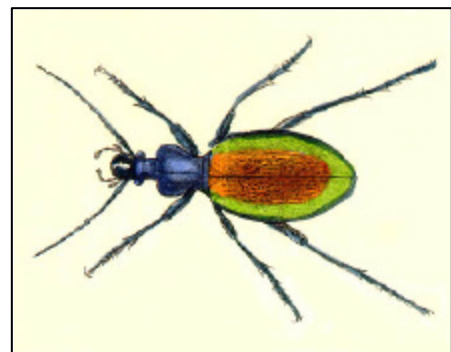


River Bars of the Middle Rio Grande

A Comparative Study of Plant and Arthropod Diversity



Middle Rio Grande Bosque Initiative



2004



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A Comparative Study of Plant and Arthropod Diversity

*Final Report*¹

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Summary

Vegetated river bars represent a significant element of the Middle Rio Grande ecosystem of New Mexico. They are perhaps its most diverse and biologically active component. These dynamic environments support young wetland and riparian vegetation along with most of the natural regeneration of Rio Grande cottonwoods in the river corridor. To quantitatively assess the biodiversity contributions that river bars make, we compared the composition and structure of the bars through time relative to adjacent mature cottonwood forests, focusing on native versus non-native vegetation and ground-dwelling arthropods as indicators of ecosystem condition. Accordingly, in 1998 we established study sites on six bars dominated by native coyote willow (*Salix exigua*) shrubs and six dominated by exotic Russian olive (*Elaeagnus angustifolia*) along with a mix of native and non-native shrubs. For comparison, in 1999 we established an additional six sites in adjacent mature Rio Grande cottonwood (*Populus deltoides* var. *wislizenii*) gallery forest ("cottonwood bosque"). Sites were distributed along a 30-mile segment of the Rio Grande between Bernalillo and the I-25 bridge through Albuquerque. At each site, a sampling grid of 32 points on five-meter centers in a four-by-eight configuration was permanently established and quadrat-based vegetation measurements conducted yearly in the fall through 2002. Ground-active arthropods were sampled seasonally between 1999 and 2002 using ten wet pitfall traps centered within the vegetation grid. To monitor ground-water conditions during the study, a single shallow ground-water well was established at each bar site in October 1998 and read monthly thereafter.

With respect to vegetation, our results indicate that the three vegetation types, Willow, Mixed, and Bosque, had significantly different compositions and structure. The Willow sites were the most diverse with nearly 40% more species than the Mixed sites, and 65% more than the Bosque, with most of this increased richness found among the grasses and forbs. Furthermore, 38% of the species were unique to Willow sites versus only 6% among the other sites. Bar sites, both the Willow and Mixed, had significantly greater number and abundance of

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natives species compared to the Bosque. Collectively, the river bars not only harbored the majority of plant species in the riparian zone (117 taxa), they contributed 68.5% of the species diversity (85 taxa) while the Bosque contributed only 5.6% unique taxa. Ground-water depths on the bars were considerably shallower than those of the Bosque, which likely contributes to the differences in species composition. Yet differences in ground water between Mixed and Willow sites were minimal, suggesting other factors are involved in the establishment and maintenance of exotic versus native species on the bars.

Among ground-dwelling arthropods there were also significant differences in community structure among the three vegetation types. Again, ant species diversity was highest on the Willow sites followed by Mixed and then Bosque sites. Based on the abundances within five major beetle families, Bosque sites were also significantly lower in species richness and diversity at the site level than the bars, but Mixed sites were significantly richer in species than Willow sites. There were marked differences in seasonality among taxonomic groups, and clear downward trends during the drought years of 2001 and 2002.

Given their exceptionally high plant diversity and their role in cottonwood regeneration, river bars represent keystone communities in the Middle Rio Grande riparian ecosystem. The distinctively different ground-dwelling arthropod communities that were unique to the bars also point to a high diversity potential for the animal component as a whole. Furthermore, these sites are *the* source points for the natural reproduction of cottonwoods in the system, and as such are key to the renewal and long-term sustainability of riparian forests in the ecosystem.



Plate 1. A newly created river bar on the west bank of the Rio Grande between Bridge Street and Rio Bravo bridges in the Albuquerque reach.

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Introduction

Vegetated river bars are a significant element of the Middle Rio Grande ecosystem, comprising upwards of 18% of vegetation throughout the Albuquerque Reach (Milford et al. 2003). Yet, while considerable attention has been devoted to the ecology and biodiversity of the neighboring riparian bosque (Hink and Ohmart 1984; Crawford et al 1993), little is known about the bars. The bars occur along the margins of the active channel (alternate bars or point bars) or in the channel itself (island bars) where they are subject to varying stream flows and ground water fluctuations along with flooding and shifting sediment loads (Figure 1). Typically, they initially support young wetland and riparian vegetation, and of particular note, they are the sites where most natural regeneration of cottonwoods takes place. Hence, in these highly dynamic environments, the expectation is that bars may be the most diverse and biologically active component of the Bosque ecosystem. Accordingly, we report here on the results of a five-year study that explored vegetation and ground-dwelling arthropod composition and dynamics on the bars in relation to adjacent mature bosque forest. We chose vegetation because it forms the foundation for biological structure within the ecosystem, and ground-dwelling arthropods because they are among the most easily measured animals in the system that can also provide indication of ecosystem status with respect to biodiversity and function.



Figure 1. River bars can form from the deposition of sediments within the channel as islands (foreground) or along the bank, and they can be dominated by a wide variety of vegetation such as the combination of Russian olive and willows on the far bank of this site near the Alameda bridge.

Adding to the complexity of the Middle Rio Grande ecosystem are the numerous hydrological modifications that have occurred during the past 50 years which have had a significant impact on biodiversity and ecosystem function (Crawford et al. 1993). Historically, river bar biota and configurations shifted with fluctuating water flow and associated differential depositional events. However, in the last 50 years, flood control structures (Jemez and Cochiti dams, levees, jetty jacks) erected along the Middle Rio Grande have restricted and altered natural flows such that river bars have become much more permanent features of the channel, and have increased significantly in aerial extent, particularly since the closure of Cochiti Dam in 1972 (Ortiz 2003). At the same time, invasions by exotic species such as *Elaeagnus angustifolia* (Russian olive), *Tamarix ramosissima* (salt cedar), and *Ulmus pumila* (Siberian elm) have also occurred on the bars, potentially leading to a loss of ecological and biodiversity value. In this context of altered hydrological regime, our study focuses on developing a clear understanding of the range of biological variability on these sites in relation to environmental characteristics and exotics, with an eye towards the role that river bars can play in the conservation and restoration in the riparian zone of the Rio Grande.

Methods

Study Area

The project area stretches along the greater Albuquerque Reach of the Rio Grande between Bernalillo, NM and the I-25 bridge over the Rio Grande south of the city (Figure 2). Climatically, the Middle Rio Grande through Albuquerque is located in a semi-arid zone where precipitation ranges from 138 to 477 mm (5.42 to 18.8 in) around a mean of 252 mm (9.92 in) as reported at Los Lunas, NM, 15 miles to the south along the river corridor (Table 1). About 50% of the precipitation arrives during the four-month summer "monsoon" season (June-September). During the period of the project, precipitation was above normal between 1998 and 2000, but dipped significantly below normal in 2001 and 2002 as extreme drought took hold throughout New Mexico (Figure 3). Precipitation was also highly variable from month to month, an important factor when comparing arthropod values among sampling periods (Figure 4).

Similarly, river discharges were essentially normal from 1998 through 2000, with peak releases from Cochiti Reservoir, 50 miles up stream, occurring in the late spring following snowmelt (Figure 5). Beginning in 2001, releases began a downward trend (except for the small spike in early spring of 2001) in response to drought conditions that continued on through 2002. For a review of the history of climate and discharges within the reach see Crawford et al. (1993).

Study design and site selection

Our objective was to understand differences in biodiversity composition and structure through time in mature forest versus bars, and between exotic and native vegetation dominated bars. Accordingly, in 1998 we established study sites on six native coyote willow (*Salix exigua*) and six exotic Russian olive dominated sites distributed between Bernalillo and the I-25 bridge along the Albuquerque reach of the Rio Grande (Figure 2). For comparison, we established in 1999 an additional six "control" sites in adjacent mature Rio Grande cottonwood (*Populus deltoides* var. *wislizenii*) gallery forest (bosque). The largest and most accessible bar sites were selected from a pool of 50 sites visited in the summer of 1998. Those dominated by willow were designated as the Willow vegetation type, and those dominated by a mixture of willow and Russian olive were classified as the Mixed vegetation type (pure Russian Olive sites were rare). The bosque sites were chosen based on their proximity to established bar study sites and on the presence of a mature cottonwood overstory. Appendix A contains a table that lists the site names, locations, dominant vegetation type and brief directions to each site. Appendix A also contains a set of detailed maps showing the locations of individual study sites.

Over the course of the study, one Bosque site was lost to fire. This happened in year four of the project, and rather than add a new site at this late date, the lost site was compensated for statically in the analysis.

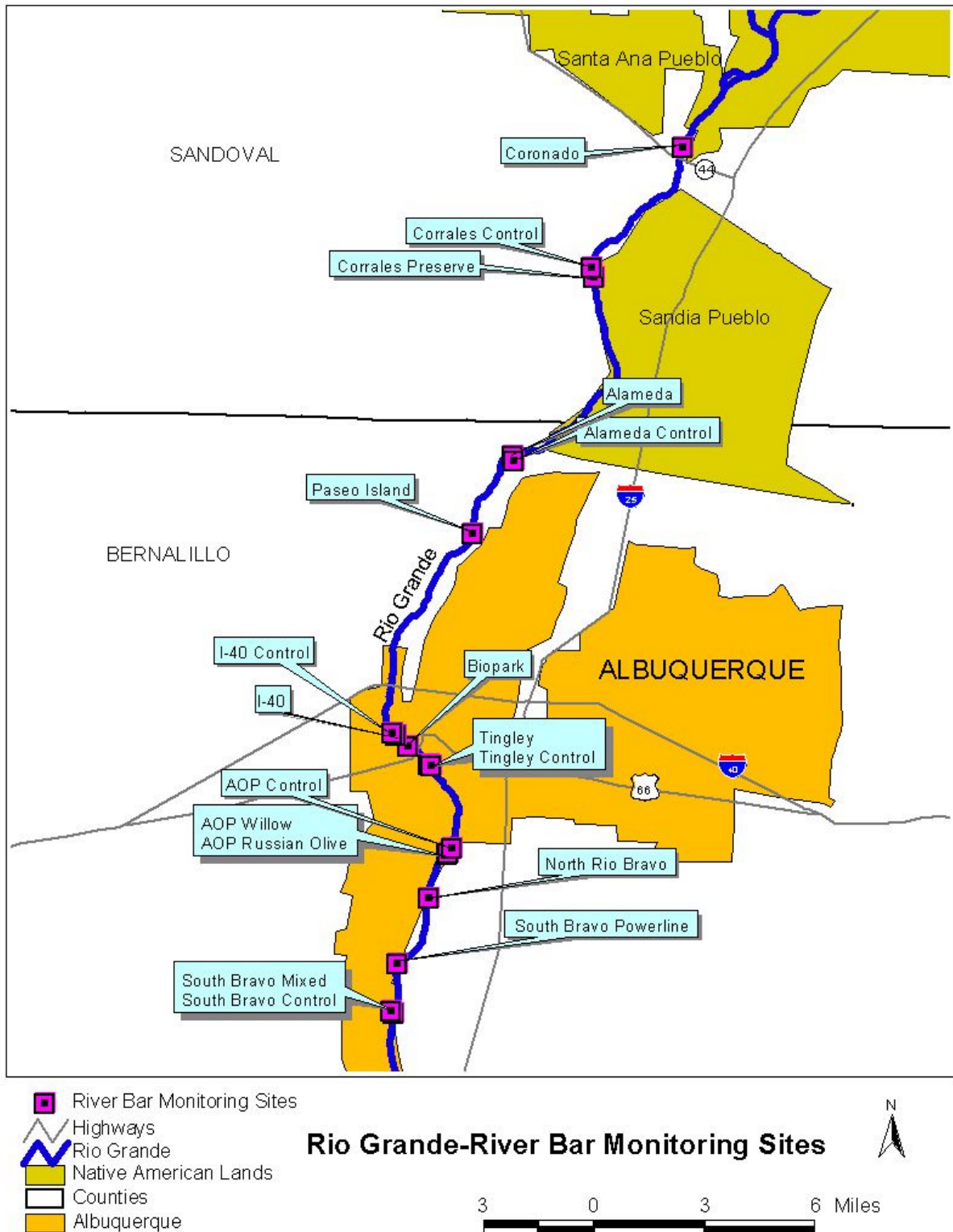


Figure 2. Middle Rio Grande River biodiversity studies project area showing the 18 study sites which were distributed between Bernalillo and the I-25 bridge through the Albuquerque reach.

Table 1. Climate summary for Los Lunas 3 SSW, NM (Station 295150), located approximately 10 to 30 miles south of the river bar sites, and the nearest valley bottom weather station. (source: Western Regional Climate Center web page <http://www.wrcc.dri.edu/>).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	51.6	58.9	66.1	73.3	81.4	90.2	92.5	90.0	84.1	73.8	59.0	51.3	72.9
Average Min. Temperature (F)	19.0	23.6	29.5	36.0	44.6	53.2	59.8	58.7	50.5	37.8	25.5	19.1	38.2
Average Total Precipitation (in.)	0.46	0.42	0.55	0.52	0.57	0.59	1.36	1.74	1.49	1.08	0.63	0.51	9.92

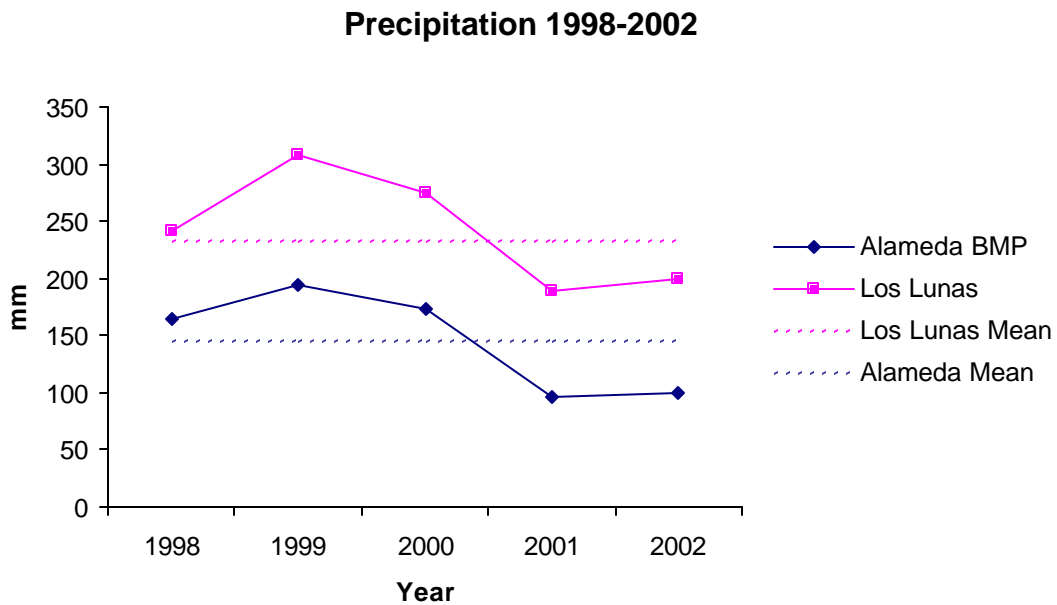


Figure 3. Average yearly precipitation over the river bar project period as reported at Los Lunas 3, SSW (Station 295150), and from the Alameda Bosque Monitoring Program site (Eichhorst et al 2003).

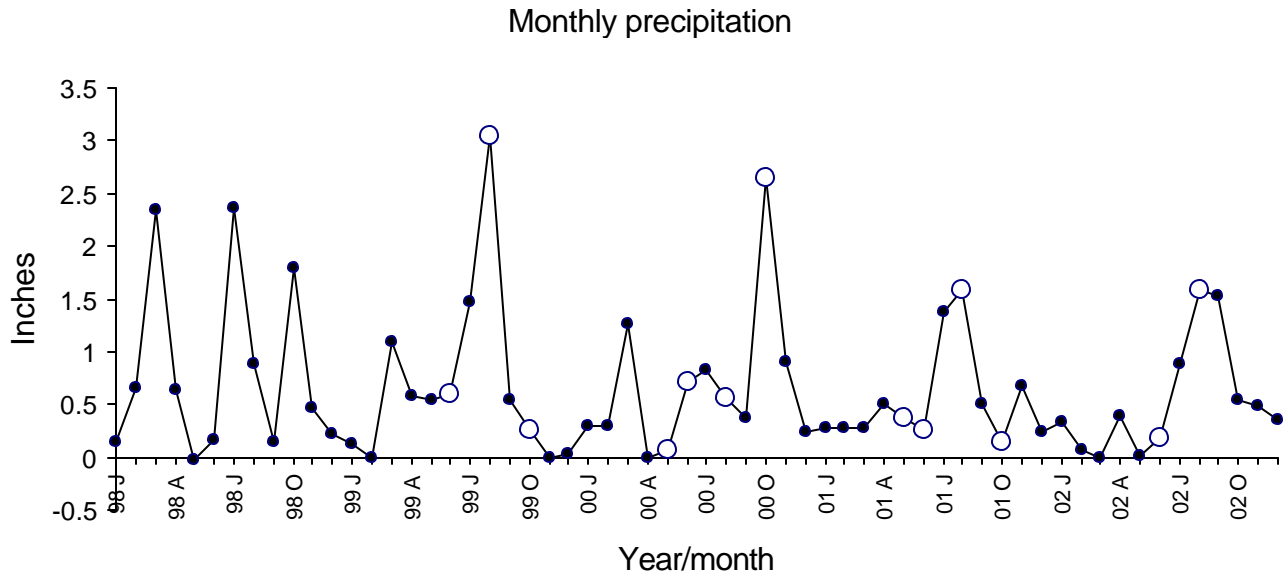


Figure 4. Monthly precipitation over the period of sampling (Station 295150 Los Lunas 3, SSW). Open circles indicate months where sampling occurred for arthropods. Vegetation sampling occurred in September of each year.

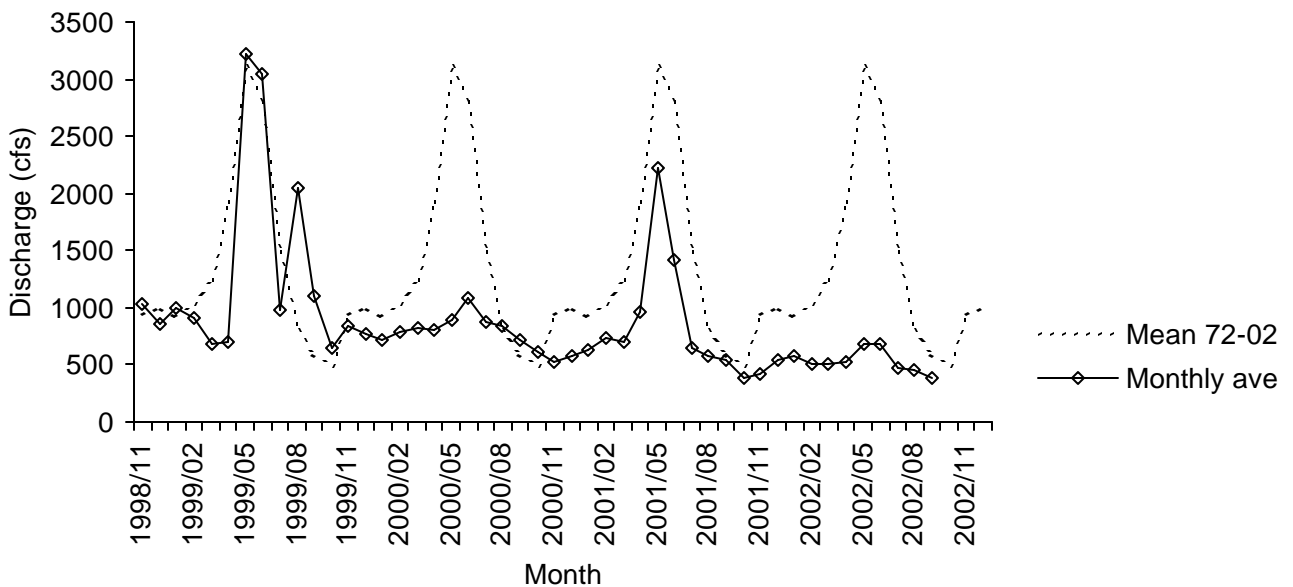


Figure 5. Discharge profile of the Rio Grande through Albuquerque, NM during the period of the project (data from <http://waterdata.usgs>).

Sampling

Within each site, we selected stands that were homogenous with respect to tree/shrub dominance, on a uniform geomorphic surface, and that were away from obvious public access routes and impacts. A sampling grid of 32 points was established on five-meter centers in a four-by-eight configuration (Figure 6). To accommodate the narrow linear nature of one site (Paseo Island), we set up a three-by-eleven grid. Each grid point was monumented with a four-foot rebar stake. The corner rebar stakes were jacketed with white PVC pipe, labeled with aluminum tags, and had a GPS position taken.

For vegetation measurements, one-meter-square quadrats made of rigid PVC were extended off the northeast corner of each rebar. The opposite corner of the quadrat was marked with a surveyor pin flag to aid spatial replication. The orientation of the quadrats was noted on the data sheets. Percent canopy cover was recorded for all species within and overhanging the quadrat along with litter, soil, rock, and total herbaceous cover. Voucher specimens were collected and later identified and deposited at the University of New Mexico Herbarium. Besides cover, tree and shrub stems were counted in two-inch diameter classes along with an estimate of modal height within each one-meter quadrat. Additionally, trees were counted using the same size classes in the larger five-by-five-meter grid cells. Vegetation sampling was conducted yearly in the fall between September and early October.

Wet pitfall traps were used to sample ground active arthropods. At each site, a grid of ten traps was centered within the vegetation grid, with five pitfalls, each five meters apart, placed down the two centerlines (Figure 6). Traps were positioned midway between the rebar stakes of the vegetation grids, starting between the second and third rebars, and ending between the sixth and seventh. The design was modified at Paseo del Norte to fit the narrower

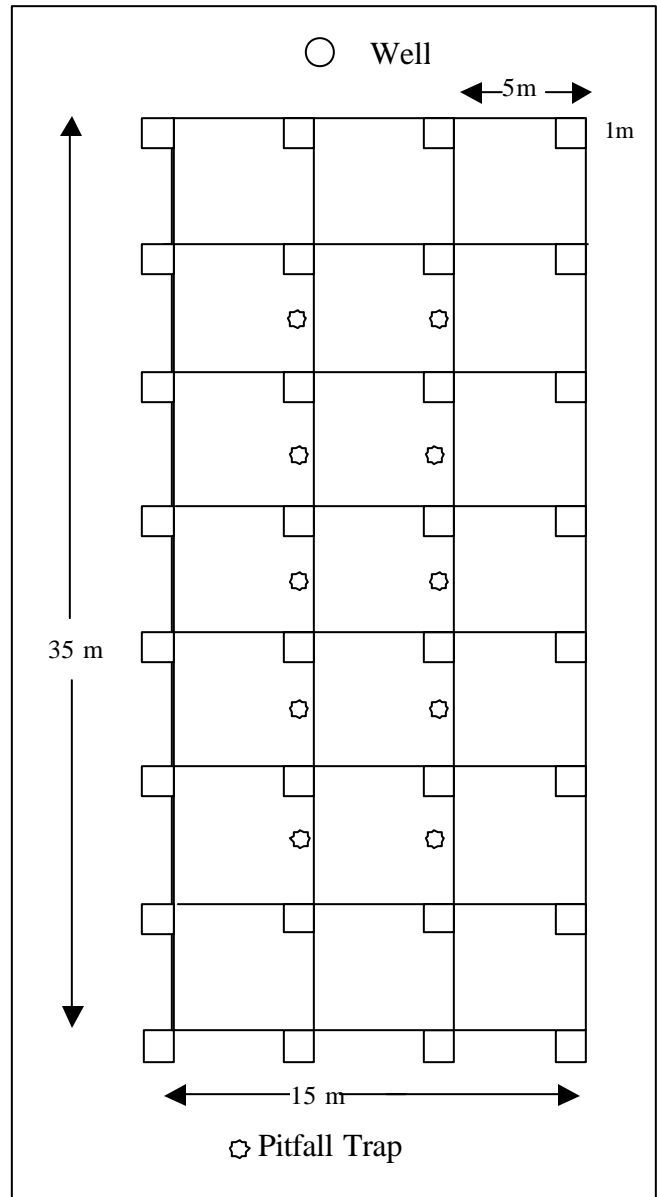


Figure 6. River bar vegetation and arthropod pitfall sampling grid layout with one-meter quadrats for percent cover of all species, and five-by-five-meter cells for shrub stems counts. Pitfall traps are systematically offset from the quadrats in the interior of the grid. A single groundwater well is located adjacent to each grid.

vegetation, i.e., traps were placed midway between the stakes of the first and second, and second and third lines of the vegetation grid starting at the fourth stake and ending at the eighth stake. Pitfalls were constructed of two nested 16-oz plastic cups placed in the ground so that the lip of the inner cup was flush with the soil. The inner cup was partially filled with propylene glycol to preserve the insects and to prevent predation among the insects. Traps were then covered with a six-by-six-inch piece of plywood, with three-inch screws drilled into each corner.

Arthropods were sampled on June 21-25, August 19-22 and October 5-8, 1999; May 5-8, June 27-30, August 17-20 and September 29-October 2, 2000; May 1-4, June 25-28, August 25-28, and Oct 3-6, 2001; June 4-7 and August 20-23, 2002. At each site, pitfalls were set and left open for 48 hours. To keep out detritus, the lids were left propped up on their screws over the traps during sample periods. To prevent vertebrate kills, ladders made of one-by-five-inch strips of wire mesh were hooked through one of the lid screws so that they hung just above the surface of the propylene glycol. Between sample periods, the lids were pushed down tight over the traps and the inner cups were emptied of propylene glycol to prevent unnecessary kills. The trap contents were collected in individual vials and labeled with the date and location.

Five major groups of arthropods were counted and sorted out of the pitfall samples. Spiders (Order Araneae), Isopods (*Armadillium vulgare* and *Prcellio laevis*) and Crickets (Order Othopetera; Suborder Ensifera) were only counted for total abundance with no further identification. The ants (Order Hymenoptera, Family Formicidae) and the beetles (Order Coleoptera) were further identified to the genus and species level when possible with particular attention being focused on the beetle families Carabidae, Tenebrionidae, Elateridae, Staphylinidae and Cryptophagidae. Several specimens were sent out for identification by specialists³. Other taxa that were collected, but not identified due to time and resource constraints have been deposited with the Arthropod Division of the Museum of Southwestern Biology at UNM.

