# DRAFT

# MEMORANDUM

Date: October 22, 2001

To: The Honorable Chair and Members
Pima County Board of Supervisors

From: C.H. Huckelberry
County Administrator

Re: **Biological Values of the West Branch of the Santa Cruz River**

**Background**

The attached study on the *Biological Values of the West Branch of the Santa Cruz River* has its origins in a dispute about where to site a bus barn in an area, that, as the study says, "to an untrained eye is not necessarily exceptional, and has accumulated the usual junk, trash, and urban flotsam that one expects of an area that has been largely neglected."

Eighty-six years ago, a water control and irrigation project diverted flow from the West Branch of the Santa Cruz River, turning the east branch into the Santa Cruz River as we know it today, and leaving the West Branch,"high and dry, and more or less forgotten."

But this neglect -- in light of the ecological disasters that our attention has wrought on other riparian systems over the past decades -- has turned out to be a gift to the surrounding natural system. Because we have left this area alone, it has a chance to recover and become, as the study proposes, a part of the larger Paseo de las Iglesias project, and a cornerstone of a more extensive effort at ecological restoration involving the mesic corridors of Pima County, the Santa Cruz, Rillito, and Pantano.

Dr. Phil Rosen, the author of the study and proposal, followed news about the presence of Giant spotted whiptail lizards into the seemingly unlikely area that is bounded by Silverlake Road and Ajo Way, and through his combined ingenuity, knowledge of history, and mastery of his field of biology, he discovered not only species that have been located nowhere else on the basin floor, but a whole system that might be brought back if we understand and do not undervalue the opportunity for conservation and restoration before us.

This memorandum is written to introduce the biological assessment and the preservation and restoration proposals of the attached study, and to recommend that such proposals become a part of the Sonoran Desert Conservation Plan that we actively pursue at this time.

**Significance of the Study Area from Dr. Phil Rosen's Perspective**

The following description came from Dr. Phil Rosen late last summer, as he began to realize the historical context and significance of the study area. In words that convey the excitement of his discovery, Dr. Rosen wrote:

> "The work on the West Branch has been an eye-opener for me. The first revelation came from comparing Betancourt and Turner's unpublished figures to the on-the-ground, present structure of the West Branch, and realizing the channel hasn't changed much since around 1900!
>
> From there, and again being led by those same authors, plus the best old 1904 map by the United States Geological Survey, I realized that the West Branch wasn't subordinate or subsidiary, but was most originally equal to the east branch or perhaps it was even the main branch.
>
> Then the irony set in, that by diversion of the West Branch to the main in 1915 to protect farm fields, the structure of the West Branch channel and its floodplain were preserved, while the east branch widened, deepened, and degraded, degraded, degraded. The irony is that we have all overlooked and forgotten the West Branch as if it were just an arroyo or just a smaller and insignificant sidekick of the Santa Cruz.
>
> Here I want to reinforce my feeling that the study area for this document is indeed quite unique. It is the herpetofauna, for me, that has stories to tell. First, the structure of the habitat -- the vegetation density plus the connection between the xeroriparian bosque and the surrounding floodplain -- is apparently unique in the area. That is because the erosion that bypassed (literally) the West Branch hit all the other major riparian areas. This erosion has opened wide arroyos, and thinned the vegetation structure on the streambanks and in the surrounding bosque. So we don't see the density and complexity that is on the West Branch. This is why the giant spotted whiptails apparently persist only at West Branch, and up in the un-eroded canyons.
>
> Second, the West Branch retains the history of the Santa Cruz -- the Sonoran Mexican, south-facing history. I don't think an animal like the Sinaloan narrow-mouthed toad ever lived north of downtown. It is on the West Branch today because that's where it was 100 and 1000 years ago. Almost all birds, most mammals, and some herps and plants disperse and find the good habitat readily. But many things, like small frogs and toads, undoubtedly many plants, just don't do that. They might as well be buried treasure, embedded in the land as they are. Thus, I suspect that if we want to find what is richest about our area, we may need to pay careful attention to the floodplain from about four miles south of San Xavier Mission right up to downtown Tucson."

**Significance of the Study Method and Findings, from the Peer Review Perspective**

The *Biological Values of the West Branch of the Santa Cruz River* study involved collaboration among, and peer review by individuals in the science community. Kathryn Mauz of the Arid Lands Resources Sciences Department of the University contributed a companion study of the *Plants of the West Branch of the Santa Cruz*. In a review of the study the Executive Director of the Drylands Institute had this to say about the Rosen-Mauz effort, which also conveys the excitement and the importance of this work:

> "I see an original and novel way of documenting a present-day situation as well as deciphering the composition and historical change in riparian ecosystems and associated habitats, and relating this information in a useful manner. This accurate information is essential for restoration and management that can help sustain riparian places. The revision and re-interpreting of century old published work and locating and accurate identification of specimens is not hum-drum work -- it is brilliant and can only be accomplished by a very dedicated and accomplished individual. It is original science at its best. I just cannot stop praising this work. This is the model for work that we need. I feel that much of our riparian habitats can be brought back, even in view of the horrific changes that have gone on over the last half dozen and more decades. I sure want to see southern Arizona riparian places returned to their rightful glory. Here are the tools that we need."

**Conclusion**

Three years ago this week the Board accepted the draft Concept Sonoran Desert Plan and launched a research series that has evolved to include such outstanding work as this study led by Dr. Rosen on the *Biological Values of the West Branch of the Santa Cruz River.* Dr. Rosen states as he proposes to conserve the West Branch as a part of the larger Paseo de las Iglesias project, and as a cornerstone of a more extensive effort at ecological restoration involving the mesic corridors of Pima County:

> "The Sonoran Desert Conservation Plan in Pima County is currently the arena in which such integrated planning may take place. Available lands, ongoing projects, currently active park concepts, and geographic setting in a broad sense make this set of concepts and areas suitable as a resource planning area that could produce fine benefits to the city, county, Tohono O'odham Nation, and existing neighborhoods."

I recommend that Dr. Rosen's proposals become a part of the Sonoran Desert Conservation Plan, and that we actively pursue conservation of the West Branch at this time.

Attachment

# BIOLOGICAL VALUES OF THE WEST BRANCH OF THE SANTA CRUZ RIVER, WITH AN OUTLINE FOR A POTENTIAL PARK OR RESERVE

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# BIOLOGICAL VALUES OF THE WEST BRANCH OF THE SANTA CRUZ RIVER, WITH AN OUTLINE FOR A POTENTIAL PARK OR RESERVE

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15 October 2001

## Summary

The West Branch of the Santa Cruz River is the least degraded and highest-biodiversity portion of the Santa Cruz River floodplain near Tucson. The study area here (Fig. 1), between Silverlake Road and Ajo Way, and bounded by Mission Road and Cottonwood Lane, has intact bosque, flora, and fauna, and open space suitable for preservation and restoration. It is equal to or better than anything available elsewhere in Pima County on the Santa Cruz River or West Branch. It supports at least three Priority Vulnerable Species (as defined by Pima County in the Sonoran Desert Conservation Plan — giant-spotted whiptail, Abert□s towhee, and rufous-winged sparrow) and a fourth on immediately adjoining land in similar habitat (Tumamoc globeberry). The West Branch on the Tohono O□odham San Xavier District also retains high-quality lands, but there is as yet no recent evidence that these lands support as much or the same biodiversity found on the present study area.

Survey and analysis of the amphibians and reptiles of the floodplain reveals that the study area is the only known place to support a full or nearly full contingent of the original riparian fauna seen around 1900. Included are the giant spotted whiptail, Clark□s spiny lizard, at least 8 other lizard species, the Southwestern black-headed snake, and 6 species of frogs and toads. Among the amphibians, which are more abundant here than elsewhere in the Tucson region, is the Sinaloan narrow-mouthed toad, which is not recently documented within 40 miles, and had been thought extinct in the Tucson region.

A plant survey also shows high diversity and remarkably good floodplain conditions. In addition to some of the densest mesquite, blue paloverde, and vine thicket woodland, several unusual, rare, and/or attractive plants have been documented by Kathryn Mauz this summer on the West Branch. Will Turner, Susan Randolph, and others have documented very good bird diversity, including riparian species no longer well-represented elsewhere in the Tucson basin. Mammals and invertebrates also remain in diversity above that expected in Tucson. For all of these groups, of course, the aquatic and streamside biotic elements are currently absent.

The study area is within two miles of downtown Tucson, and adjoins existing or planned projects including Santa Cruz River Park, Paseo de las Iglesias, and Rio Nuevo Downtown Revitalization Project. It is feasible to connect the area to these and to Tucson Mountain Park and Kennedy Park, via corridors or trails. Local residents currently representing the Santa Cruz Southwest Neighborhood Association have protected the West Branch from urban encroachment, for decades. It is suitable for restoration of stream flow and aquatic species. An active program to preserve and enhance the existing character of the area would be appropriate, would meet with approval from area residents, and may significantly assist recreating a cultural and natural core for the Tucson metropolitan area.

## Acknowledgements

This document has evolved quickly following the essential support for its initiation from Maeveen Behan and Julia Fonseca. Julia assisted its progress in numerous key ways, foremost among them by providing a steady stream of vital references, facts, ideas, and information. Clay May is credited with putting me and Peter Holm onto the West Branch in search of an uncommon lizard no one believed could be there. Clay and Michelle May provided varied historical information about the area□s herpetofauna, as have Cecil Schwalbe, Dennis Suhre, and Dennis Cornejo. If I hadn□t been following these leads I□d have discovered nothing. Similarly, Drs. Bob Bezy and Charles Lowe□s tireless and astute collecting in decades past was critical in keeping the trail alive and providing the context that permits us to understand what we see today. The efforts of much earlier herpetologists, botanists, and ornithologists are commended below by literature citation. Arizona Game and Fish Department□s Heritage Fund has supported me extensively over the years, greatly contributing to my knowledge of Arizona□s biota. Our first work at West Branch was on a Heritage-funded whiptail lizard project.

The active members of the Santa Cruz Southwest Neighborhood Alliance facilitated our work and provided historical and current insight into local history and ecology. Moreover, without their decades-long conservation effort we might have little or nothing left to preserve on the West Branch. Jean Russell, Barbara Stroud, Susan Randolph, Judy Fraser, and Beryl Baker all deserve thanks for informing me about the area□s culture and environment, and facilitating access to the area. Will Turner, Susan Randolph, and Judy Fraser generously provided detailed data on birds of the West Branch. Beryl Baker has been a wealth of information, literature, history, guidance, and motivation throughout the effort leading to this document. Without her help, we would presumably still be ignorant of the great amphibian diversity in the area. I thank Phil Jenkins for assisting us with the basics and specifics of local floristics, Bill Kendall for sharing with us his extensive plant lists, and Julio Betancourt and Ray Turner for allowing us access to their unpublished material. Kathryn Mauz□s flora of the West Branch study area, included here under her authorship, adds a precise scientific depth to this document. Her work, presented here and in progress, exemplifies the kind of botanical knowledge we will need if we are to pursue ecological restoration. Her assistance with maps, production, and in the intellectual exploration of the status and history of the study area must also be acknowledged.

Reviews and comments by Richard Felger, Diana Hadley, Cecil Schwalbe, and William Shaw substantially improved the document.

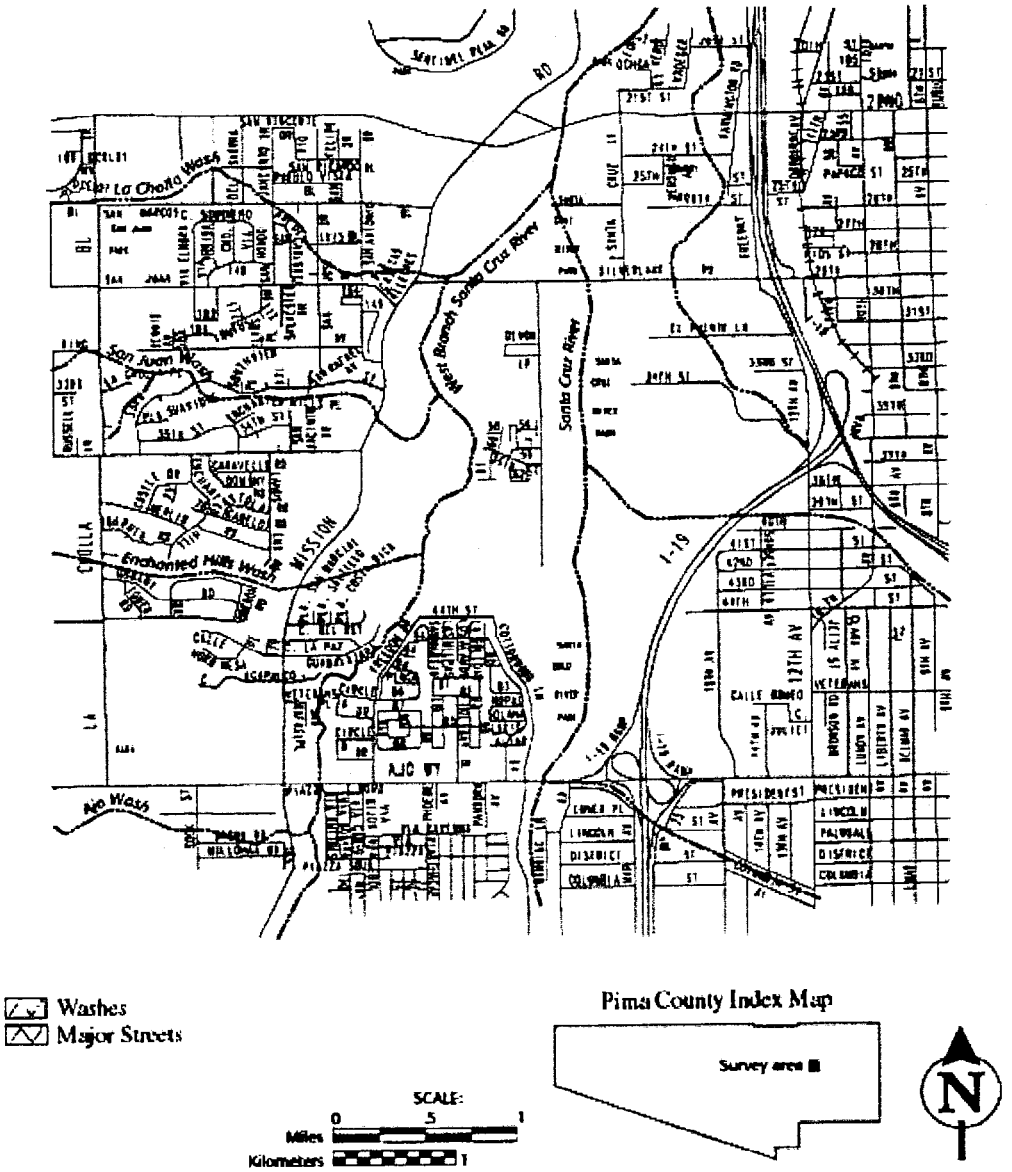



**Figure 1. The Area of Study, Bounded by Silverlake Road, Ajo Way, Mission Road, and Cottonwood Lane.**

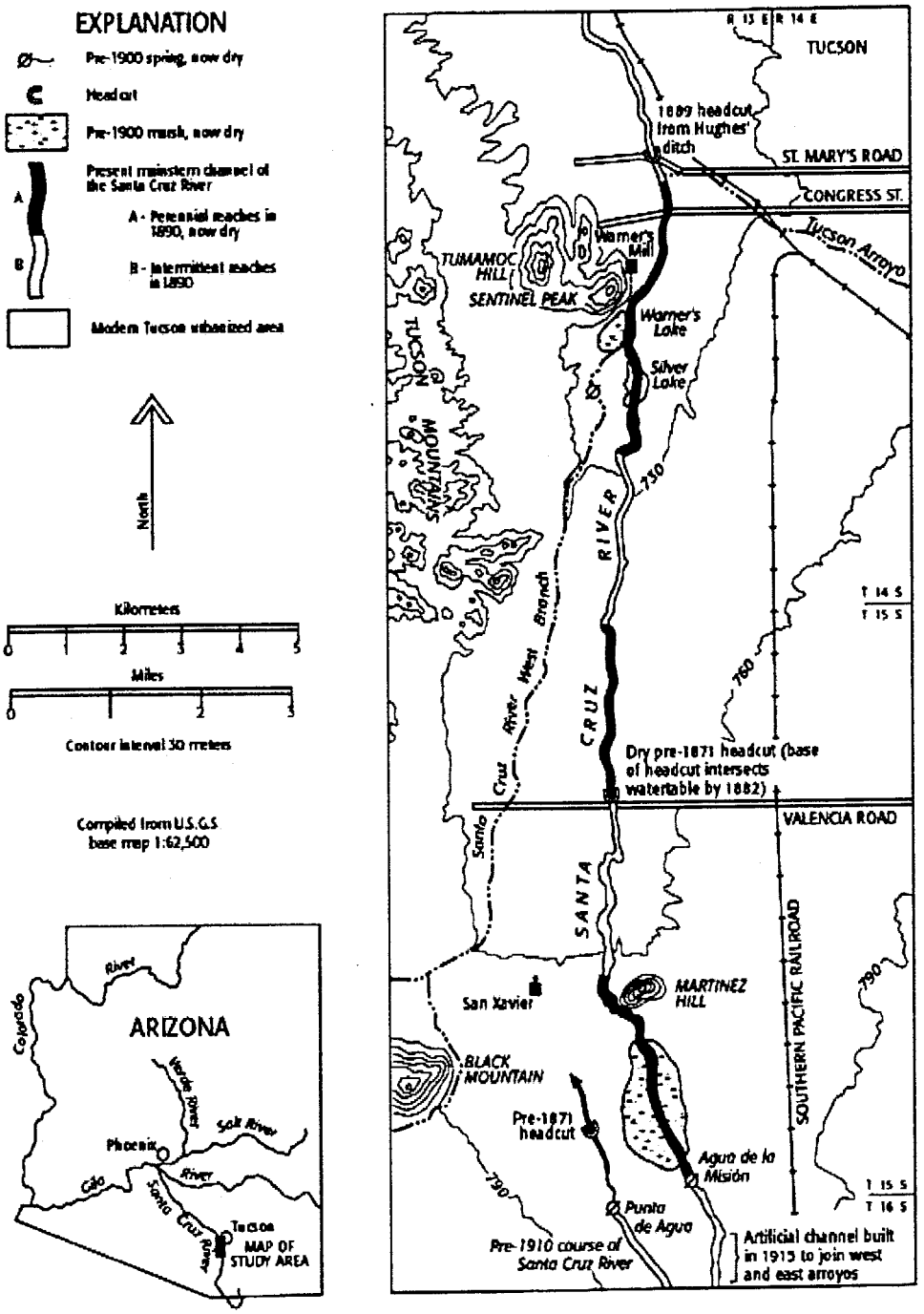
## The Nature of the Resource

The area of the West Branch of the Santa Cruz River contains all that is left of the original fertile and biologically diverse floodplain and river channel system that was the original reason for Tucson□s existence. The Santa Cruz River, first and foremost, was the heart of the regional ecosystem. The best remaining habitat available on the West Branch, outside the Tohono O□odham Nation, stretches from Ajo Way north to Silverlake Road. Various animals and plants remain on this area simply because their populations originally occurred no further north and have been largely or totally eliminated to the south and east on the Santa Cruz and Pantano systems. Other species are present because the valley bottom habitat here remains exceptionally good for them. Finally, the area focused on here offers a high potential for preservation, restoration, and public enjoyment of natural and cultural values. The remainder of this document provides details and substantiation for these statements.

The Santa Cruz River runs down from the international border near Nogales to the Tucson region, where the floor of its valley broadens into a fertile floodplain. This wider floodplain begins about 4 and 1/2 miles upstream (to the south) of the Tohono O□odham village of Wa:k (translated as, □where the water rises□, □standing water□ or □irrigation□ [Lumholtz, 1912 [1990]; A. Begay, personal communication, 2001; Saxton et al., 1983]), now called San Xavier del Bac. Here, live water originally rose from the sands onto the floodplain, and here, the river already had two major branches (Fig. 2). The east branch, or Spring Branch (Betancourt and Turner, 1990 ms.), was a marshy ci□nega and sacaton meadow around and to the south of the southwest foot of Martinez Hill. The West Branch was at the town and mission, where it supported an agricultural center with extensive field irrigation (see Lumholtz, 1912 [1990]).

