

The Vegetation of the Middle Effluent Dominated Santa Cruz

Josh Gormally

Santa Cruz River Researchers' Day 2011

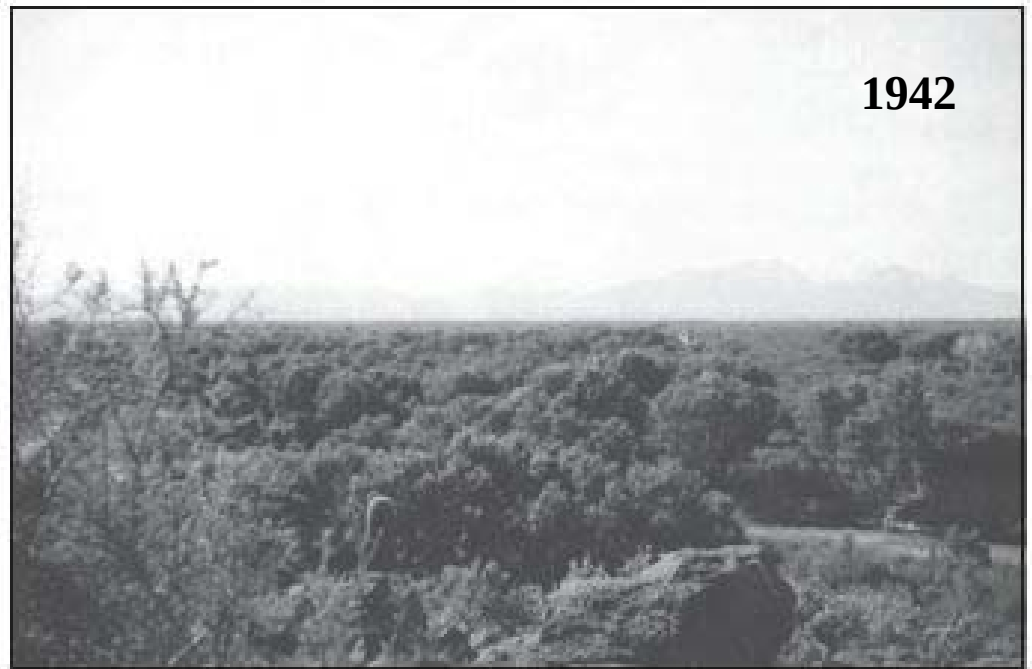
Riparian Vegetation Loss Due to Overuse of Water Resources

Photograph taken of Santa Cruz
River Basin south of Tucson in
1942 showing dense stands of
Mesquite and Cottonwood.

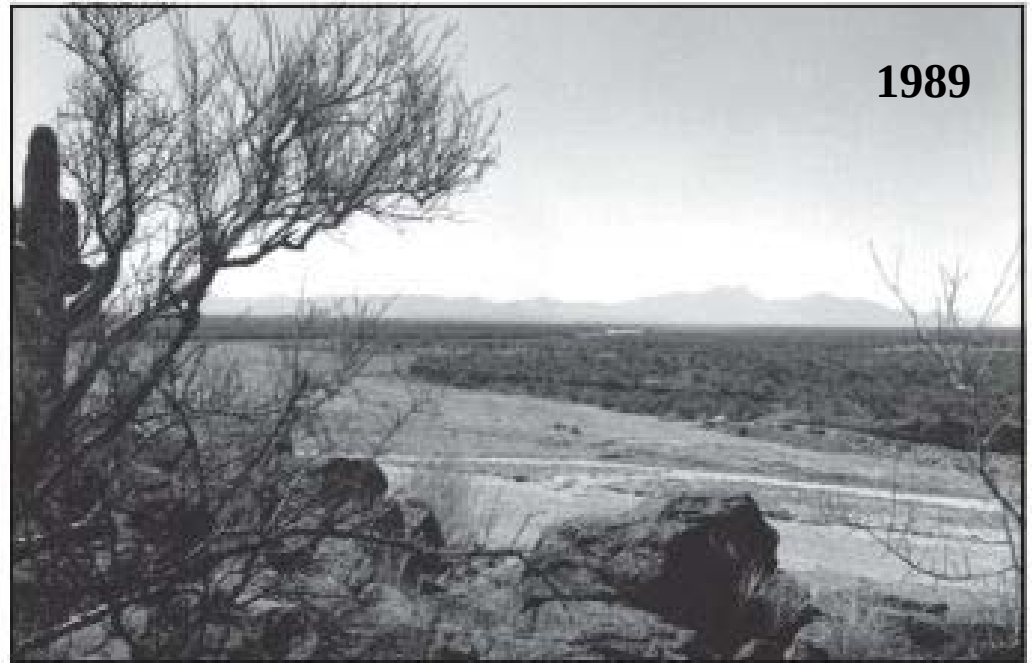


Photograph taken at the same
location in 1989 showing the loss
of the riparian tree ecosystem due
to unsustainable aquifer pumping.

1942

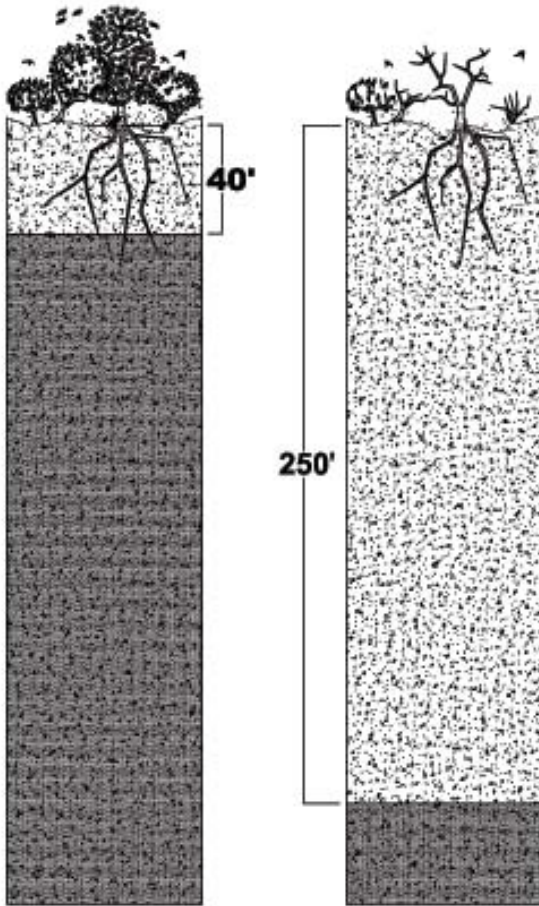


1989



Photographs taken by Robert H. Webb,
courtesy USGS,
<http://pubs.usgs.gov/fs/fs-103-03/>

The Depleted & Damaged Santa Cruz River



Two hundred years ago the groundwater table was less than 50 ft. below the surface. By 1923 groundwater usage rates had surpassed recharge rates (Nabhan 1999). Today the groundwater table is 200 - 250 ft. below the surface (Fabre 2009).