To measure ground-water status at each site, we established a single PVC-pipe shallow ground-water well at each bar site. We placed wells along an easily accessible side of the site grids to avoid site disturbance. The wells are constructed of two lengths of PVC pipe, each about 1.5 m long. The bottom end is perforated to allow water seepage and capped with a pointed tip to allow it to be driven into the soil. It is coupled to a solid top end with a removable cap. We augured into the ground until we reached the water table, and then drove the pipe with a sledgehammer as deep as possible (most to about 2.0m from the surface). All pipes were cut to one meter height above ground and labeled. Wells were established in October 1998 and monthly readings started in November 1998 and continued through January 2003. Over the four year period, two wells were vandalized and had to be replaced, and two had to be replaced because they went dry when water tables dropped or because they became clogged with roots. For comparison to water table measurements within the bosque, we relied upon the monitoring well network established as part of the Bosque Ecology Monitoring Program (BEMP) of Eichhorst et al. (2003). Many of these wells are near our bosque sites, and hence to add wells would have been a duplication of effort.

³ Beetle specimens were given to entomologist Richard Fagerlund of University of New Mexico; ant specimens were sent to Dr. William Mackay of the University of Texas, El Paso.

Analysis

The vegetation and arthropod data was entered into the NHNM Ecology Group relational database (Microsoft Access platform), and quality controlled through error checking routines and manual readbacks. The majority of the statistical analysis was performed using PC-SAS version 8.2 software (SAS Institute Inc. 2001). For repeated measures analysis of vegetation cover, percentage native cover, and monthly abundance trends among spiders, isopods and crickets a mixed ANOVA model was used. As the majority of the arthropod data are counts, and thus right skewed, non-parametric tests were used where appropriate. For pairwise comparisons, a Wilcoxon t-test was used for comparison of individual pairs, while Bonferonni pairwise comparisons were used to compare multiple pairs simultaneously, as no non-parametric test was available for multiple pair comparisons in SAS. For species diversity indices, we used Species Diversity and Richness 3.02 software (Henderson and Seaby 2002).

Canonical discriminant analysis (CDA) was used to compare ant and beetle community structure between vegetation types. The number of pitfalls occupied per site was used for ants and the number of individuals per site for beetles. Due to its outlier status, the AOP Willow site was excluded from all canonical discriminant analysis for the insects. Because pitfalls were sometimes lost to animal disturbance before collection, all ant pitfall counts were converted into a ratio of pitfalls occupied over total number of pitfalls collected. The collected number was always seven or greater per site. In the one case where fewer than seven pitfalls were collected the sample was excluded from the analysis

Statistical analysis of beetle data used only data from the Carabidae, Cryptophagidae, Elateridae, Staphylinidae and Tenebrionidae families, as these five taxa include a number of species that spend all or significant portions of their lives on the ground and thus would occur in the pitfalls with some regularity. Although many other beetle families were identified from the pitfall samples, their occurrences were incidental or related to stochastic events not being examined (the presence of carrion near a pitfall, etc.). For the canonical discriminant analysis of the beetles, the 51 taxa identified from the five families above were reduced to 24 taxa, 22 of which were selected through a stepwise analysis, and two of which were added due to the large number of collected individuals that they represented.

Results

Hydrological context

Ground-water depths on the river bars were anywhere from 0.5 to 2 m shallower than Bosque forest sites (Figure 7). At base flows, the bar water tables ranged from as little as 0.5 m to as much as 1.5 m, and at peak-flows water was often within 0.5 m of the surface, or in the case of the AOP Willow site, at the surface (see Figure 5 river discharges). Hence, bar vegetation, is likely to be more connected to the ground-water system than the understory vegetation of the Bosque sites where the water tables are anywhere from 2 to 3 m deep. With the exception of the AOP Willow site, there was little difference between Willow and Mixed sites, although there is some indication of a downward trend in 2002 among Willow sites, perhaps due to exceedingly low flows coincident with the drought (See Appendix B and accompanying CD for complete well data set).

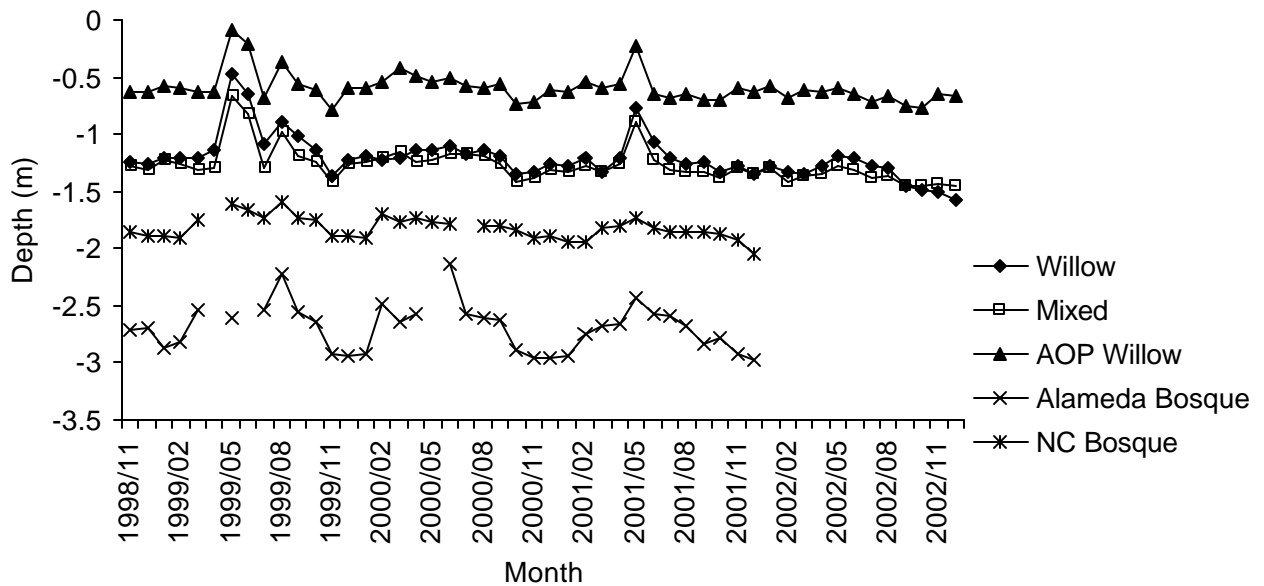


Figure 7. Monthly variation in ground-water depths as measured on a single day each month at each site. The Willow and Mixed points represent averages among all sites except AOP Willow. AOP Willow was separated because it had a much shallower water table relative to other sites. Similarly, Alameda Bosque and NC (Nature Center) Bosque are forested sites with significantly deeper depths to water (forest data from Bosque Ecology Monitoring Program (BEMP) at www.bosqueschool.org/Environmental%20Science%20Programs/data_sets.htm).

Vegetation abundance patterns and trends

The three vegetation types have distinctively different vegetation compositions and structure (Table 3). The Bosque sites were characterized by a canopy of *P. deltoides* var. *wislizeni* with an understory of exotic trees and shrubs and an occasional native *Salix gooddingii* (Goodding's willow) (Figure 8). The primary exotic tree was *Elaeagnus angustifolia* (Russian olive), but *Ulmus pumila* (Siberian elm), *Ailanthus altissima* (tree of heaven), *Tamarix ramosissima* (salt cedar), and *Morus alba* (mulberry) were also prevalent, and together approached 40% of the woody cover (Figure 9). The oft-perceived uniformity of Middle Rio Grande cottonwood forests is belied by the species variation in basal area among the individual sites (Table 2). Not only was there a four-fold difference in *P. deltoides* basal area among sites, there were large differences in the abundance of exotics, particularly *Elaeagnus* and *Tamarix* (although, with the exception *Elaeagnus*, the presence of exotic trees was sporadic and idiosyncratic). Shrub cover was also variable, with *Forestiera pubescens* (New Mexico olive), *Amorpha fruticosa* (desert indigobush), and *Rhus trilobata* (skunkbush sumac) the most common native indicators of a mature cottonwood stand. The herbaceous layer was typically sparse, but in some cases where tree canopies were relatively open grasses such as *Distichillia spicata* (inland saltgrass), *Sporobolus airoides* (alkali sacaton), and *Muhlenbergia asperifolia* (alkali muhly) were abundant (see Appendix C).



Figure 8. Closed canopy forests of Rio Grande cottonwood typify Bosque sites such as this one between Central Avenue bridge and I-40.

Table 2. Total woody basal area (m²/ha) among forest (Bosque) sites in 2001.

Site Name	Alameda	AOP	Corrales	I-40	South Bravo	Tingley	Average
Natives							
<i>Populus deltoides</i>	82.13	31.64	65.22	68.34	16.70	47.15	51.86
<i>Salix gooddingii</i>			0.43				0.07
Exotics							
<i>Ailanthus altissima</i>		3.13			26.67		4.97
<i>Elaeagnus angustifolia</i>	0.94	13.59	1.43	13.77	2.95	14.82	7.92
<i>Morus alba</i>				0.38	0.32		0.12
<i>Tamarix ramosissima</i>		2.85	6.58	0.52			1.66
<i>Ulmus pumila</i>	23.82			2.84	3.34	10.26	6.71
Total	106.88	51.21	73.66	85.85	49.97	72.24	73.30

Table 3. Vegetation summary table. Species percent cover (average over all years) and constancy (number of occurrences among six plots) by vegetation type.

Species Name	Common Name	Bosque	Mixed	Willow
Trees				
<i>Ailanthus altissima</i>	tree of heaven	34.63 (8)		
<i>Elaeagnus angustifolia</i>	Russian olive	20.63 (22)	44.64 (30)	3.28 (24)
<i>Morus alba</i>	white mulberry	5.02 (15)	3.11 (5)	1.35 (13)
<i>Populus deltoides</i> ssp. <i>wislizenii</i>	Rio Grande cottonwood	71.52 (22)	4.23 (23)	1.92 (29)
<i>Salix gooddingii</i>	Goodding's willow	4.76 (12)	0.06 (3)	0.47 (10)
<i>Ulmus pumila</i>	Siberian elm	14.62 (19)	3 (19)	3.27 (21)
Shrubs				
<i>Amorpha fruticosa</i>	desert indigobush	0.32 (5)	0.83 (9)	
<i>Baccharis salicina</i>	false willow	1.15 (3)	6.68 (16)	1.9 (11)
<i>Clematis ligusticifolia</i>	western white clematis	7.5 (4)		
<i>Forestiera pubescens</i> var. <i>pubescens</i>	New Mexico olive	4.41 (7)		
<i>Parthenocissus vitacea</i>	Virginia creeper	8.15 (10)	0.06 (1)	0.06 (5)
<i>Rhus trilobata</i>	skunkbush sumac	1.62 (4)		
<i>Ribes aureum</i>	golden currant	0.48 (4)		
<i>Salix exigua</i>	coyote willow		9.18 (24)	42.19 (30)
<i>Tamarix ramosissima</i>	saltcedar	4.31 (13)	5.51 (15)	0.96 (24)
Sub-shrubs				
<i>Gutierrezia sarothrae</i>	broom snakeweed			0.08 (2)
<i>Heterotheca villosa</i>	hairy goldenaster			0.25 (5)
<i>Opuntia phaeacantha</i>	tulip pricklypear			0 (1)
Graminoids				
<i>Agrostis gigantea</i>	redtop		1.35 (3)	2.83 (12)
<i>Bothriochloa laguroides</i> ssp. <i>torreyana</i>	silver beardgrass		3.75 (5)	0.06 (2)
<i>Bouteloua barbata</i>	sixweeks grama			0.03 (1)
<i>Bouteloua gracilis</i>	blue grama			0.03 (1)
<i>Bromus carinatus</i>	California brome			0.15 (2)
<i>Bromus japonicus</i>	Japanese brome	0.06 (1)	1.16 (4)	0.57 (9)
<i>Carex emoryi</i>	Emory's sedge		1.73 (4)	3.74 (10)
<i>Carex occidentalis</i>	western s edge		6.94 (4)	8.58 (4)
<i>Cenchrus longispinus</i>	longspine sandbur			0.02 (4)
<i>Cynodon dactylon</i>	bermudagrass		20.62 (10)	0.25 (6)
<i>Cyperus odoratus</i>	fragrant flatsedge		0.02 (3)	0.1 (2)
<i>Cyperus squarrosus</i>	bearded flatsedge			0.02 (2)
<i>Distichlis spicata</i>	inland saltgrass	0.38 (1)	1.82 (13)	1.91 (3)
<i>Echinochloa crus -galli</i>	barnyardgrass			0.06 (4)
<i>Eleocharis palustris</i>	common spikerush			0.02 (1)
<i>Elymus canadensis</i>	Canada wildrye	0.42 (5)	0.77 (21)	0.42 (21)
<i>Elymus elymoides</i>	bottlebrush squirreltail	0.28 (4)	0.05 (2)	0.51 (11)
<i>Elymus</i> spp.	wildrye		0.06 (1)	0.12 (1)
<i>Elymus x pseudorepens</i>	false quackgrass		0.25 (12)	0.13 (5)
<i>Eragrostis pectinacea</i>	tufted lovegrass			0.09 (1)
<i>Festuca arundinaceae</i>	tall fescue or K-31		1.71 (6)	9.24 (11)
<i>Hordeum jubatum</i>	foxtail barley			0.5 (7)
<i>Juncus arcticus</i> var. <i>balticus</i>	Baltic rush	1.03 (4)	0.05 (8)	0.34 (7)
<i>Juncus torreyi</i>	Torrey's rush		0.06 (1)	0.01 (5)

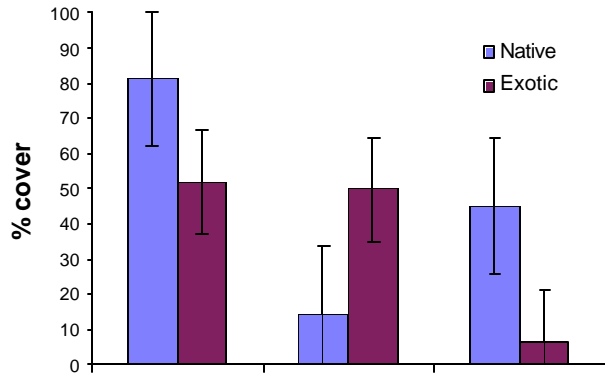
Table 3 cont.

Species Name	Common Name	Bosque	Mixed	Willow
Graminoids cont.				
<i>Leersia oryzoides</i>	rice cutgrass			0.14 (7)
<i>Muhlenbergia asperifolia</i>	alkali muhly	13.95 (4)	5.35 (26)	2.1 (27)
<i>Muhlenbergia racemosa</i>	marsh muhly		0.09 (1)	0.42 (9)
<i>Panicum bulbosum</i>	bulb panicgrass			0.09 (1)
<i>Panicum capillare</i>	witchgrass			0.13 (4)
<i>Panicum hirticaule</i>	Mexican panicgrass			0.17 (2)
<i>Panicum obtusum</i>	vine mesquite	0.23 (3)	5.86 (6)	0.68 (7)
<i>Panicum</i> spp.	panicgrass			0.02 (1)
<i>Paspalum distichum</i>	knotgrass			0.62 (7)
<i>Phragmites australis</i>	common reed		3.17 (5)	0.58 (2)
<i>Poa compressa</i>	Canada bluegrass		0.47 (1)	2.43 (9)
<i>Polypogon interruptus</i>	ditch rabbitsfoot grass			0.03 (1)
<i>Polypogon monspeliensis</i>	annual rabbitsfoot grass			0.27 (6)
<i>Saccharum ravennae</i>	ravennagrass			1.06 (3)
<i>Schoenoplectus pungens</i>	common threesquare			0.25 (4)
<i>Schoenoplectus tabernaemontani</i>	softstem bulrush			0.26 (5)
<i>Setaria pumila</i>	yellow bristlegrass			0 (1)
<i>Sorghastrum nutans</i>	Indiangrass		13.1 (12)	9.6 (20)
<i>Sorghum halepense</i>	johnsongrass			1.23 (3)
<i>Sphenopholis obtusata</i>	prairie wedgescale			0.37 (5)
<i>Sporobolus airoides</i>	alkali sacaton	0.97 (4)	5.23 (28)	1.34 (1)
<i>Sporobolus compositus</i> var. <i>compositus</i>	tall dropseed		6.44 (23)	0.94 (9)
<i>Sporobolus contractus</i>	spike dropseed			0.2 (2)
<i>Sporobolus cryptandrus</i>	sand dropseed		0.98 (10)	1.52 (12)
Unidentified grass			0.16 (1)	0.06 (1)
Forbs				
<i>Ambrosia psilostachya</i>	Cuman ragweed	2.34 (4)	5.34 (30)	7.18 (30)
<i>Anemopsis californica</i>	yerba mansa			0.09 (4)
<i>Apocynum cannabinum</i>	Indianhemp		0.58 (9)	3.52 (18)
<i>Argentina anserina</i>	silverweed cinquefoil			0.02 (3)
<i>Artemisia ludoviciana</i>	Louisiana sagewort			0 (1)
<i>Asclepias speciosa</i>	showy milkweed			0.4 (5)
<i>Asclepias subverticillata</i>	whorled milkweed	0.02 (2)	0.57 (21)	0.2 (5)
<i>Asparagus officinalis</i>	garden asparagus	0.47 (1)		
<i>Bidens frondosa</i>	devil's beggartick			0.06 (8)
<i>Chamaesyce serpyllifolia</i>	thymeleaf sandmat		0.13 (2)	0.4 (15)
<i>Chenopodium berlandieri</i> var. <i>berlandieri</i>	Berlandier's goosefoot		0.12 (2)	
<i>Chenopodium</i> spp.	goosefoot			0.01 (2)
<i>Chloracantha spinosa</i>	spiny chloracantha		1.21 (3)	
<i>Convolvulus arvensis</i>	field bindweed	0.82 (8)	1.9 (10)	0.45 (6)
<i>Conyza canadensis</i>	Canadian horseweed	0.04 (3)	2.96 (7)	2.72 (17)
<i>Croton texensis</i>	Texas croton		0.03 (1)	
<i>Dalea leporina</i>	foxtail prairieclover			0.03 (2)
<i>Dalea</i> spp.	prairieclover			0 (2)
<i>Desmanthus illinoensis</i>	prairie bundleflower		0.02 (2)	
<i>Equisetum laevigatum</i>	smooth horsetail	0.03 (2)	0.16 (26)	0.39 (15)

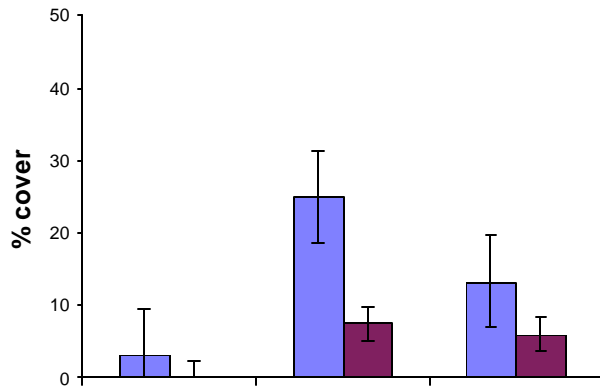
Table 3 cont.

Species Name	Common Name	Bosque	Mixed	Willow
Forbs cont.				
<i>Erigeron divergens</i>	spreading fleabane			0 (1)
<i>Erigeron flagellaris</i>	trailing fleabane		0 (1)	0.08 (7)
<i>Euthamia occidentalis</i>	western goldenrod		0.69 (13)	6.97 (25)
<i>Gaura parviflora</i>	velvetweed	0.06 (1)	0.21 (14)	0.12 (6)
<i>Grindelia nuda</i> var. <i>nuda</i>	curlytop gumweed			1.14 (7)
<i>Helenium autumnale</i>	common sneezeweed			0 (2)
<i>Helianthus annuus</i>	common sunflower	0.03 (1)	0.88 (16)	0.27 (12)
<i>Helianthus petiolaris</i>	prairie sunflower		0.12 (3)	0.03 (1)
<i>Kochia scoparia</i>	common kochia		0 (1)	
<i>Lactuca serriola</i>	prickly lettuce	1.3 (2)	1.18 (7)	0.07 (8)
<i>Lactuca tatarica</i> var. <i>pulchella</i>	blue lettuce		0.09 (1)	0.12 (2)
<i>Linum lewisii</i>	prairie flax		0.03 (1)	
<i>Lycopus americanus</i>	American bugleweed			1.04 (11)
<i>Machaeranthera canescens</i> ssp. <i>glabra</i>	hoary tansyaster		1.16 (5)	0.47 (8)
<i>Machaeranthera pinnatifida</i>	lacy tansyaster		0.03 (1)	
<i>Melilotus officinalis</i>	yellow sweetclover	0.36 (2)	1.66 (22)	2.88 (25)
<i>Mentha arvensis</i>	wild mint			0.49 (3)
<i>Oenothera elata</i> ssp. <i>hirsutissima</i>	Hooker's eveningprimrose	0.03 (1)	0.38 (9)	2.39 (17)
<i>Plantago major</i>	common plantain			0.14 (6)
<i>Polygonum lapathifolium</i>	curlytop knotweed			0 (1)
<i>Pseudognaphalium stramineum</i>	cottonbatting cudweed			0.4 (8)
<i>Pyrrhopappus pauciflorus</i>	desert chicory			0.03 (3)
<i>Ranunculus cymbalaria</i>	alkali buttercup			0.02 (1)
<i>Ratibida tagetes</i>	green prairie coneflower			0.55 (2)
<i>Salsola tragus</i>	prickly Russian thistle		0.74 (4)	1.02 (4)
<i>Senecio riddellii</i>	Riddell's ragwort	0.49 (4)		0.06 (4)
<i>Solanum</i> spp.	nightshade			1.25 (2)
<i>Solidago canadensis</i>	Canada goldenrod		5.78 (9)	2.17 (20)
<i>Sonchus asper</i>	spiny sowthistle		0.06 (1)	0.11 (4)
<i>Sphaeralcea incana</i>	gray globemallow	0.17 (4)		
<i>Sphaeralcea</i> spp.	globemallow	0.06 (3)		0.06 (1)
<i>Symphotrichum ericoides</i>	heath aster		4.58 (21)	1.25 (25)
<i>Symphotrichum lanceolatum</i> ssp. <i>hesperium</i>	white panicle aster		0.07 (4)	1.67 (8)
<i>Taraxacum officinale</i>	common dandelion		0.03 (1)	0.13 (7)
<i>Thelesperma megapotamicum</i>	Hopi tea greenthread	0.54 (3)	1.39 (2)	0 (1)
Unidentified forb		0.01 (1)	0.08 (2)	0.02 (3)
<i>Verbascum thapsus</i>	common mullein			0.06 (2)
<i>Xanthium strumarium</i>	rough cocklebur			0.19 (12)

a) trees and shrubs



b) graminoids



c) forbs

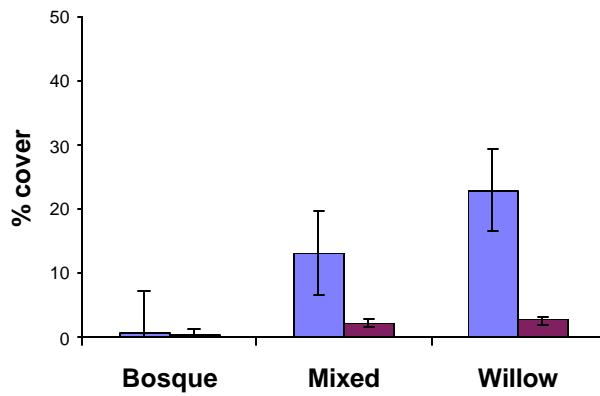


Figure 9. Percent canopy cover by vegetation type stratified by major life forms and exotic-versus-native species.

In contrast, river bar sites lacked the overstory canopy of *Populus* and were typically dominated by shrubs less than three meters tall. With respect to Mixed river bar sites, *Elaeagnus* was either the dominant, or co-dominant with *S. exigua* (an obligate wetland species) (Figure 10 & Table 4). *Ulmus* had also become established on most sites, along with occasional *Populus* sapling or pole reproduction. *Baccharis salicina* (seepwillow), a native shrub, was a co-dominant on one site (Alameda). The herbaceous undergrowth was typically high in cover (>50%) and dominated by graminoids (Figure 9). The common grass dominants were the native *Sporobolus compositus* (tall dropseed), *S. airoides*, *Muhlenbergia asperifolia*, and exotic *Cynodon dactylon* (bermudagrass). While forbs in general were less prevalent, *Symphotrichum ericoides* (heath aster) and *Conyza canadensis* (Canadian horseweed) were often abundant. With respect to wetland indicator status, facultative, facultative upland, and upland species were predominant over facultative wetland or obligate wetland.



Figure 10. Russian olive typically dominates Mixed sites such as this one on the west bank south of the I-40 bridge.

Table 4. Woody basal area (m²/ha) among Mixed sites in 2001.

Site Name	Alameda	AOP Russian Olive	Biopark	I-40	North Rio Bravo	South Bravo Mixed	Average
Natives							
<i>Amorpha fruticosa</i>	0.67						0.11
<i>Baccharis salicina</i>	12.92						2.15
<i>Populus deltoides</i>			5.71	4.56	0.54		1.80
<i>Salix exigua</i>	39.87	2.62	14.66			25.48	13.77
<i>Salix gooddingii</i>	0.16						0.03
Exotics							
<i>Elaeagnus angustifolia</i>	28.30	43.52	36.34	32.38	39.89	21.42	33.64
<i>Tamarix ramosissima</i>	6.06						1.01
<i>Ulmus pumila</i>	0.32		1.43		4.47		1.04
Total	88.30	46.13	58.14	36.94	44.90	46.91	53.55

In contrast, the Willow sites were overwhelmingly dominated by the native wetland obligate *Salix exigua*, while exotic shrubs were generally low in cover (Figure 11). With the exception of *Tamarix*, the exotic trees and shrubs were sporadic in occurrence among sites (Table 5).

Populus reproduction was detected on the majority of the sites but not all. In contrast to the Mixed sites, native forbs tended to dominate over grasses (Figure 9) and facultative wetland and obligate wetland species were more common e.g., *Apocynum cannabinum* (indianhemp), *Euthamia occidentalis* (western goldenrod), and *Oenothera elata* ssp. *hirsutissima* (Hooker's evening primrose).



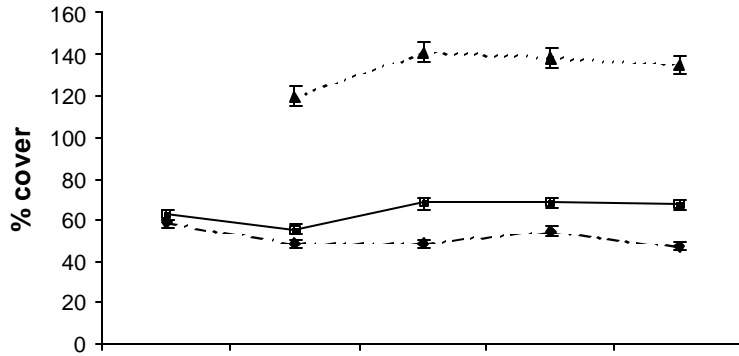
Figure 11. Coyote willow dominates the Willow sites such this one south of the Rio Bravo bridge.

There were different trends of abundance through time among the life form strata (Figure 12). Forb cover on the Willow sites peaked in 1999, corresponding to the peak in annual precipitation (Figure 3), and then declined to a low point in 2002 at the height of the drought. The Mixed sites showed less of a response to precipitation, but still declined in 2002. Grass cover increased on both types through 2001 and then dropped in 2002. Total woody cover was relatively constant among all three types over the five years, but *S. exigua* basal area declined from 2001 to 2002 while *Elaeagnus* did not (Figure 13).