In 1915, a Tucson water control and irrigation project diverted the West Branch flow into the east branch, at a point upstream of Wa:k (also □Wahk□) to prevent Tucson□s entrenchment of the east branch from destroying the farmland around the West Branch. This left the West Branch and its surrounding floodplain in an original condition, while the east branch became □the Santa Cruz River□, and absorbed all of the subsequent erosional degradation. The incised and highly erosive bed of the Santa Cruz River today is an ecological disaster area that will be restored only with great difficulty. The West Branch was not even included in the Santa Cruz River Park (City of Tucson, 1991), and only the most foresightful have recognized its great value (Beckwith et al., 1986; Rogers et al., 1986; Shaw et al., 1986, 1996). In a strange twist of fate, the West Branch, which was probably the original main channel (such as it was, in a floodplain irrigated from ancient times), was left high and dry, and has been more or less forgotten despite its relatively undamaged state (Fig. 3).

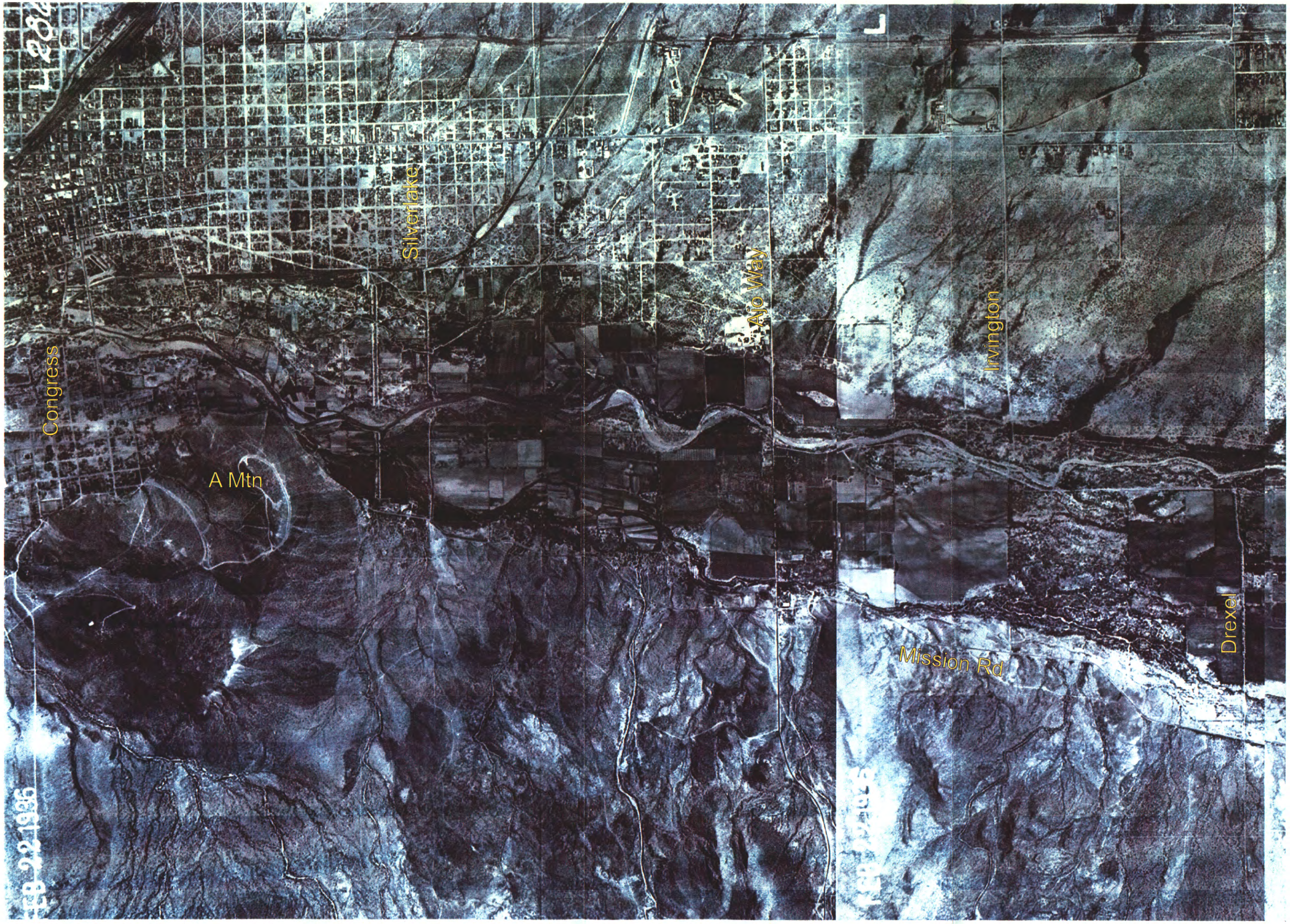
What now remains of earlier, outstanding ecological conditions of the Santa Cruz River at Tucson is along the West Branch, and it is here that ecological restoration is most feasible. Parts of the landscape and ground surface are intact today within a mile or so of downtown Tucson and adjoining the planned Rio Nuevo downtown rejuvenation project. At this area, which will be described in some detail in this document, there remain relict populations of native lizards, desert



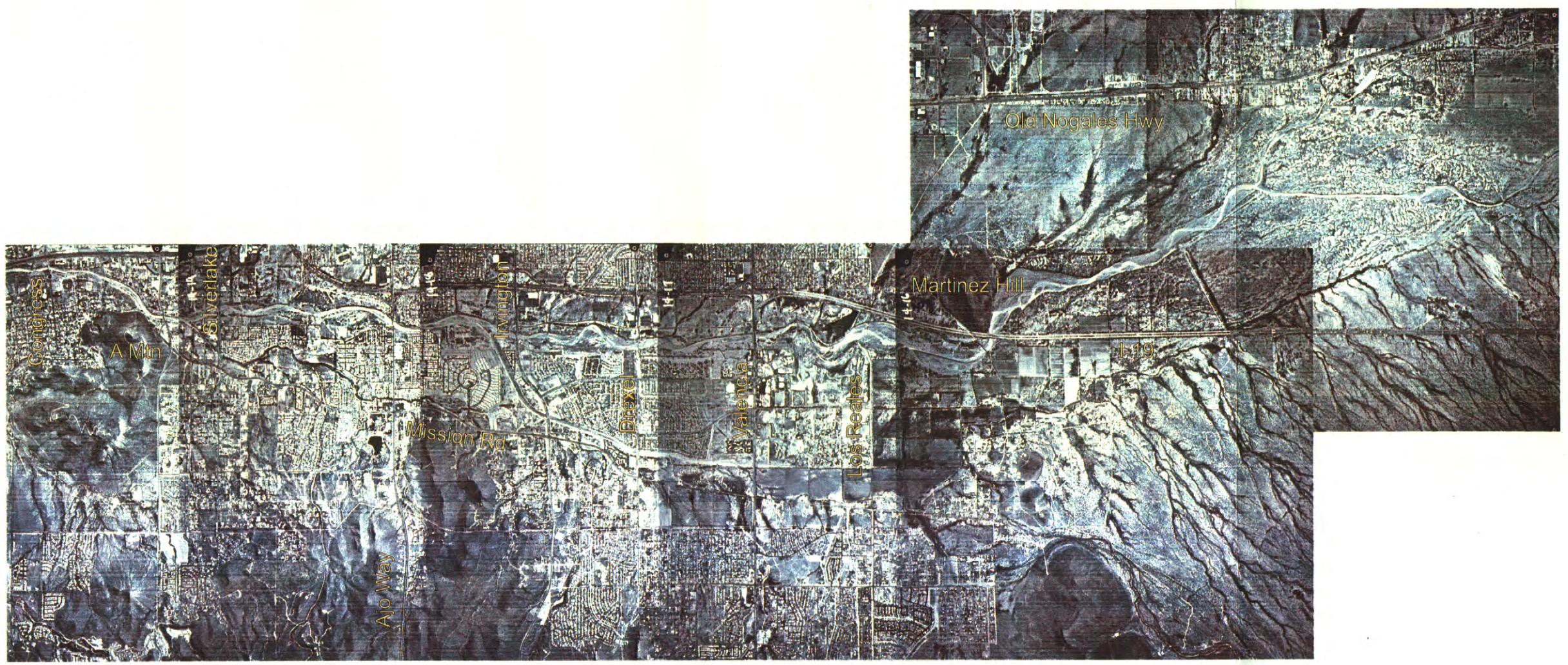

Historic map of the Santa Cruz Valley in the Tucson-San Xavier area, summarizing some of the principal features that played a role in arroyo development. (from Hinderlider 1913, in Betancourt and Turner, unpublished manuscript).

**Figure 2. At this time, the riverbed had already incised, and floodplain desiccation was underway.**

1936


Congress
Silverlake
Ajo Way
Irvington
A Mtn
Mission Rd
Drexel

1998


Old Nogales Hwy
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Ajo Way
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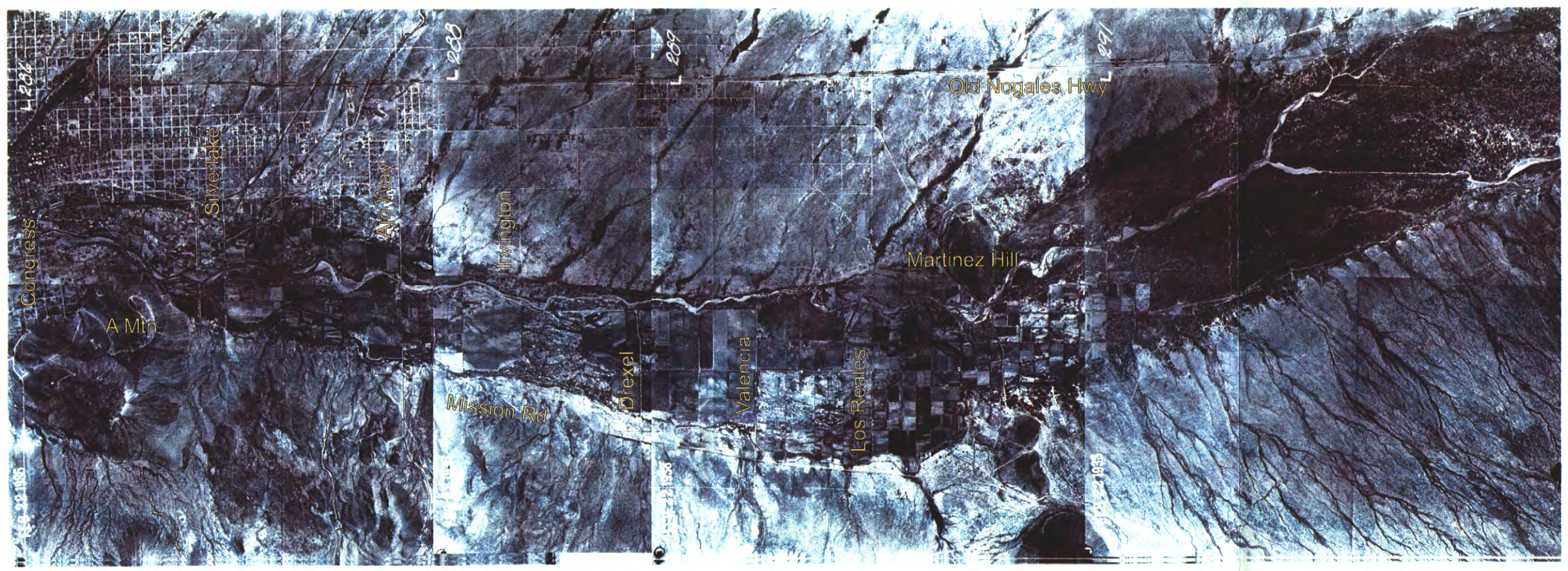
Drexel
Valencia
Los Reales

1936


Old Nogales Hwy
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Los Reales

amphibians, and plants that were once characteristic of Tucson and San Xavier del Bac as riparian communities. Some of these no longer occur anywhere else on the Tucson Basin floor, except possibly at San Xavier District of the Tohono O□odham Nation.

**Giant spotted whiptail, Oracle, July 2000. P. Rosen. This large, attractive, lizard was apparently widespread in Santa Cruz River riparian habitats, but is now found only on West Branch and near Nogales.**

The West Branch at Tucson (the area considered here) currently retains substantial acreage of open space. There is sufficient control over flood intensity to guarantee that severe erosional degradation is unlikely (in fact, recent flood control diversions dating to 1979-1982 may ultimately aridify and degrade the existing high quality habitat). There is strong neighborhood interest in maintaining the characteristics of the West Branch area. Furthermore, there are city water supplies (wells unusable for drinking water, and a reclaimed water line terminus) that could be pressed into service with City and County support. Thus, this area may be suitable for preservation through purchase, easements, maintenance or restoration of existing bosque and floodplain ecology, development of a natural park or reserve, and even re-creation of gallery and aquatic conditions that could include leopard frogs, turtles (which only disappeared in the last 5 or 10 years), and native fishes. Hydroriparian restoration will be easier here than elsewhere in Tucson because catastrophic flooding strikes the main channels but not the West Branch.

## Ecological History Background

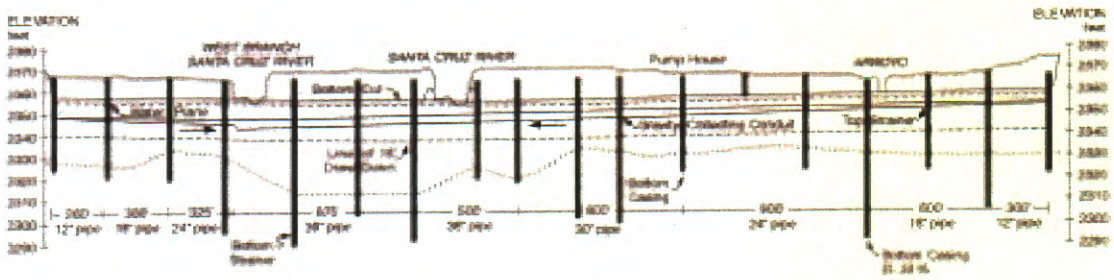
As widely detailed elsewhere, the Santa Cruz River was originally level with the valley floor over much of its length, including at Tucson. It retained significant riparian qualities at Tucson as recently as the 1940□s, although severe degradation began in the late 1880□s. It was perennial down to about Tubac and again between San Xavier and Tucson, where it originally flowed over a level valley floor. The San Xavier and Tucson river reach included great mesquite bosques, perennial streams, riparian gallery forests and thickets, and even ci□nega marshes, and was in large measure occupied by irrigated fields and flood controlled by a complex network of

**Sinaloan narrow-mouthed toad, 29 July 2001, West Branch. K. Mauz. This unusual species may remain in the Tucson region only at the West Branch study area, where it, along with five other frogs and toads, is abundant.**

canals (Betancourt and Turner, 1990).

At the turn of the last century, the West Branch Santa Cruz River was apparently fairly similar to the main branch (Fig. 4): a small, moderately incised channel in a level, productive floodplain, a characteristic it retains today. A spectacular mesquite bosque, with some associated well-developed riparian gallery forest, persisted into the mid-century from the source of the West Branch down to the area of the mission and Martinez Hill (Fig. 5). Downstream to Sentinel Peak the floodplain supported irrigation agriculture, with dense bosque persisting only in a narrow strip along West Branch within a mile and a half south of Sentinel Peak, and in the extreme northwest corner of the broad floodplain, on lands now split by Silverlake and Mission roads (aerial photos on file at Pima County Floodplain Management Division).

Between 1880 and 1910, biologists noted a rich aquatic and riparian fauna at □Tucson□, by which they meant the floodplain and channels from San Xavier del Bac to current downtown Tucson (Ruthven, 1907; Minckley, 1999; Pima County, 2000). Originally, there were 6 species of fishes here, including the presently endangered desert pupfish and Gila topminnow, and the threatened Gila chub. No native fish remain. The pupfish was lost before 1900, with other species disappearing with successive episodes of habitat degradation and desiccation (Minckley, 1973, 1999; Pima County 2000). These species persist elsewhere in small numbers, and could be restored at Tucson, and even utilized for mosquito control, as they are quite hardy and voracious. Some opportunities for restoring native fishes along the West Branch are suggested below.



Vertical profile of the line of wells, pump houses and gravity collecting conduit associated with the Tucson Farms Company Crosscut. Note the intercept of the water plane by both the West Branch and the Santa Cruz River (from Hinderlider 1913, in Betancourt and Turner, unpublished manuscript).

**Figure 4. Note that West Branch is much like the main river, and that both intersect water table.**

Alexander Ruthven, who went on to become president of University of Michigan and founder of its renowned Museum of Zoology, surveyed amphibians and reptiles in the Tucson region in the summer of 1906 (Ruthven, 1907). He defined in detail the characteristic riparian fauna on the Santa Cruz from downtown to a short (not clearly stated) distance to the south. Remarkably, he included species such as the giant spotted whiptail, Clark□s spiny lizard, and lowland leopard frog that are currently thought of as primarily or exclusively mountain canyon inhabitants. Various professional and student herpetologists collected these species and others, including such rarities as the Sinaloan narrow-mouthed toad and the Sonoran green toad between 1905 and 1985 along the West Branch and in the vicinity of San Xavier del Bac (Van Denburgh and Slevin, 1913; Van Denburgh, 1922, Slevin, 1928; personal observation based on museum specimen records), although this is not well known. Sullivan et al. (1996) was not able to find the rare amphibians in the region. However, most, if not all of these species persist here in small numbers, as will be described below.

In 1909, the eminent botanist at University of Arizona, John J. Thornber, prepared a list of plants for the Santa Cruz River floodplain near Tumamoc Hill, in an area near the smaller area of the West Branch focused on herein. He reported a total of 114 native species, including 16 winter annuals. Although we have not had opportunity to survey the winter annuals adequately, and despite the loss of riparian gallery species, a total of 96 native plant species were found in our brief study, including several of unusual occurrence.

Not surprisingly, invertebrates have not been systematically surveyed on the West Branch or the Santa Cruz in general. However, this summer□s investigations have shown that a substantial diversity of native species persists there. This would be an excellent area of study to elucidate area biodiversity, although such use of invertebrates is not yet a well-utilized method.

**Figure 5. May 1998 aerial photo showing the study area, with Santa Cruz River bed on east edge of photo. The West Branch is seen as a dark line of bosque from lower left to top center. Photo is about 1.7 miles North-South.**

I do not have a historical record for birds in the area of the West Branch at Tucson, although there are impressive records for the former mesquite bosque at San Xavier (Swarth, 1905; Willard, 1912; Brandt, 1951). The current bird list at West Branch is quite extensive, and includes at least several birds not common elsewhere in Tucson. Similarly, historical data for mammals have not been identified, and in this case the fauna appears to be modest at present, although more diverse than elsewhere in urban Tucson.

## Environmental Settings and Ownership Patterns

This section will focus on the study area between Silverlake Road (= 29th Street) on the north and Ajo Way (which lies at about 49th Street alignment) to the south, and between Mission Road on the west and Cottonwood Lane adjoining the Santa Cruz River on the east. This land includes floodplain environments (in bottomland or xeroriparian); no upland environments (in bajada or rock slope) are included. Upstream and downstream areas, which are less suitable for preservation or restoration, will be discussed in a broader context of human use and longer-term restoration potential. The Santa Cruz River proper will be discussed primarily in terms of potential connections to the West Branch. West of the West Branch floodplain, west of Mission Road, there remains some undeveloped bajada that, while not unique like the floodplain, also retains excellent habitat characteristics, especially along major arroyos. However, here I will focus only on values this bajada may contribute to the floodplain ecosystem. To the south lies the San Xavier District of the Tohono O□odham Nation, with the best remaining native species habitat settings in Tucson□s Santa Cruz River environment outside the focal study area. This area is not well known biologically at present, but is undoubtedly rich.