- By 1923 groundwater use-age rates surpassed natural recharge rates & water use-age became unsustainable sealing the fate of the River.
- 200 years ago groundwater table was less than 50 ft. below surface
- Today it is 200-250 ft. below the surface
- Currently the Tucson area withdraws water at a rate 5 times greater than the tables are recharged



- Increased ground water removal in 40's led to final demise of the riparian forests.

Lost Wildlife of the Santa Cruz

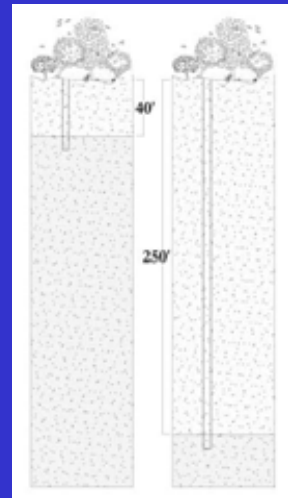
- 100 years ago regionally extinct species
- muskrats, beaver, black tailed prairie dogs, edible fish and wild turkeys



The Santa Cruz River

Severely Damaged Ecosystem

- Perrenial Waters **GONE**
- Riparian Forests **GONE**
- Riparian Wildlife Species **GONE**
- Sustainable Natural Aquatic System **GONE**
- Fish species **GONE**
- 10' to 50' Water Table **GONE** and being harvested at 5 times a sustainable rate.
- 90% of our riparian areas in the Southwest are severely depleted.



River Restoration, Rehabilitation & Reconciliation

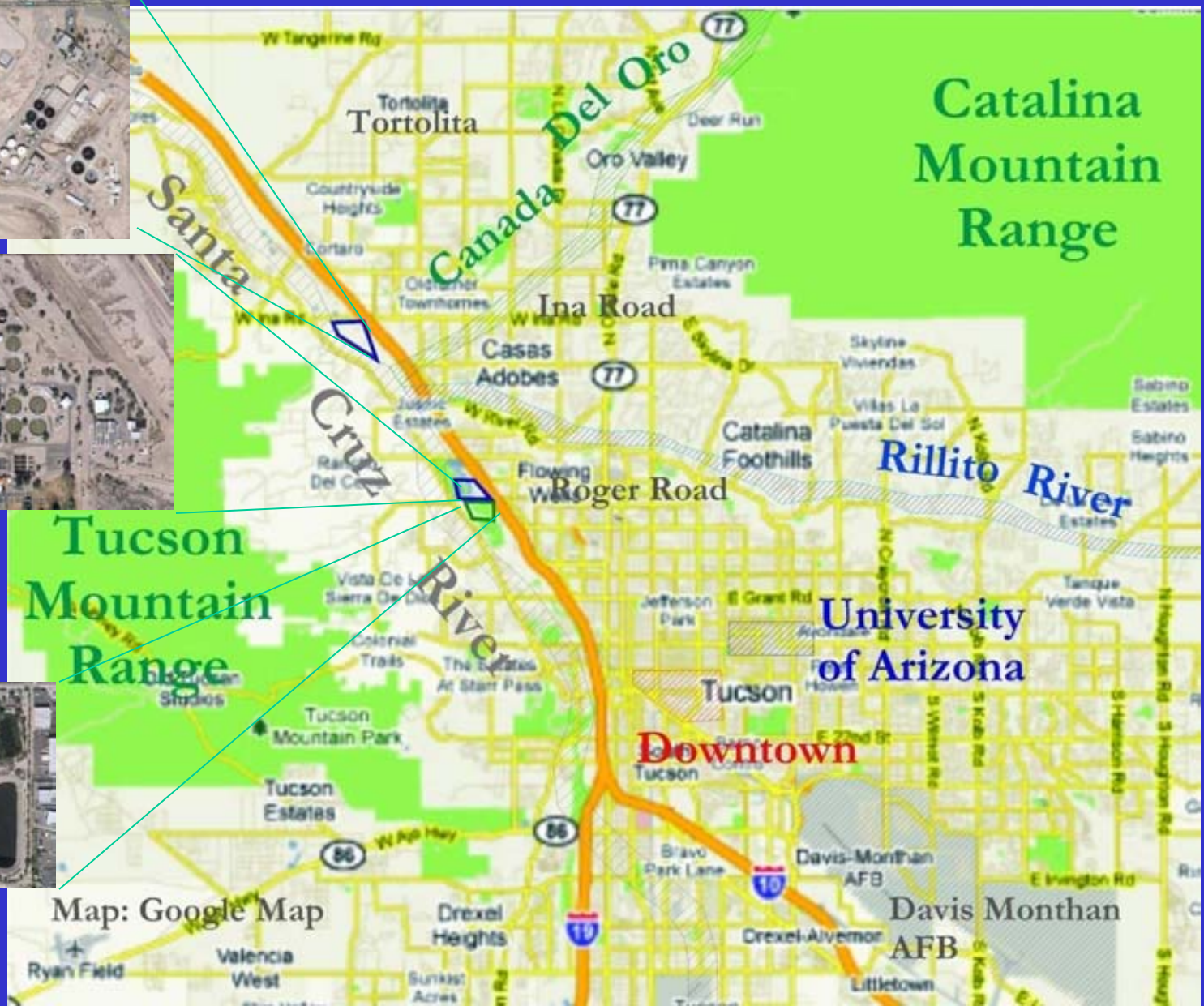
- Restoration efforts are aimed at returning a damaged ecosystem to what it once was.
- Rehabilitation efforts seek to repair damage done to an ecosystem.
- Reconciliation efforts seek to make an amends to the ecosystem and the planet as a whole by creating a new ecosystem resembling the old debilitated one.

Effluent Water Release

- Groundwater Re-charge
 - >60,000 acre feet/year released into the river bed
 - Partial River Rehabilitation
 - since 1977
 - ~30 effluent dependent miles
- In 2000 48,050,000 gallons effluent water released daily.
- Approximately 30 miles partially rehabilitated .



