

# Santa Cruz River at Canoa Ranch Photo Monitoring



2002



2004



2006



2002



2004



2006

Field Work Dates  
June 20-21, 2006

by  
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Pima County  
Natural Resources,  
Parks and Recreation

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*Cover: Two sets of photographs taken in 2002, 2004, and 2006 show vegetation and channel changes along the Santa Cruz River at Canoa Ranch. (Photo points 12 West and 16 North.)*

# INTRODUCTION

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*Changes in the vegetation and channel along the Santa Cruz River are of intense regional interest.*

Pima County purchased Canoa Ranch in 2001 for historical and cultural preservation, as well as for open-space protection. Canoa Ranch totals 4,800 acres. Pima County Regional Flood Control District took ownership of the portions most susceptible to flooding. Roughly, 1,300 acres are within the floodway. The Santa Cruz River at Canoa Ranch is primarily ephemeral, though in most years effluent flow from the Nogales Wastewater Facility reaches Canoa Ranch during the winter. Historic straightening, berming, and removal of vegetation due to ranching and flood control activities have compromised floodplain functions along this reach. Groundwater pumping in the area has reduced the availability of surface water, though groundwater is generally less than 50 feet below the surface at the south edge of the ranch. In this area, riparian plant species such as Fremont cottonwood, Goodding willow, and seep willow are present along the Santa Cruz River.

Pima County Regional Flood Control District is monitoring vegetation and channel changes along the Santa Cruz River because a change in floodplain vegetation is of intense regional interest. The presence of vegetation roughness in the floodplain helps to reduce flood peaks downstream by slowing down and spreading out the flows. Groundwater recharge and reduction of the peak flows are some of the most important ecosystem functions provided by Canoa Ranch to Green Valley. In order to document changes in floodplain vegetation and the location of river banks, the District established a baseline condition along the Santa Cruz River at Canoa Ranch in 2002. While regional aerial photography will be available for documenting major changes in the flow path of the Santa Cruz River every two years, aerial photographs alone cannot provide information about change in vegetation roughness. Rather, ground photographs are useful for documenting and detecting this change.

In 2002, photo points were established for baseline conditions for Canoa Ranch along the Santa Cruz River. In June 2004 and 2006, Pima County Water Resources staff repeated the photo monitoring effort to document any changes that had occurred between each two-year period. The following report and attached photographs document the 2006 photo-monitoring effort in Canoa Ranch.

# METHODS

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In 2002, Environmental Planning Group (EPG) established 20 photo points at Canoa Ranch; 17 points in the channel or on the banks of the Santa Cruz River and 3 points in upland sites between the river and the railroad right-of-way on the east side of the river (EPG, 2002).

According to EPG (2002), the procedure for establishing the 2002 baseline was as follows:

*At each photo point, a length of 1/4-inch rebar was driven into the ground. After the photo point was marked, the location was recorded in UTM's using a Garmin 12CX GPS receiver. Compass bearings in each cardinal direction from the rebar center point were then taken and a 50-meter transect was laid out from the center point along each cardinal bearing. At the end of each transect, another length of 1/4-inch rebar was driven into the ground. Transect centerlines were marked with braided nylon mason's twine. A tripod-mounted 35mm camera (Nikon F2A) with a 55mm lens was placed directly over the rebar center point and one photograph was taken along each transect line, for a total of four photographs per photo point. Photographs were made on Fujicolor 400 ASA color print film.*

EPG biologists also measured the distance from the center of the photo point to the nearest bank of the Santa Cruz River. This measurement was not taken at all 20 photo points. Three photo points on the east side of the river were 300 or more feet from the eastern bank of the river and the distance to river bank measurement was not taken. Two other photo points were in the river channel proper and the distance from the center point to the bank was not measured.

Using GIS technology, photo point locations were placed on an orthophotoquad of the Canoa Ranch. (EPG, 2002)

For the 2006 survey, a tripod-mounted digital camera was used. Using the UTM coordinates from 2004,

a GPS unit was used to find the 20 photo points. Photos were taken in the cardinal directions, for a total of four photos for each photo point. The direction of our photos was aligned using the photos taken in 2002 and 2004. Photographs were printed on Fujicolor Crystal Archive paper.

The 2006 digital photographs were downloaded into the computer, and then each photo was cut and paste so that the 2002, 2004, and 2006 years were side by side. This was done to allow broader access to the photographs (Appendix A).

We measured the distance from the center of the photo point to the nearest bank of the Santa Cruz River. The intent of this measurement was to detect whether the bank was experiencing degradation or aggradation over time. In 2006, staff reviewed the hydrology of the site. This was done by reviewing rainfall records from the area, the annual flow of the Santa Cruz River at that point, and several well hydrographs.

# EFFORT

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The photo monitoring effort took two staff members a full two days to locate and document all 20 sites at Canoa Ranch. The orthophoto map with the GIS overlay of the photo points was necessary, as well as a GPS unit to locate the rebar center-point stakes. It proved helpful to have a second camera available as a backup to the tripod mounted camera. A color copy of the original photographs was used to properly set up and orient the photographs in the field.

# EQUIPMENT

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The following equipment is needed for this survey:

- 1 35-mm camera with a 50-mm lens
- 1 camera tripod
- 1 digital camera (for backup – proved useful in 2004 and 2006)
- 1 GPS unit
- 1 measuring tape, at least 100' in length
- 1 compass
- Color-copies of the original photographs
- Aerial orthophoto of Canoa Ranch showing approximate locations of Photo Points
- Copy of the UTM Coordinates for the 20 Photo Points
- Field forms to note any changes between “now and then” photographs

1/4-inch ebar may be needed to replace rebar buried by debris at certain photo points.

Photo Point Number	Northing	Easting
1	3512348	0496718
2	3512845	0496584
3	3513314	0497096
4	3513720	0497294
5	3516020	0498251
6	3518945	0499993
7	3518641	0499845
8	3518572	0499968
9	3518154	0499487
10	3518070	0499707
11	3517683	0499390
12	3517227	0498944
13	3517163	0498976
14	3512748	0496938
15	3512850	0497009
16	3513430	0497371
17	3515391	0498293
18	3515849	0498366
19	3517348	0499543
20	3518869	0500168

Table 1 (above): UTM Coordinates for each of the Canoa Ranch Photo Points. Map Datum for these points is WGS 84.

Table 2 (right) : Distance from Photo Point Center to Top of Nearest Bank. Measuring distance to bank can be quite subjective without set markers to measure to and from. Comparing notes and distances from previous years seems to suggest that in some cases, different points of the banks were measured and comparisons are not valid. This year, we used a compass and noted the degree to the shortest distance to the bank from the photopoint stake. This will allow some consistency in measuring distance to banks in the future. At some photo points, a stake placed one-foot from the bank was used to mark future measuring points. Because the bank may erode and the distance to bank stake may be lost, the staking method will not be as efficient as using the compass to measure the degrees from the photo point stake.

Photo Point Number	2006 Top of Bank	2004 Top of Bank	2002 Top of Bank	2006 Bottom of Bank	2004 Bottom of Bank
1	12' To main flow: 100'	13.5" (west)	14"10"	112' (to main flow channel)	190"
2	18.5' at 290 degrees. (221' to west bank)	220" (west)	48"		2110"
3	39'	27.5"	27"10"		340"
4	13'. To nearest braid: 52' feet.	52.5" to nearest bank (E)	58' to center of nearest braid; 13' to "bank"	15' to lowest spot	14' to lowest spot
5	27" Pounded in stake at TOB. 310 degrees	30.6"	34.7"	37.5"	360"
6	28' (to secondary) 39' (to primary channel)	43.4"	43.4"	50'	Not measured
7	32.5' at 120 degrees. Eroding, lots of migrant use. Bottom filling in.	360"	31.9"	51'	Not measured
8	33.5' Downcutting occurring.	33.7"	33"10"	59'	Not measured
9	64.5' (bank to east) at 120 degrees	46' (bank to east)	63.9' (bank to east)	Not measured	Not measured
10	26' (bank to south) at 180 degrees	31' (bank to south)	30"10" (bank to south)	Not measured	36'
11	84' at 290 degrees	82.6" to secondary bank	82.5" to secondary bank	Not measured	Not measured
12	NA Photo Point is in the channel	NA Photo Point is in the channel	NA Photo Point is in the channel	NA Photo Point is in the channel	NA Photo Point is in the channel
13	New low flow channel formed. 40' at 290 degrees. Downcutting occurred to west of photopoint.	NA Photo Point is in the channel	NA Photo Point is in the channel	NA Photo Point is in the channel	NA Photo Point is in the channel
14	34' at 310 degrees. Not much erosion. Annuals growing on slope.	350"	350"	46'	390"
15	46' 305 degrees grass growing on slope.	44.5"	45.5"	50'	480"
16	58.2' 290 degrees.	57.0"	57.7"	61.6'	60.5"
17	48" 265 degrees	46.0"	49.0"	53'	470"
18	NA at least 300' on east side of river	NA at least 300' on east side of river	NA at least 300' on east side of river	NA at least 300' on east side of river	NA at least 300' on east side of river
19	148' 300 degrees. Stake pounded in 1' away. Bank sloughing off, erosion, steep bank slope.	147.0"	152.10"	162'	150' No obvious signs of erosion
20	NA at least 300' on east side of river	NA at least 300' on east side of river	NA at least 300' on east side of river	NA at least 300' on east side of river	NA at least 300' on east side of river

# RESULTS

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Attached to this report is a series of 80 photographs taken at 20 different photo points (see Map 1), with notes comparing these photos to those taken during the previous years. The following excerpt taken from the 2002 report gives an overview of conditions found at the Canoa Ranch photo points:

*Examination of the photos reveals a certain level of uniformity inasmuch as mesquite (*Prosopis velutina*) is the overwhelmingly dominant woody species on the riverbanks and adjacent uplands. The floodplain, and to some extent the river channel, is dominated by burro bush (*Hymenoclea monogrya*). The riparian species, Fremont cottonwood, Goodding willow, and seep willow are sparingly distributed, mostly occurring upstream near the crossing of the Santa Cruz by Elephant Head Road (see for example Photo Points 14, 15, and 16). Further downstream, there is one cottonwood present in the east view on Photo Point 12 and one seep willow near the terminus of the south transect on Photo Point 5. Also across the river from Photo Point 5 is a large Goodding willow that also appears in the north view of Photo Point 18. (EPG, 2002)*

The 2006 photo monitoring took place during June 20th and 21st. Photo points were found using the accompanying orthophoto and a Garmin GPS unit. The UTM coordinates for each photo are presented in Table 1 and the points are displayed on the accompanying orthophoto. Several points either did not correspond to the location of the stakes, or were revised due to placement of a new stake. Table 1 reflects our UTM coordinates for the photo points.

In previous years' monitoring, the cameras featured a set lens length (50 mm or 55 mm). It was not possible to determine or set the focal length of the digital camera used in 2006. We used the zoom feature to determine the range of the photo. This was not an effective tactic as the range and width of the photos seemed to vary from the original photographs. Photo accuracy was also compromised due to the

fact that both the LCD screen and viewfinder of the camera became increasingly hard to see out of as the day wore on. Despite these technical difficulties, most photos are comparable to the 2002 and 2004 photos. The exception to this was Photo Point 3, where the stake was not found and the UTM coordinates did not align with the features of the 2002 and 2004 pictures.

There were few major changes between 2002 and 2006. There has been an overall increase in burrobush cover in the floodplain. There were several photo points with riparian obligate species such as seep willow, Fremont cottonwoods, and Goodding willows. The changes in these species vary. At Photo Point 15 and 16 East, the Goodding willows appear sparser compared to the 2002 photos. Meanwhile, most of the cottonwoods found in Photo Points 12 East, 14 West and have increased in size and vigor. The seep willows, primarily found in Photo Point 15 North, appear to have increased in size and vigor.

In 2002, the ephemeral vegetation consisted primarily of tall annuals, while shorter annuals were more prevalent in 2004. In 2006, tall annuals were more prevalent than shorter annuals. There seemed to be a slight increase of groundcover at most of the photo points. Many of the mesquites had increased foliage in 2004 and slightly decreased vigor in 2006, especially on the east bank terrace.

Vegetation cover and plant vigor varied from site to site. In some cases, even within the same site, cover and vigor varied depending on which direction the photo was taken. For example, in Photo Point 5, the burro bush in the North photo shows signs of dieback compared with the 2002 photo. However, in the East photo, the burro bush show increased vigor and sprouting in the channel.

At Photo Point sites 3 and 15, between 2002 and 2004, there was an increase of woody flood debris. In 2006, much of the debris had been swept away by flooding. At these same sites, the channel appeared aggraded and coarse materials were present in the channel bed. Both sites needed new stakes, and Photo Point 3 was so changed that it was difficult to match the photo points.

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At Photo Points 6 and 20 there is evidence of increased motorized traffic through the area (new trails evident in Photo Point 6 East and South photos). In 2004, throughout the entire Canoa Ranch, there was evidence of a large increase in migrant traffic as compared to 2002. Under every large tree lay scattered piles of clothing, water bottles, travel bags, and other discarded items. In 2006, while there was evidence of migrant traffic, there were less discarded items under trees. Footpaths were evident on the upland sites (17, 19 and 20) between the Santa Cruz River and the railroad.

The distance from the center of the photo point to the nearest bank of the Santa Cruz River was also taken (see Table 2). We took two measurements, one from the top of the bank, and one from the bottom of the bank. EPG's original measurements were to the top of the bank (E. Linwood Smith, personal communication). When compared to 2002 and 2004 and 2006 measurements, some of the distances were very similar; some were widely off the mark. It was difficult to tell if these changes were due to measuring discrepancies (distance to the bank varied depending on the exact trajectory), or if there was erosion to channel bank. Not every bank that had apparently moved bore signs of recent erosion. In 2006 we used a compass to measure the degree from the photo point to the nearest bank. Following that measurement in successive years will allow the same trajectory to be followed at each photo point distance to bank measurement.

Overall, it appears that some banks have remained stable and some have eroded several feet. In 2004, we noted the bank at Photo Point 7 appeared to have moved inward. In 2006, the same bank showed signs of erosion and heavy use by foot traffic. Based on visual observations of vertical banks around six feet high, it appears that many of the banks remain susceptible to erosion.

Because of inconsistent measuring practices and intangible results, we recommend dropping the distance to bank measurement. To address monitoring of future bank erosion we propose measuring the

bank erosion changes evident in orthophotographs. For example, Frank Postillion noted the Santa Cruz River thalweg at Canoa Ranch based on the 2005 orthophoto and this measurement can be repeated from future orthophotos.

## **Evaluating Vegetative Response on Canoa Ranch Photo Monitoring Points with Hydrologic Data**

Over the past five years (2002-2006) floodplain vegetation on Canoa Ranch has responded to fluctuations in precipitation, Santa Cruz River flow, and removal of livestock. In the southern portion of Canoa Ranch, flood flows and river-bed recharge play an important role in sustaining hydro-riparian species as cottonwoods and willows, and the density and health of mesquites. Many riparian ecosystems are dependent upon a water table that is so close to the surface that it intersects the root zone or the bottom of a stream bed. In order to correlate vegetative response with hydrologic data, we evaluated the last five years of precipitation and river flow in the vicinity of Canoa Ranch, and also evaluated several historical well hydrographs of on and off Ranch wells.

Precipitation data was reviewed for calendar years 2002-2006 at Pima County Regional Flood Control District (PCRFC) ALERT stations at Elephant Head Road and the Santa Cruz River, at Continental Bridge and Santa Cruz River, and at Florida Canyon and Keystone Peak in the Sierrita Mountains.

The data indicate that, except for 2003, rainfall was significantly below the long-term mean of 12-14 inches per year in southern Pima County. Streamflow based on ALERT data was unavailable before 2002. Most of the average rainfall (65%) at these gages was recorded during the summer monsoon season between July and September. The rainfall at the higher elevation gages at Keystone Peak and Florida Canyon varied from 12-15 inches/year, also below a more normal 16-20 inch/year output for more mountainous areas. The first months of 2006 had very sparse rainfall.