In the near or medium term, ecological restoration could best proceed from the present study area, to a co-effort with the Tohono O□odham tribe, and in that context to regulated development of the intervening area to enhance its ecological value as urban infill proceeds. These efforts should be viewed carefully in terms of (and integrated into) the Paseo de las Iglesias concept for a Santa Cruz River Park, which adjoins the West Branch along its whole eastern margin, and the Rio Nuevo Downtown Revitalization Project, which adjoins the West Branch to the north. Further downstream, the concept of the Paseo de los Arboles along the Santa Cruz River is also complementary with the proposals developed in the present document. Development and restoration of an urban and suburban riparian core suitable for human enjoyment and natural environmental conservation and restoration is the appropriate overarching vision that justifies such a large planning area. The Sonoran Desert Conservation Plan in Pima County is currently the arena in which such integrated planning may take place. Available lands, ongoing projects, currently active park concepts, and geographic setting in a broad sense make this set of concepts and areas suitable as a resource planning area that could produce fine benefits to the city, county, tribe, and existing neighborhoods.

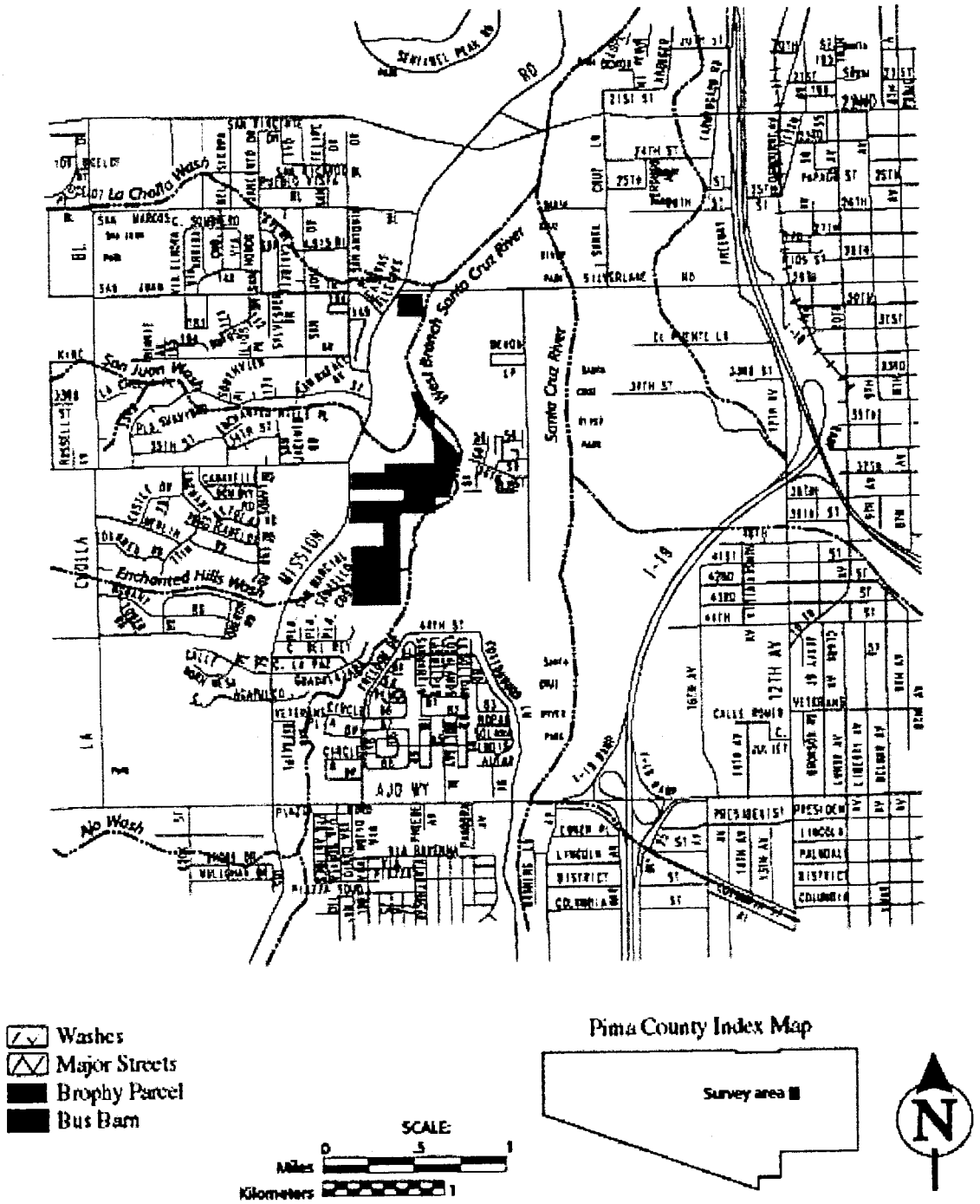



**Figure 6. Diagrammatic view of the general location and position of key parcels of land. Both parcels actually include long reaches of the West Branch channel.**

Land ownership in this area is mixed. Pima County owns a 17-acre parcel in the northwest corner of the study area, and City of Tucson owns two parcels totaling to similar acreage. On the floodplain, a large block of about 54 acres of important habitat is currently offered for sale (see Fig. 6), and there may be approximately 20 other owners of lands still supporting important wildlife and vegetation resources. These properties include open, regenerating fields, areas with collections of old cars or reusable items, and areas with corrals, livestock (cattle, horses, sheep, goats); these areas thus retain some of the agricultural character of the floodplain that prevailed during the 20th century. Nearly half the area — the northeast fifth and the south quarter — is densely developed for housing, no longer retaining the unique values or character of the Santa Cruz floodplain.

I. The Floodplain

Most of the West Branch, from San Xavier Mission to its confluence with the Santa Cruz River just near Sentinel Peak (□A□ Mountain), was utilized in old-time irrigation agriculture for many decades. Some of the areas have been farmed for centuries. Exceptions to this utilization are the big, chopped down and now-desiccated bosque above San Xavier, the banks of the West Branch arroyo proper, and smaller areas around the margins of the main agricultural areas.

Farming declined markedly or largely ended in the 1960□s along the West Branch between Ajo Way and Silverlake Road, although sporadically it has re-appeared in places. During the 1900□s in this area, the banks of the arroyo retained substantially dense bosque for much of the reach. Two large irrigation ditches on the east side between West Branch and Cottonwood Lane (the old raceway extending south from Silver Lake resort [Betancourt and Turner, 1990]) persisted with dense bosque and even standing water, turtles, and cottonwood trees almost to the 21st century. These ditches are becoming desiccated now, but still support bosque. In the northwest corner of this study area, from just south of the corner of Mission and Silverlake Roads, an area of un-ploughed bosque is seen in aerial photos from 1936 through 1998.

This area of longest-standing bosque on the upland flats includes the south third of the □bus barn□ property owned by the county, as well as private lands in 3 or four major properties. Although there is a great deal of junk on the ground, this bosque has become dense in places, and currently supports very high amphibian diversity, as well as high plant and bird diversity. Several unusual species occur there, like the crucifixion thorn (a small tree, *Koeberlinia spinosa*), the only breeding sites known in the Tucson region in 2001 for the Sinaloan narrow-mouthed toad (a microhylid frog, rather than a true toad; *Gastrophryne olivacea mazatlanensis*), and a fine population of the showy perennial herb, ruellia (*Ruellia nudiflora*). This area has some special ecological significance by virtue of its history of low disturbance, and because it retains ponds and swales critical for amphibian breeding.

This northwest bosque comprises several properties used as small businesses (i.e., Fluidaire, Tucson Ready Mix) and semi-rural residences (the Fraser, Romero, and Padilla properties), including long-standing residents like the Frasers and Beryl Baker who are strong supporters of the neighborhood and its environment.

South of this "northwest bosque" is a large area of mostly open space on the floodplain between Mission Road and the West Branch channel. This area was in agriculture until about 1960, and its major drainage, Enchanted Hills Wash coming down from Tucson Mountains, was confined within straight levees. During the 1960"s and early 1970"s, mesquites began to grow here, and floods during the mid-late 1970"s broke through the levees, eliminating much of the channelization. Since then, the Enchanted Hills Wash has debouched on the floodplain in a natural way now almost unique in the Tucson region that includes a delta-like formation with distributaries and sheet flow over the fine soil surface. The result is an impressive regeneration of a mesquite and blue palo verde bosque with a rich herbaceous understory. Also at this area, the bosque of the West Branch channel reaches its highest (densest, tallest) development. The wide sandy main channel of Enchanted Hills Wash on the floodplain also provides a habitat setting otherwise absent in the local area, although one found widely elsewhere in Tucson.

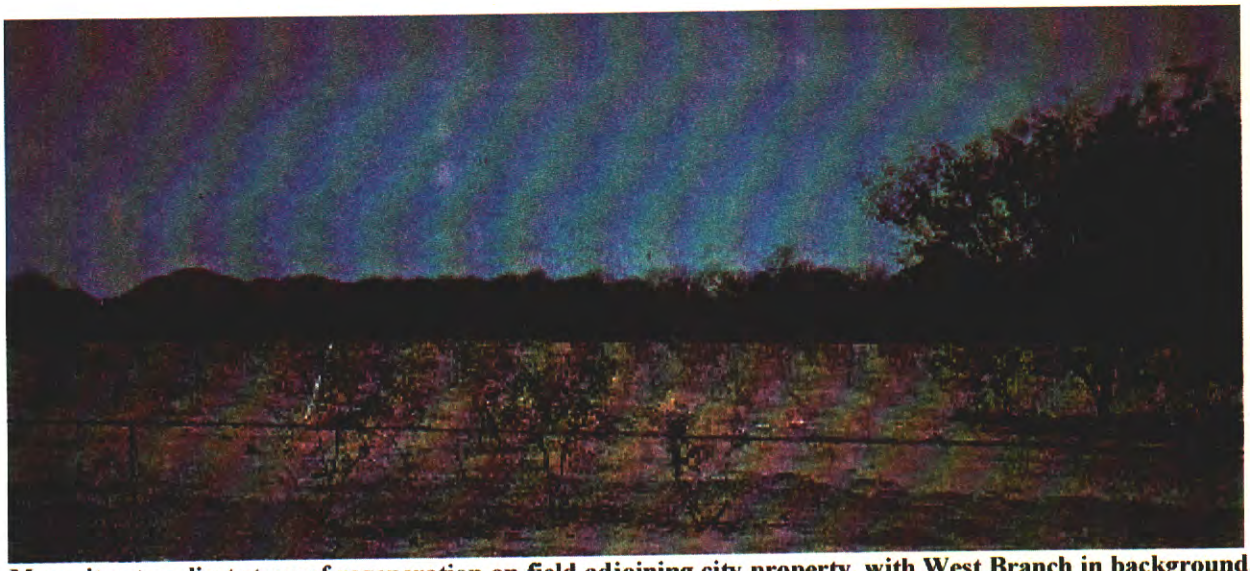
**Regenerating bosque on the distributary floodplain of Enchanted Hills Wash at West Branch, in the dry season, June 2000. P. Rosen. Areas like this, which are outside the usual wash corridor, are essential for maintaining the biodiversity of the area.**

This west-central area of regenerating bosque and open space is a key part of the ecology of the study area. The most immediate and outstanding opportunity to restore natural floodplain hydrology and associated soils and bosque development are here. The largest area of open space in the central Tucson area that has good mesquite is also here. To support a functioning ecosystem with predators like the coyote, roadrunner, kit fox, and raptorial birds, and to pursue objectives of natural reserve park or ecological restoration along the West Branch, this area will be essential. The largest part of this area (about 54 acres) is currently available for purchase. To the west of the sale property are about 10 owners on mostly-undeveloped land that supports developing arroyo-side floodplain vegetation associated with the Enchanted Hills Wash.

Adjoining this area to the south are developed housing tracts, between the West Branch and Mission Road, occupying the whole area from the alignment of 44th Street to Ajo Way. East of the West Branch is also occupied by housing south of the 44th Street alignment, as far east as the south arm of Cottonwood Lane. The City of Tucson owns the West Branch channel and its

immediate environs in the Ajo - 44th reach, providing potential continuity with habitat south of Ajo Way. Considerable bulldozing has been done recently in the arroyo and its environs here, although potential for restoration as riparian or aquatic habitat remains.

The east side floodplain of the study area has a very different character. Across from the northwest bosque (□bus barn□ property), between the West Branch channel and Cottonwood Lane, there are trailer courts and manufactured housing from Silverlake Road south to about 38th Street alignment, and again from 44th Street alignment to Ajo Way. East of Cottonwood Lane are the highly degraded areas of the Santa Cruz River and its floodplain. The area between 38th and 44th street alignments remains largely open, with several properties retaining the original rural character of the area. A number of the owners here are very active in and supportive of neighborhood and environmental issues.



**Mesquite at earliest stage of regeneration on field adjoining city property, with West Branch in background. South end of Tucson Mountain Park in left horizon. May 2000, P. Rosen. Restoration is feasible here.**

Near the center of this area, the City of Tucson owns about 14 acres that encompasses a former gravel pit now filled with decomposing garbage. As a result of this, the area is fenced and not available for development, and the nearby city well cannot be used to supply drinking water (Frank Sousa, personal communication, August 2001). However, this property could assist in developing a corridor between the Santa Cruz River Park and the West Branch, within the context of the Paseo de las Iglesias.

West and northwest of the City of Tucson landfill fence are three key private holdings (Lavonne G. Baker, John E. Martinez, and Caesar J. Lopez) that contain sparsely vegetated and regenerating land that was fairly recently agricultural, substantial sized ditch-bosque habitats that supported a mud turtle population at least into the early 1990□s, and some of the currently most well-developed bosque lining the West Branch channel. Through easement and purchase offers, these areas could become part of a natural area and would assist in connecting the West Branch to

the Santa Cruz River Park. To the east of the city property is another, similar private holding (J. Chaffin) that is also largely open, and is bounded on its east by Pima County and City of Tucson property.

The area to the north between these properties and the high-density housing is occupied by older, small ranches and homes with historic corrals and small pastures (especially on the Leon and Figueroa properties), and one short section of the West Branch channel. The historic corrals, landscaping, and the West Branch section in this area provide important wildlife habitat.

The ditch-bosque habitat on the Romero and adjoining city properties was known as the prime habitat for turtles and breeding amphibians (Michelle May, Clay May, Cecil Schwalbe, personal communications, 2001), at least until the city well and irrigation operations were eliminated during the mid-late 1990□s. With appropriate neighborhood and city support, this area could be re-watered for development of riparian gallery vegetation, could again support turtles and amphibians, and would be potentially suitable for maintaining native fish.

Thus, the several older properties in the east-central part of the study area could importantly contribute to maintaining and enhancing the area□s character through easements, agreements, or purchase-based additions to public holdings. It is at least realistic to approach this matter with the view that current owners would certainly benefit from improvements of the neighborhood character or from easement or land sale income, or all three.

## II. The West Branch Channel Xeroriparian

Details of the West Branch vegetation and habitat settings are provided below in □Plants of the West Branch of the Santa Cruz□ and in sections dealing with the animal groups. In those sections will also be found explanations of why certain aspects of this habitat and area are uniquely important. Here I will give a brief overview of habitat conditions.

The West Branch channel is a narrow arroyo (10-30 meters [33-100 feet] wide) that is moderately incised (2-4 meters [6-14 feet]) into the surrounding flat floodplain. For the entire 2.2-mile reach in the study area, both banks are covered with variably dense bosque composed of mesquite, blue paloverde, graythorn, thornbushes, other large shrubs, and a diversity of flowering vines. Most of this bosque is dense, and a majority of it is very dense, even tangled, providing xeroriparian habitat of the highest quality for birds and lizards.

The bus barn property has open to high quality bosque on the arroyo banks, while the Brophy-Rosen (no known relation to author) sale property, which has the longest reach of the West Branch on any single holding, tends to support mostly high-density bosque with some open portions. The highest quality xeroriparian bosque is found on the Baker, Martinez, and Romero properties in the central fifth of the study area, where the Enchanted Hills Wash distributary network contacts the West Branch channel xeroriparian.

The interior (bottom) of the West Branch channel has a narrow flow channel (1-3 meters [3-9 feet] wide) surrounded by inner benches of grass and shrub only slightly above the sandy-gravelly flow channel. This bottom is narrowest and simplest in the northern third of the area, more varied, complex, and of intermediate width in the central third, and more open and simple in the southern third where the City of Tucson has carried out bulldozing operations in the past.

The bottom and the flow channel have a fairly dense substratum that would support stream flow additions to the system very well. The width, depth, and complexity of the flow channels in the central third of the area, and on at least part of the city-owned upper third, offer a broader channel bottom that would support a modestly complex stream wetland. The northern area, including the □bus barn□ property, could also support a small stream ecosystem, and may be a good place to start so that the first attempt doesn□t affect the best existing bosque section. These areas could support any or all of the following species that formerly occurred here: Gila topminnow, pupfish, longfin dace, lowland leopard frog, Sonoran mud turtle, and Mexican garter snake. Upstream diversion projects have already protected this small area from excessive scour that may call for more art in aquatic restoration elsewhere, while still leaving sufficient scour to provide native species with advantages over exotics like the bullfrog and bass. Further, the existing upstream diversions could potentially be altered to adjust the amount of scour to a desired level.

**Bosque astride the West Branch channel, at the south end of the county property. May 2000, P. Rosen. This key habitat has allowed the persistence of Priority Vulnerable Species despite a long history of heavy human use of the area. The density of thickets found here is rarely seen elsewhere near Tucson, and perhaps nowhere on the same scale as at West Branch.**

## Flora and Fauna

The study area between Silverlake Road and Ajo Way was examined initially during the summer of 2001. The lists and descriptions that follow are based primarily on these recent observations, and are of course not nearly complete. They nonetheless show beyond the shadow of doubt that truly exceptional conditions exist at the site. If we do wish to restore the natural elements along the Santa Cruz River in Pima County and adjoining parts of Santa Cruz County, there is no doubt that we should retain the relictual elements present here, as they are not likely to be found collectively, and for some individual species gene pools, anywhere else.

The only relief we might find from these restrictive statements would be on the San Xavier District, whose occupants have not treated the land as we have, but whose lands (and waters) have notwithstanding been degraded by our culture□s actions. We should certainly hope to include the Tohono O□odham in planning to rejuvenate the Santa Cruz. However, in the absence of survey data from San Xavier, we must proceed on the assumption, which may unfortunately prove correct, that the resources described below are principally the only ones remaining for some species, genetic strains, and biotic assemblages of the Santa Cruz River ecosystem of the Tucson Basin.

### I. Plants

A diverse assemblage of plants is demonstrated by the appended paper by Kathryn Mauz, which is a preliminary flora for the West Branch study area. She has included a portion of the historic document by University of Arizona Botanist J. J. Thornber, which she is in process of updating for direct comparison with the current riparian flora of the area. Kathryn Mauz□s list and prose speaks for itself, and here I offer only the following comments based on e-mail exchanges between me, her, Richard Felger, and Phil Jenkins at the University of Arizona herbarium.

The vegetation of the area is especially valuable in terms of the density and stature of the bosque, which includes mesquites nearly 3 feet across at the base, and many other large mesquites and blue paloverdes that grow with dense tangles of woody vines. The bosque may be unique in the Tucson area for combining high density, structural complexity, and a scarcity of invasive and non-native woody plants. True riparian trees found in Thornber□s list (cottonwood, Gooding willow, coyote willow, Arizona ash, hackberry, soapberry, and elderberry) are absent now, although we could readily attempt restoration of favorable conditions for them.

There are a number of rare and interesting plant species on or near the study area, and many that are indicative of healthy floodplain conditions. The Priority Vulnerable Species Tumamoc globeberry (*Tumamoca macdouglii*) is known from the edge of the floodplain just off the focal area as defined here, and may occur on the site. The small aster-like *Machaeranthera coulteri* and the amaranth *Amaranthus obcordatus* are rarely found elsewhere in the region. Populations of the native poinsettia, *Euphorbia heterophylla*, ruellia (*Ruellia nudiflora*), desert

seepweed (*Suaeda torreyana*), the grasses sand dropseed (*Sporobolis crypantdrus*), *Panicum stramineum*, and little barley (*Hordeum pusillum*, Annita Harlan, *in litt.*, 2001), and all-thorn (*Koeberlinia spinosa*) found on the site are of special interest.

More generally, the existence of such a large number of native mesoriparian plant species in a relatively intact (un-incised) floodplain of the Santa Cruz River makes this area unique. Although rich floodplain floras persist upstream, in Santa Cruz County, the study area, along with a portion of the San Xavier District, is all that remains of the floodplain flora within the Sonoran Desert. That it does remain, and so close to central Tucson, presents us with remarkable opportunities to see and explore, draw upon, and restore.

