, edge, ground shrub, invasive, mid-story, open, and water birds. Table A-1 in Appendix A shows the groupings of individual bird species into guilds for analysis purposes as well as scientific names of the bird species.

Simple linear regression was used to test for statistically 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 or Analysis of Variance (ANOVA) was used for normally distributed data and the Mann-Whitney or Kruskal-Wallis nonparametric tests of medians were used for data that were not normally distributed.

Southwestern Willow Flycatcher Surveys

Three presence/absence surveys were conducted per year for the endangered SWFL within the LLRS from 2004 through 2010 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 Velarde to Elephant Butte Reservoir (Moore and Ahlers 2010).

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. This area was not revegetated using seed or potted shrubs. 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. 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 stretch was recorded by species.

The methodology used for cover measurements was revised in 2007. 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 vegetation grew in height, the original methodology did not account for a separate overstory measurement, and understory vegetation cover was not fully captured.

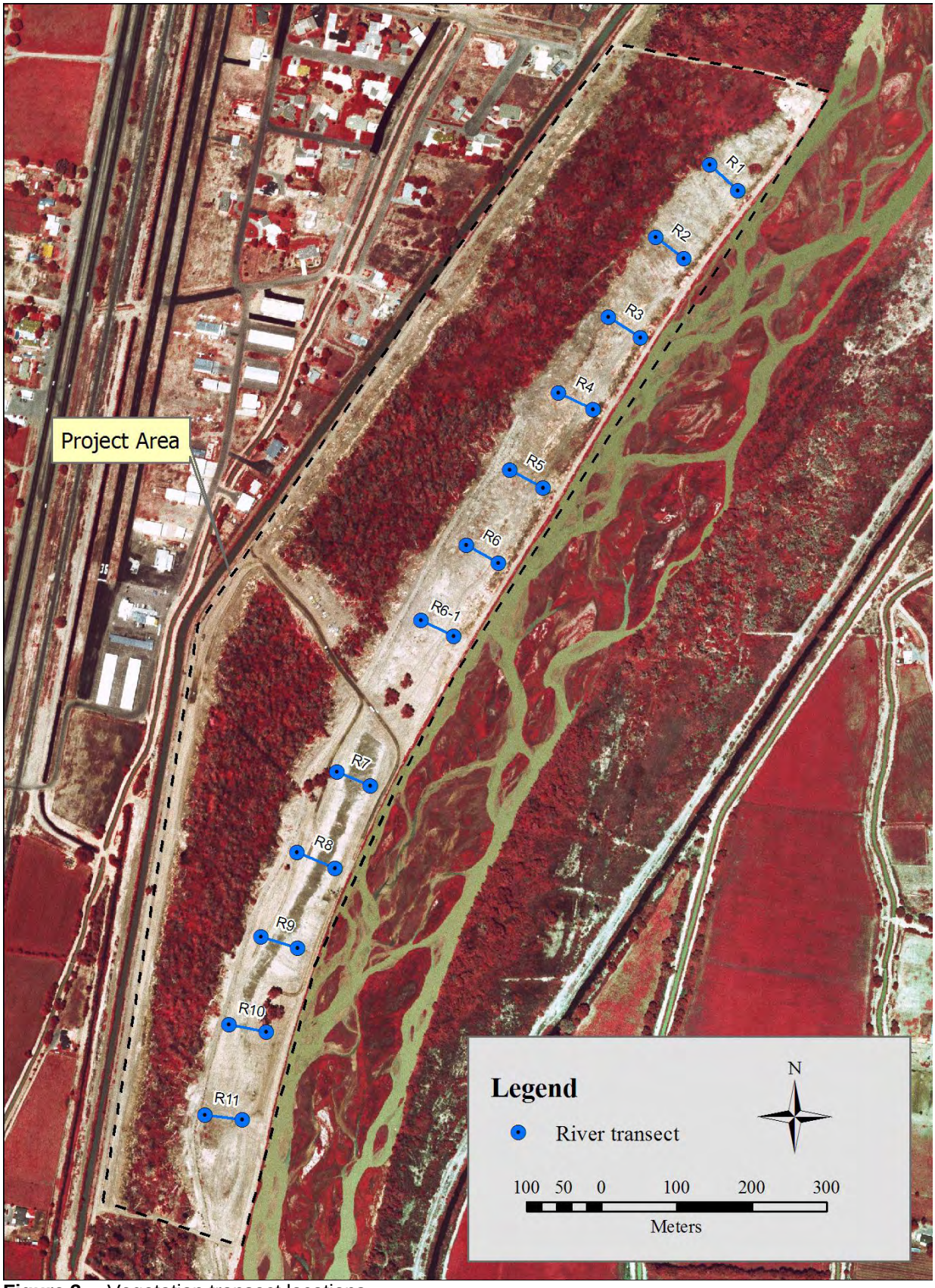


Figure 3.—Vegetation transect locations.

Because of the change in methodology, data from 2007 to 2010 were not directly comparable to data from earlier years. Data were collected sometime between mid-August and mid-September from 2003 through 2010.

Data from the 8 years of monitoring were compared to evaluate any statistically significant changes within vegetation types over time. The paired t-test was used to statistically compare normally distributed data, and the signed rank nonparametric test was used to compare data that were not normally distributed. Total percent cover (*i.e.* actual cover estimate) was analyzed for cover types (*i.e.* plant, litter, or bare) and overstory cover. Relative percent cover was analyzed for life-forms and native species. Relative cover is cover of a species or life-form expressed as a percent of total vegetation. At present, there are no similar restoration projects in the region to use for comparison.

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 4). All wells were installed using the Army Corps of Engineers (2000) methodology. All wells averaged 5.0 feet in depth, with the ground water depth at a range of 2.0 to 4.0 feet below the surface, at the time of installation. Eight wells were installed in June 2003 and the remaining westernmost three were installed July 2004.

Photo Stations

Ten photo stations were established throughout the study area with permanent numbered t-posts (Figure 4). Digital photographs were taken sometime between mid-August and mid-September in 2003 through 2010 to visually document vegetation height, density, species composition, and overall site development.

Annual photos were compared to evaluate visual changes over time.

Results

Avian Monitoring

Point Counts

Cleared/Overbank Area

Table B-1 in Appendix B 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"

Figure 4.—Ground water well and photo station locations.

and "SD" columns represent the mean number and standard deviation of detections per point for the species.

Fifty-four bird species were detected in the Cleared/Overbank Area during the point counts conducted from 2003 to 2010. 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 2010 were spotted towhees, brown-headed cowbirds, and black-chinned hummingbirds.

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 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. There was an increase in both relative abundance and species richness of total birds over the monitoring period; however both of these variables were on a decreasing trend in recent years. There was also an increase in relative abundance and species richness within the cavity, dense shrub, ground shrub, and mid-story species guilds. The increasing trend for these guilds was consistent with the development of vegetation within the Cleared/Overbank Area, *i.e.*, as the cover and height of vegetation have increased, so have the number and types of birds. Although the ground shrub species guild increased just slightly from 2003 to 2010 in both relative abundance and species richness, there were peak numbers detected in 2007 and 2008. This trend was also consistent with development of vegetation at this site; ground shrub habitat was optimal approximately 4 to 5 years following restoration as vegetation became thicker but decreased as vegetation became taller 6 to 7 years following restoration. There were opposite results within the canopy and water species guilds, where the number of individual birds and species decreased since 2003. The decrease in the abundance of canopy species was unexpected since the amount of this habitat type would presumably be lower at the beginning of the study, when vegetation in the Cleared/Overbank Area was just developing. Canopy species detected in 2003 were exclusively turkey vultures, which have not been documented at this site since then. As trees and shrubs became denser, the number of water birds decreased, which would be expected. No birds were detected in the open species guild (the only species being barn swallows) in 2010, but numbers were low throughout the study. Relative abundance and species richness within the edge species guild has remained essentially the same over the monitoring period.

In regression analysis examining the relationship between relative abundance of birds (*i.e.* average number of birds per point) and time (*i.e.* year), only dense shrub, mid-story,

Table 1.—Total, mean, and standard deviation by species guilds for the Cleared/Overbank Area from 2003 to 2010.

Cleared/Overbank Area	2003 8 points		2004 8 points		2005 8 points		2006 8 points		2007 12 points		2008 12 points		2009 12 points		2010 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)
# Species	18	1.79 (1.25)	20	2.92 (1.61)	23	3.67 (1.40)	21	3.71 (2.07)	25	3.81 (1.72)	24	3.53 (1.72)	19	2.69 (1.49)	17	2.86 (1.53)
# Birds	22	2.75 (3.08)	37	4.58 (2.92)	80	10.04 (4.61)	71	8.83 (9.17)	94	7.83 (11.21)	68	5.64 (3.25)	41	3.39 (2.10)	47	4.03 (3.08)
# Canopy spp.	1	0.04 (0.20)	0	0.00 (0.00)	1	0.04 (0.20)	1	0.04 (0.20)	1	0.03 (0.17)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)
# Canopy birds	3	0.42 (2.04)	0	0.00 (0.00)	1	0.04 (0.20)	1	0.04 (0.20)	1	0.03 (0.17)	0	0.00 (0.00)	0	0.00 (0.00)	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)	0	0.00 (0.00)	2	0.17 (0.45)
# 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)	0	0.00 (0.00)	7	0.19 (0.52)
# 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)	2	0.39 (0.49)	1	0.47 (0.51)	2	0.28 (0.45)
# 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	0.44 (0.61)	6	0.50 (0.56)	3	0.28 (0.45)
# 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)	3	0.44 (0.56)	2	0.39 (0.55)	2	0.47 (0.56)
# 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)	7	0.61 (0.87)	6	0.47 (0.74)	7	0.56 (0.73)
# 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)	3	0.47 (0.70)	4	0.44 (0.69)
# 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)	9	0.75 (1.23)	7	0.58 (1.00)
# Invasive spp.	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)
# Invasive birds	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)
# 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)	7	0.75 (0.73)	6	1.39 (0.99)
# Mid-story birds	1	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)	11	0.89 (0.95)	24	2.03 (1.93)
# Opening 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)	1	0.03 (0.17)	0	0.00 (0.00)
# Opening 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)	1	0.03 (0.17)	0	0.00 (0.00)
# Water spp.	5	0.83 (0.83)	4	0.88 (0.90)	10	2.33 (1.05)	7	1.08 (0.83)	7	0.83 (0.94)	8	1.03 (1.06)	5	0.58 (0.77)	2	0.11 (0.32)
# Water birds	9	1.08 (1.21)	15	1.83 (2.48)	63	7.83 (3.83)	12	1.50 (1.25)	20	1.69 (2.25)	24	2.00 (2.07)	9	0.75 (1.05)	5	0.39 (1.48)

*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.

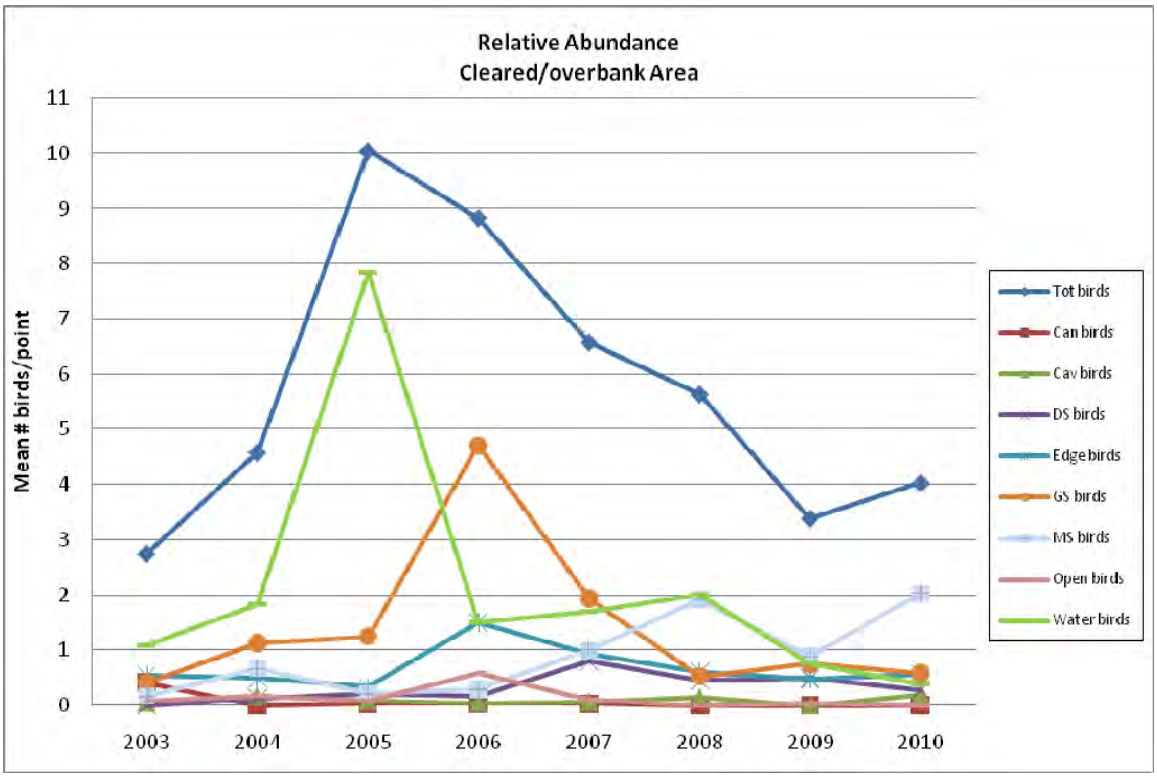


Figure 5.—Relative abundance by species guilds in the Cleared/Overbank Area over time.

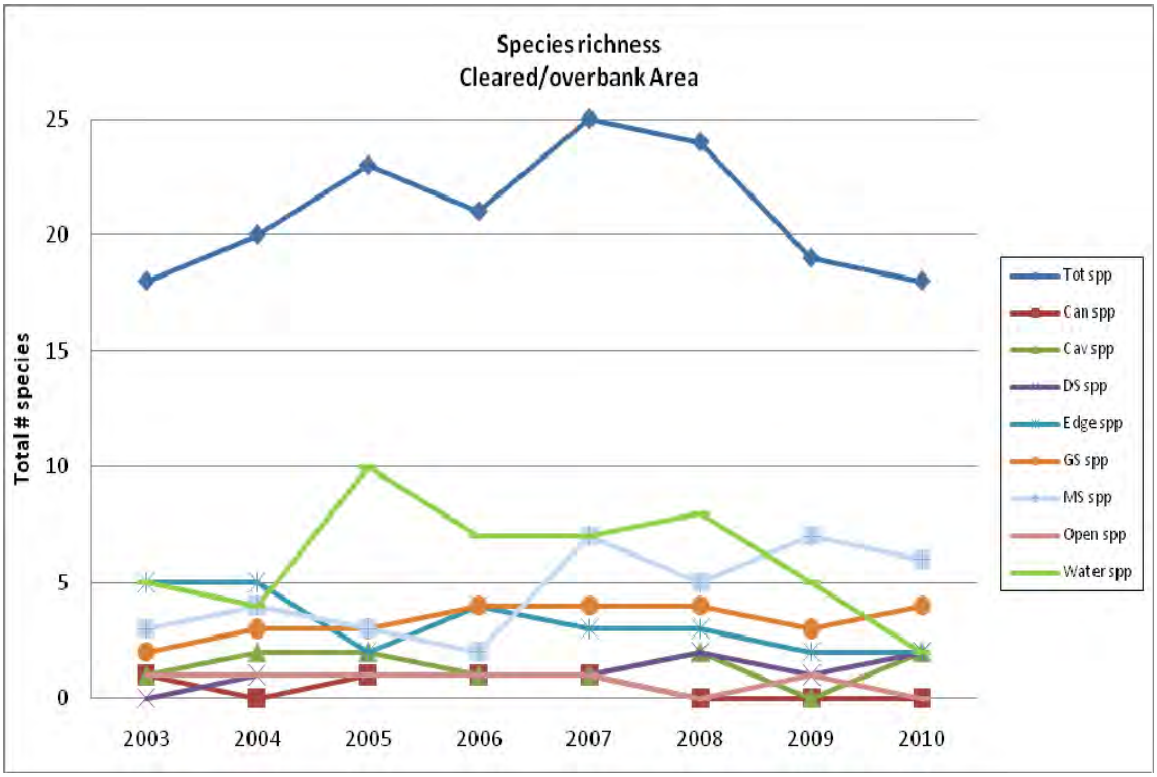


Figure 6.—Species richness by species guilds in the Cleared/Overbank Area over time.

and water bird guilds showed significance at the 95 percent confidence level (Table 2). In other words, the P-value indicated that a significant slope was identified for these three guilds as shown in Figure 7. Linear trends for all other guilds in the Cleared/Overbank Area are shown in Appendix C.

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 2010	
	P	R^2
Total birds	0.194	0.0216
Canopy birds	0.067	0.0423
Cavity birds	0.614	0.0033
Dense shrub birds	0.005	0.0988
Edge birds	0.842	0.0005
Ground shrub birds	0.295	0.0141
Invasive birds	No invasive birds detected	
Mid-story birds	0.000	0.2613
Open birds	0.101	0.0341
Water birds	0.002	0.1208

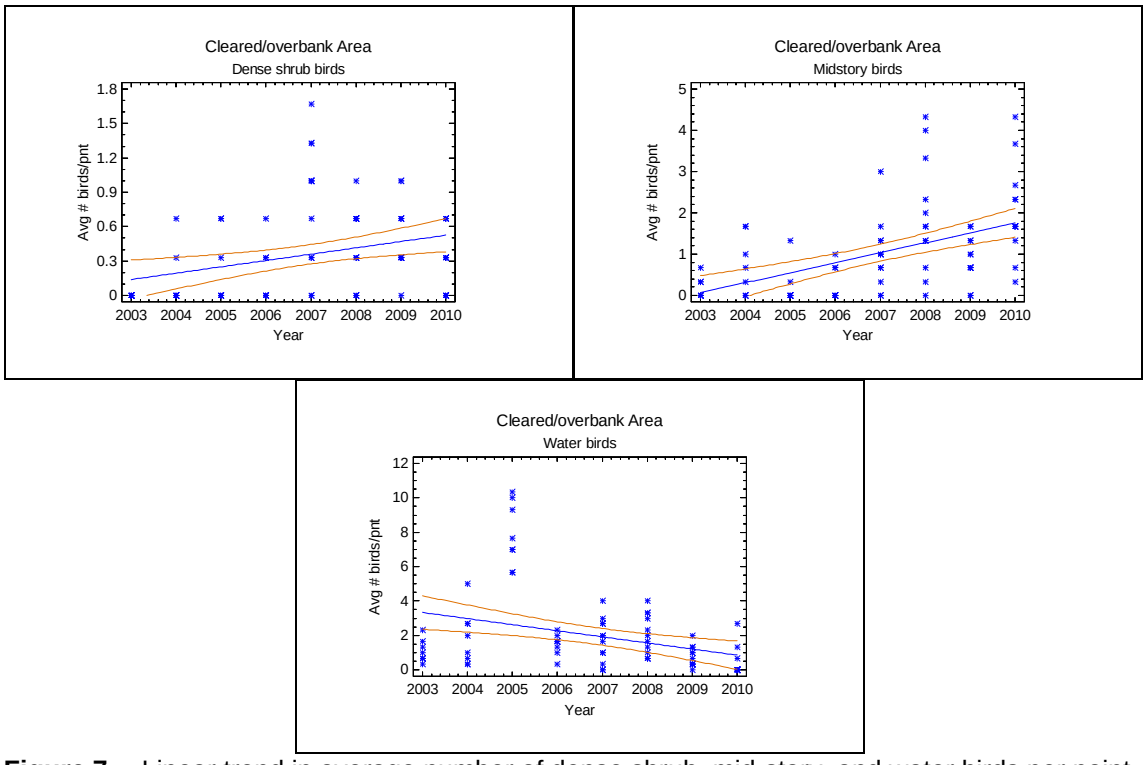


Figure 7.—Linear trend in average number of dense shrub, mid-story, and water birds per point in relation to year (2003 to 2010) in the Cleared/Overbank Area. Points represent the average number of observations within 3 reps at each point in each year, straight blue line represents best-fitting trend, and red curving lines represent 95 percent confidence intervals.