Two effluent Outlet Points Into S.C. in Tucson Metro Region



Direct Effluent Release



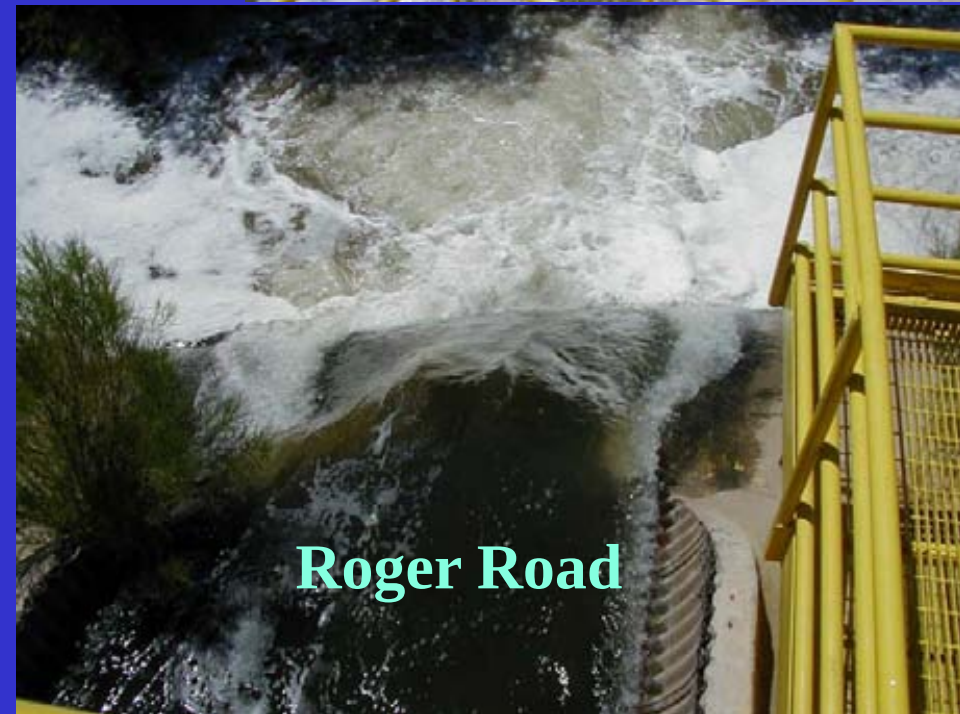
Ina Road



2002



2010



Roger Road

Effluent
Outflow

Ina Road
Treatment
Plant

Ina Road

Santa

Cruz

River

Aerial: Google Earth

© 2010 Europa Technology

© 2010 Google



A scenic view of a river with yellow and green trees reflected in the water. The image shows a calm body of water reflecting the surrounding trees and a clear blue sky. On the left, there are trees with bright yellow foliage. In the center and right, there are green trees. The reflection is very clear, creating a mirror-like effect.



A photograph of a pond surrounded by tall grass and trees under a clear blue sky. The pond is in the center, reflecting the sky and the surrounding greenery. The grass is tall and green, and the trees are in the background, some with pink blossoms. The sky is a clear, bright blue.

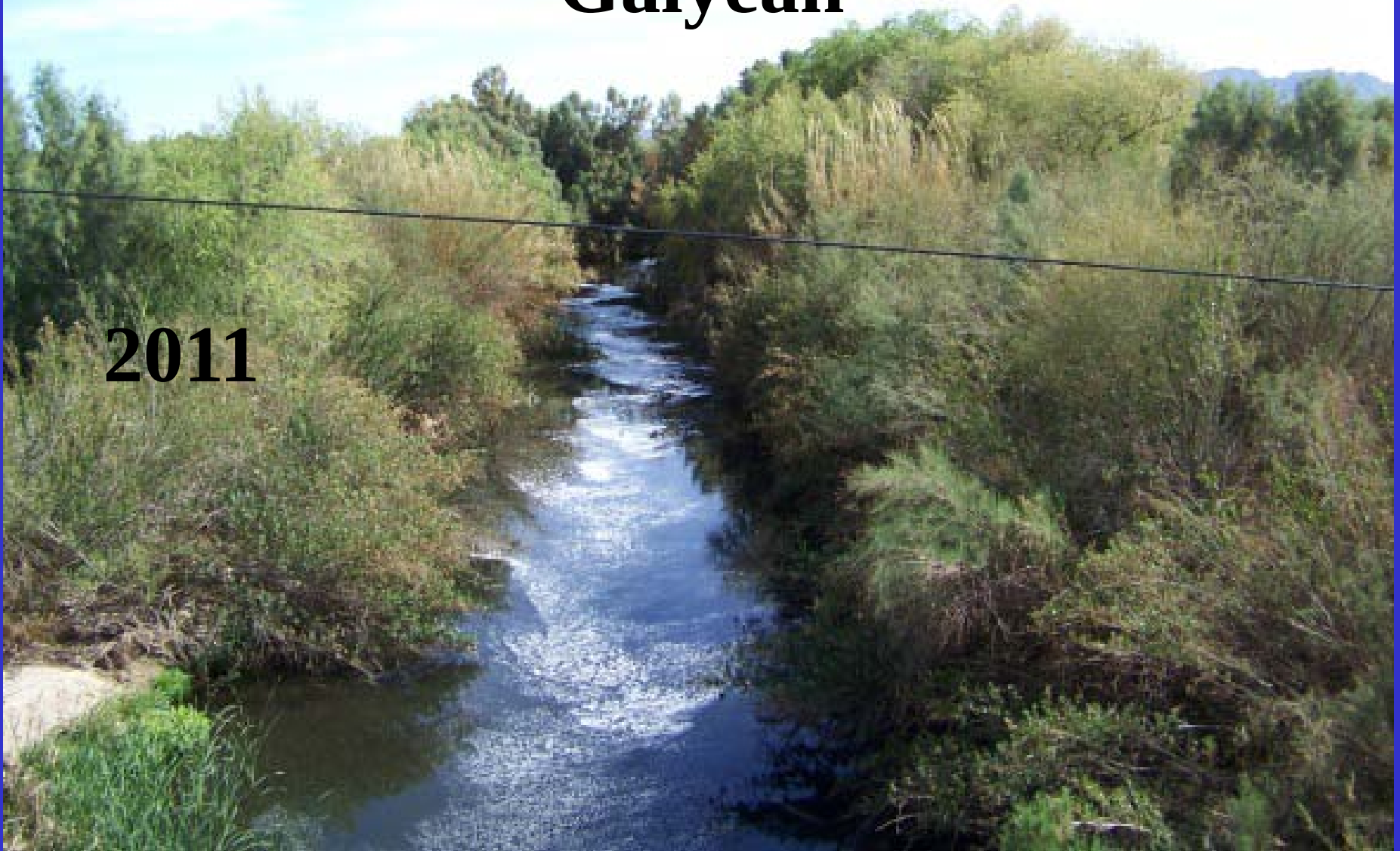
Efficiency of river recharge

2002

- Study by Ken Galyean concluded that 89.8% of effluent released into the S.C. from October 1990 to September 1993 percolated down to the water tables and recharged the aquifers.

**10.2% lost to evapotranspiration,
Galyean**

2011





Effluent Effected



Thesis

“Changes in Riparian Vegetation
Following Release of Reclaimed
Effluent Water Into the Santa Cruz
River: As a Corollary, the Effects of
Channelization on Vegetation in the
Santa Cruz River”

University of Arizona 2002

Effects of Effluent on Vegetation in the Santa Cruz River ?