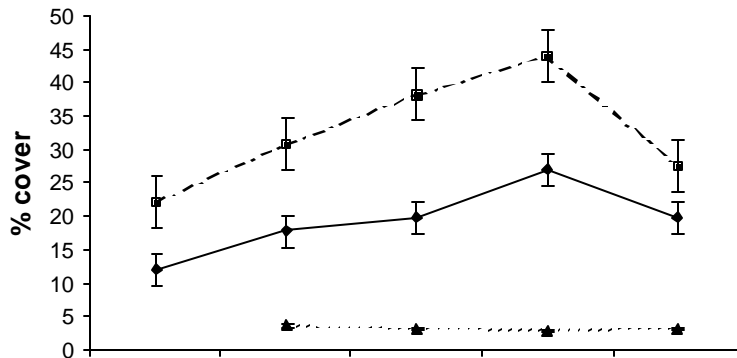
Table 5. Woody basal area (m²/ha) among Willow sites in 2001.

Site Name	AOP Willow	Coronado	Preserve	Paseo Island	South Bravo Power	Tingley	Average
Natives							
Baccharis salicina				5.23	0.32		0.92
Populus deltoides	3.57			0.31	6.42	1.59	1.98
Salix exigua	66.54	74.90	125.16	103.07	73.68	70.11	85.58
Salix gooddingii						1.03	0.17
Exotics							
Elaeagnus angustifolia				5.23			1.87
Morus alba	2.97				0.63	0.16	0.63
Tamarix ramosissima		1.07	7.61	0.77	0.32	1.43	1.87
Ulmus pumila				0.15	9.35	1.31	1.80
Total	73.08	75.97	132.77	114.75	90.72	75.62	93.82

a) trees and shrubs



b) graminoids



c) forbs

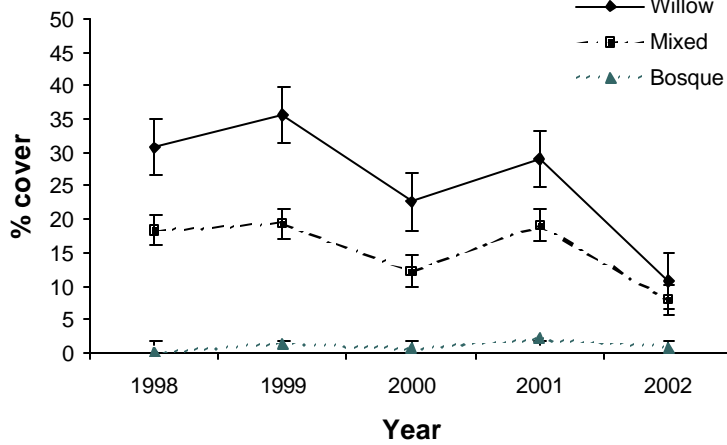


Figure 12. Yearly changes in percent canopy cover stratified by vegetation type and major life forms.

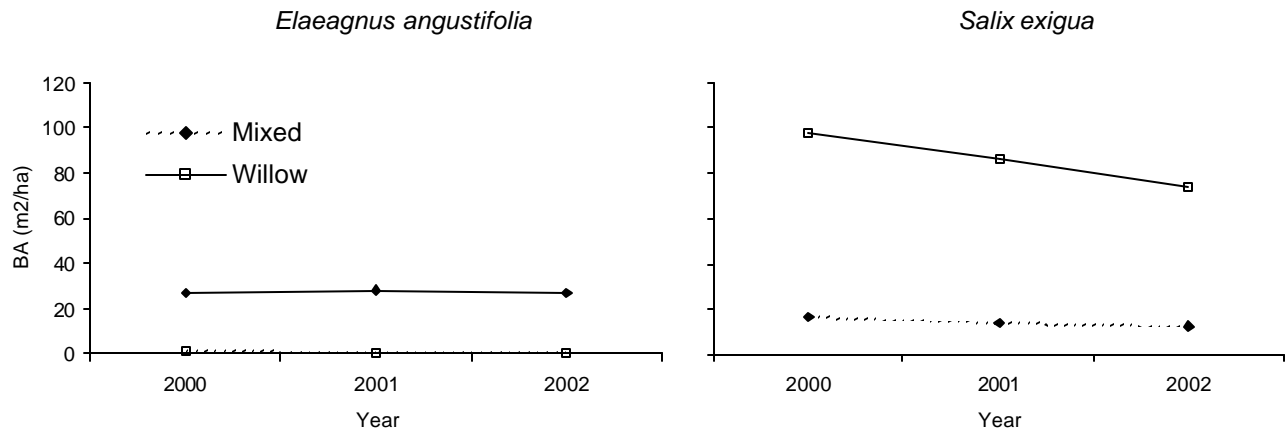


Figure 13. Yearly changes in basal area of the exotic *Elaeagnus angustifolia* (Russian Olive) versus the native *Salix exigua* (coyote willow).

Vegetation diversity

Middle Rio Grande riparian vegetation communities are diverse—we recorded 124 plant taxa—but there were significant differences in species richness among sites (Table 6, and Appendix D). By repeated sampling, we gained 25 taxa between 1998 and 2002, probably as a function of increased search time, seed bank, and possibly immigration. The Willow sites were far more diverse with nearly 40% more species than the Mixed sites, and 65% more than the Bosque. Most of this increased richness was found among the grasses and forbs where 38% of the species were unique to Willow sites (versus 6% among the other sites). Furthermore, both the Willow and Mixed sites had a significantly greater number of natives species and greater native diversity as measured by the Shannon-Wiener Index compared to the Bosque (Figure 15). On a per-site basis, Willow sites ranged from 32 to 74 species while Mixed had only 25 to 39. But Bosque diversity ranged as low as six species up to 17. Collectively, the riverbars not only harbored the majority of plant species in the riparian zone (117 taxa), they contributed 68.5% of the species diversity (85 taxa) while the Bosque contributed only 5.6% unique taxa.

Table 6. Total species 1998-2002 per vegetation type and growth form along with the number of unique species found in a given vegetation type.

	Vegetation Type			Total
	Bosque	Mixed	Willow	
Trees (>3 m)	6	5	5	6
Shrubs (>0.5 m and < 3 m)	8	5	4	9
Sub-shrubs (<0.5 m)	1	1	3	4
Graminoids	8	25	49	49
Forbs	16	31	48	56
All species	39	67	110	124
Unique species	7	7	47	--

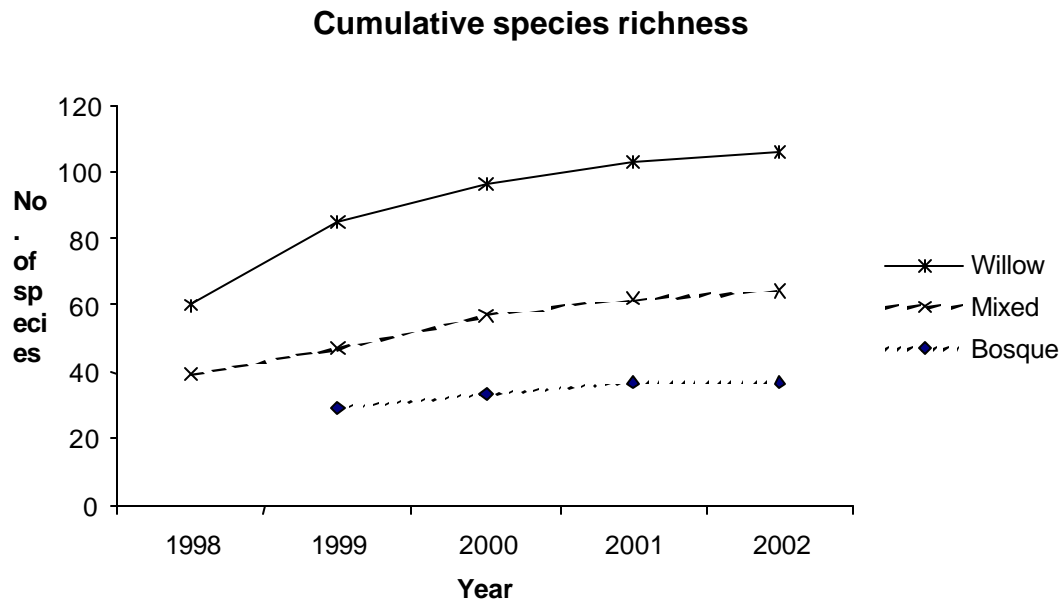


Figure 14. Cumulative plant species richness over the duration of the study. Bosque sites were not established until 1999.

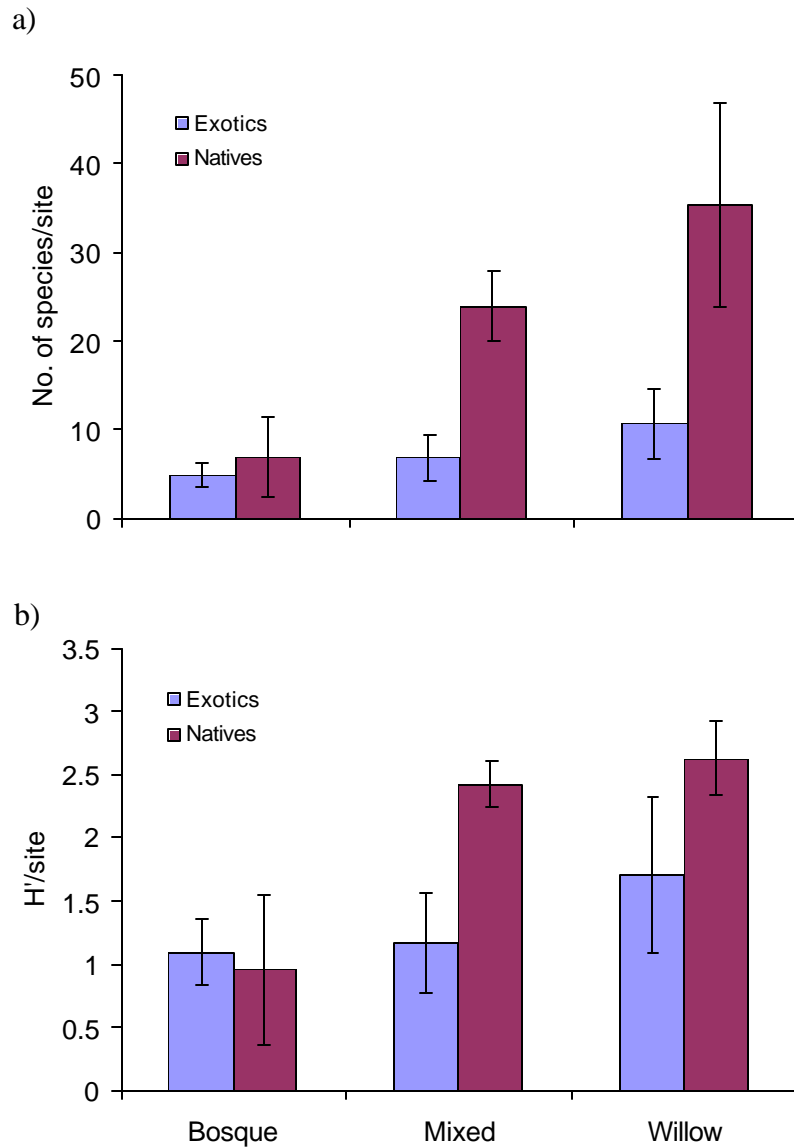


Figure 15. a) Plant species richness between vegetation types stratified by native versus exotic origin. b) Corresponding Shannon-Wiener diversity index.

Arthropod Diversity

Among ground-dwelling arthropods there were clear patterns of species richness and abundance across the Bosque, Willow, and Mixed vegetation types, particularly with respect to ants. We collected 17 species or operational ant species complexes during the four-year sampling period (including one probable new record for the state, *Pyramica* sp.⁴)(Table 7). With the exception of the AOP Willow site, there were significant differences in the average number of ant species per site and site diversity as measured by the Shannon-Wiener Index (S-W Index), with willow-dominated sites the highest, followed by the Mixed sites, and then the mature cottonwood forest stands (Figure 16). These differences were driven not by the number of rare species, but rather by the significantly greater number of common species at both Willow and Mixed sites, and the significantly greater number of *very* common species at Willow sites (Figure 17).

A community ordination analysis based on 14 of the most common ant taxa further emphasized the differences among the three vegetation types (Figure 18). The first axis isolated bar sites, both Willow and Mixed, from Bosque sites and was driven by the high abundance of *Lasius pallitarsis* (field ant), *Crematogaster mormonum* (acrobat ant), and *Camponotus* spp. (carpenter ant) in the Bosque versus *Tapinoma sessile* (odorous house ant), *Monomorium minimum* (little black ant) and *Solenopsis* sp. (native fire ant) on the bars. The second axis primarily served to distinguish Willow from Mixed sites, where higher abundances of *Dorymyrmex insanus* (crater-nest ant), *T. sessile*, *L. pallitarsis*, and *C. mormonum* defined the Willow sites, while *M. minimum*, *Brachymyrmex depilis*, and *Solenopsis* sp. characterized Mixed sites.

This pattern is in keeping with previous studies on ant distribution in the Rio Grande Bosque (Milford 1999, Ellis 2001, Ellis et al. 2001). For example, ground nesting *Lasius pallitarsis* was found to be a dominant species at primarily unflooded forest sites (Milford 1999) and this was the case here where it dominated Bosque sites that have not been flooded for at least ten years or more. Similarly, *Camponotus* spp. are more or less restricted to Bosque sites because they prefer to nest in large trees or dead wood. *Crematogaster mormonum* is a common Bosque species that favors trees for nesting sites and is tolerant of periodic flooding (Milford 1999). *Tapinoma sessile* is a species that moves its nests often and has a predisposition for colonizing disturbed areas (Smallwood, 1982) which probably fosters its dominance on bar sites. Milford (1999) found these species were co-dominant at flooded Bosque sites elsewhere in the Rio Grande, thus their dominance at Willow sites may indicate that they are more frequently flooded than are Mixed sites.

Other species are clearly bar-defining species. *Monomorium minimum* is a species known from forest clearings and grassy meadows, where it is active at high temperatures (Holldobler and Wilson 1990). While previously observed occasionally in the mature Bosque (Milford 1999, Ellis et al. 2001), it was dominant at the bar sites, occupying 70-80% of pitfalls at Willow and Mixed sites. Bar sites, lacking the overhead canopy of mature cottonwoods, are

⁴ Currently being identified to species by Dr. Mackay, University of Texas El Paso.

Table 7. Ant species abundance across vegetation types as measured by the average number of pitfalls occupied per site/survey date over all years (ordered taxonomically by subfamily and alphabetically within subfamily). Also included are the univariate ANOVA significance probabilities and the canonical discriminant analysis total structure correlation coefficients.

Speices/Species complex	Bosque	Mixed	Willow	AOP Willow	<i>P</i>	CAN1**	CAN2**
Ponerinae							
Hypoponera sp.	0.01	0.04	0.06	0.23	0.3375	0.103	0.040
Ecitoninae							
Neivamyrmex sp.	0.01	0.03					
Myrmicinae							
Unid Myrmicinae		0.03	0.12	0.08	0.0319	0.165	0.116
Crematogaster mormonum*	1.89	0.09	0.80	0.31	<.0001	-0.439	0.380
Leptothorax sp.	0.52	0.05			<.0001	-0.361	0.069
Monomorium minimum*	0.52	8.31	7.12	5.69	<.0001	0.821	-0.399
Pheidole sp.	0.04	0.04	0.26		0.0002	0.196	0.258
Pogonomyrmex occidentalis*	0.01	0.68	2.28		<.0001	0.427	0.300
Pyramica sp.*		0.01					
Solenopsis sp.	0.48	2.59	3.09	0.08	<.0001	0.517	-0.049
Dolichoderinae							
Dorymyrmex insanus *	0.03	0.19	1.82		<.0001	0.486	0.522
Tapinoma sessile *	0.10	3.13	7.68	7.62	<.0001	0.825	0.415
Formicinae							
Acanthomyops sp.		0.03					
Brachymyrmex depilis *	0.05	0.46	0.06	0.08	0.0054	0.083	-0.257
Camponotus sp.	0.52	0.04	0.03		<.0001	-0.436	0.122
Formica sp.	1.34	2.05	4.23	2.23	<.0001	0.384	0.301
Lasius pallitarsis	7.25	1.49	2.54	0.15	<.0001	-0.743	0.397

* ID's confirmed by W. Mackay.

** Canonical discriminant function eigenvalues: CAN1 = 5.9848; CAN2 = 1.7445.

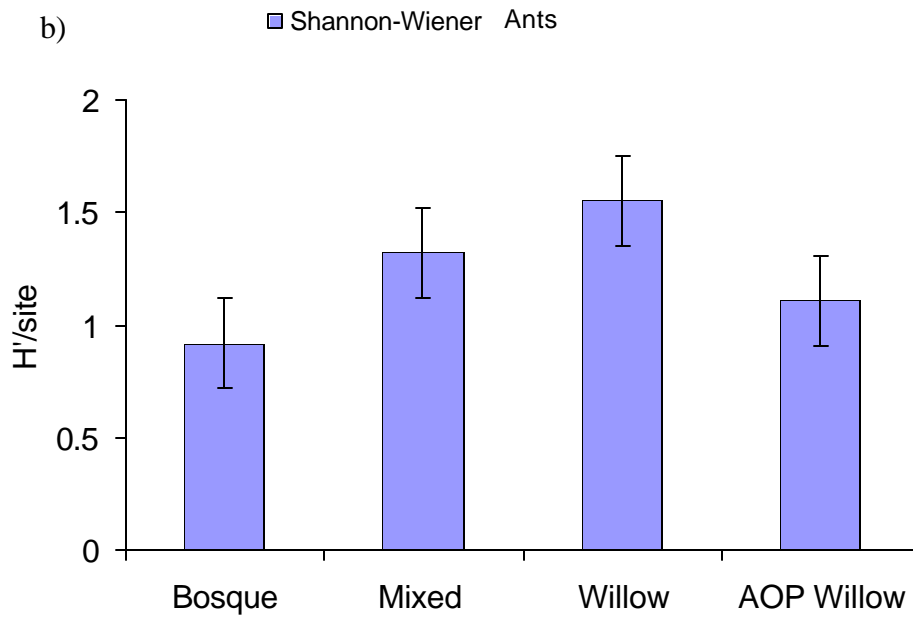
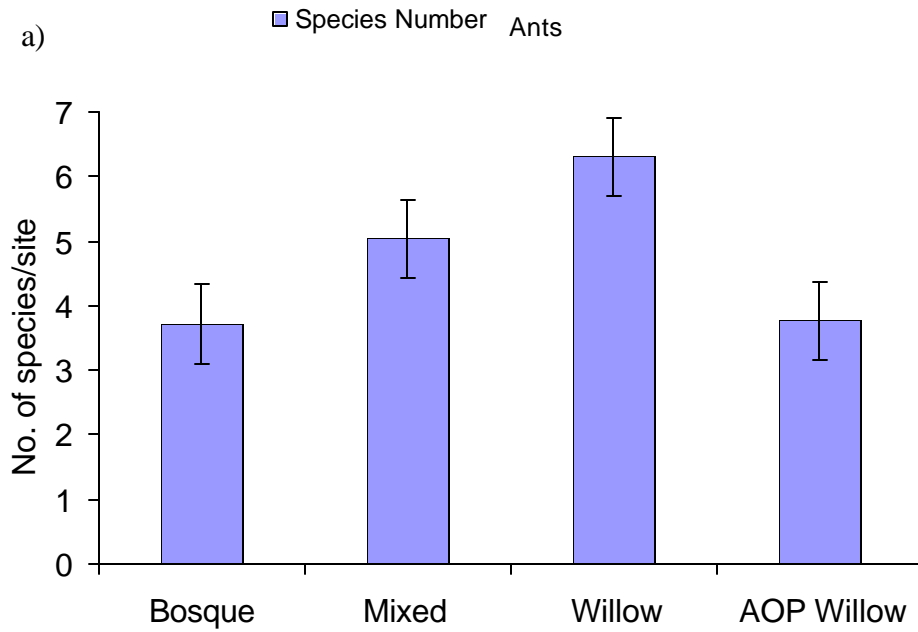


Figure 16. a) Ant species richness between vegetation types. b) Corresponding Shannon-Wiener diversity index.

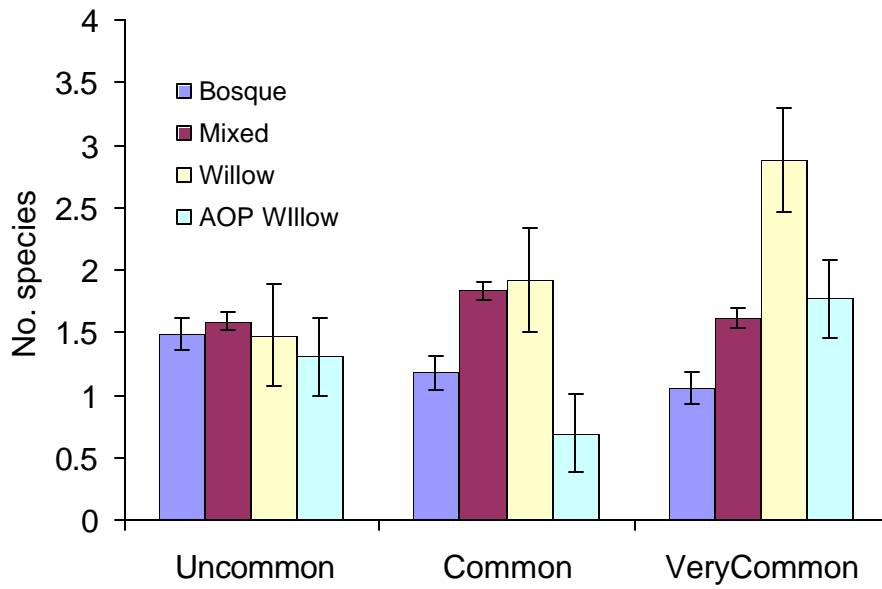


Figure 17. Number of uncommon, common or very common ant species between vegetation types.

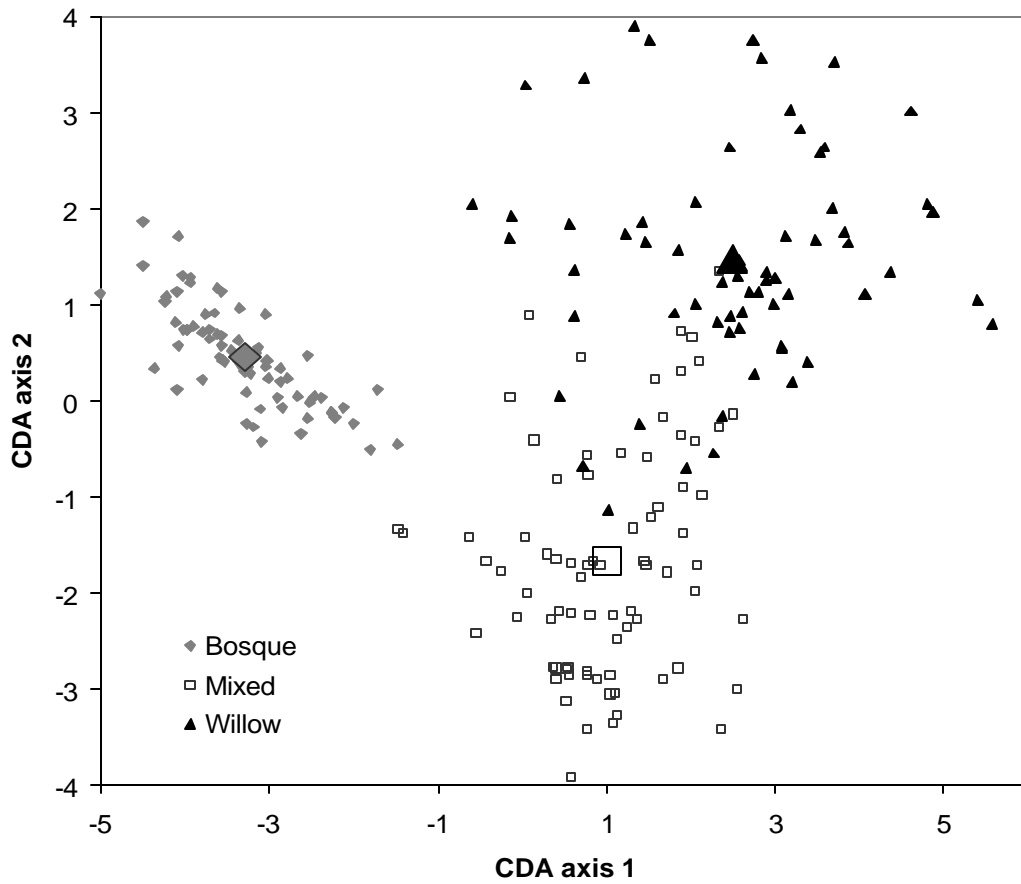


Figure 18. Ant canonical discriminant analysis (large symbols represent group centroids).

more open and sunny than Bosque sites, and thus warmer during the day, which may contribute to this species' dominance on the bars. It, along with the native *Solenopsis* sp., characterize bar sites, but they are particularly important in distinguishing Mixed sites, indicating that Mixed sites are likely warmer than Willow sites. *Dorymyrmex insanus* is known to prefer nesting in open areas, often near *Pogonomyrmex* (harvester ant) nests. Hence, they tend to favor Willow sites because they often have more open sandy areas. In contrast, *Brachymyrmex depilis* is a common, though rarely collected, soil-nesting species that may prefer the less sandy soils of Mixed sites. Overall, our results suggest that willow sites may provide a more diverse and resource-rich habitat for the ants, due possibly to greater vegetative species diversity, higher productivity, or greater habitat heterogeneity.

With respect to beetles, the cumulative species richness across all sites and years was 120 unique taxa from among 31 families (Appendix E). As with the ants, while there were not striking differences in overall species numbers among vegetation types, there were distinct preferences among individual species (Table 8). In addition, when considering the five major beetle families combined, Bosque sites were significantly lower in species richness and diversity at the site level than the bars (Figures 19). And among the bar sites, Mixed sites were significantly richer in species than Willow sites (with the exception of AOP Willow). This was driven primarily by *Carabidae* on Mixed sites and *Staphylinidae* on the Willow sites.

A beetle community ordination based on 24 species further differentiated the vegetation types (Figure 20). Along the first axis various Carabid beetles were key to differentiating Willow sites from Mixed and Bosque sites, e.g. *Calathus opaculus* (ground beetle), *Harpalus pennsylvanicus* (dingy ground beetles), and *Cyclotrachelus* spp.(ground beetle) at Mixed and Bosque sites versus *Scarites subterraneus* (pedunculate ground beetle), *Cicindela* sp.(tiger beetle), and *Amara* sp.(seed-eating ground beetle) along with the Tenebrionid *Blapstinus pimalis* (small darkling beetle) at Willow sites (Table 8). *Calathus opaculus* is known to be abundant in both native and exotic dominated mature bosque (Ellis et al. 2000; Ellis et al. 2001; Bess et al. 2002), and its abundance on Mixed sites points to a linkage between Mixed sites and mature bosque. The exception once again was the AOP Willow site where *C. opaculus* was exceptionally abundant, but this may be a function of this site being imbedded in a larger Russian olive stand at AOP. Ellis (2001) reported that *C. opaculus* was the most abundant beetle in forest, Russian olive, and in adjacent cleared restoration areas of AOP, indicating that AOP Willow may be strongly co-varying with some site-wide factor at AOP. If AOP Willow is set aside, our results suggests that for *C. opaculus* there is a significant difference in structure between Willow types and the Bosque and Mixed vegetation types. While flooding is not considered a primary determining factor for abundance of *C. opaculus* (Ellis 2001; Ellis et al 2001), surface moisture, ground cover or litter density may be key to the differences observed between vegetation types.

