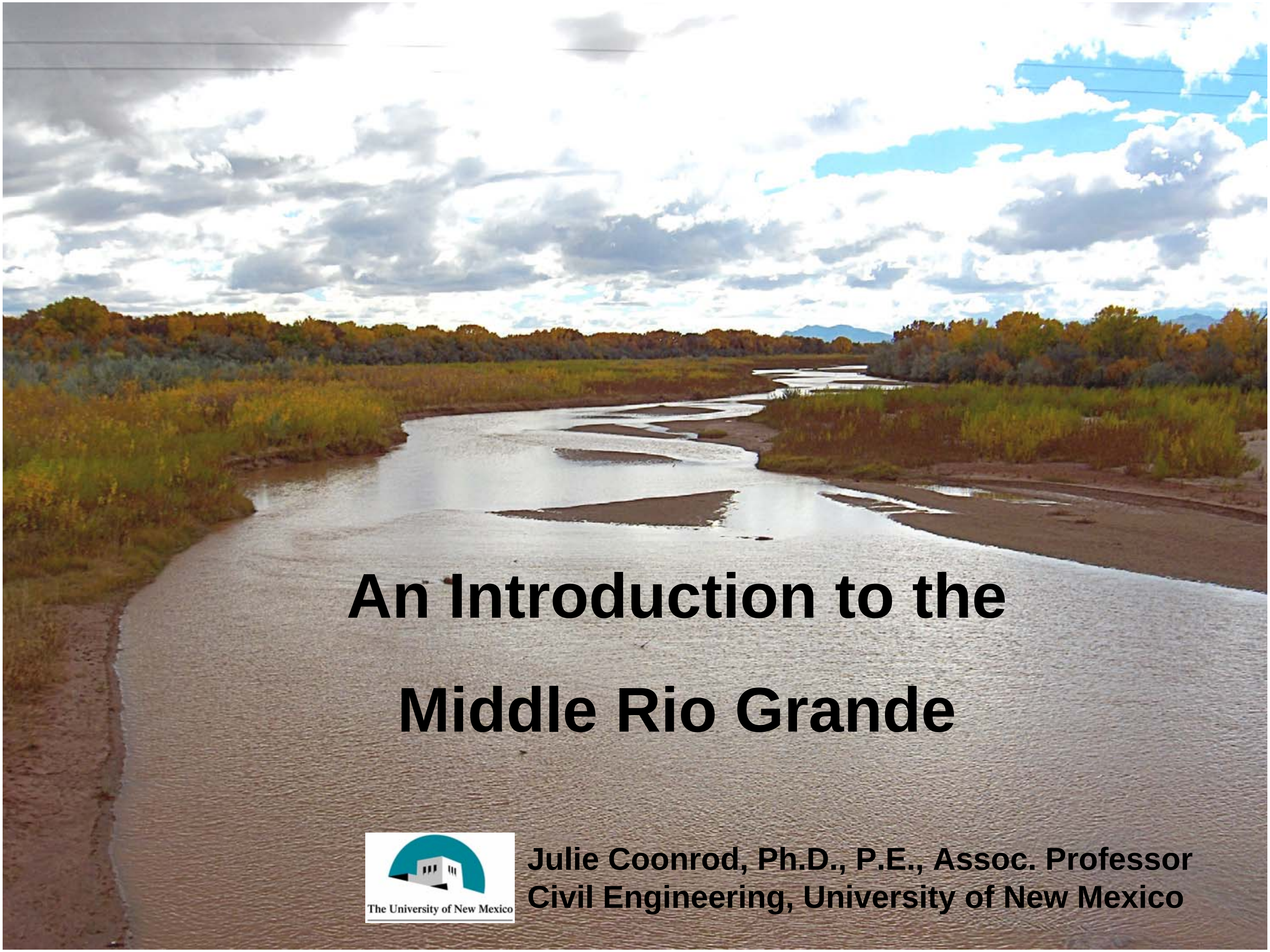
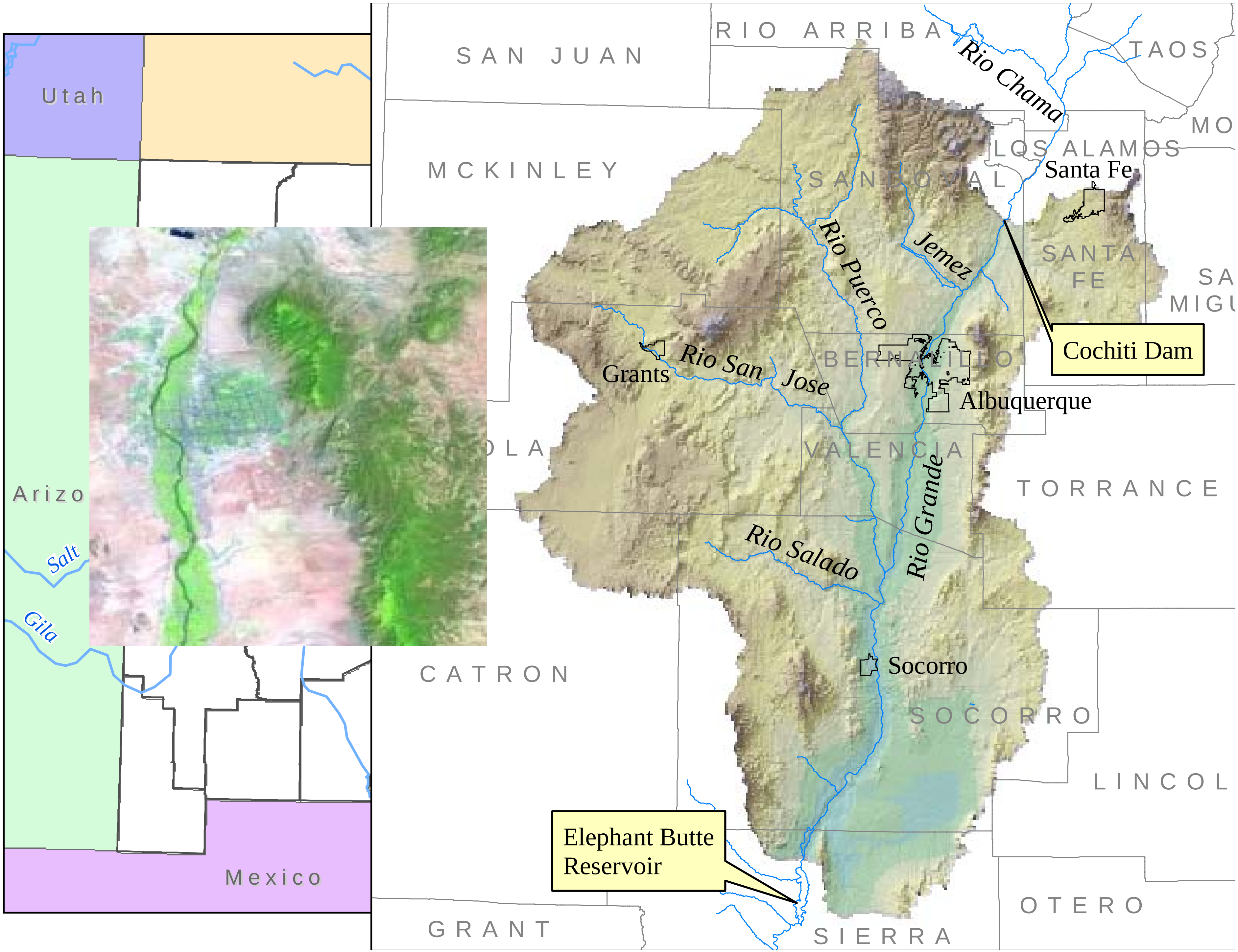


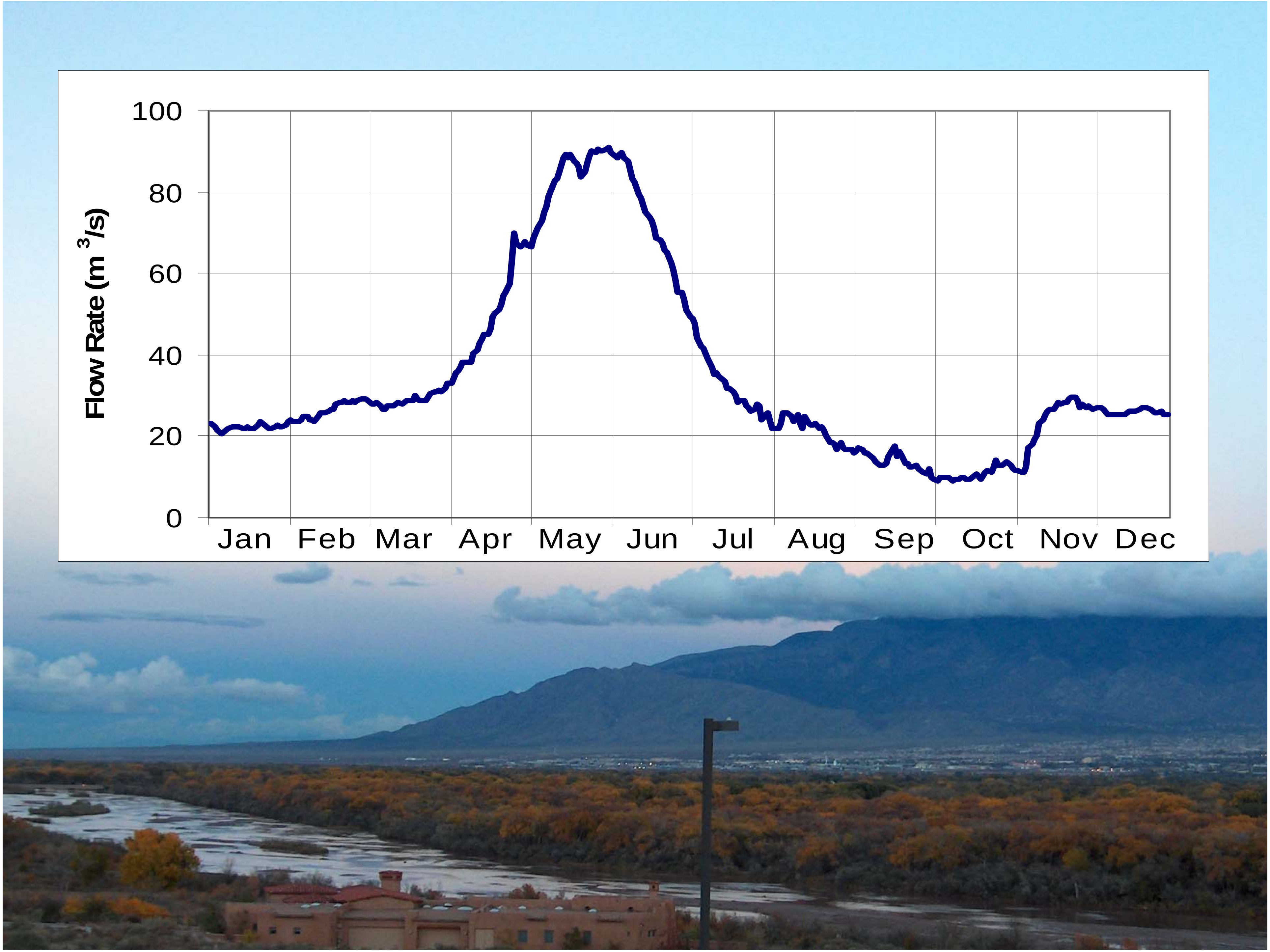
An Introduction to the Middle Rio Grande

The University of New Mexico

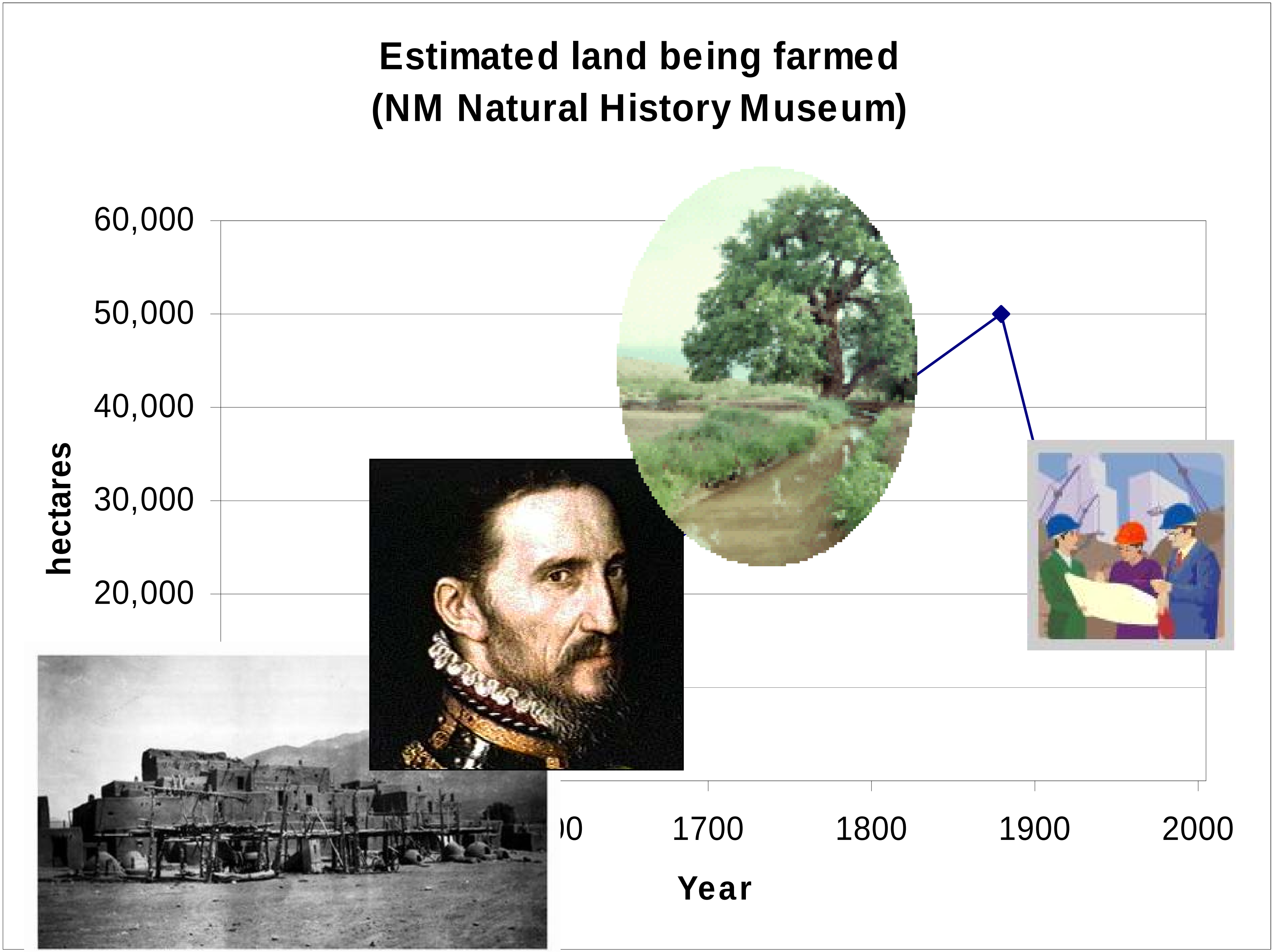
Julie Coonrod, Ph.D., P.E., Assoc. Professor
Civil Engineering, University of New Mexico