Effects of Channelization on Vegetation in the Santa Cruz River

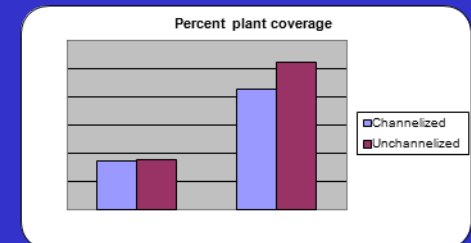
Channelized with Effluent



Channelized
without
Effluent



- Density
- Richness
- Diversity
- Nativity
- Plant Type Composition
- Cover
- Cover w/Nativity
- Plant Type Cover



Project Model: Effects on Vegetation

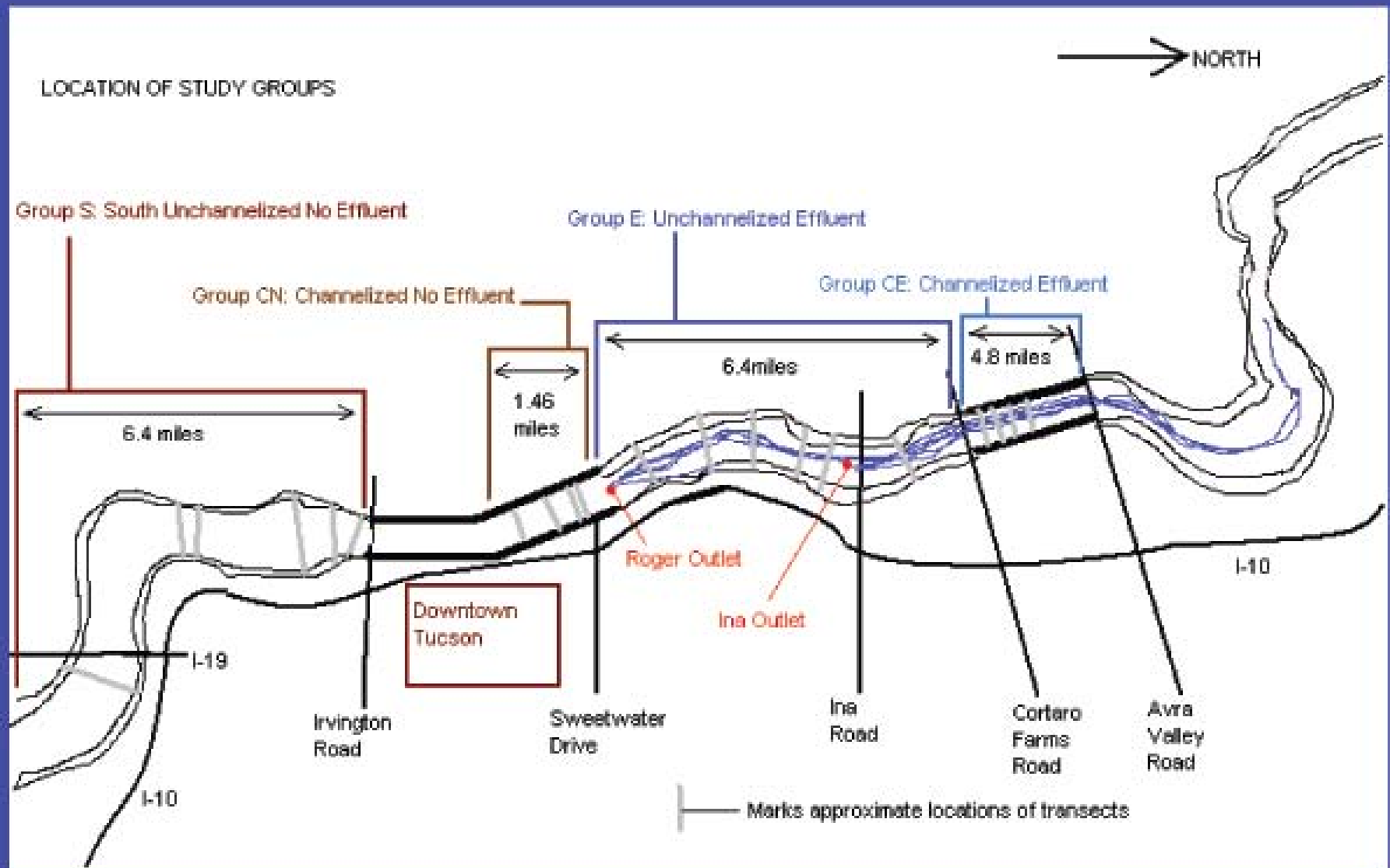
Effluent

- Quasi-experimental model
- Similar to a control group study
- Treated groups have effluent
- Control groups contain no effluent

Channelization

- Quasi-experimental model
- Similar to a control group study
- Treated groups are channelized
- Control groups are not channelized