**Crucifixion thorn, or all-thorn, (*Koeberlinia spinosa*) West Branch, July 2000. P. Rosen. This plant persists in the least-disturbed portion of the West Branch floodplain.**

**Ruellia (*Ruellia nudiflora*), West Branch, August 2001, K. Mauz. This is an abundant and colorful component of the West Branch bosque understory.**

## II. Fishes

The only fish I observed were mosquitofish (*Gambusia affinis*), a harmful exotic species, being used for mosquito control in a small pool being maintained near the West Branch. If aquatic restoration is pursued along the West Branch, these can be replaced with native Gila topminnows, which are just as good at mosquito control and equally able to sustain a small population in such artificial habitat. Gila topminnows are also less likely to attack hatchling frog tadpoles than are non-native fishes.

Table 1. Fish species that formerly occurred in or near the West Branch of the Santa Cruz River at Tucson, with notations on suitability for re-establishment.

| **English Name** | ***Scientific Name*** | **Potential for Re-establishment at West Branch Study Area** |
|---|---|---|
| Desert Pupfish | *Cyprinodon macularius* | Good potential, especially as lone species in bosque-ditch habitat, or with *Agosia* in stream channel. |
| Gila Topminnow | *Poeciliopsis o. occidentalis* | Necessary in area to replace use of mosquitofish, this fish will thrive in any waters we establish here. |
| Sonoran Sucker<br>Desert Sucker | *Catostomus insignis*<br>*Pantosteus clarkii* | These systems will probably be too small and not rocky enough for these two species. |
| Longfin Dace | *Agosia chrysogaster* | Will thrive in stream channel. |
| Gila Chub | *Gila intermedia* | Probably requires deeper pools and more space than would be established at West Branch. This species is likely to prey on pupfish and topminnows, and may impact their abundance under some circumstances. |

Among the fishes, it will be easiest to re-establish the longfin dace, as it is not a protected species and is likely to be hardy in a stream setting. The Gila topminnow will be the most useful species to re-establish. Establishment of a pupfish population would represent an exceptional achievement to assist a severely endangered species. If no fishes are established, it will not be possible to successfully re-establish the Mexican garter snake.

## III. Amphibians and Reptiles

### The Giant Spotted Whiptail

The occurrence of this species in the West Branch study area was the first and most irrefutable indicator that the area was a unique resource. With Peter Holm and Shawn Sartorius, I have been intensively examining the distribution, behavior and ecology of this species during the past three years. The next four paragraphs describe some details and certain inferences based on distributional survey, habitat observation, and radiotelemetric study of this animal.

I first became aware of the existence of the West Branch in connection with a tip that the giant spotted whiptail, regarded as a canyon species in Arizona, might be found there (Clay May, personal communication, 2000). It was the verification of that seemingly unlikely suggestion that has ultimately resulted in the present report. Giant spotted whiptails persist in abundance as a large, attractive, very alert animal in the dense thickets of the West Branch. We have been unable to locate them anywhere else in the riparians of the basin floor, although as late as 1970 they were seen at San Xavier. The nearest remaining populations we have found outside narrow canyons are at Potrero Creek and Santa Cruz River, just north of Nogales.

It is becoming apparent that the primary populations of this species in Arizona, along the Santa Cruz River and its tributaries, have been lost to habitat degradation, and that this species is slow to reach and re-occupy scattered patches of regenerating habitat. It would appear that its spread may be slowed by site pre-emption by unisexual clones of hybrid whiptails (collectively referred to under the name □Sonoran spotted whiptail, *Cnemidophorus sonorae*□). These hybrid unisexuals are rapid colonists because no male is required, and hence a single immigrant can found a population. Unisexuals are also favored by the constant disturbance people cause with bulldozers and unnatural flood regimes because by producing only female offspring they have the potential to re-populate devastated habitat at an exponentially faster rate (i.e., 2X faster in one generation; 4X faster over two generations; 8X, 16X, and so on) than bi-parental species.

The giant spotted whiptail is our largest whiptail, at total lengths exceeding 18 inches. It is slower to mature than most other lizards in the Southwest, and utilizes top-notch cover, within riparian and xeroriparian thickets, that protects it from predation. This allows it to delay maturity, reach large size, and enjoy long adult life. These life historical and behavioral features make it a hardy and well-adapted species, and one that may long persist under declining habitat quality. However, they make it quintessentially sensitive to riparian and xeroriparian disturbance regimes in our community. It is remarkable that this species still thrives in an isolated population so close to downtown Tucson, but I surmise that it is declining there, and will be lost unless true riparian conditions are restored.

This was one of five species identified and substantiated with specimen records by Ruthven (1907) and Van Denburgh and Slevin (1913) as characteristic of Tucson□s riparian habitat. The others were the Clark□s spiny lizard (also still present at West Branch), Sonoran

mud turtle (present here until the 1990□s), lowland leopard frog (gone from Tucson proper by 1975 at the latest), and Mexican garter snake (extinct in Tucson Basin by 1985 or much earlier). Where they occur in desert valleys, these species are associated with perennial or near-perennial waters in general, and specifically in each case with large stature mesoriparian habitat (fully developed bosque) and/or true riparian gallery forest. These species are similar to severely threatened birds of the Southwest, such as the Yellow-billed Cuckoo and Southwestern Willow Flycatcher, and to the fence lizard: all had strong affinity for Tucson□s original riparian characteristics (Arnold, 1940; Brandt, 1951; Van Denburgh and Slevin, 1913; and personal observation). Clark□s spiny lizard, the giant spotted whiptail, and Bell□s vireo are the members of this at-risk group most able to persist, but none can be expected to survive indefinitely in the absence of the primary habitat type. This concept clearly points to a need for water for sustaining the remaining high biodiversity as well as for the return of the missing hydroriparian plants and aquatic animals.

Other Lizards

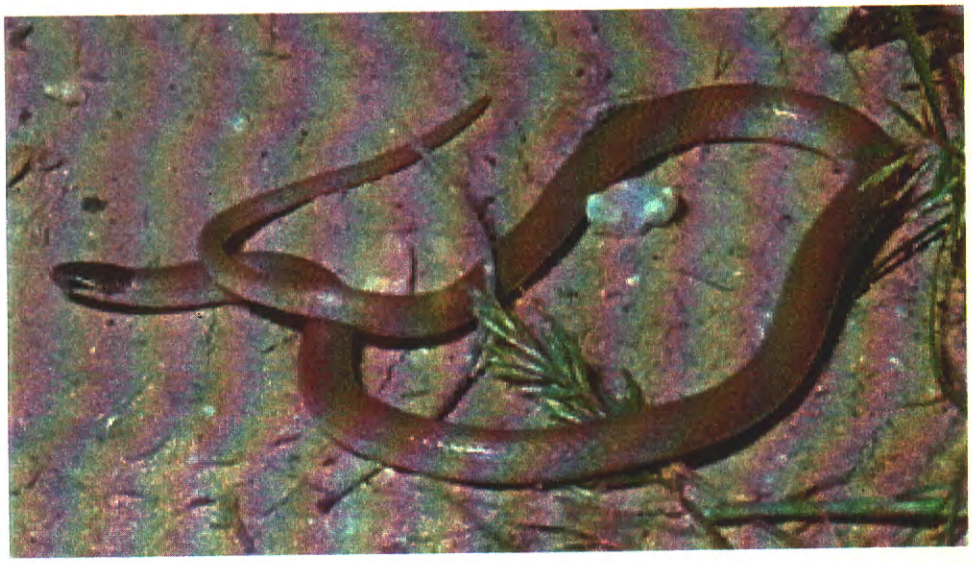
With 10 already-observed lizard species, the West Branch area has upper-end lizard biodiversity by standards anywhere in Arizona. During 1938-1940, Arnold (1940) observed 12 lizard species (probably actually 13, as whiptail lizard species were not properly distinguished at that time) on the floodplain surface at San Xavier. These figures compare with 9 lizard species observed over the entire Tucson area in an extensive and intensive riparian survey (Frederick, 1996). Maximum observed abundances of whiptail lizards along the West Branch were greater than or equal to those I have seen elsewhere in the Southwest. With additional sampling and habitat regeneration, the known number of lizard species along the West Branch is likely to increase. For example, the side-blotched lizard is known on the Santa Cruz floodplain north of downtown Tucson (near Camino del Cerro), and the fence lizard was at downtown Tucson at least as recently as 1995 (personal observations, 1995, 2001). The Gila monster, leopard lizard, side-blotched lizard, Mediterranean gecko (an introduced species), and the fence lizard are likely to be present now or could establish themselves at West Branch. That would yield a total of 15 species, equaling or exceeding maximal lizard diversity for Southwestern North America.

True riparian (□hydroriparian□) restoration would not be expected to reduce species richness or eliminate any individual species. An examination of published work and early museum specimens reveals that the lizard fauna of the Santa Cruz River from Nogales through Tucson has shifted significantly. Preliminary findings indicate that the giant spotted whiptail was the dominant whiptail throughout the sampled area, whereas today the Sonoran spotted whiptail has strong dominance everywhere. From San Xavier through Tucson, both the fence lizard (*Sceloporus undulates consobrinus*) and Clark□s spiny lizard were dominant along the river riparian habitat and even in bosque. Today few herpetologists would even suspects that the fence lizard is (or even was) a component of Tucson□s herpetofauna, and Clark□s spiny lizard would generally not be expected outside rocky canyons and slopes. These data suggest that this lizard fauna is near an extinction terminus at which the original mesoriparian assemblage has almost been fully supplanted by the usual desert taxa. Presumably, there is still the opportunity

to preserve this high-diversity lizard assemblage, although full recovery would seem unlikely without addition of water and restoration of stable gallery forest environments in at least some areas.

Snakes

The single known snake species at the West Branch study area is the diminutive and harmless southwestern black-headed snake. Undoubtedly, the even more inoffensive western blind snake is also present. Although other species were present (Clay May, personal communication), and some are probably present nearby, the general scarcity of snakes is surprising. Intractable problems with venomous snakes in a park setting are not very likely at the West Branch due to its isolation from source populations of lowland rattlesnakes, its small area, and the dense road network (lethal to the larger, more mobile snakes) that surrounds it. Re-establishment of the harmless Mexican garter snake in an urban riparian setting may succeed insofar as marking studies at San Bernardino National Wildlife Refuge, Cochise County, show it to be sedentary as long as the habitat is not desiccated.



Frogs and Toads

The occurrence of an assemblage of 6 breeding anurans within a stone□s throw of downtown Tucson is remarkable, and might not be matched in any other major city in the United States. Six species is the normal maximum for temporary pond-breeding anurans at any single site in Arizona. Most sites will have four or less such species.

One of the species present, the narrow-mouthed toad (a frog, actually), is not generally known to occur within 50 miles of the site, although museum records and reliable reports (Dennis Suhre, Clay May, personal communication, 2001) place it at San Xavier in the 1950□s and at Three Points and a bosque northwest of Snyder Hill in the Avra Valley within the past three decades. This is another example of a rare species with a highly specific habitat occurrence living in the study area. In 2001 this species was breeding in natural and enhanced scour pools in pre-historic and historic scour channels of the West Branch of the Santa Cruz and the Church Wash,

all in the northwest bosque portion of the study area. I estimate that 100-200 adults were breeding in this area, with only 2 or 3 individuals heard calling elsewhere in the study area, and none anywhere else, in the vicinity of paved or graded gravel roads, on the West Branch during appropriately wet weather. Formerly this species was abundant in the bosque-ditch habitat just east of the West Branch channel, but these did not fill this year and may have become too dry in general since the mid-1990□s de-activation of the well and irrigation in the area.

In addition to the presence of an unusual indicator species of frog, and the high species richness, the abundance and behavior of the frogs and toads was remarkable. This area has by far the largest number of frogs and toads observed at any site in Tucson, and the abundance seen may equal or exceed the highest values seen in large agricultural areas of the Santa Cruz River floodplain at Avra Valley Road. A highly significant observation is occurrence of breeding natural situations at West Branch, rather than primarily in man-made habitats. Currently, most temporary pond amphibians are to be found breeding in artificial ponds or irrigation ditches, whereas at West Branch many or most were breeding as they did under aboriginal conditions — in scour pools, cut-off channels (□oxbows□), puddles, sink holes, and arroyo-bottom pools in a natural floodplain. I can offer no other prominent examples where this occurs in southern Arizona, although I do not doubt that it exists on the Tohono O□odham lands and locally in the Sulphur Springs and San Bernardino Valleys.

Under the normal process of urbanization, all of these amphibian populations will be lost. In urban parks, generally a single species occurs, the Great Plains toad, where it may be joined by Couch□s spadefoot. Across the Santa Cruz River from the study area, these, the New Mexico spadefoot, and the Sonoran Desert toad were breeding at the 34th Street alignment this year; these four did, and may still, occur around Columbus Park and Roger Road Wastewater Treatment Facility. If further losses of habitat occur on the study area, it is predictable that the narrow-mouthed toad and New Mexican spadefoot will vanish from the area. On the other hand, sustaining and enhancing the existing populations would present no special difficulty. It may be appropriate to establish the Sonoran green toad — a troll of exceptional beauty — in this area, as early records demonstrate its occurrence near San Xavier — where it may still occur. The West Branch channel would be suitable for re-establishment of the lowland leopard frog, which was formerly highly abundant along the perennial Santa Cruz River at Tucson, San Xavier, and points between.

Table 2. Amphibian and reptile species observed (PCR) in 2000-1 at West Branch study area, Tucson, in area of floodplain environment near Silverlake and Mission roads, Cottonwood Lane, and Ajo Way.

*Species Total = 17*

| | |
|---|---|
| Amphibians (6 species) | |
| Anurans (Frogs and Toads) | |
| Toads (true toads, Family *Bufonidae* ) | |
| Great Plains Toad | *Bufo cognatus* |
| Red-Spotted Toad | *Bufo punctatus* |
| Sonoran Desert ("Colorado River") Toad | *Bufo alvarius* |
| Spadefoots (spadefoot toads, Family *Pelobatidae* ) | |
| Couch's Spadefoot | *Scaphiopus couchii* |
| New Mexico Spadefoot | *Scaphiopus (Spea) multiplicatus* |
| Microhylid Frogs (narrow-mouthed toads, Family *Microhylidae* ) | |
| Sinaloan Narrow-mouthed Toad | *Gastrophryne olivacea mazatlanensis* |
| Reptiles (11 species) | |
| Lizards (10 species) | |
| whiptail lizards (Family *Teiidae)* | |
| **Giant Spotted Whiptail **** | ***Cnemidophorus burti stictogrammus*** |
| Sonoran Spotted Whiptail (desert form) | *Cnemidophorus "sonorae"* |
| Western Whiptail | *Cnemidophorus tigris* |
| iguana-like lizards (Family *Iguanidae* ) | |
| Clark's Spiny Lizard | *Sceloporus clarkii* |
| Desert Spiny Lizard | *Sceloporus magister* |
| Lesser Earless Lizard | *Holbrookia maculata* |
| Regal Horned Lizard | *Phrynosoma solare* |
| Tree Lizard | *Urosaurus ornatus* |
| Zebra-tailed Lizard | *Callisaurus draconoides* |
| eublepharid geckos (Family *Eublepharidae* ) | |
| Tucson Banded Gecko | *Coleonyx variegatus bogerti* |
| Snakes (1 species) | |
| common snakes (Family *Colubridae)* | |
| Southwestern Black-headed Snake | *Tantilla hobartsmithi* |

**** Priority Vulnerable Species**

## IV. Birds

The list of birds seen in the West Branch study area, gathered in just 2001, is already quite long at 75 species, and will undoubtedly exceed this substantially with future work. Early ornithologists reported a total of 42 birds species from the region of the bosque at San Xavier (Swart, 1905; Willard, 1912) in brief springtime studies, whereas Arnold (1940) reported 111 species there, including 55 in some abundance, during a year and a half of more intensive study. Although certain rare or uncommon species such as the Yellow-billed Cuckoo, Willow Flycatcher, and Bell□s Vireo that were observed decades ago near San Xavier have not been recorded at the West Branch so far, a number of unusual and significant birds have been.

According to Will Turner (August 21, 2001) at the University of Arizona, who is directing the largest-ever bird survey of the Tucson area,

> While some of the birds occur elsewhere in Tucson, many of them are rare in developed areas other than some low-density residential areas. All of the following, found on the West Branch, are species that depend on particular habitats not often found in Tucson. Yellow-breasted Chat, Yellow Warbler, Abert□s Towhee, Western Tanager, Hooded Oriole, and Brown-crested Flycatcher are generally only found in dense riparian/xeroriparian areas around Tucson. Black-tailed Gnatcatcher, Canyon Towhee, Costa□s Hummingbird, Gilded Flicker, Greater Roadrunner and Pyrrhuloxia are seldom found away from dense desertscrub. Rufous-winged Sparrow, which requires mixed desert scrub and bunchgrass, has a very small range, of which Tucson is thought to be an important part. In addition to the above species breeding (or potentially breeding) near Tucson, the presence of Gray Flycatcher, Plumbeous Vireo, MacGillivray□s Warbler, and Wilson□s Warbler suggests that birds find this a good migration stopover, while the presence of Brewer□s Sparrow, Green-tailed Towhee, Dark-eyed Junco, Lincoln□s Sparrow, Vesper Sparrow, and Yellow-rumped Warbler indicate that this habitat is used by wintering birds.

This is probably the premier birding spot close to downtown Tucson. Additional rare or uncommon species are likely to be found, especially the Bell□s Vireo. With restoration of riparian conditions along the West Branch, and continued growth of regenerating bosque, other rare species can be expected to return.

Here, it is worth reproducing certain notable statements by the foregoing ornithologists regarding the grand mesquite forest at San Xavier. These should serve as motivation and guide in some of our efforts that may involve restoration work:

> South of Tucson, Arizona, along the banks of the Santa Cruz River, lies a region offering the greatest inducements to the ornithologist. The river running underground for most of its course rises to the surface at this point, and the bottomlands on either side are covered, miles in extent, with a thick growth of giant mesquite trees, literally giants, for a person accustomed to the scrubby bush that grows everywhere in the desert regions of the southwest, can hardly believe that these fine trees, many of them sixty feet high and over, really belong to the same species. (Swarth, 1905).

> The mesquite trees are wonders of their kind. There were some whose trunks, at the base, scaled over four feet in diameter. The large bases branched a few feet above the ground into several limbs fifteen or eighteen inches in diameter. The tallest

> reached a height of over sixty feet. The undergrowth is a thick mass of hackberry, etc., with various thorny bushes growing close to the ground. (Willard, 1912).

Years later, this bosque, though severely damaged by wood-cutting, retained some of its original, forceful beauty, although by 1939 even the best of the mesquite was on twenty to twenty-five feet tall (Arnold, 1940):

> The following quotation by Swarth (1905) might well be applied to describe the ornithological condition which still exists in the more heavily wooded sections during the summer months. □In early morning the medley of bird songs was absolutely confusing, and the number of individuals of the many species found in this region was far beyond what is usually the case in the lowlands of Arizona.□

While it will take many decades for the mesquite to reach veritable forest stature, along the way we can count on it providing outstanding habitat for many rare or unusual species of birds, as attested by both the historical record and the more limited work undertaken this year along the West Branch. If we accomplish no more than to ensure the re-growth of a shady mesquite forest on the floodplain surfaces of the West Branch, we will have done well.