Along the second canonical axis, the greater abundance of tenebrionids was pivotal to distinguishing Bosque types from Mixed types, e.g., *Embaphion contusum* (darkling beetle), *Eleodes longicollis* (darkling beetle), and *Eleodes suturalis* (darkling beetle) in the Bosque versus *Aeolus livens* (click beetle), *Cryptophagus* sp.(silken fungus beetle), *Galerita janus* (false bombardier beetle) and *H. pennsylvanicus* in Mixed sites (Elateridae, Cryptophagidae, and Carabidae families). This is in keeping with studies that show that Tenebrionids decrease after

Table 8. Beetle species abundance across vegetation types as measured by the average number of individuals per site/survey date (ordered taxonomically by family and species). Also included are the univariate ANOVA significance probabilities and the canonical discriminant analysis total structure correlation coefficients.

Family	Scientific Name	Bosque	Mixed	Willow	AOP	P	CAN1**	CAN 2**
					Willow			
Carabidae								
	Amara spp.	0.05	0.21	0.38	0.46	0.018	0.255	0.186
	Calathus opaculus	6.33	5.56	1.25	26.31	0.018	-0.298	-0.077
	Calosoma scrutator	0.01				0.377		
	Cicindela sp.		0.01	0.15		0.003	0.364	0.068
	Cyclotrachelus spp.	0.77	1.45	0.37	0.08	0.036	-0.227	0.179
	Galerita janus		0.19	0.02	0.85	0.002	-0.198	0.370
	Harpalus caliginosus	0.05	0.10	0.05	0.08	0.482		
	Harpalus fuscipalpus	0.01	0.01		0.08	0.650		
	Harpalus pennsylvanicus	0.62	1.41	0.29	11.15	0.001	-0.302	0.277
	Lebia sp.		0.01	0.02		0.593		
	Omophron americanum			0.03		0.314		
	Pasimachus californicus	0.04	0.14	0.02	0.15	0.041	-0.194	0.213
	Pasimachus elongatus		0.03			0.169		
	Poecilus chalcites				0.08	.		
	Poecilus lucublandus		0.03		0.62	0.169	-0.116	0.186
	Pterostichus restrictus	0.03	0.03		0.08	0.418	-0.142	-0.023
	Pterostichus sp.				0.08	.		
	Scarites subterraneus	0.04	0.06	0.54	0.62	<.0001	0.479	0.069
	Tachys sp.			0.03		0.097	0.234	0.023
Cryptophagidae								
	Anchicera sp.		0.01			0.415		
	Cryptophagidae	1.19	0.03	0.05		0.316	0.126	0.118
	Cryptophagus spp.	0.08	3.83	1.52	0.62	0.059	-0.059	0.278
	Toramus sp.		0.03			0.415		
Elateridae								
	Aeolus livens	0.58	5.71	1.62	6.85	0.000	-0.174	0.436
	Agrypnus rectangularis	0.03	0.03	0.08	0.08	0.312		
	Conoderus sp.	0.04	0.03	0.02	0.15	0.893		
	Heterodes sordidus	0.01				0.377		
	Lanelater schottii	0.08	0.10	0.05		0.517		
	Melanotus longulus			0.02		0.314		
Staphylinidae								
	Aleocharinae	0.03	0.21	0.45	0.15	0.053	0.224	0.151
	Baeocera sp.			0.02		0.314	0.165	0.016
	Brachygluta texana				0.08	.		
	Creophilus maxillosus	0.01			0.08	0.377		
	Hapalareaa cacti	0.01	0.01	0.02	0.08	0.992		
	Lobrathium angusta			0.02		0.314		
	Ocypus ater		0.01			0.415		
	Philonthus semiruber		0.01			0.415	-0.082	0.132
	Platydacus sepulchralis	2.26	10.33	1.08	26.38	0.031	-0.187	0.238
	Pselaphinae		0.03		0.08	0.169	-0.116	0.186
	Quedius sp.	0.01		0.08		0.383		
	Staphylinidae	0.01				0.377		

Table 8 cont.

Family	Scientific Name	AOP				P	CAN1**	CAN 2**
		Bosque	Mixed	Willow	Willow			
Tenebrionidae								
	<i>Araeschizus decipiens</i>		0.04	0.02		0.543		
	<i>Blapstinus fortis</i>	3.48	2.81	5.23	0.85	0.303	0.166	-0.025
	<i>Blapstinus pimalis</i>	0.05	0.08	1.57	0.08	<.0001	0.510	0.066
	<i>Eleodes extricata</i>	0.01	0.05	0.08	0.62	0.380		
	<i>Eleodes longicollis</i>	0.10		0.03		0.047	-0.024	-0.295
	<i>Eleodes obsoleta</i>	0.01				0.377		
	<i>Eleodes suturalis</i>	0.40	0.28	0.20	0.23	0.305	-0.124	-0.125
	<i>Embaphion contusum</i>	0.73	0.05	0.03	0.15	<.0001	-0.197	-0.480
	<i>Eusattus reticulata</i>		0.01		0.08	0.415		
	<i>Lobometopon fusiformis</i>	0.01	0.14	0.05	0.08	0.138		

** Eigenvalues: CAN1 = 0.6530 CAN2 = 0.4763

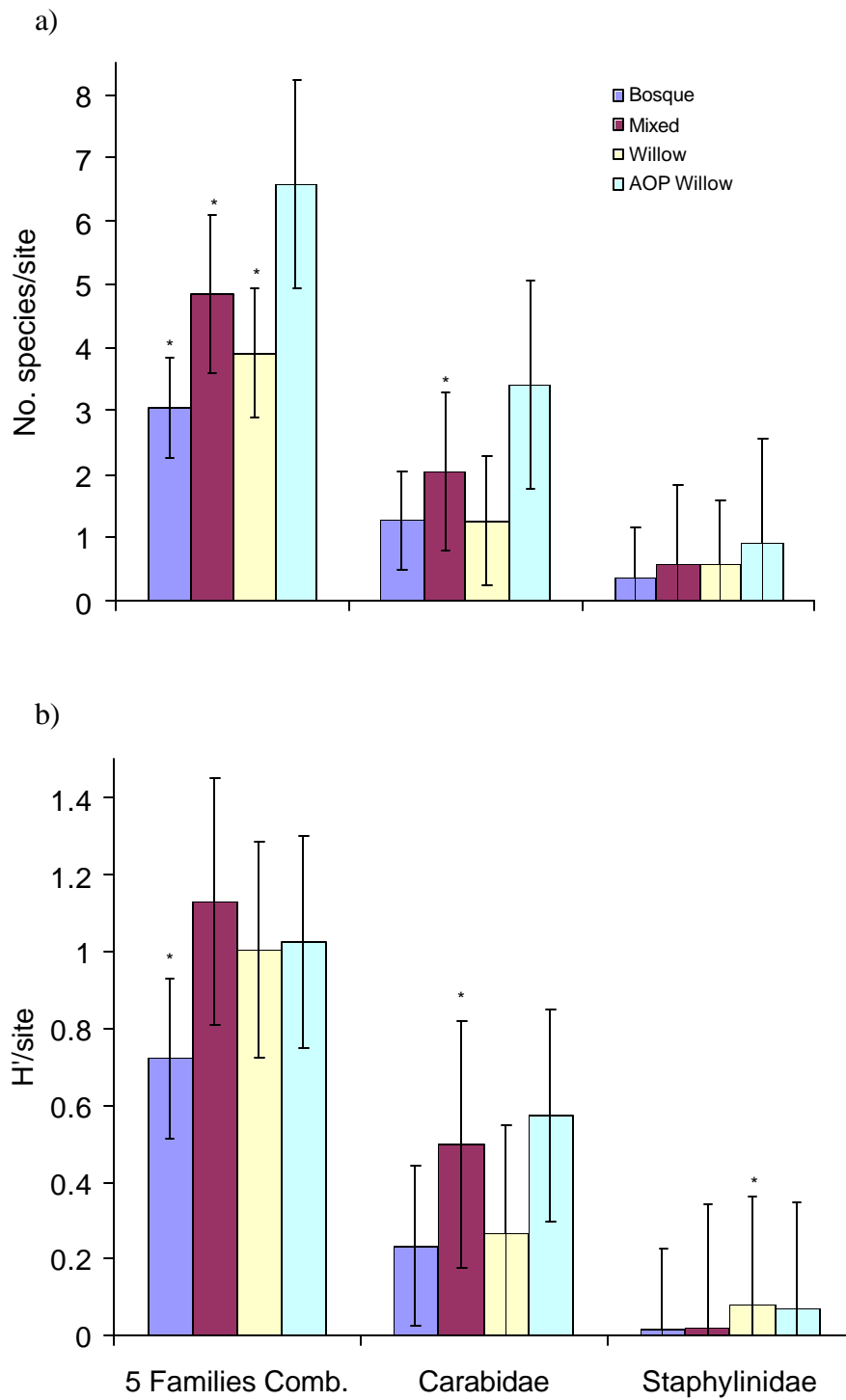


Figure 19. a) Beetle species richness between vegetation types for the five major families combined, the Carabidae, and the Staphylinidae. b) Corresponding Shannon-Wiener diversity index (* indicates significantly different values).

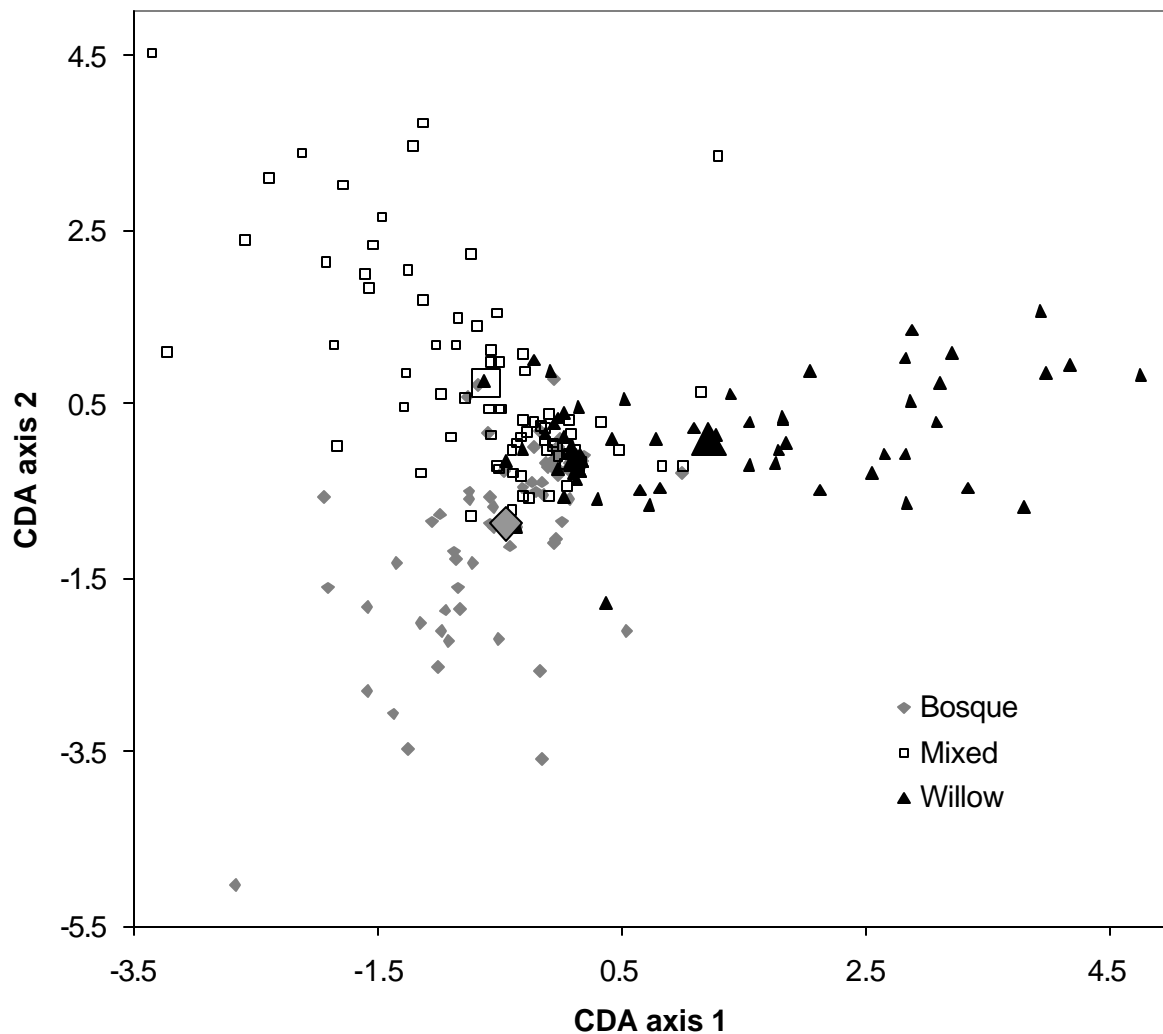


Figure 20. Beetle canonical discriminant analysis (large symbols represent group centroids).

experimental flooding and generally prefer arid environments (Ellis et al, 2000, 2001). Borror et al. (1989) state that “throughout the arid regions of the United States these beetles [Tenebrionidae] take over the ecological niche that is occupied by the Carabidae in the more verdant areas.” However, even very young and recently flooded willow bars can still have tenebrionids, although in lower numbers than in the mature bosque (Ellis 2001), and this is reflected here by the strong presence of *Blapstinus fortis* and *B. pimalis* on Willow sites. In addition, many tenebrionids are detritivores (White 1983; Ellis 2001), so the difference between Bosque and Mixed types may also be related to a differences in available litter as well as moisture.

Differing life history traits are likely responsible for the significantly different seasonal patterns of abundance observed in the Carabidae and Tenebrionidae (Figure 21). Tenebrionids were at maximum numbers in early spring and quickly tailed off in the summer while Carabids (with the exception of AOP Willow) gradually increased to a peak in the late fall. While AOP Willow always had more Carabids through the year than other sites, the August numbers in 2001

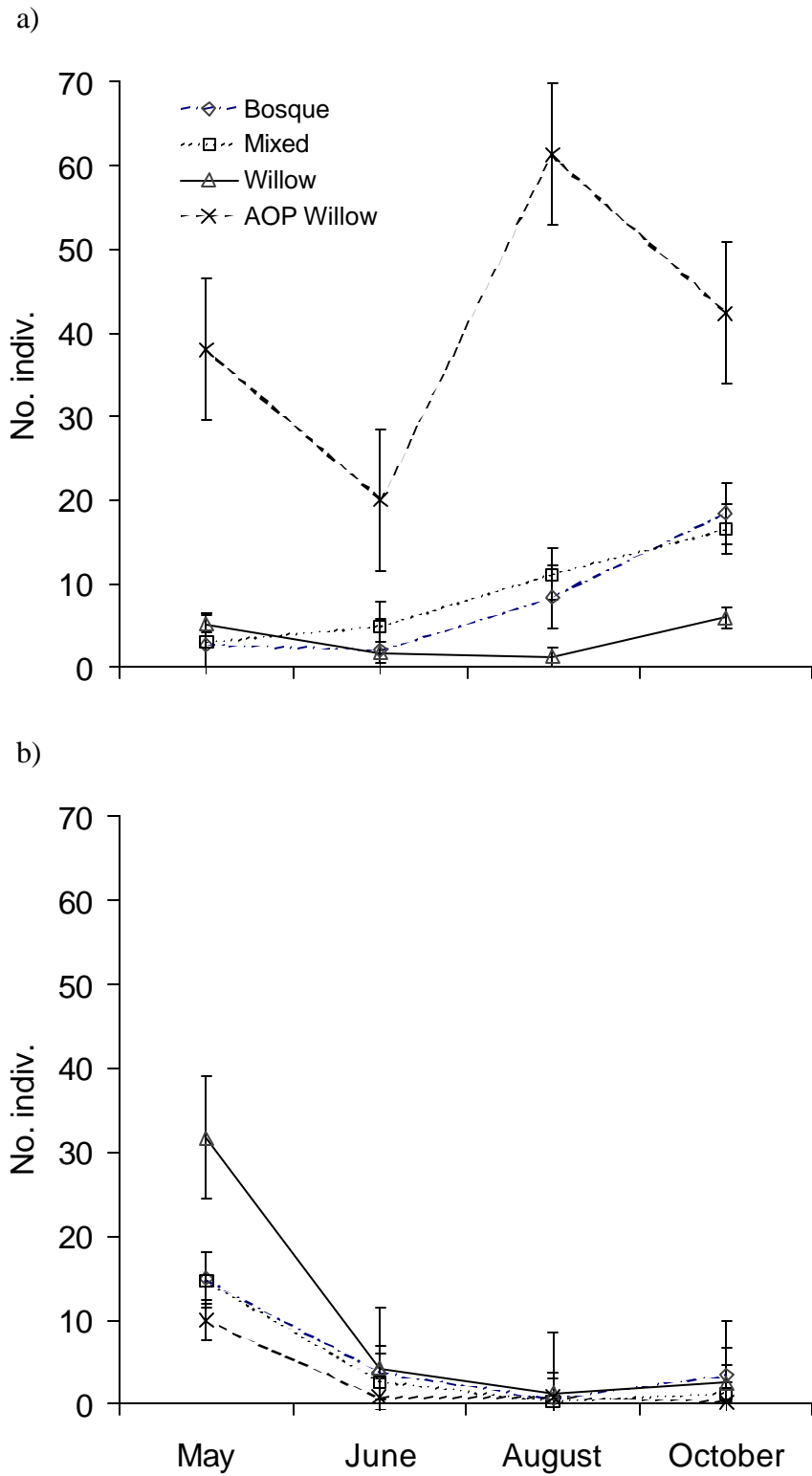


Figure 21. a) Carabidae monthly abundance per site between vegetation types. b) Corresponding Tenebrionidae abundance.

were exceptionally high (180 individuals versus an average of 10 among the other sites that year). Across years, carabid abundance generally peaked in 2001 and dropped precipitously in 2002 following the severe winter drought of 2001-02 (Figure 22). Tenebrionids followed a similar pattern, but there was an exceptionally strong response among a few willow sites in the spring of 2000, and the decline in 2002 was not as steep as that of Carabids, suggesting that amount and timing of precipitation along with site factors play complex roles in the abundances of ground-dwelling arthropods.

Isopods (pillbugs) and crickets, the two main detritivores (consumers of litter) found at the sites, also showed some significant temporal patterns (Figure 23 & 24). Isopods are non-native crustaceans that outnumber crickets by two to three orders of magnitude. Isopods were abundant year-round, but numbers were unusually high in May of 2000, particularly on the Mixed bar sites. AOP Willow continued to be an outlier, with generally greater abundance than most sites. Moisture may play a role, e.g., Ellis et al (2001) found cricket abundance increased after two years of experimental flooding, but isopods decreased. While none of our sites were flooded during the study period, sites such as AOP Willow had water at or near the surface, which presumably would have favored the crickets. Either high surface moisture without flooding is beneficial to isopods or another site-wide factor on the greater AOP bar, such as the clay-rich soils, is responsible for the high number of isopods observed. Heinzlmann et al. (1995) found that the distribution of the isopod *Armadillidium vulgare* was correlated more with clay loam soils than with tree species, although they did find that *Armadillidium* grew and survived better on Russian olive leaf litter versus cottonwood. Thus, the greater peak number of isopods at the Mixed types may be due to a preference for Russian olive litter and possibly soil characteristics (Mixed soils tend to have more clays than Willow). Similarly, there was a peak in cricket abundance in 2001 at the Bosque and Willow sites versus Mixed sites, indicating that differences in litter type may be important for crickets as well as isopods.

Spiders, who feed primarily on other arthropods, showed a significant seasonal pattern of peak abundance in the spring and early summer samples with a steady decline through late summer and early fall (Figure 25 and 26). This likely reflects large numbers of young spiders present in the spring followed by age-specific mortality over the summer. While Bosque sites tend to have the highest number of spiders, there were generally no significant differences among vegetation types through time. The drought of 2001-02 may have favored spiders, whose numbers were up across all types in 2002 during the height of drought. Hence, the diversity and dynamics among ground-dwelling arthropods is complex, reflecting an interaction between species across and within trophic levels, and in relation to site characteristics and climatic patterns.

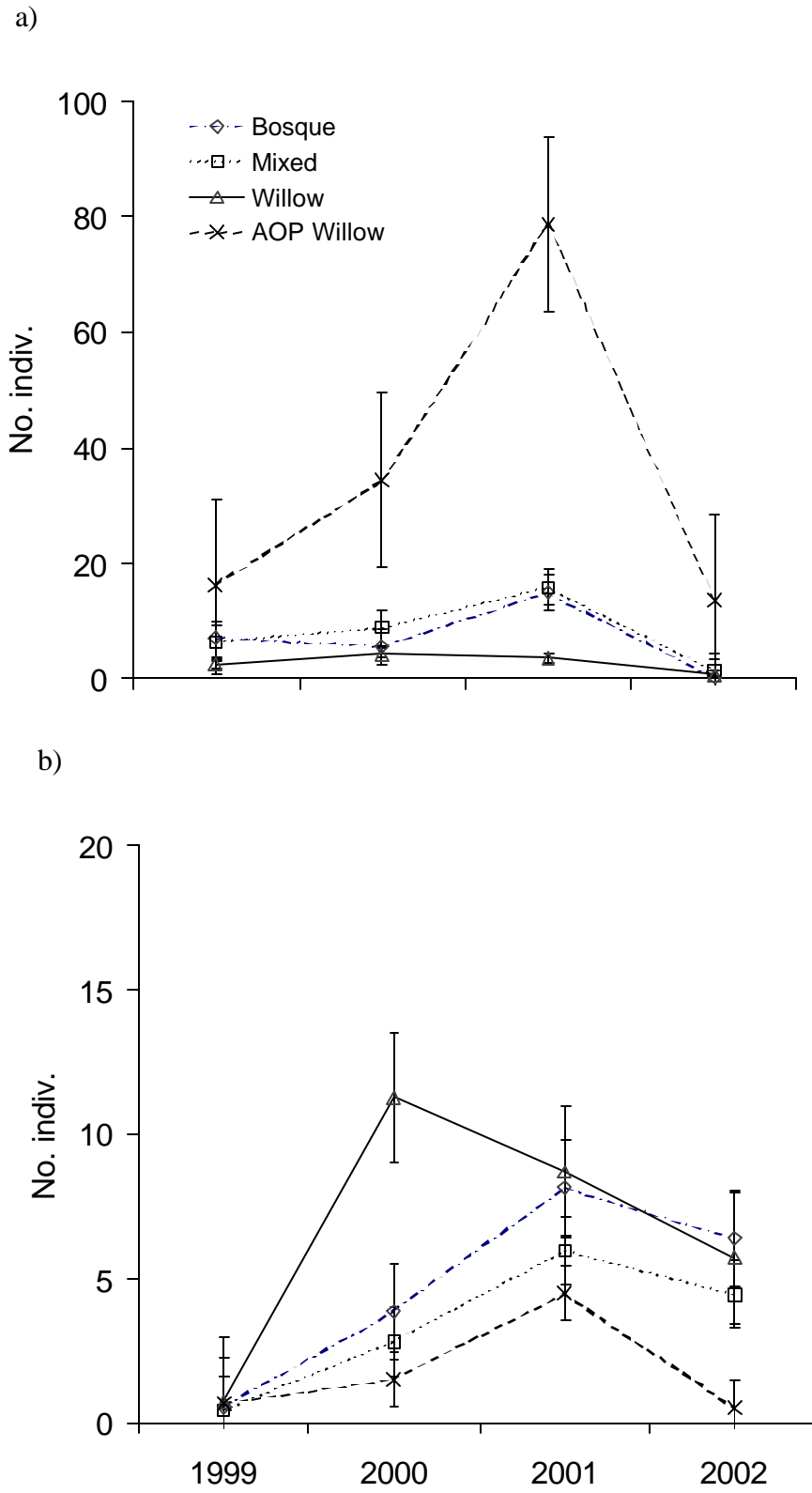


Figure 22. a) Carabidae annual abundance per site between vegetation types. b) Corresponding Tenebrionidae abundance.

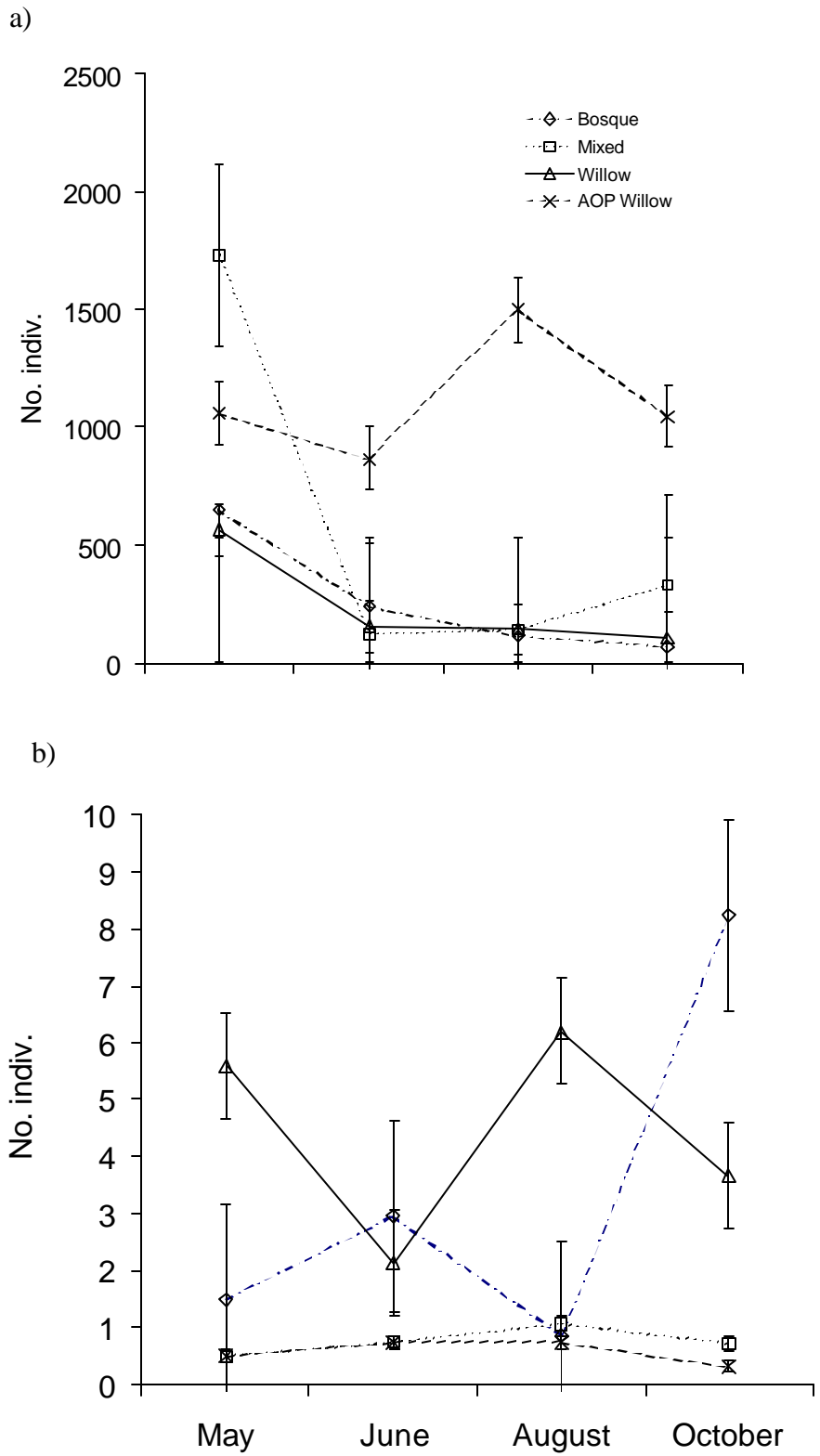


Figure 23. a) Isopod monthly abundance per site between vegetation types. b) Corresponding cricket abundance.