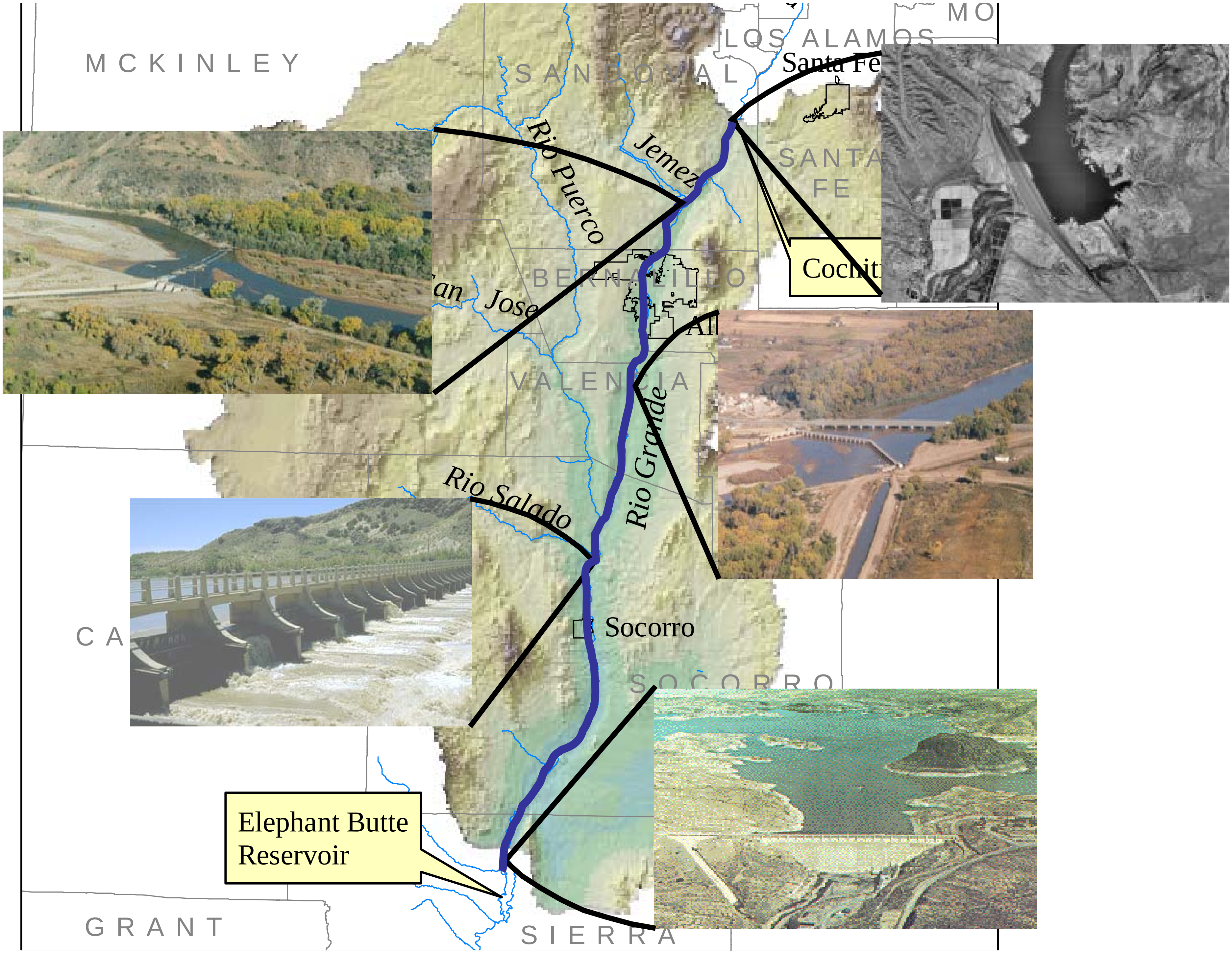
Utah
Arizo
Salt
Gila
Mexico
SAN JUAN
RIO ARRIBA
Rio Chama
TAOS
MO
LOS ALAMOS
Santa Fe
MCKINLEY
SANDOVAL
Rio Puerco
Jemez
SANTA FE
SA MIGU
Cochiti Dam
Grants
Rio San Jose
BERNALILLO
Albuquerque
VALENCIA
TORRANCE
Rio Grande
Rio Salado
CATRON
Socorro
SOCORRO
LINCOL
Elephant Butte Reservoir
GRANT
SIERRA
OTERO



Flow Rate (m^3/s)
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Estimated land being farmed
(NM Natural History Museum)
60,000
50,000
40,000
30,000
20,000
hectares
1700
1800
1900
2000
Year


Jetty jacks



MCKINLEY
SANDOVAL
LOS ALAMOS
MO
Santa Fe
SANTA FE
Rio Puerco
Jemez
Cochiti
BERNALILLO
San Jose
VALENCIA
Rio Grande
Rio Salado
Socorro
SOCORRO
CA
Elephant Butte Reservoir
GRANT
SIERRA

San Juan Chama Drinking Water Project
Diversion Dam / Intake Structure

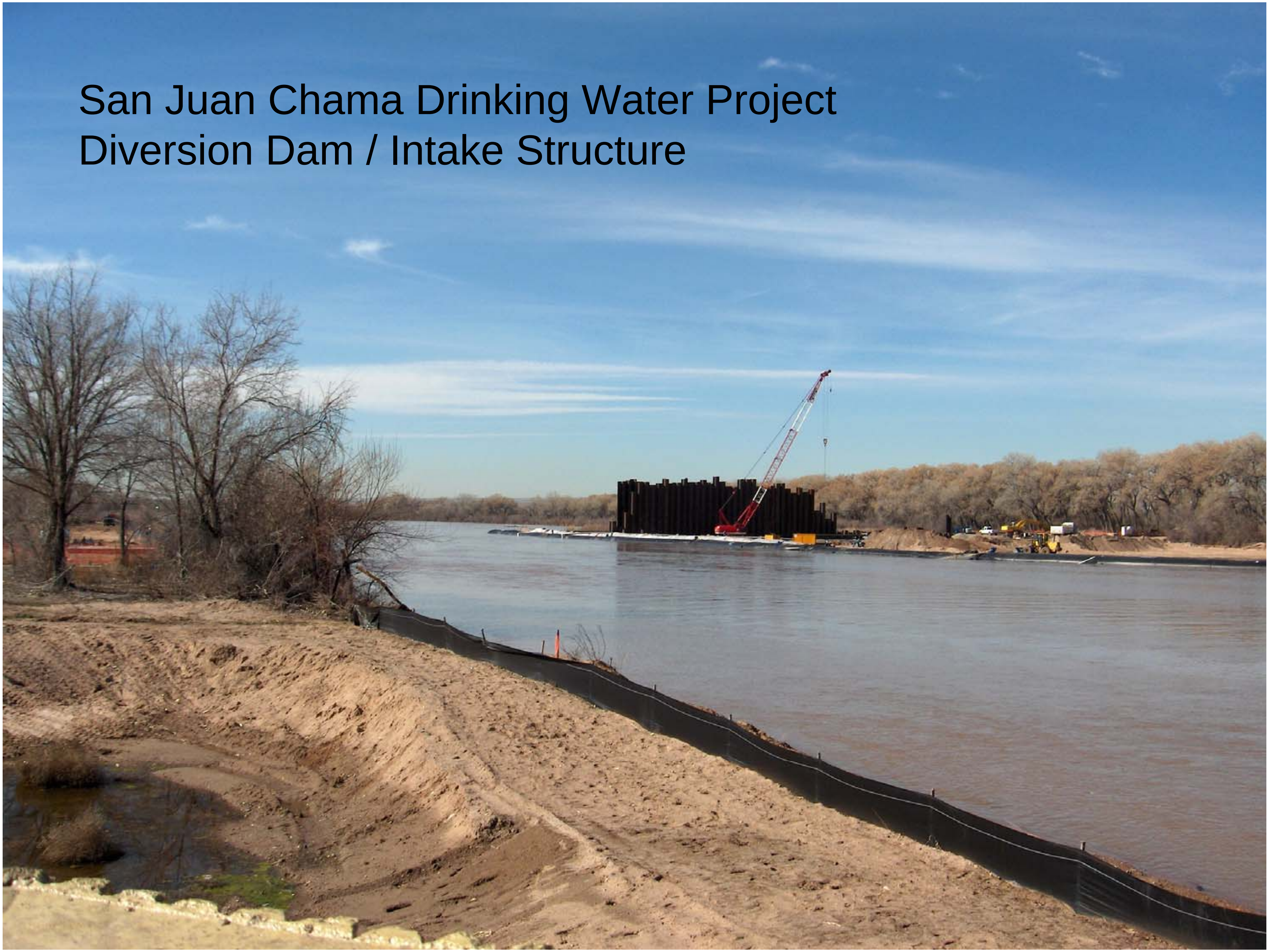
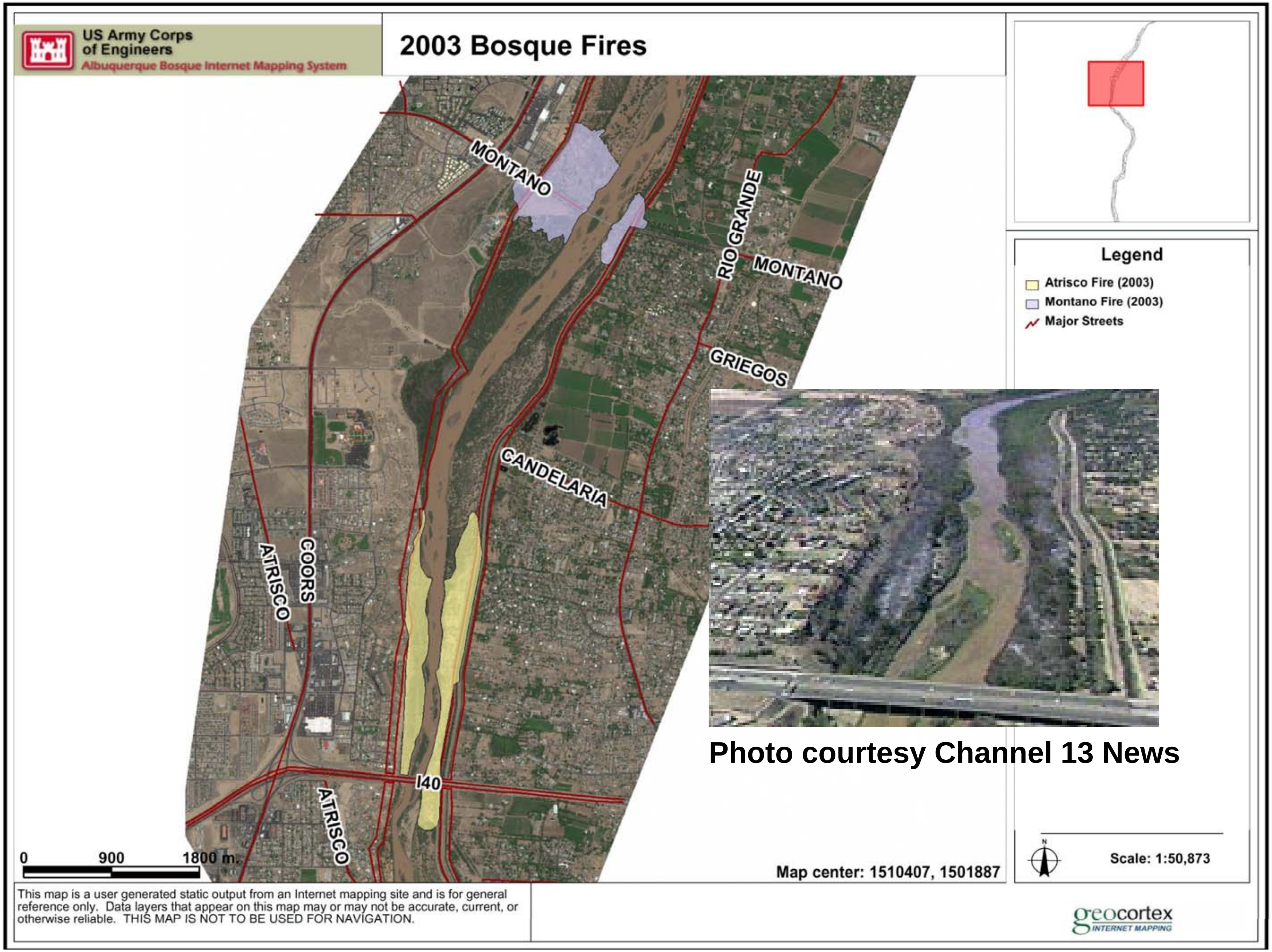