Table 3. Bird species observed in 2001 at West Branch study area, Tucson, in area bounded by Silverlake and Mission roads, West Branch xeroriparian, and 44th Street alignment. X = present, T=recorded in xeroriparian thicket. Priority Vulnerable Species are highlighted

| Species | Observed at Fraser's, 2403 S. Mission, Jan. 1-April 12, 2001 | Susan Randolph and Karen McBride, West Branch, 7 May 2001 | Susan Randolph and Will Turner, West Branch, 2nd spring count, plus August count |
|---|---|---|---|
| *Species Total = 75* | *57* | *46* | *36* |
| **Abert's Towhee** | **X** | **X** | **X** |
| American Kestrel | X | | |
| Anna's Hummingbird | | X | X |
| Ash-throated Flycatcher | X | T | X |
| Black-chinned Hummingbird | X | X | X |
| Black-tailed Gnatcatcher | | | X |
| Blue-gray Gnatcatcher | X | | |
| Brewer's Sparrow | X | | |
| Bronzed Cowbird | | X | |
| Brown-crested Flycatcher | | X | |
| Brown-headed Cowbird | X | T | X |
| Cactus Wren | X | X | X |
| Canyon Towhee | X | T | |
| Cassin's Kingbird | | T | |
| Curve-billed Thrasher | X | X | X |
| Common Raven | X | T | |
| Cooper's Hawk | X | T | |
| Costa's Hummingbird | | T | |
| Dark-eyed Junco | X | | |
| European Starling | X | X | |
| Gambel's Quail | X | X | X |
| Gila Woodpecker | X | X | X |
| Gilded Flicker | X | X | X |
| Gray Flycatcher | | | X |
| Greater Roadrunner | X | | X |
| Great-tailed Grackle | X | T | X |
| Green-tailed Towhee | X | T | |
| Harris's Hawk | X | | |
| Hooded Oriole | X | | |
| House Finch | X | X | X |
| House Sparrow | X | T | X |
| Hutton's Vireo | X | | |
| Inca Dove | X | T | X |
| Killdeer | | T | X |
| Ladder-backed Woodpecker | | T | X |
| Lark Bunting | X | | X |
| Lark Sparrow | X | T | X |
| Lawrence's Goldfinch | X | | |

*(continued)*

Table 3, *continued* , West Branch birds, year 2001.

| | | | |
|---|---|---|---|
| Lesser Goldfinch | X | | X |
| Lincoln's Sparrow | X | | |
| Loggerhead Shrike | X | | X |
| Lucy's Warbler | X | X | X |
| MacGillivray's Warbler | X | X | |
| Mountain Bluebird | X | | |
| Mourning Dove | X | XT | X |
| Northern Cardinal | | X | X |
| Northern Harrier | X | | |
| Northern Mockingbird | X | X | X |
| Peregrine Falcon | X | | |
| Phainopepla | X | X | X |
| Plumbeous Vireo | X | | |
| Prairie Falcon | X | | X |
| Pyrrhuloxia | X | X | X |
| Red-naped Sapsucker | X | | |
| Red-tailed Hawk | X | T | |
| Rock Dove | X | | X |
| Rock Wren | X | | |
| **Rufous-winged Sparrow** | | **T** | **X** |
| Say's Phoebe | X | T | |
| Sharp-shinned Hawk | X | | |
| Turkey Vulture | X | | |
| Verdin | X | X | X |
| Vermilion Flycatcher | X | | |
| Vesper Sparrow | X | | |
| Western Kingbird | | T | |
| Western Tanager | | T | X |
| Western Wood Peewee | | T | |
| White-crowned Sparrow | X | T | |
| White-throated Swift | X | | |
| White-winged Dove | X | X | X |
| Wilson's Warbler | | X | |
| Yellow Warbler | | X | |
| Yellow-breasted Chat | | T | X |
| Yellow-headed Blackbird | | T | |
| Yellow-rumped Warbler | X | | |

## V. Mammals

Although I have only observed 8 species of mammals on the West Branch, native desert species were present and it is evident that several others will certainly be found: white-throated packrat, Merriam□s kangaroo rat, house mouse, white-footed mouse, antelope ground squirrel, and rock squirrel, and several species of bats. Other species are also possible, including other mice (possibly including uncommon species like Merriam□s mouse), badgers, skunks, porcupines, and foxes. Recent occurrence of kit foxes was reported by Beryl Baker, and this and other small carnivorous species could return under reduced disturbance by recreational vehicles.

The abundance of desert rodents was not as high as usually seen in similar habitat this year, for reasons unknown. The occurrence of house cats on the floodplain may be a partial explanation. The consistent presence of un-collared dogs and coyotes in the West Branch is important in preventing excessive impacts from cats on populations of lizards and small birds in the thickets. Maintaining sufficient access and living space for such predators will be a significant consideration if the area□s biodiversity is to be sustained.

Livestock is prominent in the study area. Some owners still pasture a few cattle on the site. A number have horses, and some owners have moderately sizable stables and corrals. At least two owners keep penned sheep and goats in small but significant plots. The impacts of livestock are present, but are not significant in terms of threats to the area.

Table 4. Mammal species incidentally observed (PCR) in 2000-1 at West Branch study area, Tucson, during other sampling in floodplain near Silverlake and Mission roads, Cottonwood Lane, and Ajo Way.

| **English Common Name** | ***Scientific Name*** |
|---|---|
| *Species Total = 8* | |
| Coyote | *Canis latrans* |
| Domestic Dog | *Canis familiaris* |
| House Cat | *Felis catus* |
| Desert Cottontail | *Sylvilagus auduboni* |
| Black-tailed Jackrabbit | *Lepus californicus* |
| Cotton Rat | *Sigmodon* cf. *arizonae* |
| Desert Pocket Mouse | *Chaetodipus penicillatus* |
| Round-tailed Ground Squirrel | *Spermophilus tereticaudus* |

## Use Values for the Area

I. Natural Park or Habitat Reserve Design

The West Branch between Silverlake Road and Ajo Way clearly has valuable diversity and a locally or regionally unique assemblage of plants and animals. Its appearance to an untrained eye, however, is not necessarily exceptional, and it has accumulated the usual junk, trash, and urban flotsam that one expects of an area that has been largely neglected. As a park standing alone it would be of interest primarily to the most avid bird-watchers and nature-lovers among the public in general. Justification for preserving habitat on such potentially valuable real estate may require that we consider the West Branch in a larger context: (1) as part of a larger Santa Cruz River Park, Paseo de las Iglesias, Rio Nuevo Downtown Redevelopment Project, and Paseo de los Arboles and (2) as a cornerstone of a more extensive effort at ecological restoration involving the mesic corridors of Pima County, the Santa Cruz, Rillito, and Pantano.

The Sonoran Desert Conservation Plan (SDCP) is aimed at establishing a thoroughly functional network of reserves and conservation areas that will preserve and restore the unique native flora and fauna of Pima County. Many of the most threatened and endangered forms, as well as those now locally extinct, are characteristic of natural waters and riparian communities of the valley floors. The plan□s primary focal area, eastern Pima County, although mostly made up of arid lands, is actually structured around current and former wet and non-arid valley floors of the Santa Cruz, Ca□ada de Oro, Rillito, Pantano system. A large part of the area□s biodiversity is dependent on existing and former aquatic and riparian environments. We are fortunate that we still have the opportunity to save some of this original value, and to restore a great deal more of it. The West Branch study area, and if suitable collaboration could be achieved, the San Xavier area, contain the key remaining resources for preserving and restoring the Tucson area part of the Santa Cruz. Here I will focus on some of the specifics of how this might be brought about at the West Branch study area.

A West Branch Park (see Fig. 7) could be connected to a functioning part of the Santa Cruz River Park simply by extending a trail or roller blade path through easements north of the 44th Street alignment, over the branch on a bridge, and then up the west side floodplain to Silverlake Road. A return path to the main part of Santa Cruz River Park could be located along the branch as it goes northeast between the County Jail and other buildings, although this would require an underpass or overpass at Silverlake Road. I would suggest that, at the outset at least, foot access and a footbridge would be appropriate development, as the park area would be involved with cleanup, rehabilitation, ecological restoration, and development of necessary accords with neighborhood residents and landholders. As such, trail access would be simplified, as foot traffic could proceed along Silverlake Road to the Santa Cruz River Park or could return via a loop trail design. Parking with direct access to the park area could easily be established near the corner of Mission and Silverlake roads.

At present, although probably not for long, a connection (pedestrian, equestrian,

ecological) could be made between the West Branch and Tucson Mountain Park via not-yet-developed land up 36th Street west to La Cholla Boulevard, and along that area south to 44th Street where Kennedy Park and Tucson Mountain Park. It is also possible, and simpler though less aesthetically satisfactory, to go on foot or horseback up the Enchanted Hills Wash to a point at which a convenient southward path to Tucson Mountain Park or Kennedy Park could be located.

The ecological connection of the West Branch can only be adequately maintained to the east with the Santa Cruz River Park via properties with low residential development, and to the west through wash bed or xeroriparian corridors (which are quite lush on the adjoining bajada) to the Tucson Mountains. The study area is cut off by urban development both north and south.

The West Branch upstream of the study area retains open space in a modest, rather degraded strip from about _ mile south of Ajo Way south to the West Branch Diversion channel, which starts near Ajo Way and Irvington Road and directs flow down a highly simplified channel to the Santa Cruz River. There is a considerable tract of open land around the West Branch Diversion that is also highly degraded. These areas might be utilized in context of a West Branch Park to satisfy public demand for either more active recreation (ball fields, etc.) or more intensive, start-from-scratch ecological restoration, or both. These areas connect readily to the Santa Cruz River Park via land along the diversion channel, and a xeroriparian connection to the north and south could still be maintained without difficulty along the original West Branch arroyo.

Establishing an ecological connection or recreational path to the less-disturbed O□odham lands to the south will be difficult. Although it is less than 1 mile from Irvington Road to the San Xavier District boundary at Drexel Road, the only obvious connection is along the West Branch itself. Because these O□odham lands have high ecological potential and also connect directly to non-urbanized terrain to the south and west, the county and city should protect their options by maintaining control of the arroyo and its close surroundings.

II. Uses of a West Branch Natural Area Park

There would probably be significant interest in use of such a park by bird-watchers and nature-lovers as a result of public awareness that would be raised during any attempt to establish the park. As downtown redevelopment proceeds, along with enhancement of the Santa Cruz River Park, use would increase among park users looking for a quiet side-path and those who would, gradually, □discover□ the subtle attractions of the area. These attractions are likely to manifest themselves more clearly to the public as Rio Nuevo projects reinforce awareness of the historical sense of place of the river system. Likewise, a successful park at West Branch may influence the tone of redevelopment downtown and along the Santa Cruz River by helping define the rich biological character of the environment.

A West Branch Park would offer a great deal in addition to this, however, as it brings the natural laboratory an order of magnitude closer to school children and high school science

students (see, e.g., Kloor, 2001). On-site ecology projects such as courtyard ponds with native species exist at several schools in Douglas, Arizona, as well as at Palo Verde High School and Flowing Wells Junior High and, at least as plans, at Pueblo and Cholla High Schools, in Tucson. I would think that Tucson and South Tucson area schools would be able to use the West Branch as an outdoor classroom. An obvious initial approach would be in site cleanup and ecological restoration, which are suitable for class and school projects.

A diversity of projects available for school participation come to mind. Removal of trash and establishment of suitable trail conditions would be a first step. Control of non-native species like buffel grass is also an activity that requires little background work or decision-making. Identification, propagation, and planting of native vegetation are also suitable for school and class participation. Should there be a decision to go forward with true riparian restoration and aquatic habitat re-establishment at the park, schools may play vital roles in breeding and growing native fishes and other animals, educating the students and their parents about the ecological relationships leading to the problems that now require ecological restoration, and assisting in the monitoring and maintenance of restored or existing populations.

## III. Easements as a Conservation Approach on West Branch

Neighborhood residents currently use the study area for horseback riding, hiking, and birdwatching. Local use of the area might increase with establishment of a park or reserve, and neighborhood interest will contribute significantly to keeping the park safe and well maintained. Many of these people have deep awareness, appreciation, and affection for the environment. They have a long history of attempting to protect the West Branch, and despite an underlying sense of discouragement, it is true that we have them to thank, in part, for the survival of the resource into the 21st century.

The current Santa Cruz Southwest Neighborhood Association is an active one, with at least five core participants who are regularly active in West Branch issues. It has roots in the Cottonwood Lane Association that was working to protect the West Branch and the Santa Cruz River in the 1970□s, if not earlier. The participants and many others in the neighborhood enjoy the semi-rural character of the area, and the inducements available with easements should permit successful use of the approach. To my knowledge, the neighborhood association is fully in support of county acquisition and possession of area properties. They would be receptive to easement offers, in addition, and I do not see why other neighbors would not.

Larger residential owners — involving the existing trailer courts and housing developments — may gain from having a developing park next door, although this might be offset by foreclosure of options for further, environmentally severe, flood control diversions that would permit additional development options. However, in the context of downtown revitalization, it would seem that the balance of value would be strongly in favor of □spruce□n up□ the floodplain. I have no idea about what easements might apply in these situations, if any.

I think there are a range of possible easement provisions, including the following, some or all of which may all be negotiable on a case-by-case basis: voluntary use of native plantings around houses; mandatory non-use of exotic plantings on open space areas; reduction of vehicular access to necessary minima on privately held open space; reduction of areas used by livestock; permission to re-vegetate; permission to develop and maintain aquatic habitat; permission to develop and maintain trails or trail heads; permission to allow park users on privately held open space; restrictions on the nature and placement of new buildings.

Any agency developing a park or reserve in the area will do well to involve the neighborhood in the fullest possible way. Currently, the study area is little used — or not used at all — by squatters. This appears to be a result of patrolling by the residents. Maintaining safety in a natural environmental setting will be more difficult than in a typical manicured urban park, and participation of neighbors in this, along with strict rules and enforcement to prevent squatting and muggings, would be essential for a successful park.

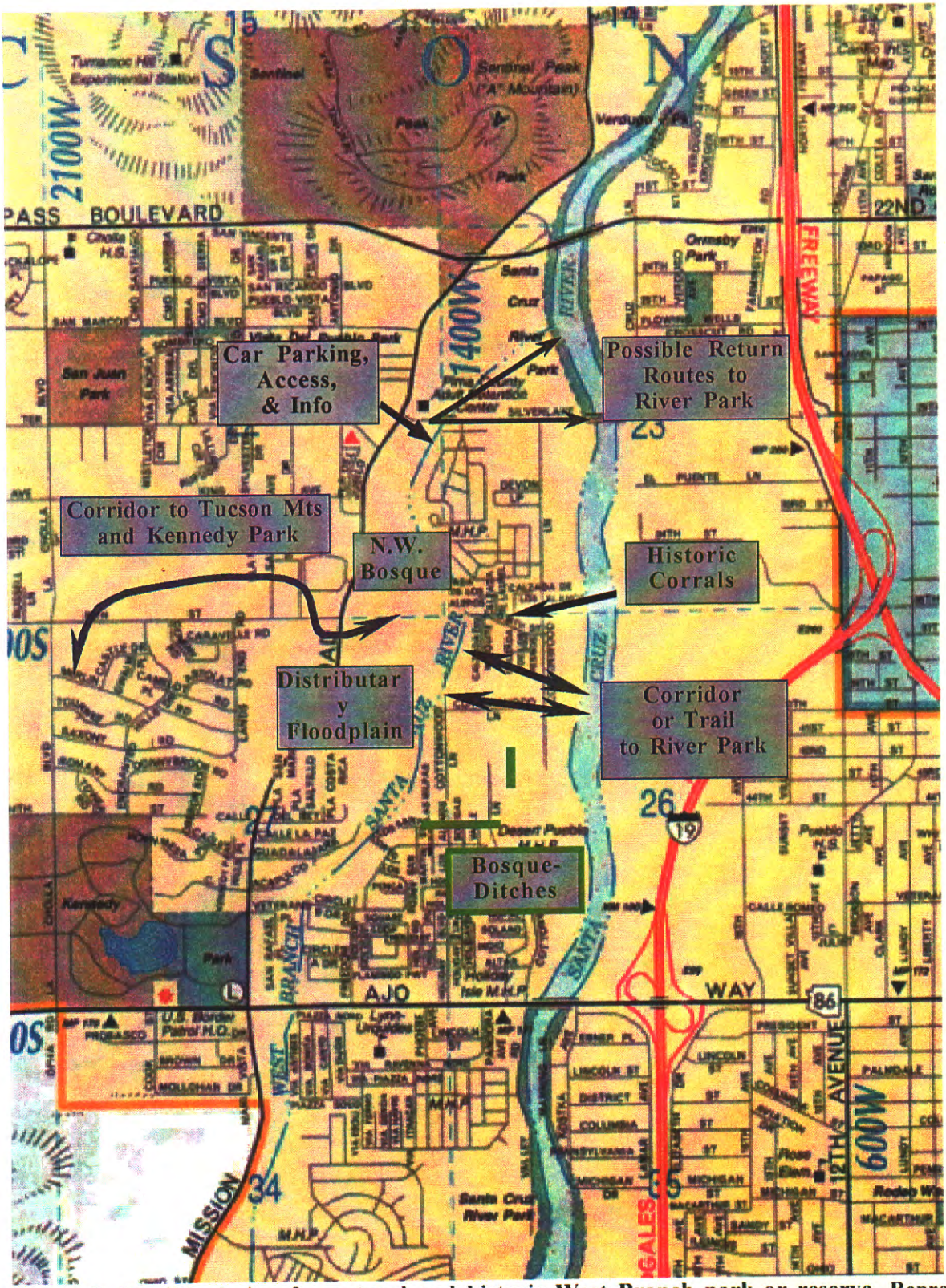



**Figure 7. Possible design for natural and historic West Branch park or reserve. Reproduced with permission #JLW961, from 1998 Tucson Metropolitan Street Atlas, Wide World of Maps, Inc.**

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# Plants of the West Branch of the Santa Cruz, Tucson, Arizona

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12 October 2001

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## Introduction

The plants represented in this inventory have been collected along several segments of the West Branch of the Santa Cruz and lower tributaries, as well as on immediately adjacent floodplain surfaces between Silverlake Road and Ajo Way, and between Mission Road and the West Branch channel (Figure 1). Fieldwork has taken place between July and September 2001, during which time plants have been documented by observation, and/or photography, and/or collection. Species with positive identifications are listed in this report, while collection and identification of additional specimens are ongoing. Voucher specimens have been deposited at the University of Arizona Herbarium (ARIZ). Identifications have been made using the plant collections at ARIZ and available regional taxonomic and botanical literature. This inventory does not include cultivated or ornamental plants except in those cases where these are adventive along the washes or on the floodplain.

## Previous Work

University of Arizona Botany professor and Herbarium curator John J. Thornber contributed a chapter to the Carnegie Desert Laboratory publication, *Distribution and Movements of Desert Plants*, entitled "Vegetation Groups of the Desert Laboratory Domain" (Thornber, 1909) that was based on plant collections made in the earliest years of the Twentieth Century. The flora was subdivided into four physiographic zones: Tumamoc Hill (I), mesa-like mountain slopes (II), the Santa Cruz floodplain (III), and the Santa Cruz River and irrigation ditches (IV). In addition to these four groups, a fifth, Miscellaneous Introduced Species, included exotic species "limited almost wholly to area III, though a few occur in I and II" (Thornber, 1909:103). While the last group represents many conspicuous or troublesome weeds, there are non-native species in the other plant groups (I-IV), as well. The plants of zone IV are described as "hydrophytic species growing in the Santa Cruz River and adjacent irrigation ditches" (Thornber, 1909:103), and three of the seven vascular plant species listed in this group are fully aquatic herbs.

The type of area included in the present survey corresponds to Thornber's zone III, and possibly formerly to his zone IV. Combining these two zones and the Miscellaneous Introduced Species group, the list includes 194 vascular plant species in 49 families: 117 species in zone III, 7 in zone IV, 52 in "Miscellaneous Introduced Species", and 18 species whose primary occurrence is in zone I or zone II but which also occur in zone III. The list is subdivided into growth forms, including 11 trees, 14 shrubs, five subshrubs, 52 perennial or biennial herbs, 109 annual herbs, and three vines (his "woody climbers"). Among Thornber's herbaceous plants, 39 species are grasses.

In 1988, the City of Tucson initiated the Tucson Stormwater Management Study (TSMS), aimed at developing a comprehensive management plan for watercourses and floodwaters in the city. An outcome of Phase II of this study was the 1994 "Natural Riparian Habitat Inventory", a watershed-based, qualitative accounting of wash-margin vegetation density estimated from 1990-series aerial photography. This effort was not accompanied by ground-based survey or species-level inventory (Frank Sousa, TDOT, personal communication).

Habitat classes were assigned based on estimates of vegetation volume per square foot: xeroriparian high (BH=5.2), xeroriparian intermediate (BI=3.0), and xeroriparian low (BL=2.0). Seventeen wash segments in the West Branch Santa Cruz watershed that lie along or are tributaries of the West Branch (downstream of the Irvington Road diversion) were identified and analyzed during the TSMS, including parts of the Ajo Wash, Cholla Wash, San Juan Wash, Enchanted Hills Wash, and the West Branch of the Santa Cruz. From about _ mile south of Ajo Way to about _ mile south of Silverlake Road, the vegetation along the West Branch channel was classified as high-density xeroriparian habitat. From about _ mile south of Silverlake Road to Silverlake Road, the vegetation was classified as intermediate-density

xeroriparian habitat (Simons, Li & Assoc., 1995).