Study Sites

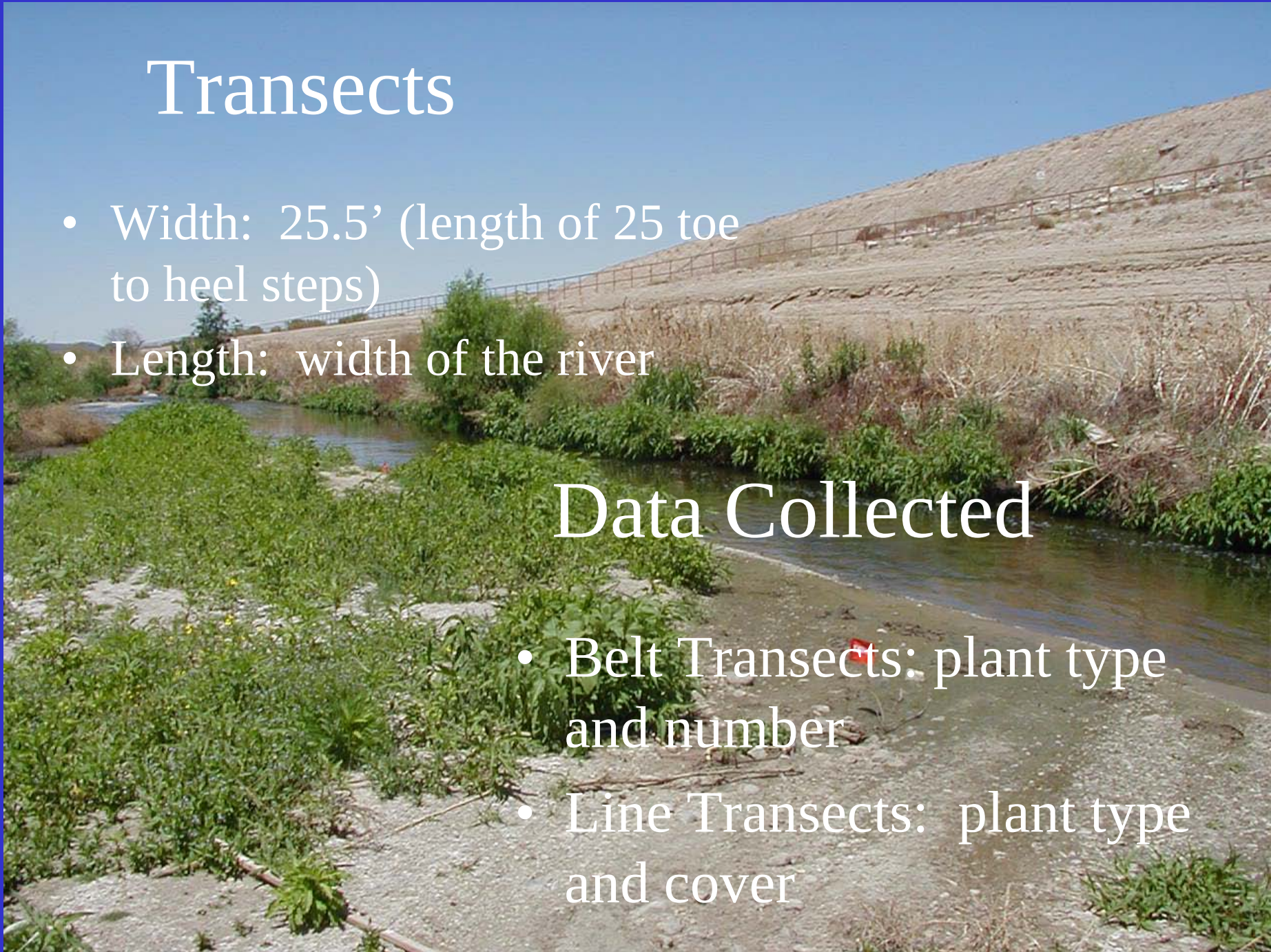


Transects

- Width: 25.5' (length of 25 toe to heel steps)
- Length: width of the river

Data Collected

- Belt Transects: plant type and number
- Line Transects: plant type and cover



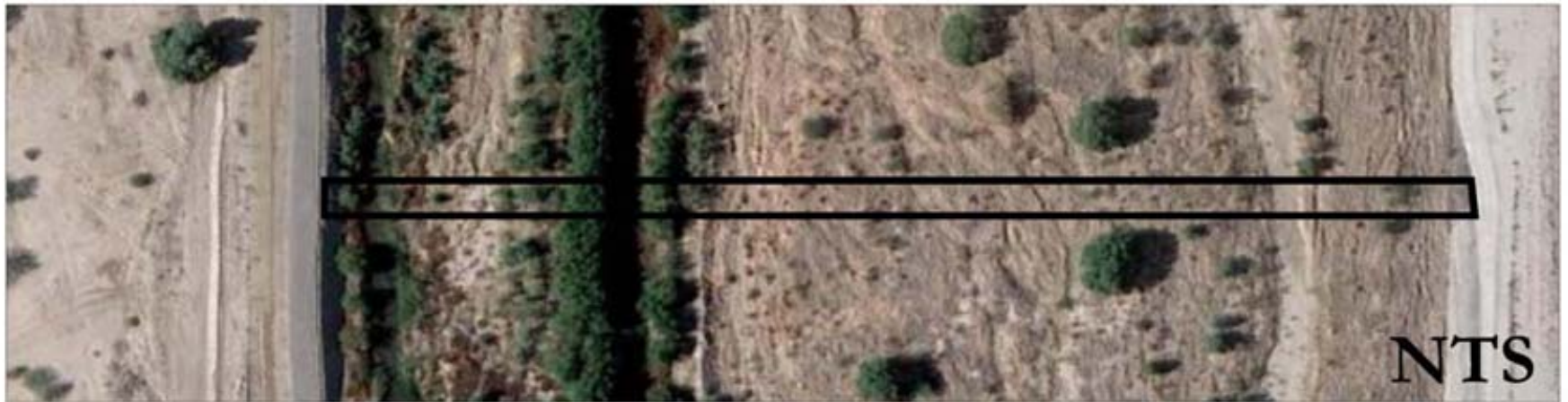
Sample Un-Channelized Transects



Transects $25 \frac{1}{2}$ feet by river width of river



Sample Channelized Transects