Photo by Steven Gonzales

To “restore” can mean to put a system into a more natural state than it is currently.

remove exotic vegetation
re-introduce native species
provide habitat for threatened or endangered species
provide recreational opportunities
re-connect a river and its floodplain
remove dams, diversions, and other flow barriers
provide water quality
import fish and/or wildlife


US Army Corps
of Engineers
Albuquerque Bosque Internet Mapping System
2003 Bosque Fires
MONTANO
RIO GRANDE
MONTANO
GRIEGOS
CANDELARIA
ATRISCO
COORS
I40
ATRISCO
0
900
1800 m.
Legend
Atrisco Fire (2003)
Montano Fire (2003)
Major Streets
Photo courtesy Channel 13 News
Map center: 1510407, 1501887
Scale: 1:50,873
This map is a user generated static output from an Internet mapping site and is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.
geocortex
INTERNET MAPPING

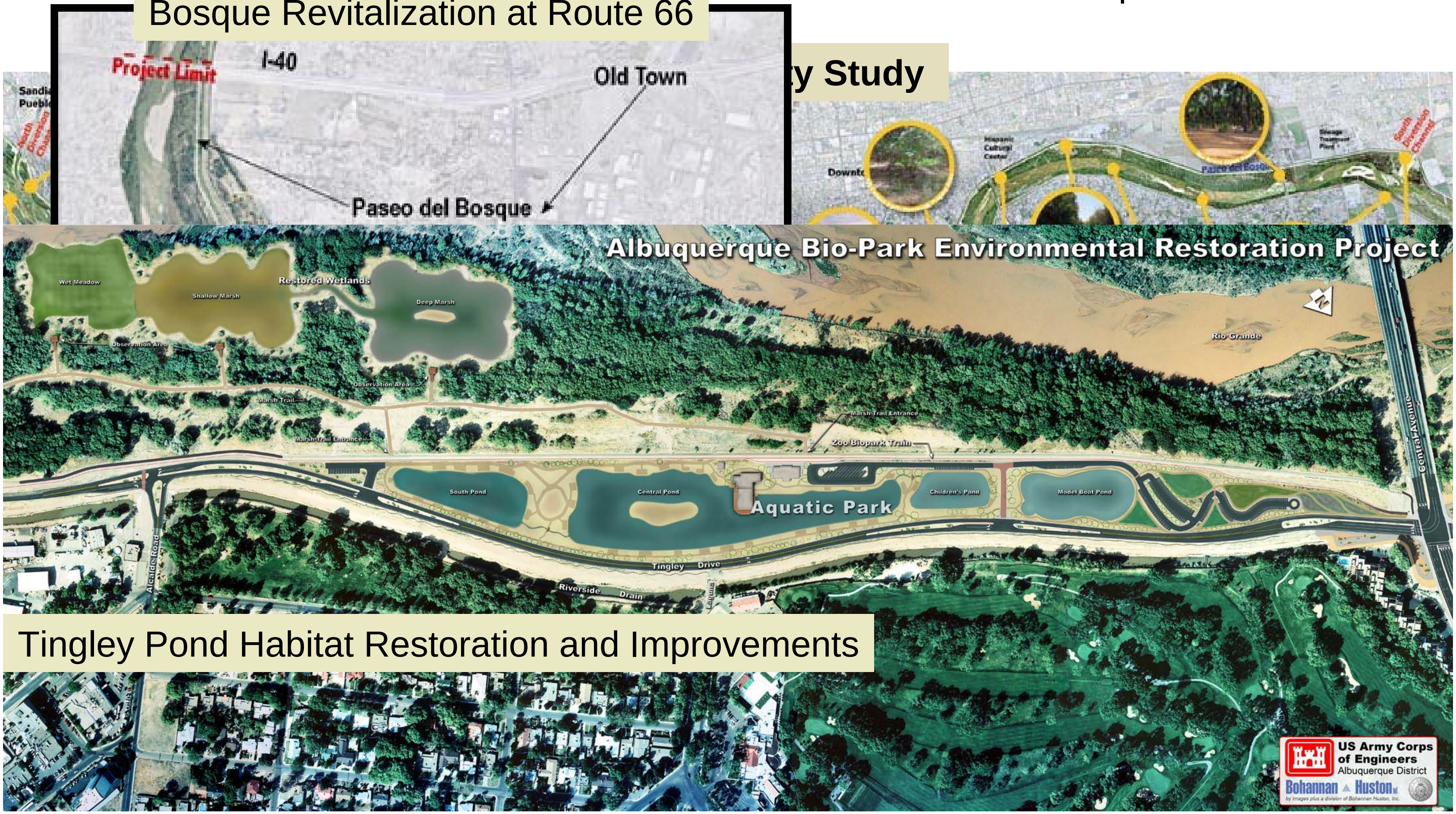
Albuquerque

Bosque

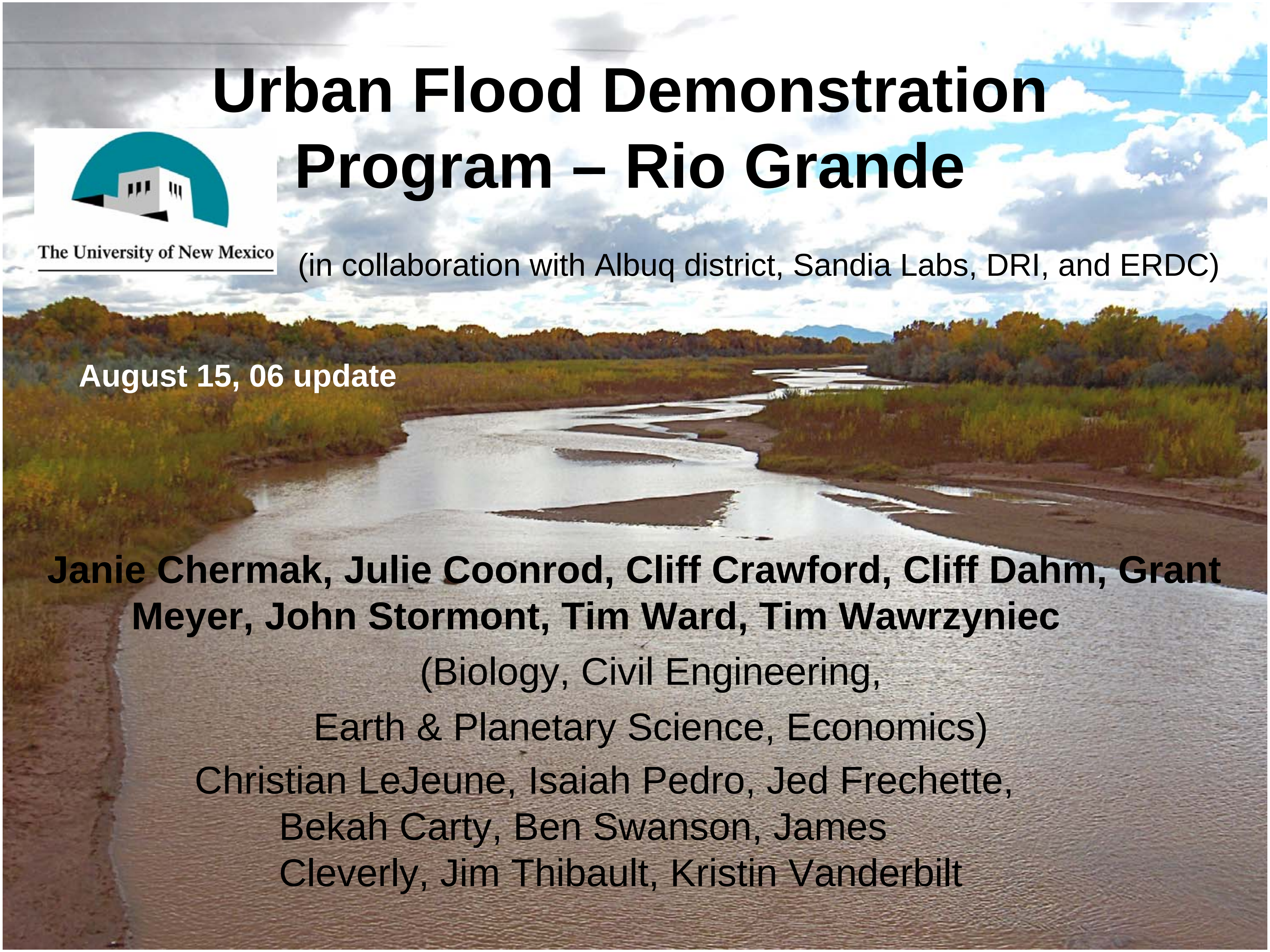
Restoration Projects

US Army Corps of Engineers®

www.bosquerevive.com




Successes:
Endangered species populations increased
Public awareness increased
Fire threat reduced
Challenges:
Sustainability
More water demands
Conflicting opinions/priorities



Urban Flood Demonstration Program – Rio Grande

The University of New Mexico

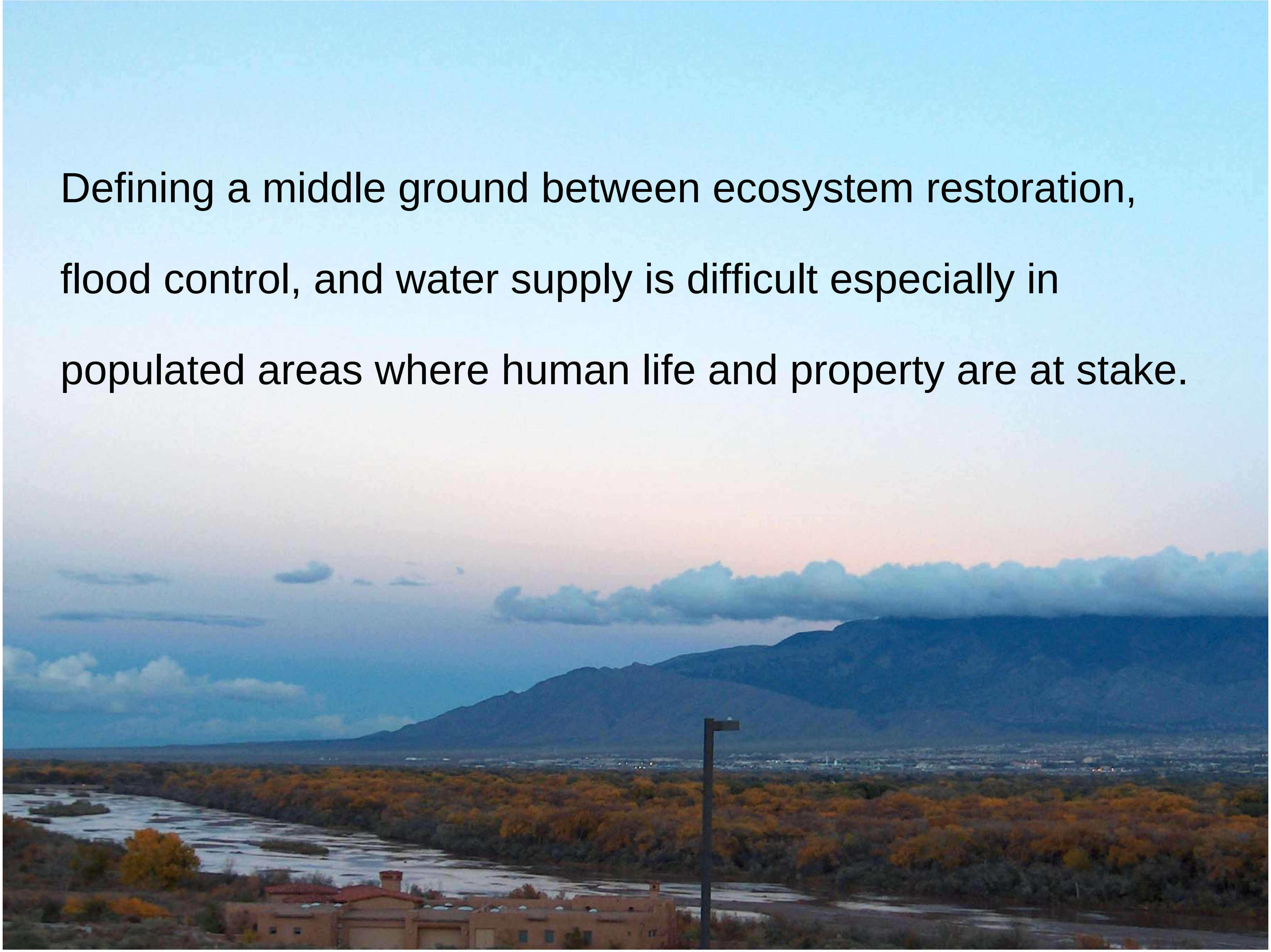
(in collaboration with Albuq district, Sandia Labs, DRI, and ERDC)

August 15, 06 update

Janie Chermak, Julie Coonrod, Cliff Crawford, Cliff Dahm, Grant Meyer, John Stormont, Tim Ward, Tim Wawrzyniec

(Biology, Civil Engineering, Earth & Planetary Science, Economics)

Christian LeJeune, Isaiah Pedro, Jed Frechette, Bekah Carty, Ben Swanson, James Cleverly, Jim Thibault, Kristin Vanderbilt


Defining a middle ground between ecosystem restoration, flood control, and water supply is difficult especially in populated areas where human life and property are at stake.

Where is the common ground?