Table 3: Annual mean rainfall (inches) at and North of Canoa Ranch (2002-2006)

Year	Elephant Head Rd./Santa Cruz River	Continental Bridge
2002	7.99	8.07
2003	11.18	10.00
2004	5.40	8.00
2005	9.30	8.00
2006	0.91 (Jan-June)	0.79 (Jan-June)
Mean	8.46 (2002-2005)	8.52 (2002-2005)

The data indicate that, except for 2003, rainfall was significantly below the long-term mean of 12-14 inches per year in southern Pima County. Streamflow based on ALERT data was unavailable before 2002. Most of the average rainfall (65%) at these gages was recorded during the summer monsoon season between July and September. The rainfall at the higher elevation gages at Keystone Peak and Florida Canyon varied from 12-15 inches/year, also below a more normal 16-20 inch/year output for more mountainous areas. The first months of 2006 had very sparse rainfall.

The U.S. Geological Survey (USGS) provides annual stream-flow data for the Santa Cruz River with gages at Elephant Head Road and near Continental Bridge. The Continental site has a much longer gauge record. Table 4 summarizes data since fall of 2001.

The average annual flow of 2,571 at Continental Bridge from 2002-2005 was significantly lower than the average annual flow at Continental Bridge (16,870

AF/yr) from 1941-2005. The declining flow led to significantly less groundwater recharge and subsequent declines in shallow water levels in the area.

Most of the large flows and rainfall recorded in 2005 occurred in the late summer. The resulting channel loss (seepage of water from the channel into the soil, and thus recharge to the aquifer), from the Elephant Head Bridge to Continental Bridge were just over 50% of the Elephant Head flow total, or 6570 acre-feet (AF). The lower 2004 flows resulted in more channel losses as a percentage of flow at Elephant Head Bridge (75%), but less recharge overall (3230 AF). The overall rainfall for 2004 was divided fairly evenly between winter and summer storms, with less extreme events, thereby allowing for more recharge as a percentage of total flow. Stream flows in water year 2002 was very low at Continental Bridge probably resulting in lower recharge rates up to 1000 AF from Elephant Head Road to Continental Bridge. 2003 was similar to 2004 with 1,400 AF of flow at Continental Bridge.

Table 4: Annual Santa Cruz River Flow (Ac-ft) at and North of Canoa Ranch (2002-2006)

Water Year	Flow at Elephant Head Rd./Santa Cruz River	Flow at Continental Bridge
2002	NR	385
2003	NR	1,400
2004	4,330	1,100
2005	13,970	7,400
2006	NA	NA
Mean	9,150 (2004-2005)	2,571 (2002-2005)

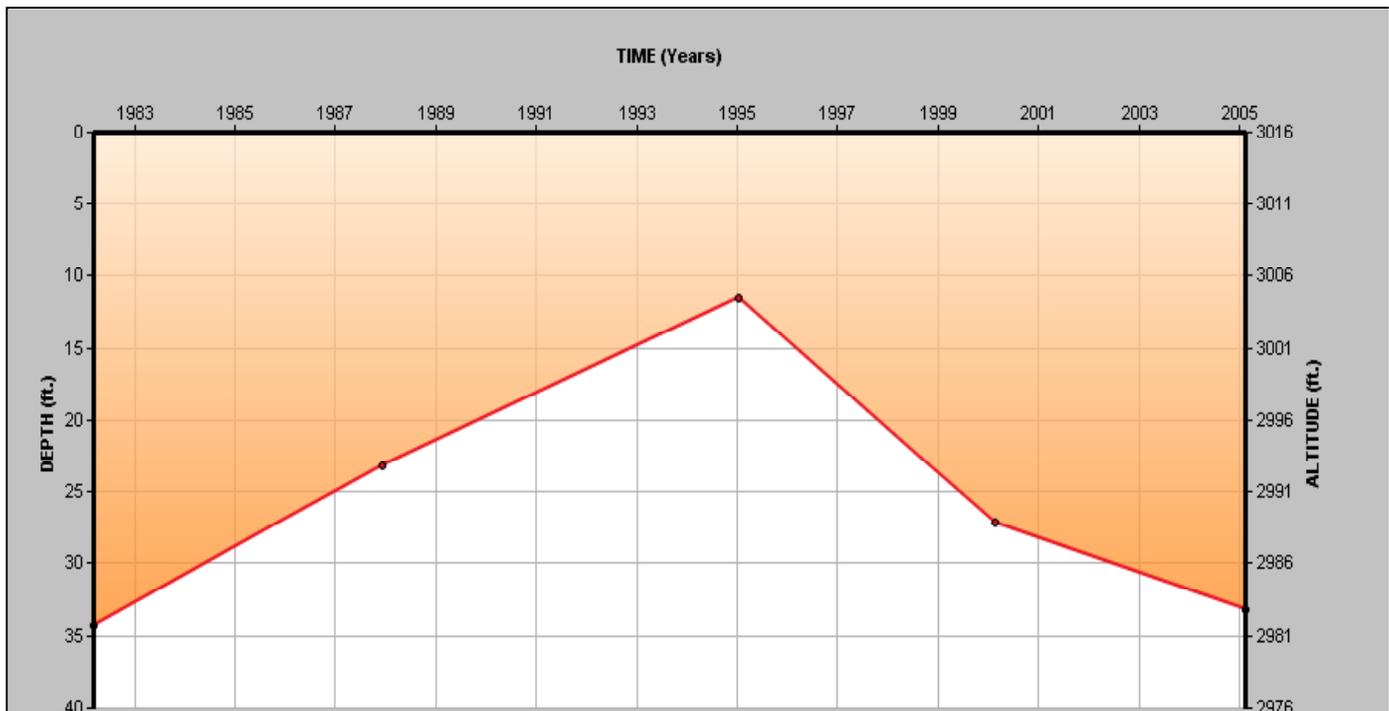


Figure 1: Depth to groundwater at the Underdown Well near Canoa Ranch. The large rise in 1995 reflects gains in groundwater after the 1993 floods.

The following description of water level hydrographs in the area describes recent water-level declines and historical water level trends. We examined the ADWR Groundwater Site Inventory (GWSI) Data Base to evaluate historic water-level trends on Canoa Ranch. The water level hydrographs illustrate the significant response to flood flows of local groundwater levels near the Santa Cruz River and Canoa Ranch. The first hydrograph is for the Underdown well at D(19,13)32ABC (ADWR Well Registration # 55-626063), approximately 1/2-mile southeast of Elephant Head Road and 900 feet east of the Santa Cruz River (Figure 1). Data were not available in 1984 after the significant flow events of 1983 (149,500AF at Continental Bridge). However water levels rose to 23 feet below land surface (bls) in 1987 and reached a high of 11.5 feet bls in 1995, after the large flows in 1993 on the Santa Cruz River. Since 1995, water levels in this well have dropped to pre-1983 wet weather periods to 33.2 feet bls in February 2005.

Another example of large water-level responses to stream-flow recharge events is a Canoa Ranch well

at D (19,13) 21BAA, approximately 1.9 miles north of Elephant Head Road and 850 feet east of the Santa Cruz River (ADWR Well Registration # 55-623123). The water levels maintained a range of 30-50 feet bls from 1952-1969 (Figure 2). Introduction of the Sierrita Mine supply wells about 1970 and peak pumping by 1977 (22,000 AF/yr), just west of the Santa Cruz River on Canoa Ranch, and concomitant low river flow conditions sent water levels in this well plummeting to a low of 103 feet bls in 1977. (USGS data showed a pattern of lower total flows at Continental Bridge from 1969-1977, averaging 6650 AF/yr.) After a very wet 1983-85 seasons (annual flow at Continental Bridge of 149,500 AF for WR 1983 and average total flow was 75,426 AF/yr) and large river flows to scour the river bottom (45,000 cfs), the well water levels recovered to 32 feet bls in 1987. Sierrita Mine wells were still at peak production of 15,000-20,000 AF/yr. After 1993 floods (annual flow at Continental Bridge for WR 1993 of 88,780 AF), the well recovered to 13.5 feet bls by 1995. No data were available to examine current conditions. This well should be measured again soon.

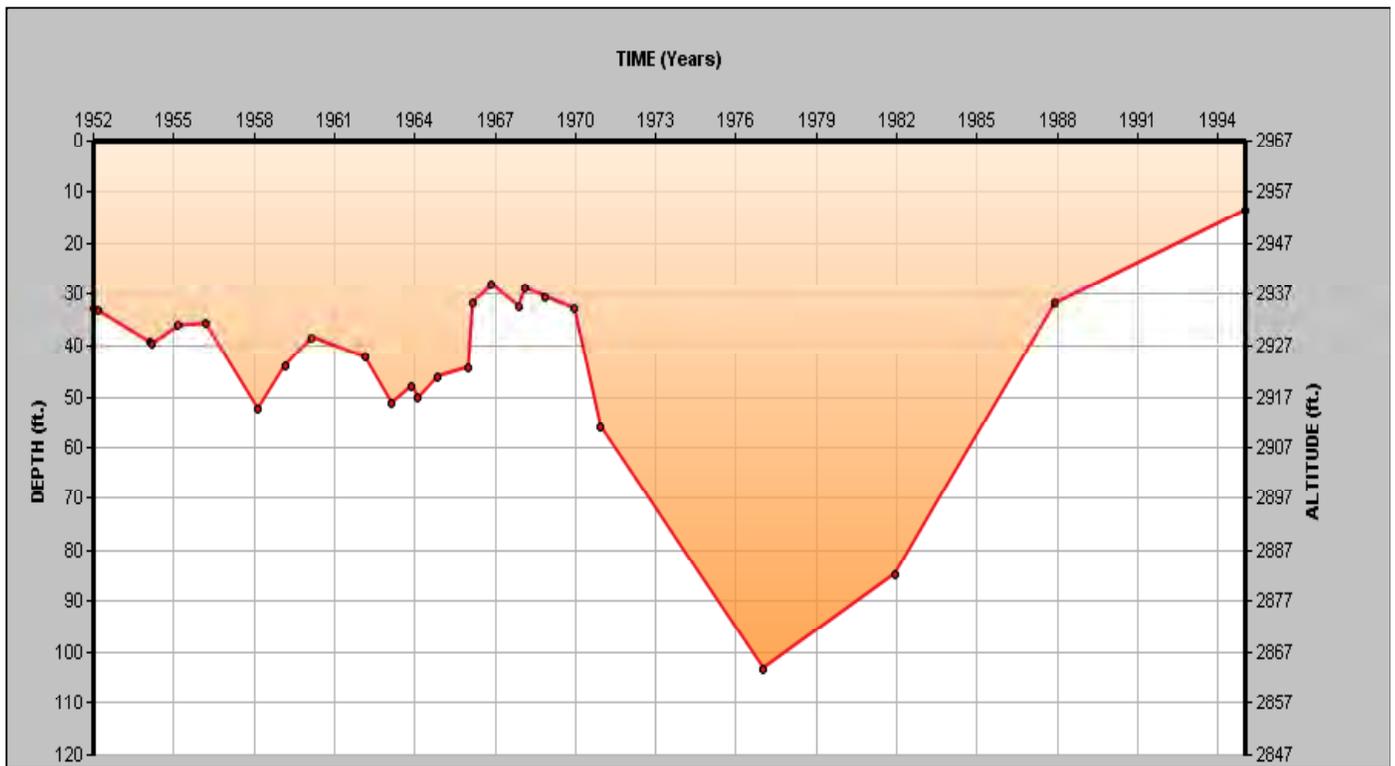


Figure 2: Canoa Ranch Well 55-623123. D (19,13) 21BAA. The dip at this well reflects the drought conditions during 1969-1977 and the 1970 installation and subsequent pumping of Sierrita Mine supply wells. Wetter years in the 1980s and a decrease of Sierrita Mine pumping in 1992 lead to a slow rise in groundwater levels.

A Pima County-owned well approximately 0.4 miles northwest of the Santa Cruz River and Elephant Head Road illustrates the extent of shallow groundwater on the broad floodplain of Canoa Ranch, and potential for establishing riparian recruitment (Fig. 3). Water-level lows were experienced during the drought period of 1969–1977 and 1970 installation and subsequent pumping of Sierrita Mine supply wells (20,000–22,000 AF/yr), reaching over 90 feet bls (Figure 3). By 1987, water levels recovered to 41.5 feet bls and as high as 34.7 feet bls in 1995. During the period of 1992–1994, Sierrita Canoa wells reduced pumping to an average of 14,670 AF/yr as their tailing pond interceptor wells increased production. In addition, water year 1993 was the second wettest year on record next to 1983. Later levels then began a downward decline with some resurgence in March 2001 to 36.7 feet bls. Since 2001, water levels in this well declined to 60 feet bls by May 2005. As described, flood flows at Elephant

head Road Bridge and Continental Bridge were significantly lower than normal.

These wells illustrate the responsiveness of the recharge capacity of the Santa Cruz River and the effects of the Sierrita Mine wells that have annually pumped a range of 14,000–22,000 AF/yr since the early 1970s. Other examples of wells with hydrographs are available and illustrate similar trends. However, they are located in the northern reaches of Canoa Ranch and have water levels below riparian root zones (75–100 feet bls).

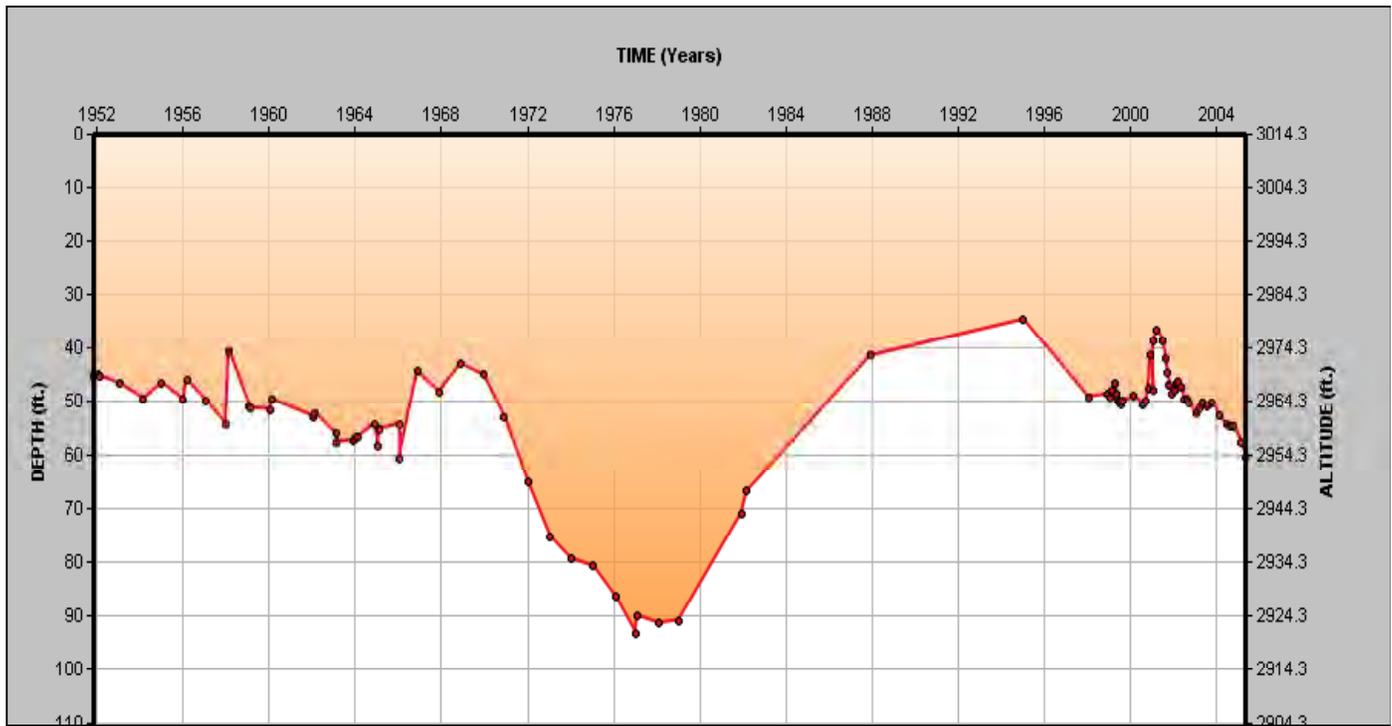


Figure 3: Canoa Ranch Well 55-623122. at D(19,13 29BCC). The dip from 1970 to 1977 reflects peak pumping by a nearby groundwater user combined with low flow river conditions.