Transects 25 $\frac{1}{2}$ feet by river width of river

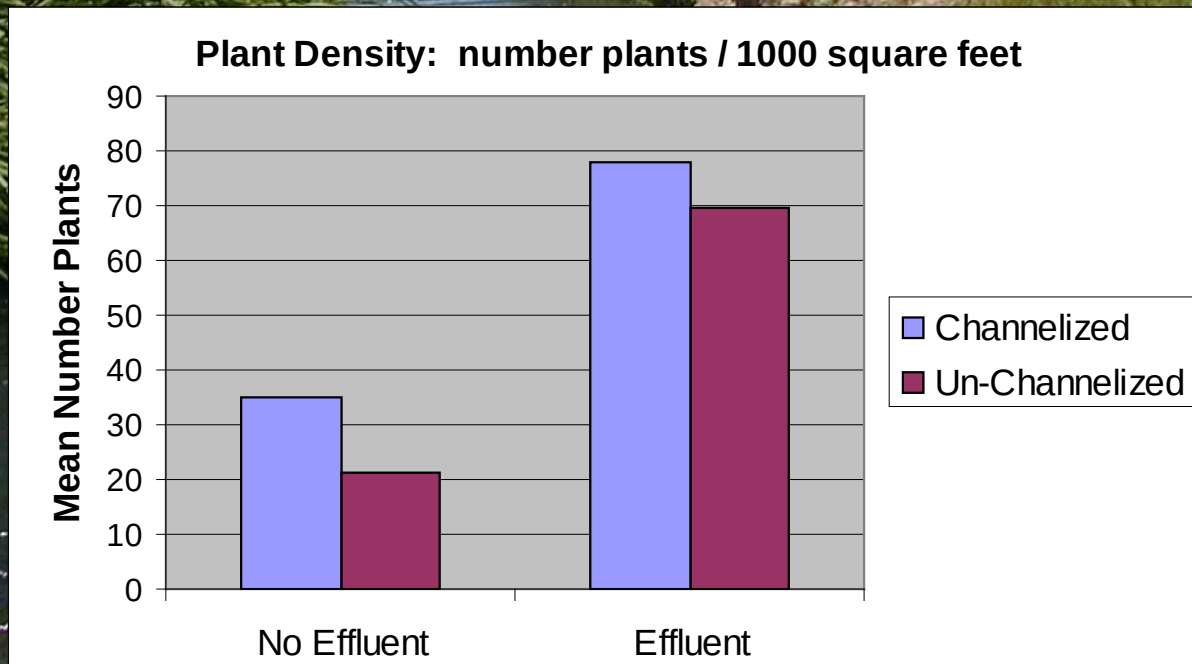


Analytical Measurements

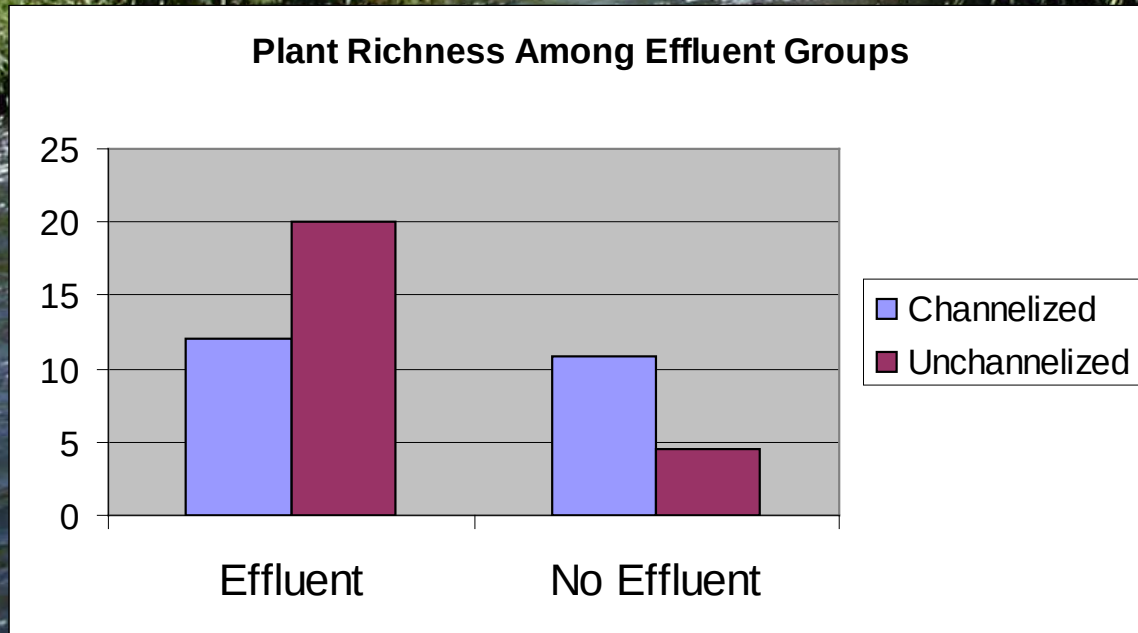
- **Density:** No. of plants/1000 sq.ft.
- **Richness:** Menhinick's Index
- **Diversity:** Shannon Weiner Diversity Index
- **Percent Native Plants:** No. native/total
- **Cover:** total length of all plant canopies/length line transect