Flood Control	'Restoration'
freeboard	overbank
ba	bility
m	ency of
c	lled
no extr	ents

Use of floodplain

Better understanding role of vegetation along banks and current role (if any) of jetty jacks

What flood frequencies can the current system handle?
How is sediment moved at those frequencies?

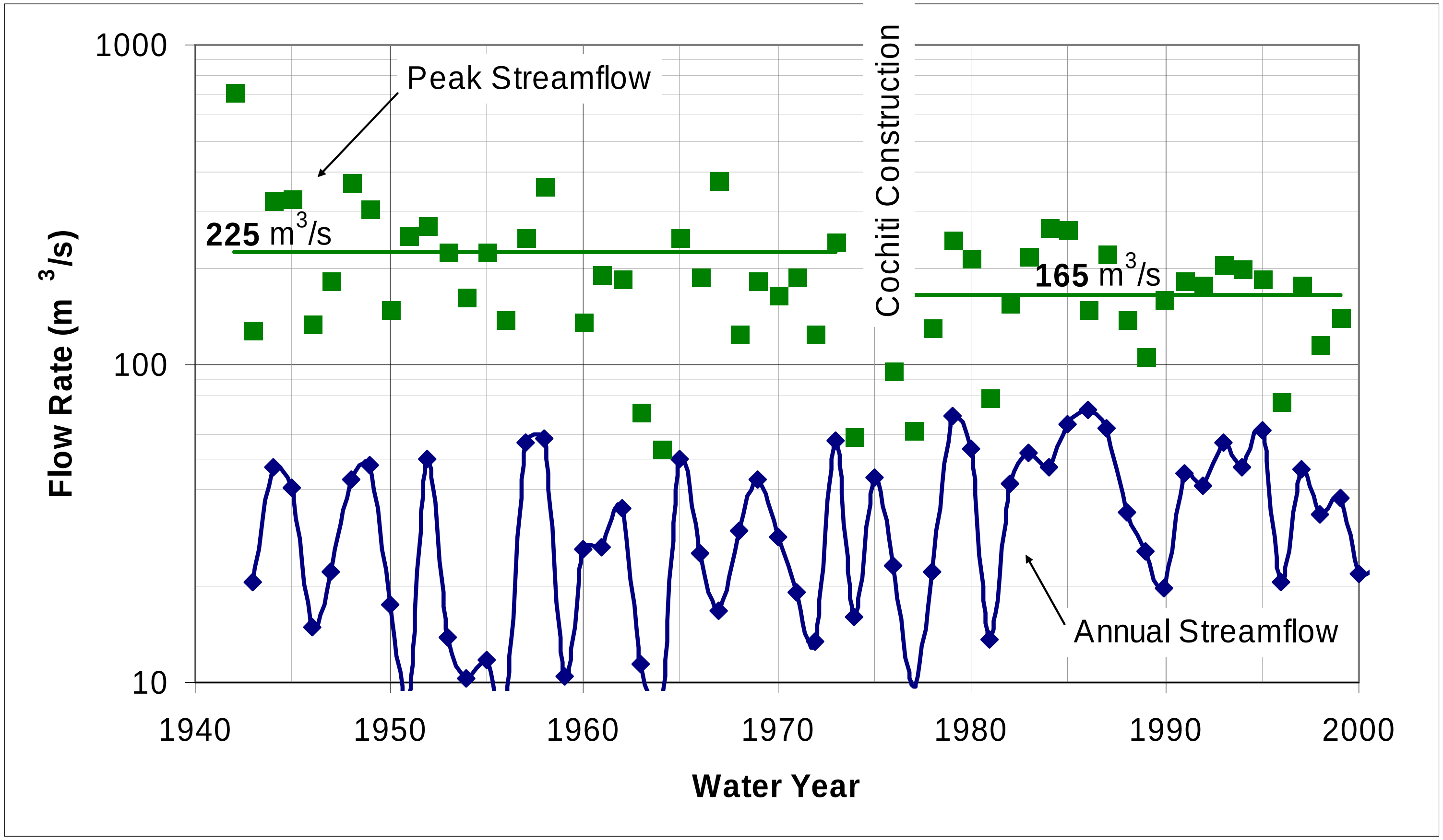
Control where human life is at stake is necessary

Engineer "extreme" events back into the system

All while water deliveries are met.

Albuquerque river system

- Cochiti Dam in 1970's
- River continues to incise (resulting in less overbanking even when higher flows exist)
- Channel bottom becoming more coarse



FY06 UNM projects

16. State of flood related modeling
17. Investigating groundwater/surface water interaction between Alameda and Paseo del Norte bridges
18. ET, water tables, diel fluctuations, flow fields and riparian zone restoration
20. Bank erosion monitoring
21. Coupling of hydrologic/hydraulic models and aerial photos through time

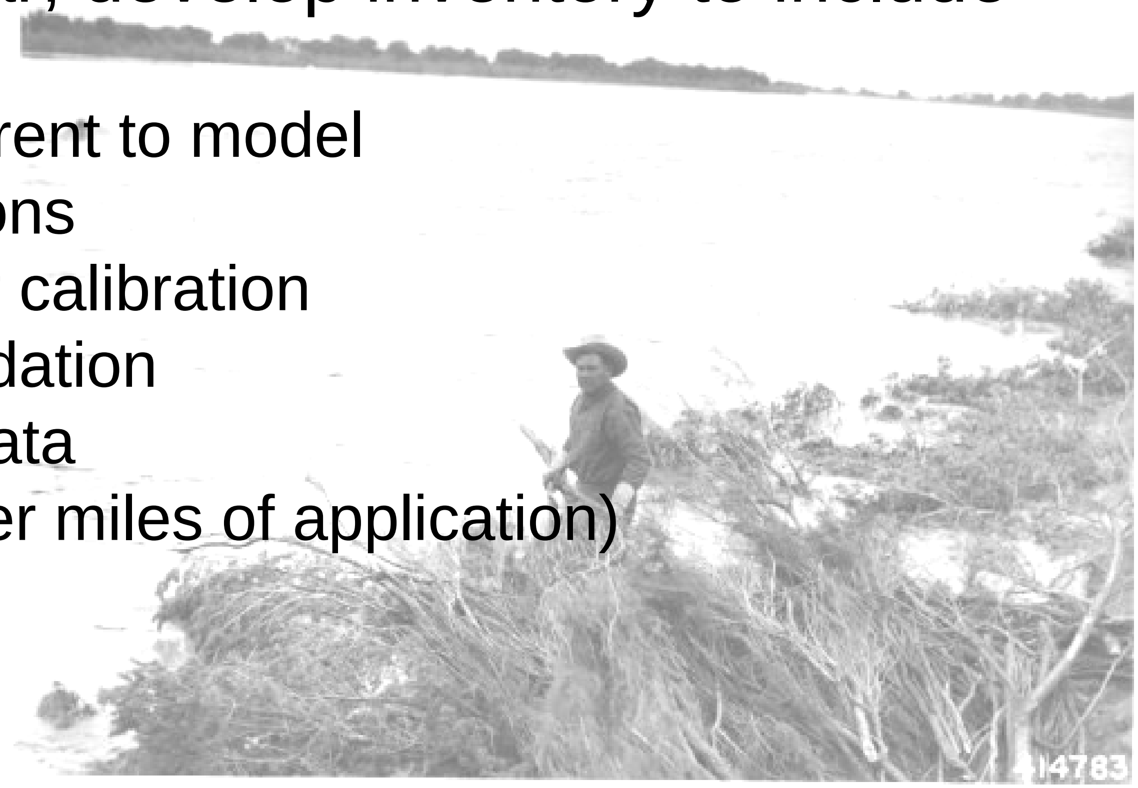
State of flood related modeling

Location: Middle Rio Grande

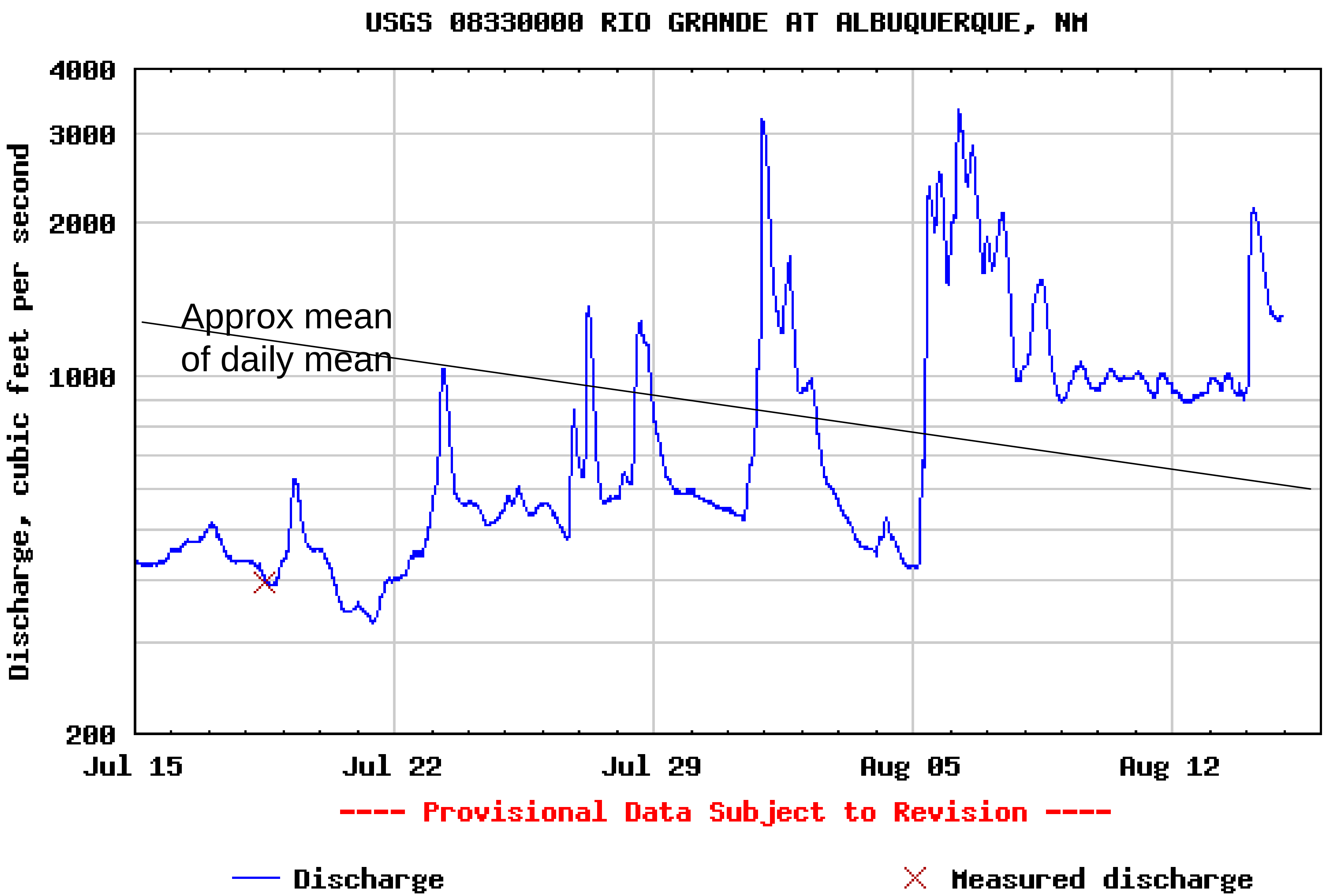
Purpose: Identify issues and needs

Methods: Literature review, stakeholder interviews, seminar, develop inventory to include

- Model used
- Assumptions inherent to model
- Governing equations
- Variables used for calibration
- Data used for validation
- Ranges of input data
- Spatial extent (river miles of application)



Greatest focus to date: field work!


USGS 08330000 RIO GRANDE AT ALBUQUERQUE, NM
Discharge, cubic feet per second
4000
3000
2000
1000
200
Jul 15
Jul 22
Jul 29
Aug 05
Aug 12
Approx mean
of daily mean
---- Provisional Data Subject to Revision ----
Discharge
Measured discharge

Investigating groundwater/surface water interaction between the Alameda and Paseo del Norte bridges

Location characteristics: downstream of urban outfall, new diversion dam, Calabacillas outfall

Purpose: adaptive bosque management, bank storage, provide validation/calibration for Sandia, ERDC & DRI models

Monitor ground water levels

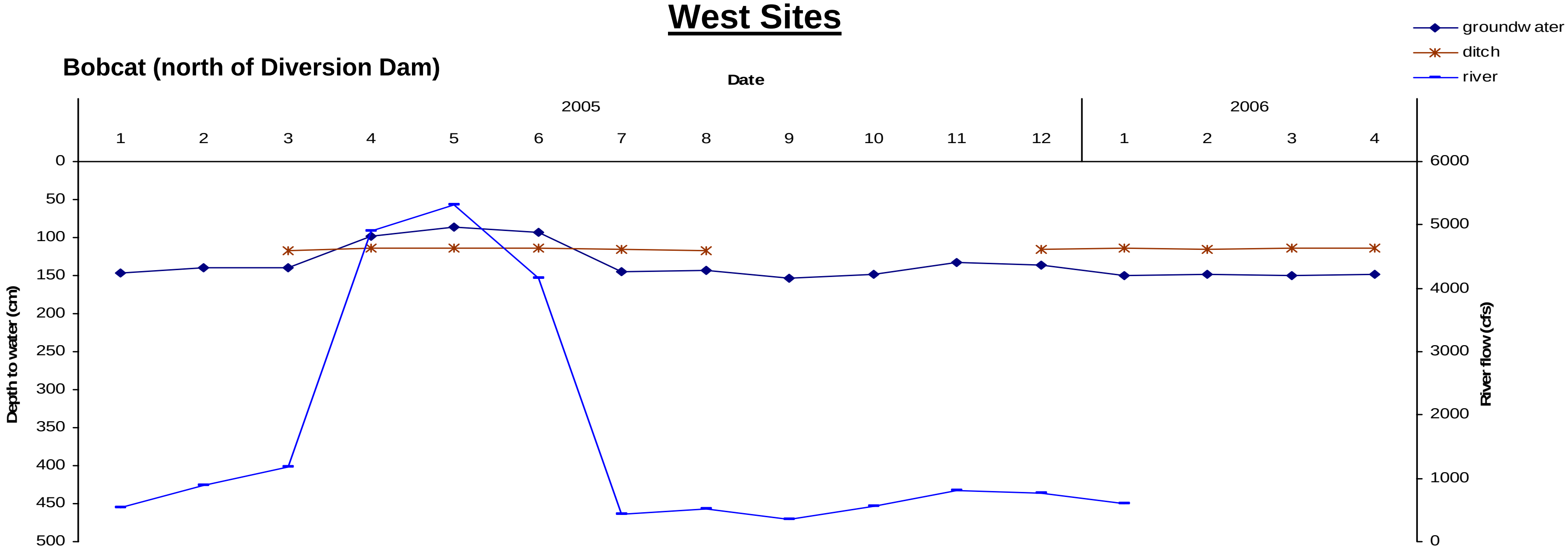
Continue monitoring 6 wells with pressure transducers and conduct manual measurements of existing wells.