In both the dense shrub and mid-story guilds, there was an increasing trend in the relative abundance of birds detected; among water birds there was a decreasing trend. However, the percent of the variability in abundance that could be attributed to year indicated a relatively weak relationship between the variables among the dense shrub birds (R^2 value of 0.0988 or 10 percent; Table 2) and the water birds (R^2 value of 0.1208 or 12 percent). An R^2 value of 0.2613 (26 percent) indicated a moderately strong relationship between year and relative abundance among mid-story birds.

The mean numbers of detections per point for the most common bird species within selected guilds in the Cleared/Overbank Area are graphed in Figure 8. The general trend detected in the abundance of many of the individual species was an increase from the early years of the study (e.g. 2003 and 2004) to the mid years (approximately 2005 to 2007), followed by a gradual decrease in the last few years. There were slight increases in abundance among mid-story species from 2009 to 2010, but this trend was not consistent among all guilds.

Results from the Cleared/Overbank Area indicated statistically significant increases in relative abundance of the dense shrub and mid-story guilds, and a significant decrease in the water species guild. However, analysis did not suggest that there was a strong relationship between abundance and year for the dense shrub and water guilds, so factors other than time may have influenced trends for these guilds. The only dense shrub species detected in 2010 was the common yellow-throat, which gradually increased in abundance from 2003 — when none were detected — to 2007. Although abundance of common yellow-throats has been on a decreasing trend since 2007, detections are still higher than when monitoring began. Dense shrub habitat developed as vegetation filled in at the restoration site, however as vegetation continued to grow taller, dense shrub habitat likely decreased. Abundance of water bird species, principally redwing blackbirds, peaked in 2005 when river levels were high and the area was flooded for most of the breeding season. Detections have decreased since that time, which is consistent with development at the site. Dense vegetation has replaced the open water bird habitat adjacent to the river. 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 could be beneficial. Abundance of this species increased in 2010, however, and it was again one of the most common species in the Cleared/Overbank Area. Other mid-story species have also increased in abundance over time and species richness has increased from 3 in 2003 to 6 in 2010 (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. The increasing trend in mid-story species is an indication that the LLRS is potentially developing suitable habitat for SWFLs.

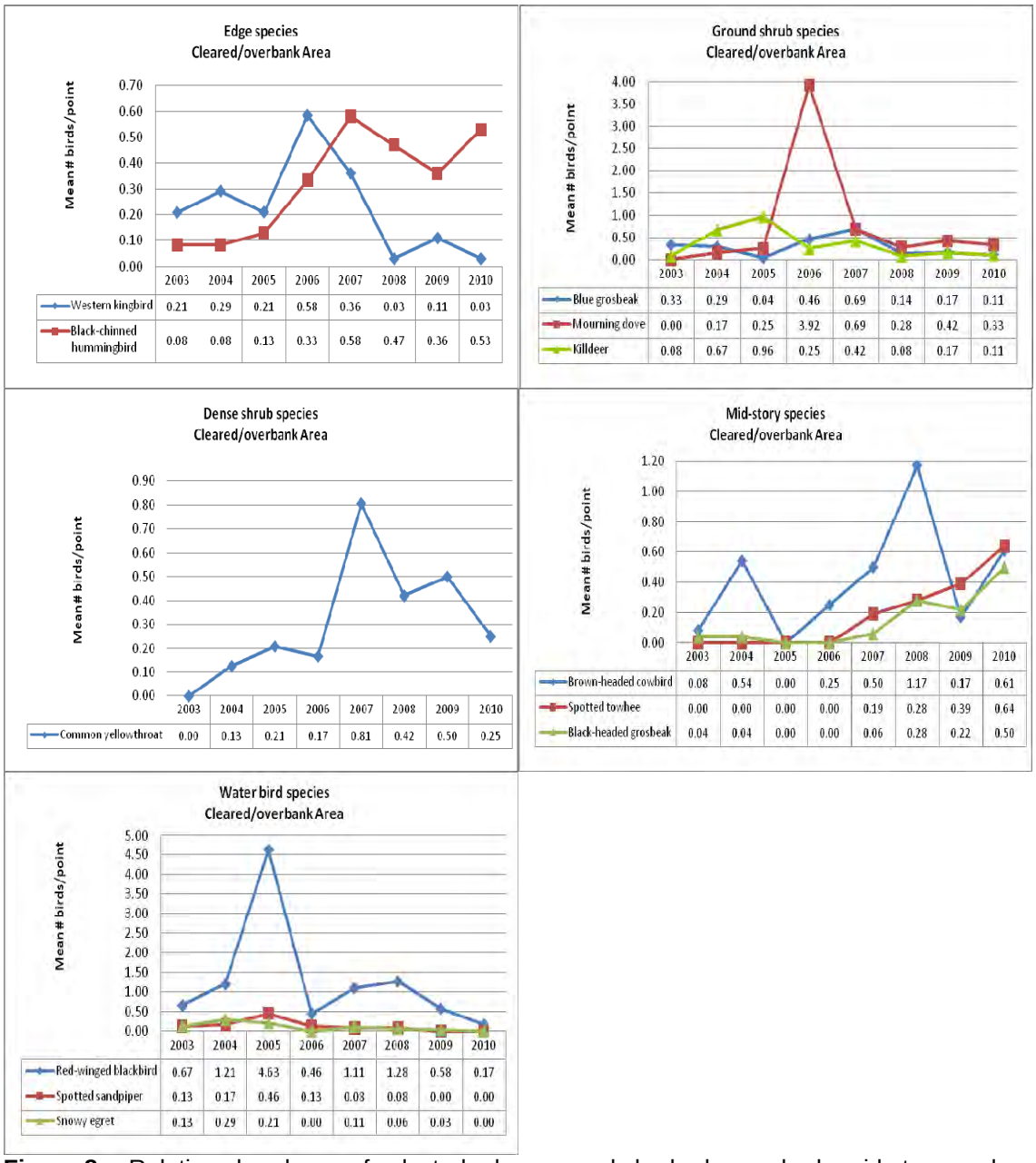


Figure 8.—Relative abundance of selected edge, ground shrub, dense shrub, mid-story, and water bird species in the Cleared/Overbank Area from 2003 to 2010.

Burned Area

Table B-2 (Appendix B) shows relative abundance of individual species for the Burned Area by year. A total of 47 species were detected in this area in 2003, 2004, and 2007 to 2010. The most abundant species in 2003 were the brown-headed cowbird, yellow-breasted chat, and spotted towhee. In 2010, the most common species included the black-chinned hummingbird, mourning dove, and spotted towhee.

Means and totals by species guilds for the Burned Area are shown in Table 3. Relative abundance and species richness are graphed in Figures 9 and 10, respectively. The

Table 3.—Total, mean, and standard deviation by species guilds for the Burned Area for 2003, 2004, and 2007 to 2010.

Los Lunas Burned Area	2003 17 points		2004 17 points		2007 12 points		2008 12 points		2009 12 points		2010 12 points	
	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)	18	3.89 (1.56)	24	4.42 (1.44)	18	3.89 (1.53)
# Birds	146	8.45 (3.23)	118	7.34 (2.55)	107	8.89 (3.77)	66	5.50 (3.53)	75	6.28 (2.35)	66	5.50 (2.81)
# 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)
# 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)
# 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)
# 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)
# 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)
# 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)
# Edge spp.	4	0.62 (0.58)	2	0.64 (0.61)	3	1.08 (0.65)	4	0.58 (0.73)	4	0.89 (0.46)	2	0.83 (0.51)
# Edge birds	15	0.83 (0.93)	12	0.70 (0.69)	20	1.69 (1.21)	7	0.61 (0.80)	17	1.44 (0.91)	17	1.39 (1.13)
# 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)
# 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)
# 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)
# 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)
# 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)
# 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)
# Opening 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)
# Opening 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)
# 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)
# 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)

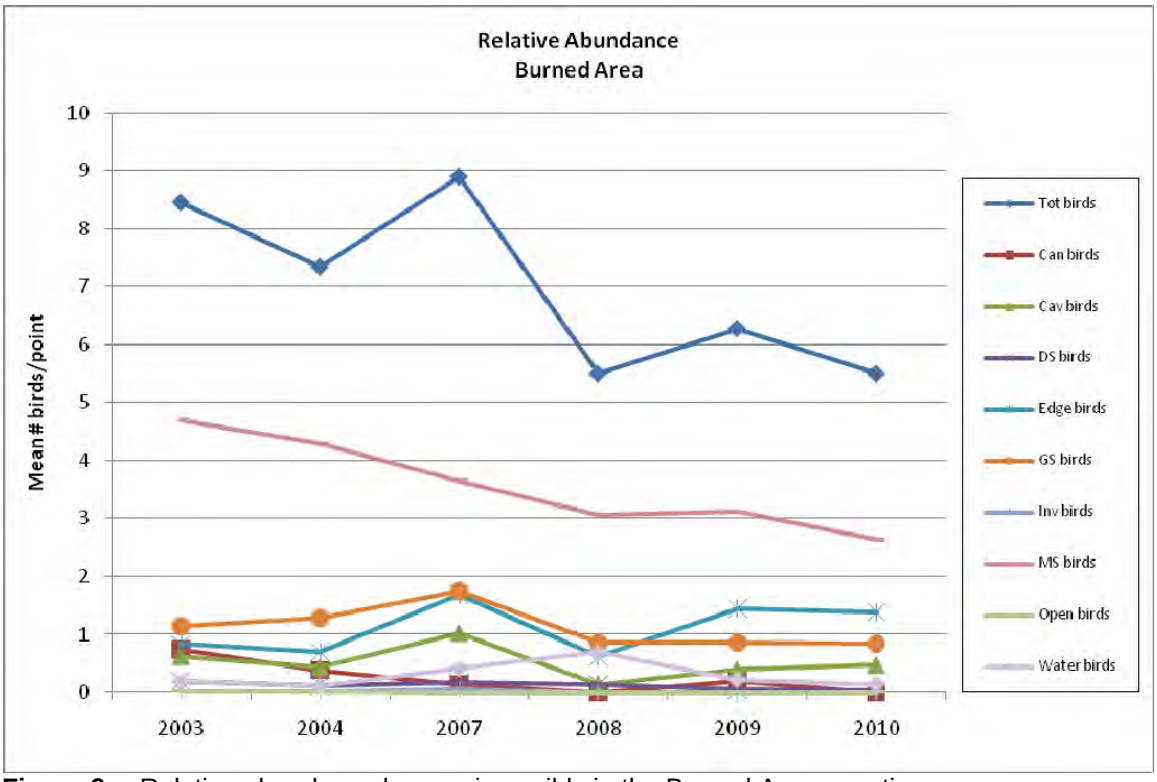


Figure 9.—Relative abundance by species guilds in the Burned Area over time.

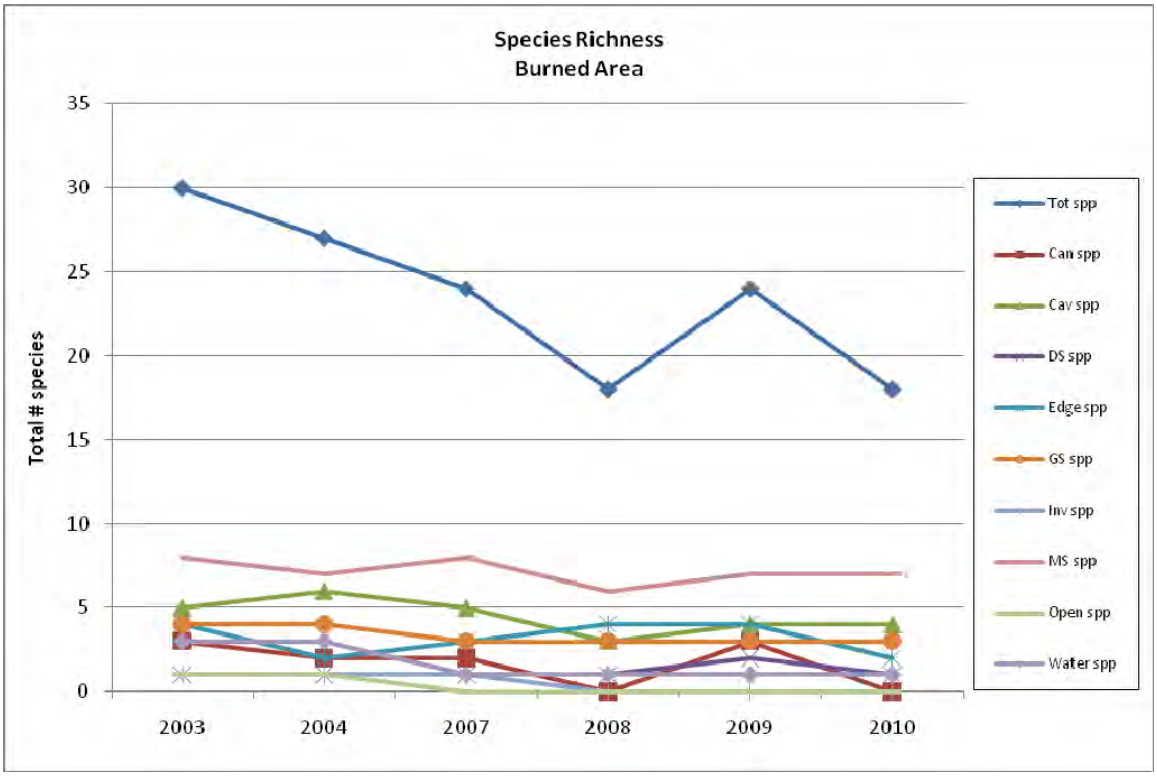


Figure 10.—Species richness by species guilds in the Burned Area over time.

relative abundance of birds decreased over the monitoring period within all guilds except for edge birds, which increased since 2003. Species richness within each guild also decreased over time. The average number of canopy, cavity, and mid-story birds detected per point decreased as development of the habitat for these species presumably increased over time. Cottonwood snags that were created following the fire have gradually fallen down, and thus decreased over the monitoring period, which may have affected the number of canopy and cavity birds nesting in the Burned Area. As in the Cleared/Overbank Area, turkey vultures were the primary canopy species early in the study (2003 and 2004), but were not detected in recent years.

In simple linear regression of abundance in relation to year, total, canopy, edge, and mid-story bird guilds all showed a significant relationship or slope with $P<0.05$ (Table 4). The linear trends for these guilds within the Burned Area are plotted in Figure 11. Linear trends for all other guilds in the Burned Area are shown in Appendix C.

Among the total, canopy, and mid-story 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 total, canopy, and edge species guilds. The percent of the variability in relative abundance that could be attributed to year was 20 percent for total birds ($R^2=0.1987$), 11 percent for canopy birds ($R^2=0.1073$), and 9 percent for edge birds ($R^2=0.0862$; Table 4). There was a moderately strong relationship between abundance and year for mid-story birds with 28 percent of the variability in relative abundance that could be attributed to year ($R^2=0.2810$).

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 to 2010	
	P	R^2
Total birds	0.000	0.1987
Canopy birds	0.003	0.1073
Cavity birds	0.268	0.0155
Dense shrub birds	0.071	0.0407
Edge birds	0.008	0.0862
Ground shrub birds	0.242	0.0173
Invasive birds	0.355	0.0108
Mid-story birds	0.000	0.2810
Open birds	0.110	0.0320
Water birds	0.629	0.0030

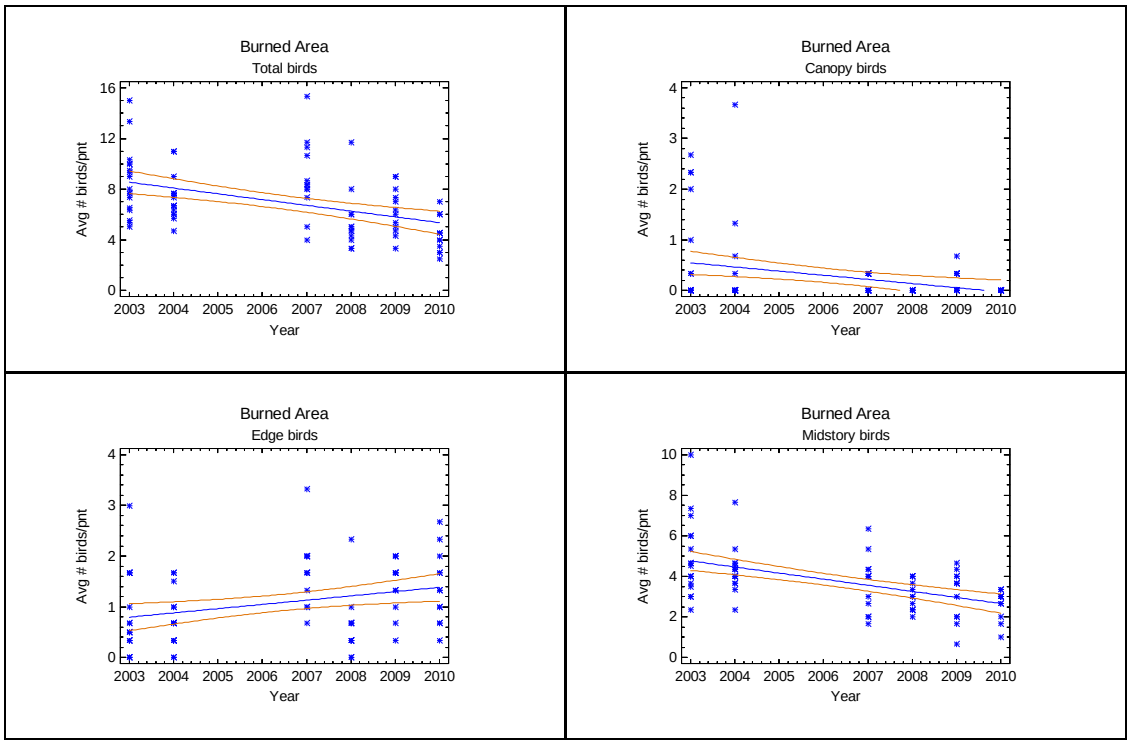


Figure 11.—Linear trend in average number of total, canopy, edge, and mid-story birds per point in relation to year (2003 to 2010) in the Burned Area. Points represent the average number of observations within 3 reps at each point in each year, straight blue line represents best-fitting trend, and red curving lines represent 95 percent confidence intervals.