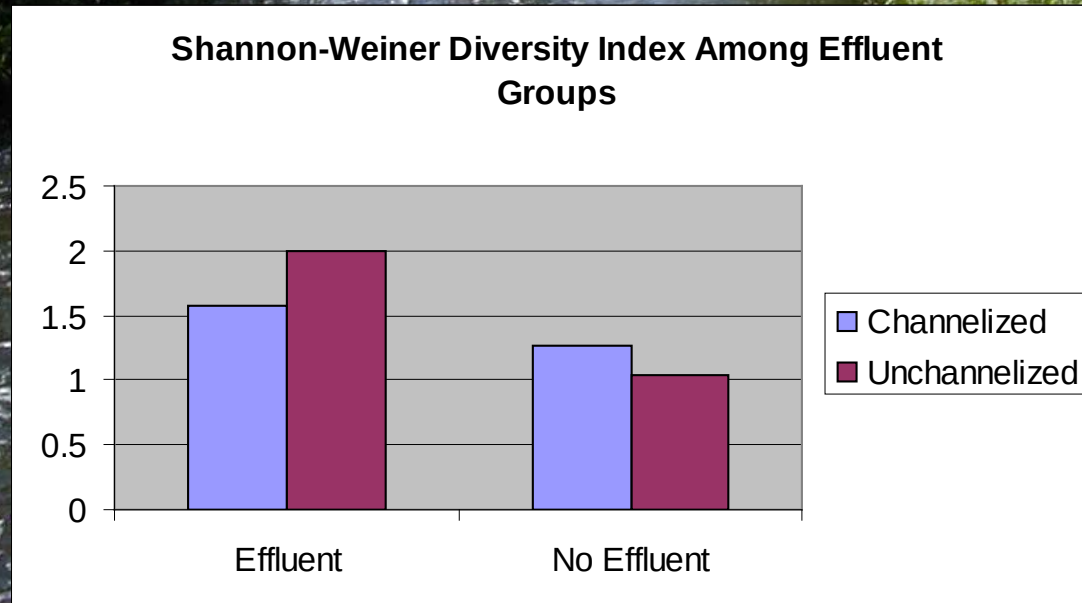
Density



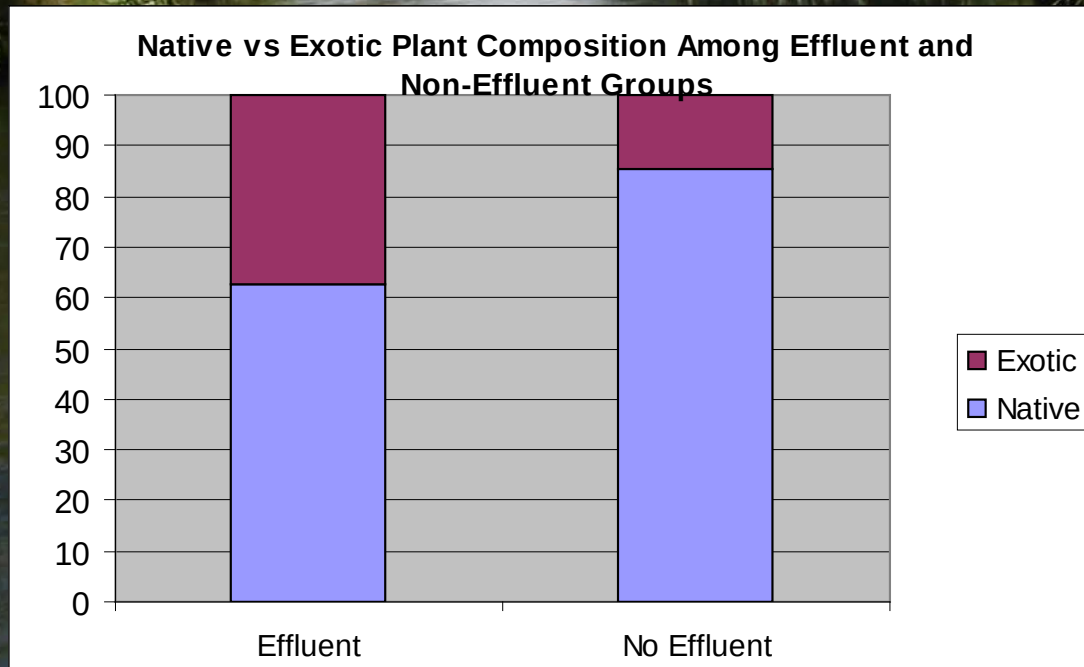
Richness



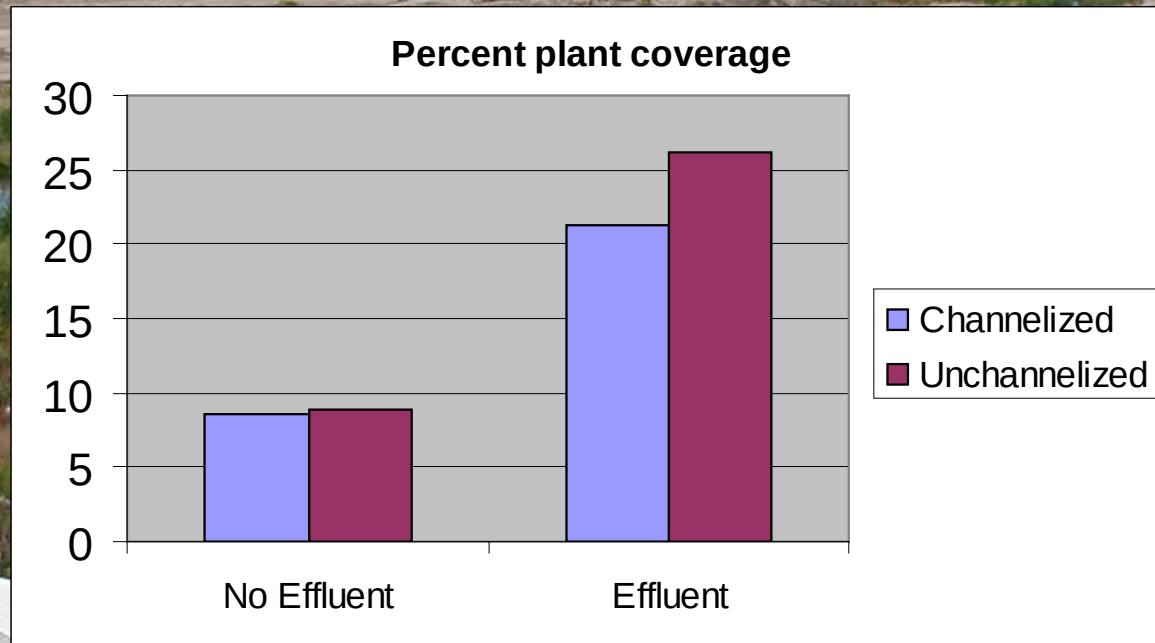
Diversity



Nativity

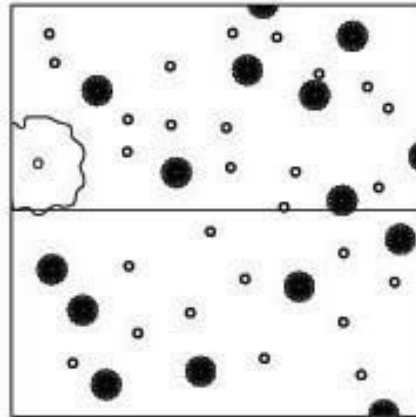


Cover

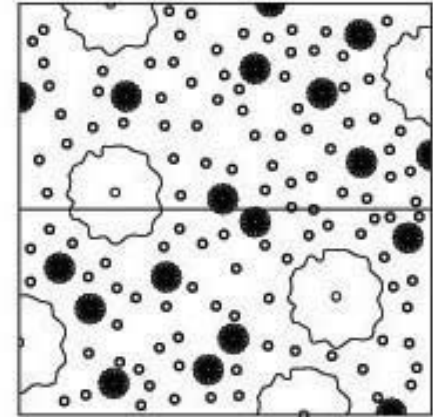


Santa Cruz River: Vegetative Cover in the Effluent Effected Stretch,
Gormally 2002.