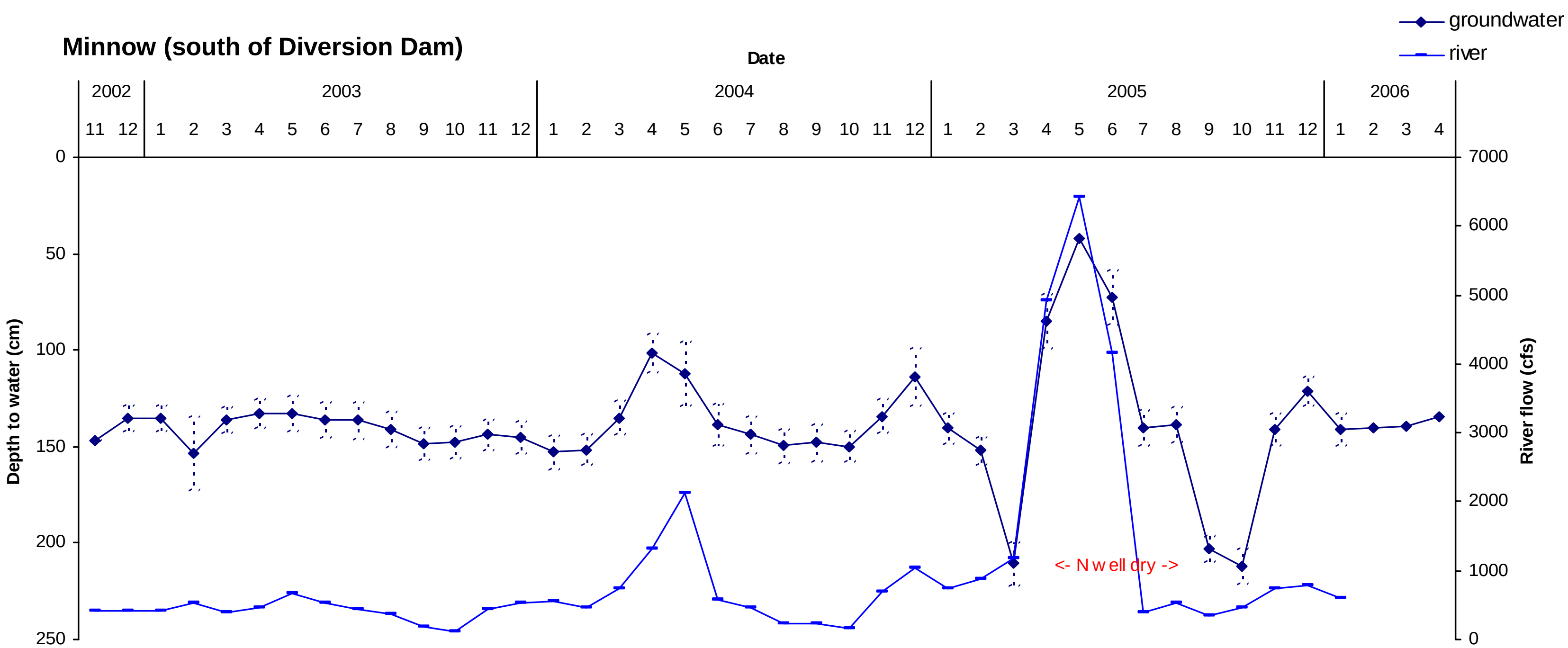
Instrument an additional 12 wells for continuous ground water levels using pressure transducers.

Christian LeJeune Measuring Water Depth Using a Well Beeper

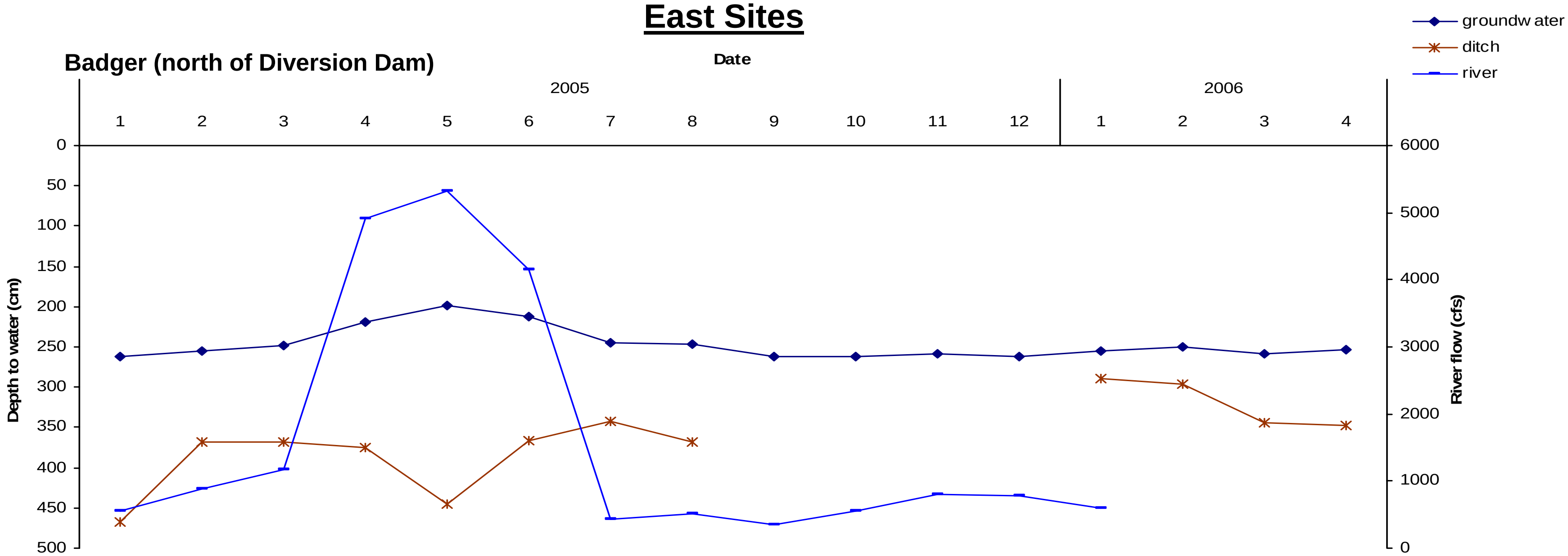
Status: pressure transducers ordered.

West Sites

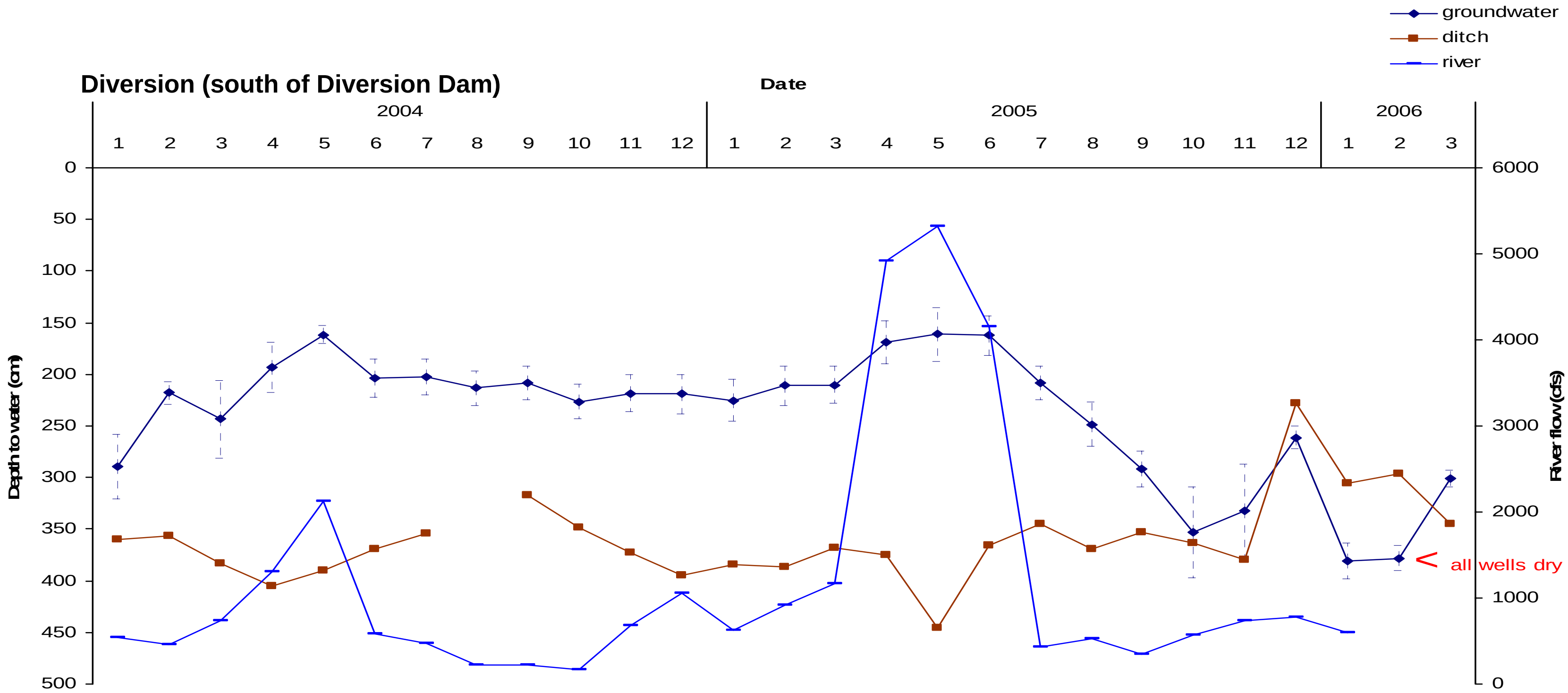

Bobcat (north of Diversion Dam)
Date
2005
2006
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4
Depth to water (cm)
0 50 100 150 200 250 300 350 400 450 500
River flow (cfs)
6000 5000 4000 3000 2000 1000 0
groundw ater
ditch
river


Minnow (south of Diversion Dam)
Date
2002
2003
2004
2005
2006
11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4
Depth to water (cm)
0 50 100 150 200 250
River flow (cfs)
7000 6000 5000 4000 3000 2000 1000 0
groundwater
river
<- N well dry ->

East Sites



Badger (north of Diversion Dam)
Date
2005
2006
Depth to water (cm)
River flow (cfs)
groundwater
ditch
river



Diversion (south of Diversion Dam)
Date
2004
2005
2006
Depth to water (cm)
River flow (cfs)
groundwater
ditch
river
all wells dry

Riparian soil characterization

Intensely sample soils between surface and ground water

Classify soils, and measure their hydraulic properties, e.g.,

•Hydraulic conductivity

•Unsaturated parameters

•Water-holding capacity

Status: 8 of 20 boring for samples completed.

Isaiah Pedro Using Auger to
Drill Coring Sample

Placing Coring Sample
on Table for Testing

I. Pedro and C. LeJeune Field
Classifying Coring Sample

Soil samples brought to laboratory for
hydraulic properties testing.