# DISCUSSION

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Pima County is developing an Ecological Monitoring Plan (EMP) as part of the Multi-species Conservation Plan. The goal of the EMP will be to “detect and quantify changes to select ecosystem components at appropriate spatial and temporal scales to inform adaptive management and to determine if the SDCP biological goal is being achieved (RECON, 2007). Photo monitoring has long been used as a tool for monitoring landscape level change (Turner and Karpiscak 1980; Webb 1996; Turner et al. 2003; Webb et al. 2004 in Webb and Leake 2005). Repeat photography is a quick and effective way to document change in vegetation (Hall, 2002). Most published repeat photography studies have been used to infer vegetation changes over large areas and long periods of time (Turner and Karpiscak 1980; Webb 1996; Turner et al. 2003; Webb et al. 2004 in Webb and Leake 2005).

Photo monitoring may document landscape changes resulting from management techniques, climate change and the effects of plant maturation and death but in many cases, photo analysis alone can not determine why landscape changes are occurring. Other techniques to look at changes in riparian vegetation

include reviewing aerial photography, remote sensing, belt transects and qualitative approaches such as proper riparian function assessments (Webb and Leake 2005).

Photo monitoring can be used to inform land managers about trends in vegetative condition or hydraulic roughness. Visual observation is the primary means used for evaluating channel roughness (Thomsen and Hjalmarson 1991), and photography is the primary archival tool for documenting changes in roughness in sandy channels (Phillips and Ingersoll 1998, Phillips and Tadayon 2006).

One difficulty we have encountered with the Canoa photo monitoring project is data management. We do not have an effective system to digitally or manually store and display consecutive years of photos (each monitoring effort at Canoa yields 80 photos), though there is at least one online resource to assist with creating such a system (<http://www.controlledvocabulary.com/imagedatabases/>). We will be exploring options to digitally link photo point locations with their associated photos and year by year comparisons on a database that can be accessed online.

# CONCLUSIONS

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*The Santa Cruz River channel is generally increasing in roughness, even as drought reduces the vigor of some long-lived perennial trees, scrubs, and grasses.*

The purpose of photo monitoring at Canoa Ranch was to document changes in floodplain vegetation and channel banks. Photo monitoring points were used to establish a baseline condition to compare to future conditions. The Canoa photo monitoring has been effective at documenting change in the floodplain and in the Santa Cruz River channel, but has not been effective in determining if channel banks are changing. Additional analyses had been used for the Canoa Ranch monitoring to assist with a better understanding of the site, including aerial photo analysis and gathering nearby well data information to determine approximate ground water levels.

The Santa Cruz River channel in Canoa Ranch is generally increasing in roughness, even as drought reduces the vigor of some long-lived perennial trees, shrubs, and grasses. The channel vegetation has increased in roughness largely due to burrobush recruitment and some coarsening of bedload. The floodplain is capturing woody debris and maintaining annuals, but drought is causing loss or impaired vigor on mesquites and other long-lived perennials farther from the channel. Changes in riparian vegetation vary, with the apparent trend of willows showing sparser foliage while cottonwoods appear much more vigorous than 2002.

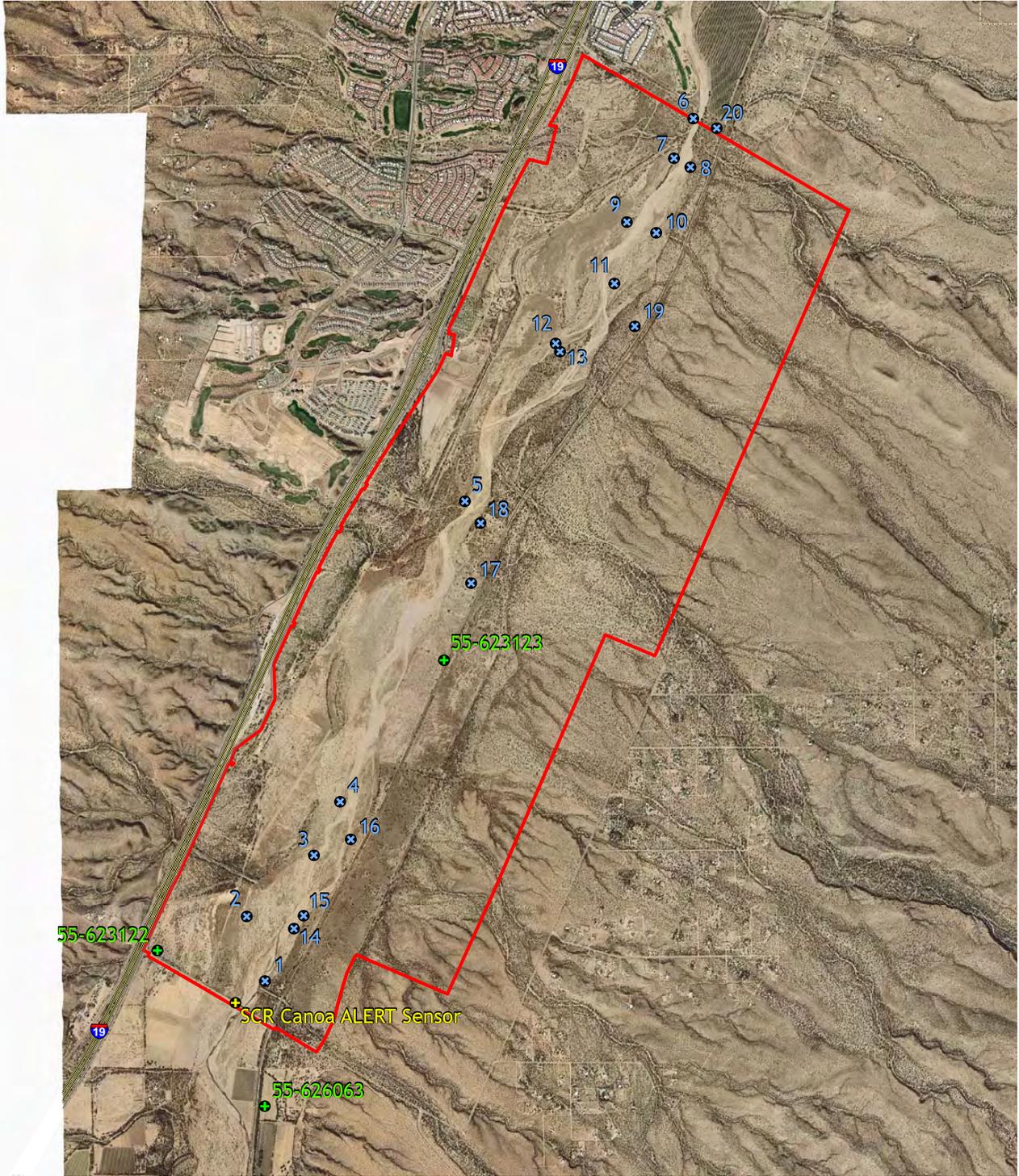
Regional drought has decreased the amount of riverbed recharge, affecting shallow water levels in the upper (southern) part of Canoa Ranch. Depth to groundwater in the lower (northern) part of the Ranch is too great to support riparian vegetation.

A water-level monitoring program of wells on Canoa Ranch should be implemented to evaluate water-level response to flood flows and nearby mine well pumping, especially farther from the channel. Preference should be given to monitoring the aquifer conditions in the southern portion of Canoa Ranch, where cottonwoods and willow are more common, and effluent flows from Santa Cruz County sometimes occur.

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## Map 1: CANOA RANCH PHOTO MONITORING SITES

The information depicted on this display is the result of digital analysis performed on a variety of databases provided and maintained by several governmental agencies. The accuracy of the information presented is limited to the collective accuracy of these databases on the date of the analysis. The Pima County Department of Transportation Geographic Information Services Disclaimer makes no claims regarding the accuracy of the information depicted herein.

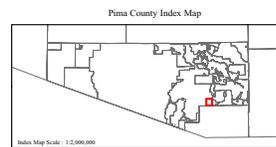
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- ALERT Monitoring Station
- Photo Monitoring Site
- Well
- Canoa Property Boundary

Orthophoto Date: December 2006



04/07/08

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# APPENDIX A – PHOTOGRAPHS

## Photo Point 1 North and East Views



**Photo Point No. 1**  
Looking north across the Santa Cruz River from a point just upstream of the Elephant Head Road bridge. Foreground plant is burro bush (*Hymenoclea monogyra*).



**Photo Point No. 1 North**  
\*\*\*  
Burro bushes have increased in size and quantity. Tumbleweed in channel.



**Photo Point No. 1 North**  
Burrobrush has increased in size. Evidence of channel scouring, increase of coarse materials in channel.



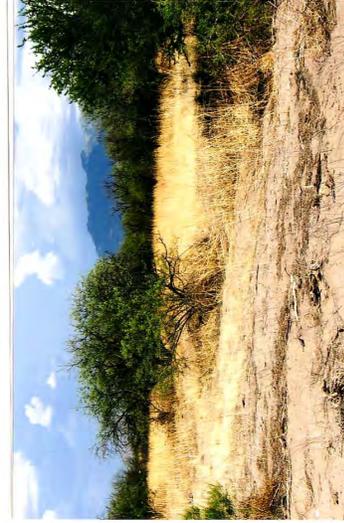
**Photo Point No. 1**  
Looking east toward the Santa Rita Mountains. Dominant vegetation shown here is mesquite.

2002



**Photo Point No. 1 East**  
\*\*\*  
There is an increase in annual groundcover. Bunch grasses are taller.  
\*\*\* These photos are not exact matches to 2002. See report.

2004



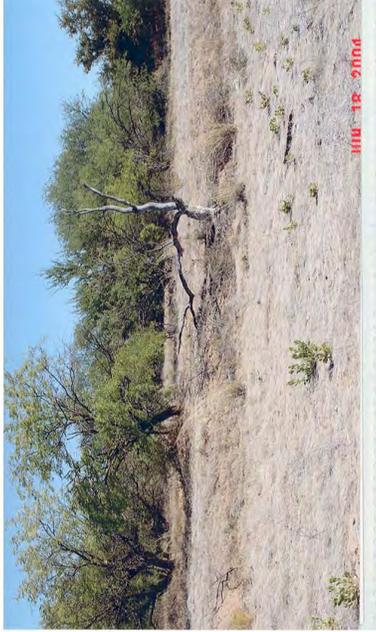
**Photo Point No. 1 East**  
Mesquite trees are showing signs of stress. Evidence of overbank flooding and flood debris deposition.

2006

# Photo Point 1 South and West Views



**Photo Point No. 1**  
Looking south toward Elephant Head Road. Mesquite is dominant here. Midground vegetation consists of dried Russian thistle (*Salsola iberica*), Chenopods, Amaranth and Polygonaceae.



**Photo Point No. 1 South**  
\*\*\*  
The bunch grasses are taller. There are fewer tumbleweeds. Mesquite on far left appears less vigorous.



**Photo Point No. 1 South**  
The dead tree has fallen over. Evidence of overbank flooding. Trees show signs of stress likely due to extended drought conditions.



**Photo Point No. 1**  
Looking west across the Santa Cruz River. Vegetation on the distant floodplain is strongly dominated by burro bush.



**Photo Point No. 1 West**  
There is more groundcover in the channel (primarily tumbleweeds). There is more groundcover on the far bar. There is an increase in foreground cover.



**Photo Point No. 1 West**  
Channel shows evidence of flood flows. Slightly more incised low-flow channel, more coarse materials in channel.

2002

2004

2006

\*\*\*These photos are not exact matches to 2002. See report.

## Photo Point 2 North and East Views

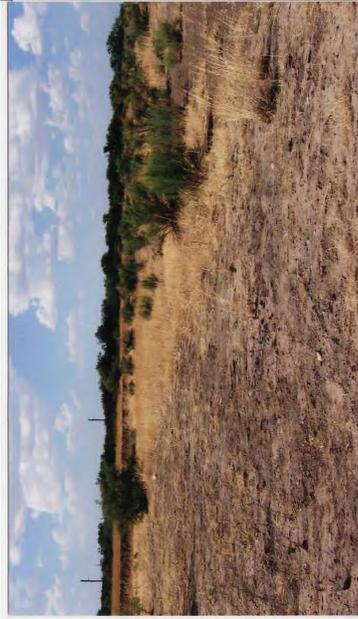


**Photo Point No. 2**  
Looking north from the west bank of the Santa Cruz River. Dominant vegetation below the river bank is burro bush. Foreground plants appear to be buckwheat (*Eriogonum* sp.).



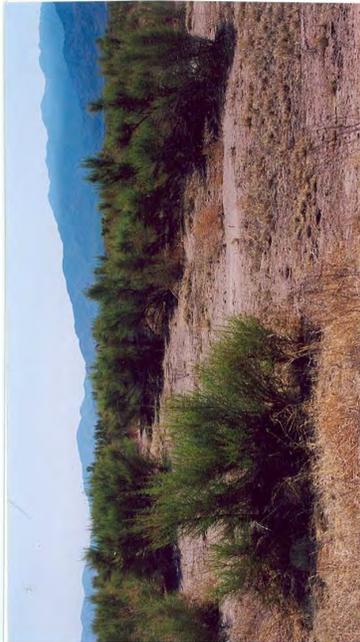
**Photo Point No. 2 North**

There is little change in this site from the April, 2002 photo.



**Photo Point No. 2 North**

Less annual growth on center left of photo. Increase in burrobush size and recruitment.



**Photo Point No. 2**  
Looking East across the Santa Cruz River floodplain, strongly dominated by burro bush with cured patches of Bermuda grass (*Cynodon dactylon*).

2002



**Photo Point No. 2 East**

There appears to be slightly more groundcover on this site.



**Photo Point No. 2 East**

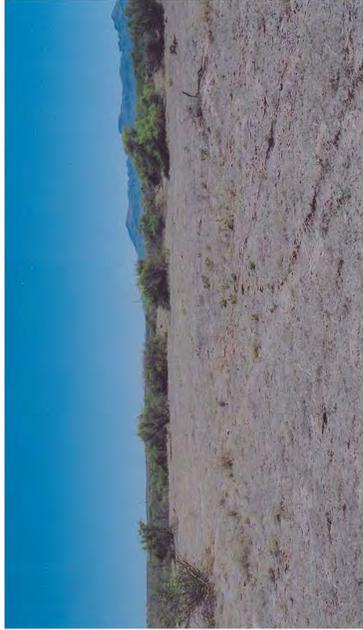
There appears to be less groundcover than 2004 photos. Very slight increase in burrobush recruitment.

2006

# Photo Point 2 South and West Views



**Photo Point No. 2**  
Looking south along the Santa Cruz River floodplain, dominated by burro bush.



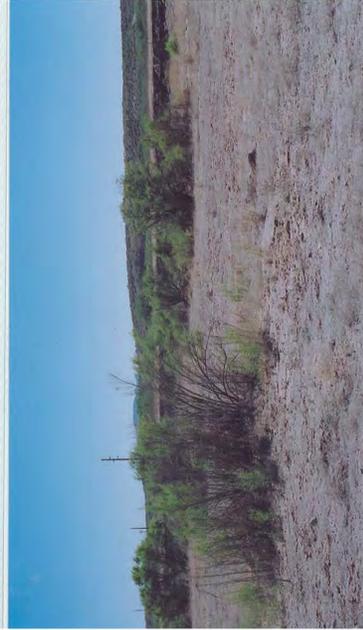
**Photo Point No. 2 South**  
There is little change. Slightly more groundcover.



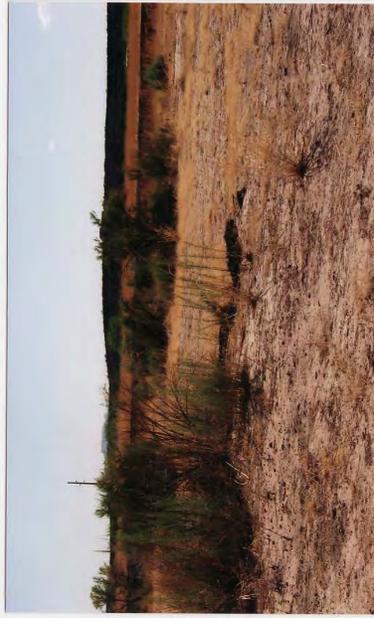
**Photo Point No. 2 South**  
There is little change. Debris mound (center right) seems to have increased amount of debris.