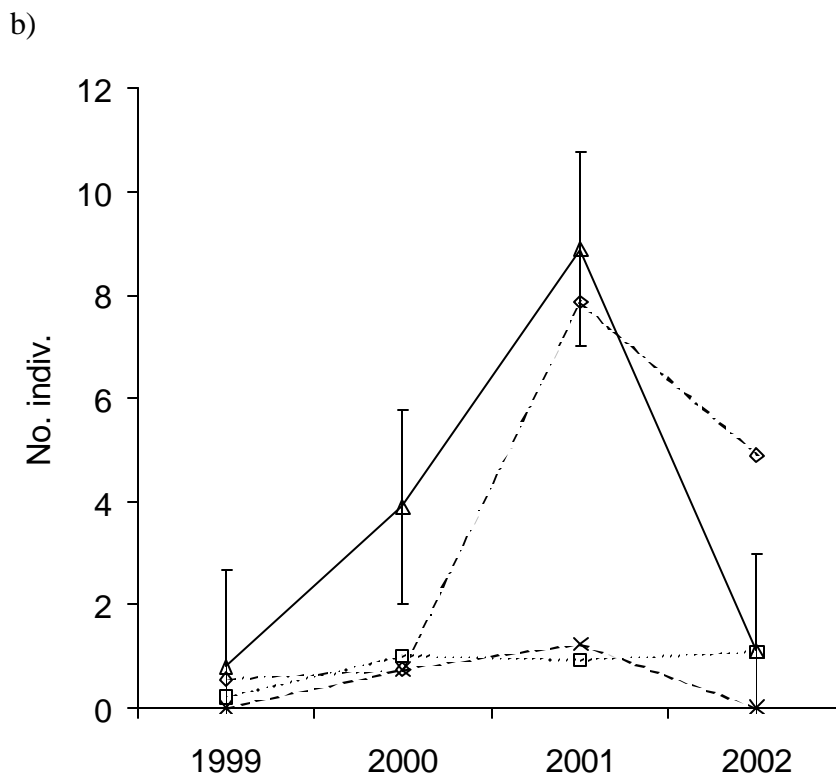
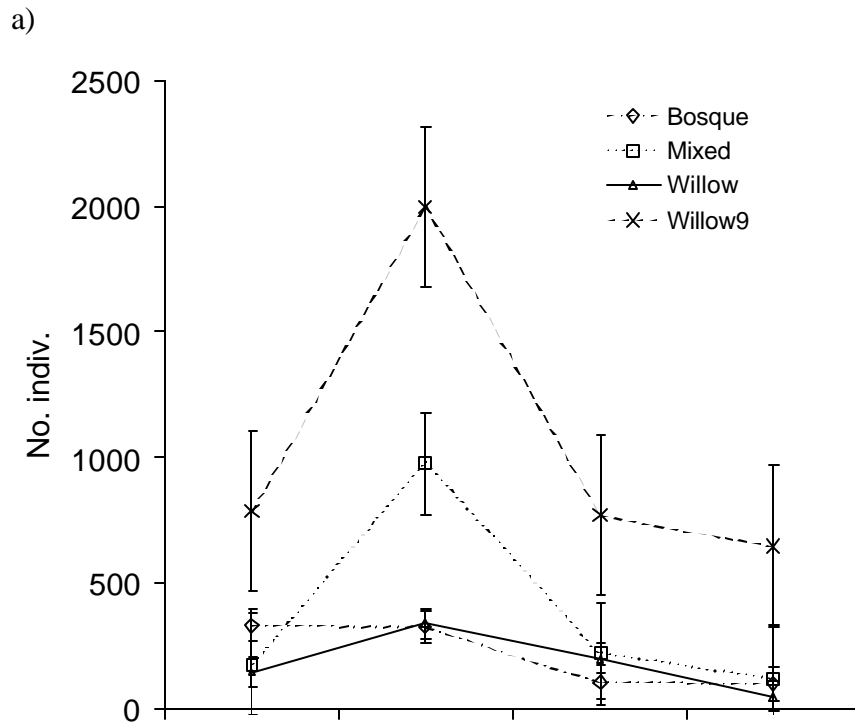


Figure 24. a) Isopod annual abundance per site between vegetation types. b) Corresponding cricket abundance.

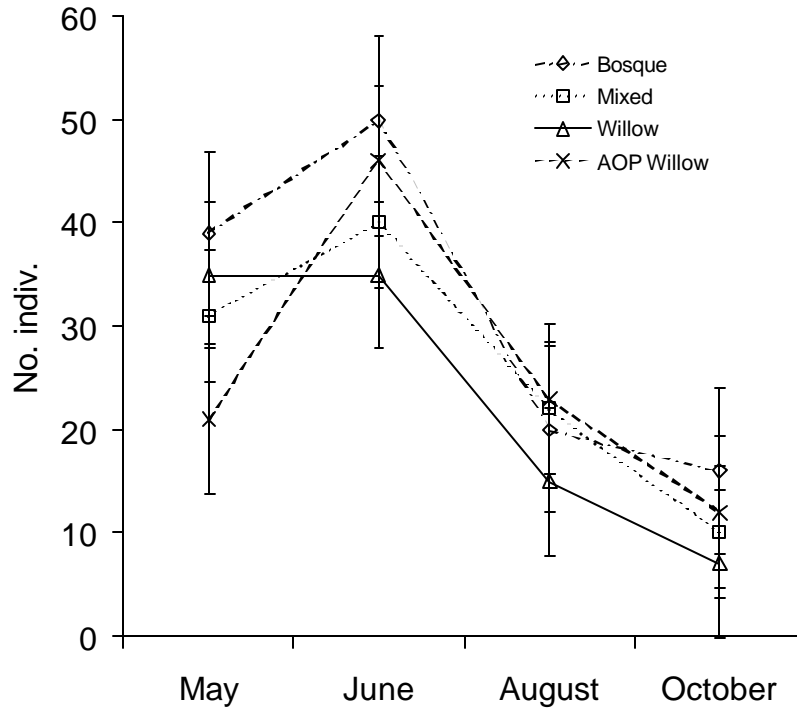


Figure 25. Spider monthly abundance per site between vegetation types.

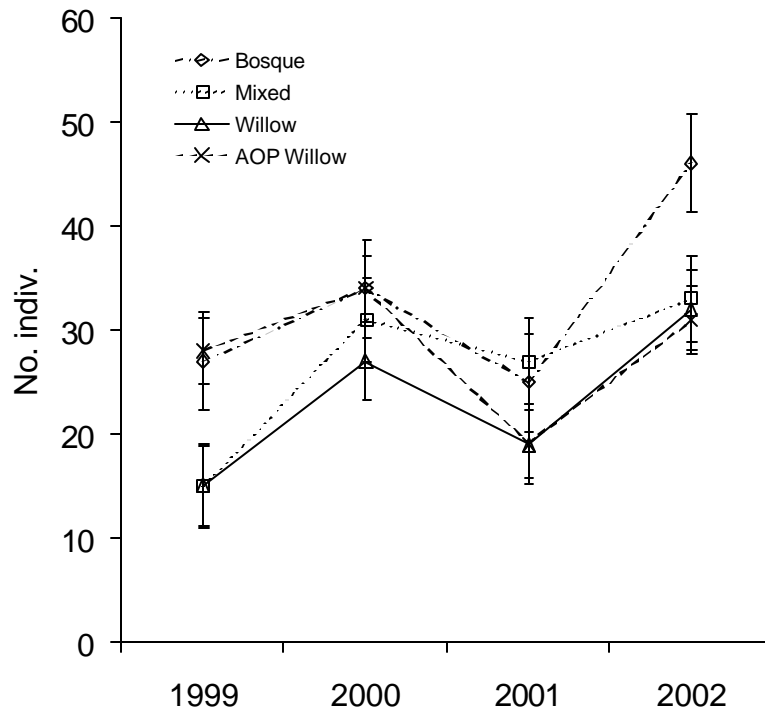


Figure 26. Spider annual abundance per site between vegetation types.

Discussion

Given their exceptionally high plant and arthropod diversity, and their role in cottonwood regeneration, river bars represent keystone communities in the Middle Rio Grande riparian ecosystem. This is particularly the case for bars dominated by coyote willow where plant diversity was nearly twice that of Russian olive bars and three times that of the adjacent mature Rio Grande cottonwood bosque. The distinctively different ground-dwelling arthropod communities that were unique to the bars also points to a high diversity potential for the animal component as a whole. Furthermore, these sites are *the* source points for the natural reproduction of cottonwoods in the system, and as such are key to the renewal and long-term sustainability of riparian forests in the ecosystem. Without river bars, cottonwood forests along the river are likely to senesce and be replaced by exotic-dominated woodlands, open dry grasslands, shrublands and bare ground rather than new, vigorous stands of native trees and shrubs as found on the bars.

Our results suggest that biodiversity of this ecosystem can be further enhanced by removing Russian olive on bars and encouraging willow and cottonwood establishment (see Muldavin, Crawford, and Umbreit (2004) for an example of the use of overbank flooding and geomorphic manipulations to generate cottonwood and willow stands on bars). Based on our data, the expectation is that besides the willows, native herbaceous species richness and abundance would increase along with the potential for natural cottonwood regeneration. This in turn would likely provide the composition and added structure necessary to support a richer faunal component of birds, mammals, and insects (studies are currently underway on the aerial insect biodiversity of bar sites to test this hypothesis). This concept could also be extended to replacing senescing forest stands with periodically flooded bars to generate a complex mosaic of forest, shrublands, and herbaceous wetlands that, per Crawford and Grogan (2004), maximizes native landscape-wide biodiversity, reduces fire hazard, and helps ensure long-term sustainability of the Rio Grande riparian ecosystem.

Under this scenario, there are still some important information needs with respect to bars. For example, given that cottonwoods and willows have specific germination and establishment requirements with respect to substrate and moisture that are not found in Russian olive (Shafroth et al. 1995), what are some of the particular soil, geomorphic, and hydrological conditions in the Middle Rio Grande that favor Russian olive establishment over willows and cottonwoods? Similarly, the relationship of groundwater depth with vegetation expression needs additional study, e.g., expanded groundwater well networks within and among sites that are well-correlated to soil and geomorphic conditions in order to understand how groundwater dynamics affect maintenance of willow or Russian olive stands. More information is also needed on the consequences of willow versus Russian olive dominance with respect to water use, channel stabilization, and nutrient cycling. Lastly, bars may have important positive consequences for aquatic biodiversity, and we urge research on the contributions bars might make to improve fish habitat through increasing channel heterogeneity and generating local food resources.

Given their importance, river bars need to play a central role in the redynamization and restoration of Middle Rio Grande ecosystem as envisioned by Crawford et al. (1993), and

Crawford and Grogan (2004). As managers look toward restoring a modicum of the natural processes, including disturbance to the system, how much and where river bars are generated in the shifting mosaic will become a focal point in the design of a functioning system. Studies have shown that the distribution of bars in the Middle Rio Grande is heterogeneous in space and time (Ortiz 2003; Milford et al. 2003). Under the low flow regime since the Cochiti impoundment and particularly during the past few years of drought, island bars are increasing in some portions of the reach, but possibly in ways counter to the goals of redynamization. Hence, more follow-up research is needed on the causal factors in this heterogeneity, e.g., the role of surface and subsurface flow dynamics, channel configuration, and sediment availability in the development and demise of bars in the reach to aid restoration.

Acknowledgements

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Appendix A Site locations and directions.

Site Name	Plot ID	Vegetation Type	UTM (NAD27 Zone 13)		Access Point	Directions
			Northing	Easting		
Coronado	98RB001	Willow	3910127	358578	Coronado State Monument	Island bar just south of Coronado State Monument, cross river at pull-out by camping area near the Monument.
Corrales Control	99RB013	Bosque	3904900	354600	Corrales ditch road	From SR 448 at north end of Corrales, turn on to ditch side road at boundary between Rio Rancho and Corrales and follow NE to parking lot by river. From parking lot walk south ~ 0.25 miles on trail then west to site.
Corrales Preserve	98RB002	Willow	3904490	354697	Corrales ditch road	From SR 448 at north end of Corrales, turn on to ditch side road at boundary between Rio Rancho and Corrales and follow NE to parking lot by river. From parking lot walk south ~ 0.5 miles on trail then east to bar.
Alameda	98RB003	Mixed	3896696	351155	Alameda Bridge	From Alameda road take eastern riverside drain road north 0.6 miles, cross river to island bar.
Alameda Control	99RB014	Bosque	3896550	351163	Alameda Bridge	From Alameda road take eastern riverside drain road north 0.6 miles. Site in forest approx. 50m south of trail to river.
Paseo Island	98RB004	Willow	3893338	349452	Paseo del Norte Bridge off Rio Grande Blvd	Access eastern riverside drain road from Rio Grande Blvd. just south of Paseo del Norte overpass. Go 0.5 miles south from Paseo Bridge on levee road, then follow bosque trail west to river edge, wade to island bar.
I-40 Control	99RB015	Bosque	3884713	345846	Central Bridge	Take western levee road north from Central Ave. to second diversion dam (~ 0.7 miles), walk east into bosque.
I-40	98RB005	Mixed	3884659	346010	Central Bridge	Take western riverside drain road north from Central Ave. to second diversion dam (~ 0.7 miles), then follow bosque trail east to bar.
Biopark	98RB006	Mixed	3884254	346467	Central Bridge	Eastern side of river, just north of Central Ave. bridge, follow footpath north along river approx. 400m, then walk east to site.

<i>Site Name</i>	<i>Plot ID</i>	<i>Vegetation Type</i>	<i>UTM (NAD27 Zone 13)</i>		<i>Access Point</i>	<i>Directions</i>
			<i>Northing</i>	<i>Easting</i>		
Tingley Control	99RB016	Bosque	3883392	347435	Tingley Beach	Take Tingley beach road south from Central Ave. ~0.5 miles, walk west into bosque on trail.
Tingley	98RB007	Willow	3883347	347372	Tingley Beach	Take Tingley beach road south from Central Ave. ~0.5 miles, walk west on bosque trail out to bar.
AOP Control	99RB017	Bosque	3879541	348291	Bridge Street Bridge	Take western riverside drain road south from Cesar Chavez Blvd. (Bridge St.) 1.5 miles.
AOP Russian Olive	98RB008	Mixed	3879375	348340	Bridge Street Bridge	Take western riverside drain road south from Cesar Chavez Blvd. (Bridge St.) 1.5 miles. Take road into bar, follow trail to weather station north of AOP site, go north approx. 100m to site.
AOP Willow	98RB009	Willow	3879338	348305	Bridge Street Bridge	Take western riverside drain road south from Cesar Chavez Blvd. (Bridge St.) 1.5 miles. Take road into bar, follow trail out to weather station north of AOP site, go north approx. 20m to site.
North Rio Bravo	98RB010	Mixed	3877444	347517	Rio Bravo Bridge	On eastern side of river, just north of Rio Bravo Bridge. Follow riverside trail north from park approx 50m.
South Bravo Powerline	98RB011	Willow	3874570	346146	Rio Bravo Bridge	Take western levee road 1.8 miles south from Rio Bravo Bridge to power line. Follow trail under power lines west and then south to site.
South Bravo Control	99RB018	Bosque	3872472	345848	Rio Bravo Bridge	Take western riverside drain road 3.1 miles south from Rio Bravo Bridge. Follow trail into bosque approx 40m, then south 20m to site.
South Bravo Mixed	98RB012	Mixed	3872434	345988	Rio Bravo Bridge	Take western riverside drain road 3.1 miles south from Rio Bravo Bridge. Follow trail east to bar, then south to site.

Appendix B

Depth to ground water measured in meters, listed by PlotID for all bar sites.

Date	Mixed Sites						Willow Sites					
	98RB003	98RB005	98RB006	98RB008	98RB010	98RB012	98RB001	98RB002	98RB004	98RB007	98RB009	98RB011
16-Nov-98		1.435	1.49	1.181	1.141	1.278					1.187	0.624
17-Nov-98	1.157						1.435	1.346	1.158			
19-Nov-98												1.085
18-Dec-98							1.46					
20-Dec-98	1.16							1.355	1.15			
21-Dec-98		1.449	1.497	1.17	1.185	1.397				1.215	0.635	1.105
18-Jan-99		1.38	1.42	1.101	1.1	1.257				1.162	0.57	1.03
19-Jan-99	1.102						1.415	1.298	1.13			
19-Feb-99	1.14						1.396	1.336	1.09			
20-Feb-99		1.47	1.39	1.133	1.158	1.284				1.205	0.598	1.045
21-Mar-99	1.213						1.431		1.115			
22-Mar-99			1.457	1.165	1.172	1.303					0.627	1.072
23-Mar-99		1.55								1.234		
24-Apr-99				1.178							0.628	1.089
25-Apr-99	1.144	1.488	1.389				1.307		1.018	1.154		
20-May-99		0.79	0.672	0.567		0.76				0.482	0.088	0.479
27-May-99	0.549						0.535		0.392			
23-Jun-99				0.735	0.775	0.765					0.217	0.447
24-Jun-99							0.82	1.92				
30-Jun-99	0.71	0.981	0.972						0.621	0.698		
21-Jul-99							1.27					
22-Jul-99				1.225	1.19	1.235				1.09	0.685	0.99
23-Jul-99	1.15	1.545	1.44						0.96			
21-Aug-99		1.136	1.071	0.908	0.939	0.938				0.864	0.36	0.767
22-Aug-99	0.875						1.044	1.135	0.629			
21-Sep-99	1.093						1.049	1.172	0.845			
23-Sep-99				1.124	1.151	1.145					0.564	0.969
24-Sep-99		1.349	1.29							1.008		
23-Oct-99		1.41	1.34	1.174	1.192	1.19				1.13	0.612	1.021
24-Oct-99	1.097						1.31	1.401	0.845			
23-Nov-99	1.32						1.485	1.569	1.075			
25-Nov-99		1.58	1.513	1.352	1.372	1.372				1.398	0.789	1.295
20-Dec-99		1.375	1.313	1.14	1.263	1.318				1.108	0.602	1.082
21-Dec-99	1.154						1.417	1.49	1.068			
20-Jan-00	1.145	1.367	1.302				1.406		1.057	1.096		
22-Jan-00				1.131	1.25	1.304					0.591	
22-Feb-00		1.32	1.255							1.048		
23-Feb-00	1.1			1.082	1.203	1.262	1.359	1.448	1.01		0.544	1.024
24-Mar-00		1.275	1.275	0.958		1.184					0.412	1.938
25-Mar-00	1.097						1.348	1.425	0.952	1.072		
14-Apr-00		1.44	1.354	1.4		1.215				1.1	0.484	0.976
17-Apr-00	1.08						1.286	1.391	0.912			

Date	Mixed Sites						Willow Sites					
	98RB003	98RB005	98RB006	98RB008	98RB010	98RB012	98RB001	98RB002	98RB004	98RB007	98RB009	98RB011
19-Apr-00					1.143							
23-May-00		1.472	1.35	1.077	1.165	1.209				1.096	0.543	0.951
24-May-00	1.103						1.29	1.405	0.902			
18-Jun-00	1.053						1.241	1.317	0.975			
19-Jun-00		1.394	1.277	1.031	1.125	1.129				1.05	0.505	0.906
20-Jul-00		1.103	1.347	1.111	1.185	1.199				1.465	0.578	1.015
21-Jul-00	1.123						1.304	1.385	0.955			
17-Aug-00		1.141	1.384	1.141	1.191	1.222				1.489	0.601	1.015
18-Aug-00	1.035						1.304	1.373	0.83			
20-Sep-00	1.153	1.478	1.374	1.111	1.187	1.224	1.375	1.421	1.023	1.129	0.568	1.039
21-Oct-00	1.293	1.645	1.584	1.298	1.329	1.366		1.674	1.214	1.277	0.732	1.234
18-Nov-00		1.595	1.527	1.279	1.311	1.358				1.288	0.716	1.238
19-Nov-00	1.258							1.584	1.225			
18-Dec-00		1.497	1.423	1.154	1.241	1.301				1.213	0.611	1.106
19-Dec-00	1.215							1.553	1.189			
22-Jan-01		1.529	1.466	1.183	1.268	1.339				1.263	0.634	1.118
24-Jan-01	1.227						1.869	1.578	1.159			
19-Feb-01	1.163	1.469	1.394	1.093	1.211	1.303	1.711	1.524	1.056	1.202	0.548	1.043
19-Mar-01	1.234	1.529	1.448	1.156	1.249	1.318	1.661	1.626	1.059	1.215	0.593	1.074
20-Apr-01	1.165	1.45	1.382	1.111	1.201	1.246	1.366	1.53	0.988	1.14	0.561	1.018
18-May-01	0.821	1.035	0.94	0.739	0.915	0.951	0.758	1.095	0.54	0.793	0.225	0.664
20-Jun-01	1.084	1.413	1.352	1.202	1.189	1.143	1.055	1.419	0.852	1.094	0.64	0.95
20-Jul-01		1.547	1.435	1.239	1.256	1.254	1.188		1.016		0.678	1.035
24-Jul-01	1.192							1.559				
17-Aug-01	1.256	1.534	1.433	1.213	1.246	1.261	1.319	1.635	1.091	1.145	0.646	1.111
23-Sep-01	1.224	1.555	1.451	1.246	1.255	1.286	1.285	1.538	1.116	1.173	0.701	1.118
22-Oct-01	1.299	1.626	1.527	1.267	1.308	1.313	1.385	1.624	1.221	1.219	0.698	1.176
23-Nov-01	1.197	1.504	1.401	1.149	1.235	1.267	1.373	1.549	1.123	1.171	0.595	1.133
20-Dec-01	1.296	1.529	1.446	1.193	1.255	1.324	1.536	1.601	1.233	1.215	0.636	1.184
21-Jan-02	1.286	1.459	1.381	1.115	1.203	1.298	1.459	1.521	1.136	1.162	0.579	1.106
18-Feb-02	1.431	1.577	1.521	1.226	1.316	1.405	1.652		1.224	1.265	0.689	1.208
18-Mar-02	1.403	1.535	1.466	1.154	1.268	1.325	1.559	1.609	1.142	1.236	0.615	1.151
22-Apr-02	1.343	1.552	1.454	1.178	1.275	1.304	1.361	1.613	1.081	1.181	0.637	1.143
17-May-02	1.249	1.483	1.384	1.113	1.233	1.244	1.225	1.527	1.026	1.129	0.587	1.044
20-Jun-02	1.269	1.519	1.398	1.183	1.274	1.244	1.242	1.539	1.033	1.165	0.655	1.072
18-Jul-02	1.344	1.585	1.463	1.248	1.309	1.295	1.316	1.591	1.104	1.195	0.714	1.156
20-Aug-02	1.451						1.368	1.565	1.131			
21-Aug-02		1.555	1.425	1.209	1.281	1.294				1.178	0.659	1.243
20-Sep-02	1.606	1.66	1.527	1.324	1.236	1.363			1.27	1.262	0.748	1.362
21-Sep-02							1.574	1.757				
16-Oct-02	1.588		1.542	1.353	1.385	1.431			1.3	1.285	0.775	1.39
21-Oct-02							1.633	1.81				
18-Nov-02	1.67	1.596	1.483	1.212	1.313	1.339	1.818	1.738	1.3	1.24	0.653	1.394
18-Dec-02	1.719	1.578	1.486	1.215	1.339	1.35				1.255	0.658	1.36
24-Dec-02							1.92	1.735				

Date	Mixed Sites						Willow Sites					
	98RB003	98RB005	98RB006	98RB008	98RB010	98RB012	98RB001	98RB002	98RB004	98RB007	98RB009	98RB011
22-Jan-03	1.706	1.566	1.475	1.23	1.325	1.357	1.935	1.745	1.27	1.26	0.658	1.367
19-Feb-03							1.92					
24-Feb-03	1.671	1.538	1.429	1.153	1.316	1.336		1.756	1.275	1.23	0.604	1.243
24-Mar-03	1.547	1.519	1.43	1.15	1.3	1.322	1.82	1.67	1.134	1.186	0.602	1.248
23-Apr-03	1.465	1.451	1.351	1.074	1.235	1.227	1.451	1.562	1.051	1.122	0.512	1.114
22-May-03	1.467	1.48	1.375	1.154	1.28	1.232	1.441	1.553	1.039	1.16	0.585	1.159
17-Jun-03	1.483						1.461	1.577	1.088			
19-Jun-03		1.543	1.451	1.21	1.305	1.277				1.204	0.665	1.162
17-Jul-03	1.491	1.567	1.46	1.232	1.331	1.21	1.476	1.59	1.116	1.222	0.675	1.21
28-Aug-03	1.57		1.494	1.284	1.365	1.318	1.542	1.612	1.175		0.722	1.255

Appendix C

Individual site floristic summary tables, ordered by PlotId within vegetation types

Bosque Sites

Plot: 99RB013 Corrales Control

Species Name	Common Name	1999	2000	2001	2002
Trees					
Elaeagnus angustifolia	Russian olive	6.72 (3)	7.34 (3)	1.41 (1)	0.16 (1)
Populus deltoides ssp. wislizenii	Rio Grande cottonwood	72.47 (30)	91.56 (32)	86.53 (32)	90.75 (32)
Salix gooddingii	Goodding's willow	5.16 (5)	8.19 (7)	9.34 (7)	8.28 (6)
Ulmus pumila	Siberian elm				0 (1)
Shrubs					
Amorpha fruticosa	desert indigobush	0.19 (1)	0.31 (1)	0.31 (1)	0.31 (1)
Baccharis salicina	false willow	0.94 (1)	0.94 (1)	1.56 (1)	
Clematis ligusticifolia	western white clematis	12.5 (13)	10.53 (16)	4.75 (11)	2.23 (11)
Forestiera pubescens var. pubescens	New Mexico olive	7.34 (7)	7.19 (6)	5.88 (5)	10.41 (5)
Tamarix ramosissima	saltcedar	5.31 (6)	9.88 (7)	9.84 (6)	7.19 (6)
Graminoids					
Distichlis spicata	inland saltgrass		0.38 (2)		
Elymus canadensis	Canada wildrye	0.62 (7)	0.59 (6)	0.66 (7)	0.22 (3)
Juncus balticus	Baltic rush	0.66 (2)	2.09 (2)	0.67 (2)	0.69 (2)
Muhlenbergia asperifolia	alkali muhly	18.78 (22)	13.82 (23)	10.47 (22)	12.75 (18)
Sporobolus airoides	alkali sacaton	0.94 (3)	0.91 (3)	0.78 (2)	1.25 (2)
Forbs					
Ambrosia psilostachya	Cuman ragweed	2.34 (7)	0.89 (7)	5.41 (7)	0.72 (5)
Asparagus officinalis	garden asparagus	0.47 (1)			
Thelesperma megapotamicum	Hopi tea greenthread		0.47 (1)	1.09 (1)	0.06 (1)