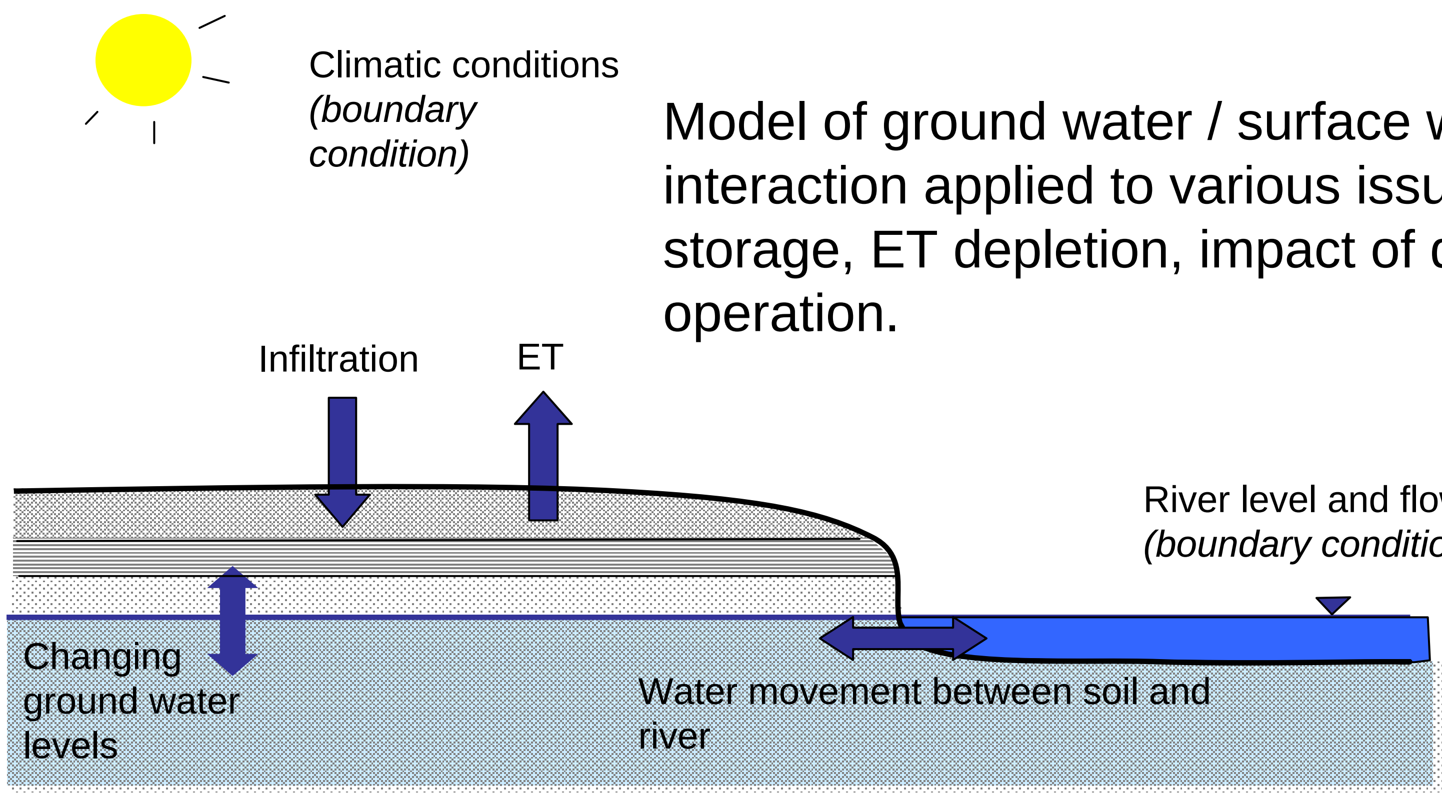
Monitor bosque ecology

Vegetation Plot Within Well Area

Model of ground water / surface water interaction
measurements and monitoring data used as input

Data base available to all, including river levels and flows, ground water levels, soil types and properties, and ecological response.

Model of ground water / surface water interaction applied to various issues, e.g.: bank storage, ET depletion, impact of dam operation.



ET, water tables, diel fluctuations, flow fields, and riparian zone restoration

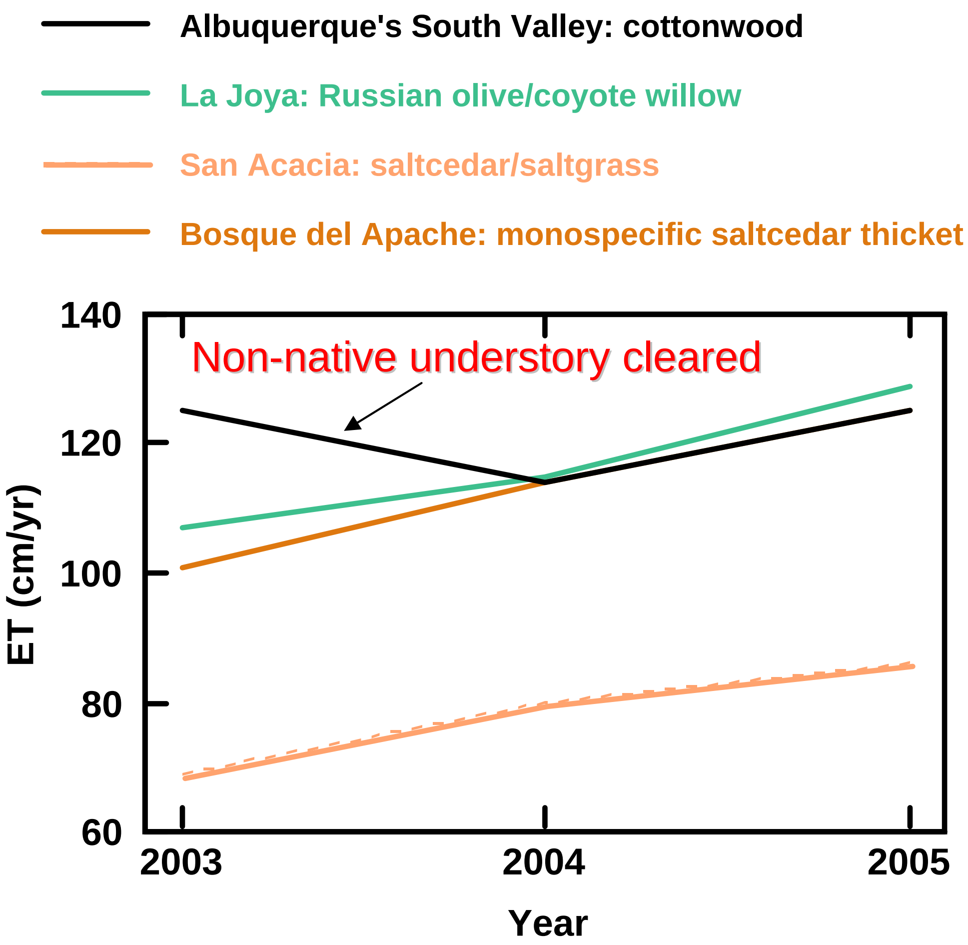
Location: Middle Rio Grande

Purpose: Restoration and flooding effects on ET and alluvial groundwater dynamics

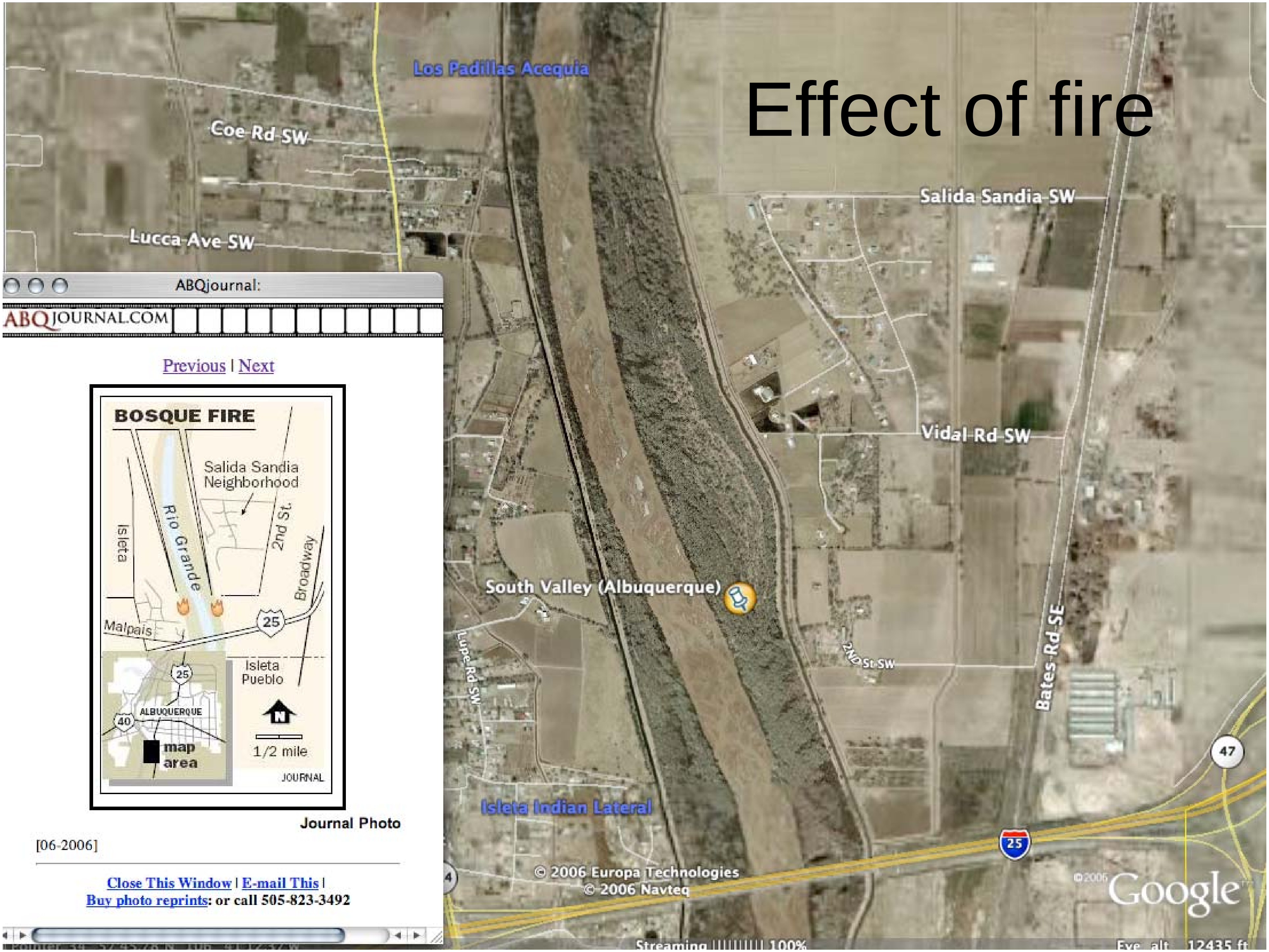
Methods: 3-D eddy covariance towers, groundwater wells, compare diel groundwater fluctuations to measured ET

Restoration water salvage

- Understory Russian olive and saltcedar removed from South Valley Albuquerque cottonwood forest between 2003 and 2004 growing seasons
- First year reduction in ET of 9% while other sites increasing by 12% (total = -21% or -26 cm/yr)
- Second year increase matched increase at other sites: 0 cm/yr



Effect of fire



Bank Erosion Monitoring

Location: Calabacillas outfall

Purpose: determine river response to tree removal, evaluate bank stability

Methods: monitor bank stability with erosion pins and LiDAR

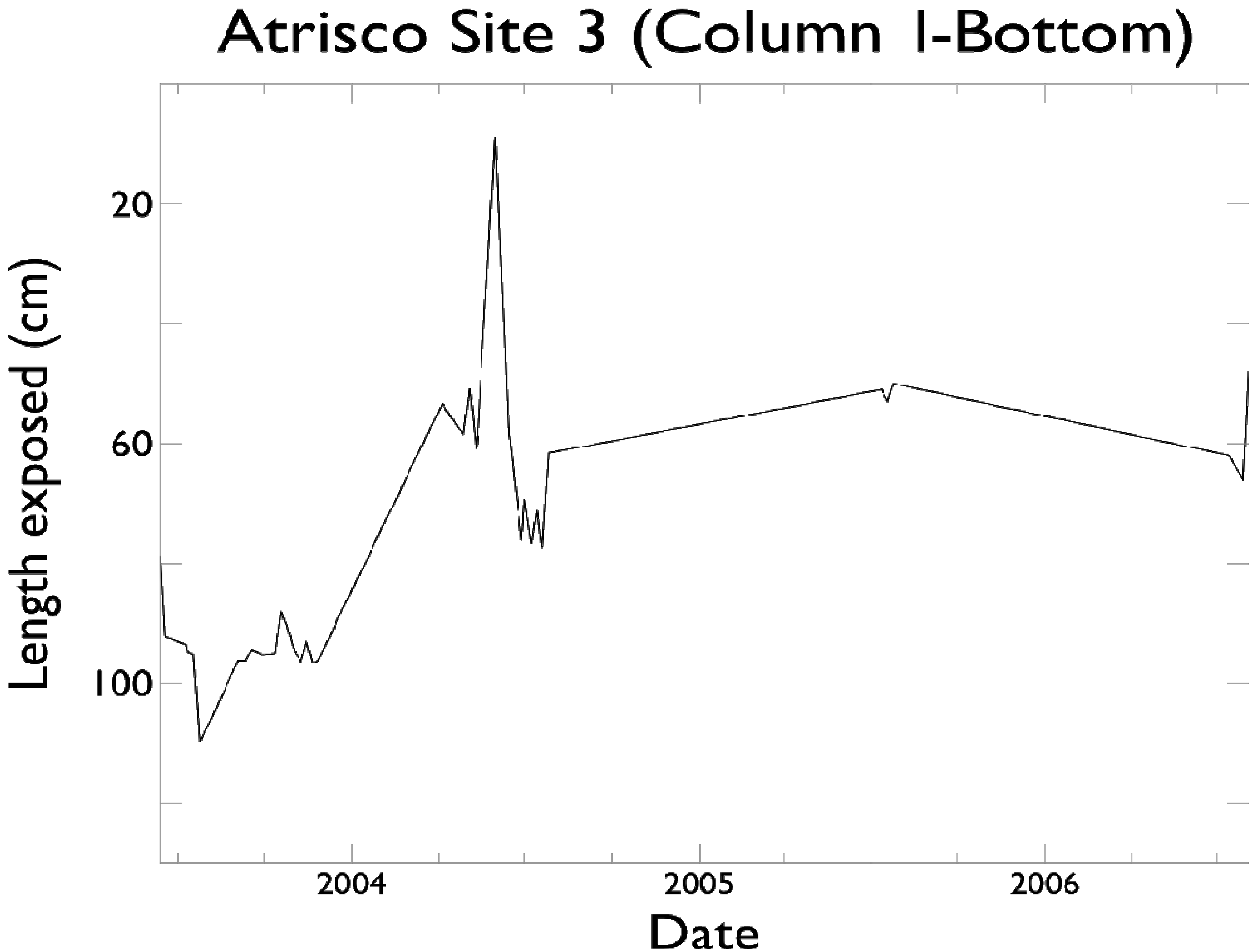
Erosion pins

Located in sets above and below typical water surfaces.