No Effluent

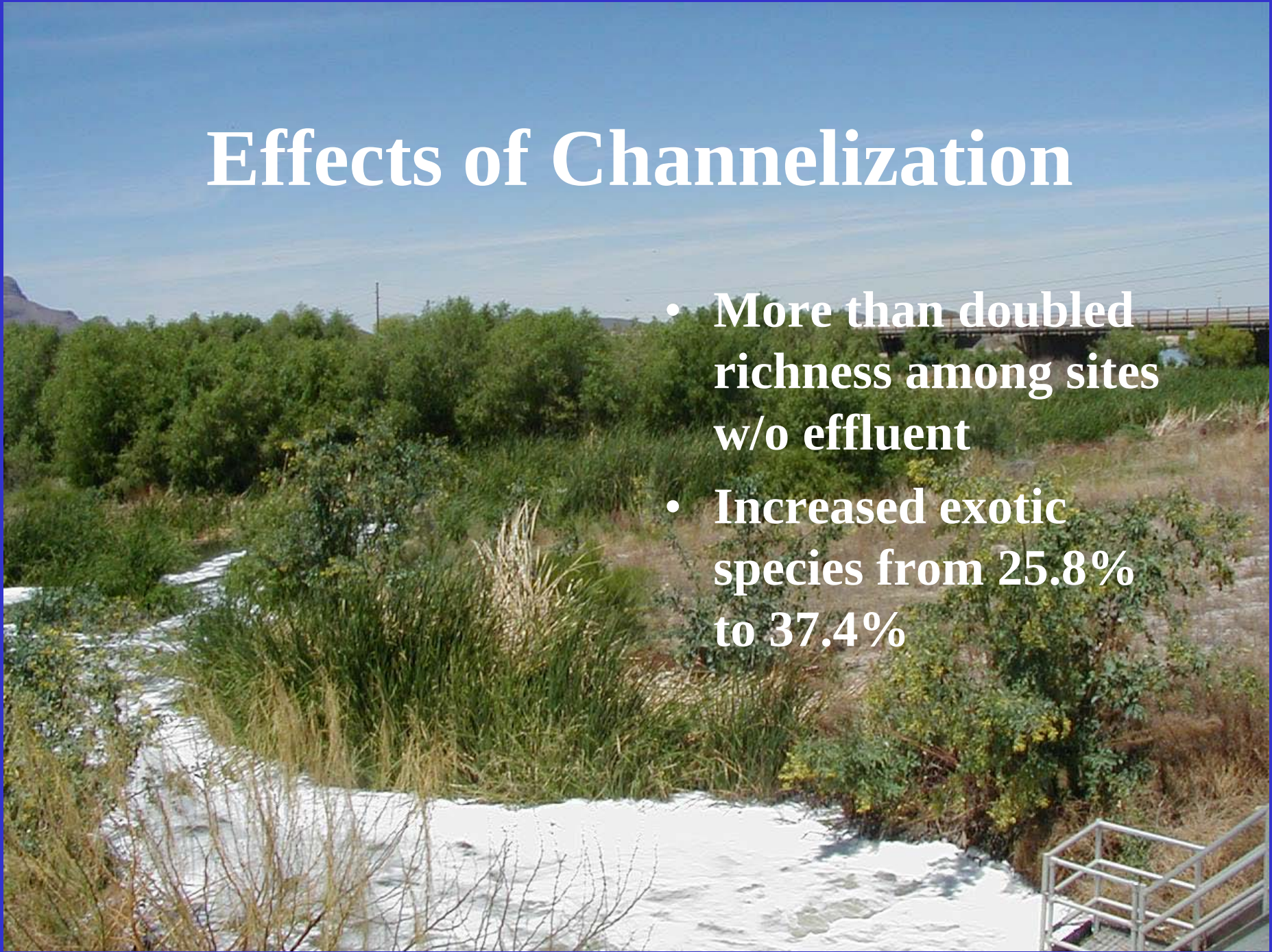


Effluent



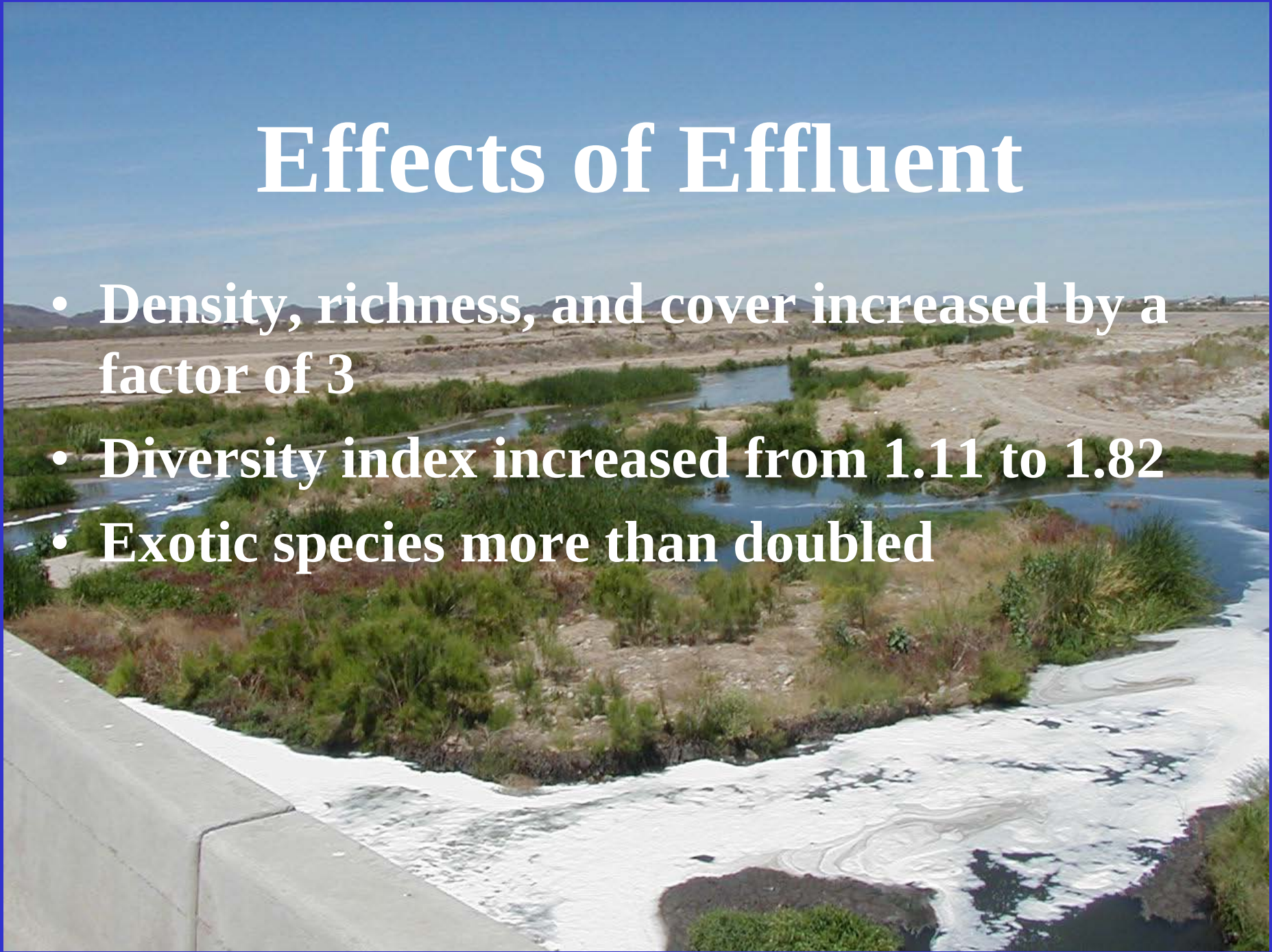
Effects of Channelization

- More than doubled richness among sites w/o effluent
- Increased exotic species from 25.8% to 37.4%



Effects of Effluent

- Density, richness, and cover increased by a factor of 3
- Diversity index increased from 1.11 to 1.82
- Exotic species more than doubled



A photograph of a river flowing through a dense forest of willow trees. The water is calm and reflects the surrounding greenery. The trees are lush and green, with some branches hanging over the water. The sky is visible through the canopy. The text "Partial River Rehabilitation" is overlaid at the bottom in a white serif font.

Partial River Rehabilitation

A photograph of a river flowing through a lush forest of willows and cottonwoods. The river is in the center, with water reflecting the sky and trees. The banks are covered in dense green vegetation, including large trees with long, drooping branches. The overall scene is a serene natural landscape.

Perrenial Waters (~30 miles),
Mature Partially Restored
Goodding Willow and
Cottonwood Forest

Diverse Plant Ecosystem



but high occurrence Exotic Species

Wildlife Habitat



Wildlife Habitat continued.



Layered & Diverse Habitat



Temporal Changes

2002



2010



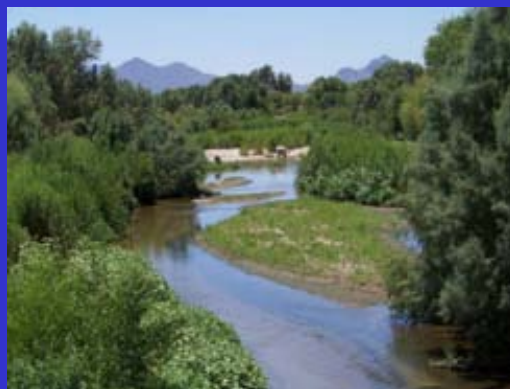
2002



2010



Diverse Patch Mosaic



Ina Road Outlet Point

Typical of observed Density & Cover
Increase, 2002-2010/11

Has diversity and richness also increased?

Has percent exotics?

What types of patches exist and what are their
dynamics?



**Extremely Diverse and
Complex Rehabilitated
Riparian Ecosystem**