**Photo Point No. 2**  
Looking west across the Santa Cruz River floodplain. The bank in the center of the photograph is 48 feet from the photo point and is the location where bank soil samples were taken.



**Photo Point No. 2 West**  
There is little change. Slightly more groundcover.



**Photo Point No. 2 West**  
Main burro bush has died. Resprouts occurring. Debris piles evident.

2002

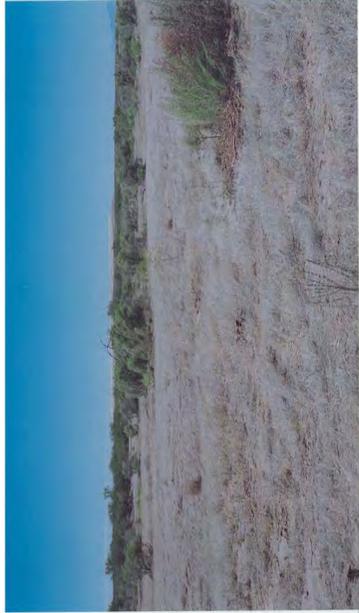
2004

2006

## Photo Point 3 North and East Views



**Photo Point No. 3**  
Looking north. Vegetation here is dominated by burro bush with cured forbs and grasses.



**Photo Point No. 3 North**  
There is an increased amount of ground cover. The burro bush is bigger, and there is more grass cover.



**Photo Point No. 3 North**  
\*Stake not found. Old coordinates did not match photos, restaked photopoint with new GPS coordinates. Increased recruitment and growth of burrobush and tumbleweed. Increased debris. Channel is more apparent.



**Photo Point No. 3**  
Looking east across the braided Santa Cruz River. Burro bush is the dominant perennial species here. The distant bank supports a stand of mesquite.



**Photo Point No. 3 East**  
There are more burro bushes present, and existing burro bushes have increased in size. There is more flood debris against burro bush on bar.



**Photo Point No. 3 East**  
\*Stake not found. Old coordinates did not match photos, restaked photopoint with new GPS coordinates. Flood flows have reduced burrobush and washed away debris. Channel is more evident. Coarse materials in channel.

2002

2004

2006

# Photo Point 3 South and West Views



**Photo Point No. 3**  
 Looking south along a braid of the Santa Cruz River. Vegetation consists of cured Bermuda grass and a variety of forbs with burro bush the dominant perennial species.



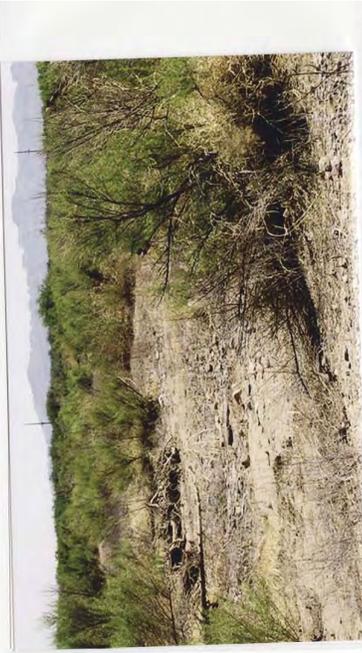
**Photo Point No. 3 South**  
 There is more grass cover present on the bar. The burro bush have increased. Increased annual vegetation in the channel.



**Photo Point No. 3**  
 Looking west. Burro bush is in the fore and mid-ground with mesquite in the background.



**Photo Point No. 3 West**  
 This site appears very similar to conditions in 2002. There appears to be more flood debris at the base of the shrub in the far left of the photo.



**Photo Point No. 3 South**  
 \*Stake not found. Old coordinates did not match photos, restaked photopoint with new GPS coordinates. Photo does not seem to represent 3 South. Increase of burrobush and woody debris.



**Photo Point No. 3 West**  
 \*Stake not found. Old coordinates did not match photos, restaked photopoint with new GPS coordinates. Increase in groundcover. Increase in debris piles.

2002

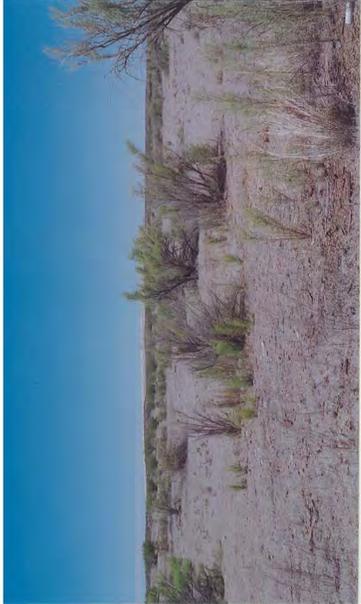
2004

2006

# Photo Point 4 North and East Views



**Photo Point No. 4**  
Looking north along the west side of the Santa Cruz River. Burro bush is the dominant perennial vegetation here.



**Photo Point No. 4 North**

There is an increase of young burro bush, though 2 older burro bushes have died.



**Photo Point No. 4 North**

Increased burro bush recruitment. Increase of woody debris.



**Photo Point No. 4**  
Looking east across the Santa Cruz River. Burro bush is dominant here with mesquite dominating the more upland sites in the background.



**Photo Point No. 4 East**

There is more ground cover. Some dieback of older burro bush, yet sprouts of young burro bush evident.



**Photo Point No. 4 East**

Decrease in groundcover. Burrobush on left has died.

2002

2004

2006

# Photo Point 4 South and West Views



**Photo Point No. 4**  
Looking south along a bank of the Santa Cruz River. The river channel and banks are dominated by burro bush, with cured grasses and Forbs



**Photo Point No. 4 South**  
Slight increase in groundcover. Increase in burro bush size and sprouts.



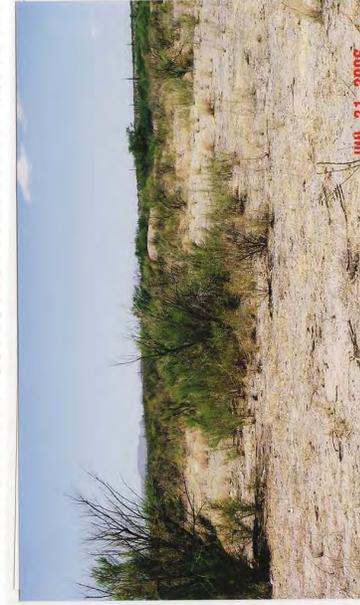
**Photo Point No. 4 South**  
Photo does not match previous photos well. Decrease in groundcover, increase in burro bush cover.



**Photo Point No. 4**  
Looking west toward a man-made berm that presumably was constructed to protect a nearby aircraft landing strip. Burro bush is the dominant plant species.



**Photo Point No. 4 West**  
Increase in burro bush sprouts. Slight increase in groundcover.



**Photo Point No. 4 West**  
Burrobush (middle) has died. New burrobush recruitment has increased. Slight decrease in woody debris.

2002

2004

2006

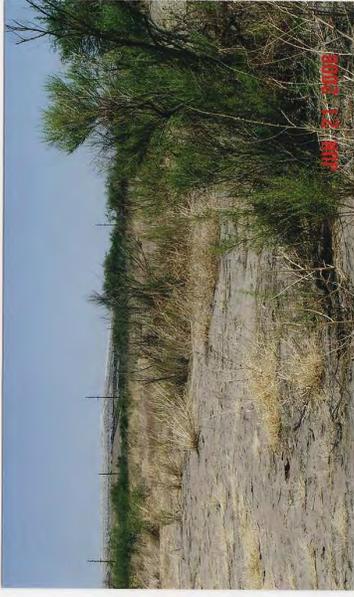
## Photo Point 5 North and East Views



**Photo Point No. 5**  
Looking north across lands dominated by burro bush and cured Bermuda grass and a variety of forbs.



**Photo Point No. 5 North**  
Burro bush shows signs of dieback.



**Photo Point No. 5 North**

Mature burrobush showing signs of dieback. Some burrobush recruitment. Decrease in short annuals, increase of bunch grass and amaranth stalks.



**Photo Point No. 5**  
Looking east across the Santa Cruz River. The eastern bank is dominated by mesquite and the river channel is bordered by burro bush.

2002



**Photo Point No. 5 East**

Slight increase in annual groundcover. Burro bush shows increased vigor and sprouting in channel.

2004



**Photo Point No. 5 East**

Increase in tall annuals. Decrease in short annuals.

2006

# Photo Point 5 South and West Views



**Photo Point No. 5**  
Looking south along the Santa Cruz River. Foreground consists of cured Bermuda grass and forbs. Near the terminus of this 50 m transect is a seep willow (*Baccharis glutinosa*).



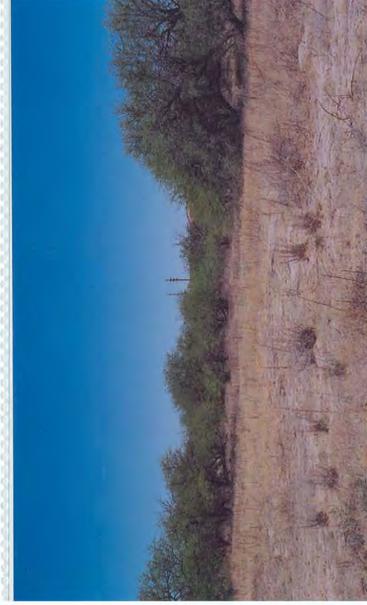
**Photo Point No. 5 South**  
Increase in annual groundcover over gravel in channel bed.



**Photo Point No. 5 South**  
Slight decrease in burrobush cover. More tall annuals.



**Photo Point No. 5**  
Looking west over mesquite-dominated lands. Tall, cured forbs. In this photo are species of Chenopodiaceae and/or Amaranthaceae.



**Photo Point No. 5 West**  
Mesquite foliage appears less vigorous. Increase in fine grass (annual) cover.



**Photo Point No. 5 West**  
Trees showing sign of stress. Decrease in short annuals, increase in tall annuals.

2002

2004

2006

# Photo Point 6 North and East Views



**Photo Point No. 6**  
Looking north from a point near the northern boundary of Pima County land at Canoa Ranch. Mesquite is the dominant plant species in this area. Small cactus at left-center is a cane cholla (*Opuntia spinosior*).



**Photo Point No. 6**  
Looking east across the Santa Cruz River. The river channel at this location is fairly narrow, supports little vegetation and has well-defined banks.

2002



**Photo Point No. 6 North**  
Burro bush has increased its vigor (lower left). Cholla morphology has changed.

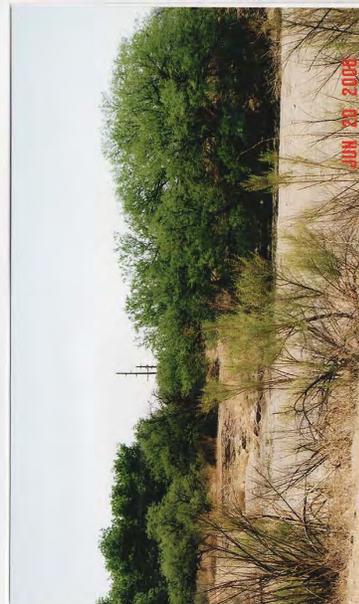


**Photo Point No. 6 East**  
The mesquites, cat claw acacia, and burro bush have increased vigor. It appears the west wash bank-center left in the photo-has experienced an increased in OHV traffic.

2004



**Photo Point No. 6 North**  
Burrobush has experienced dieback. Decrease in groundcover. Mesquites showing signs of stress. Cholla has experienced some dieback.



**Photo Point No. 6 East**  
Note new powerline in distance. Catclaw has increased in vigor. Some dieback in burrobush.

2006

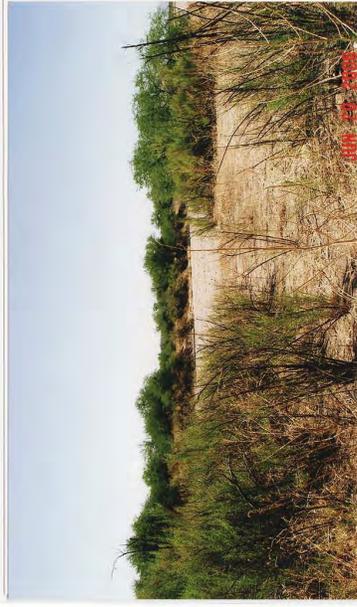
# Photo Point 6 South and West Views



**Photo Point No. 6**  
Looking south across the Santa Cruz River. Burro Bush is common here, but not as dominant as it is further downstream.



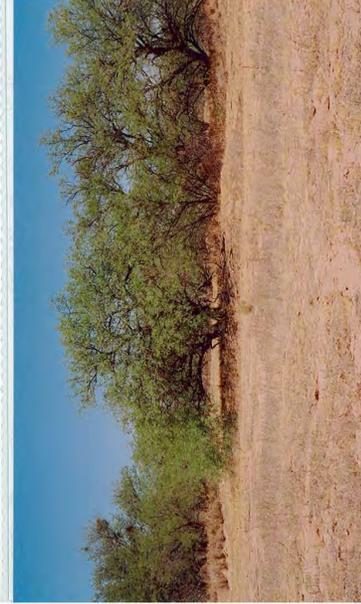
**Photo Point No. 6 South**  
The burro bush has increased. Note the road cut into the west bank (center left).



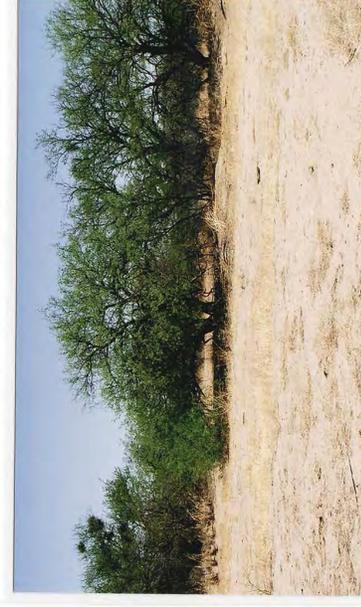
**Photo Point No. 6 South**  
Some dieback of burro bush. Road on far bank has begun to erode away. Less downcutting apparent. Vegetation on far bank appears to have increased.



**Photo Point No. 6**  
Looking west across weedy lands where mesquite is the dominant perennial species.



**Photo Point No. 6 West**  
There is a slight increase in mesquite vigor.



**Photo Point No. 6 West**  
Some stress evident with mesquites. Slight decrease in groundcover.

2002

2004

2006

# Photo Point 7 North and East Views



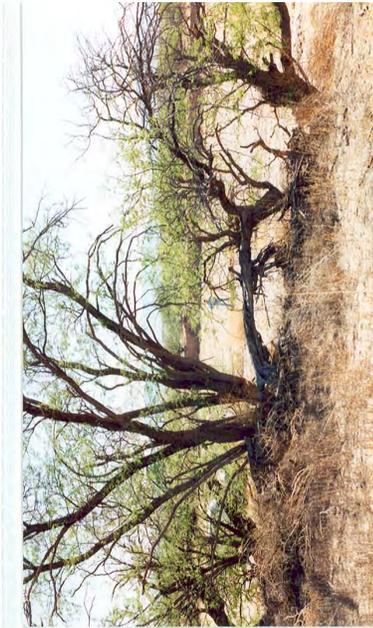
**Photo Point No. 7**  
Looking north across what appears to be a long-abandoned agricultural field bordered by mesquite.



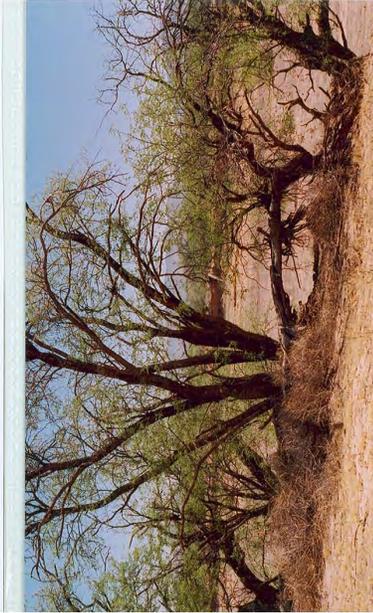
**Photo Point No. 7 North**  
Not much change. Shorter annuals. Slightly increased mesquite vigor.