The mean numbers of detections per point for the most common bird species within selected guilds in the Burned Area are graphed in Figure 12. Corresponding to the general decreasing trend in relative abundance of all species guilds, most individual bird species also decreased in abundance since monitoring began in 2003. There were a few exceptions, as with the cavity nesting Bewick's wren, the mid-story gray catbird, the edge species black-chinned hummingbird, and the ring-necked pheasant, a grounds shrub species, showing increases. None of these species are in the same guild, which therefore doesn't provide an indicator about specific habitat quality at this site.

Results for the Burned Area indicated decreasing trends in both relative abundance and species richness among the majority of bird guilds, although none of the guilds showed exceptionally strong statistically significant relationships between abundance and year. This suggested that decreases in bird populations may not have been strictly temporal and could have been caused by other factors affecting the site. As mentioned, a number of cottonwood snags have fallen since point counts were initiated, which changed the habitat somewhat. However, guilds in various habitat types showed decreasing trends in abundance, not just those dependent upon snags. Statistically, mid-story guild abundance showed the strongest trend within the Burned Area. The only increase in relative abundance was among the edge guild, which was associated with an increase in the number of black-chinned hummingbirds detected.

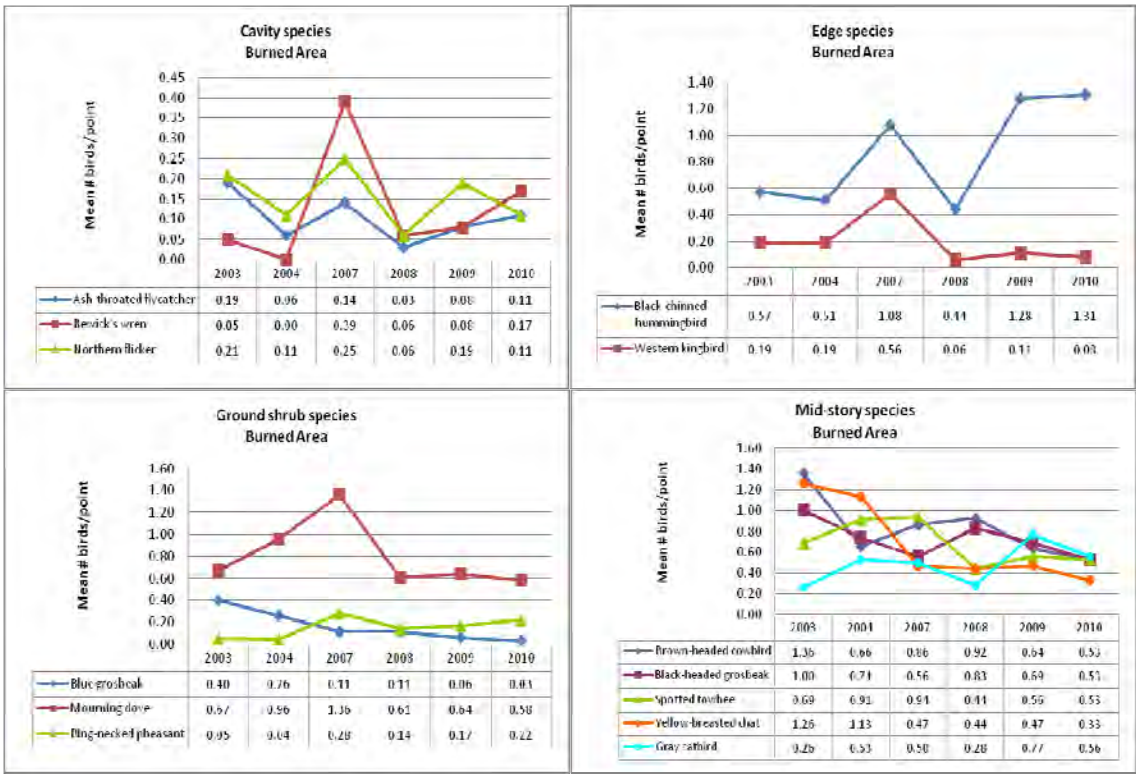


Figure 12.—Relative abundance of selected cavity, edge, ground shrub, and mid-story bird species in the Burned Area for 2003, 2004, 2007-2010.

Desired Future Conditions Area

Table B-3 (Appendix B) provides data on the relative abundance of individual species for the Desired Future Conditions Area from 2006 to 2010. There was a total of 30 species detected during point counts conducted in these 5 years. The most common species in 2006 were comprised of a variety of swallows, including bank, barn, and violet-green, as well as the black-chinned hummingbird. In 2010, the most abundant species were the spotted towhee, blue grosbeak, and black-chinned hummingbird.

Means and totals by species guilds for the Desired Future Conditions Area are shown in Table 5. Relative abundance and species richness are graphed in Figures 13 and 14, respectively. Relative abundance of all species guilds in 2010 either decreased or was equal to values in 2006 with the exception of the dense shrub and ground shrub species guilds, which increased slightly over this period. Species richness decreased or stayed the same over the monitoring period within all of the guilds except dense shrub, ground shrub, and edge species, which increased slightly.

Table 5.—Total, mean, and standard deviation by species guilds for the Desired Future Conditions Area from 2006 to 2010.

Desired Future Conditions Area	2006 12 points		2007 12 points		2008 12 points		2009 12 points		2010 12 points	
	Total	Mean (SD)	Total	Mean (SD)	Total	Mean (SD)	Total	Mean (SD)	Total	Mean (SD)
# Species	17	2.94 (1.43)	16	4.00 (1.62)	20	2.96 (1.33)	14	1.86 (1.36)	12	2.42 (1.06)
# Birds	61	5.08 (2.93)	65	5.38 (2.93)	46	3.87 (2.72)	29	2.38 (2.04)	23	2.83 (1.58)
# Canopy spp.	0	0.00 (0.00)	1	0.13 (0.34)	2	0.09 (0.29)	0	0.00 (0.00)	0	0.00 (0.00)
# Canopy birds	0	0.00 (0.00)	2	0.13 (0.34)	2	0.09 (0.29)	0	0.00 (0.00)	0	0.00 (0.00)
# Cavity spp.	0	0.00 (0.00)	0	0.00 (0.00)	1	0.04 (0.21)	0	0.00 (0.00)	0	0.00 (0.00)
# Cavity birds	0	0.00 (0.00)	0	0.00 (0.00)	1	0.04 (0.21)	0	0.00 (0.00)	0	0.00 (0.00)
# Dense shrub spp.	1	0.14 (0.35)	1	0.33 (0.48)	1	0.30 (0.47)	1	0.21 (0.41)	1	0.25 (0.44)
# Dense shrub birds	2	0.17 (0.45)	5	0.42 (0.65)	5	0.35 (0.57)	3	0.21 (0.42)	2	0.25 (0.44)
# Edge spp.	2	0.50 (0.65)	2	0.75 (0.53)	3	0.35 (0.57)	2	0.38 (0.58)	2	0.58 (0.58)
# Edge birds	9	0.72 (0.97)	11	0.92 (0.72)	4	0.35 (0.57)	6	0.46 (0.78)	6	0.71 (0.81)
# Ground shrub spp.	3	0.42 (0.65)	1	0.63 (0.49)	1	0.13 (0.34)	2	0.29 (0.46)	2	0.54 (0.66)
# Ground shrub birds	6	0.50 (0.77)	10	0.79 (0.72)	2	0.13 (0.34)	6	0.46 (0.78)	5	0.67 (0.87)
# Invasive spp.	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	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.	6	0.92 (1.11)	7	1.96 (1.12)	6	1.52 (0.99)	6	0.79 (0.78)	5	0.92 (0.65)
# Mid-story birds	16	1.36 (1.76)	33	2.75 (2.07)	24	2.00 (1.48)	12	0.96 (1.23)	9	1.08 (1.21)
# Opening spp.	1	0.31 (0.47)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)
# Opening birds	8	0.69 (1.14)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)
# Water spp.	4	0.67 (0.63)	4	0.21 (0.51)	6	0.52 (0.73)	3	0.21 (0.41)	2	0.13 (0.34)
# Water birds	20	1.64 (1.74)	5	0.38 (1.01)	11	0.91 (1.83)	4	0.29 (0.62)	2	0.13 (0.34)

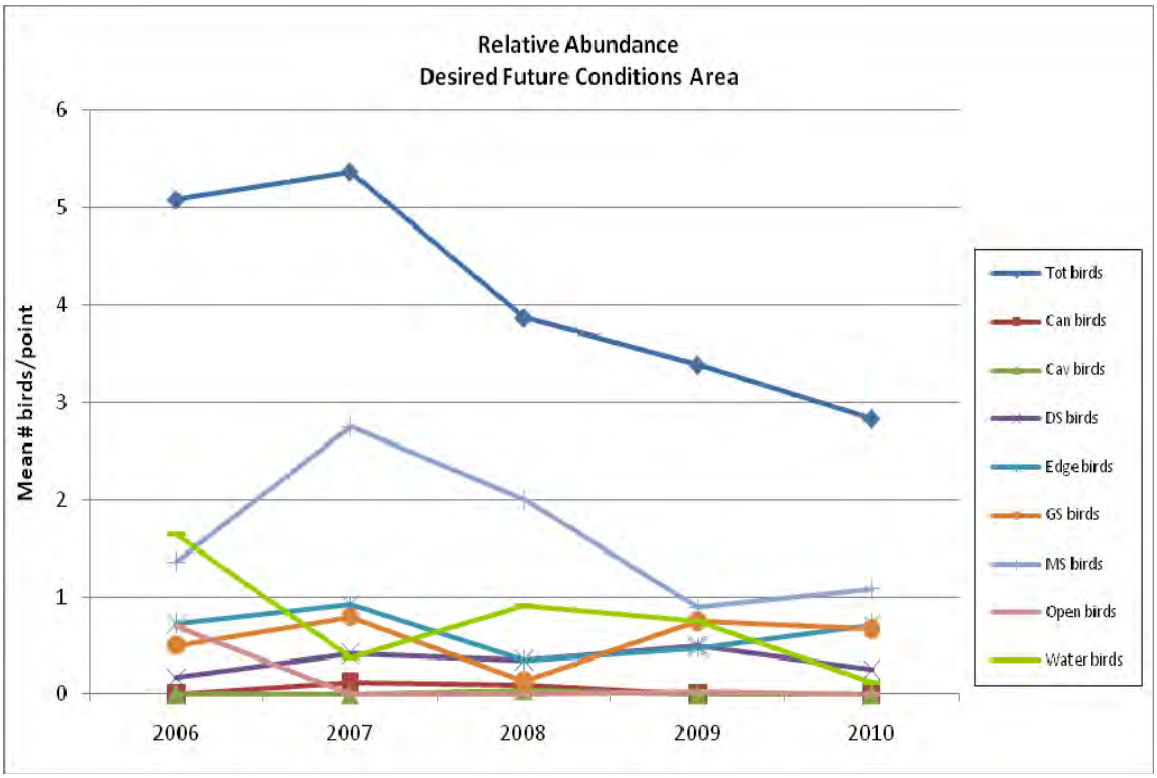


Figure 13.—Relative abundance by species guilds in the Desired Future Conditions Area over time.

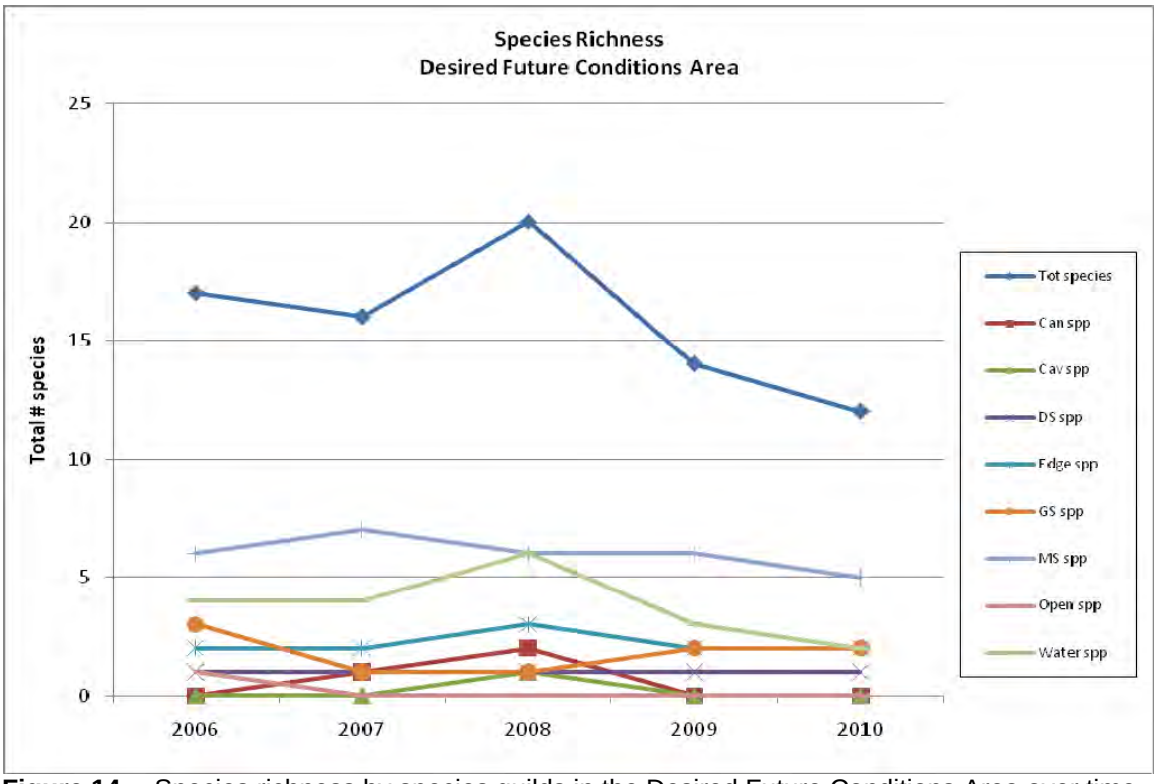


Figure 14.—Species richness by species guilds in the Desired Future Conditions Area over time.

In simple linear regression of abundance in relation to year, total, open, and water bird guilds showed a significant relationship or slope with $P \leq 0.05$ (Table 6). The linear trends for these species guilds within the Desired Future Conditions Area are plotted in Figure 15. Linear trends for all other guilds in the Desired Future Conditions Area are shown in Appendix C.

Table 6. —P and R^2 values for simple linear regression analysis between year and relative abundance by guild in the Desired Future Conditions Area. Alpha = 0.05.

Guilds	Desired Future Conditions Area 2006 to 2010	
	P	R^2
Total birds	0.000	0.2504
Canopy birds	0.330	0.0164
Cavity birds	1.000	0.0000
Dense shrub birds	0.901	0.0003
Edge birds	0.337	0.0159
Ground shrub birds	1.000	0.0000
Invasive birds	No inv. birds detected	
Mid-story birds	0.055	0.0620
Open birds	0.000	0.2952
Water birds	>0.001	0.2281

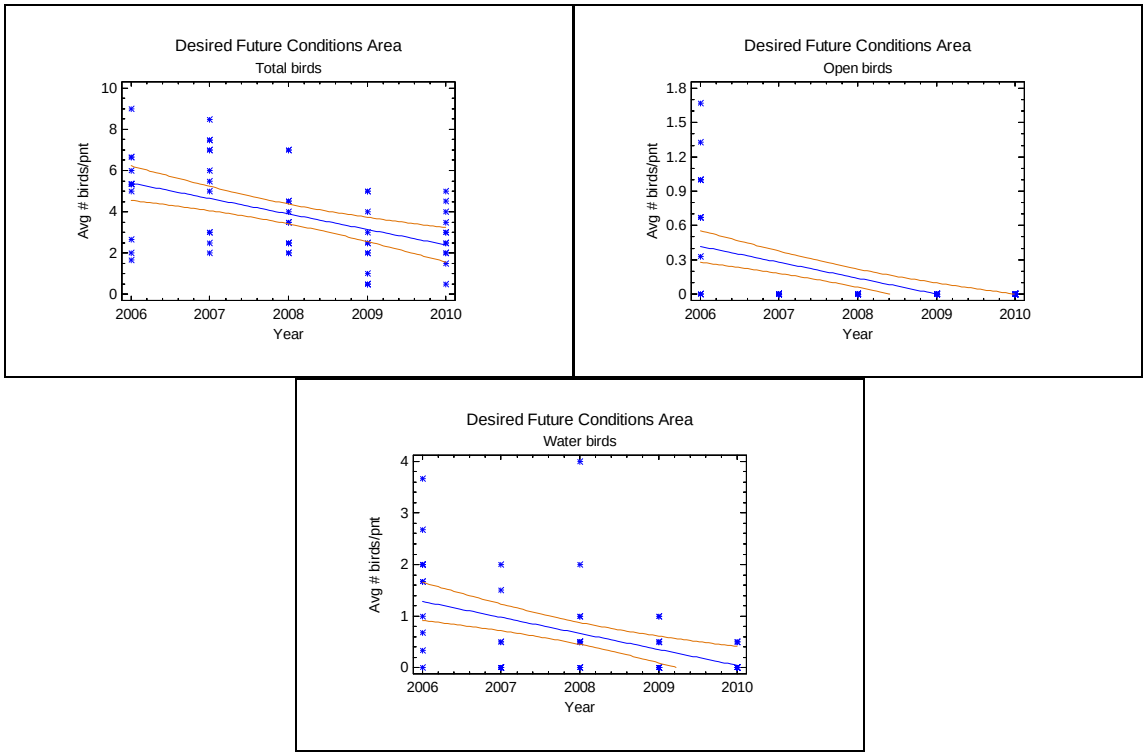


Figure 15.—Linear trend in average number of total, open, and water birds per point in relation to year (2006 to 2010) in the Desired Future Conditions Area. Points represent the average number of observations within 3 reps at each point in each year, straight blue line represents best-fitting trend, and red curving lines represent 95 percent confidence intervals.