Bosque Sites

Plot: 99RB014 Alameda Control

Species Name	Common Name	1999	2000	2001	2002
Trees					
<i>Elaeagnus angustifolia</i>	Russian olive	2.5 (1)	2.03 (3)	1.72 (2)	1.66 (2)
<i>Morus alba</i>	white mulberry	0.19 (1)			
<i>Populus deltoides</i> ssp. <i>wislizenii</i>	Rio Grande cottonwood	70.53 (30)	81.56 (32)	86.41 (32)	83.59 (32)
<i>Salix gooddingii</i>	Goodding's willow	0.78 (1)			
<i>Ulmus pumila</i>	Siberian elm	32.61 (25)	40.66 (25)	43.84 (24)	42.53 (22)
Shrubs					
<i>Forestiera pubescens</i> var. <i>pubescens</i>	New Mexico olive		0 (1)	0 (1)	0.03 (1)
<i>Parthenocissus quinquefolia</i> var. <i>quinquefolia</i>	Virginia creeper	1.69 (4)	1.34 (6)	1.53 (5)	0.88 (5)
<i>Rhus trilobata</i>	skunkbush sumac	2.03 (1)	3.12 (1)	0.94 (1)	0.38 (1)
<i>Tamarix ramosissima</i>	saltcedar		0.62 (1)	0.78 (1)	0.78 (1)
Graminoids					
<i>Bromus japonicus</i>	Japanese brome			0.06 (1)	
<i>Elymus elymoides</i>	bottlebrush squirreltail	0.25 (3)	0.38 (5)	0.47 (6)	0.03 (1)
<i>Panicum obtusum</i>	vine mesquite		0.19 (1)	0.34 (2)	0.16 (1)
Forbs					
<i>Asclepias subverticillata</i>	whorled milkweed			0.03 (1)	0.02 (1)
<i>Conyza canadensis</i>	Canadian horseweed		0.06 (1)	0.03 (2)	
<i>Gaura parviflora</i>	velvetweed			0.06 (1)	
<i>Lactuca serriola</i>	prickly lettuce	2.17 (13)		0.42 (7)	
<i>Melilotus officinalis</i>	yellow sweetclover	0.47 (4)	0.25 (2)		
<i>Senecio riddellii</i>	Riddell's ragwort	0.44 (2)	0.38 (2)	0.69 (2)	0.47 (1)
<i>Sphaeralcea</i> spp.	globemallow	0.09 (1)	0.03 (1)	0.06 (1)	
Unidentified forb			0.01 (2)		

Bosque Sites

Plot: 99RB015 I-40 Control

Species Name	Common Name	1999	2000	2001	2002
Trees					
<i>Elaeagnus angustifolia</i>	Russian olive	37.94 (22)	41.75 (20)	4.38 (3)	
<i>Morus alba</i>	white mulberry	4.69 (2)	7.66 (3)		
<i>Populus deltoides</i> ssp. <i>wislizenii</i>	Rio Grande cottonwood	59.97 (30)	86.41 (32)	1.28 (5)	
<i>Ulmus pumila</i>	Siberian elm	1.56 (2)	7.69 (5)		
Shrubs					
<i>Parthenocissus quinquefolia</i> var. <i>quinquefolia</i>	Virginia creeper	14.02 (14)	19.59 (12)	7.53 (10)	
<i>Tamarix ramosissima</i>	saltcedar	2.72 (4)	3.44 (3)	1.25 (2)	

Bosque Sites

Plot: 99RB016 Tingley Control

Species Name	Common Name	1999	2000	2001	2002
Trees					
<i>Elaeagnus angustifolia</i>	Russian olive	43.59 (19)	51.41 (20)	47.19 (20)	42.19 (18)
<i>Morus alba</i>	white mulberry	6.34 (9)	9.19 (9)	10.94 (9)	6.56 (6)
<i>Populus deltoides</i> ssp. <i>wislizenii</i>	Rio Grande cottonwood	70.91 (31)	86.09 (32)	89.69 (32)	87.66 (32)
<i>Salix gooddingii</i>	Goodding's willow	4.06 (2)	5.62 (2)	5 (2)	5 (2)
<i>Ulmus pumila</i>	Siberian elm	13.12 (7)	16.09 (9)	16.88 (9)	15.94 (9)
Graminoids					
<i>Elymus canadensis</i>	Canada wildrye			0 (1)	
Forbs					
<i>Equisetum laevigatum</i>	smooth horsetail	0.03 (1)	0.03 (1)		

Bosque Sites

Plot: 99RB017 AOP Control

Species Name	Common Name	1999	2000	2001	2002
Trees					
<i>Ailanthus altissima</i>	tree of heaven	9.72 (7)	13.47 (8)	14.75 (10)	13.69 (9)
<i>Elaeagnus angustifolia</i>	Russian olive	24.91 (14)	30.94 (15)	29.72 (17)	26.28 (15)
<i>Morus alba</i>	white mulberry	2.97 (1)	0.03 (1)	3.28 (2)	3.12 (2)
<i>Populus deltoides</i> ssp. <i>wislizenii</i>	Rio Grande cottonwood	64.84 (28)	73.91 (27)	77.66 (28)	77.81 (28)
<i>Salix gooddingii</i>	Goodding's willow		1.88 (1)	1.88 (1)	1.88 (1)
<i>Ulmus pumila</i>	Siberian elm	3.59 (3)	10.31 (4)	8.14 (4)	7.94 (4)
Shrubs					
<i>Amorpha fruticosa</i>	desert indigobush	0.47 (2)			
<i>Parthenocissus quinquefolia</i> var. <i>quinquefolia</i>	Virginia creeper	10.31 (9)	10.94 (7)	11.47 (8)	9.75 (8)
<i>Tamarix ramosissima</i>	saltcedar	2.88 (5)	6.09 (8)	3.22 (7)	3.22 (7)
Forbs					
<i>Convolvulus arvensis</i>	field bindweed	0.12 (1)	0.06 (1)	0.44 (2)	0.31 (2)

Bosque Sites

Plot: 99RB018 South Bravo Control

Species Name	Common Name	1999	2000	2001	2002
Trees					
<i>Ailanthus altissima</i>	tree of heaven	57.72 (26)	50.62 (25)	58.03 (29)	59.06 (28)
<i>Elaeagnus angustifolia</i>	Russian olive	17.78 (10)	10.31 (5)	12.81 (6)	13.44 (7)
<i>Morus alba</i>	white mulberry	2.81 (2)	5.94 (2)	5.78 (2)	5.78 (2)
<i>Populus deltoides</i> ssp. <i>wislizenii</i>	Rio Grande cottonwood	33.03 (15)	27.03 (11)	34.38 (17)	40.62 (18)
<i>Ulmus pumila</i>	Siberian elm	6.8 (7)	2.86 (3)	4.75 (8)	2.42 (8)
Shrubs					
<i>Ribes aureum</i>	golden currant	0.06 (1)	0.62 (1)	0.62 (1)	0.62 (1)
Forbs					
<i>Convolvulus arvensis</i>	field bindweed	0.64 (11)	0.78 (8)	1.44 (9)	2.73 (17)
<i>Conyza canadensis</i>	Canadian horseweed		0.03 (1)		
<i>Helianthus annuus</i>	common sunflower	0.03 (1)			
<i>Oenothera elata</i> ssp. <i>hirsutissima</i>	Hooker's eveningprimrose			0.03 (1)	
<i>Sphaeralcea incana</i>	gray globemallow	0.44 (4)	0.09 (2)	0.09 (3)	0.07 (4)

Mixed Sites

Plot 98RB003 Alameda

Species Name	Common Name	1998	1999	2000	2001	2002
Trees						
<i>Elaeagnus angustifolia</i>	Russian olive	14.47 (11)	13.75 (10)	19.12 (17)	20.94 (16)	22.03 (15)
<i>Populus deltoides</i> ssp. <i>wislizenii</i>	Rio Grande cottonwood	1.44 (3)	2 (3)	2.19 (3)	1.09 (2)	0.78 (3)
<i>Salix gooddingii</i>	Goodding's willow			0 (1)	0.16 (1)	0.03 (1)
<i>Ulmus pumila</i>	Siberian elm	0.03 (1)		0.16 (1)	1.09 (1)	0.78 (1)
Shrubs						
<i>Amorpha fruticosa</i>	desert indigobush	0.31 (1)	1.56 (2)	1.72 (2)	1.41 (2)	1.03 (3)
<i>Baccharis salicina</i>	false willow	10.56 (11)	7.44 (8)	6 (8)	7.12 (7)	4.22 (7)
<i>Parthenocissus quinquefolia</i> var. <i>quinquefolia</i>	Virginia creeper					0.06 (1)
<i>Salix exigua</i>	coyote willow	28.16 (25)	22.72 (26)	19.03 (27)	19.94 (27)	18.38 (28)
<i>Tamarix ramosissima</i>	saltcedar	7.88 (7)	10.09 (7)	13.28 (10)	13.34 (12)	14.16 (12)
Graminoids						
<i>Bromus japonicus</i>	Japanese brome	0 (1)			2.85 (15)	
<i>Elymus canadensis</i>	Canada wildrye		0.16 (3)	0.38 (3)	0.81 (3)	0.28 (3)
<i>Elymus elymoides</i>	bottlebrush squirreltail			0.03 (2)		
<i>Elymus x pseudorepens</i>	false quackgrass		0.19 (1)	0.47 (3)	0.47 (1)	0.03 (1)
<i>Festuca arundinaceae</i>	tall fescue or K-31			2.66 (2)	3.28 (5)	3.03 (3)
<i>Juncus balticus</i>	Baltic rush			0.12 (2)	0.06 (1)	0.16 (3)
<i>Juncus torreyi</i>	Torrey's rush		0.06 (1)			
<i>Muhlenbergia asperifolia</i>	alkali muhly	5.75 (22)	13.38 (26)	19.16 (27)	20.07 (28)	7.88 (22)
<i>Sporobolus airoides</i>	alkali sacaton			0.03 (1)	0.03 (1)	0.03 (1)
<i>Sporobolus compositus</i> var. <i>compositus</i>	tall dropseed		0.03 (1)	0.16 (2)	1.03 (5)	0.3 (4)
<i>Sporobolus cryptandrus</i>	sand dropseed		1.12 (4)	0.75 (4)	1.47 (4)	1.44 (6)
Unidentified grass		0.16 (1)				
Forbs						
<i>Ambrosia psilostachya</i>	Cuman ragweed	9.77 (27)	10.84 (26)	4.38 (26)	5 (26)	1.12 (9)
<i>Asclepias subverticillata</i>	whorled milkweed	1.09 (1)	0.41 (1)	0.12 (1)	0.03 (1)	0.06 (1)
<i>Conyza canadensis</i>	Canadian horseweed				0.07 (3)	
<i>Equisetum laevigatum</i>	smooth horsetail		0 (1)	0.07 (5)	0.12 (6)	0.23 (10)
<i>Euthamia occidentalis</i>	western goldenrod	0.81 (5)	0.66 (6)	0.31 (1)	0.28 (3)	
<i>Gaura parviflora</i>	velvetweed		0 (1)			
<i>Lactuca serriola</i>	prickly lettuce	0.34 (1)				
<i>Linum lewisii</i>	prairie flax	0.03 (1)				
<i>Melilotus officinalis</i>	yellow sweetclover	0.16 (4)	0.19 (5)	0 (1)	0.04 (4)	
<i>Oenothera elata</i> ssp. <i>hirsutissima</i>	Hooker's eveningprimrose		0.03 (1)			0.03 (1)
<i>Solidago canadensis</i>	Canada goldenrod	11.19 (29)	15.31 (30)	12.25 (30)	10.62 (30)	2.14 (23)
<i>Sonchus asper</i>	spiny sowthistle				0.06 (1)	
<i>Symphotrichum ericoides</i>	heath aster		0.78 (7)	3.25 (22)	6.25 (23)	4.88 (23)

Mixed Sites

Plot 98RB005 I-40

Species Name	Common Name	1998	1999	2000	2001	2002
Trees						
<i>Elaeagnus angustifolia</i>	Russian olive	42.94 (27)	37.66 (26)	53.19 (29)	49.5 (30)	46.59 (30)
<i>Populus deltoides</i> ssp. <i>wislizenii</i>	Rio Grande cottonwood	12 (6)	11.06 (7)	10.47 (5)	10.31 (5)	10.31 (5)
Shrubs						
<i>Baccharis salicina</i>	false willow	15.75 (10)	9.66 (7)	10.66 (9)	3.91 (6)	2.66 (5)
<i>Salix exigua</i>	coyote willow			2.19 (2)	0.16 (1)	0.31 (1)
<i>Tamarix ramosissima</i>	saltcedar	0.44 (2)	0.47 (2)	3.16 (4)	4.22 (4)	3.47 (4)
Graminoids						
<i>Distichlis spicata</i>	inland saltgrass	0.47 (2)			0.06 (1)	0.07 (2)
<i>Elymus canadensis</i>	Canada wildrye		0.19 (2)	0.03 (1)	0.12 (5)	0.03 (2)
<i>Elymus x pseudorepens</i>	false quackgrass			0.53 (5)	0.16 (2)	
<i>Muhlenbergia asperifolia</i>	alkali muhly	0.53 (2)	4.58 (13)	1.59 (8)	4.73 (15)	0.57 (9)
<i>Sporobolus airoides</i>	alkali sacaton	16.44 (23)	18.91 (18)	16.69 (27)	18.89 (27)	10.59 (24)
<i>Sporobolus compositus</i> var. <i>compositus</i>	tall dropseed		0.06 (1)			
<i>Sporobolus cryptandrus</i>	sand dropseed	0.69 (6)			0.03 (1)	0.03 (1)
Forbs						
<i>Ambrosia psilostachya</i>	Cuman ragweed	4.22 (20)	4.73 (19)	3.48 (16)	6.05 (24)	0.06 (1)
<i>Asclepias subverticillata</i>	whorled milkweed					0.03 (2)
<i>Chloracantha spinosa</i>	spiny chloracantha	0.91 (3)	1.34 (3)			1.38 (5)
<i>Conyza canadensis</i>	Canadian horseweed		0.03 (1)		0.03 (1)	
<i>Equisetum laevigatum</i>	smooth horsetail		0 (1)	0.01 (2)		
<i>Gaura parviflora</i>	velvetweed				0.03 (1)	
<i>Helianthus annuus</i>	common sunflower		2.2 (15)		2.34 (25)	
<i>Machaeranthera canescens</i> ssp. <i>glabra</i>	hoary tansyaster				5.47 (18)	
<i>Melilotus officinalis</i>	yellow sweetclover	1.08 (7)	13.22 (18)	0.51 (11)	0.74 (14)	
<i>Oenothera elata</i> ssp. <i>hirsutissima</i>	Hooker's eveningprimrose		0.06 (1)			
<i>Salsola tragus</i>	prickly Russian thistle		0.56 (5)	0.41 (4)	1.97 (5)	0 (1)
<i>Symphotrichum ericoides</i>	heath aster		0.03 (1)			
<i>Thelesperma megapotamicum</i>	Hopi tea greenthread			1.5 (3)	1.28 (3)	

Mixed Sites

Plot 98RB006 Biopark

Species Name	Common Name	1998	1999	2000	2001	2002
Trees						
<i>Elaeagnus angustifolia</i>	Russian olive	37.72 (24)	29.72 (22)	37.69 (23)	41.28 (26)	42.09 (25)
<i>Populus deltoides</i> ssp. <i>wislizenii</i>	Rio Grande cottonwood	5.34 (6)	6.81 (7)	5.75 (10)	6.88 (11)	5.03 (11)
<i>Ulmus pumila</i>	Siberian elm	0.5 (1)	0.19 (1)	1.31 (3)	1.5 (5)	2.88 (6)
Shrubs						
<i>Amorpha fruticosa</i>	desert indigobush		0.25 (1)	0.47 (1)	0.62 (1)	0.06 (1)
<i>Baccharis salicina</i>	false willow	10.22 (6)	6.41 (5)	4.81 (5)	2.09 (3)	2.81 (2)
<i>Salix exigua</i>	coyote willow	8.12 (10)	5.28 (9)	6.62 (11)	7.59 (11)	10.03 (13)
Graminoids						
<i>Carex emoryi</i>	Emory's sedge			0.05 (1)	0.05 (3)	0.16 (5)
<i>Cyperus odoratus</i>	fragrant flatsedge				0.03 (2)	0.01 (1)
<i>Distichlis spicata</i>	inland saltgrass			3.11 (11)	2.75 (13)	2 (12)
<i>Elymus canadensis</i>	Canada wildrye			0.16 (1)	0.19 (3)	0.09 (1)
<i>Elymus elymoides</i>	bottlebrush squirreltail				0.06 (2)	
<i>Elymus x pseudorepens</i>	false quackgrass			0.09 (2)		0.02 (1)
<i>Festuca arundinaceae</i>	tall fescue or K-31				0.06 (1)	
<i>Juncus balticus</i>	Baltic rush			0 (1)	0 (2)	0 (1)
<i>Muhlenbergia asperifolia</i>	alkali muhly	1.34 (6)	8.25 (23)	4.78 (18)	7.39 (19)	3.69 (18)
<i>Panicum obtusum</i>	vine mesquite		0.62 (1)			
<i>Phragmites australis</i>	common reed	1.91 (5)	1.89 (5)	1.53 (5)	3.28 (5)	7.22 (4)
<i>Poa compressa</i>	Canada bluegrass			0.47 (5)		
<i>Sorghastrum nutans</i>	Indiangrass	17.44 (25)	21.19 (25)	29.41 (23)	34.13 (25)	27.34 (19)
<i>Sporobolus airoides</i>	alkali sacaton	1.03 (2)	0.84 (1)	0.78 (1)	1.25 (1)	0.31 (1)
<i>Sporobolus compositus</i> var. <i>compositus</i>	tall dropseed			0.16 (1)	0.72 (4)	0.32 (2)
Forbs						
<i>Ambrosia psilostachya</i>	Cuman ragweed	12.77 (32)	11.25 (29)	5.88 (30)	3.33 (30)	0.27 (6)
<i>Apocynum cannabinum</i>	Indianhemp		0.03 (1)	0.16 (1)	0.09 (1)	0.03 (1)
<i>Convolvulus arvensis</i>	field bindweed					0.03 (1)
<i>Equisetum laevigatum</i>	smooth horsetail	0.03 (2)	0.01 (2)	0.1 (13)	0.04 (5)	0.1 (10)
<i>Euthamia occidentalis</i>	western goldenrod	0.59 (2)	0.5 (2)	0.72 (4)	2.06 (5)	2.33 (5)
<i>Gaura parviflora</i>	velvetweed	0.12 (1)		0.08 (3)	0.19 (4)	
<i>Helianthus annuus</i>	common sunflower		1.8 (10)	0 (1)	0.24 (7)	
<i>Helianthus petiolaris</i>	prairie sunflower	0.25 (5)				
<i>Machaeranthera canescens</i> ssp. <i>glabra</i>	hoary tansyaster			0.05 (1)	0.12 (1)	
<i>Melilotus officinalis</i>	yellow sweetclover	0.06 (3)	10.48 (20)	1.85 (24)	1.84 (17)	0.27 (9)
<i>Oenothera elata</i> ssp. <i>hirsutissima</i>	Hooker's eveningprimrose	0.06 (1)	0.16 (1)			
<i>Solidago canadensis</i>	Canada goldenrod	0.03 (1)	0.03 (1)		0.31 (2)	0.12 (2)
<i>Symphotrichum ericoides</i>	heath aster		0.03 (1)			
<i>Symphotrichum lanceolatum</i> ssp. <i>hesperium</i>	white panicle aster				0.05 (1)	0.12 (1)
<i>Taraxacum officinale</i>	common dandelion		0.03 (1)			
Unidentified forb		0.06 (1)				

Mixed Sites

Plot 98RB008 AOP Russian Olive

Species Name	Common Name	1998	1999	2000	2001	2002
Trees						
<i>Elaeagnus angustifolia</i>	Russian olive	66.84 (27)	59.91 (26)	72.31 (27)	71.88 (29)	68.12 (29)
<i>Morus alba</i>	white mulberry	2.25 (1)	2.5 (1)	3.12 (1)	3.91 (2)	3.75 (2)
<i>Populus deltoides</i> ssp. <i>wislizenii</i>	Rio Grande cottonwood		0 (1)	0.03 (1)	0.16 (1)	0.09 (1)
<i>Ulmus pumila</i>	Siberian elm				0.22 (1)	0.28 (2)
Shrubs						
<i>Baccharis salicina</i>	false willow	2.5 (1)				
<i>Salix exigua</i>	coyote willow	2.62 (4)	2.75 (3)	3.82 (6)	1.23 (6)	1.44 (6)
Graminoids						
<i>Agrostis gigantea</i>	redtop			0.62 (1)		
<i>Cynodon dactylon</i>	bermudagrass	26.41 (15)	13.56 (11)	38.25 (23)	49.84 (23)	42 (25)
<i>Distichlis spicata</i>	inland saltgrass	0.66 (2)	1.88 (1)	4.53 (2)	4.84 (2)	3.12 (2)
<i>Elymus canadensis</i>	Canada wildrye			0.25 (4)	0.84 (7)	0.36 (7)
<i>Muhlenbergia asperifolia</i>	alkali muhly	3.81 (7)	17.53 (14)	1.31 (10)	3.66 (14)	1.84 (8)
<i>Sorghastrum nutans</i>	Indiangrass		2.34 (1)			0.12 (1)
<i>Sporobolus airoides</i>	alkali sacaton	6.56 (4)	3.94 (3)	6.12 (6)	3.62 (5)	3 (4)
<i>Sporobolus compositus</i> var. <i>compositus</i>	tall dropseed	9.12 (11)	6.98 (12)	16.06 (16)	19.85 (17)	9.53 (17)
Forbs						
<i>Ambrosia psilostachya</i>	Cuman ragweed	15.72 (30)	8.8 (29)	3.13 (23)	4.34 (23)	4.08 (24)
<i>Apocynum cannabinum</i>	Indianhemp	2.03 (6)	1 (6)	1.59 (8)	0.1 (2)	0.22 (3)
<i>Asclepias subverticillata</i>	whorled milkweed	0.06 (1)	0.16 (2)	0.06 (1)	0.47 (1)	0.06 (2)
<i>Convolvulus arvensis</i>	field bindweed		0.06 (1)	0.16 (3)	0.41 (3)	0.25 (5)
<i>Equisetum laevigatum</i>	smooth horsetail	0.1 (10)	0.03 (3)	0.04 (6)	0.07 (8)	0.21 (9)
<i>Euthamia occidentalis</i>	western goldenrod		0.41 (1)	0.06 (2)		
<i>Gaura parviflora</i>	velvetweed			0.03 (1)		
<i>Helianthus annuus</i>	common sunflower	0.17 (4)	0.09 (1)	0.03 (2)	0.16 (1)	
<i>Lactuca tatarica</i> var. <i>pulchella</i>	blue lettuce					0.09 (1)
<i>Melilotus officinalis</i>	yellow sweetclover	0.55 (8)	1.33 (12)			
<i>Symphotrichum ericoides</i>	heath aster	5.84 (19)	6.7 (23)	10.27 (25)	12 (26)	10.82 (25)

Mixed Sites

Plot 98RB010 North Rio Bravo

Species Name	Common Name	1998	1999	2000	2001	2002
Trees						
<i>Elaeagnus angustifolia</i>	Russian olive	61.78 (24)	52.66 (27)	71.25 (30)	75.62 (31)	76.56 (31)
<i>Populus deltoides</i> ssp. <i>wislizenii</i>	Rio Grande cottonwood	2.97 (1)	0.78 (1)	1.56 (1)		0.16 (1)
<i>Ulmus pumila</i>	Siberian elm	3.12 (1)	5.31 (4)	8.5 (6)	14.75 (9)	16.1 (9)
Shrubs						
<i>Salix exigua</i>	coyote willow			3.12 (1)		
<i>Tamarix ramosissima</i>	saltcedar	2.81 (1)	2.5 (1)	1.88 (1)	2.5 (1)	2.5 (1)
Graminoids						
<i>Agrostis gigantea</i>	redtop	2.81 (2)			0.62 (1)	
<i>Bothriochloa laguroides</i> ssp. <i>torreyana</i>	silver beardgrass	2.88 (3)	4.38 (5)	5.62 (4)	3.97 (4)	1.91 (3)
<i>Bromus japonicus</i>	Japanese brome				0.91 (10)	0.88 (2)
<i>Carex emoryi</i>	Emory's sedge	6.66 (6)				
<i>Carex occidentalis</i>	western sedge		9.93 (11)	7.14 (11)	7.09 (10)	3.59 (11)
<i>Cynodon dactylon</i>	bermudagrass	0.22 (1)	4.53 (3)	11.16 (8)	10.91 (10)	9.34 (11)
<i>Distichlis spicata</i>	inland saltgrass				0.09 (1)	
<i>Elymus canadensis</i>	Canada wildrye	0.31 (2)	5.64 (10)	0.12 (4)	4.83 (19)	1.22 (11)
<i>Festuca arundinaceae</i>	tall fescue or K-31				0.94 (1)	0.31 (1)
<i>Juncus balticus</i>	Baltic rush				0.02 (1)	0.02 (1)
<i>Muhlenbergia asperifolia</i>	alkali muhly	1.69 (6)	1.69 (8)	1.78 (4)	1.22 (5)	0.84 (7)
<i>Muhlenbergia racemosa</i>	marsh muhly			0.09 (1)		
<i>Panicum obtusum</i>	vine mesquite	7.19 (6)	0.25 (3)	13.82 (11)	8.53 (10)	4.75 (12)
<i>Sorghastrum nutans</i>	Indiangrass	4.62 (6)	6.66 (5)	7.09 (4)	4.44 (5)	2.38 (5)
<i>Sporobolus airoides</i>	alkali sacaton	6.78 (6)	0.88 (2)	3.12 (3)	2.81 (3)	1.56 (2)
<i>Sporobolus compositus</i> var. <i>compositus</i>	tall dropseed	0.56 (2)	0.72 (2)	0.19 (2)	1.34 (5)	0.38 (4)
Forbs						
<i>Ambrosia psilostachya</i>	Cuman ragweed	9.11 (25)	3.66 (21)	3.74 (17)	2.97 (17)	0.57 (9)
<i>Asclepias subverticillata</i>	whorled milkweed	1.78 (4)	1.06 (7)	1.66 (7)	1.25 (10)	1.88 (9)
<i>Chenopodium berlandieri</i> var. <i>berlandieri</i>	Berlandier's goosefoot		0.16 (2)	0.09 (1)		
<i>Convolvulus arvensis</i>	field bindweed	0.09 (2)	0.91 (6)	2.53 (8)	4.64 (11)	9.91 (10)
<i>Conyza canadensis</i>	Canadian horseweed	0.25 (4)				
<i>Equisetum laevigatum</i>	smooth horsetail	0.72 (16)	0.04 (8)	0.47 (13)	0.25 (11)	0.31 (9)
<i>Erigeron flagellaris</i>	trailing fleabane		0 (1)			
<i>Euthamia occidentalis</i>	western goldenrod			0.22 (1)		
<i>Gaura parviflora</i>	velvetweed	0.31 (3)		1.53 (9)	0.06 (2)	0.11 (3)
<i>Helianthus annuus</i>	common sunflower	1.06 (6)	0.38 (6)	1.13 (7)	0.53 (2)	
<i>Kochia scoparia</i>	common kochia			0 (1)		
<i>Lactuca serriola</i>	prickly lettuce	0.67 (4)	0.14 (3)	0.97 (8)	5.66 (10)	0.44 (3)
<i>Machaeranthera canescens</i> ssp. <i>glabra</i>	hoary tansyaster				0.03 (1)	
<i>Melilotus officinalis</i>	yellow sweetclover	1.25 (2)	0.03 (2)	0.18 (4)	0.84 (3)	
<i>Oenothera elata</i> ssp. <i>hirsutissima</i>	Hooker's eveningprimrose		0.02 (1)			
<i>Symphotrichum ericoides</i>	heath aster	7.12 (19)	7.21 (20)	7 (19)	6.14 (17)	2.34 (13)
<i>Symphotrichum lanceolatum</i> ssp. <i>hesperium</i>	white panicle aster				0.06 (1)	0.03 (1)
Unidentified forb			0.09 (2)			