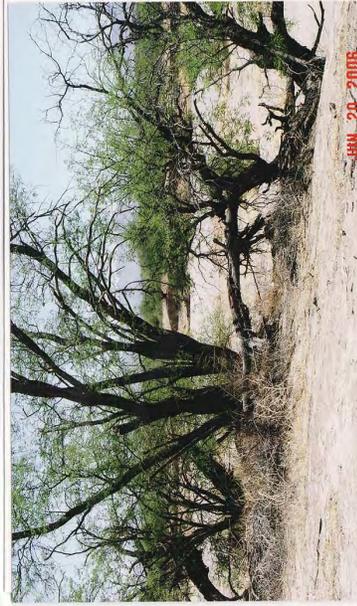
**Photo Point No. 7 North**  
Mesquite showing signs of stress, with some dieback and leaf loss. Taller annuals present.



**Photo Point No. 7**  
Looking east across the Santa Cruz River. The river at this location continues to be fairly narrow with well-defined banks.



**Photo Point No. 7 East**  
No significant change.



**Photo Point No. 7 East**  
Little change visible.

2002

2004

2006

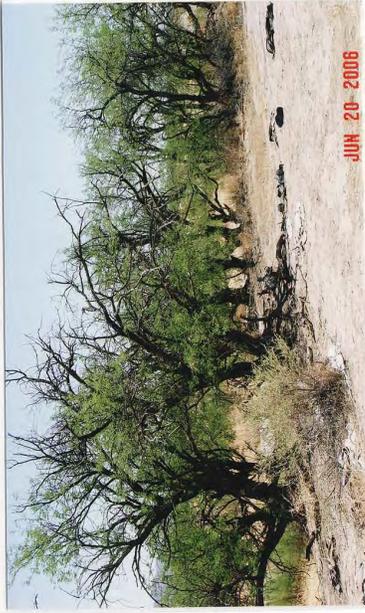
# Photo Point 7 South and West Views



**Photo Point No. 7**  
Looking south along the mesquite-lined west bank of the Santa Cruz River.



**Photo Point No. 7 South**  
No significant change.



**Photo Point No. 7 South**  
Slight increase in mesquite dieback. Less groundcover.



**Photo Point No. 7**  
Looking west across an abandoned, mesquite-bordered agricultural field.

2002



**Photo Point No. 7 West**  
No significant change.

2004



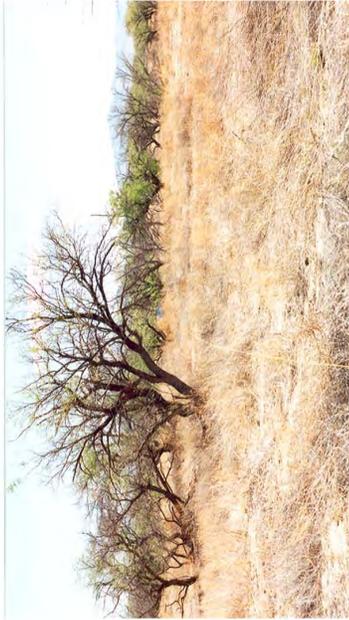
**Photo Point No. 7 West**  
Taller annuals present. Mesquites in distance showing signs of dieback.

2006

## Photo Point 8 North and East Views

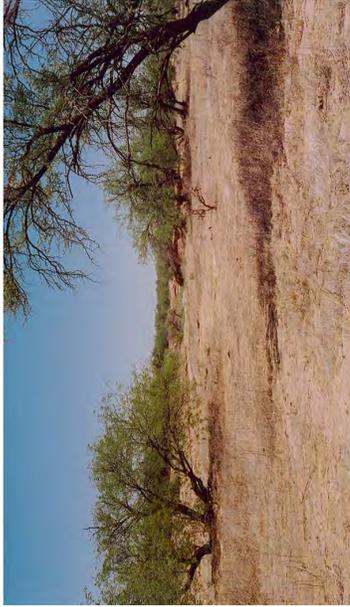


**Photo Point No. 8**  
Looking north along the east bank of the Santa Cruz River. A variety of cured weed, forb, and grass species along with mesquite are dominant at this location.



**Photo Point No. 8**  
Looking east across mesquite-dominated lands. Also in this photograph are two Mexican elders (*Sambucus mexicana*) to the left of the transect line near the center of the photo.

2002



**Photo Point No. 8 North**

Slightly increased foliage on mesquite. Cholla has changed morphology.



**Photo Point No. 8 East**

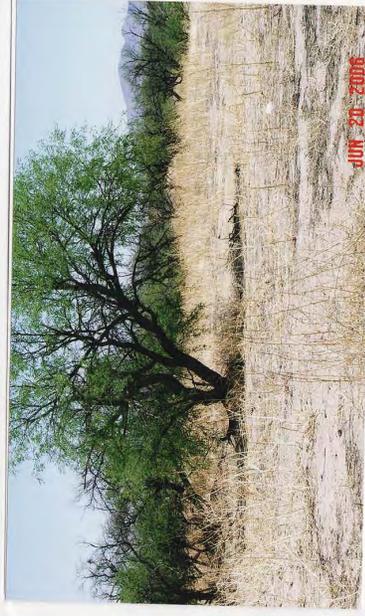
Increased foliage on foreground mesquite. The background mesquite appears dead.

2004



**Photo Point No. 8 North**

Mesquite in foreground experiencing dieback. Channel more apparent, note formation of island (center left). Cholla dieback.



**Photo Point No. 8 East**

Little change evident. Increase in tall annuals, decrease in short annuals.

2006

# Photo Point 8 South and West Views



**Photo Point No. 8**

Looking south across an opening in the mesquite bosque that supports a variety of grass, forb, and weed species.



**Photo Point No. 8 South**

Well-used path through the center of the photo. Bunchgrass is more prominent. Increased mesquite vigor.



**Photo Point No. 8 South**

Little change in mesquite vigor. Bunch grasses not visible, tall annuals prominent.



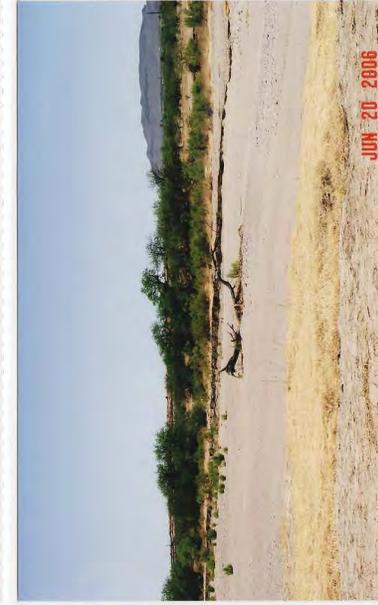
**Photo Point No. 8**

Looking west across the Santa Cruz River to the location of Photo Point No. 8.



**Photo Point No. 8 West**

Desert broom and mesquite on the far side of the channel have increased vigor. It appears a grass bar has formed in the channel.



**Photo Point No. 8 West**

Mesquites show signs of stress. Slight channel incision has occurred. Large woody debris deposited, some coarse materials present.

2002

2004

2006

# Photo Point 9 North and East Views



**Photo Point No. 9**  
Looking east across long-abandoned agricultural field on the west bank of the Santa Cruz River.



**Photo Point No. 9**  
Looking east across the Santa Cruz River. Note the foreground head cuts that are beginning to erode into the field on the west bank of the river.

2002



**Photo Point No. 9 North**

Mesquites in background more vigorous. Groundcover has decreased.



**Photo Point No. 9 East**

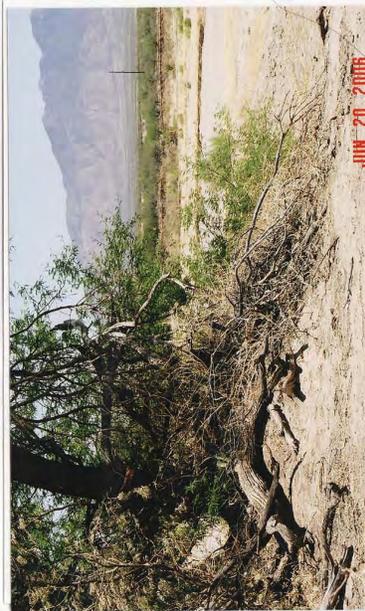
Mesquites have increased vigor. Annuals are shorter. Mesquite trees used as an immigrant camp.

2004



**Photo Point No. 9 North**

Decrease in annual groundcover. Test pits visible.

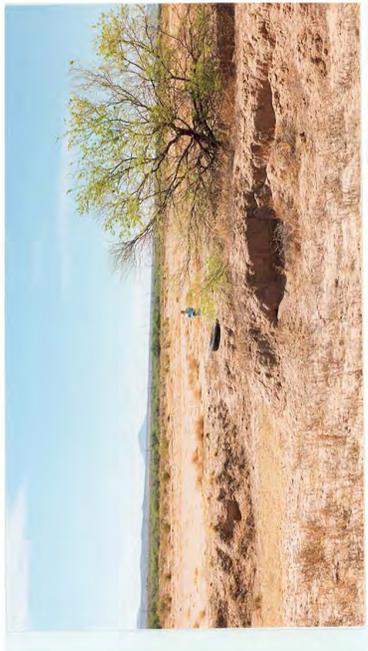


**Photo Point No. 9 East**

Very slight increase in debris at base of mesquite. Channel showing signs of aggradation.

2006

# Photo Point 9 South and West Views

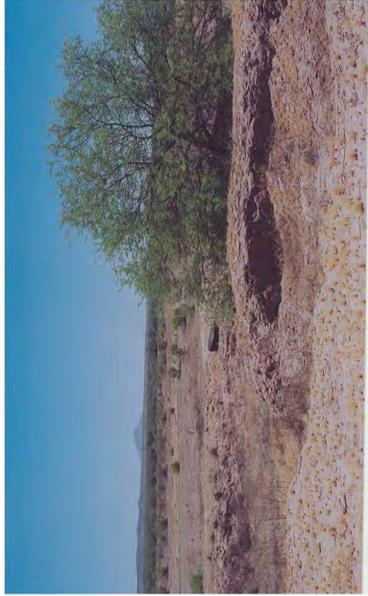


**Photo Point No. 9**  
Looking south across the Santa Cruz River. Note the foreground head cuts that are beginning to extend into the field on the west bank of the river.



**Photo Point No. 9**  
Looking west across the large field at this location.

2002



**Photo Point No. 9 South**

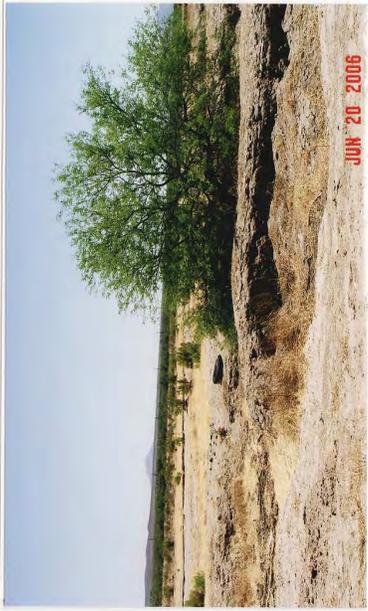
Mesquite has increased vigor. Desert broom in channel are more prominent.



**Photo Point No. 9 West**

The annuals are shorter. Cholla visible in the center left of the photo.

2004



**Photo Point No. 9 South**

Little change. Increase of woody debris (center left).



**Photo Point No. 9 West**

Test pits visible. Taller annuals, few short annuals.

2006

# Photo Point 10 North and East Views



**Photo Point No. 10**  
Looking north along the flood plain of the Santa Cruz River. This photo point is west of the main east bank and just of a secondary bank.

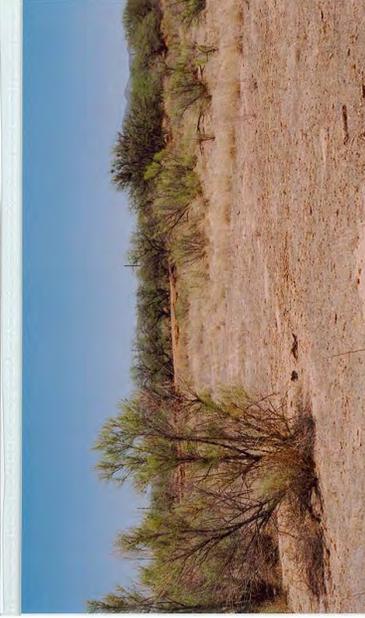


**Photo Point No. 10**  
Looking east toward the main (primary) bank of the Santa Cruz River. Vegetation here is burro bush on the floodplain with mesquite on the adjacent uplands.

2002

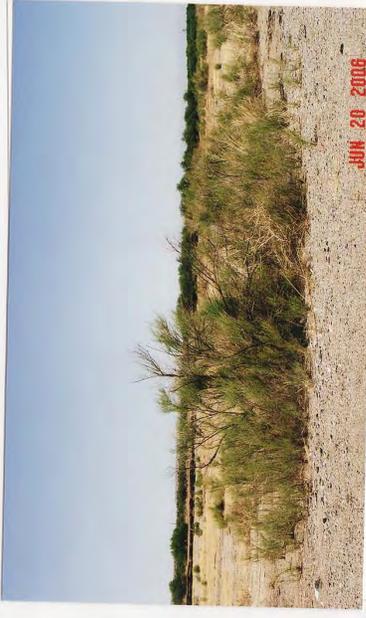


**Photo Point No. 10 North**  
The burro bush has grown. Annuals are present within the channel.

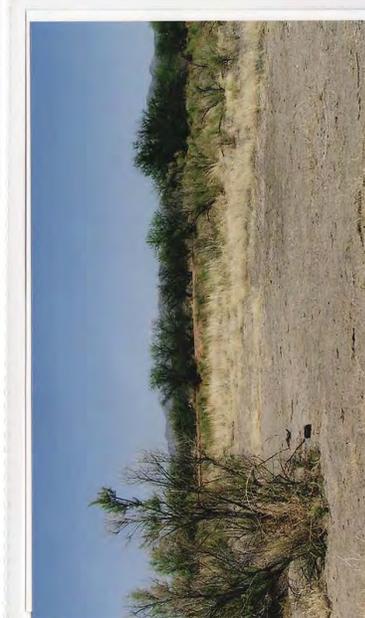


**Photo Point No. 10 East**  
No significant change.

2004



**Photo Point No. 10 North**  
Burrobush increase.



**Photo Point No. 10 East**  
Little change.

2006

# Photo Point 10 South and West Views



**Photo Point No. 10**  
Looking south across the burro bush-dominated Santa Cruz floodplain



**Photo Point No. 10**  
Looking west across the Santa Cruz River. A secondary bank is situated 82.5' west of this photo point. Burro Bush is the dominant plant species at this site.



**Photo Point No. 10 South**  
No significant change.



**Photo Point No. 10 West**  
No significant change.



**Photo Point No. 10 South**  
Little change. Decrease in groundcover.



**Photo Point No. 10 West**  
Slight increase in burro bush. Increase in tumbleweeds.

2002

2004

2006

# Photo Point 11 North and East



**Photo Point No. 11**  
Looking east across the center of the channel of the Santa Cruz River. Burro bush is essentially the only perennial plant species at this location.



**Photo Point No. 11**  
Looking east across the Santa Cruz River channel. Burro bush dominates the river channel at this location.

2002



**Photo Point No. 11 North**  
There is little change from 2002.



**Photo Point No. 11 East**  
Burro bush on the far side of the bank appears to have some dieback. Burro bush on the near side of the bank appear more vigorous.

2004



**Photo Point No. 11 North**  
Increase in tumbleweed and woody debris.



**Photo Point No. 11 East**  
Increase in burrobush vigor. Increase in groundcover.

2006

# Photo Point 11 South and West



**Photo Point No. 11**  
 Looking south across the Santa Cruz River Channel.  
 Straw-colored, cured plants in the left foreground are Russian thistle.