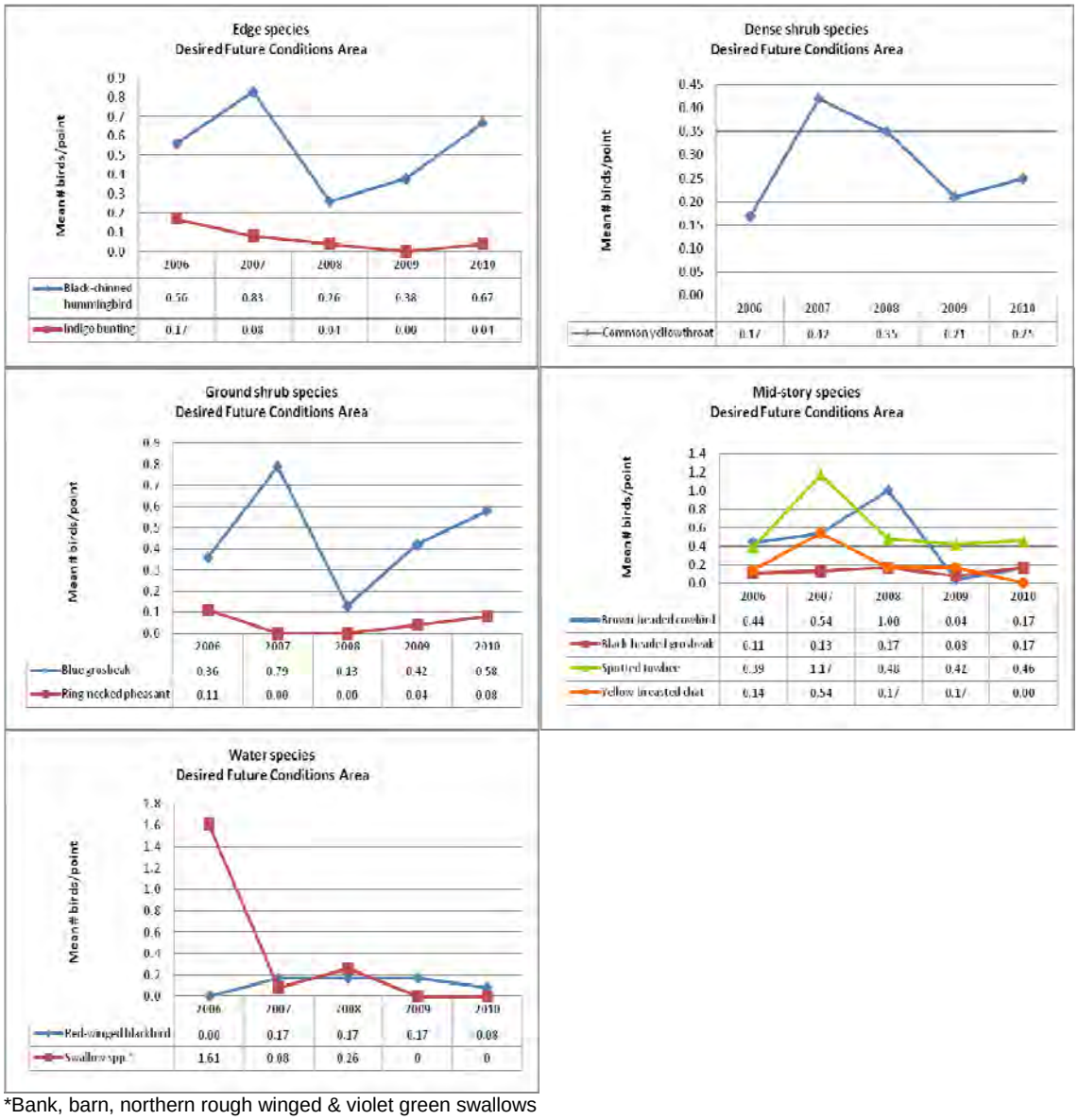
All of the guilds in which significant slopes were found showed decreasing trends in the relative abundance of birds detected. A relatively low R^2 value for the water bird species guild (R^2= 0.2281) indicated a weak relationship between abundance and year, with 23 percent of the variability in relative abundance that could be attributed to year. On the other hand, an R^2 value of 0.2504 (or 25 percent of the variability explained by the model) among total number of birds and R^2 of 0.2952 (30 percent) among open birds indicated a moderately strong relationship between year and relative abundance for these species.

The mean numbers of detections per point for the most common bird species within selected guilds in the Desired Future Conditions Area are graphed in Figure 16. Relative abundance of individual species followed various trends over the monitoring period and across all guilds. The most common pattern identified was a decrease in population from 2008 to 2009, although the individual birds within the ground shrub species increased during this time.

Based on results in the Desired Future Conditions Area, total and open bird guilds showed the strongest statistically supported trend among all guilds, with relative abundance of birds decreasing over time. Decreases in mid-story, open, and water birds contributed to significant drops in the total number of birds over the monitoring period. A number of barn swallows, which were the only open bird species documented at this site, were detected the first year of monitoring, but none have been recorded since, which explains the trend for this guild.

Comparisons between the Cleared/Overbank, Burned, and Desired Future Conditions Areas

The relative abundance (*i.e.* the average number of birds per point) was statistically compared between the three monitoring areas by year in which they were sampled and by species guilds (see Table 7 for statistical results and P-values). In 2003 and 2004, the Cleared/Overbank and Burned Areas were the only plots monitored and the Cleared/ Overbank Area had significantly fewer mean detections of total birds per point than the Burned Area. Within specific guilds, cavity and mid-story birds were significantly less in the Cleared/Overbank Area than in the Burned Area in these first few years of monitoring. There were significantly more water birds in the Cleared/Overbank Area, however, which isn't surprising given that the site was adjacent to the river and relatively open at that time. In 2005, the Cleared/Overbank Area was the only site that was monitored, therefore no comparisons between plots were made. In 2006, the Cleared/Overbank and Desired Future Conditions Area were monitored. That year there were significantly more total, edge, and ground birds and significantly less mid-story birds detected in the the Cleared/Overbank Area than in the Desired Future Conditions Area.



*Bank, barn, northern rough winged & violet green swallows

Figure 16.—Relative abundance of selected edge, dense shrub, ground shrub, mid-story, and water bird species in the Desired Future Conditions Area from 2006 to 2010.

Table 7.—Statistical comparisons of relative abundance between Areas by year and guild. Alpha =0.05.

Guilds	Year (Plots sampled)							
	2003 (Cleared vs Burned)	**2004 (Cleared vs Burned)**	**2005 (Cleared only)**	**2006 (Cleared vs Desired)**	**2007 (Cleared vs Burned vs Desired)**	**2008 (Cleared vs Burned vs Desired)**	**2009 (Cleared vs Burned vs Desired)**	**2010 (Cleared vs Burned vs Desired)**
Total birds	P<0.001[1] Burned>Cleared	P=0.004[1] Burned>Cleared	NA	P=0.036[2] Cleared>Desired	P=0.011[4] Burned>Desired	P=0.051[4]	P=0.000[3] Burned>Cleared Burned>Desired	P=0.050[3]
Canopy birds	P=0.275[2]	No canopy spp. in Cleared	NA	No canopy spp. in Desired	P=0.222[4]	P=0.128[4]	P<0.000[4] Burned>Cleared Burned>Desired	No canopy spp. in any plot
Cavity birds	P=0.006[2] Burned>Cleared	P=0.045[2] Burned>Cleared	NA	No cavity spp. in Desired	P<0.001[4] Burned>Cleared Burned>Desired	P=0.506[4]	P<0.000[4] Burned>Cleared Burned>Desired	P=0.003[4] Burned>Desired
Dense shrub birds	No dense shrub spp. in Cleared	P=0.938[2]	NA	P=0.997[1]	P=0.008[4] Cleared>Desired Cleared>Burned	P=0.048[3] Cleared>Burned	P=0.001[4] Cleared>Burned Cleared>Desired	P=0.052[4]
Edge birds	P=0.329[2]	P=0.346[1]	NA	P=0.015[1] Cleared>Desired	P=0.004[4] Burned>Cleared Burned>Desired	P=0.240[4]	P=0.000[3] Burned>Cleared Burned>Desired	P=0.008[3] Burned>Cleared Burned>Desired
Ground shrub birds	P=0.057[1]	P=0.660[1]	NA	P<0.001[2] Cleared>Desired	P=0.026[4] Cleared>Desired	P=0.001[3] Cleared>Desired Burned>Desired	P=0.324[4]	P=0.644[3]
Mid-story birds	P<0.001[2] Burned>Cleared	P<0.001[2] Burned>Cleared	NA	P=0.011[1] Desired>Cleared	P<0.001[3] Burned>Cleared Desired>Cleared	P=0.029[3] Burned>Cleared Burned>Desired	P=0.000[3] Burned>Cleared Burned>Desired	P=0.001[3] Burned>Desired Cleared>Desired
Open birds	P=0.578[2]	P=0.059[2]	NA	P=0.704[1]	P=0.368[4]	No opening spp. in any plot	P=0.368[4]	No opening spp. in any plot
Water birds	P<0.001[2] Cleared>Burned	P<0.001[2] Cleared>Burned	NA	P=0.733[1]	P=0.004[4] Cleared>Desired Cleared>Burned	P<0.001[4] Cleared>Desired Cleared>Burned	P=0.008[4] Cleared>Desired Cleared>Burned	P=0.543[4]

1=Student's t-test; 2=Mann-Whitney test of medians; 3= ANOVA; 4=Kruskal-Wallis test
Highlighted boxes = significant difference at the 95-percent confidence level

In 2007 through 2010 all three Areas were included in monitoring. When compared to the Cleared/Overbank Area, there was a significantly greater number of cavity, edge, and mid-story birds detected in the Burned Area in 2007, while there was a significantly greater number of mid-story birds detected in the Desired Future Conditions Area. There were significantly higher numbers of dense shrub and water birds in the Cleared/ Overbank Area than in either of the two reference areas in 2007. In 2008, a significantly greater number of dense shrub, ground shrub, and water birds were detected in the Cleared/Overbank Area than in the Burned and/or Desired Future Conditions Areas. There were, however, significantly more mid-story birds detected within the Burned Area this same year. In 2009, the Burned Area had significantly greater abundances of birds within the total, canopy, cavity, edge and mid-story species guilds than in the Cleared/Overbank and Desired Future Conditions Areas. The Cleared/Overbank Area had significantly higher abundances of birds within the dense shrub and water bird guilds than in the other two areas in 2009. In 2010, there were fewer differences detected between the areas. The Burned Area had significantly more cavity and mid-story bird species than the Desired Future Conditions Area, and significantly more edge bird species than both the Desired Future Conditions and Cleared/Overbank Areas. The Cleared/Overbank Area had significantly more mid-story bird species than the Desired Future Conditions Area. The total number of birds was barely statistically equal (P=0.050) between all three monitoring areas in 2010.

Using the two reference areas for comparison, it appeared that desirable bird habitat developed over time within the Cleared/Overbank Area. In 2008, relative abundance in this area became either statistically equal or greater than the other two areas within most guilds over the course of monitoring, with the exception of the mid-story guild, which had consistently greater abundance in the Burned Area. Despite the trend reverting in 2009, when the Burned Area showed greater numbers of birds in the majority of guilds, the Cleared/Overbank Area was again either statistically equal or greater than the two reference areas in 2010. The exception was among edge bird species; relative abundance within this guild was significantly greater in the Burned Area. Relative abundance of mid-story species was equal between the Cleared/Overbank and Burned Areas in 2010, and both of these areas had greater abundance of mid-story species than the Desired Future Conditions Area. Results indicated a desirable trend in vegetative development, with both treated areas (*i.e.* restored and burned) appearing to show promising potential for providing SWFL habitat. 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.

Comparisons of trendlines and R^2 values for relative abundance and species richness between all monitoring sites are shown in Figures 17 and 18, respectively. Note that the R^2 values listed here are generally higher than those analyzed within each area and each guild, in which data from all points were used. In this case, only one number – the average number of birds detected per year – was plotted, which decreased the variability and thus increased the R^2. These graphs are provided to show general trends, with R^2 as an indicator as to how well the linear model explained the data used. Notice, however, that the Cleared/Overbank Area had relatively low R^2 values. This is because although

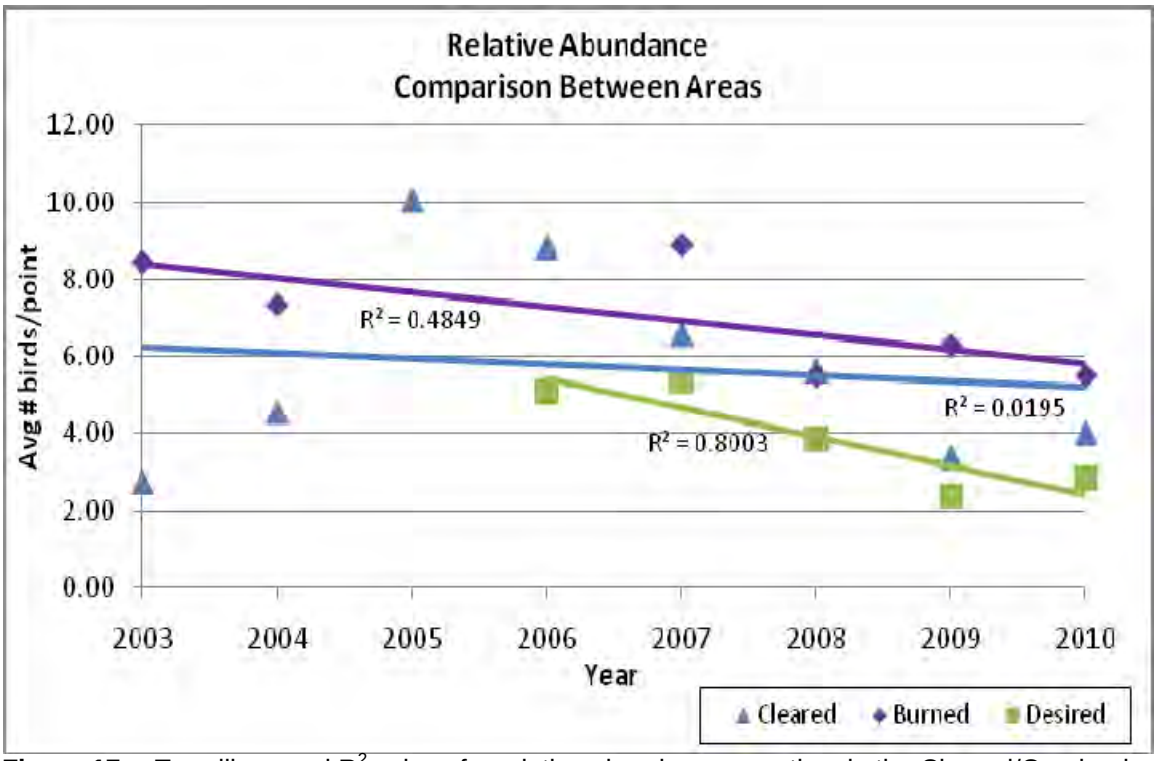


Figure 17.—Trendlines and R^2 values for relative abundance over time in the Cleared/Overbank Area (2003-2010), Burned Area (2003, 2004, 2007-2010), and Desired Future Conditions Area (2006-2010).

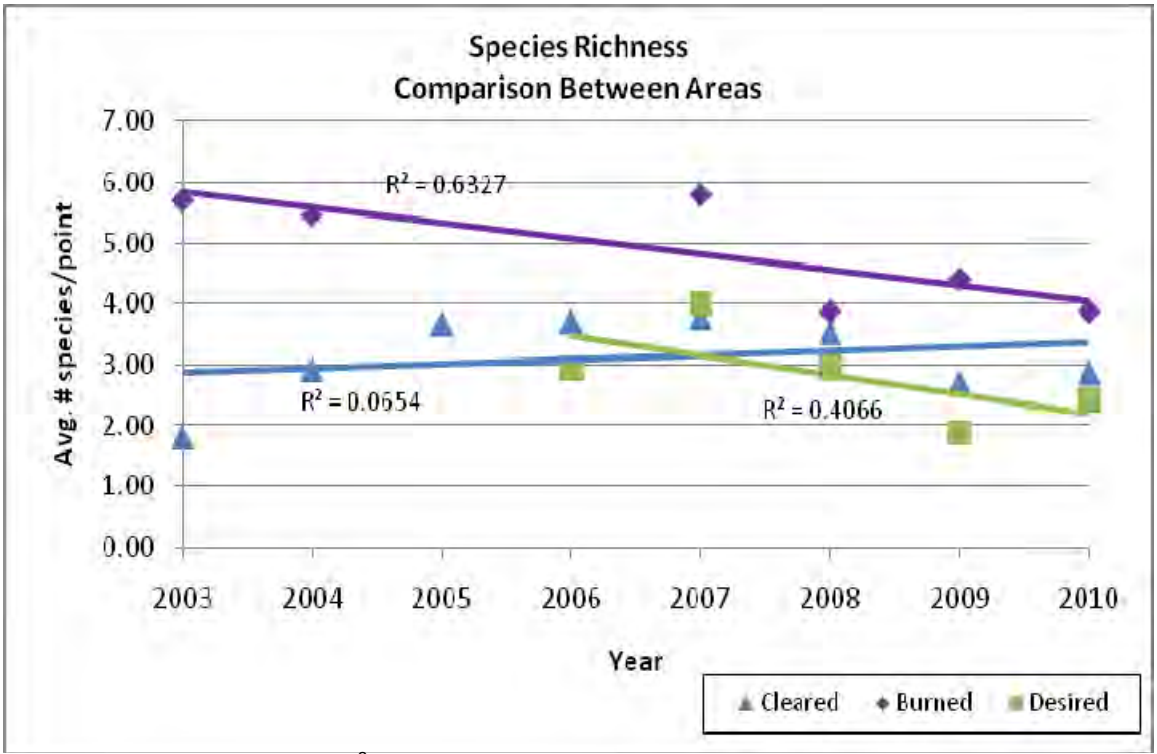


Figure 18.—Trendlines and R^2 values for species richness over time in the Cleared/Overbank Area (2003-2010), Burned Area (2003, 2004, 2007-2010), and Desired Future Conditions Area (2006-2010).

relative abundance and species richness were on a decreasing trend within this area in recent years (resulting in an overall decreasing trend in relative abundance), they have actually increased in numbers since monitoring began, a pattern that resulted in a weak relationship with time. None of the monitoring areas had increasing trendlines for relative abundance of birds detected over time. Only the Cleared/Overbank Area showed an increasing trendline for species richness over time.

As can be seen on the graphs, in terms of actual values the Burned Area had consistently higher numbers of birds than the other two areas. 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 and 5.08 in the Desired Future Conditions Area. This trend continued throughout the monitoring period with relative abundance of total birds in 2010 being 5.50 in the Burned Area, 4.03 in the Cleared/Overbank Area, and 2.83 in the Future Desired Conditions Area. Although relative abundance has been on a decreasing trend in the Cleared/Overbank Area since 2005, note that it was the only area to have actually increased in relative abundance over the entire monitoring period (*i.e.* from 2003 to 2010). This increase, however, was not determined to be statistically significant (P=0.139).

Southwestern Willow Flycatcher Surveys

Willow flycatcher survey forms and maps are shown in Appendix D. In 2010, 1 migrant SWFL was detected within the boundaries of the LLRS. There was a total of 4 SWFLs detected at areas within the Belen reach between the Los Lunas and Belen bridges (Figure 19). All detections were determined to be migrants and no territories were documented.

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 vegetation monitoring, the area has been productive in terms of developing native overstory habitat, and suitable SWFL breeding habitat in the LLRS could potentially be occupied in time if the current trend continues. It appears that small areas of highly suitable habitat currently exist within adjacent sites in the Belen reach. These sites were apparently unoccupied by breeding SWFLs. However, much of the riparian habitat in the Belen reach, including the LLRS, was suitable as stopover habitat for migrating SWFLs as confirmed by presence/absence surveys. The closest breeding populations that could serve as sources for SWFL dispersal into the Los Lunas site were 15 miles upstream at Isleta Pueblo or 35 miles downstream near the confluence of the Rio Puerco and Rio Grande.