## Present Work

### *Composition of the West Branch flora*

At this writing, 152 vascular plant species in 37 families have been documented in the survey area. Included in this total are 77 herbs, 40 grasses, 4 subshrubs, 11 shrubs, 7 trees, 6 succulents, 5 vines, and two parasites (Figure 2). Seventy-six percent of these plants (115 species) are native. Slightly more than half of the current flora (80 species) is comprised of annuals. Despite that these collections and observations have been made in the summer, many winter annuals (n=35) have been identifiable, owing to the abundance, size, and fecundity of plants produced by the unusually wet preceding fall, winter, and spring. The winter flora compiled thus far is dominated by annuals, while a narrow majority of plants in the summer flora are perennials (Figure 3). A full accounting of species in the flora follows at the end of this document.

### *Non-native and special status species*

There are currently 37 non-native plant species in the West Branch flora, including three trees and 17 grasses (Table 1). Over half of the non-native species are cool season annuals, nine are warm season annuals, seven are warm season perennials, and two are non-seasonal herbs; there are two non-native stem succulents (*Opuntia microdasys* and *Opuntia ficus-indica*) growing as escapes from cultivation. Half of the non-native plants in the current inventory are not listed by Thornber, including the three non-native trees (*Rhus lancea, Morus alba, Tamarix aphylla*). Only saplings of the first two have been observed, and large tamarisks are planted at several locations in the vicinity of the West Branch channel and neighboring floodplain. Both *Rhus* and *Tamarix* have the potential to become invasive in riparian settings.

Only a few of the non-native plants in the West Branch flora are both abundant where they occur and widespread in the flora area, notably Bermuda grass (*Cynodon dactylon*) along watercourses, London rocket (*Sisymbrium irio*) on floodplains, and Russian thistle (*Salsola tragus*) on floodplains. Buffel grass (*Pennisetum ciliare*) is present and is a potentially invasive species, however it has not been observed in abundance thus far. While many of the non-native species in the flora favor well-watered sites, only the silver-sheath knotweed (*Polygonum argyrocoleon*) requires saturated ground. This plant was observed growing abundantly around a small pond on the old Church Wash. Johnson grass (*Sorghum halepense*) is widely scattered along the banks and occasionally in the channel of the West Branch; it is a potentially invasive, and tenacious, weed under irrigation. Finally, an area of coarse fill dirt and disturbed ground southeast of Silverlake and Mission Roads supports *Matthiola longipetala* and *Brassica tournefortii*, which have not been observed elsewhere in the flora area.

The Arizona Department of Agriculture lists morning glories (*Ipomoea* spp.) – with the exception of *I. carnea* (Mexican bush morning glory), *I. triloba* (three-lobed morning glory) and *I. aborescens* (morning glory tree), but including all others – as noxious weeds. All species of dodder (*Cuscuta* spp.) are similarly listed. Insofar as these designations includes native as well as introduced species, whether the plant(s) should be considered problematic should be heavily context-dependent. One native, annual morning glory (*I. hederacea*) is prevalent along the West Branch and is fairly innocuous. A native dodder (*Cuscuta umbellata*) is an annual parasite on annual plants, including on the non-native Russian thistle (*Salsola tragus*) in the study area. One plant species, puncture vine or goat-head (*Tribulus terrestris*), is classified as a Regulated and Restricted Noxious Weed. This plant was found scattered along the Church Wash diversion and appeared to be uncommon. The Arizona Seed Law applies to curly-leaf dock (*Rumex crispus*) and to Johnson grass (*Sorghum halepense*) (see Kendall n.d., for seed law designations). Special plant status designations under the Arizona Native Plant Law apply to the native cacti (Salvage Restricted) and to the woody legumes (Salvage Assessed and/or Harvest Restricted) in the flora (see Table 2; refer to Arizona Department of Agriculture 1999a,b, for all plant status designations).

### *Vegetation: Purely qualitative observations*

The closed-canopy mesquite forest (bosque) that extends along parts of the West Branch through the flora area supports

a diverse and tangled understory of native shrubs, vines, and herbs, some of which only occur or thrive best in deep shade (e.g., *Aristolochia, Rhyncosida, Ruellia*). This is particularly true near the Enchanted Hills Wash distributary (segment 5 in Figure 1) where the West Branch channel is relatively shallow, perhaps only one to a few meters below the floodplain surface, and where the west bank appears to be little disturbed. Areas of abundant Bermuda grass tend to correspond to segments with few trees or more open canopy cover, including the Church Wash diversion (segment 4), downstream of the Church Wash diversion (upper segment 3) and upstream of segment 1. Along these stretches, where the channel is narrower and may be more deeply incised, the non-Bermuda herbaceous component is less (though not absent) and is also less diverse. The Church Wash diversion itself supports numerous grasses, many of which are native, including Mexican sprangletop (*Leptochloa uninervia*), southwestern cupgrass (*Eriochloa acuminata*), and witchgrass (*Panicum stramineum*), which have not been seen elsewhere in the study area thus far.

The forest along the old Church Wash, downstream of the pond at 36th street (segment 2), shelters a full complement of shrub species but a relatively weedy, less species-rich herbaceous understory. Perhaps, relative to segment 5 and even segment 3, this area has experienced greater disturbance to the floodplain on either side and/or to the understory itself (i.e. segment 2 does not enjoy the wide buffer of floodplain that upstream segments do). The beheading of Church Wash and consequent loss of watershed may also be a contributing factor to the diminished herbaceous component. Upstream of the toad pond, however, on the eastern channel of the old Church Wash and the adjacent floodplain (segment 6), there grow some remarkable natives that have not been seen elsewhere – alkali sacaton (*Sporobolus airoides*), *Brachiaria fasciculata*, *Atriplex linearis* – as well as large *Lycium fremontii* and the semisucculent *Suaeda*, which is generally uncommon elsewhere. This stretch of wash appears to be little disturbed. The segment of the West Branch south of Silverlake Road (segment 1) is a well-developed arroyo, incised several meters with mesquite lining the rims. Sun-loving herbs and grasses are abundant on the banks along this stretch, cacti are widely scattered on the banks, and shrubs (*Lycium* spp., *Zizyphus*, *Atriplex* spp.) hold on to the uppermost banks beneath the discontinuous canopy.

Floodplain surfaces on the west side of the West Branch are varied. The area adjacent to segment 5, between the Enchanted Hills Wash and the Church Wash diversion, is heavily invaded with the cool-season annual mustard, *Sisymbrium irio*, and to a lesser extent with the warm-season annual Russian thistle, *Salsola tragus*. Native herbs and grasses, as well as other non-native species, are widely scattered, and both mesquite (*Prosopis velutina*) and blue palo verde (*Parkinsonia florida*) appear to be recruiting. Across the Church Wash diversion and adjacent to segment 3, plant cover is limited to shallow swales of varying extent and to the canopies of scattered mesquite trees, however these patches tend to contain a variety and abundance of native grasses and herbs. The annual devil's claw (*Proboscidea parviflora*) and *Trianthema portulacastrum*, a semi-succulent herb, are widespread natives. The native bunchgrasses, sand dropseed (*Sporobolus cryptandrus*), feather fingergrass (*Chloris crinita*), and bearded cupgrass (*Eriochloa aristata*) are widely scattered on this surface. The floodplains (probably no longer functionally so, however) adjacent to segments 2 and 1 are largely disturbed by vehicle traffic. Herbs and grasses are scattered, or grow in the canopies of mesquite and other shrubs. *Koeberlinia* (an all-thorn shrub) occurs uncommonly in both of these areas, and *Atriplex* spp. are common. An area of perhaps 2 meters of coarse fill southeast of Silverlake and Mission Roads supports several native and non-native grasses and herbs, *Atriplex* spp., scattered mesquite, and creosotebush. This surface is rather disturbed and seems to be more xeric than other floodplain areas that are underlain by fine, heavy soil.

Recommendations

Of the 152 plants in the current inventory, only 67 (48 native, 19 non-native) are also listed by Thornber. Nearly 100 years ago, Thornber remarked that "the data relating to species growing in the Santa Cruz flood-plain are of less value than those of the two former areas, in consequence of agricultural operations that have been carried on there for many years. The distribution, frequence [sic], and abundance of numerous plants have been changed; exotic species have found their way in, and not unlikely, indigenous plants have suffered eradication" (Thornber, 1909:105). If this was the case at the turn of the last century, it is probably even more true today. It is a challenge to assess whether some of the differences between the 1909 and 2001 plant lists are real, reflecting comings and goings of taxa, or are artifacts of sampling (e.g., due to differences in the visibility of plant species, or to the cross-section of temporal and spatial variability, and particularly the spatial extent, represented by Thornber's collections). I have been re-locating Thornber's (pre-1909) voucher specimens among the ARIZ collections to determine his collection locations. At the same time, I have been documenting, using herbarium specimens and to the extent possible, the collection history in Tucson, and

on the Santa Cruz floodplain in particular, of species in the current flora not listed by Thornber. The effort to fully update the 1909 list and to reconstruct the geographic area representing zones III and IV is ongoing.

Additional field work and herbarium research will be necessary to fully document the current flora of the West Branch and to address what changes have taken place in the last century. Contrary to Thornber's opinion on the importance of the floodplain flora, the plants that have been documented thus far are a remarkable assemblage for an urban and agricultural watershed – few washes in Tucson still support such a forest, and even undisturbed washes are lucky to contain such diversity. The importance of this flora – the variety of floral resources (pollen, nectar, and host plants) made available year-round – to native insect pollinators, from flies and beetles to bees, moths, and butterflies, should not be underestimated, and perhaps should be documented.

Both irrigation and disturbance incurred should be important considerations in the development and management of a natural area due to potential consequences of these management tools for non-native and native plant populations. Because of the thorough admixture of native and non-native plant species in the flora, chemical management of noxious plants is strongly discouraged. Consideration of the roles that the non-native species have assumed in this ecosystem should be foremost in any management plan for non-native and noxious plants in the area. Preventive maintenance, including monitoring and targeted, small-scale mechanical removal of potentially invasive, non-native individuals or localized populations is strongly encouraged.

**Figure 1.** Collection locations on the West Branch of the Santa Cruz. Colored and numbered wash segments indicate areas in which plants have been collected: 1) Bus Barn site, 2) old Church Wash, 3) the West Branch downstream of the Church Wash diversion, 4) the Church Wash diversion, 5) the West Branch between the Enchanted Hills Wash and the Church Wash diversion, 6) upstream of the toad pond on the east segment of the old Church Wash. Background image: 1-foot digital aerial photography of May 1998; 1000-m UTM grid shown. The dry channel of the Santa Cruz River is visible to the right of center.

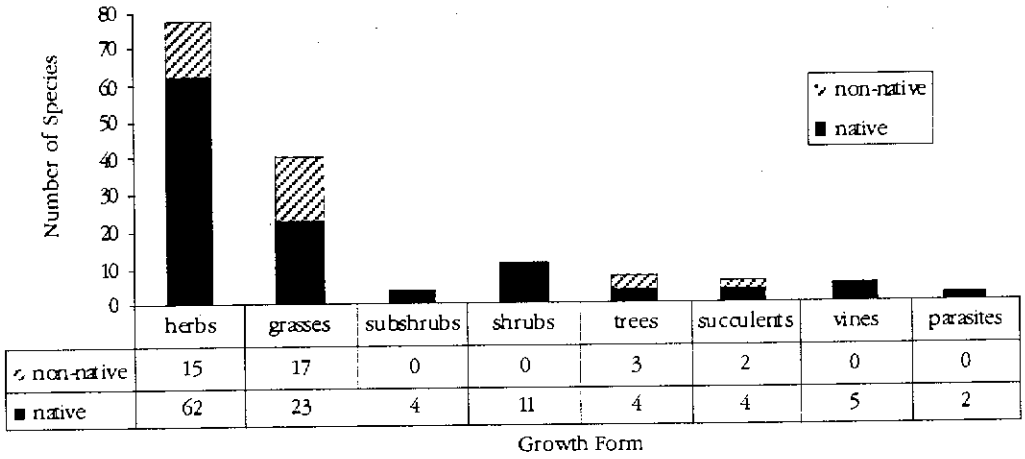


**Figure 2.** Composition of the West Branch flora.

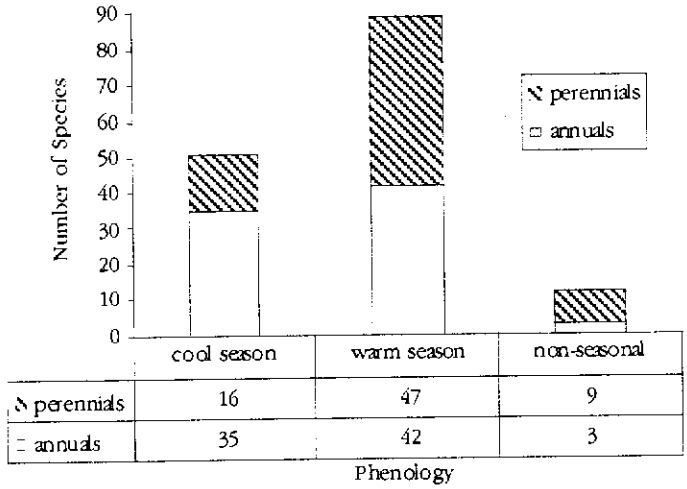


**Figure 3.** Life strategies and phenologies represented by the West Branch flora.

**Table 1.** Non-native species in the West Branch flora.

| Plant Family | Taxon | Common Name |
|---|---|---|
| Anacardiaceae | *Rhus lancea* L. | African sumac |
| Asteraceae | ‡ *Centaurea melitensis* L. | Malta star thistle |
| | *Conyza bonariensis* (L.) Cronquist [a] | |
| | *Lactuca seriola* L. | Prickly lettuce |
| | ‡ *Sonchus oleraceus* L. | Sow thistle |
| | ‡ *Xanthium strumarium* L. | Cocklebur |
| Brassicaceae | *Brassica tournefortii* Gouan | Sahara mustard |
| | ‡ *Matthiola bicornis* de Candolle | Evening stock |
| | *Sisymbrium irio* L. | London rocket |
| Cactaceae | *Opuntia microdasys* (Lehm.) Pfeifl. | Bunny ears cactus |
| | *Opuntia ficus-indica* (L.) Miller | Nopal |
| Chenopodiaceae | *Salsola tragus* L. | Russian thistle |
| Fabaceae | *Medicago sativa* L. | Alfalfa |
| | ‡ *Melilotus indicus* (L.) All. | Yellow sweet clover |
| Malvaceae | ‡ *Malva parviflora* L. | Cheeseweed |
| Moraceae | *Morus alba* L. | Mulberry |
| Poaceae | ‡ *Arundo donax* L. | Giant-reed |
| | ‡ *Avena fatua* L. | Wild oat |
| | ‡ *Bromus catharticus* Vahl. | Rescue grass |
| | ‡ *Bromus rubens* L. | Red brome |
| | ‡ *Cynodon dactylon* L. | Bermuda grass |
| | *Dactylotenium aegyptium* (L.) Richt. | Crowfoot grass |
| | ‡ *Echinochloa colonum* (L.) Link | Junglerice |
| | ‡ *Eragrostis cilianensis* (All.) Link | Stink grass |
| | *Eragrostis lehmanniana* Nees | Lehmann's lovegrass |
| | ‡ *Hordeum murinum* L. subsp. *glaucum* (Steud.) Tzvelev | Wild barley |
| | *Hordeum vulgare* L. | Common barley |
| | ‡ *Leptochloa viscida* (Scribn.) Beal. | Sticky sprangletop |
| | *Melinis repens* (Willdenow) Zizka subsp. *repens* | Natal grass |
| | *Panicum antidotale* Retz. | Giant panic grass |
| | *Pennisetum ciliare* (L.) Link | Buffelgrass |
| | ‡ *Phalaris caroliniana* Walt. | Carolina canary grass |
| | ‡ *Sorghum halepense* (L.) Pers. | Johnson grass |
| Polygonaceae | *Polygonum argyrocoleon* Steud. ex Kunze | Silver-sheath knotweed |
| | ‡ *Rumex crispus* L. | Curly-leaf dock |
| Tamaricaceae | *Tamarix aphylla* L. | Athel salt cedar |
| Zygophyllaceae | ‡ *Tribulus terrestris* L. | Goat-head, puncture-vine |

‡ species is listed in Thornber (1909)

[a] native to the Eastern U.S., adventive in the Southwest

**Table 2.** Plants in the West Branch flora with Arizona Department of Agriculture special plant status designations.

| Plant Family | Taxon | Common Name | Special Status |
|---|---|---|---|
| Cactaceae | *Cylindropuntia arbuscula* Engelm. | Pencil cholla | SR |
| | *Cylindropuntia spinosior* (Engelm.) Toumey | Cane cholla | SR |
| | *Cylindropuntia leptocaulis* de Candolle | Christmas cholla | SR |
| | *Opuntia phaeacantha* Engelm. | Prickly pear | SR |
| Convolvulaceae | (*) *Cuscuta* spp. | Dodder | NWR |
| | (*) *Ipomoea* spp. | Morning glory | NWR |
| Fabaceae | *Parkinsonia florida* (Benth. ex A. Gray) S. Watson | Blue palo verde | SA |
| | *Prosopis glandulosa* Torr. var. *glandulosa* | Honey mesquite | SA, HR |
| | *Prosopis velutina* Woot. | Velvet mesquite | SA, HR |
| Poaceae | * *Sorghum halepense* (L.) Pers. | Johnson grass | ASL, NWR |
| Polygonaceae | * *Rumex crispus* L. | Curly-leaf dock | ASL |
| Zygophyllaceae | * *Tribulus terrestris* L. | Goat-head, puncture-vine | NWR, RRNW |

Native Plant Law: HS – Highly Safeguarded SR – Salvage Restricted SA – Salvage Assessed HR – Harvest Restricted;
NWR – Noxious Weed Regulation RRNW – Regulated and Restricted Noxious Weed ASL – Arizona Seed Law
(Arizona Department of Agriculture 1999a,b; Kendall n.d.)' * non-native plant species (*) category includes both native and non-native species

The West Branch Flora

Symbols and abbreviations used in the entries are as follow: ‡ Indicates a plant that was included in Thornber's (1909) list of plants occurring in his Zone III (Santa Cruz floodplain) and/or Zone IV (Santa Cruz River and irrigation ditches), and in his category "Miscellaneous Introduced Species". * Indicates a non-native species. Arizona Department of Agriculture plant status designations: HS – Highly Safeguarded; SR – Salvage Restricted; SA – Salvage Assessed; HR – Harvest Restricted; NWR – Noxious Weed Regulation; RNNW – Regulated and Restricted Noxious Weed; ASL – Arizona Seed Law (see Arizona Department of Agriculture 1999a,b, for current plant status designations; Kendall n.d., for seed law designations). The nomenclature appearing in this list is consistent with that employed at ARIZ as of August 2001, with a few exceptions. Collections are numbered consecutively following the prefix 21-, and have been deposited at the University of Arizona Herbarium (ARIZ). Common names are listed after the scientific name when they are known.

Angiosperms

**Dicotyledons**

ACANTHACEAE

*Carlowrightia arizonica* A. Gray
Native, perennial herbs, flowering in the summer. Scattered under the canopy of the mesquite forest along the West Branch channel.
K.Mauz 21-032

*Dicliptera resupinata* (Vahl.) Juss.
Native, warm-season herbs. Populations scattered in the mesquite understory, plants locally abundant. Corolla lobes dark pink.
K.Mauz 21-135

*Ruellia nudiflora* (Engelm. & A. Gray) Urban
‡ Native, perennial herbs, flowering in the summer. Common, scattered all along the margins and sometimes in the channel of the West Branch, occasional on the floodplain under mesquite canopies.
K.Mauz 21-033

AIZOACEAE

*Trianthema portulacastrum* L. Horse purselane.
‡ Native or naturalized, warm season annuals. Common, scattered on the floodplain.
K.Mauz, 21-104

AMARANTHACEAE

*Amaranthus obcordatus* (A. Gray) Standl.
Native, warm-season annuals. Uncommon?, growing abundantly under a large, dying *Tamarix aphylla* near the Church Wash diversion.
K.Mauz 21-116

*Amaranthus palmeri* S. Watson. Pigweed.
‡ Native, warm season annuals. Scattered on the floodplain and occasionally along or in the channel of the West Branch.
K.Mauz 21-034

*Tidestromia lanuginosa* (Nutt.) Standl.
‡ Native, warm season annuals. Scattered on the floodplain west of the West Branch channel north of the Church Wash diversion.
K.Mauz 21-097

ANACARDIACEAE

*Rhus lancea* L. African sumac.
* Non-native, trees flowering in the cool season. Uncommon, a few small individuals observed along the West Branch and the old Church Wash channel.
K.Mauz 21-062

APIACEAE

*Daucus pusillus* Michaux. Wild carrot.
Native, cool season annuals. Common, scattered or occasionally locally abundant along the West Branch, old Church Wash, and the Church Wash diversion. Observed in the summer as dry plants, fruit intact.
K.Mauz, Obs.