**Photo Point No. 11 South**  
 Burro bush appears more vigorous. No significant change.



**Photo Point No. 11 South**  
 Increase in burrobush. Increase in tumbleweed debris. More bunch grasses present.



**Photo Point No. 11**  
 Looking west across the Santa Cruz River Channel.  
 Note the stacked up driftwood near the center of the photo.



**Photo Point No. 11 West**  
 Burro bush appears slightly more vigorous. No significant change.



**Photo Point No. 11 West**  
 Increase of woody debris, slight increase in grasses.

2002

2004

2006

## Photo Point 12 North and East Views



**Photo Point No. 12**  
Looking north from the primary bank of the Santa Cruz River. The bright green tree above the extreme left center of the photograph is a cottonwood (*Populus fremontii*).

**Photo Point No. 12**  
Looking east toward the primary bank of the Santa Cruz River. The bright green tree above the extreme left center of the photograph is a cottonwood (*Populus fremontii*).

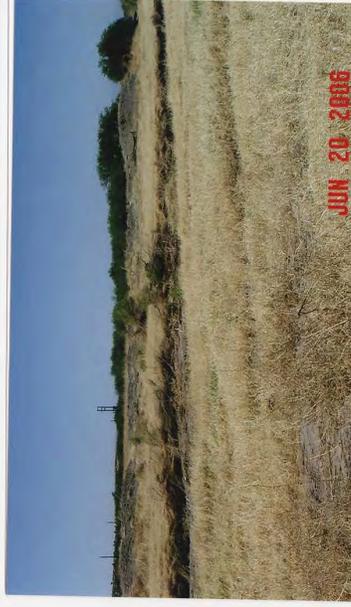
2002



**Photo Point No. 12 North**  
More groundcover on bar. Increase of burro bush. Increased plant cover on berms. Mesquites in background look the same.

**Photo Point No. 12 East**  
Mesquite in background look more vigorous. Cottonwood (extreme left) has grown. Increased groundcover on bar. Seepwillow (center-left) has greened-up.

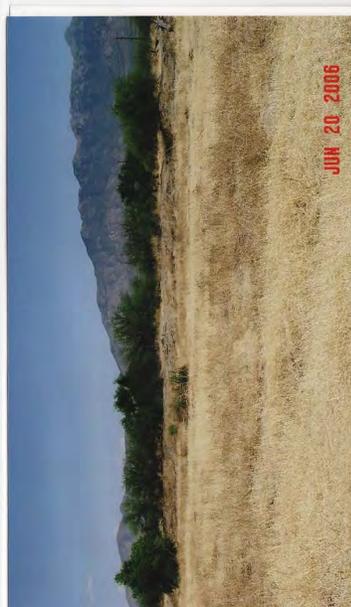
2004



**Photo Point No. 12 North**  
Flood flows have washed out some burro bush. Increase in Bermuda grass.

**Photo Point No. 12 East**  
Cottonwood (far left) has increased in vigor. Seepwillow (center left) has decreased in vigor, no change in mesquites on bank. Slight increase in Bermuda grass and tumbleweed.

2006



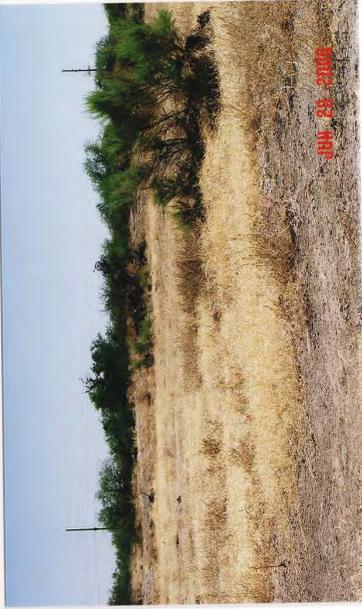
# Photo Point 12 South and West



**Photo Point No. 12**  
Looking south along the channel of the Santa Cruz River. There is a single seep willow in the channel at this location.



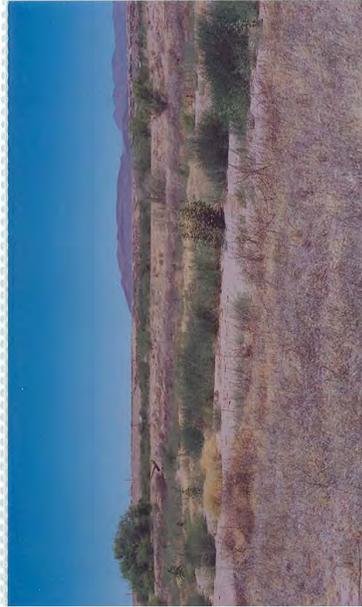
**Photo Point No. 12 South**  
Burro bush has increased in size. Increase of annual groundcover on bar.



**Photo Point No. 12 South**  
Mexican paloverde (growing within burro bush—note 2004 photos) has increased in vigor. Increase in tumbleweed and Bermuda grass.



**Photo Point No. 12**  
Looking west across the Santa Cruz River Channel. There is no perennial woody vegetation in the channel at this location.



**Photo Point No. 12 West**  
Mesquite (far-left) and burro bush show increased vigor. Increase in annual growth in channel.



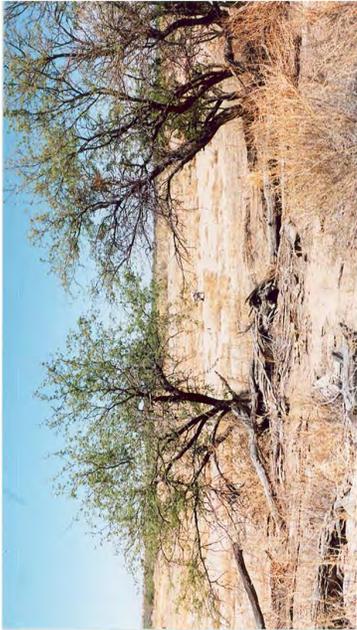
**Photo Point No. 12 West**  
Channel aggradation evident. Burrobush increase. Increase in Bermuda grass.

2002

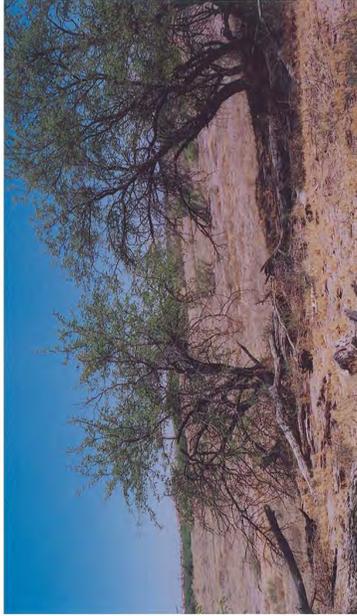
2004

2006

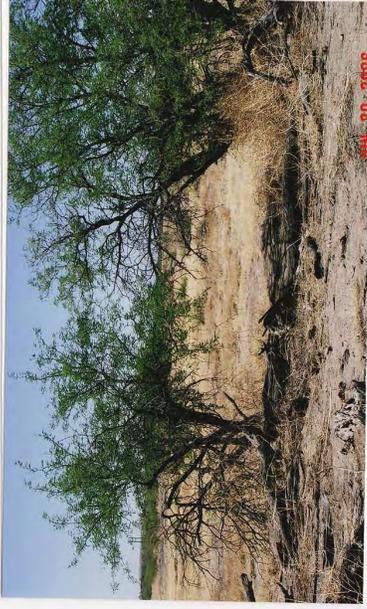
# Photo Point 13 North and East Views



**Photo Point No. 13**  
Looking north, or downstream, from the west bank of an "island" in the Santa Cruz River. Mesquite is the dominant perennial plant here.



**Photo Point No. 13 North**  
Burro bush in channel and distance is green. Slight increase in channel vegetation.



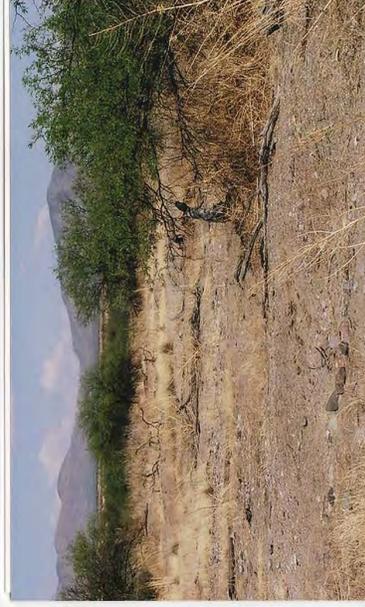
**Photo Point No. 13 North**  
Increase in tumbleweed debris. Short annuals not present.



**Photo Point No. 13**  
Looking east across the "island". Mesquite strongly dominates the perennial vegetation.



**Photo Point No. 13 East**  
Bunch grass is more prominent. Little change.



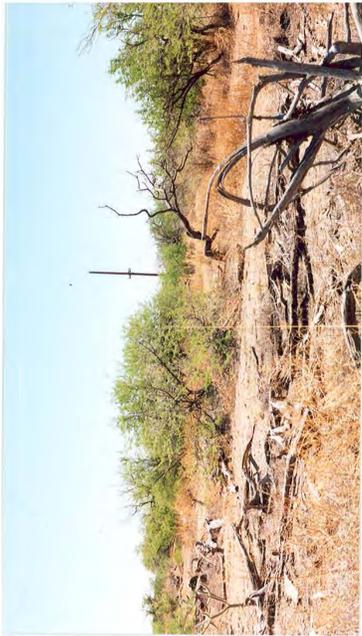
**Photo Point No. 13 East**  
Photo does not match previous years very well. Increase of tumbleweed debris. Increase in tall annuals.

2002

2004

2006

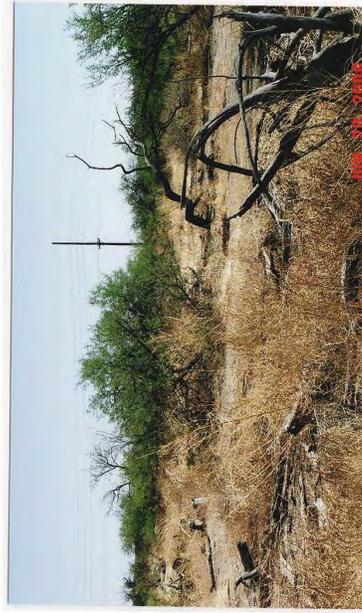
# Photo Point 13 South and West Views



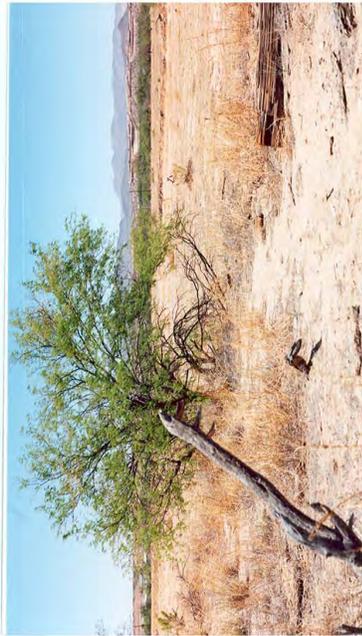
**Photo Point No. 13**  
Looking south along the west bank of the "island".  
Mature Mexican elder trees are also present at this site.



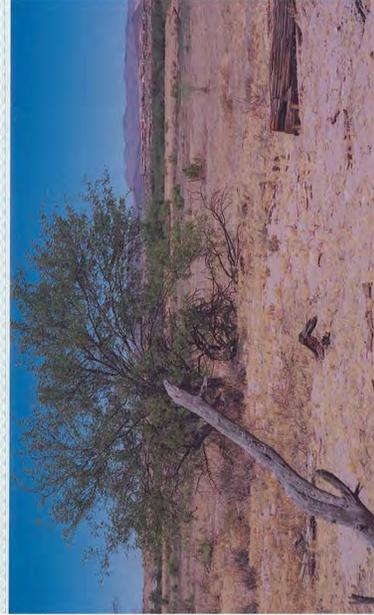
**Photo Point No. 13 South**  
There is very little change at this site. There are fewer tall annuals present.



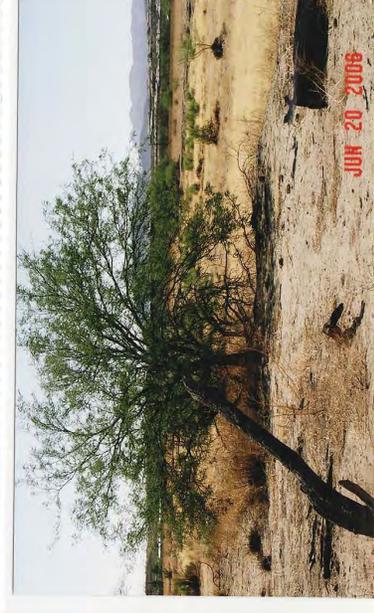
**Photo Point No. 13 South**  
Increase in tumbleweed debris. Mesquite showing slight stress with some leaf loss.



**Photo Point No. 13**  
Looking west across the Santa Cruz River.



**Photo Point No. 13 West**  
Desert broom in channel is green. There are no tall annuals.



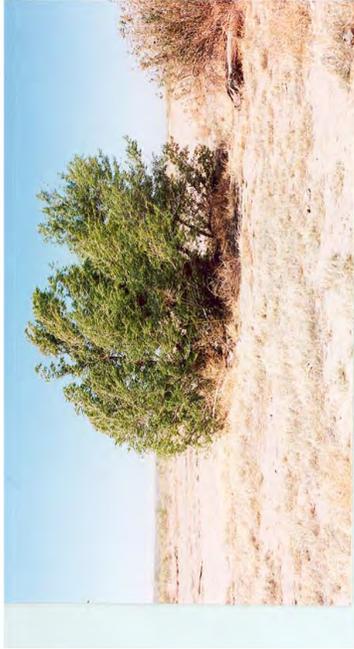
**Photo Point No. 13 West**  
Little change. More fall annuals, less short annuals. Mexican paloverde (center right) has increased in vigor. Increased flood debris on Mexican paloverde and shrub to right.

2002

2004

2006

# Photo Point 14 North and East Views



**Photo Point No. 14**  
Looking north from the east bank of the Santa Cruz River. The large plant in the center of the photo is a Goodding willow (*Salix gooddingii*), an obligate Wetland species, and the plant at right-center is a seep willow.



**Photo Point No. 14**  
Looking east over an area dominated by weedy species, primarily Russian Thistle. An old bank of the Santa Cruz River is visible across the center of the photo.

2002



**Photo Point No. 14 North**

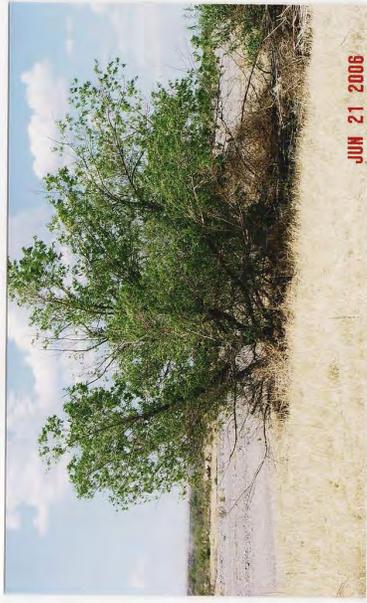
The Goodding willow has less foliage. There is an increase in Bermuda grass.



**Photo Point No. 14 East**

Burro bush has increased in size and number. Tumbleweeds are no longer present in the quantities shown in 2002.

2004



**Photo Point No. 14 North**  
\*New stake pounded in at this location.

Increase of woody debris between willow and seepwillow. Channel in the background has been scoured of most vegetation. Increase of coarse materials. Groundcover shows no change.



**Photo Point No. 14 East**  
\*New stake pounded in at this location.

Increase in burrobush vigor. Small mesquite (middle left) has increased in size. Less woody debris.