Vegetation Monitoring

Of the 3 areas included in avian point count monitoring, the Cleared/Overbank Area was the only area where vegetation monitoring was conducted. 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 surrounding the Cleared/Overbank and Burned Areas. Monitoring of mixed shrub and cottonwood pole

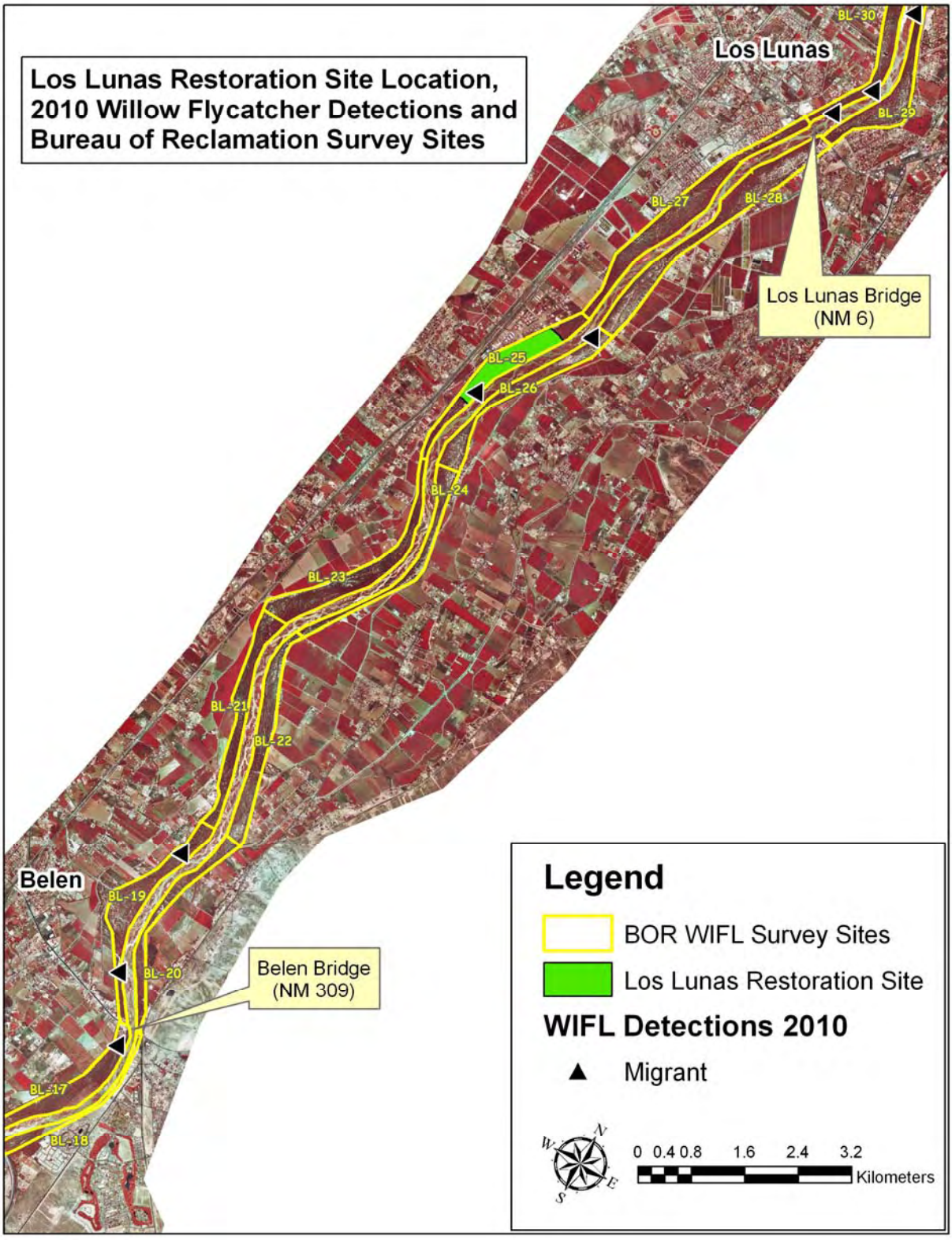
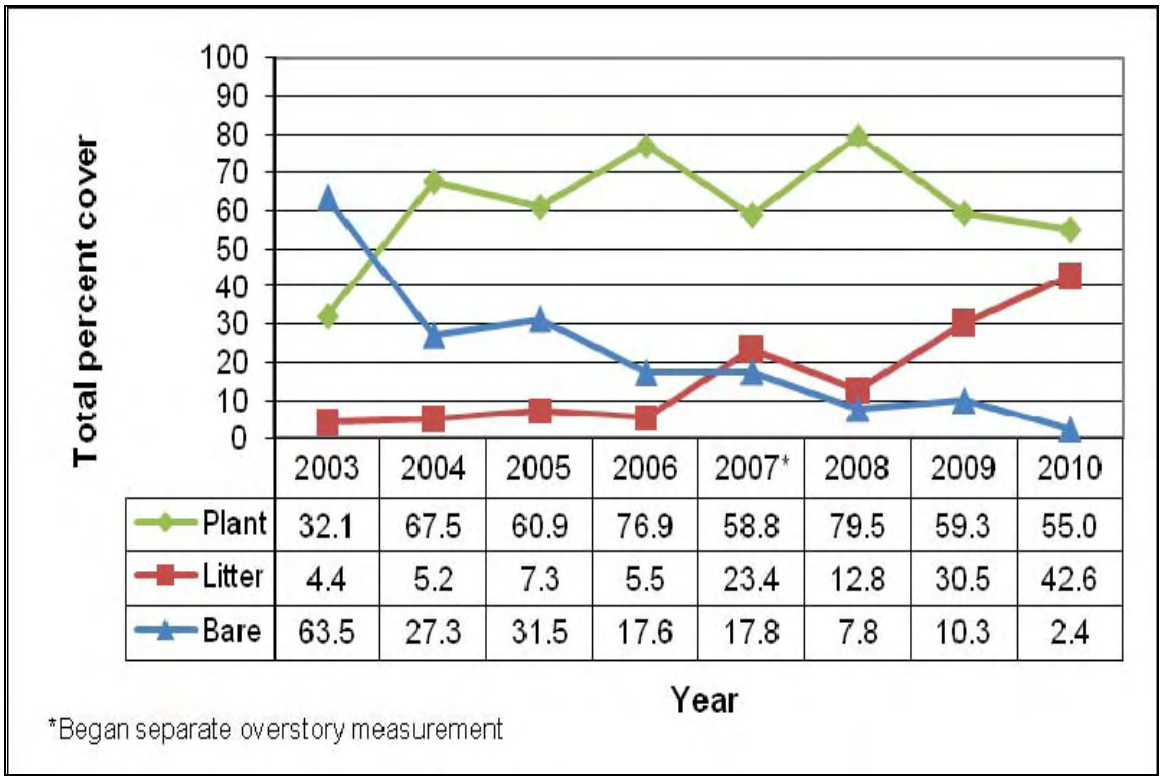


Figure 19.—SWFL detections in the Belen reach in the vicinity of LLRS.

plantings was discontinued once mortality/survivorship was documented.

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 herbaceous layer (*i.e.* understory) are shown in Table E-1 in Appendix E. Sixty-two annual and perennial species were detected in both the understory and over-story measurements during 8 years of vegetation monitoring in the Cleared/Overbank Area adjacent to the river. Species diversity increased from 18 species detected in 2003 to 42 in 2010.

Total plant cover (*i.e*. shrubs, grasses, and forbs) in the herbaceous layer was variable over the course of monitoring but showed an overall increase from 32.1 percent in 2003 to 55.0 percent in 2010 (Figure 20). This change was significant as indicated by statistical analysis comparing paired samples (refer to Table 8 for P-values). Mean differences and standard deviations of paired samples between years are shown in Table 9. Total cover of plant litter was 4.4 percent in 2003 and remained relatively stable until 2007, when it significantly increased to 23.4 percent, followed by a significant decrease to 12.8 percent in 2008. In 2010, plant litter peaked with a significant increase to 42.6 percent cover. Total cover of bare ground decreased significantly over the monitoring period, from 63.5 percent in 2003 to 2.4 percent in 2010.



	2003	2004	2005	2006	2007*	2008	2009	2010
Plant	32.1	67.5	60.9	76.9	58.8	79.5	59.3	55.0
Litter	4.4	5.2	7.3	5.5	23.4	12.8	30.5	42.6
Bare	63.5	27.3	31.5	17.6	17.8	7.8	10.3	2.4

Figure 20.—Total plant, litter, and bare ground cover in the herbaceous layer from 2003 to 2010.

Table 8.—Statistical comparison of paired samples between consecutive years and between the 1st year of monitoring (2003 for herbaceous; 2007 for overstory) and the last year (2010) for total cover of herbaceous plant, litter, bare soil, and overstory shrubs and for relative cover of life-forms. Alpha = 0.05.

Total cover	2003vs 2004	2004vs 2005	2005vs 2006	2006vs 2007	2007vs 2008	2008vs 2009	2009vs 2010	1stvs Last
Plant	03<04 P<0.001[1]	04=05 P=0.239[1]	05<06 P=0.021[2]	06>07 P<0.001[1]	07<08 P<0.001[1]	08>09 P<0.001[1]	09=10 P=0.173[1]	03<10 P<0.001[1]
Litter	03=04 P=0.240[2]	04=05 P=0.918[2]	05=06 P=1.0[2]	06<07 P=0.003[2]	07>08 P=0.002[1]	08<09 P<0.001[1]	09<10 P<0.001[1]	03<10 P<0.001[1]
Bare	03>04 P<0.001[1]	04=05 P=0.291[1]	05>06 P=0.023[2]	06=07 P=0.920[1]	07>08 P=0.001[1]	08=09 P=0.095[1]	09>10 P=0.003[1]	03>10 P=0.003[2]
Native shrub overstory	NA	NA	NA	NA	07<08 P<0.001[1]	08<09 P=0.001[1]	09>10 P=0.011[2]	07<10 P<0.001[1]
Introduced shrub overstory	NA	NA	NA	NA	07=08 P=0.121[1]	08<09 P=0.015[1]	09=10 P=1.00[2]	07<10 P=0.021[1]
Relative cover	**2003vs 2004**	**2004vs 2005**	**2005vs 2006**	**2006vs 2007**	**2007vs 2008**	**2008vs 2009**	**2009vs 2010**	**2003vs 2010**
Native shrub understory	03=04 P=0.418[2]	04<05 P=0.013[1]	05<06 P=0.005[1]	06>07 P<0.001[1]	07=08 P=0.512[1]	08=09 P=0.189[1]	09=10 P=0.851[1]	03=10 P=0.205[2]
Introduced shrub understory	03=04 P=1.0[2]	04<05 P=0.042[2]	05=06 P=0.083[2]	06>07 P=0.041[2]	07=08 P=1.0[2]	08=09 P=0.420[1]	09=10 P=0.317[1]	03<10 P=0.003[1]
Native grass	03=04 P=0.486[1]	04=05 P=0.690[1]	05>06 P=0.004[1]	06<07 P=0.002[1]	07=08 P=0.069[1]	08=09 P=0.368[1]	09<10 P=0.042[1]	03<10 P=0.040[1]
Introduced grass	03=04 P=0.292[1]	04=05 P=0.770[1]	05>06 P=0.025[1]	06=07 P=0.477[1]	07=08 P=0.430[1]	08>09 P=0.015[1]	09=10 P=0.365	03>10 P=0.009[1]
Native forb	03=04 P=0.744[1]	04=05 P=0.161[1]	05=06 P=0.863[1]	06=07 P=0.239[1]	07=08 P=0.526[1]	08=09 P=0.703[1]	09>10 P=0.026[1]	03=10 P=0.373[1]
Introduced forb	03=04 P=0.075[1]	04>05 P=0.020[1]	05<06 P=0.007[2]	06=07 P=0.243[1]	07>08 P=0.004[1]	08=09 P=0.915[1]	09=10 P=0.111[1]	03>10 P<0.001[1]
All native spp	03=04 P=0.239[1]	04=05 P=0.050[1]	05=06 P=0.079[1]	06<07 P=0.032[1]	07<08 P=0.017[1]	08<09 P=0.042[1]	09=10 P=0.120[1]	03<10 P<0.001[1]

[1]Paired t-test; [2]signed rank test

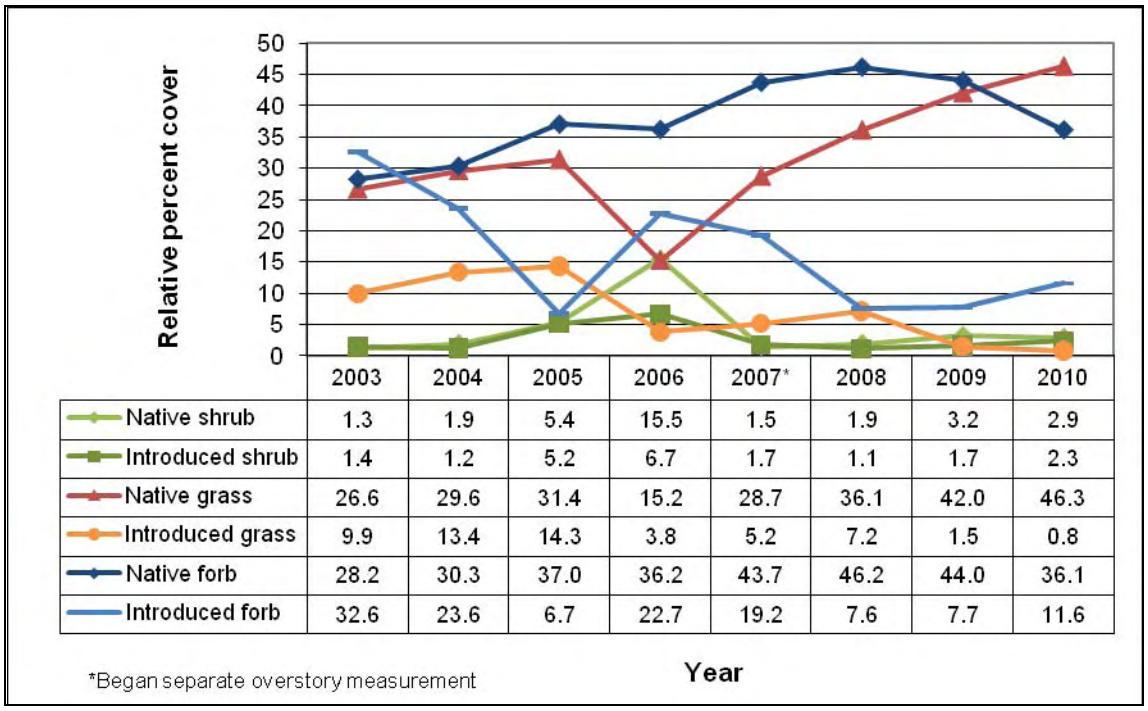
Highlighted boxes = significant difference at the 95% confidence level

Table 9.—Mean difference and standard deviation between paired samples comparing consecutive years and 1st year of monitoring (2003 for herbaceous; 2007 for overstory) and the last year (2010) of the study.

		03vs 04	04vs 05	05vs 06	06vs 07	07vs 08	08vs 09	09vs 10	1st vs Last
Total plant	**Mean**	-35.42	6.58	-16.00	18.17	-20.75	20.25	4.25	-22.92
	SD	14.82	18.31	19.19	9.37	12.12	10.05	10.12	14.84
Total litter	**Mean**	-0.75	-2.17	1.83	-17.92	10.67	-17.75	-12.08	-38.17
	SD	7.62	11.23	10.49	7.32	9.22	6.50	8.52	18.05
Total bare	**Mean**	36.17	-4.17	13.92	-0.25	10.08	-2.50	7.83	61.08
	SD	14.46	13.01	15.08	8.48	7.89	4.74	7.09	15.25
Native shrub overstory	**Mean**					-29.70	-28.18	16.92	-40.97
	SD	NA	NA	NA	NA	16.15	23.16	27.39	18.59
Introduced shrub overstory	**Mean**					-2.05	-4.30	0.53	-5.82
	SD	NA	NA	NA	NA	4.23	5.21	4.12	7.52
Native shrub understory	**Mean**	-0.64	-3.51	-10.06	14.00	-0.43	-1.26	0.28	-1.62
	SD	3.25	4.10	9.94	10.31	2.21	3.11	5.09	5.11
Introduced shrub understory	**Mean**	0.18	-4.01	-1.50	4.95	0.62	-0.55	-0.68	-10.20
	SD	1.56	7.08	7.43	8.52	2.66	2.27	2.26	9.22
Native grass	**Mean**	-2.96	-1.75	16.14	-13.48	-7.41	-5.95	-4.24	-19.65
	SD	14.23	14.82	15.38	11.42	12.76	21.94	6.40	29.19
Introduced grass	**Mean**	-3.46	-0.91	10.51	-1.38	-2.03	5.72	0.66	9.12
	SD	10.82	10.51	14.09	6.52	8.56	6.88	2.41	9.89
Native forb	**Mean**	-2.11	-6.73	0.85	-7.54	-2.43	2.18	7.86	-7.92
	SD	21.80	15.49	16.72	21.00	12.86	19.35	10.62	29.54
Introduced forb	**Mean**	8.96	16.92	-15.96	3.45	11.64	-0.13	-3.86	21.03
	SD	15.81	21.63	17.42	9.70	11.27	3.96	7.72	15.37
Native species	**Mean**	-5.72	-12.00	6.93	-6.98	-10.28	-5.03	3.88	-29.18
	SD	15.92	18.90	12.42	9.83	12.70	7.57	7.99	13.14

Relative plant cover by life-form in the understory from 2003 to 2010 is shown in Figure 21. Over the monitoring period, the proportion of introduced shrubs and native grasses significantly increased, while the proportion of introduced grasses and forbs significantly decreased (Table 8).

As of 2007, with the modification in methods, relative cover represented understory shrubs (<1 m). Take note that understory shrub cover data from 2006 was much higher than other years since shrubs over 1 m tall were not yet recorded separately and this was the point that shrubs began reaching greater heights, so all size classes of shrubs were included. When comparing the first year of monitoring to the last, there was not a significant difference between relative cover of native shrubs in 2003 at 1.3 percent and 2010 at 2.9 percent (Table 8). Relative cover of native shrubs in comparisons between consecutive years showed significant differences, however, with relative cover significantly increasing from 2004 to 2006, then decreasing from 2006 to 2007. This decrease was due to the change in data collection methodology in 2007. There was a statistical increase in relative cover of introduced shrubs between 2003 — at 1.4 percent — and 2010— at 2.3 percent. Relative cover of introduced shrubs increased significantly from 2004 to 2005, and decreased from 2006 to 2007 when comparing consecutive years, the decrease again due to the change in methodology. The regeneration of woody species, as represented by shrub cover in the herbaceous layer, has remained stable over time with native and introduced species being relatively close in cover values.



	2003	2004	2005	2006	2007*	2008	2009	2010
Native shrub	1.3	1.9	5.4	15.5	1.5	1.9	3.2	2.9
Introduced shrub	1.4	1.2	5.2	6.7	1.7	1.1	1.7	2.3
Native grass	26.6	29.6	31.4	15.2	28.7	36.1	42.0	46.3
Introduced grass	9.9	13.4	14.3	3.8	5.2	7.2	1.5	0.8
Native forb	28.2	30.3	37.0	36.2	43.7	46.2	44.0	36.1
Introduced forb	32.6	23.6	6.7	22.7	19.2	7.6	7.7	11.6

Figure 21.—Relative percent cover of life-forms in the herbaceous layer from 2003 to 2010.

Fragrant flatsedge, witchgrass, barnyard grass, and rabbitfoot grass consistently had the highest average cover among grass and grass-like species found during the sampling period from 2003 to 2005. By 2010, the most common grass species had shifted to predominately thin paspalum, followed by barley foxtail and Baltic rush. Total cover of native grasses increased from 8.0 percent to 25.0 percent from 2003 to 2010 (Table E-1). Total cover of introduced grasses remained somewhat stable but did decrease over time, from 2.9 percent in 2003 to 0.9 percent in 2010. The maximum cover of introduced grass species was 8.8 percent in both 2004 and 2005.