Mixed Sites

Plot 98RB012 South Bravo Mixed

Species Name	Common Name	1998	1999	2000	2001	2002
Trees						
Elaeagnus angustifolia	Russian olive	22.84 (14)	27.25 (16)	31.22 (18)	35.19 (19)	36.97 (20)
Ulmus pumila	Siberian elm		0.12 (2)		0.08 (1)	0.09 (2)
Shrubs						
Salix exigua	coyote willow	9.88 (19)	12.56 (20)	12.41 (22)	11.19 (20)	10.73 (19)
Sub-Shrubs						
Desmanthus illinoensis	prairie bundleflower			0.02 (1)	0.02 (1)	
Graminoids						
Cyperus odoratus	fragrant flatsedge					0.01 (3)
Distichlis spicata	inland saltgrass				0.03 (1)	
Elymus canadensis	Canada wildrye				0.12 (3)	0.02 (1)
Elymus spp.	wildrye		0.06 (1)			
Elymus x pseudorepens	false quackgrass		0.28 (2)	0.03 (1)	0.28 (2)	0.47 (6)
Muhlenbergia asperifolia	alkali muhly		0.02 (1)			
Sporobolus airoides	alkali sacaton	1.56 (6)	7.69 (10)	6.09 (12)	6.16 (9)	0.72 (4)
Sporobolus compositus var. compositus	tall dropseed	4.95 (22)	23.49 (30)	22.31 (25)	22.67 (29)	7.25 (21)
Sporobolus cryptandrus	sand dropseed	0.06 (1)	0.62 (2)			3.61 (15)
Forbs						
Ambrosia psilostachya	Cuman ragweed	18.19 (32)	1.27 (15)	0.08 (7)	1.26 (17)	0.23 (4)
Asclepias subverticillata	whorled milkweed	0.19 (1)	0.88 (1)	0.44 (3)	0.06 (2)	0.16 (3)
Chamaesyce serpyllifolia	thymeleaf sandmat		0.22 (3)			0.04 (4)
Conyza canadensis	Canadian horseweed		0.22 (5)	0.25 (10)	19.88 (27)	
Croton texensis	Texas croton				0.03 (1)	
Equisetum laevigatum	smooth horsetail	0.25 (18)	0.1 (10)	0.47 (23)	0.17 (20)	0.29 (21)
Euthamia occidentalis	western goldenrod					0 (1)
Gaura parviflora	velvetweed		0.03 (1)	0.15 (6)	0.19 (7)	0.1 (6)
Helianthus annuus	common sunflower	0.44 (8)	1.44 (9)		2 (18)	
Helianthus petiolaris	prairie sunflower	0.1 (6)		0 (1)		
Lactuca serriola	prickly lettuce				0.03 (1)	
Machaeranthera canescens ssp. glabra	hoary tansyaster				0.14 (4)	
Machaeranthera pinnatifida	lacy tansyaster				0.03 (1)	
Melilotus officinalis	yellow sweetclover	0.23 (4)	1.5 (4)		0.08 (3)	
Oenothera elata ssp. hirsutissima	Hooker's eveningprimrose		1.44 (11)	0.72 (11)	0.88 (10)	
Symphotrichum ericoides	heath aster	0.03 (1)	2.06 (12)	0.69 (9)	1.41 (11)	1.39 (10)

Willow Sites

Plot: 98RB001 Coronado

Species Name	Common Name	1998	1999	2000	2001	2002
Trees						
<i>Elaeagnus angustifolia</i>	Russian olive	0.38 (1)	0.78 (1)	0.81 (2)	2.5 (2)	2.69 (4)
<i>Populus deltoides</i> ssp. <i>wislizenii</i>	Rio Grande cottonwood	0.75 (2)	0.84 (3)	0.38 (2)	1.75 (3)	1.91 (3)
<i>Ulmus pumila</i>	Siberian elm	0.06 (2)				
Shrubs						
<i>Baccharis salicina</i>	false willow			0 (1)		
<i>Salix exigua</i>	coyote willow	51.59 (32)	35.41 (32)	26.75 (31)	42.06 (32)	37.88 (32)
<i>Tamarix ramosissima</i>	saltcedar	0.06 (1)		0.06 (1)	0.25 (1)	0.09 (1)
Sub-Shrubs						
<i>Heterotheca villosa</i>	hairy goldenaster	0 (1)	0.17 (2)	0.09 (1)	0.81 (3)	0.19 (4)
Graminoids						
<i>Bouteloua barbata</i>	sixweeks grama					0.03 (1)
<i>Elymus canadensis</i>	Canada wildrye					0.06 (1)
<i>Hordeum jubatum</i>	foxtail barley				0.03 (1)	
<i>Muhlenbergia asperifolia</i>	alkali muhly	0.34 (4)	0.53 (3)	0.02 (1)	0.16 (2)	0.28 (2)
<i>Panicum obtusum</i>	vine mesquite					0.02 (2)
<i>Sphenopholis obtusata</i>	prairie wedgescale	0.09 (1)				
Forbs						
<i>Ambrosia psilostachya</i>	Cuman ragweed	2.33 (11)	3.02 (10)	0.09 (3)	0.59 (4)	0.03 (1)
<i>Asclepias subverticillata</i>	whorled milkweed				0.31 (1)	0.55 (6)
<i>Chamaesyce serpyllifolia</i>	thymeleaf sandmat		0.23 (4)	0.1 (6)		2.82 (21)
<i>Chenopodium</i> spp.	goosefoot				0.02 (1)	0 (1)
<i>Convolvulus arvensis</i>	field bindweed				0 (1)	
<i>Conyza canadensis</i>	Canadian horseweed	0.02 (1)	1.76 (17)		9.5 (27)	
<i>Erigeron flagellaris</i>	trailing fleabane		0 (1)		0.03 (1)	
<i>Euthamia occidentalis</i>	western goldenrod	0.03 (1)				
<i>Grindelia nuda</i> var. <i>nuda</i>	curlytop gumweed	1.48 (11)	2.25 (13)		3.91 (15)	0.3 (6)
<i>Helianthus annuus</i>	common sunflower		0.02 (1)		0.09 (2)	
<i>Lactuca serriola</i>	prickly lettuce		0.02 (1)			
<i>Machaeranthera canescens</i> ssp. <i>glabra</i>	hoary tansyaster	0.16 (1)	0.34 (3)	0.06 (3)	2.69 (15)	0.4 (8)
<i>Melilotus officinalis</i>	yellow sweetclover	9.3 (29)	14.09 (29)	0.6 (8)	3.97 (22)	0.55 (6)
<i>Oenothera elata</i> ssp. <i>hirsutissima</i>	Hooker's eveningprimrose	0.03 (1)	0.03 (1)			
<i>Ratibida tagetes</i>	green prairie coneflower		0 (1)		1.09 (2)	
<i>Salsola tragus</i>	prickly Russian thistle		0.25 (1)	0.33 (4)	2.94 (6)	0.58 (6)
<i>Senecio riddellii</i>	Riddell's ragwort	0 (1)		0.03 (1)	0.12 (1)	0.09 (1)
<i>Solidago canadensis</i>	Canada goldenrod	0.78 (4)	1 (5)	0.7 (6)	2.56 (6)	0.56 (8)
<i>Sphaeralcea</i> spp.	globemallow				0.06 (1)	
<i>Symphotrichum ericoides</i>	heath aster	2.58 (13)	5.76 (15)	1.16 (13)	6.75 (18)	1.05 (15)
<i>Symphotrichum lanceolatum</i> ssp. <i>hesperium</i>	white panicle aster	0.09 (1)	0.41 (7)			
<i>Taraxacum officinale</i>	common dandelion				0.23 (4)	
<i>Xanthium strumarium</i>	rough cocklebur					0.15 (4)

Willow Sites

Plot: 98RB002 Corrales Preserve

Species Name	Common Name	1998	1999	2000	2001	2002
Trees						
Populus deltoides ssp. wislizenii	Rio Grande cottonwood	0.94 (1)	1.25 (1)		3.75 (2)	3.75 (2)
Ulmus pumila	Siberian elm	2.53 (2)	3.12 (2)	2.81 (1)	4.06 (2)	4.22 (2)
Shrubs						
Salix exigua	coyote willow	51.88 (32)	46.81 (32)	44.58 (32)	57 (32)	45.09 (29)
Tamarix ramosissima	saltcedar	3.91 (3)	2.09 (5)	1.31 (3)	5.78 (5)	5.41 (5)
Sub-Shrubs						
Opuntia phaeacantha	tulip pricklypear				0 (1)	
Graminoids						
Bouteloua gracilis	blue grama					0.03 (1)
Bromus japonicus	Japanese brome		0 (1)		0.28 (2)	
Cenchrus longispinus	longspine sandbur		0.03 (1)		0 (1)	0.02 (1)
Elymus canadensis	Canada wildrye	0.55 (7)	1.57 (10)	0.06 (1)	0.14 (3)	0.16 (1)
Elymus elymoides	bottlebrush squirreltail			0.16 (2)	0.09 (2)	0.06 (1)
Elymus x pseudorepens	false quackgrass		0.06 (1)			
Muhlenbergia asperifolia	alkali muhly	0.18 (5)	0.16 (4)	0.02 (1)		
Panicum obtusum	vine mesquite			1.34 (5)	0.94 (6)	2.34 (5)
Sorghastrum nutans	Indiangrass	0.47 (1)	1.41 (1)	0.78 (1)	0.47 (1)	0.16 (1)
Sporobolus contractus	spike dropseed			0.38 (2)		
Sporobolus cryptandrus	sand dropseed	1.12 (11)	2.96 (15)	3.44 (12)	3.42 (14)	3.1 (17)
Forbs						
Ambrosia psilostachya	Cuman ragweed	2.45 (14)	3.84 (13)	0.62 (10)	4.06 (13)	0.71 (11)
Chamaesyce serpyllifolia	thymeleaf sandmat		0.41 (5)	0.09 (4)	0.41 (7)	1.28 (13)
Conyza canadensis	Canadian horseweed	0.81 (11)	1.96 (13)	0.02 (1)	6.73 (23)	0 (1)
Dalea spp.	prairieclover		0 (1)			
Euthamia occidentalis	western goldenrod	0.12 (1)	0.38 (3)	0.06 (1)	0.22 (1)	
Grindelia nuda var. nuda	curlytop gumweed	0.02 (1)	0.03 (1)			
Helianthus annuus	common sunflower		0.12 (2)		0.12 (2)	
Lactuca serriola	prickly lettuce		0.02 (1)			
Machaeranthera canescens ssp. glabra	hoary tansyaster	0.03 (1)		0.02 (1)	0.05 (2)	
Melilotus officinalis	yellow sweetclover	1.59 (13)	16.23 (24)	3.44 (17)	4.77 (19)	0.99 (8)
Oenothera elata ssp. hirsutissima	Hooker's eveningprimrose	0.06 (1)	0.22 (4)	0.06 (1)		
Solanum spp.	nightshade		0 (1)			
Symphotrichum ericoides	heath aster	0.56 (10)	1.7 (14)	0.79 (8)	0.48 (6)	0.06 (2)
Taraxacum officinale	common dandelion			0.03 (1)		0.03 (1)
Thelesperma megapotamicum	Hopi tea greenthread		0 (1)			
Xanthium strumarium	rough cocklebur		0.03 (1)			

Willow Sites

Plot: 98RB004 Paseo Island

Species Name	Common Name	1998	1999	2000	2001	2002
Trees						
Elaeagnus angustifolia	Russian olive	6.64 (4)	5.06 (4)	6.06 (2)	6.08 (3)	11.67 (6)
Populus deltoides ssp. wislizenii	Rio Grande cottonwood	0.82 (5)	0.36 (4)	0.15 (3)	0.08 (3)	0.27 (6)
Salix gooddingii	Goodding's willow	0.3 (1)			0.15 (1)	
Ulmus pumila	Siberian elm		0.12 (1)	0.24 (3)	0.42 (4)	0.39 (4)
Shrubs						
Baccharis salicina	false willow	4.3 (3)	5.3 (3)	3.85 (7)	3.7 (7)	3.39 (6)
Salix exigua	coyote willow	44.91 (33)	30.64 (31)	36 (32)	38.06 (32)	33.39 (32)
Tamarix ramosissima	saltcedar	0.17 (2)	0.42 (2)	0.15 (1)	0.15 (1)	0.18 (2)
Graminoids						
Agrostis gigantea	redtop	10.42 (17)		5.52 (6)	6.22 (9)	1.21 (6)
Bromus carinatus	California brome			0.3 (1)	0 (1)	
Carex emoryi	Emory's sedge			0.06 (2)	0.03 (2)	0.27 (3)
Echinochloa crus-galli	barnyardgrass				0.01 (1)	0 (1)
Elymus canadensis	Canada wildrye		0.33 (5)	0.21 (5)	0.3 (3)	1.85 (10)
Elymus elymoides	bottlebrush squirreltail	0 (1)	0.4 (8)	0.26 (6)	0 (1)	
Elymus x pseudorepens	false quackgrass			0.3 (1)	0.15 (1)	
Festuca arundinaceae	tall fescue or K-31		15.06 (15)	23.33 (22)	36.06 (28)	18.68 (23)
Hordeum jubatum	foxtail barley				0.34 (5)	
Juncus balticus	Baltic rush	0.8 (3)	0.24 (2)	0.3 (1)	0.11 (2)	0.79 (2)
Juncus torreyi	Torrey's rush		0.01 (1)			
Muhlenbergia asperifolia	alkali muhly	0.94 (9)	4.03 (8)	2.15 (6)	5.36 (13)	5.79 (16)
Paspalum distichum	knotgrass			0.55 (2)	0.24 (2)	0.02 (2)
Poa compressa	Canada bluegrass	2.61 (2)	6.42 (5)		0.31 (2)	0.15 (1)
Polypogon interruptus	ditch rabbitsfoot grass			0.03 (1)		
Schoenoplectus pungens	common threesquare	0.87 (10)	0.13 (4)			
Schoenoplectus tabernaemontani	softstem bulrush	0.91 (2)	0.12 (2)	0.23 (3)	0.06 (1)	0 (1)
Forbs						
Ambrosia psilostachya	Cuman ragweed	27.33 (32)	21.64 (30)	28.89 (31)	18.86 (32)	6.18 (25)
Anemopsis californica	yerba mansa		0.06 (1)			
Apocynum cannabinum	Indianhemp	0.15 (1)	0.03 (1)	0.06 (3)	0.65 (6)	0.27 (4)
Argentina anserina	silverweed cinquefoil		0 (1)		0.06 (1)	
Bidens frondosa	devil's beggartick	0.09 (2)		0.06 (1)	0.06 (2)	
Conyza canadensis	Canadian horseweed	0.24 (1)				
Equisetum laevigatum	smooth horsetail	0.18 (13)	0.16 (14)	0.64 (24)	0.82 (30)	2.08 (32)
Euthamia occidentalis	western goldenrod	16.42 (21)	18.18 (24)	18.64 (29)	16.38 (29)	4.41 (17)
Gaura parviflora	velvetweed			0.06 (1)	0.03 (1)	0.45 (1)
Helianthus annuus	common sunflower		0 (1)	0.11 (2)	0.03 (1)	
Lactuca serriola	prickly lettuce	0.06 (1)	0.12 (1)			
Lycopus americanus	American bugleweed	0.21 (3)	0.58 (8)	0.55 (3)	0.95 (8)	0 (1)
Melilotus officinalis	yellow sweetclover			0.76 (1)	2.03 (3)	2.88 (2)
Oenothera elata ssp. hirsutissima	Hooker's eveningprimrose	0.03 (1)	0.12 (1)		0.15 (1)	1.27 (2)

Willow Sites

Plot: 98RB004 Paseo Island cont.

Species Name	Common Name	1998	1999	2000	2001	2002
Forbs cont.						
<i>Plantago major</i>	common plantain	0.15 (1)			0.03 (1)	
<i>Polygonum lapathifolium</i>	curlytop knotweed				0 (1)	
<i>Pseudognaphalium stramineum</i>	cottonbatting cudweed	0.79 (3)				
<i>Solidago canadensis</i>	Canada goldenrod	1.8 (8)	2.06 (5)	6.42 (10)	4.5 (10)	2.24 (8)
<i>Sonchus asper</i>	spiny sowthistle			0.02 (1)	0.26 (3)	
<i>Symphyotrichum ericoides</i>	heath aster			0.67 (4)	0.91 (6)	0.29 (5)
<i>Symphyotrichum lanceolatum</i> ssp. <i>hesperium</i>	white panicle aster				0.03 (1)	0.03 (1)
Unidentified forb		0.03 (1)				
<i>Xanthium strumarium</i>	rough cocklebur	0.18 (1)	0.23 (5)		0.02 (1)	

Willow Sites

Plot: 98RB007 Tingley

Species Name	Common Name	1998	1999	2000	2001	2002
Trees						
Elaeagnus angustifolia	Russian olive	0.06 (1)	0.38 (2)	2.47 (4)	5.47 (7)	6.72 (7)
Morus alba	white mulberry		0.16 (1)	0.01 (3)	0 (1)	0 (1)
Populus deltoides ssp. wislizenii	Rio Grande cottonwood	1.31 (4)	3.81 (5)	3.69 (7)	3.23 (8)	3.03 (6)
Salix gooddingii	Goodding's willow	0.25 (1)		0.94 (1)	0.22 (1)	0.22 (1)
Ulmus pumila	Siberian elm	1.75 (3)	2.91 (4)	3.78 (5)	4.19 (7)	3.5 (5)
Shrubs						
Baccharis salicina	false willow				0 (1)	
Parthenocissus quinquefolia var. quinquefolia	Virginia creeper				0 (1)	
Salix exigua	coyote willow	53.34 (32)	47.41 (32)	50.25 (32)	31.47 (32)	24.06 (32)
Tamarix ramosissima	saltcedar	0.34 (2)	0.5 (3)	1.06 (4)	0.41 (4)	0.38 (3)
Sub-Shrubs						
Gutierrezia sarothrae	broom snakeweed					0.16 (1)
Graminoids						
Agrostis gigantea	redtop			2.33 (9)	2.72 (8)	0.53 (5)
Bromus japonicus	Japanese brome		0.19 (2)	2.22 (3)	1.62 (4)	0 (1)
Cynodon dactylon	bermudagrass	0.47 (3)	0.08 (3)		0.28 (2)	0.47 (2)
Cyperus odoratus	fragrant flatsedge		0.02 (1)			
Cyperus squarrosus	bearded flatsedge		0.03 (1)			
Distichlis spicata	inland saltgrass		5.27 (9)			
Echinochloa crus-galli	barnyardgrass	0.19 (2)	0.05 (3)			
Elymus canadensis	Canada wildrye			0 (1)	0.03 (1)	0.02 (2)
Elymus elymoides	bottlebrush squirreltail	0.34 (6)	1.61 (9)			
Festuca arundinaceae	tall fescue or K-31		1.72 (2)	3.12 (4)	2.88 (4)	0.69 (5)
Hordeum jubatum	foxtail barley			1 (9)	0.06 (2)	
Leersia oryzoides	rice cutgrass	0.28 (1)	0.31 (1)	0.06 (1)	0 (1)	
Muhlenbergia asperifolia	alkali muhly	0.31 (1)	1.45 (9)	2.47 (16)	1.7 (15)	1.97 (15)
Muhlenbergia racemosa	marsh muhly	0.59 (2)	0.34 (2)	0.09 (2)	0.03 (1)	0.03 (1)
Panicum bulbosum	bulb panicgrass		0.09 (1)			
Panicum capillare	witchgrass	0 (1)	0.02 (1)			
Panicum hirticaule	Mexican panicgrass	0.03 (1)				
Panicum spp.	panicgrass		0.02 (1)			
Paspalum distichum	knotgrass	1.06 (3)				
Phragmites australis	common reed	1 (2)	0.16 (1)			
Poa compressa	Canada bluegrass	1.81 (6)	4.41 (7)		0.16 (1)	
Polypogon monspeliensis	annual rabbitsfoot grass	0.41 (6)	0.77 (3)			
Sorghastrum nutans	Indiangrass	2.53 (4)	2.2 (5)	2.53 (4)	3 (8)	1.86 (7)
Sporobolus contractus	spike dropseed			0.02 (1)		
Sporobolus cryptandrus	sand dropseed		0.06 (1)		0 (1)	0.07 (2)

Willow Sites

Plot: 98RB007 Tingley cont.

Species Name	Common Name	1998	1999	2000	2001	2002
Forbs						
<i>Ambrosia psilostachya</i>	Cuman ragweed	1.25 (4)	5.12 (12)	9.72 (19)	9.52 (20)	1.74 (19)
<i>Apocynum cannabinum</i>	Indianhemp	0.41 (2)	0.69 (2)	0.16 (3)	0.16 (4)	0.09 (3)
<i>Artemisia ludoviciana</i>	Louisiana sagewort				0 (1)	
<i>Bidens frondosa</i>	devil's beggartick		0.03 (1)			
<i>Chamaesyce serpyllifolia</i>	thymeleaf sandmat	0.03 (2)	0.13 (3)		0.07 (4)	0.13 (7)
<i>Conyza canadensis</i>	Canadian horseweed	8.19 (25)	7.09 (18)	0.05 (1)	0.81 (8)	
<i>Erigeron divergens</i>	spreading fleabane				0 (1)	
<i>Erigeron flagellaris</i>	trailing fleabane		0.06 (1)			
<i>Euthamia occidentalis</i>	western goldenrod	4.75 (7)	13.59 (18)	7.16 (24)	9.65 (25)	2.64 (15)
<i>Gaura parviflora</i>	velvetweed			0.02 (1)		
<i>Helenium autumnale</i>	common sneezeweed				0 (1)	
<i>Lactuca serriola</i>	prickly lettuce	0.06 (1)				
<i>Melilotus officinalis</i>	yellow sweetclover	0.06 (1)	0.06 (1)	0.02 (2)	2.38 (5)	3.09 (6)
<i>Oenothera elata</i> ssp. <i>hirsutissima</i>	Hooker's eveningprimrose	10.7 (15)	12.56 (23)	7.55 (23)	2.57 (18)	
<i>Pseudognaphalium stramineum</i>	cottonbatting cudweed	1.84 (6)	0.03 (2)	0.16 (5)	0.05 (1)	
<i>Solanum</i> spp.	nightshade		2.5 (2)			
<i>Solidago canadensis</i>	Canada goldenrod	1.34 (2)	0.75 (4)	4.22 (5)	5.12 (6)	3.28 (5)
<i>Sonchus asper</i>	spiny sowthistle		0.12 (2)		0.03 (1)	
<i>Symphyotrichum ericoides</i>	heath aster	2.47 (1)	0.19 (3)			
Unidentified forb						0 (1)
<i>Xanthium strumarium</i>	rough cocklebur	0.05 (2)	0.25 (3)	0 (1)		

Willow Sites

Plot: 98RB009 AOP Willow

Species Name	Common Name	1998	1999	2000	2001	2002
Trees						
Elaeagnus angustifolia	Russian olive		1.38 (3)	2.5 (3)	2.81 (3)	4.38 (4)
Morus alba	white mulberry	1.97 (3)	2.25 (5)	3.47 (4)	6.16 (7)	3 (6)
Populus deltoides ssp. wislizenii	Rio Grande cottonwood	2.88 (5)	1.09 (3)	4.47 (8)	5.72 (8)	4.59 (8)
Salix gooddingii	Goodding's willow	1.09 (1)		0.7 (3)	0.78 (2)	0.03 (1)
Ulmus pumila	Siberian elm			1.25 (1)		
Shrubs						
Baccharis salicina	false willow		0.12 (1)			
Salix exigua	coyote willow	34.59 (25)	26.66 (27)	29.69 (30)	37.41 (31)	36.81 (31)
Graminoids						
Carex emoryi	Emory's sedge		9.66 (16)	7.88 (9)	9.75 (12)	9.06 (11)
Carex occidentalis	western sedge	18.12 (19)	6.44 (6)		7.78 (8)	1.97 (7)
Distichlis spicata	inland saltgrass				0.16 (1)	
Eleocharis palustris	common spikerush	0.02 (1)				
Elymus canadensis	Canada wildrye			0.08 (4)	0.66 (9)	0.47 (8)
Elymus x pseudorepens	false quackgrass					0.06 (1)
Juncus balticus	Baltic rush				0.05 (2)	0.12 (3)
Muhlenbergia asperifolia	alkali muhly		0.34 (4)	1.28 (8)	2.5 (8)	2.44 (9)
Poa compressa	Canada bluegrass			5.94 (7)	0.06 (1)	
Sorghastrum nutans	Indiangrass	14.72 (22)	17.91 (25)	35.34 (29)	48.78 (30)	51.28 (31)
Sorghum halepense	johnsongrass			0.09 (1)	2.66 (1)	0.94 (1)
Sporobolus compositus var. compositus	tall dropseed	0.12 (1)	1.09 (1)	0.25 (1)	1.56 (1)	1.66 (2)
Forbs						
Ambrosia psilostachya	Cuman ragweed	10.5 (16)	8.31 (17)	9.38 (21)	7.19 (22)	4.61 (23)
Anemopsis californica	yerba mansa			0.12 (3)	0.05 (3)	
Apocynum cannabinum	Indianhemp	44 (30)	9.94 (27)	2 (21)	1.53 (15)	2.03 (22)
Argentina anserina	silverweed cinquefoil			0 (1)		
Asclepias speciosa	showy milkweed	0.19 (1)	0.56 (6)	0.55 (7)	0.22 (5)	0.47 (9)
Asclepias subverticillata	whorled milkweed			0 (1)		
Convolvulus arvensis	field bindweed	0.06 (2)	0.09 (1)	0.55 (9)	0.56 (11)	1.44 (9)
Equisetum laevigatum	smooth horsetail	0.11 (4)	0 (1)	0.09 (12)	0.08 (11)	0.17 (9)
Euthamia occidentalis	western goldenrod	8.75 (25)	15.47 (27)	11.41 (29)	9.8 (30)	2.31 (22)
Helianthus annuus	common sunflower	1.92 (12)	0.57 (8)	0.1 (5)	0.08 (3)	
Helianthus petiolaris	prairie sunflower				0.03 (1)	
Lactuca tatarica var. pulchella	blue lettuce					0.22 (3)
Lycopus americanus	American bugleweed	1.84 (6)	5.72 (20)	0.89 (15)	0.62 (13)	0.09 (2)
Melilotus officinalis	yellow sweetclover	1.38 (8)	1.28 (4)			
Mentha arvensis	wild mint	0.81 (1)	0.62 (1)	0.03 (1)		
Symphyotrichum ericoides	heath aster	0.38 (1)	0.66 (4)	0.53 (3)	0.66 (3)	0.91 (5)
Symphyotrichum lanceolatum ssp. hesperium	white panicle aster			2.2 (15)	4.89 (20)	5.7 (19)
Taraxacum officinale	common dandelion			0.09 (2)	0.09 (2)	0.38 (5)
Unidentified forb			0.03 (1)			