2006

# Photo Point 14 South and West Views

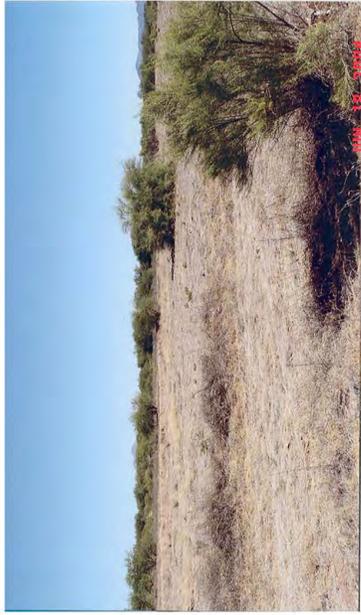


**Photo Point No. 14**  
Looking south across the Santa Cruz River floodplain. A burro bush is present in the center foreground and a seep willow at left center.



**Photo Point No. 14**  
Looking west across the Santa Cruz River. The large plants at left center are Fremont cottonwood and Goodding willow trees. Soils were moist within one centimeter of the surface at this location in the river channel.

2002



**Photo Point No. 14 South**  
\*\*\*

The burro bush has increased in vigor. Tamarisk has increased in size. Increased groundcover

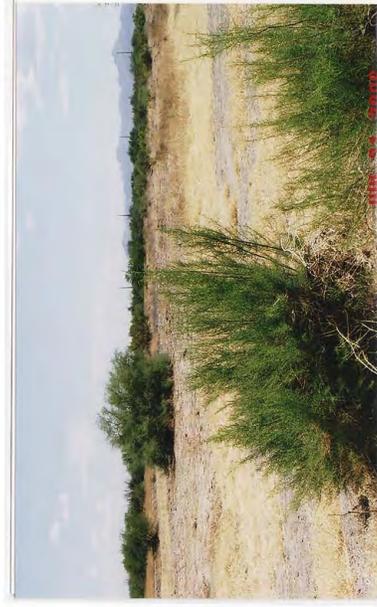


**Photo Point No. 14 West**  
\*\*\*

The cottonwoods have grown taller. Groundcover increase on bar. More burro bush and tumbleweed in wash.

\*\*\* These photos are not exact matches to 2002. See report for details.

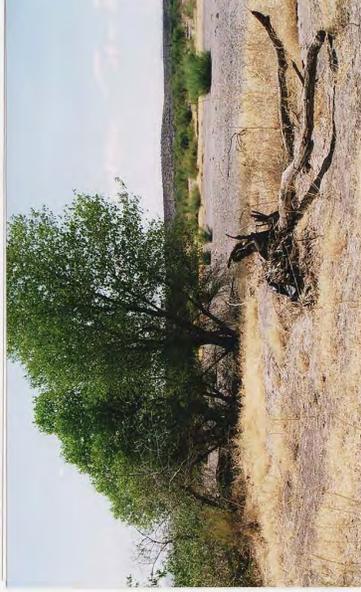
2004



**Photo Point No. 14 South**

\*New stake pounded in at this location.

Tamarisk has increased in vigor. Burrobush has increased. Fewer tumbleweed, less annual groundcover.



**Photo Point No. 14 West**

\*New stake pounded in at this location.

Increase in cottonwood vigor. Tree stump deposited. Channel bed scoured of most vegetation, except for burrobush (center-right).

2006

# Photo Point 15 North and East Views

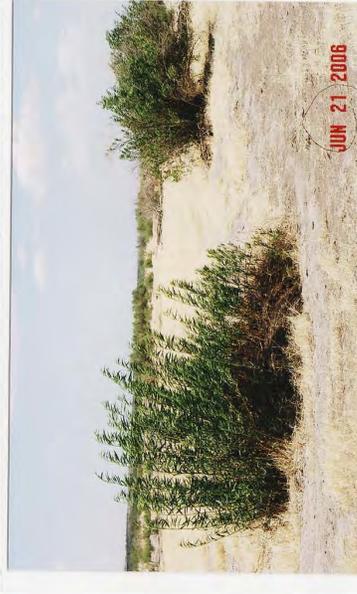


**Photo Point No. 15**  
Looking north on the Santa Cruz River from the east bank. Shrubs in this photograph are seep willows, a facultative wetland plant species.



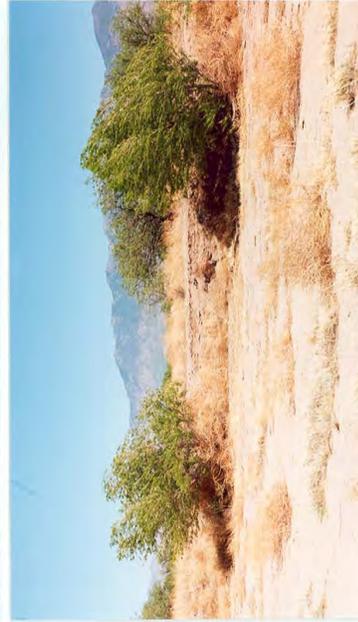
**Photo Point No. 15 North**  
\*\*\*

The seep willows have increased in size and vigor. There is an increase in groundcover. Air quality appears better, despite the very windy conditions.



**Photo Point No. 15 North**  
\*New stake pounded in at this location.

Increase in seepwillow vigor. Decrease in groundcover.



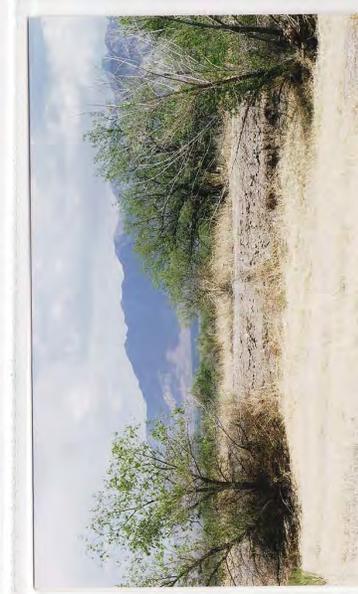
**Photo Point No. 15**  
Looking east at two Goodding willow trees just below the primary bank of the Santa Cruz River. Trees in the background are mesquites.



**Photo Point No. 15 East**

The Goodding willows appear sparser. There is an increase in groundcover. There is much woody flood debris.

\*\*\*These photos are not exact matches to 2002 photos. See reports for details.



**Photo Point No. 15 East**

\*New stake pounded in at this location.

Willows showing some stress. Top of bank has an increase in tall annuals.

2002

2004

2006

# Photo Point 15 South and West Views



**Photo Point No. 15**  
Looking south on the first terrace below the primary bank of the Santa Cruz River.  
Tree at right-center is Goodding willow; to the left are mesquite trees



**Photo Point No. 15 South**  
There are more burro bush foliage and sprouts. There is more grass cover in the channel. The banks are lacking the orange colored annual present in 2002.



**Photo Point No. 15 South**  
\*New stake pounded in at this location.  
Burrobush has grown. Less woody debris.



**Photo Point No. 15**  
Looking west across the main channel of the Santa Cruz River.  
The large plant at left-center is a seep willow with a burro bush in the river channel.



**Photo Point No. 15 West**  
\*\*\*  
The burro bush is taller. Increase in groundcover. Increase in woody flood debris.  
\*\*\*These photos are not exact matches to 2002 photos.  
See report for details.



**Photo Point No. 15 West**  
\*New stake pounded in at this location.  
Channel has aggraded. Flood flows removed annual vegetation and woody debris.

2002

2004

2006

# Photo Point 16 North and East Views



**Photo Point No. 16**  
 Looking north across the flood plain of the Santa Cruz River.  
 Larger plants in the center of the photo are young burro bushes



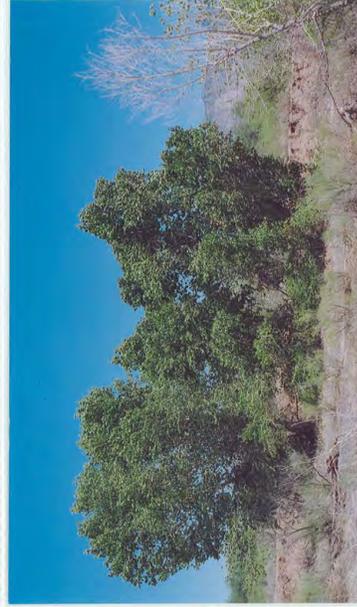
**Photo Point No. 16 North**  
 There is an increase in grass cover. The burro bush is much more vigorous. Less dust present, despite very windy conditions.



**Photo Point No. 16 North**  
 Increase in woody debris. Increased burrobush recruitment.



**Photo Point No. 16**  
 Looking east at several cottonwood trees growing on the first terrace of the Santa Cruz River. Cottonwood trees are also facultative wetland plants and have a high water requirement.



**Photo Point No. 16 East**  
 Burro bush shows increased vigor. Cottonwoods show increase in size. Cottonwood (center-left) shows dieback. Immigrant dump present under cottonwoods.



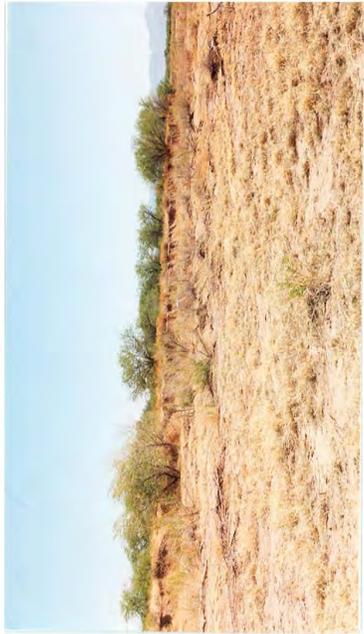
**Photo Point No. 16 East**  
 Cottonwoods showing signs of stress. Increase in tall annuals.

2002

2004

2006

# Photo Point 16 South and West Views



**Photo Point No. 16**  
Looking south across the first terrace of the Santa Cruz River. Trees in this photograph are all mesquites.



**Photo Point No. 16**  
Looking west across the main channel of the Santa Cruz River. Dark plants at the river's edge are seep willows. Lighter plants in the center of the photo are burro bush.



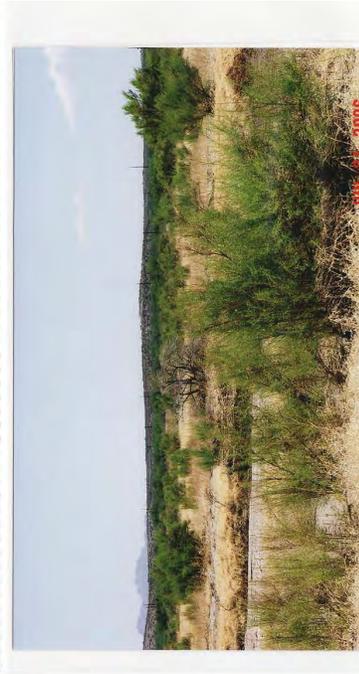
**Photo Point No. 16 South**  
Mesquite on top-left has died. More burro bush present.



**Photo Point No. 16 West**  
Increase in burro bush sprouts and vigor. More annual groundcover present in channel.



**Photo Point No. 16 South**  
Photo is not an exact match. Increase in burrobush vigor. Increase in groundcover, primarily tumbleweed.



**Photo Point No. 16 West**  
Photo is not an exact match (zoomed in too closely). Increase in burrobush vigor. Mesquite (center left) has died, or is extremely stressed.

2002

2004

2006

# Photo Point 17 North and East Views



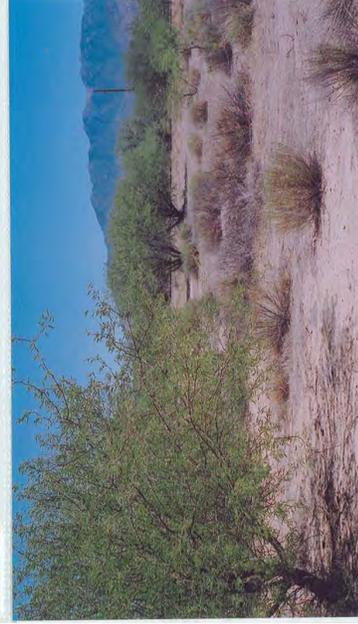
**Photo Point No. 17**  
Looking north across this upland site on the east side of the Santa Cruz River. Dominant vegetation here is mesquite with burrow weed (*Gouania temnisecta*) a common shrub species.



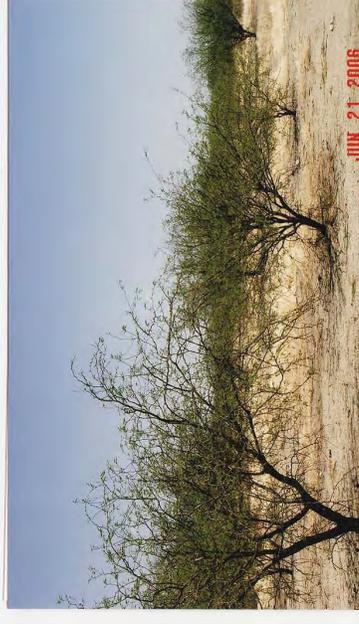
**Photo Point No. 17**  
Looking east toward the railroad tracks. Larger plants are mesquites. The small shrub at lower, right-center is a burrow weed.



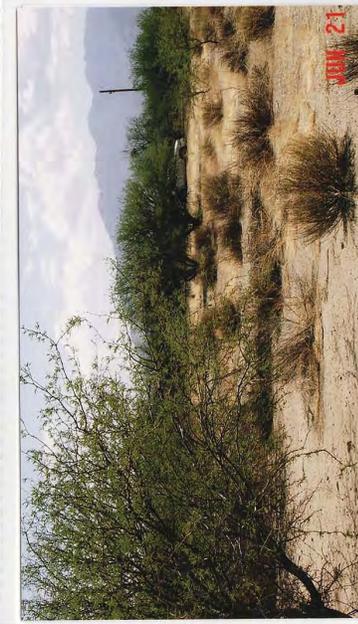
**Photo Point No. 17 North**  
The tall annuals present in April 2002 are no longer there. Mesquite vigor looks similar. A prominent trail is visible on the far left center of the photo.



**Photo Point No. 17 East**  
There is a lack of tall annuals.



**Photo Point No. 17 North**  
Mesquites showing signs of stress. More annual groundcover in photo background.



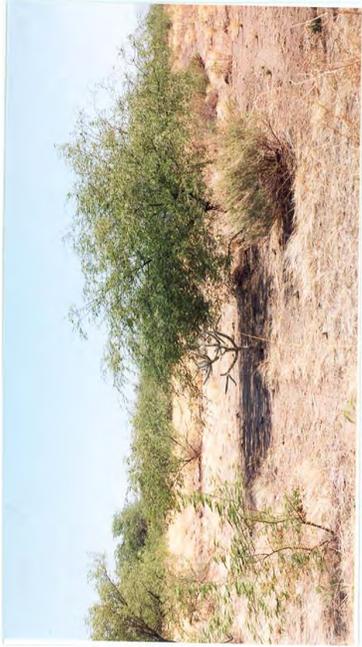
**Photo Point No. 17 East**  
Little change apparent.

2002

2004

2006

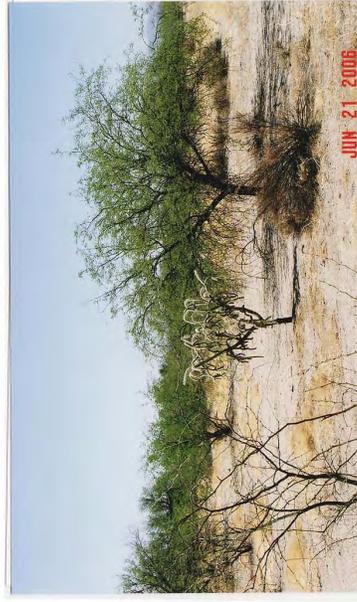
# Photo Point 17 South and West Views



**Photo Point No. 17**  
Looking south over the mesquite-dominated landscape on the east side of the Santa Cruz River.



**Photo Point No. 17 South**  
The cholla has grown.



**Photo Point No. 17 South**  
Mesquites and shrubs showing signs of stress. Cholla has grown.



**Photo Point No. 17**  
Looking west toward the Santa Cruz River. Small, green shrubs in this photo are burrow weed. Telegraph plant (*Heterotheca psammophila*) is a common fall annual at this site.