ARISTOLOCHIACEAE

*Aristolochia watsonii* Woot. & Standl. Pipevine.
Native, perennial vines, flowering in the summer. Uncommon, in the canopy of the mesquite forest along the West Branch. Adult pipevine swallowtails observed and their red caterpillars photographed.
K.Mauz 21-077

ASCLEPIADACEAE

*Sarcostemma cynanchoides* Decne. subsp. *cynanchoides*

‡ Native, warm season vines, flowering in the summer. Scattered under the mesquite canopy and climbing into the trees and on other shrubs.
K.Mauz 21-035

ASTERACEAE

*Ambrosia confertiflora* de Candolle. Slimleaf bursage.
‡ Native, herbaceous perennial, flowering in the summer. Plants scattered along the West Branch channel, occasionally occurring in small populations.
K.Mauz 21-083

*Ambrosia cordifolia* (A. Gray) Payne. Sonoran bursage.
Native subshrub, flowering in the spring. Uncommon, a few large individuals observed under the canopy of the mesquite forest along the West Branch.
K.Mauz 21-063

*Baccharis sarothroides* A. Gray. Desert broom.
Native shrubs, flowering in the warm season. Scattered along the West Branch channel and occasional on the floodplain.
K.Mauz, Obs.

*Baileya multiradiata* Harv. & A. Gray. Desert marigold.
Native, perennial herbs, flowering in spring and summer. Uncommon, scattered on the floodplain.
K.Mauz, Obs.

*Brickellia coulteri* A. Gray. Brickelbush.
Native subshrub, flowering in cooler weather. Scattered under the mesquite canopy along the West Branch.
K.Mauz 21-036

*Centaurea melitensis* L. Malta starthistle.
‡ * Non-native, cool season annuals. Scattered on the floodplain and along wash channels. Observed in the summer as dry plants with heads intact.
K.Mauz, Obs.

*Conyza bonariensis* (L.) Cronquist
* Native to eastern North America and adventive in the Southwest. Warm season annuals. Uncommon, one plant observed on the floodplain near the Church Wash diversion.
K.Mauz 21-037

*Conyza canadensis* (L.) Cronquist. Horseweed.
‡ Native, warm season annuals. Common, scattered on the floodplain.
K.Mauz 21-070

*Conyza coulteri* A. Gray
‡ Native, warm season annuals. Common, scattered on the floodplain and occasional along the margin of the West Branch.
K.Mauz 21-100

*Erigeron divergens* Torr. & A. Gray. Fleabane.
‡ Native, warm season annuals. Common?, scattered along wash margins, occasional under the mesquite canopy or on the floodplain.
K.Mauz 21-038

*Gutierrezia microcephala* (de Candolle) A. Gray
‡ Native subshrubs, flowering in late summer. Uncommon?, scattered in the Enchanted Hills Wash distributary and West Branch floodplain.
K.Mauz 21-141

*Hymenothrix wislizeni* A. Gray
‡ Native, summer annuals. Common on the banks of the West Branch.
K.Mauz 21-121

*Isocoma coronopifolia* (A. Gray) Greene. Burrow weed.
‡ Native subshrub, flowering in the warm season. Scattered on coarse fill.
K.Mauz 21-127

*Lactuca seriola* L. Prickly lettuce.
* Non-native, cool season annuals. Scattered on the floodplain, occasional on wash margins and under the mesquite canopy.
K.Mauz 21-064

*Machaeranthera coulteri* (A. Gray) Turner & Horne var. *arida* (Turner & Horne) Turner
‡ Native, annual or perennial herbs, flowering in summer or non-seasonal. Uncommon?, growing on the floodplain.
K.Mauz 21-082

*Machaeranthera tagetina* Greene
Native, (annuals, biennials, or) short-lived perennials

flowering in the summer. Uncommon, scattered on the Church Wash diversion and banks of the West Branch.
K.Mauz 21-123

*Porophyllum gracile* Benth. Odorata.
Native, perennial herbs, flowering in all but the driest months. Scattered on the margins of the West Branch in the shade of the mesquite forest.
K.Mauz, Obs.

*Psilostrophe cooperi* (A. Gray) Greene. Paper flower.
Native, perennial herbs, flowering in warmer weather. Uncommon?, one small plant observed on the floodplain.
K.Mauz, Obs.

*Sonchus oleraceus* L. Sow thistle.
‡ * Non-native, cool season annuals. Scattered along the washes, under the mesquite canopy, and occasionally on the floodplain. Observed as dry plants with remaining spinescent leaves and heads.
K.Mauz, Obs.

*Stephanomeria pauciflora* A. Gray. Wire lettuce.
Native, perennial herbs, flowering in the warm season. Uncommon, scattered under the mesquite canopy along the West Branch.
K.Mauz 21-078

*Verbesina encelioides* (Cav.) A. Gray. Cowpen daisy.
‡ Native, warm season annuals. Scattered along the margin of the West Branch and occasional on the floodplain.
K.Mauz 21-058

*Xanthium strumarium* L. Cocklebur.
‡ * Non-native, warm-season annuals. Apparently uncommon, a single plant observed in the West Branch channel near Silverlake Road.
K.Mauz, Obs.

BORAGINACEAE

*Lappula occidentalis* (S. Watson) Greene. Stickseed.
Native, cool season annuals. Scattered along wash margins and occasional on the floodplain. Observed as dry plants in the field, fruits intact.
K.Mauz, Obs.

BRASSICACEAE

*Brassica tournefortii* Gouan. Sahara mustard.
* Non-native, cool season annuals. Scattered on disturbed ground and fill dirt, populations apparently localized. Observed as dry plants and tumbleweeds, capsules and seeds collected.
K.Mauz, Obs.

*Caulanthus lasiophyllus* (Hook. & Arn.) Payson
Native, cool season annuals. Scattered along the banks of the West Branch. Observed as dry plants, some capsules intact and a seed packet saved.
K.Mauz, Obs.

*Descurainia pinnata* (Walt.) Britton. Tansy mustard.
‡ Native, cool season annuals. Scattered along the banks of the West Branch. Observed as dry plants, some capsules intact and a seed packet saved..
K.Mauz, Obs.

*Lepidium lasiocarpum* Nutt. ex Torr. & A. Gray
Native, cool season annuals. Scattered along the banks of the West Branch. Observed as dry plants.
K.Mauz, Obs.

*Lesquerella gordonii* (A. Gray) S. Watson. Bladderpod.
Native, cool season annuals. Scattered along the banks of the West Branch. Observed as dry plants.
K.Mauz, Obs.

*Matthiola longipetala* (Vent.) de Candolle. Evening stock.
‡ * Non-native, cool season annuals. Scattered on disturbed ground and fill dirt, populations apparently localized. Observed as dry plants and tumbleweeds, capsules and seeds collected.
K.Mauz, Obs.

*Sisymbrium irio* L. London rocket.
* Non-native, cool season annuals. Common, abundant on the floodplain and persistent as dry plants through the summer. Observed as dry plants.
K.Mauz, Obs.

CACTACEAE

*Cylindropuntia arbuscula* Engelm. Pencil cholla.
Native stem succulent, flowering in the spring. One plant observed under a mesquite on a cutbank of the West Branch. SR
K.Mauz, Photo

*Cylindropuntia leptocaulis* de Candolle. Christmas cholla.
Native stem succulent, flowering in warmer weather. Scattered, growing under shrubs or trees, occasionally in the open on the floodplain. SR
K.Mauz, Photo

*Cylindropuntia spinosior* (Engelm.) Toumey. Cane cholla.
Native stem succulent, flowering in late spring. Uncommon, but locally abundant where these occur on the floodplain. SR
K.Mauz 21-095 (stem segment and fruit), Photo (plant)

*Opuntia ficus-indica* (L.) Miller. Nopal.
* Non-native stem succulent, flowering in spring. A few plants observed widely scattered along the West Branch channel, escaped from cultivation.
K.Mauz, Photo

*Opuntia microdasys* (Lehm.) Pfeifl. Bunny ears cactus.
* Non-native stem succulent, flowering in the spring. A small cluster of plants, probably escaped from neighboring housing, on the bank of the West Branch.
K.Mauz, Photo

*Opuntia phaeacantha* Engelm. Prickly pear.
Native stem succulent, flowering in late spring. Uncommon, widely scattered individuals on the floodplain and on the banks of the West Branch. SR
K.Mauz 21-096 (fruit), Photo (plant)

CAPPARACEAE

*Polanisia trachysperma* Torr. & A. Gray.
Western clammyweed.
Native, warm season annuals. Uncommon, scattered on the floodplain, occasionally in the wash channel.
K.Mauz 21-039

CARYOPHYLLACEAE

*Silene* sp. Catchfly.
Native, cool season annuals. Locally common along the margins of the West Branch and Church Wash diversion. Observed as dry plants in the field
K.Mauz, Obs.

CHENOPODIACEAE

*Atriplex canescens* (Pursh) Nutt. Four-wing saltbush.
‡ Native shrubs, fruiting in the warm season. Not common, scattered along the edges of the floodplain.
K.Mauz 21-059

*Atriplex elegans* (Moq.) Dietr. Wheelscale.
Native, non-seasonal annuals. Common on the floodplain.
K.Mauz 21-060

*Atriplex linearis* S. Watson
Native shrubs, fruiting in the summer. Locally common on flats bordering the old Church Wash channel on the west.
K.Mauz 21-126

*Atriplex polycarpa* (Torr.) S. Wats. Allscale.
‡ Native shrubs, fruiting in the summer. Scattered on the floodplain and on drier wash margins.
K.Mauz 21-061

*Atriplex wrightii* S. Watson
Native, summer annuals. Common, widespread on the floodplain and along the Church Wash diversion.
K.Mauz 21-040

*Chenopodium watsoni* A. Nels.
Native, warm season annuals. Scattered along the banks and in the channel of the West Branch.
K.Mauz 21-041 (vegetative) and 21-090 (fruit)

*Salsola tragus* L. Russian thistle.
* Non-native, warm season annuals. Common on the floodplain.
K.Mauz, Obs.

*Suaeda moquinii* (Torr.) Greene. Desert seepweed.
‡ Native, semi-succulent shrubs, flowering in summer. Uncommon, scattered on the Church Wash diversion and old Church Wash east channel.
K.Mauz 21-114

CONVOLVULACEAE

*Cuscuta umbellata* H.B.K. Dodder.
Native, parasitic herbs on summer annuals. Growing on *Salsola tragus* and *Atriplex elegans* on the floodplain near the Church Wash diversion. NWR
K.Mauz 21-136

*Ipomoea hederacea* Jacq. Ivy-leaf morning glory.
‡ Native, warm season annual vines. Common, scattered all along the West Branch channel and margins. NWR
K.Mauz 21-120

CUCURBITACEAE

*Cucurbita digitata* A. Gray. Coyote gourd.
Native, perennial vines flowering in the summer. Widely scattered on the wash margin and under the mesquite canopy along the West Branch. K.Mauz 21-134

EUPHORBIACEAE

*Euphorbia abramsiana* Wheeler
Native, warm-season annuals. Common, growing abundantly on fill and floodplain areas.
K.Mauz 21-117

*Euphorbia capitellata* Engelm.
Native, herbaceous perennial flowering in the warm season. Uncommon?, growing on the margin of the West Branch channel.
K.Mauz 21-079

*Euphorbia heterophylla* L. Painted spurge.
Native, late summer annuals. Common, growing scattered along the banks and edges of wash channels.
K.Mauz 21-105

*Euphorbia hyssopifolia* L.
‡ Native, warm season annuals. Scattered along the margins of the West Branch.
K.Mauz, 21-110

*Euphorbia pediculifera* Engelm.
Native, non-seasonal, short-lived perennial herbs. Growing scattered on the banks of the West Branch.
K.Mauz 21-139

FABACEAE

*Acacia greggii* A. Gray. Catclaw acacia.
‡ Native shrubs, flowering in the cool season. Common, scattered along the West Branch.
K.Mauz, Obs.

*Medicago sativa* L. Alfalfa.
* Non-native, non-seasonal perennial herbs. Widely scattered along the Church Wash diversion and the West Branch amid Bermuda grass.
K.Mauz 21-099

*Melilotus indicus* (L.) All. Yellow sweet clover.
‡ * Non-native, cool season annuals. Common?, scattered along the margins of the West Branch. Observed as dry plants, identified from fruit.
K.Mauz, Obs.

*Parkinsonia aculeata* L. Mexican palo verde.
Native trees, flowering in warmer weather. Common, scattered along the margins of the West Branch.
K.Mauz 21-094

*Parkinsonia florida* (Benth. ex A. Gray) S. Watson. Blue palo verde.
Native trees, flowering in late spring. Uncommon?, scattered along the margins of the West Branch. SA
K.Mauz, Obs.

*Prosopis glandulosa* Torr. var. *glandulosa*. Honey mesquite.
Native to southeastern Arizona and east to Texas. A few trees planted along the Church Wash diversion. SA, HR
K.Mauz 21-044

*Prosopis velutina* Woot. Velvet mesquite.
‡ Native trees, flowering in the spring. Common, trees to several meters tall forming a dense bosque-like forest along much of the West Branch, smaller trees scattered on the floodplain. SA, HR
K.Mauz, Obs.

HYDROPHYLLACEAE

*Phacelia ambigua* M. E. Jones. Caterpillar plant.
Native, cool season annuals. Scattered on the margins of the West Branch. Observed as dry plants, identified from seeds.
K.Mauz, Obs.

KOEBERLINIACEAE

*Koeberlinia spinosa* Zucc. All-thorn.
‡ Native shrubs, flowering in summer. Uncommon,

widely scattered at the edges of the floodplain.
K.Mauz, Photo

LAMIACEAE

*Salvia columbariae* Benth. Chia.
Native, cool season annuals. Uncommon?, observed as a single cluster of dry plants on the floodplain.
K.Mauz, Obs.

MALVACEAE

*Abutilon incanum* (Link) Sweet. Indian mallow.
Native, perennial herbs, flowering in warmer weather. Uncommon, growing on the banks of the West Branch.
K.Mauz 21-111

*Malva parviflora* L. Cheeseweed.
‡ * Non-native, non-seasonal annuals. Scattered in the mesquite forest and along wash margins. Observed as dry plants and as seedlings around a pond on the old Church Wash.
K.Mauz, Obs.

*Rhyncosida physocalyx* (A. Gray) Fryxell
Native, perennial herbs flowering in the warm season. Common, scattered in the mesquite forest and on the margins of the West Branch, very occasional on the floodplain. Corollas pale orange.
K.Mauz 21-045

*Sphaeralcea laxa* Woot. & Standl. Caliche globe mallow.
Native, perennial herbs or shrubby, flowering in the summer. Scattered along the banks of the West Branch and on the floodplain. Corollas deep orange.
K.Mauz 21-071

MARTYNIACEAE

*Proboscidea parviflora* (Woot.) Woot. & Standl. Devil's claw.
‡ Native, war-season annuals. Common, scattered on the floodplain. Corollas lavender.
K.Mauz 21-106

MORACEAE

*Morus alba* L. Mulberry.
* Non-native trees, probably escaped from landscaping. One individual along the old Church Wash channel.
K.Mauz 21-072

NYCTAGINACEAE

*Allionia incarnata* L. Trailing four-o'clock.
Native, perennial herbs, flowering year-round. Uncommon?, one plant observed on the bank of the West Branch.
K.Mauz 21-085

*Boerhavia coccinea* Mill. Red spiderling.
‡ Native, perennial herbs, flowering in warmer weather. Scattered on the banks of the West Branch.
K.Mauz 21-084

*Boerhavia erecta* L. Spiderling.
Native, warm-season annuals. Common, growing widespread on the floodplain.
K.Mauz 21-091

*Boerhavia watsoni* Standl. Spiderling.
‡ Native, summer annuals. Plants common, scattered on the floodplain. Flowers white.
K.Mauz 21-109

*Commicarpus scandens* (L.) Standl. Bush spiderling.
Native, perennial herbs, flowering in the summer. Scattered under shrubs on the floodplain and in the mesquite forest.
K.Mauz 21-123

ONAGRACEAE

*Camissonia californica* (Nutt. ex Torr. & A. Gray) P. Raven
Native, cool season annuals. Scattered along the margins of the West Branch. Observed as dry plants, a seed packet saved.
K.Mauz 21-066

*Camissonia chamaenerioides* A. Gray
Native, cool season annuals. Uncommon?, scattered along the margins of the West Branch. Observed as dry plants, a seed packet saved.
K.Mauz 21-080

*Gaura parviflora* Dougl. Lizard tail.
‡ Native, cool-season annuals. Scattered along the margins of the West Branch, occasionally straggling up into lower tree branches in the mesquite forest. Observed as dry plants, fruit collected and saved.
K.Mauz, Obs.

PLANTAGINACEAE

*Plantago ovata* Forsskal. Indian wheat.
Native, cool season annuals. Scattered on the floodplain. Observed as dry plants.
K.Mauz, Obs.

*Plantago patagonica* Jacq. Pursh plantain.
Native, cool season annuals. Scattered on the floodplain and the margins of the West Branch. Observed as dry plants.
K.Mauz, Obs.

POLEMONIACEAE

*Eriastrum* sp.
Native, cool season annuals. Scattered on the floodplain. Observed as dry plants.
K.Mauz, Obs.

POLYGONACEAE

*Eriogonum abertianum* Torr. Wild buckwheat.
Native, non-seasonal annuals. Uncommon?, widely scattered on the floodplain and margins of the West Branch.
K.Mauz 21-053 and 21-57

*Eriogonum deflexum* Torr. Skeleton weed.
Native, perennial herbs, flowering in warmer weather. Uncommon, growing on the margin of the West Branch channel.
K.Mauz 21-081

*Polygonum argyrocoleon* Steud. ex Kunze. Silversheath knotweed.
* Non-native, perennial herbs, flowering in warmer weather or non-seasonal. Abundant around a pond on the old Church Wash; not observed elsewhere.
K.Mauz 21-075

*Rumex crispus* L. Curly-leaf dock.
‡ * Non-native, cool season annuals. Uncommon?, growing on the margin of the West Branch channel. Observed as a dry plant, identified from seeds and a seed packed saved. ASL
K.Mauz, Obs.

RESEDACEAE

*Oligomeris linifolia* (Vahl.) Macbr. Linearleaf cambess.
‡ Native, cool season annuals. Common, scattered on the floodplain. Observed as dry plants in the field
K.Mauz, Obs.

RHAMNACEAE

*Zizyphus obtusifolia* (Hook. ex Torr. & A. Gray) A. Gray
Graythorn.
‡ Native shrubs, flowering in the warm season. Common, scattered throughout the understory of the mesquite forest along the West Branch, occasional on the floodplain.
K.Mauz 21-054

SCROPHULARIACEAE

*Maurandya antirrhinifolia* Humb. & Bonpl.
Snapdragon vine.
Native, perennial vines, flowering in the summer. Common, climbing on shrubs in the understory of the mesquite forest and along the margins of the West Branch.
K.Mauz 21-055

*Penstemon* sp. Beardtongue.
Native, perennial herbs, flowering in the cool season. Scattered along the margins of the West Branch.
K.Mauz 21-056

*Veronica peregrina* L. Necklace weed.
‡ Native, cool season annuals. Scattered in the understory of mesquite along the old Church Wash channel. Observed as dry plants.
K.Mauz, Obs.