Relative cover of native grasses increased from 24.9 percent in 2003 to 46.3 percent in 2010 (Figure 21), which was a statistically significant change between the first and last years of monitoring (Table 8). Comparisons between consecutive years indicated a statistically significant decrease in 2006. Relative cover of introduced grasses decreased from 9.1 percent in 2003 to 0.8 percent in 2010, which was a significant decrease. Relative cover of introduced grasses between consecutive years showed a significant drop from 2005 to 2006 and from 2008 to 2009.

Native and introduced grasses followed similar patterns over time, with cover increasing gradually through 2005, then dropping considerably in 2006 with a rise again through 2008 that especially increased within the native grasses. In 2009 and 2010, the cover of native grasses continued to increase while introduced grasses decreased in cover, which is a desirable trend. Native species consistently had higher coverage than introduced species among grasses over the years.

The most common forb species shifted from sunflowers, lambsquarters, and white sweetclover in 2003 to spearleaf rabbitbrush, common cocklebur, and koshia in 2010.

Total cover of native forbs increased from 9.2 percent to 19.8 percent from 2003 to 2010 (Table 12). Introduced forbs decreased from 11.0 percent total cover to 7.0 percent over the sampling period, though there were highs of 17.8 percent cover in 2004 and 2006.

The percent cover of native forbs relative to other species showed no significant change from 28.3 percent in 2003 to 36.1 percent in 2010 (Table 8, Figure 21). There was a significant decrease from 2009 to 2010 when comparing relative cover of native forbs between consecutive years, although there was a gradual rise in cover over all years. Relative cover of introduced forbs decreased from 34.5 percent in the first year of monitoring to 11.6 percent in the last year, which was a significant change. There was a significant drop in the relative cover of introduced forbs in 2005, with a subsequent statistical increase in 2006. The relative cover of introduced forb again decreased significantly in 2008.

Native and introduced forbs showed opposite trends from each other. Relative cover of native forbs generally increased until 2008, then slightly decrease through 2010. Introduced forbs have continually decreased in cover over time, with substantial drops in 2005 and 2008. In 2010, relative cover of introduced forbs showed a slight increase. Flooding in the spring of 2005 appeared to effect composition and cover of forbs at the site. The significant decline of the introduced species in 2005 could be attributed to the inability of introduced species to adapt to flooded conditions. Native riparian species thrived, presumably because they are more tolerant of anaerobic conditions and because of less competition from exotic species. The following year, in the absence of flooding, the cover of introduced forb species increased significantly while native forb species had a small decrease. In 2008, relative cover of native forbs peaked, while cover of introduced forbs was at its lowest point since monitoring began, which could be related to relatively high discharge rates — the second highest recorded since monitoring began. The overall trend in relative cover of forbs was a general increase in native species and decrease in introduced species over time.

The change in methodology for collecting vegetation data that began in 2007 affected shrub values more than other vegetation types. The 2007 through 2010 shrub understory data (see Table E-1) were most comparable to the first 2 to 3 years of data collection — when shrub species were generally less than a meter tall — and provided an indication of current regeneration of shrub species at the site. The 2007 through 2010 overstory data (Table 10) were more comparable to the 2006 total herbaceous shrub cover data (Table E-1), when woody plant species were taller and were often the first plant that was intercepted during data collection, giving a pretty complete record of shrub species but not necessarily of the herbaceous species. The average height of the tallest overstory shrubs within each stretch by species is also shown in Table 10.

Coyote willow and saltcedar were the only two shrub species detected every year since vegetation monitoring began in 2003. In 2010, cottonwood was the dominant woody species in the overstory canopy (Table 10) and coyote willow was the dominant woody species, followed closely by saltcedar, in the understory based on total cover (Table E-1).

Table 10.—Total percent cover and average height of woody overstory species (>1 m) from 2007 to 2010.

	2007		2008		2009		2010	
Woody plant species	**Total % cover**	**Avg height (m)**	**Total % cover**	**Avg height (m)**	**Total % cover**	**Avg height (m)**	**Total % cover**	**Avg height (m)**
Coyote willow	7.4	1.6	23.9	2.1	35.8	2.4	24.8	2.3
Goodding willow	0.3	1.6	0.9	2.4	1.5	2.9	1.0	3.3
Cottonwood	15.0	2.3	27.7	3.1	43.4	4.6	37.9	4.9
Total native shrubs	22.7		52.5		80.7		63.8	
Saltcedar	4.3	2.3	5.8	2.2	9.7	2.8	8.7	2.7
Russian olive	0.6	2.9	1.1	3.4	1.6	3.9	1.9	5.2
Total introduced shrubs	4.9		6.9		11.3		10.6	
Total shrub cover (accounting for overlap)	25.9		51.1		57.2		52.9	

Total cover of shrubs in Table 8 represents the overstory (>1 m), which wasn't measured as a separate layer until 2007. The total cover of native overstory species significantly increased over time, expanding from 22.7 percent in 2007 to 63.8 percent in 2010 (Table 10). Total cover of introduced shrubs was significantly lower in 2007, at 4.9 percent, than in 2010, at 10.6 percent. The overall transect canopy cover when accounting for overlap of species showed a relatively large increase from 2007 to 2008 — from 25.9 percent to 51.1 percent — but only increased slightly to 52.9 percent in 2010. So although the wooded sections became denser, they didn't expand considerably in area over the last few years of monitoring.

When comparing total cover of native shrubs between consecutive years, there were significant increases every year from 2007 to 2009, but significantly decreased from 2009 to 2010 (Table 8). Comparisons of total cover of introduced shrubs between consecutive years indicated a significant increase in 2009.

Both native and introduced shrubs have followed a similar pattern over time, steadily increasing in total cover through 2009 and decreasing in 2010. Total cover of native shrubs increased at much greater rates than introduced shrubs, however, which was a good indication of the development of healthy native habitat.

Since the onset of vegetation monitoring, the majority of plant species have been composed of native species rather than introduced in both the herbaceous and overstory layers (Table 11). There was a significant increase in the proportion of native herbaceous plant species when comparing the first year of monitoring (56.1 percent) to the last (85.3 percent; Table 8). The native species understory composition increased significantly from 2006 to 2009 when comparing consecutive years. The majority of the native

Table 11.—Proportion of native and introduced species in the herbaceous and overstory layers by year.

	Relative Percent Cover			
	Herbaceous layer		Overstory layer	
Year	Native spp	Introduced spp	Native spp	Introduced spp
2003	56.1	43.9	NA	NA
2004	61.8	38.2	NA	NA
2005	73.8	26.2	NA	NA
2006	66.9	33.1	NA	NA
2007	73.9	26.1	82.6	17.4
2008	84.1	15.9	88.5	11.5
2009	89.2	10.8	87.7	12.3
2010	85.3	14.7	85.7	14.3

understory vegetative cover was composed of thin paspalum, spearleaf rabbitbrush, and barley foxtail. While the relative cover of introduced overstory shrub species (which includes saltcedar and Russian olive) decreased from 17.4 to 14.3 percent over the monitoring period, relative cover of native species increased slightly, from 82.6 to 85.7 percent. The total percent cover of saltcedar after 7 years of monitoring was 1.1 percent in the understory (an indicator of the rate of regeneration) and 8.7 percent in the overstory. Even with gradual increases in total percent cover over the monitoring period, cover of saltcedar was still low compared to other areas adjacent to the site. The large increase in plant cover and concurrent drop in bare soil over time was also a favorable trend for the site, helping to stabilize soil and reduce erosion.

Perennial pepperweed was documented at the site in 2003 and 2004, but inundation appeared to eradicate the species in 2005. The noxious weed was again detected in 2006 but was not documented again until 2009. 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, occurrences of perennial pepperweed within the monitoring site appeared to have increased. There was a substantial increase in total cover within transects — from minor detections in previous years to 2.3 percent in 2010. A patch was detected between transects 2 and 3 and pepperweed fell within transect 3. The patch between transects 3 and 4 had grown to approximately 2 acres in size.

Ground Water 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 Appendix F. Data from the northern, middle, and southern wells were combined across transects to get an average depth per transect per month. These data were used to create a hydrograph that also included river discharge at the Rio Grande floodway in San Acacia, New Mexico (Figure 22).

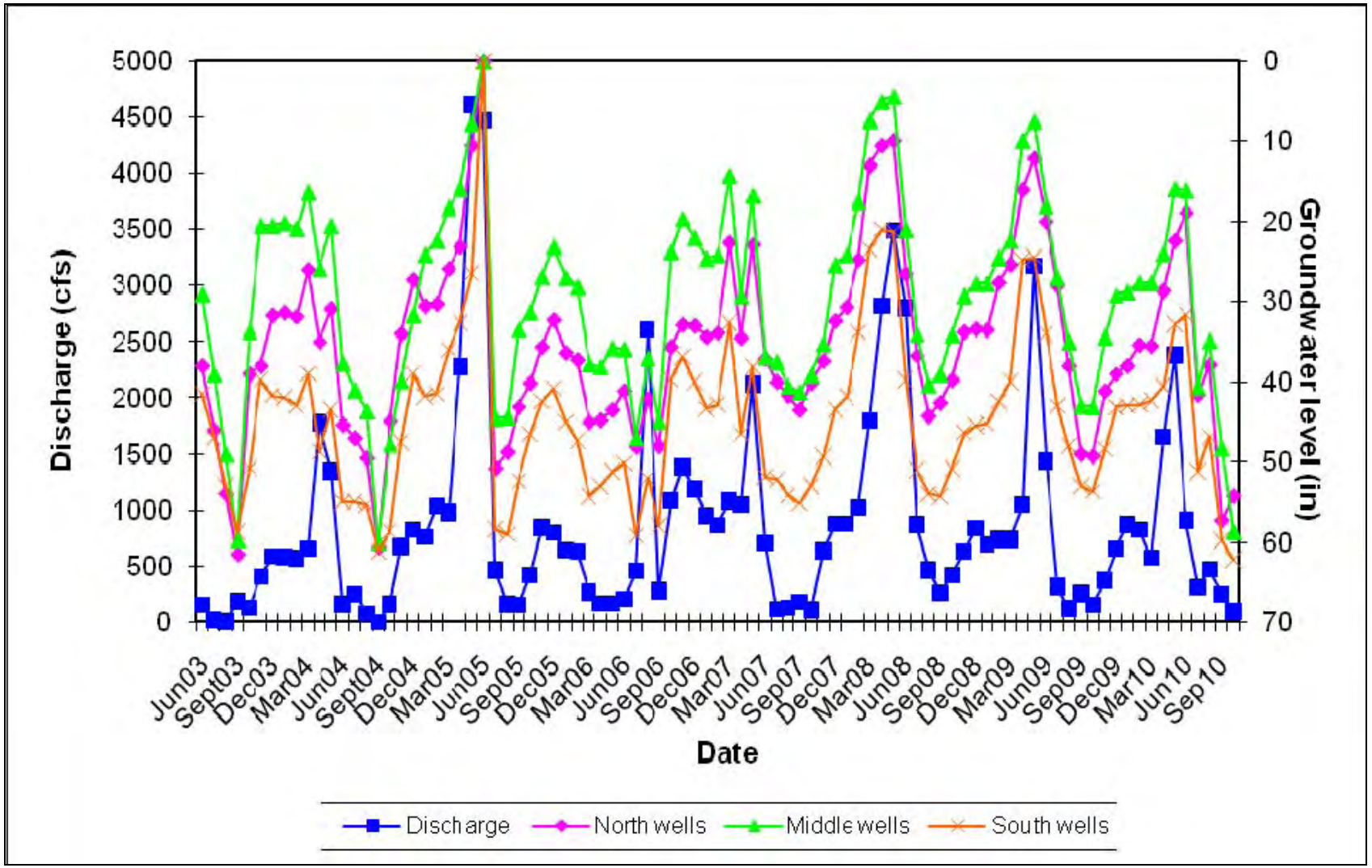
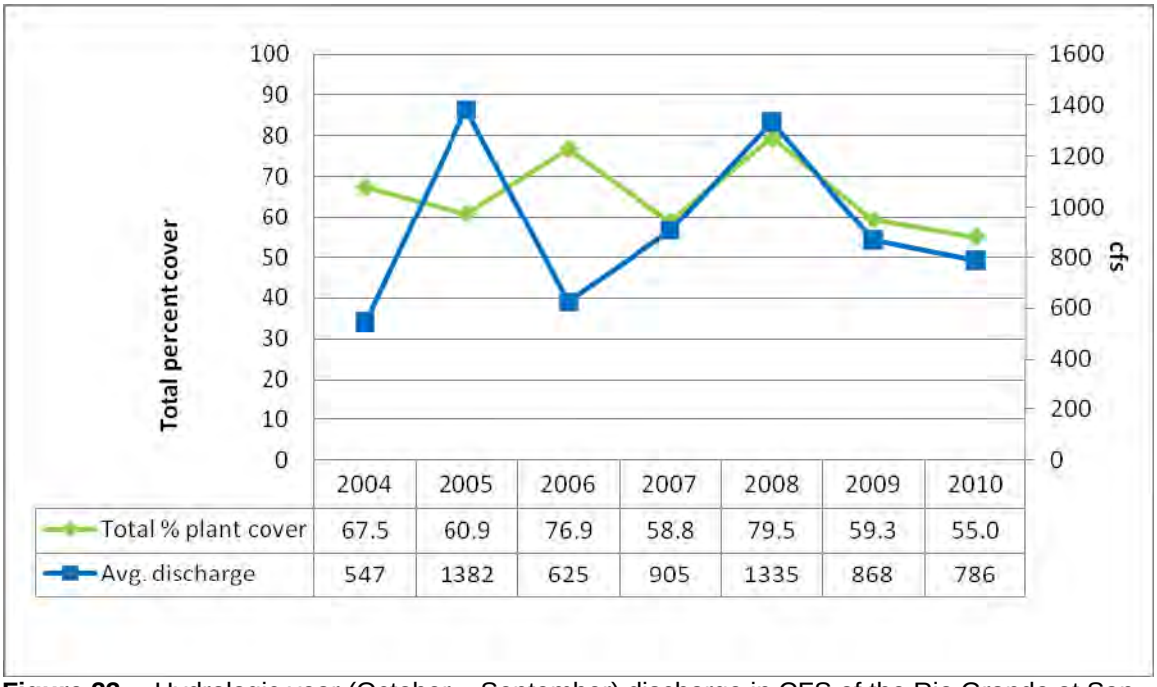


Figure 22.—Discharge in CFS (cubic ft/sec) of the Rio Grande at San Acacia, New Mexico, and average ground water levels in inches at the LLRS, New Mexico.

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. Hydrologic records were valuable in explaining trends in vegetation (Figure 23). There were shifts in vegetation composition 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. 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 vegetative cover.



	2004	2005	2006	2007	2008	2009	2010
Total % plant cover	67.5	60.9	76.9	58.8	79.5	59.3	55.0
Avg. discharge	547	1382	625	905	1335	868	786

Figure 23.—Hydrologic year (October – September) discharge in CFS of the Rio Grande at San Acacia, New Mexico, and the average total percent plant cover in transects at the LLRS, New Mexico.

Photo Stations

Photos taken from 2003 through 2010 are shown for comparison purposes in Appendix G.

Photos taken at Stations 1 through 5, which are located along the berm and face east toward the river, show considerable growth in the regenerating willow and cottonwood, particularly from 2005 to 2006 and from 2007 to 2009. The decrease in sunflowers over time is also apparent from the photos. In photos taken at Stations 6 – 10, which are located along the road and face east, the density of standing dead cottonwoods in the burned forest has noticeably decreased over the years as the growth of regenerating understory has increased. During 2010 monitoring, which was conducted September 21

and 22, it was observed that leaves were already turning yellow and beginning to fall from the vegetation, which may have been due to a relatively dry year (Figure 22). This condition is apparent in photos from 2010.

Conclusion and Recommendations

Avian Monitoring

Conclusions

Avian relative abundance and species richness data have been collected over an 8 year 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 Area where established stands of riparian vegetation bordering high flow channels is the desired future condition.

Based on data from the three monitoring areas, there appeared to be a general decline in the relative abundance of total bird species. Trendlines showed overall decreases in bird abundance in the Burned and Desired Future Conditions Areas over the study period. Although the relative abundance of total birds has increased slightly in the Cleared/ Overbank Area since monitoring began, it has been on a decreasing trend since peaking in 2005. The number of total birds was closely linked to the number of water birds in this Area until approximately 2010. For example, the number of water birds peaked in 2005, when the LLRS was flooded, as did total birds. Following restoration, the Cleared/ Overbank Area was more open, and being adjacent to the river, attracted many water birds. As vegetation in this Area developed, habitat was less conducive to water birds. In 2010, mid-story birds increased, and there was a slight increase in total birds as well. Further monitoring will determine if total birds will be more closely linked to mid-story birds with the development of this habitat type.

The abundance and diversity of breeding dense shrub, ground shrub, and mid-story bird species in the Cleared/Overbank Area have increased during monitoring. The mid-story guild serves as an indicator for SWFL habitat. The number of mid-story species detections per point increased at the Cleared/Overbank Area over time. Although detections were still lower than the Burned Area, they were higher than those in the Future Desired Conditions Area. The fact that both of the Cleared/Overbank and Burned Areas had a statistically greater abundance of mid-story species than the Desired Future Conditions Area indicated a desirable trend in vegetative development in the treated areas (*i.e.* restored and burned). These treated areas appeared 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.

Recommendations

TSC recommends continuing avian monitoring. Studies in 2011 should include vegetation quantification monitoring similar to methodology used to evaluate existing SWFL nest sites in the Elephant Butte Reservoir area downstream (Moore 2007). The data collected at the LLRS site would be compared to Elephant Butte data to determine if habitat is suitable for breeding SWFLs, or is at least developing into suitable habitat.

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. Coyote willow, Gooddings willow, and Rio Grande cottonwood – all native – were the dominant overstory species. The wetland indicator status of both willows is "obligate wetland" (*i.e.* probability of occurring in wetlands is approximately 99 percent) and the status of the cottonwood is "facultative wetland" (*i.e.* probability of occurring in wetlands is approximately 67-99 percent) based on the USFWS wetland indicator categories for New Mexico (USDA NRCS 2011). In the herbaceous layer, native species also dominated the vegetation, although were not necessarily considered riparian plants. The native grass thin paspalum, for example, was the most common herbaceous species detected at the site and is in the "upland" wetland indicator category. Plant species found in depressions, however, were categorized as "obligate wetland" (e.g. Baltic rush, common spikerush, and American threesquare) or as "facultative wetland" (e.g. fragrant flatsedge, common reed, and sword-leaved rush).

As of 2010, large patches of perennial pepperweed were detected within the LLRS. Occurrences of the noxious weed had expanded from previous years. Saltcedar, although present at the site, had relatively low cover values over the monitoring period and did not appear to be competitive with native overstory species.

Recommendations

Monitoring should be continued at the established vegetation transects. Besides collecting transect data using the current methodology, vegetation quantification monitoring similar to methodology used to evaluate existing SWFL nest sites in the Elephant Butte Reservoir area downstream should be conducted as described above in Recommendations for avian monitoring.

Ground Water Monitoring

Conclusions

Data from the 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 the development of plant communities at the site.