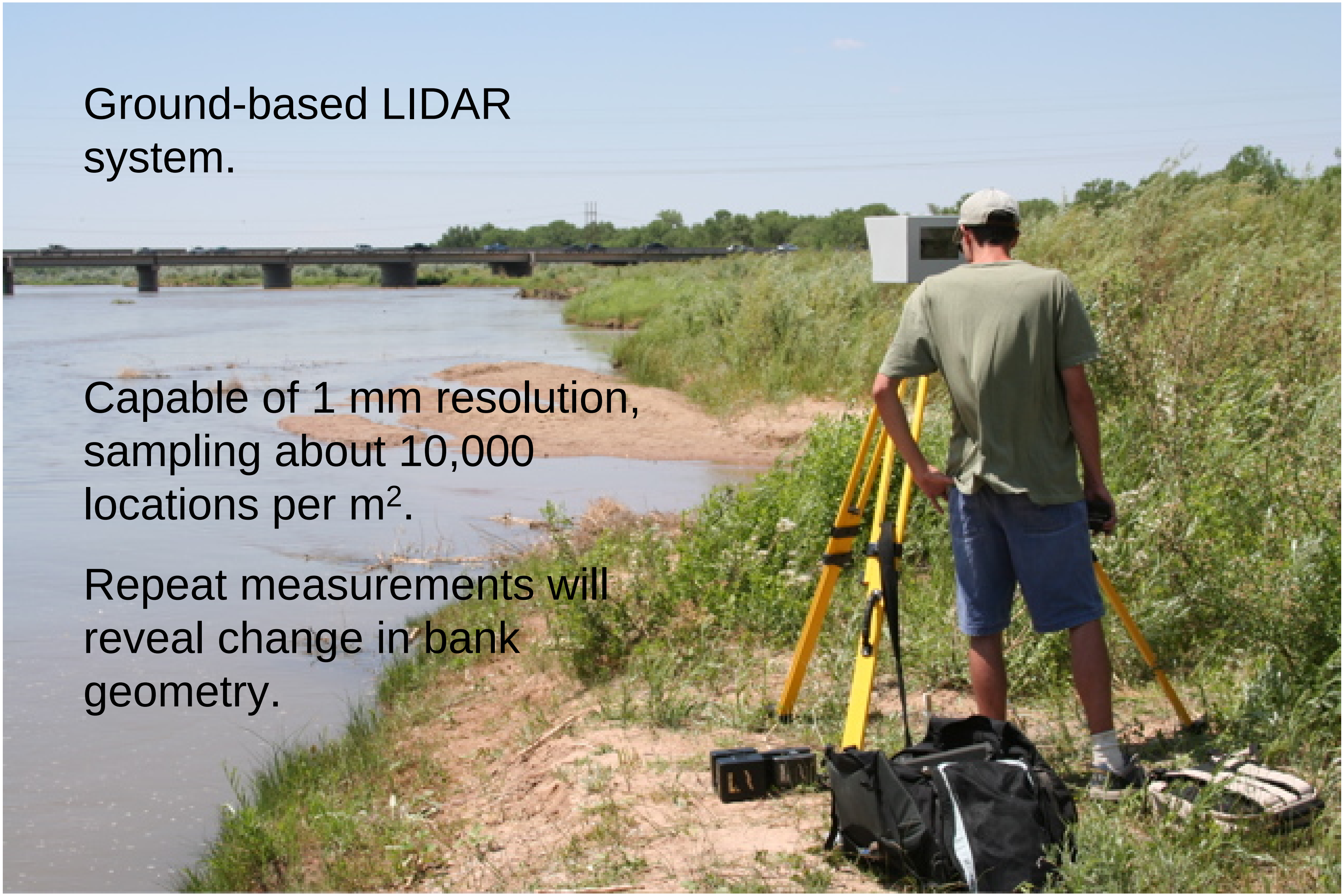
First sets installed near Central Bridge in 2000, and periodically monitored.

Second set installed near diversion dam and Calabacillas Arroyo in 2006.

Simple, manual measurement method.



Atrisco Site 3 (Column 1-Bottom)
Length exposed (cm)
20
60
100
2004
2005
2006
Date

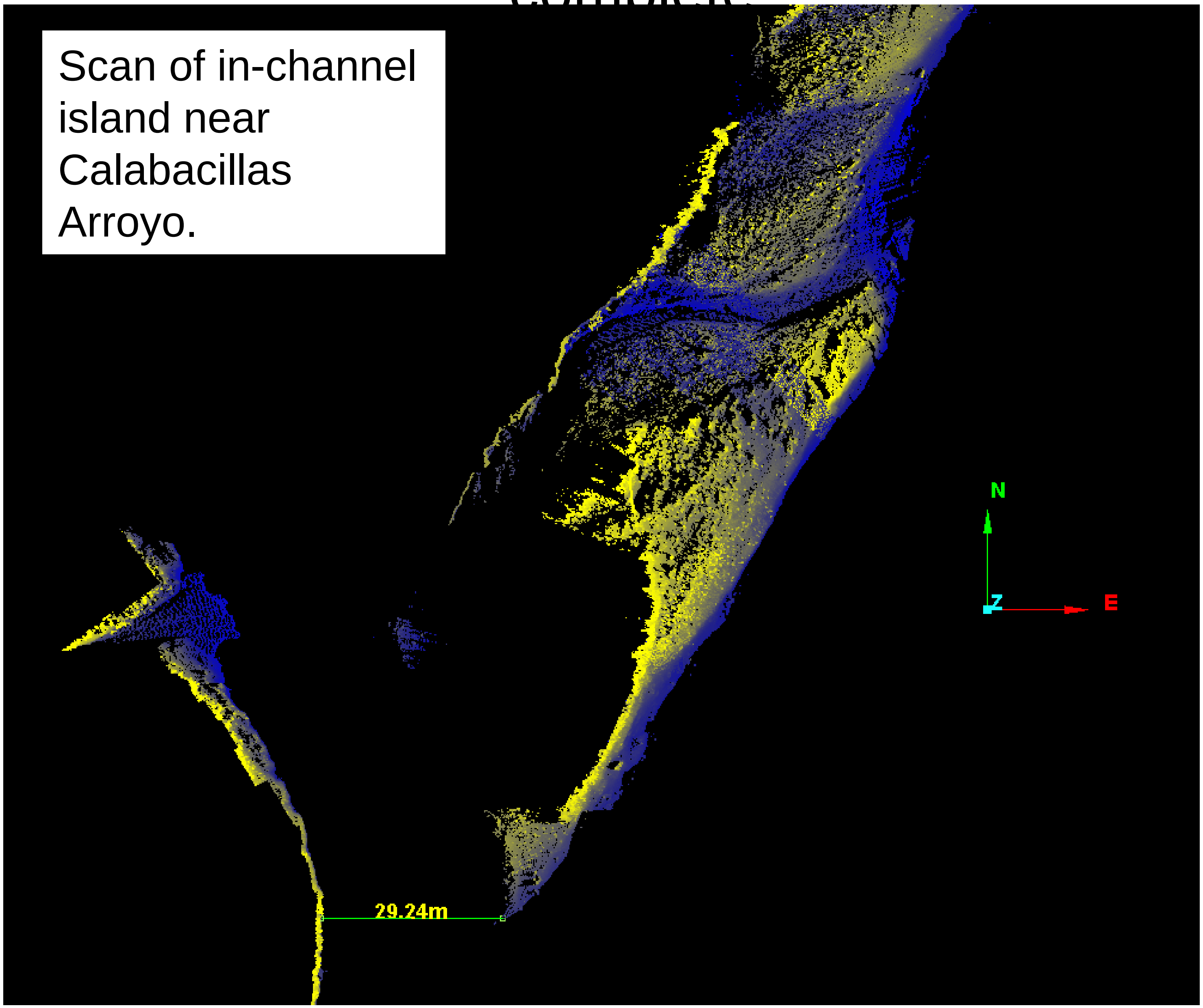


Ground-based LIDAR system.

Capable of 1 mm resolution, sampling about 10,000 locations per m^2.

Repeat measurements will reveal change in bank geometry.

Initial scans of 1 km of bank near diversion dam complete




Calabacillas Arroyo
CW20

Coupling of hydrologic/hydraulic models and aerial photos through time

Location: Albuquerque reach

Purpose: track movement of sediment through the system over time

Methods: acquire aerial photos, develop algorithm to measure river widths and sandbar widths, identify areas of sediment movement and compare with the hydrologic record

Aerial Photography

Available Photos (obtained)

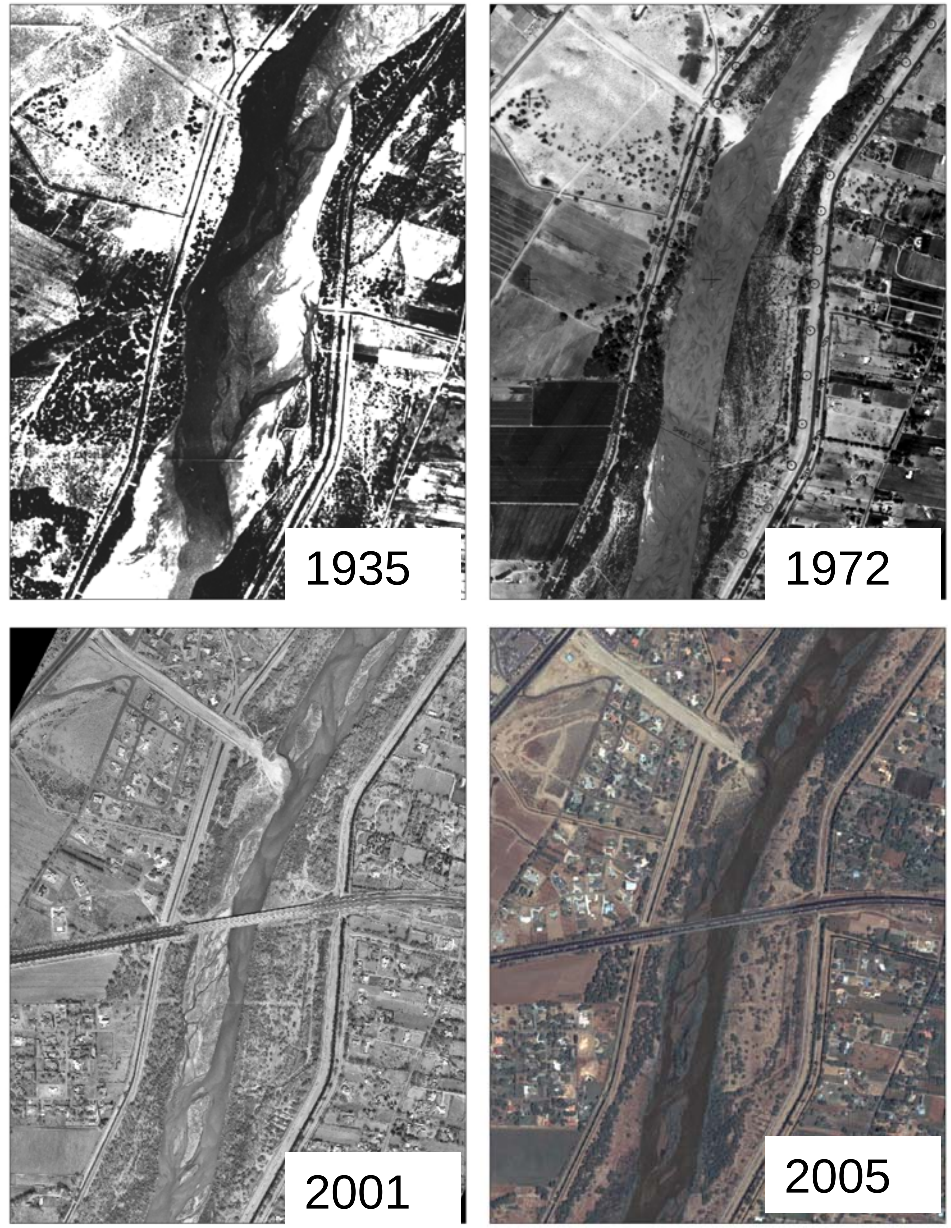
Year	From
1935	USBR/USACE
1949	USBR/USACE
1972	USBR/USACE
1984	USBR/USACE
1996	Bernalillo Co.
1999	Bernalillo Co.
2001	USBR
2002	Bernalillo Co.
2004	Bernalillo Co.
2004	USACE - Quickbird
2005	USACE - Quickbird
2006	USBR

Database Development:

Photo date

Avg Daily Discharge

Photo Resolution

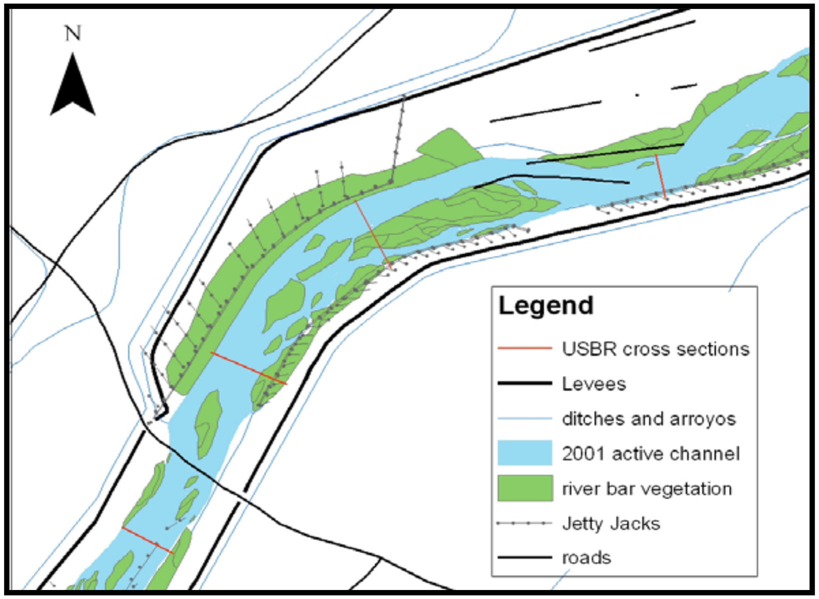


Build GIS Database

Data	Contents	Obtained from
Historic Active Channel	Channels and Vegetated Islands	USBR (Oliver 2004)
Ecology Data	Vegetation and Terraces	USBR/USACE
Infrastructure Data	Jetty Jack Lines, Levees, Temp Bridges, etc.	USACE
Elevations	2ft Contours for Bosque, DEMs	USACE
Cross Sections	Cross Section Lines and Profile Data	USBR
General	Roads, Hydro, Orthophotos, Topos, Etc	RGIS and Bernalillo Co.