**Photo Point No. 17 West**  
There are no fall annuals.



**Photo Point No. 17 West**  
Mesquites and shrubs showing signs of stress. Increase in low annuals.

2002

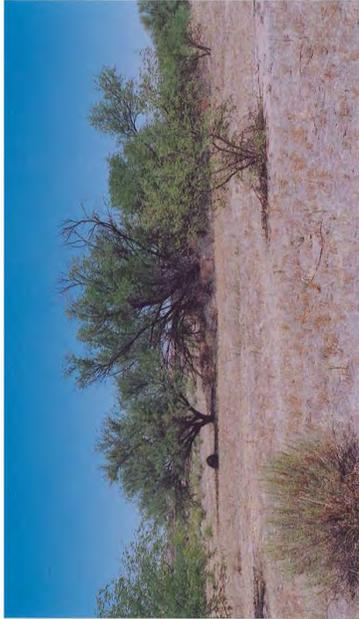
2004

2006

# Photo Point 18 North and East Views



**Photo Point No. 18**  
Looking north toward a large Goodding willow on the east bank of the Santa Cruz River.



**Photo Point No. 18 North**

The Goodding willow is dead. Mesquite vigor has not changed.



**Photo Point No. 18 North**

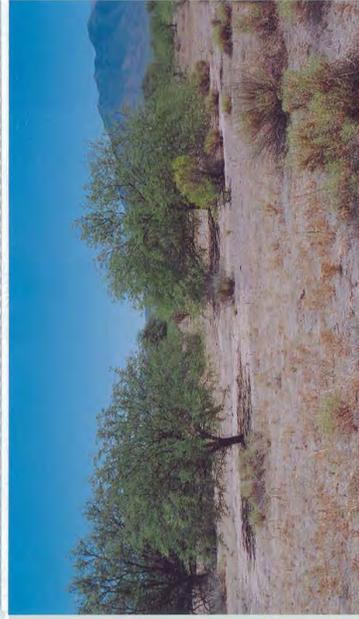
\*New stake pounded in at this location.

Decrease in annuals. Mesquites showing signs of stress and dieback.



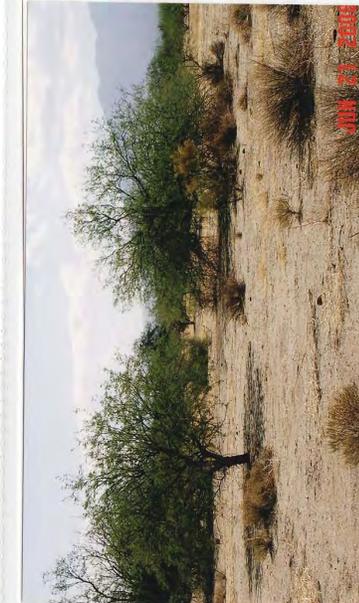
**Photo Point No. 18**

Looking east at large mesquite trees on the east bank of the Santa Cruz River.



**Photo Point No. 18 East**

Shorter annuals have replaced the taller annuals seen in 2002.



**Photo Point No. 18 East**

\*New stake pounded in at this location.

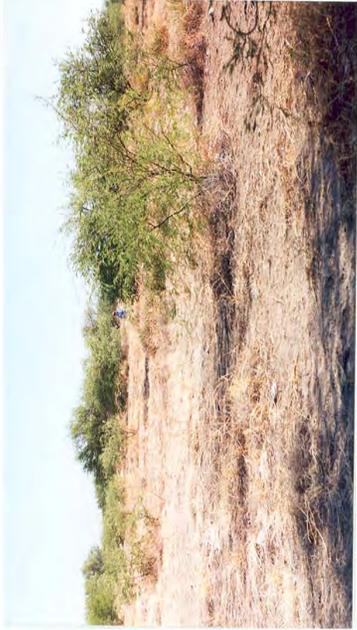
Decrease in groundcovers. Mesquites showing signs of stress. Shrubs are stressed.

2002

2004

2006

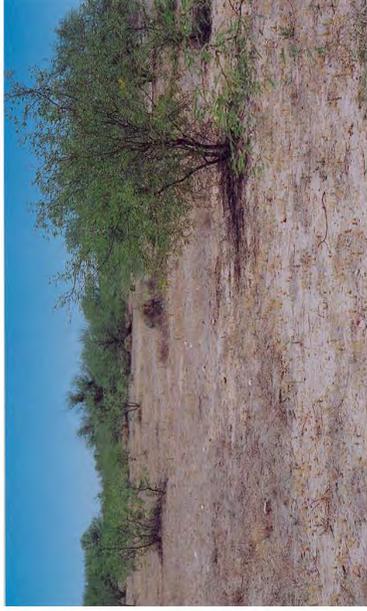
# Photo Point 18 South and West



**Photo Point No. 18**  
Looking south across the mesquite-dominated uplands on the east bank of the Santa Cruz River.



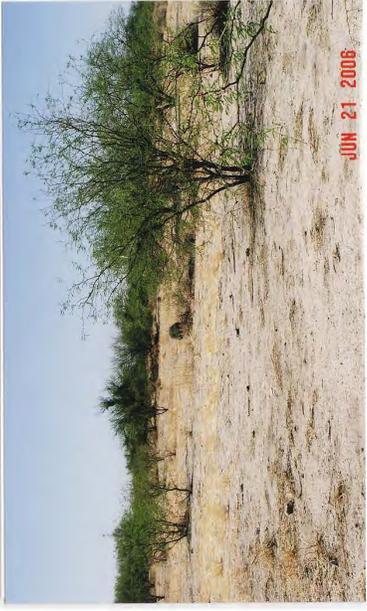
**Photo Point No. 18**  
Looking west toward the Santa Cruz River channel from the east bank. A barrel cactus (*Ferocactus Wiltzenii*) is located at the right—center of the photo.



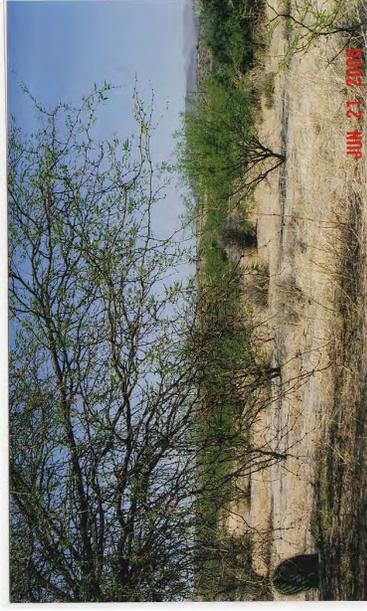
**Photo Point No. 18 South**  
Shorter annuals have replaced the taller annuals seen in 2002.



**Photo Point No. 18 West**  
The shrub in the upper middle appears dead or near-dead.



**Photo Point No. 18 South**  
\*New stake pounded in at this location.  
Decrease in groundcover. Mesquites showing signs of stress.



**Photo Point No. 18 West**  
\*New stake pounded in at this location.  
No apparent change.

2002

2004

2006

# Photo Point 19 North and East Views



**Photo Point No. 19**  
 Looking north across mesquite-dominated landscape on the east bank of the Santa Cruz River. Small shrubs in the foreground are burrow weed. Note the large barrel cactus near right-center.



**Photo Point No. 19**  
 Looking east across the grass, burrow weed, and mesquite-dominated landscape. Note the barrel cactus in the lower left corner of the photo

2002



**Photo Point No. 19 North**  
 There are fewer shrubs and less groundcover.

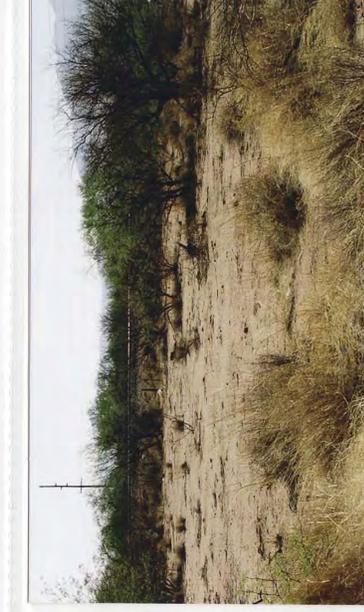


**Photo Point No. 19 East**  
 Barrel cactus (used to be lower left in the photo) had fallen over by October 2002. There are fewer and less vigorous grasses.

2004



**Photo Point No. 19 North**  
 \*New stake pounded in at this location.  
 Mesquites stressed, leaf loss, and die back.



**Photo Point No. 19 East**  
 \*New stake pounded in at this location.  
 Bunch grasses in foreground appear to be doing well. Shrubs in midground and foreground are either very stressed or have died. Very little groundcover in midground. Trees are stressed.

2006

# Photo Point 19 South and West Views

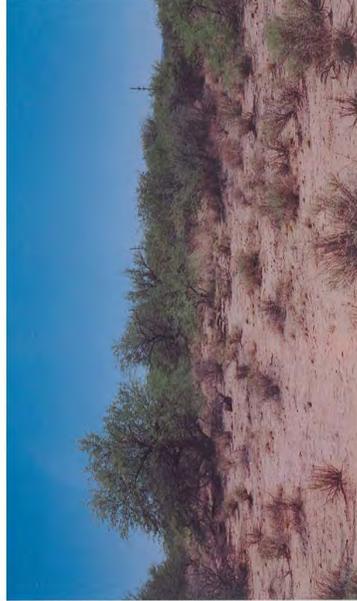


**Photo Point No. 19**  
Looking south across a landscape whose physiognomy is that of Semidesert grassland on the east bank of the Santa Cruz River.

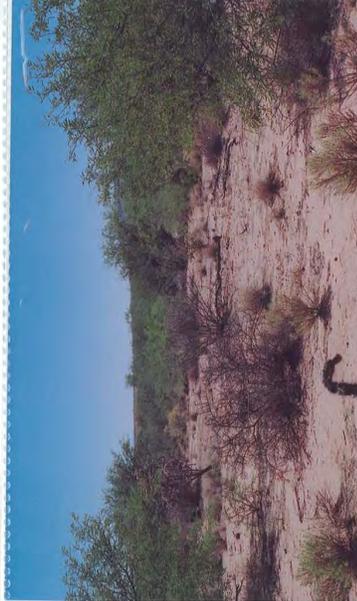


**Photo Point No. 19**  
Looking west toward the Santa Cruz River. Grasses, burrow weed, and mesquite are dominant forms and species here.

2002

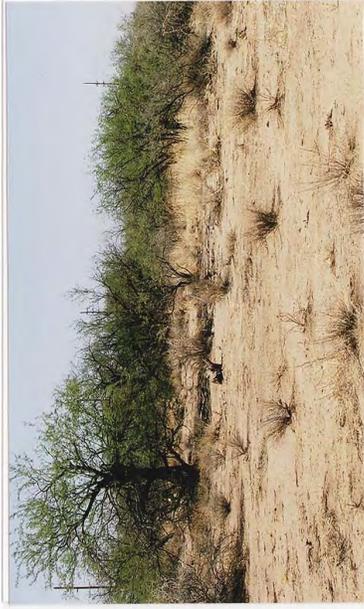


**Photo Point No. 19 South**  
There are fewer grasses.

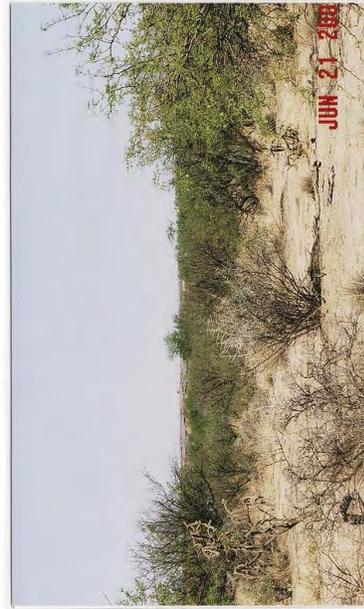


**Photo Point No. 19 West**  
There are fewer grasses.

2004



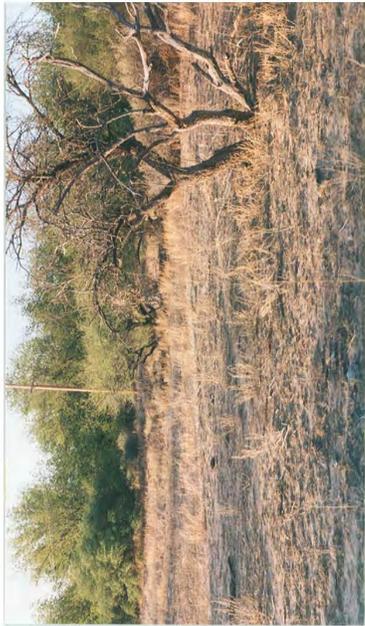
**Photo Point No. 19 South**  
\*New stake pounded in at this location.  
Trees showing signs of stress. Shrubs have died.



**Photo Point No. 19 West**  
\*New stake pounded in at this location.  
Mesquites and shrubs are stressed.

2006

# Photo Point 20 North and East Views



**Photo Point No. 20**  
Looking north from a point just south of Pima County's north property line at Canoa Ranch. The large, nearly dead tree at right-center is a mesquite.



**Photo Point No. 20**  
Looking east toward the railroad grade.



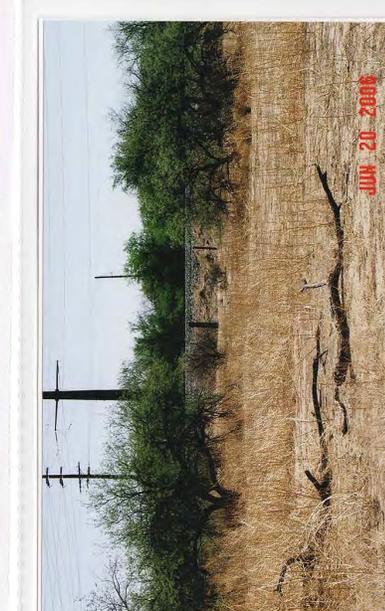
**Photo Point No. 20 North**  
Mesquite at right-center has increased vigor. Shrubs at upper center-right appear dead. Pecans appear more dense.



**Photo Point No. 20 East**  
Shorter annuals. Increased mesquite vigor.



**Photo Point No. 20 North**  
Mesquites stressed, dieback. More tall annuals.



**Photo Point No. 20 East**  
More tall annuals. Mesquites slightly stressed.

2002

2004

2006

# Photo Point 20 South and West



**Photo Point No. 20**  
Looking south across the mesquite-dominated landscape



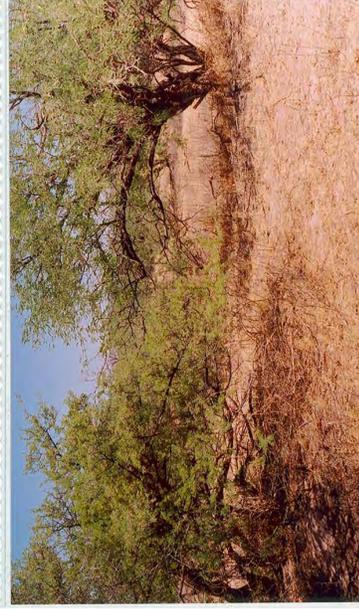
**Photo Point No. 20 South**  
Acacias have leafed-out. Increased mesquite vigor.



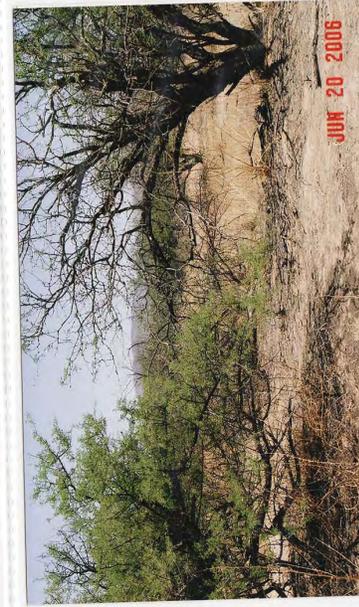
**Photo Point No. 20 South**  
More tall annuals. Small mesquite appears dead.



**Photo Point No. 20**  
Looking west into the sun.



**Photo Point No. 20 West**  
There appears to be no noticeable difference between this photo and the one taken in 2002. (For comparison, the October 2002 photo was used)



**Photo Point No. 20 West**  
Mesquite stressed, showing signs of dieback. Slight decrease in tall annuals.

2002

2004

2006