Recommendations

Well monitoring data through 2010 was sufficient to determine the hydrologic system and association with vegetation at the LLRS. Ground water monitoring will be discontinued.

Photo Stations

Conclusions

Changes in the vegetation at the LLRS are evident in photos taken over the 8 years of monitoring. Shifts in plant composition and growth stages of regenerating willow and cottonwood were visually documented.

Recommendations

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

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Appendix A

Bird Species Detected During Point Counts and Associated Habitat Guilds

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

SPECIES	Scientific name	Canopy	Cavity	Dense shrub	Edge	Ground shrub	Invasive	Mid-story	Open-ing	Water
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-chinned hummingbird	*Archilochus alexandri*				X					
Black-capped chickadee	*Poecile atricapillus*		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					
Brown-headed cowbird	*Molothrus ater*							X		
Cassin’s finch	*Carpodacus cassinii*	X								
Cattle egret	*Bubulcus ibis*									X
Cliff swallow	*Petrochelidon pyrrhonota*									X
Common bushtit	*Psaltriparus minimus*							X		
Common grackle	*Quiscalus quiscula*				X					
Common yellowthroat	*Geothlypis trichas*			X						
Cooper’s hawk	*Accipiter cooperii*	X								
Downy woodpecker	*Picoides pubescens*		X							
European starling	*Sturnus vulgaris*						X			
Gadwall	*Anas strepera*									X
Gambel's quail	*Callipepla gambelii*					X				
Gray catbird	*Dumetella carolinensis*							X		
Great-blue heron	*Ardea herodias*									X
Great-horned owl	*Bubo virginianus*				X					
Great-tailed grackel	*Quiscalus mexicanus*	X								

SPECIES	Scientific name	Canopy	Cavity	Dense shrub	Edge	Ground shrub	Invasive	Mid-story	Open-ing	Water
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						
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
Red-tailed hawk	*Buteo jamaicensis*	X								
Red-winged blackbird	*Agelaius phoeniceus*									X
Ring-necked pheasant	*Phasianus colchicus*					X				
Sandhill crane	*Grus canadensis*									X
Say's phoebe	*Sayornis saya*				X					
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								
Turkey vulture	*Cathartes aura*	X								
Unidentified swallow										X
Violet-green swallow	*Tachycineta thalassina*									X
Western kingbird	*Tyrannus verticalis*				X					
Western tanager	*Piranga ludoviciana*	X								
Western wood pewee	*Contopus sordidulus*	X								

SPECIES	Scientific name	Canopy	Cavity	Dense shrub	Edge	Ground shrub	Invasive	Mid-story	Open-ing	Water
White-breasted nuthatch	*Sitta carolinensis*		X							
White-winged dove	*Zenaida asiatica*							X		
Yellow warbler	*Dendroica petechia*			X						
Yellow-breasted chat	*Icteria virens*							X		

Appendix B

Relative Abundance of Individual Bird Species by Area

Table B-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		2009 n=36		2010 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)**
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)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
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)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
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)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
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)	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)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
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)	2.8	0.03 (0.17)	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)	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)	33.3	0.36 (0.54)	44.4	0.53 (0.65)
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)	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)	22.2	0.22 (0.42)	33.3	0.50 (0.81)
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)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
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)	13.9	0.17 (0.45)	11.1	0.11 (0.32)
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)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
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)	2.8	1.25 (7.50)	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)	8.3	0.17 (0.61)	36.1	0.61 (0.96)
Bushtit	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	0.11 (0.67)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	2.8	0.17 (1.00)
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)	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)	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)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
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)	47.2	0.50 (0.56)	25.0	0.25 (0.44)

Cleared/over bank area	2003 n=24		2004 n=24		2005 n=24		2006 n=24		2007 n=36		2008 n=36		2009 n=36		2010 n=36	
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)	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)	0.0	0.00 (0.00)	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)	2.8	0.03 (0.17)	5.6	0.06 (0.23)
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)	5.5	0.06 (0.23)	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)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
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)	0.0	0.00 (0.00)	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)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
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)	8.3	0.17 (0.56)	5.6	0.11 (0.52)
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)	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)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
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)	2.8	0.03 (0.17)	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)	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)	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)	5.5	0.06 (0.23)	2.8	0.22 (1.33)
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)	0.0	0.00 (0.00)	8.3	0.11 (0.40)
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)	25.0	0.42 (0.87)	25.0	0.33 (0.63)
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)	0.0	0.00 (0.00)	8.3	0.08 (0.28)
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)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
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)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
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)	41.7	0.58 (0.81)	8.3	0.17 (0.70)
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)	0.0	0.00 (0.00)	2.8	0.03 (0.17)
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)	0.0	0.00 (0.00)	0.0	0.00 (0.00)

Cleared/over bank area	**2003 n=24**		**2004 n=24**		**2005 n=24**		**2006 n=24**		**2007 n=36**		**2008 n=36**		**2009 n=36**		**2010 n=36**	
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)	2.8	0.03 (0.17)	0.0	0.00 (0.00)
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)	2.8	0.03 (0.17)	0.0	0.00 (0.00)
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)	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)	33.3	0.39 (0.60)	55.6	0.64 (0.64)
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)	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)	25.0	0.33 (0.64)	2.8	0.08 (0.50)	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)	25.0	0.38 (0.71)	2.8	0.03 (0.17)	8.3	0.17 (0.61)	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)	5.5	0.11 (0.46)	2.8	0.03 (0.17)
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)	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)	2.8	0.03 (0.17)	0.0	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)	0.00	0.00 (0.00)	2.8	0.03 (0.17)
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)	2.8	0.03 (0.17)	5.6	0.06 (0.23)

Table B-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	
Species	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)

Burned area	**2003 n=42**		**2004 n=47**		**2007 n=36**		**2008 n=36**		**2009 n=36**		**2010 n=36**	
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)
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)
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)
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
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)

Table B-3.— Relative abundance of individual bird species in the Desired Future Conditions Area.

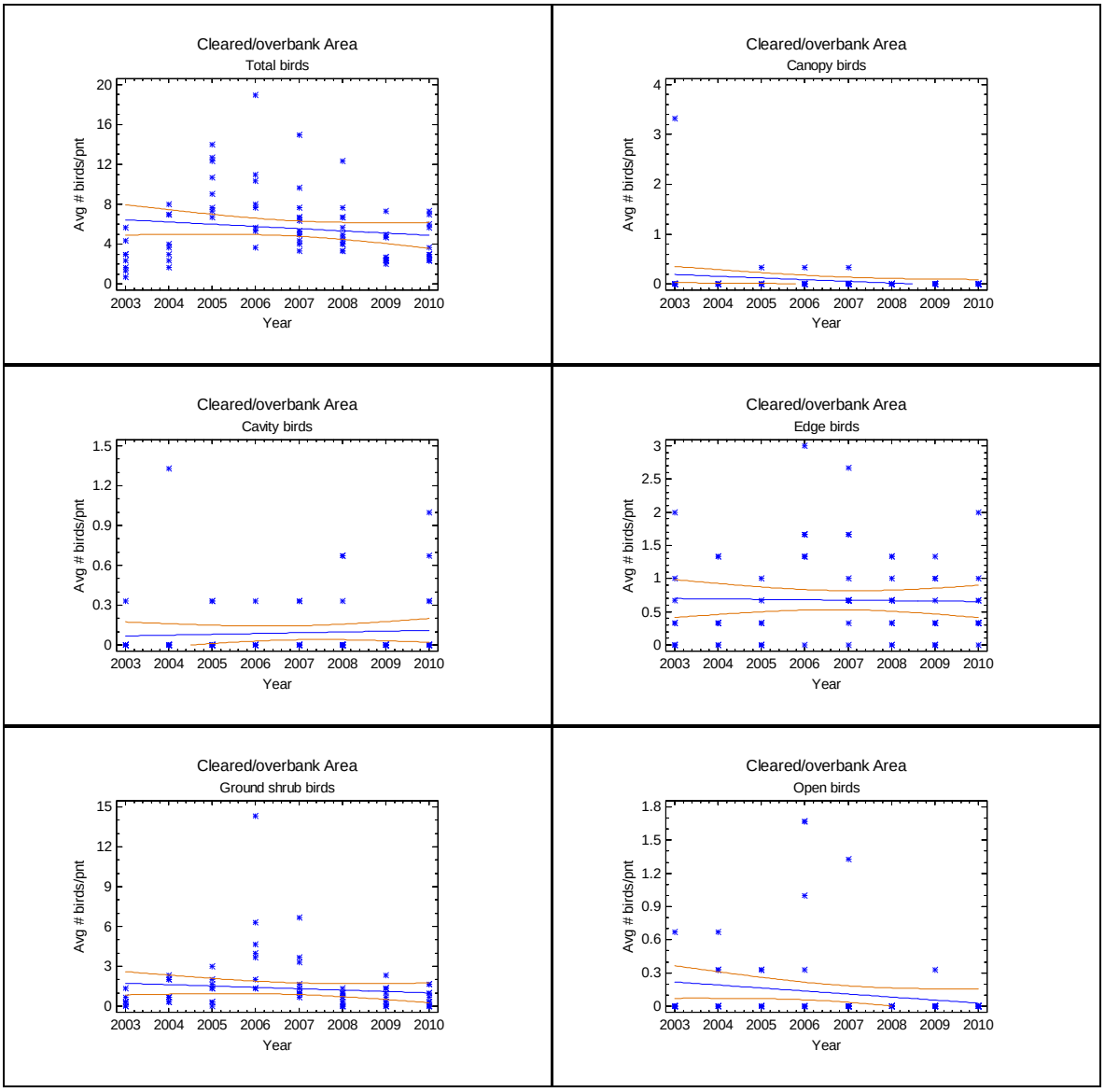
Desired conditions area	2006 n=36		2007 n=24		2008 n=23		2009 n=24		2010 n=24	
Species	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**	**% Plots**	**Mean (SD)**
Bank swallow	19.4	0.50 (1.13)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Barn swallow	30.6	0.69 (1.14)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Bewick's wren	0.0	0.00 (0.00)	0.0	0.00 (0.00)	4.3	0.04 (0.21)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Black-chinned hummingbird	38.9	0.56 (0.77)	66.7	0.83 (0.70)	26.1	0.26 (0.45)	29.2	0.38 (0.65)	54.2	0.67 (0.70)
Black-headed grosbeak	5.6	0.11 (0.52)	8.3	0.13 (0.45)	17.4	0.17 (0.39)	8.3	0.08 (0.28)	16.7	0.17 (0.38)
Blue grosbeak	27.8	0.36 (0.64)	62.5	0.79 (0.72)	13.0	0.13 (0.34)	25.0	0.42 (0.78)	45.8	0.58 (0.72)
Brown-headed cowbird	25.0	0.44 (0.84)	41.7	0.54 (0.72)	60.9	1.00 (1.13)	4.2	0.04 (0.20)	16.7	0.17 (0.38)
Bushtit	5.6	0.22 (0.96)	4.2	0.08 (0.41)	4.3	0.04 (0.21)	4.2	0.13 (0.61)	4.2	0.21 (1.02)
Common yellowthroat	13.9	0.17 (0.45)	33.3	0.42 (0.65)	30.4	0.35 (0.57)	20.8	0.21 (0.41)	25.0	0.25 (0.44)
Cooper's hawk	0.0	0.00 (0.00)	0.0	0.00 (0.00)	4.3	0.04 (0.21)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Gray catbird	5.6	0.06 (0.23)	16.7	0.21 (0.51)	8.7	0.13 (0.46)	8.3	0.13 (0.45)	8.3	0.08 (0.28)
Great blue heron	0.0	0.00 (0.00)	0.0	0.00 (0.00)	4.3	0.04 (0.21)	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)	8.7	0.09 (0.29)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Indigo bunting	11.1	0.17 (0.51)	8.3	0.08 (0.28)	4.3	0.04 (0.21)	0.0	0.00 (0.00)	4.2	0.04 (0.20)
Lazuli bunting	0.0	0.00 (0.00)	0.0	0.00 (0.00)	4.3	0.04 (0.21)	8.3	0.08 (0.28)	0.0	0.00 (0.00)
Lesser goldfinch	0.0	0.00 (0.00)	4.2	0.08 (0.41)	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)	4.3	0.30 (1.46)	4.2	0.08 (0.41)	0.0	0.00 (0.00)
Mourning dove	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)
Northern rough-winged swallow	0.0	0.00 (0.00)	4.2	0.08 (0.41)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Red-winged blackbird	0.0	0.00 (0.00)	8.3	0.17 (0.64)	17.4	0.17 (0.39)	12.5	0.17 (0.48)	8.3	0.08 (0.28)
Ring-necked pheasant	11.1	0.11 (0.32)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	4.2	0.04 (0.20)	8.3	0.08 (0.28)
Sandhill crane	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)
Snowy egret	0.0	0.00 (0.00)	4.2	0.04 (0.20)	0.0	0.00 (0.00)	4.2	0.04 (0.20)	4.2	0.04 (0.20)
Spotted sandpiper	0.0	0.00 (0.00)	4.2	0.08 (0.41)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Spotted towhee	36.1	0.39 (0.55)	79.2	1.17 (0.87)	43.4	0.48 (0.59)	37.5	0.42 (0.58)	45.8	0.46 (0.51)

Desired conditions area	**2006 n=36**		**2007 n=24**		**2008 n=23**		**2009 n=24**		**2010 n=24**	
Summer tanager	2.8	0.03 (0.17)	0.0	0.00 (0.00)	4.3	0.04 (0.21)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Unidentified swallow	22.2	0.47 (1.00)	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	22.2	0.64 (1.27)	0.0	0.00 (0.00)	13.0	0.26 (0.75)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Western wood pewee	0.0	0.00 (0.00)	12.5	0.13 (0.34)	0.0	0.00 (0.00)	0.0	0.00 (0.00)	0.0	0.00 (0.00)
Yellow-breasted chat	13.9	0.14 (0.35)	41.7	0.54 (0.72)	17.4	0.17 (0.39)	16.7	0.17 (0.38)	0.0	0.00 (0.00)

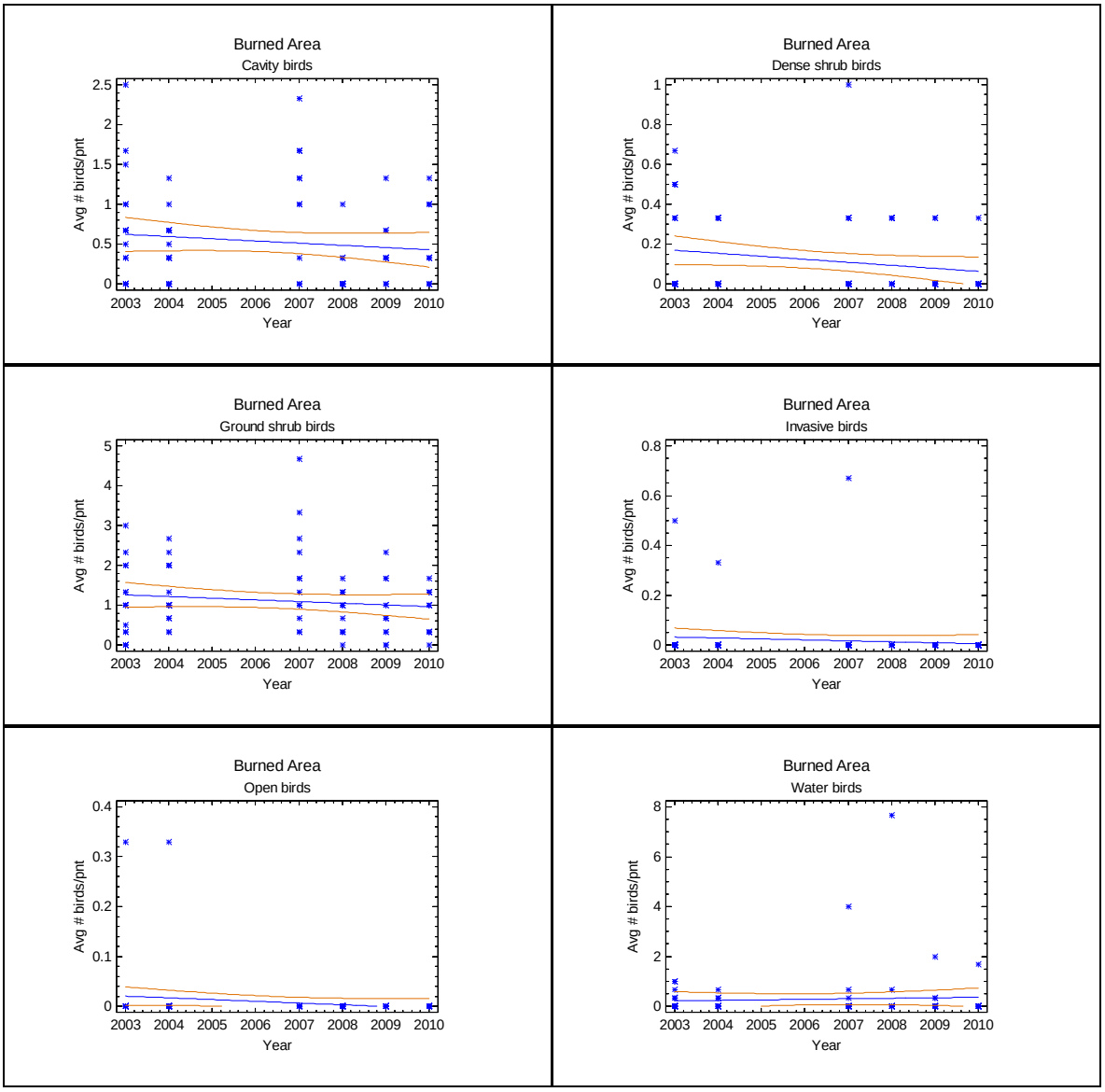
Appendix C

Linear Trend Graphs for Bird Guilds in which No Statistically Significant Trends were Detected