Willow Sites

Plot: 98RB011 South Bravo Powerline

Species Name	Common Name	1998	1999	2000	2001	2002
Trees						
Elaeagnus angustifolia	Russian olive	2.81 (1)	2.81 (1)	1.25 (1)	2.34 (1)	0.62 (1)
Morus alba	white mulberry		0.11 (5)	0 (1)	0.14 (4)	0.33 (4)
Populus deltoides ssp. wislizenii	Rio Grande cottonwood	1.95 (6)	0.81 (4)	1.2 (5)	0.61 (5)	0.36 (5)
Ulmus pumila	Siberian elm	3.59 (6)	5 (11)	4.1 (9)	10.48 (11)	10.19 (8)
Shrubs						
Baccharis salicina	false willow			0 (1)	0.09 (2)	0.19 (2)
Parthenocissus quinquefolia var. quinquefolia	Virginia creeper		0.05 (2)	0.05 (2)	0.12 (2)	0.09 (2)
Salix exigua	coyote willow	73.12 (32)	61.84 (31)	55.22 (32)	47.34 (31)	34.34 (30)
Tamarix ramosissima	saltcedar	0.01 (1)	0.02 (1)	0 (2)	0.16 (2)	0.13 (3)
Sub-Shrubs						
Gutierrezia sarothrae	broom snakeweed			0 (1)		
Graminoids						
Agrostis gigantea	redtop	0.31 (1)	1.09 (2)	1.64 (3)	1.91 (2)	0 (1)
Bothriochloa laguroides ssp. torreyana	silver beardgrass				0.06 (1)	0.06 (1)
Bromus japonicus	Japanese brome		0 (1)	0.22 (2)	0.62 (1)	
Carex emoryi	Emory's sedge			0.19 (2)	0.34 (2)	0.19 (1)
Cenchrus longispinus	longspine sandbur		0.03 (1)			
Cynodon dactylon	bermudagrass			0.03 (2)	0.16 (1)	
Cyperus odoratus	fragrant flatsedge		0.19 (3)			
Cyperus squarrosus	bearded flatsedge		0.02 (1)			
Distichlis spicata	inland saltgrass					0.31 (1)
Elymus canadensis	Canada wildrye	0.31 (1)	0.8 (6)	0.25 (2)	0.56 (6)	0.35 (7)
Elymus elymoides	bottlebrush squirreltail	0.06 (1)	2.66 (2)			
Elymus spp.	wildrye		0.12 (1)			
Elymus x pseudorepens	false quackgrass					0.06 (2)
Eragrostis pectinacea	tufted lovegrass		0.09 (1)			
Festuca arundinaceae	tall fescue or K-31			0 (1)	0.09 (2)	0.02 (2)
Hordeum jubatum	foxtail barley	0.12 (3)		0.55 (7)	1.38 (5)	
Juncus torreyi	Torrey's rush	0.02 (1)	0 (1)	0 (1)	0 (1)	
Leersia oryzoides	rice cutgrass			0.22 (1)	0.1 (2)	0.03 (2)
Muhlenbergia asperifolia	alkali muhly	4.14 (7)	7.64 (14)	3.31 (8)	5.16 (13)	2.16 (12)
Muhlenbergia racemosa	marsh muhly	0.59 (2)	1.09 (2)		0.84 (4)	0.16 (2)
Panicum capillare	witchgrass	0.13 (3)	0.39 (7)			
Panicum hirticaule	Mexican panicgrass				0.31 (1)	
Panicum obtusum	vine mesquite	0.06 (1)		0.03 (1)	0.03 (1)	
Paspalum distichum	knotgrass			1.59 (2)	0.84 (3)	0.03 (1)
Polypogon monspeliensis	annual rabbitsfoot grass	0.13 (2)	0.31 (2)	0 (1)	0.03 (1)	
Saccharum ravennae	ravennagrass			0.38 (1)	1.25 (1)	1.56 (1)
Schoenoplectus pungens	common threesquare		0.02 (1)	0 (1)		
Setaria pumila	yellow bristlegrass		0 (1)			
Sorghastrum nutans	Indiangrass	0.97 (6)	2.56 (6)	1.73 (6)	2.16 (5)	1.16 (5)
Sphenopholis obtusata	prairie wedgescale	0.62 (1)		0.72 (3)	0.33 (2)	0.06 (2)

Willow Sites

Plot: 98RB011 South Bravo Powerline cont.

Species Name	Common Name	1998	1999	2000	2001	2002
Graminoids cont.						
Sporobolus airoides	alkali sacaton			1.34 (4)		
Sporobolus compositus var. compositus	tall dropseed	0.47 (4)	0.73 (5)		1.16 (4)	1.38 (4)
Sporobolus cryptandrus	sand dropseed	1.53 (5)		0.78 (6)	0.64 (9)	1.14 (11)
Unidentified grass		0.06 (1)				
Forbs						
Ambrosia psilostachya	Cuman ragweed	3.19 (12)	11.48 (20)	3.98 (26)	7.23 (27)	1.55 (22)
Anemopsis californica	yerba mansa		0.12 (1)			
Apocynum cannabinum	Indianhemp		0.03 (1)	0.69 (2)	0.52 (4)	
Asclepias subverticillata	whorled milkweed	0.06 (1)	0.09 (1)			
Bidens frondosa	devil's beggartick	0.22 (1)	0.03 (2)	0 (1)	0 (1)	
Chamaesyce serpyllifolia	thymeleaf sandmat		0.25 (3)	0.02 (1)	0 (2)	0.04 (4)
Conyza canadensis	Canadian horseweed	4.08 (20)	4.09 (16)	0.2 (3)	0.69 (10)	
Dalea leporina	foxtail prairieclover			0 (1)	0.06 (1)	
Dalea spp.	prairieclover		0 (1)			
Equisetum laevigatum	smooth horsetail	0.08 (2)	0.16 (3)	0.5 (6)	0.29 (9)	0.47 (8)
Erigeron flagellaris	trailing fleabane		0.11 (3)	0.12 (1)	0.12 (1)	0.09 (1)
Euthamia occidentalis	western goldenrod	1.5 (4)	3.66 (6)	2.9 (12)	4.84 (14)	1.06 (11)
Gaura parviflora	velvetweed			0.06 (1)	0.09 (2)	
Grindelia nuda var. nuda	curlytop gumweed				0 (1)	
Helenium autumnale	common sneezeweed			0 (1)		
Helianthus annuus	common sunflower				0.05 (2)	
Lactuca serriola	prickly lettuce	0.03 (1)	0.2 (5)		0.03 (2)	
Lactuca tatarica var. pulchella	blue lettuce					0.02 (1)
Lycopus americanus	American bugleweed			0 (1)		
Melilotus officinalis	yellow sweetclover	0.25 (2)	0.58 (4)	0.19 (2)	1.39 (8)	0.17 (3)
Oenothera elata ssp. hirsutissima	Hooker's eveningprimrose	1.02 (11)	2.41 (16)	1.08 (12)	0.84 (10)	
Plantago major	common plantain	0.16 (1)		0.31 (3)	0.17 (3)	0.03 (1)
Pseudognaphalium stramineum	cottonbatting cudweed	0.27 (5)	0.02 (1)	0.06 (3)		
Pyrrhopappus pauciflorus	desert chicory		0.03 (1)	0.03 (2)	0.03 (1)	
Ranunculus cymbalaria	alkali buttercup			0.02 (1)		
Solidago canadensis	Canada goldenrod	0.44 (3)	3.03 (5)	0.67 (7)	1.62 (6)	0.32 (6)
Symphotrichum ericoides	heath aster	0.34 (3)	0.56 (3)	1 (7)	0.59 (6)	0.27 (4)
Symphotrichum lanceolatum ssp. hesperium	white panicle aster				0.03 (1)	
Taraxacum officinale	common dandelion		0.03 (1)			
Verbascum thapsus	common mullein		0.09 (2)		0.03 (1)	
Xanthium strumarium	rough cocklebur	0.33 (6)	0.89 (7)	0.03 (1)	0.09 (2)	

Appendix D

List of all plant species identified from all vegetation types.

Species Name	Common Name	Origin	Wetland Status
Trees			
<i>Ailanthus altissima</i>	tree of heaven	Introduced	FACU
<i>Elaeagnus angustifolia</i>	Russian olive	Introduced	FACW-
<i>Morus alba</i>	white mulberry	Introduced	NI (UPL)
<i>Populus deltoides</i> ssp. <i>wislizenii</i>	Rio Grande cottonwood	Native	NI (OBL)
<i>Salix gooddingii</i>	Goodding's willow	Native	OBL
<i>Ulmus pumila</i>	Siberian elm	Introduced	NI (UPL)
Shurbs			
<i>Amorpha fruticosa</i>	desert indigobush	Native	FACW+
<i>Baccharis salicina</i>	false willow	Native	
<i>Clematis ligusticifolia</i>	western white clematis	Native	FAC
<i>Forestiera pubescens</i> var. <i>pubescens</i>	New Mexico olive	Native	FACU (FAC)
<i>Parthenocissus vitacea</i>	Virginia creeper	Native	NI (FACW)
<i>Rhus trilobata</i>	skunkbush sumac	Native	NI (FAC)
<i>Ribes aureum</i>	golden currant	Native	
<i>Salix exigua</i>	coyote willow	Native	OBL
<i>Tamarix ramosissima</i>	saltcedar	Introduced	NI (FACW)
Sub-shrubs			
<i>Desmanthus illinoensis</i>	prairie bundleflower	Native	NI (FAC)
<i>Gutierrezia sarothrae</i>	broom snakeweed	Native	NI (UPL)
<i>Heterotheca villosa</i>	hairy goldenaster	Native	
<i>Opuntia phaeacantha</i>	tulip pricklypear	Native	NI (UPL)
Graminoids			
<i>Agrostis gigantea</i>	redtop	Introduced	FACW+
<i>Bothriochloa laguroides</i> ssp. <i>torreyana</i>	silver beardgrass	Native	NI (UPL)
<i>Bouteloua barbata</i>	sixweeks grama	Native	NI (FACU)
<i>Bouteloua gracilis</i>	blue grama	Native	NI (UPL)
<i>Bromus carinatus</i>	California brome	Native	NI (FACU)
<i>Bromus japonicus</i>	Japanese brome	Introduced	FACU
<i>Carex emoryi</i>	Emory's sedge	Native	NI (FAC)
<i>Carex occidentalis</i>	western sedge	Native	NI (FACW)
<i>Cenchrus longispinus</i>	longspine sandbur	Native	
<i>Cynodon dactylon</i>	bermudagrass	Introduced	FACU (FACW)
<i>Cyperus odoratus</i>	fragrant flatsedge	Native	
<i>Cyperus squarrosus</i>	bearded flatsedge	Native	NI (FACW)
<i>Distichlis spicata</i>	inland saltgrass	Native	FACW
<i>Echinochloa crus-galli</i>	barnyardgrass	Introduced	FACW- (FACW)
<i>Eleocharis palustris</i>	common spikerush	Native	OBL
<i>Elymus canadensis</i>	Canada wildrye	Native	FAC (FACW)
<i>Elymus elymoides</i>	bottlebrush squirreltail	Native	NI (FACU)
<i>Elymus</i> spp.	wildrye		
<i>Elymus x pseudorepens</i>	false quackgrass	Native	NI (FAC)
<i>Eragrostis pectinacea</i>	tufted lovegrass	Native	

Species Name	Common Name	Origin	Wetland Status
Graminoids cont.			
<i>Festuca arundinaceae</i>	tall fescue or K-31	Introduced	NA (FAC)
<i>Hordeum jubatum</i>	foxtail barley	Native	NI (FAC)
<i>Juncus arcticus</i> var. <i>balticus</i>	Baltic rush	Native	OBL
<i>Juncus torreyi</i>	Torrey's rush	Native	FACW (OBL)
<i>Leersia oryzoides</i>	rice cutgrass	Native	OBL
<i>Muhlenbergia asperifolia</i>	alkali muhly	Native	OBL
<i>Muhlenbergia racemosa</i>	marsh muhly	Native	FACW
<i>Panicum bulbosum</i>	bulb panicgrass	Native	
<i>Panicum capillare</i>	witchgrass	Native	FAC
<i>Panicum hirticaule</i>	Mexican panicgrass	Native	
<i>Panicum obtusum</i>	vine mesquite	Native	FAC (FACW)
<i>Panicum</i> spp.	panicgrass	Native	
<i>Paspalum distichum</i>	knotgrass	Native	OBL
<i>Phragmites australis</i>	common reed	Native	FACW+
<i>Poa compressa</i>	Canada bluegrass	Introduced	FACU
<i>Polypogon interruptus</i>	ditch rabbitsfoot grass	Introduced	
<i>Polypogon monspeliensis</i>	annual rabbitsfoot grass	Introduced	FACW+ (OBL)
<i>Saccharum ravennae</i>	ravennagrass	Introduced	
<i>Schoenoplectus pungens</i>	common threesquare	Native	OBL
<i>Schoenoplectus tabernaemontani</i>	softstem bulrush	Native	OBL
<i>Setaria pumila</i>	yellow bristlegrass	Introduced	
<i>Sorghastrum nutans</i>	Indiangrass	Native	NI (FACW)
<i>Sorghum halepense</i>	johnsongrass	Introduced	FACU+
<i>Sphenopholis obtusata</i>	prairie wedgescale	Native	
<i>Sporobolus airoides</i>	alkali sacaton	Native	FAC
<i>Sporobolus compositus</i> var. <i>compositus</i>	tall dropseed	Native	NI (UPL)
<i>Sporobolus contractus</i>	spike dropseed	Native	NI (UPL)
<i>Sporobolus cryptandrus</i>	sand dropseed	Native	FACU- (FAC)
Unidentified grass			
Forbs			
<i>Ambrosia psilostachya</i>	Cuman ragweed	Native	FAC
<i>Anemopsis californica</i>	yerba mansa	Native	OBL
<i>Apocynum cannabinum</i>	Indianhemp	Native	FAC+ (FACW)
<i>Argentina anserina</i>	silverweed cinquefoil	Native	OBL
<i>Asclepias speciosa</i>	showy milkweed	Native	FACW-
<i>Asclepias subverticillata</i>	whorled milkweed	Native	FACU
<i>Asparagus officinalis</i>	garden asparagus	Introduced	NI (FACU)
<i>Bidens frondosa</i>	devil's beggartick	Native	FACW
<i>Chamaesyce serpyllifolia</i>	thymeleaf sandmat	Native	NI (FACU)
<i>Chenopodium berlandieri</i> var. <i>berlandieri</i>	Berlandier's goosefoot	Native	NI (UPL)
<i>Chenopodium</i> spp.	goosefoot		
<i>Chloracantha spinosa</i>	spiny chloracantha	Native	FACW
<i>Convolvulus arvensis</i>	field bindweed	Introduced	NI (UPL)
<i>Conyza canadensis</i>	Canadian horseweed	Native	FACU (FAC)
<i>Croton texensis</i>	Texas croton	Native	NI (FACU)
<i>Dalea leporina</i>	foxtail prairieclover	Native	

Species Name	Common Name	Origin	Wetland Status
Forbs cont.			
Dalea spp.	prairieclover	Native	
Equisetum laevigatum	smooth horsetail	Native	FACW
Erigeron divergens	spreading fleabane	Native	NI (FAC-)
Erigeron flagellaris	trailing fleabane	Native	FAC-
Euthamia occidentalis	western goldenrod	Native	FACW
Gaura parviflora	velvetweed	Native	NI (FACU)
Grindelia nuda var. nuda	curlytop gumweed	Native	
Helenium autumnale	common sneezeweed	Native	
Helianthus annuus	common sunflower	Native	FAC-
Helianthus petiolaris	prairie sunflower	Native	NI (UPL)
Kochia scoparia	common kochia	Introduced	FAC
Lactuca serriola	prickly lettuce	Introduced	FAC
Lactuca tatarica var. pulchella	blue lettuce	Native	NI (FAC)
Linum lewisii	prairie flax	Native	
Lycopus americanus	American bugleweed	Native	OBL
Machaeranthera canescens ssp. glabra	hoary tansyaster	Native	
Machaeranthera pinnatifida	lacy tansyaster	Native	
Melilotus officinalis	yellow sweetclover	Introduced	FACU+
Mentha arvensis	wild mint	Native	FACW
Oenothera elata ssp. hirsutissima	Hooker's eveningprimrose	Native	FACW
Plantago major	common plantain	Introduced	FACW
Polygonum lapathifolium	curlytop knotweed	Native	OBL
Pseudognaphalium stramineum	cottonbatting cudweed	Native	FAC
Pyrrhopappus pauciflorus	desert chicory	Native	
Ranunculus cymbalaria	alkali buttercup	Native	OBL
Ratibida tagetes	green prairie coneflower	Native	NI (FACU)
Salsola tragus	prickly Russian thistle	Introduced	
Senecio riddellii	Riddell's ragwort	Native	
Solanum spp.	nightshade	Native	
Solidago canadensis	Canada goldenrod	Native	FACU (FAC)
Sonchus asper	spiny sowthistle	Introduced	NI (FACW)
Sphaeralcea incana	gray globemallow	Native	
Sphaeralcea spp.	globemallow	Native	
Symphyotrichum ericoides	heath aster	Native	FACU
Symphyotrichum lanceolatum ssp. hesperium	white panicle aster	Native	
Taraxacum officinale	common dandelion	Introduced	FACU
Thelesperma megapotamicum	Hopi tea greenthread	Native	NI (UPL)
Unidentified forb			
Verbascum thapsus	common mullein	Introduced	NI (FAC)
Xanthium strumarium	rough cocklebur	Native	NI (FACW)

Appendix E

Complete list of beetle species and individuals collected by vegetation type, with site AOP Willow seperated out.

Family	Scientific Name	Common name	Bosque	Mixed	Willow	AOP Willow
Anobiidae	Anobiidae	death-watch beetle		1	1	
Anthicidae	Anthicidae	antlike flower beetle	2	1	4	4
Anthicidae	Anthicus sp.	antlike flower beetle	11		5	1
Anthicidae	Baulius tenuis	antlike flower beetle	1	2	10	49
Anthicidae	Notoxus sp.	antlike flower beetle		7	3	
Bostrichidae	Bostrichidae	branch borer	1			
Carabidae	Amara sp.	ground beetle	4	16	25	6
Carabidae	Calathus opaculus	ground beetle	462	434	81	342
Carabidae	Calosoma scrutator		1			
Carabidae	Cicindela sp.	tiger beetle		1	10	
Carabidae	Cyclotrachelus sp.	ground beetle	56	113	24	1
Carabidae	Galerita janus	ground beetle		15	1	11
Carabidae	Harpalus caliginosus	ground beetle	4	8	3	1
Carabidae	Harpalus fuscipalpus	ground beetle	1	1		1
Carabidae	Harpalus pennsylvanicus	ground beetle	45	110	19	145
Carabidae	Lebia sp.	ground beetle		1	1	
Carabidae	Omophron americanum	hunch-backed beetle			2	
Carabidae	Pasimachus californicus	ground beetle	3	11	1	2
Carabidae	Pasimachus elongatus	ground beetle		2		
Carabidae	Poecilus chalcites					1
Carabidae	Poecilus lucublandus			2		8
Carabidae	Pterostichus restrictus		2	2		1
Carabidae	Pterostichus sp.					1
Carabidae	Scarites subterraneus	ground beetle	3	5	35	8
Carabidae	Tachys sp.	ground beetle			2	
Chrysomelidae	Altica sp.		1	1	2	
Chrysomelidae	Chrysomela scripta	leaf beetle	5			
Chrysomelidae	Chrysomelidae	leaf beetle			2	1
Chrysomelidae	Cryptocephalus sp.	cylindrical leaf beetle		2	7	
Chrysomelidae	Metachroma sp.				1	
Chrysomelidae	Pachybrachus sp.	leaf beetle			3	1
Chrysomelidae	Pyrrhalta luteola	elm leaf beetle	1		9	
Chrysomelidae	Xanthonia sp.			5		
Cleridae	Phyllobaenus sp.		1			
Coccinellidae	Hippodamia convergens	Ladybird beetle			1	
Coccinellidae	Hyperaspidius sp.			1		
Corylophidae	Sericoderus sp.			13		
Cryptophagidae	Anchicera sp.			1		
Cryptophagidae	Cryptophagidae	silken fungus beetle	87	2	3	
Cryptophagidae	Cryptophagus sp.	silken fungus beetle	6	299	99	8
Cryptophagidae	Toramus sp.			2		
Curculionidae	Apion sp.			1	2	
Curculionidae	Cimbocera conspersa	weevil	1			
Curculionidae	Curculionidae	weevil	18	10	9	
Curculionidae	Dyslobus sp.			1	3	

Family	Scientific Name	Common name	Bosque	Mixed	Willow	AOP Willow
Curculionidae	Lixus sp.			2		
Curculionidae	Ophryastes sulcirostris	weevil	1	2		
Curculionidae	Otiorhynchus ovatus	strawberry root weevil	99	15	6	1
Curculionidae	Otiorhynchus rugostratus	weevil	102	21	18	2
Curculionidae	Smicronyx sp.			1	1	
Curculionidae	Sphenophorus neomexicanus	New Mexico billbug	6	3		
Curculionidae	Sphenophorus phoeniciensis	weevil		1		
Dermestidae	Dermestes marmoratus		1			
Elateridae	Aeolus livens	click beetle	42	445	105	89
Elateridae	Agrypnus rectangularis	click beetle	2	2	5	1
Elateridae	Conoderus sp.	click beetle	3	2	1	2
Elateridae	Heterodes sordidus	click beetle	1			
Elateridae	Lanelater schottii	click beetle	6	8	3	
Elateridae	Melanotus longulus	click beetle			1	
Histeridae	Eremosaprinus sp.			1		
Histeridae	Hister abbreviatus	hister beetle	5	2		
Histeridae	Xerosaprinus sp.	hister beetle	7	1		
Hydrophilidae	Hydrophilus triangularis			1		
Laemophloeidae	Laemophloeus biguttatus	flat bark beetle	1			
Lathridiidae	Lathridiidae	minute brown s cavenger beetle		4		
Leiodidae	Catops sp.			2		
Leiodidae	Leiodidae	round fungus beetle	2	2	4	1
Leiodidae	Ptomaphagus texanus		1			
Meloidae	Epicauta pensylvanica			1		
Melyridae	Collops bipunctatus	Softwinged flower beetle	1	1	1	
Mordellidae	Mordella atrata	Tumbling Flower beetle		2		
Mordellidae	Mordella melaena	Tumbling Flower beetle	1			
Mordellidae	Mordella quadripunctata	Tumbling Flower beetle		1		
Nitidulidae	Nitidulidae	sap beetle	1			
Nitidulidae	Thalycra keltoni	sap beetle	2			1
Nitidulidae	Thalycra sp.	sap beetle		1		
Ochodaeidae	Ochodaeus sp.			1		
Scarabaeidae	Aphodius sp.	Aphodian dung beetle			1	
Scarabaeidae	Cremastocheilus sp.	scarab beetle	2			
Scarabaeidae	Diplotaxis carbonata	scarab beetle	5			
Scarabaeidae	Diplotaxis sp.	scarab beetle	2	2	6	
Scarabaeidae	Euoniticellus intermedius	dung beetle	2	1	1	
Scarabaeidae	Euphoria indus	bumble flower beetle	8	4	26	1
Scarabaeidae	Hoplia laticollis	scarab beetle	1	16	7	
Scarabaeidae	Onthophagus hecate	dung beetle	7	5	1	2
Scarabaeidae	Phyllophaga sp.	June beetle	1			1
Scarabaeidae	Polyphylla decemlineata	June beetle	1			
Scarabaeidae	Polyphylla hammondi	June beetle		1		
Scarabaeidae	Scarabaeidae	scarab beetle		3		
Scolytidae	Pityophthorus sp.			1		
Scolytidae	Scolytidae	bark-and-ambrosia beetle	1	1		
Scraptiidae	Anaspis rufa	false darkling beetle	2	6		
Scraptiidae	Scraptia sp.			1		
Scraptiidae	Scraptiidae		1			
Silphidae	Heterosilpha ramosa	carrion beetle		21		12
Staphylinidae	Aleocharinae	rove beetle	2	16	29	2
Staphylinidae	Baeocera sp.				1	
Staphylinidae	Brachygluta texana					1

Family	Scientific Name	Common name	Bosque	Mixed	Willow	AOP Willow
Staphylinidae	Creophilus maxillosus	rove beetle	1			1
Staphylinidae	Hapalaraea cacti	rove beetle	1	1	1	1
Staphylinidae	Lobrathium angusta	rove beetle			1	
Staphylinidae	Ocypus ater			1		
Staphylinidae	Philonthus semiruber	rove beetle		1		
Staphylinidae	Platydracus sepulchralis	rove beetle	165	806	70	343
Staphylinidae	Pselaphinae	short-winged mold beetle		2		1
Staphylinidae	Quedius sp.	rove beetle	1		5	
Staphylinidae	Staphylinidae		1			
Tenebrionidae	Araeoschizus decipiens	darkling beetle		3	1	
Tenebrionidae	Blapstinus fortis	darkling beetle	254	219	340	11
Tenebrionidae	Blapstinus pimalis	darkling beetle	4	6	102	1
Tenebrionidae	Eleodes extricata	skunk beetle (Bombardier beetle)	1	4	5	8
Tenebrionidae	Eleodes longicollis	skunk beetle (Bombardier beetle)	7		2	
Tenebrionidae	Eleodes obsoleta	skunk beetle (Bombardier beetle)	1			
Tenebrionidae	Eleodes suturalis	skunk beetle (Bombardier beetle)	29	22	13	3
Tenebrionidae	Embaphion contusum	darkling beetle	53	4	2	2
Tenebrionidae	Eusattus reticulata	darkling beetle		1		1
Tenebrionidae	Lobometopon fusiformis	darkling beetle	1	11	3	1
Trogidae	Trox punctatus	skin beetle		1		
Trogidae	Trox sp.	skin beetle	1			
Trogidae	Trox tessellatus	skin beetle	2	8	5	
Total # Species:			69	82	60	43
Speices Unique to type:			16	23	13	3