SOLANACEAE

*Lycium andersonii* A. Gray. Anderson wolfberry.
‡ Native shrubs, flowering in summer or with rain. Common, scattered in the understory of the mesquite forest, along the margins of washes, and occasionally on the floodplain.
K.Mauz 21-076

*Lycium fremontii* A. Gray. Fremont wolfberry.
‡ Native shrubs, flowering in the spring. Common, scattered in the understory of the mesquite forest and

along the margins of washes.
K.Mauz, Obs.

*Nicotiana obtusifolia* Martens & Galeotti. Desert tobacco.
‡ Native, perennial herbs, flowering year-round with rain. Scattered along the margins of the West Branch.
K.Mauz 21-133

*Physalis acutifolia* (Miers) Sandwith.
Sharpleaf ground-cherry.
‡ Native, summer annuals. Scattered on the floodplain in dense patches of other herbs.
K.Mauz 21-122

*Solanum elaeagnifolium* Cav. Silverleaf nightshade.
‡ Native, perennial herbs, flowering in the warm season. Locally common, growing in the understory in places and on the floodplain.
K.Mauz, Obs.

TAMARICACEAE

*Tamarix aphylla* L. Athel saltcedar.
* Non-native trees, flowering year-round. Occurring in residential settings and occasional on the floodplain, not observed growing adventitiously along the West Branch.
K.Mauz 21-115

VISCACEAE

*Phoradendron californicum* Nutt. Desert mistletoe.
Native epiphytic parasite on leguminous trees, fruiting in the cool season. Scattered throughout the mesquite forest along the West Branch.
K.Mauz, Obs.

ZYGOPHYLLACEAE

*Kallstroemia californica* (S. Watson) Vail
‡ Native, warm-season annuals. Uncommon, one plant photographed on the margin of the West Branch channel.
K.Mauz, Photo

*Kallstroemia grandiflora* Torr. ex A. Gray. Summer poppy.
‡ Native, warm season annuals. Scattered along the wash margins and occasional on the floodplain.
K.Mauz 21-098

*Larrea divaricata* Cav. subsp. *tridentata* (de Candolle) Felger & Lowe. Creosotebush.
Native shrubs, flowering with rains. Uncommon, one plant growing on fill southeast of the intersection of Silverlake and Mission Roads.
K.Mauz, Obs.

*Tribulus terrestris* L. Goat-head, puncture vine.
‡ * Non-native, warm-season annuals. Scattered on the Church Wash diversion, apparently uncommon.
NWR, RRNW
K.Mauz 21-119

**Monocotyledons**

POACEAE

*Aristida purpurea* Nutt. var. *longiseta* Vasey
Native perennials, flowering in the summer. Uncommon?, a few bunches observed on the bank of the West Branch.
K.Mauz 21-089

*Aristida purpurea* Nutt. var. *nealleyi* (Vasey) Allred
Native perennials, flowering in the summer. Locally common, growing in coarse soil on the floodplain.
K.Mauz 21-048

*Aristida ternipes* Cav. var. *gentilis* (Henrard) Allred.
Three-awned spider grass.
Native perennials, flowering in the summer.
Scattered, growing on the margins of washes.
K.Mauz 21-049

*Aristida ternipes* Cav. var. *ternipes*. Spider grass.
Native perennials, flowering in the summer.
Scattered on fill, possibly more common.
K.Mauz 21-118

*Arundo donax* L. Giant-reed.
‡ * Non-native perennials, woody grass flowering in late summer-fall. One clump south of Silverlake Road.
K.Mauz, Obs.

*Avena fatua* L. Wild oat.
‡ * Non-native, cool season annuals. Widely scattered, growing on the margins of washes.

Observed as dry plants.
K.Mauz, Obs.

*Bouteloua aristidoides* (H.B.K.) Griesb.
Native, summer annuals. Growing scattered on coarse fill dirt near Silverlake and Mission Roads.
K.Mauz, Obs.

*Bouteloua rothrockii* Vasey. Rothrock grama.
Native, short-lived perennials, flowering in the summer. Scattered, growing on coarse fill.
K.Mauz 21-113

*Brachiaria arizonica* (Scribn. & Merr.) Blake.
Arizona Panic grass.
Native, warm-season annuals. Uncommon?, growing in gravel in the West Branch channel, scattered on the floodplain and on fill.
K.Mauz 21-108

*Brachiaria fasciculata* (Swartz) Parodi
‡ Native, summer annuals. Plants locally common along the old Church Wash channel, not seen elsewhere.
K.Mauz 21-120

*Bromus carinatus* Hook. & Arn. Arizona brome.
‡ Native, cool season annuals. Scattered in the understory of the mesquite forest along the West Branch and the old Church Wash.
K.Mauz 21-073

*Bromus catharticus* Vahl.
‡ * Non-native, cool season annuals. Scattered in the understory of the mesquite forest along the West Branch and the old Church Wash. Identified from dry plants with intact spikelets.
K.Mauz 21-050

*Bromus rubens* L. Red brome.
‡ * Non-native, cool season annuals. Uncommon?, plants observed in two places near the Church Wash diversion and on the old Church Wash.
K.Mauz, Obs.

*Chloris crinita* (Lag.) Parodi. Feather fingergrass.
‡ Native perennials, flowering in the summer. Common, scattered on the floodplain.
K.Mauz 21-074

*Cynodon dactylon* L. Bermuda grass.
‡ * Non-native perennials, flowering in spring and summer. Ubiquitous along wash margins.
K.Mauz, Obs.

*Dactylotenium aegyptium* (L.) Richt. Crowfoot grass.
* Non-native, warm-season annuals. Growing abundantly along parts of the Church Wash diversion.
K.Mauz 21-119

*Digitaria insularis* (L.) Mez ex Eckman. Sourgrass.
Native perennials, flowering in late summer. Uncommon?, growing on the floodplain near to the mesquite forest.
K.Mauz 21-132

*Echinochloa colonum* (L.) Link. Junglerice.
‡ * Non-native, warm-season annuals. Locally common around the toad pond on old Church Wash, not seen elsewhere.
K.Mauz 21-124

*Eragrostis cilianensis* (All.) Link. Stinkgrass.
‡ * Non-native, warm season annuals. Widely scattered or uncommon, growing on the bank of the West Branch.
K.Mauz 21-086

*Eragrostis lehmanniana* Nees. Lehmann's lovegrass.
* Non-native, warm-season annuals. Scattered along the bank of the lower West Branch and on the Church Wash diversion.
K.Mauz 21-101

*Eriochloa aristata* Vasey. Bearded cupgrass.
‡ Native, warm-season annuals. Scattered on the floodplain in patches of other herbs.
K.Mauz 21-124

*Eriochloa acuminata* (Presl) Kunth var. *acuminata*.
Southwestern cupgrass.
Native, warm-season annuals. Locally abundant on the Church Wash diversion.
K.Mauz 21-120

*Heteropogon contortus* (L.) Beauv. Tanglehead.
Native perennials, flowering in summer. Uncommon, on the bank of the West Branch channel.
K.Mauz 21-138

*Hordeum murinum* L. subsp. *glaucum* (Steud.) Tzvelev.
Wild barley.
‡ * Non-native, cool season annuals. Common, sometimes locally abundant, growing in the

understory of the mesquite forest and on the floodplain. Identified from dry plants with inflorescences intact.
K.Mauz 21-051

*Hordeum pusillum* Nutt.
‡ Native, cool-season annuals. Growing in heavy soil in an enhanced swale on the West Branch of the Santa Cruz, among *H. murinum*.
A.Harlan AH-01-02

*Hordeum vulgare* L. Common barley.
* Non-native, cultivated annual crop and occasional escape. A few plants near the toad pond on the old Church Wash channel.
K.Mauz, Obs.

*Leptochloa fusca* (L.) H.B.K. subsp. *uninervia* (Presl) N. Snow. Mexican sprangletop.
‡ Native, warm season annuals. Locally common along the Church Wash diversion.
K.Mauz 21-067

*Leptochloa viscida* (Scribn.) Beal. Sticky sprangletop.
‡ * Non-native, summer annuals. Growing in wet ground around the toad pond on the old Church Wash channel.
K.Mauz 21-125

*Melinis repens* (Willdenow) Zizka subsp. *repens*. Natal grass.
* Non-native perennials, flowering in the warm season. Uncommon on the banks of the West Branch.
K.Mauz 21-068

*Panicum antidotale* Retz. Giant panic grass.
* Non-native perennials, flowering in the summer. Uncommon?, scattered along the margin of the West Branch channel.
K.Mauz 21-046

*Panicum stramineum* Hitchc. & Chase. Witchgrass.
Native, warm-season annuals. Scattered along the Church Wash diversion, not seen elsewhere.
K.Mauz 21-121

*Pappophorum vaginatum* Buckley. Pappus grass.
‡ Native, warm season annuals. Scattered along the West Branch and the Church Wash diversion.
K.Mauz 21-052

*Pennisetum ciliare* (L.) Link. Buffel grass.
* Non-native perennials, flowering in the warm season. Scattered along wash margins and occasional on the floodplain.
K.Mauz, Obs.

*Phalaris caroliniana* Walt. Carolina canary grass.
‡ * Non-native, cool season annuals. Widely scattered along the margins of the West Branch and in the forest understory. Identified from dry plants with intact spikelets and seeds present.
K.Mauz, Obs.

*Poa bigelovii* Vasey. Bigelow's bluegrass.
‡ Native, cool season annuals. Scattered on the floodplain. Identified from dry plants; seed packet saved.
K.Mauz, Obs.

*Setaria macrostachya* H.B.K. Plains bristlegrass.
‡ Native perennials, flowering in the warm season. Scattered along the banks of the West Branch
K.Mauz 21-069

*Sorghum halepense* (L.) Pers. Johnson grass.
‡ * Non-native perennials, flowering in warmer weather. Large bunches scattered along the West Branch, occasional on the floodplain. ASL
K.Mauz, Obs.

*Sporobolus airoides* (Torr.) Torr. Alkali sacaton.
‡ Native perennials, flowering in summer. Large bunches scattered along the old Church Wash channel, not seen elsewhere.
K.Mauz 21-131

*Sporobolus cryptandrus* (Torr.) A. Gray. Sand dropseed.
Native perennials, flowering in the summer. Uncommon?, large bunches scattered on the floodplain.
K.Mauz 21-107

*Vulpia octoflora* (Walt.) Rydb. var. *octoflora*. Six-weeks fescue.
Native, cool season annuals. Common? on the floodplain. Identified from dry plants with intact

spikelets.
K.Mauz, Obs.

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Appendix. Thornber's taxonomic list

Thornber, J. J. (1909) Vegetation groups of the Desert Laboratory Domain. In *Distribution and Movements of Desert Plants*, V. M. Spalding, ed., pp.103-112. Publication 113, Carnegie Institution of Washington, Washington, D.C.

Plants occurring in Zones III and IV (including those whose primary occurrence is in Zone I or II), and Miscellaneous Introduced Species (Thornber 1909), arranged alphabetically by family:

**Acanthaceae**
*Ruellia clandestina* L.
**Aizoaceae**
*Trianthema portulacastrum* L.
**Amaranthaceae**
*Amaranthus blitoides* Wats.
*Amaranthus graecizans* L.
*Amaranthus palmeri* Wats.
*Cladothrix lanuginosa* Nutt.
**Apiaceae**
*Hydrocotyle ranunculoides* L.
**Asclepiadaceae**
*Asclepias galioides* Kunth.
*Philibertella cynanchoides* (A. Gray) Vail
*Philibertella hartwegii* Vail var. *heterophylla* (Engelm.) Vail
**Asteraceae**
*Actinolepis lanosa* A. Gray
*Ambrosia aptera* DC.
*Anthemis cotula* L.
*Aster exilis* Ell.
*Aster hebecladus* DC.
*Aster incanus* (Lindl.) A. Gray
*Aster parviflorus* A. Gray
*Aster spinosus* Benth.
*Baccharis viscosa* Ruiz & Pavon
*Baeria gracilis* (DC.) A. Gray
*Centaurea melitensis* L.
*Conyza coulteri* A. Gray
*Eclipta alba* (L.) Haussk.
*Erigeron canadensis* L.
*Erigeron divergens* Torr. & A. Gray
*Franseria tenuifolia* (A. Gray)
*Guttierezzia microcephala* (DC.) A. Gray
*Helenium thurberi* A. Gray
*Helianthus annuus* L.
*Helianthus petiolaris* Nutt.
*Hemizonia fitchii* A. Gray
*Hemizonia wrightii* A. Gray
*Heterotheca subaxillaris* (Lam.) Britton & Rusby
*Hymenothrix wislizeni* A. Gray
*Isocoma hartwegii* (A. Gray) Greene
*Matricaria matricarioides* (Less.) Porter
*Parthenice mollis* A. Gray
*Pluchea sericea* (Nutt.) Coville
*Solidago canadensis* L. var. *arizonica* A. Gray
*Sonchus asper* (L.) All.
*Sonchus oleraceus* L.
*Stephanomeria exigua* Nutt.
*Verbesina encelioides* (Cav.) B. & H.
*Xanthium commune* Britton
**Brassicaceae**
*Brassica nigra* (L.) Koch
*Capsella bursa-pastoris* (L.) Medic.
*Lepidium* sp.
*Lepidium thurberi* Wooton.
*Matthiola bicornis* (Sibth.) DC.
*Roripa nasturtium* (L.) Rusby
*Sisymbrium canescens* Nutt.
*Sisymbrium incisum* Engelm.
**Capparaceae**
*Wislizenia refracta* Engelm.
**Caprifoliaceae**
*Sambucus mexicana* Presl
**Caryophyllaceae**
*Silene gallica* L.
**Chenopodiaceae**
*Atriplex bracteosa* Wats.
*Atriplex canescens* (Pursh) James
*Atriplex polycarpa* (Torr.) S. Wats.
*Atriplex* sp.
*Atriplex texana* S. Wats.
*Chenopodium album* L.
*Chenopodium fremontii* Wats.
*Chenopodium leptophyllum* Nutt.
*Chenopodium murale* L.
*Monolepis nuttalliana* (R. & S.) Wats.
*Suaeda moquini* (Torr.) Greene
*Suaeda suffrutescens* S. Wats.
**Convolvulaceae**
*Convolvulus arvensis* L.
*Cuscuta salina* Engelm.

*Ipomoea coccinea* L.
*Ipomoea hederacea* Jacq.
*Ipomoea purpurea* (L.) Roth.
**Cyperaceae**
*Cyperus aristatus* Rottb.
*Cyperus esculentus* L.
*Cyperus ferax* Rich.
**Euphorbiaceae**
*Euphorbia albomarginata* Torr. & A. Gray
*Euphorbia preslii* Guss.
**Fabaceae**
*Acacia filiculoides* (Cav.) Trelease
*Acacia greggii* A. Gray
*Hoffmanseggia stricta* Benth.
*Medicago hispida* Gaertn.
*Melilotus indica* (L.) All.
*Poinciana pulcherima* Sw. var. flava
*Prosopis odorata* Torr. & Frém.
*Prosopis velutina* Woot.
**Geraniaceae**
*Erodium cicutarium* (L.) L'Hér.
**Hydrophyllaceae**
*Nama hispida* A. Gray
**Juglandaceae**
*Juglans major* (Torr.) Heller
**Koberliniaceae**
*Koeberlinia spinosa* Zucc.
**Lamiaceae**
*Marrubium vulgare* L.
*Teucrium canadense* L. var. *angustatum* A. Gray
*Teucrium cubense* L.
**Loasaceae**
*Mentzelia wrightii* A. Gray
**Malvaceae**
*Anoda cristata* (L.) Schlecht
*Malva parviflora* L.
*Malvastrum exile* A. Gray
*Sida lepidota* A. Gray var. *sagittaefolia* A. Gray
*Sphaeralcea coulteri* (Wats.) A. Gray
*Sphaeralcea cuspidata* (A. Gray) Britton
**Martyniaceae**
*Martynia* sp.
**Nyctaginaceae**
*Boerhavia pterocarpa* S. Wats
*Boerhavia viscosa* Lag. var. *oligadena* Heimerl.
*Boerhavia watsoni* Standley
**Oleaceae**
*Fraxinus velutina* Torr.
**Onagraceae**
*Gaura parviflora* Dougl.
**Onagraceae**
*Oenothera rosea* Ait.
*Platystemon californicus* Benth.
**Plantaginaceae**
*Plantago major* L.
**Poaceae**
*Agrostis verticillata* Vill.
*Arundo donax* L.
*Avena fatua* L.
*Bromus carinatus* Hook. & Arn. var. *arizonicus* Shear
*Bromus maximus* Desf.
*Bromus rubens* L.
*Bromus uniloides* (Willd.) Kunth
*Chloris elegans* Kunth.
*Cynodon dactylon* L.
*Digitaria sanguinalis* (L.) Scop.
*Distichlis spicata* (L.) Greene
*Echinochloa colona* (L.) Link var. zonale Guss.
*Echinochloa colonum* (L.) Link
*Echinochloa crus-galli* (L.) Beauv.
*Elymus triticoides* Buckley
*Eragrostis megastachya* (Koeler) Link.
*Eragrostis neomexicana* Vasey.
*Eragrostis pilosa* (L.) Beauv.
*Eriochloa punctata* (L.) W. Hamilt.
*Festuca myuros* L.
*Hordeum murinum* L.
*Hordeum pusillum* Nutt.
*Lamarckia aurea* (L.) Moench.
*Leptochloa filiformis* (Lam.) Beauv.
*Leptochloa imbricata* Thurb.
*Leptochloa viscida* (Scribn.) Beal
*Lolium tementulum* L.
*Muhlenbergia porteri* Scribner
*Panicum capillare* L.
*Panicum fuscum* Swartz
*Panicum obtusum* H.B.K.
*Pappophorum apertum* Munro
*Paspalum distichum* L.
*Phalaris caroliniana* Walt.
*Poa annua* L.
*Poa bigelovii* Vasey & Scribn.
*Polypogon monspeliensis* (L.) Desf.
*Setaria composita* H.B.K.
*Sorghum halepense* (L.) Pers.
*Sporobolus wrightii* Monro
*Trichloris fasciculata* Fourn.
**Polemoniaceae**

*Gilia chamissonis* Greene
**Polygonaceae**
*Polygonum aviculare* L. var. *littorale* (Link) Koch
*Polygonum lapathifolium* L.
*Rumex berlandieri* Meisner
*Rumex crispus* L.
*Rumex hymenosepalus* Torr.
**Portulacaceae**
*Portulaca oleracea* L.
*Portulaca retusa* Engelm.
**Potomogetonaceae**
*Potomogeton pusillus* L.
**Primulaceae**
*Androsace occidentalis* Pursh
*Samolus floribundus* Kunth.
**Ranunculaceae**
*Clematis ligusticifolia* Nutt.
*Myosurus minimus* L.
**Resedaceae**
*Oligomeris glaucescens* Camb.
**Rhamnaceae**
*Condalia lycioides* (A. Gray) Weberbaur
*Condalia spathulata* A. Gray
**Rubiaceae**
*Cephalanthus occidentalis* L.
**Salicaceae**
*Populus fremontii* S. Wats.
*Salix nigra* Marsh
*Salix* sp.
**Sapindaceae**
*Sapindus drummondii* Hook. & Arn.
**Scrophulariaceae**
*Maurandia antirrhiniflora* (Poir.) Willd.
*Veronica peregrina* L.
**Solanaceae**
*Chamaesaracha coronopus* (Dunal) A. Gray
*Datura meteloides* DC.
*Lycium andersonii* A. Gray var. *wrightii* A. Gray
*Lycium fremontii* A. Gray var. *gracilipes* A. Gray
*Lycium torreyi* A. Gray
*Nicotiana glauca* Graham
*Nicotiana trigonophylla* Dunal
*Petunia parviflora* Juss.
*Physalis angulata* L. var. *linkiana* (Nees.) A. Gray
*Physalis lobata* Torr.
*Physalis longifolia* Nutt.
*Solanum douglasii* Dunal
*Solanum elaeagnifolium* Cav.
**Ulmaceae**
*Celtis mississippiensis* Bosc. var. *reticulata* (Torr.) Sargent
**Verbenaceae**
*Verbena canescens* Kunth
**Vitaceae**
*Psedera vitacea* (Knerr) Greene
*Vitis arizonica* Engelm.
**Zanichelliaceae**
*Zannichella palustris* L.
**Zygophyllaceae**
*Kallstroemia brachystylis* Vail.
*Kallstroemia grandiflora* Torr.
*Tribulus terrestris* L.