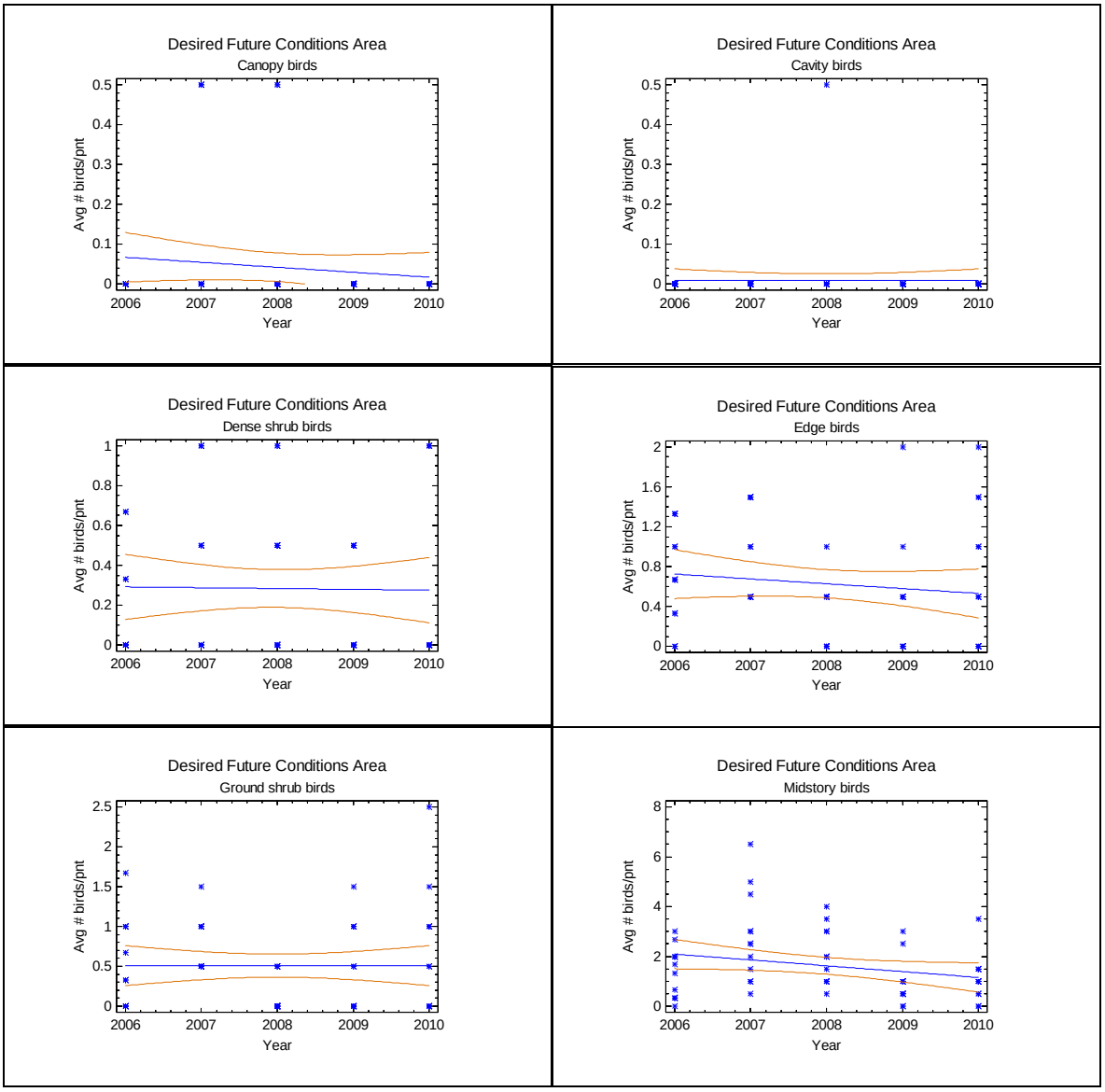
Cleared/overbank Area



Burned Area


Burned Area
Cavity birds
Avg # birds/pnt
Year
Burned Area
Dense shrub birds
Avg # birds/pnt
Year
Burned Area
Ground shrub birds
Avg # birds/pnt
Year
Burned Area
Invasive birds
Avg # birds/pnt
Year
Burned Area
Open birds
Avg # birds/pnt
Year
Burned Area
Water birds
Avg # birds/pnt
Year

Desired Future Conditions Area



Appendix D

Southwestern Willow Flycatcher
Survey Forms and Maps

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

Site Name: Los Lunas Restoration Site (part of 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)? *Yes* X *No* ____

Survey Coordinates: Start: E 340,938 N 3,847,943 UTM Datum: NAD 83 (See instructions)

Stop: E 340,432 N 3,846,343 UTM Zone: 13S

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:						# Birds	Sex	UTM E	UTM N
Observer(s):	5/23/2010						1	M	340,412	3,846,812
R. Dewitt	Start: 7:00	1	0	0	N					
	Stop: 9:30									
	Total hrs: 2.5									
Survey # 2	Date:						# Birds	Sex	UTM E	UTM N
Observer(s):	6/2/2010									
M. Hayes	Start: 6:30	0	0	0	N					
	Stop: 9:00									
	Total hrs: 2.5									
Survey # 3	Date:						# Birds	Sex	UTM E	UTM N
Observer(s):	7/2/2010									
T. Nelson	Start: 6:45	0	0	0	N					
	Stop: 9:00									
	Total hrs: 2.3									
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	Were any WIFLs color-banded? Yes **No**				
Totals do not equal the sum of each column. Include only resident adults. Do not include migrants, nestlings, and fledglings. 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: 7.3										

Reporting Individual: **David Moore** Date Report Completed: **8/31/2010**

US Fish & Wildlife Service Permit #: **TE819475-0** State Wildlife Agency Permit #: ____

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

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

Reporting Individual: David Moore | Phone #: 303-445-2242

Affiliation: Bureau of Reclamation | E-mail: sdavidmoore@usbr.gov

Site Name: Los Lunas Restoration Site (part of BL-25) | Date report Completed: 8/31/2010

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? _____

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): Middle Rio Grande Conservation District

Length of area surveyed: 1.6 (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.

Populus deltoides, Salix exigua, Eleagnus angustifolia

Average height of canopy (Do not include a range): 5 (meters)

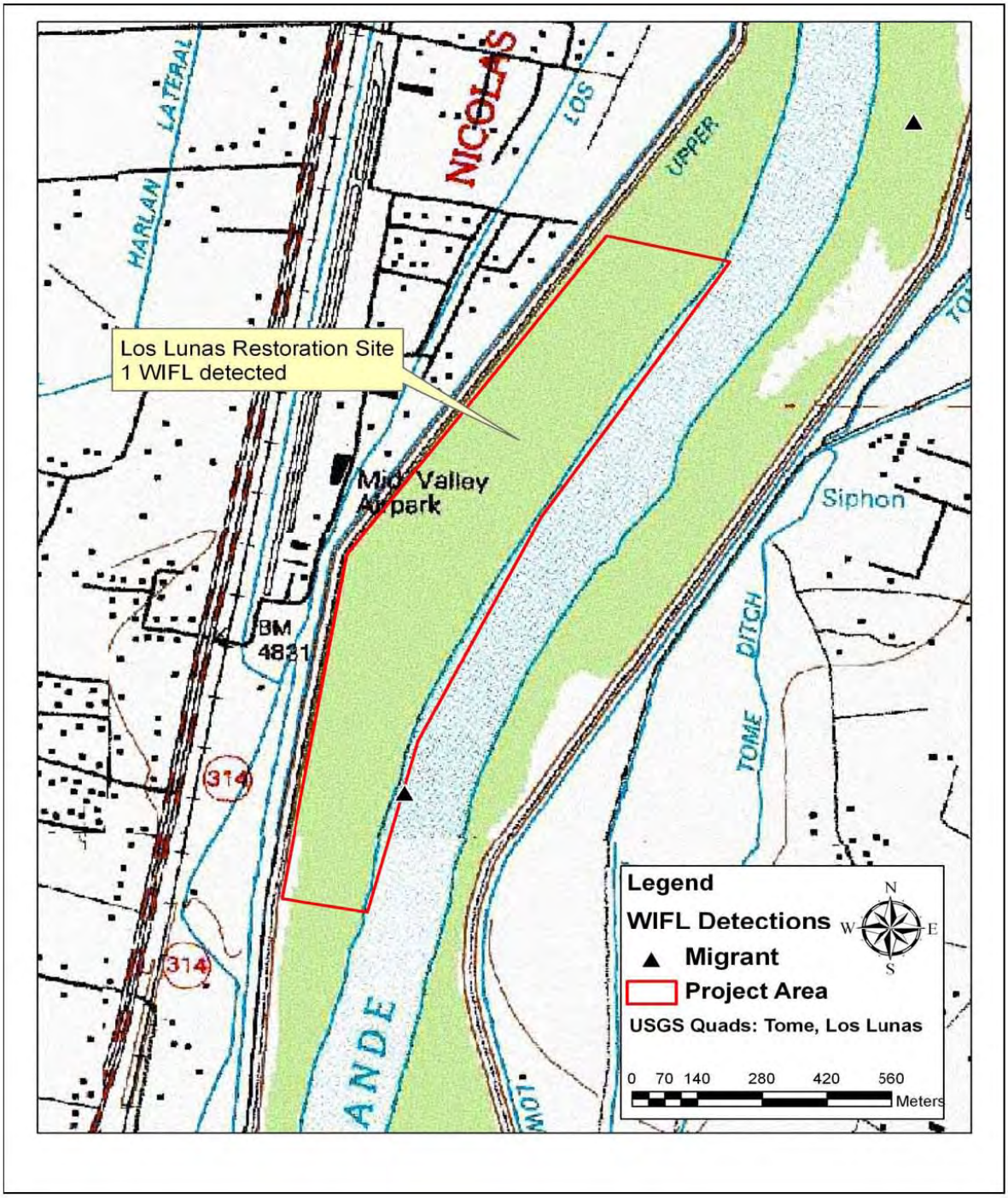
Attach the following: 1) copy of USGS quad/topographical map (REQUIRED) of survey area, outlining survey site and location of WIFL detections;
2) sketch or aerial photo showing site location, patch shape, survey route, location of any detected WIFLs or their nests;
3) photos of the interior of the patch,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

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.

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


HARLAN LATERAL
NICOLAS
LOS
UPPER
Los Lunas Restoration Site
1 WIFL detected
Mid Valley
Airpark
Siphon
BM
4831
314
314
TOME DITCH
ANDE
Legend
WIFL Detections
Migrant
Project Area
USGS Quads: Tome, Los Lunas
N
W
E
S
0 70 140 280 420 560
Meters

Appendix E

Total Percent Cover of Plants Detected in the Herbaceous Layer
by Individual Species, Life-form, and Cover Type
2006 to 2010

Table E-1.— Total percent cover of by individual species, life-form and cover type in the herbaceous layer.

	Total Percent Cover							
Herbaceous layer	**2003**	**2004**	**2005**	**2006**	**2007***	**2008**	**2009**	**2010**
Coyote willow	0.6	1.0	1.9	4.7	0.5	1.0	1.3	1.2
Cottonwood (*Salix exigua*)	0.0	0.4	1.3	7.1	0.3	0.5	0.3	0.1
Gooddings willow (*Salix gooddingii*)	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0
Total native shrubs	0.6	1.4	3.2	11.9	0.9	1.5	1.7	1.3
Saltcedar (*Tamarix* spp.)	0.4	0.8	2.8	5.0	1.0	0.8	0.8	1.1
Russian olive (*Eleagnus anustifolia*)	0.0	0.0	0.0	0.2	0.0	0.1	0.0	0.0
Total introduced shrubs	0.4	0.8	2.8	5.2	1.0	0.9	0.8	1.1
Fragrant flatsedge (*Cyperus odoratus*)	1.7	3.5	8.4	0.5	2.1	4.4	1.0	0.1
Baltic rush (*Juncus balticus*)	1.3	0.0	0.0	0.0	0.0	0.0	1.1	0.8
Muhly (*Muhlenergia racemosa*)	1.3	2.7	0.0	0.0	0.0	0.0	0.0	0.0
Witchgrass (*Panicum capillare*)	1.1	5.2	4.4	0.8	0.4	1.7	0.4	0.5
Thin paspalum (*Paspalum setaceum*)	0.4	0.4	1.6	4.7	7.6	12.2	16.9	15.8
Dropseed (*Sporobolus* sp.)	2.2	6.7	0.0	0.0	0.0	0.0	0.0	0.0
Common spikerush (*Eleocharis palustris*)	0.0	0.2	0.0	0.0	0.2	0.4	0.5	0.5
Saltgrass (*Distichlis spicata*)	0.0	0.1	0.0	0.0	0.0	0.0	0.2	0.0
Fowl bluegrass (*Poa palustris)*	0.0	0.2	0.6	0.3	0.1	0.0	0.0	0.4
Sedge (*Carex* sp.)	0.0	0.1	0.0	0.0	0.1	0.6	0.1	0.7
Mexican sprangletop (*Leptochloa fusca*)	0.0	0.0	1.1	2.5	0.1	0.7	0.4	0.3
Teal lovegrass (*Eragrostis hypnoides*)	0.0	0.0	2.6	0.0	0.3	0.2	0.2	0.0
Barley foxtail (*Hordeum jubatum*)	0.0	0.0	0.0	2.8	3.6	7.3	2.5	4.3
Squirreltail (*Elymus elemoides*)	0.0	0.0	0.0	0.0	1.7	0.1	0.1	0.0
Common reed (*Phragmites australis*)	0.0	0.0	0.0	0.0	0.8	0.4	0.6	0.7
Sword-leaved rush (*Juncus ensifolius)*	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2
Rice cutgrass (*Leersia oryzoides*)	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.2
Hardstem bulrush (*Schoenplectus acutis*)	0.0	0.0	0.0	0.0	0.0	0.4	0.2	0.0
American threesquare (*Schoenplectis americanus*)	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.2
Scratchgrass (*Muhlenbergia asperifolia*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
Total native grasses	8.0	19.1	18.7	11.6	17.0	28.8	25.4	25.0
Barnyard grass (*Echinochloa crus-galli*)	1.3	4.3	6.0	2.8	1.0	1.1	0.4	0.1
Rabbitfoot grass (*Polypogon monspeliensis*)	1.6	4.5	2.8	0.1	2.0	3.2	0.2	0.0
Smooth brome (*Bromus inermis*)	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0
Tall fescue (*Festuca arundinacea*)	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.4
Japanese brome (Bromus japonicus)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
Total introduced grasses	2.9	8.8	8.8	2.9	3.0	5.7	0.9	0.9
Horseweed (*Conyza canadensis*)	0.2	0.0	0.0	4.3	7.7	0.0	0.0	0.7
Common sunflower (*Helianthus annuus*)	7.9	13.9	0.3	3.9	1.1	1.9	0.0	1.0
Pale smartweed (*Polygonum lapathifolium*)	0.8	1.2	0.2	5.9	1.0	0.2	0.1	0.1
Common cocklebur (*Xanthium strumarium*)	0.3	3.3	17.9	8.1	10.3	19.4	11.8	3.8
Beggarstick (*Bidens frondosa*)	0.0	0.9	3.4	0.5	0.1	0.2	0.2	0.0
Spearleaf rabbitbrush (*Chrysothamnus linifolius*)	0.0	0.3	0.8	1.7	2.9	11.9	9.2	7.3
Clasping-leaf dogbane (*Apocynum cannabinum*)	0.0	0.0	0.3	0.2	0.9	1.5	1.5	1.4
Milkvetch (*Astragalus* sp.)	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0

Cottonbatting cudweed (*Pseudognaphalium stramineum*)	0.0	0.0	0.0	1.2	0.6	0.0	0.2	0.1
Hooker's evening primrose (*Oenothera elata*)	0.0	0.0	0.0	1.2	0.0	0.2	0.1	0.7
Dodder (*Cuscuta* sp.)	0.0	0.0	0.0	0.1	0.0	0.0	0.4	0.0
Bundleflower (*Desmanthus illinoensis*)	0.0	0.0	0.0	0.0	0.5	0.2	0.7	1.3
Western ragweed (*Ambrosia psilostachya*)	0.0	0.0	0.0	0.2	0.4	0.7	1.1	2.0
Silverweed cinquefoil (*Argentina anserina*)	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
American water horehound (*Lycopus americanus*)	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.0
Penstemon (*Penstemon* sp.)	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
Smooth scouringrush (*Equisetum laevigatum*)	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.8
New Mexico giant hyssop (*Agastache pallidiflora ssp. neomexicana)*	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.2
Curlycup gumweed (*Grindelia squarrosa*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Thymeleaf spurge (*Chamaesyce serpyllifolia*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Small-flowered gaura (*Gaura parviflora*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Total native forbs	9.2	19.6	22.9	27.5	25.5	37.0	26.1	19.8
Lambsquarters (*Chenopodium album*)	6.2	5.2	0.3	0.1	0.0	0.1	0.1	0.0
Kochia (*Kochia scoparia*)	0.5	3.6	3.8	4.2	2.8	2.7	2.7	3.3
Prickly lettuce (*Lactuca serriola*)	0.1	0.8	0.0	6.0	2.3	0.9	0.0	0.2
White sweetclover (*Melilotus albus*)	4.2	7.1	0.4	6.8	4.7	1.7	1.5	1.2
Russian thistle (*Salsola iberica*)	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0
Perrenial pepperweed (*Lepidium latifolium*)	0.0	0.2	0.0	0.0	0.0	0.0	0.1	2.3
Wormwood (*Artemisia absinthium*)	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Curly dock (*Rumex crispis*)	0.0	0.0	0.1	0.5	1.6	0.1	0.0	0.1
Prostrate amaranth (*Amaranthus blitoides*)	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
Goats head (*Tribulus terrestris*)	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
Field bindweed (*Convulvulus arvensis*)	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Total Introduced forbs	11.0	17.8	4.8	17.8	11.4	5.7	4.4	7.0
Total herbacious vegetation	32.1	67.5	61.2	76.9	58.8	79.6	59.3	55.0
Litter	4.4	5.2	7.3	5.5	23.4	12.7	30.5	42.6
Bare soil	63.5	27.3	31.5	17.6	17.8	7.7	10.2	2.4
Total cover	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

*NS=Native shrub; IS=Introduced shrub; NG=Native grass; IG=Introduced grass; NF-Native forb; IF=Introduced forb

Appendix F

Shallow Monitoring Well Monthly Data
June 2003 – September 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

Appendix G

Photo Stations
2003 - 2010

Photo Station 1 - Facing North

2003

2004

2005

2006

2007

2008

2009

2010

Photo Station 1 – Facing River

2003

2004 **No photo**

2005

2006


2007


2008


2009


2010

Photo Station 1 – Facing South


2003


2004


2005


2006


2007


2008


2009


2010

Photo Station 2 – Facing North

2003

2004

2005

2006

2007

2008

2009

2010

Photo Station 2 – Facing River

2003

2004 **No photo**

2005

2006

2007

2008

2009

2010

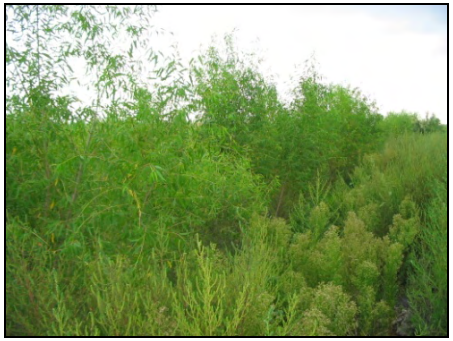
Photo Station 2 – Facing South

2003

2004

2005

2006



2007

2008

2009

2010

Photo Station 3 – Facing North

2003

2004

2005

2006

2007

2008

2009

2010

Photo Station 3 - Facing South

2003

2004

2005

2006


2007


2008


2009


2010

Photo Station 4 – Facing North


2003


2004


2005


2006


2007


2008


2009


2010

Photo Station 4 – Facing South


2003


2004


2005


2006


2007


2008


2009


2010

Photo Station 5 – Facing North


2003


2004


2005


2006

2007

2008

2009

2010

Photo Station 5 – Facing South

2003

2004

2005

2006

2007

2008

2009

2010

Photo Station 6 – Facing North

No photo
2003


2004


2005


2006


2007


2008


2009


2010

Photo Station 6 – Facing South


2003


2004


2005


2006

2007

2008

2009

2010

Photo Station 7 – Facing North

2003

2004

2005

2006

2007

2008

2009

2010

Photo Station 8 – Pond

2003

2004

2005

2006

2007

2008

2009

2010

Photo Station 9 – Facing South

2003

2004

2005

2006

2007

2008

2009

2010

Photo Station 10 – Facing North

2003

2004

2005

2006

2007

2008

2009

2010