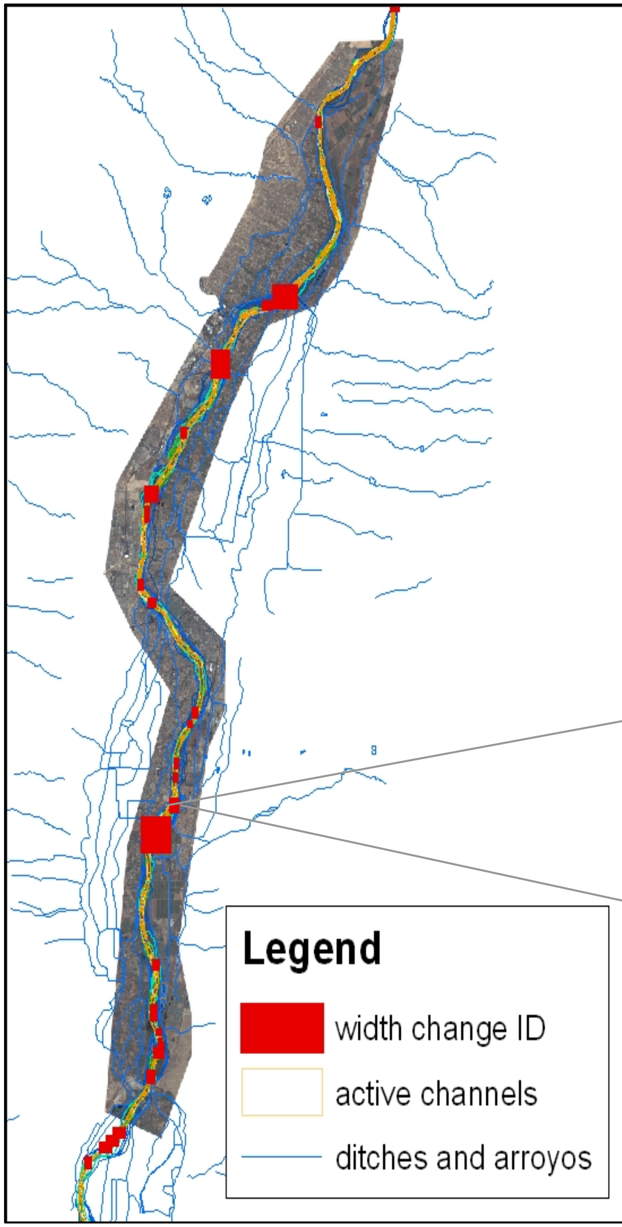
For use in this or other UFDP projects –

gw/sw interaction, bank erosion, etc.



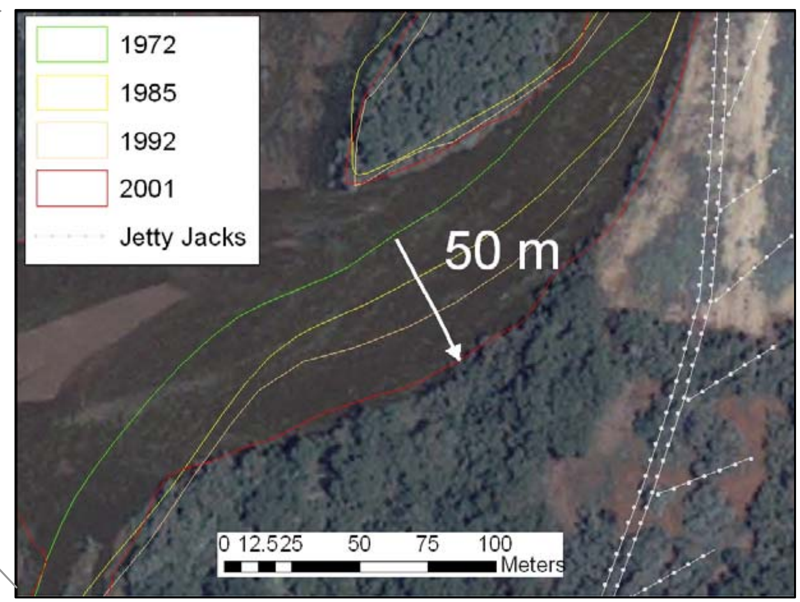
Rio Grande Above Alameda Blvd Bridge

Measure changes in channel and sandbar widths



- Bank erosion and channel change identified using historical channels (1935 to 2002 – Oliver 2004 data USBR).
- Banks are being digitized from more recent photos (2004, 2006).
- USBR (Massong 2005) observed little erosion after 2005 high flows.

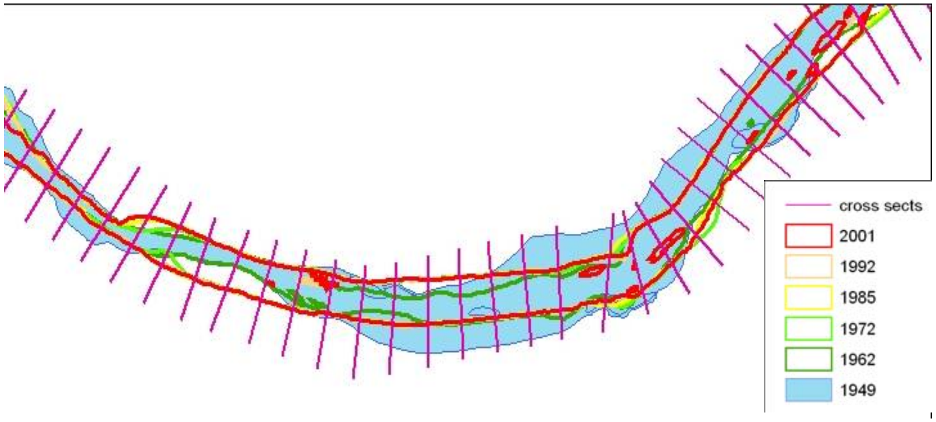
Rio Grande Above Arroyo Tijeras



Channel, Island, and Bar Measurements

Developing GIS Methodology

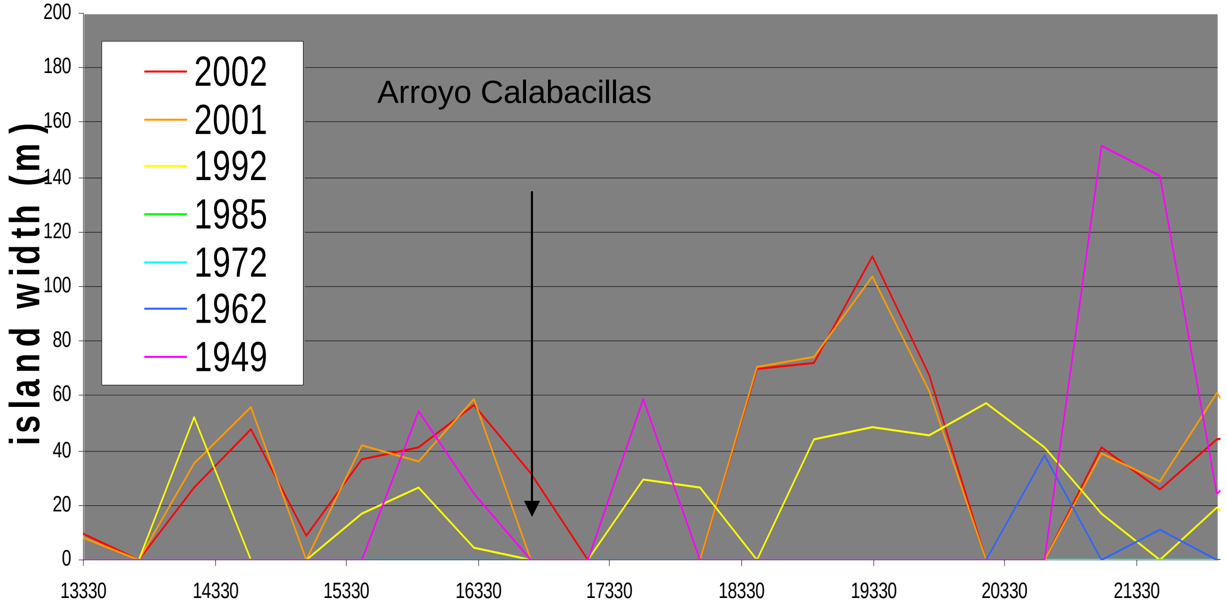
- Digitize active channel, islands, and sandbars
- Produce cross sections orthogonal to bank centerline (used Oliver 2004 channels and cross sections).



•Use above channel features to “clip” cross sections

•“Measure” new cross section lengths (Xtools)

Contemporary Width Changes - Rio Grande, Albuquerque
Arroyo Calabacillas Reach



Approximate River Length (ft)

Similar method used in Makar et al. 2006

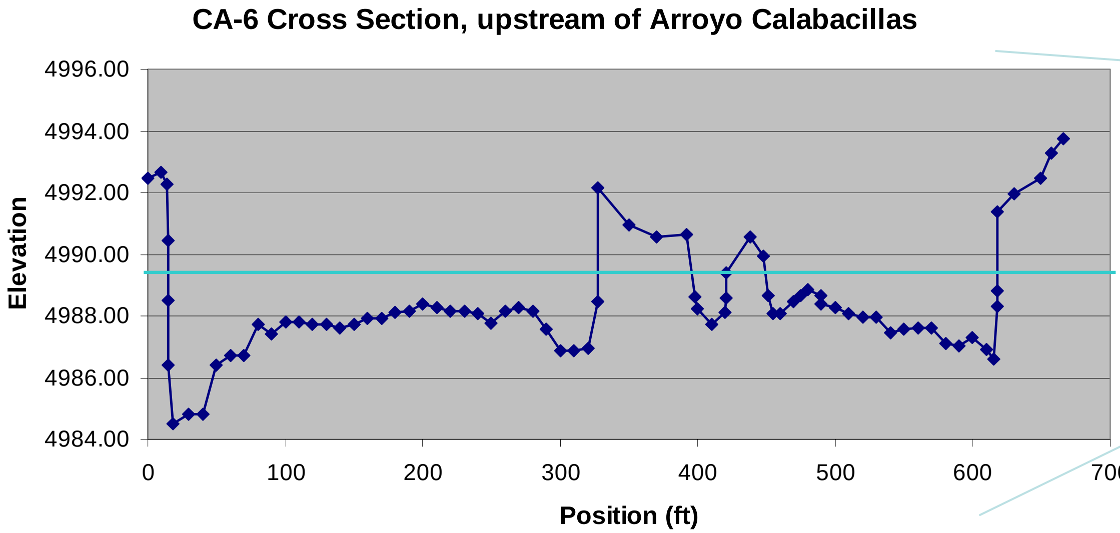
Measuring Water Depths from Air Photos

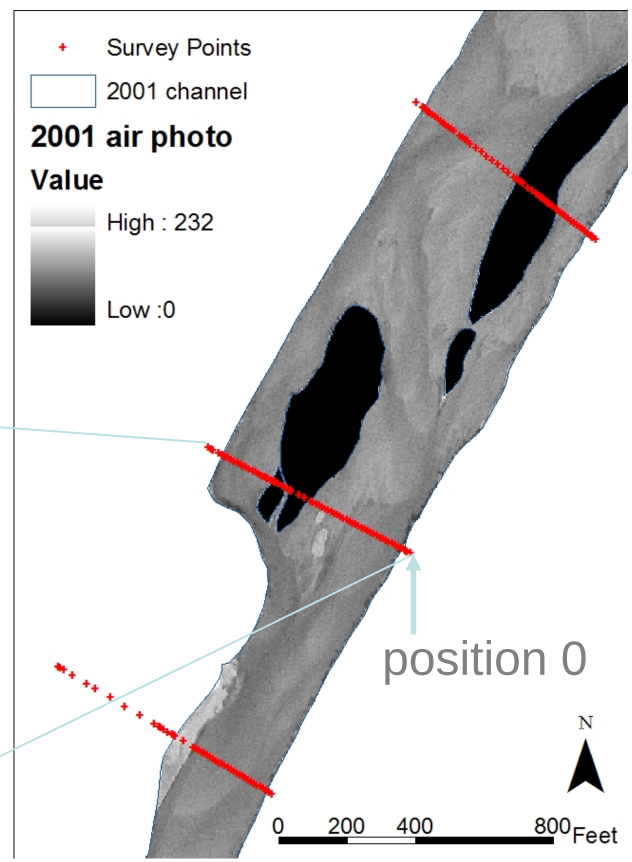
Use regression between cross section depths and photo reflectance to predict depths

Jordan and Fonstad, 2005 - Brazos River, TX

Winterbottom and Gilvear, 1997 – UK rivers

- -Use Depths to track bar movement
- -Use depths in conjuction with other measured variables (slope, roughness, etc) to calculate shear stress, stream power.
- -Use above with vegetation, bank heights, bank material, etc. to predict bank erosion





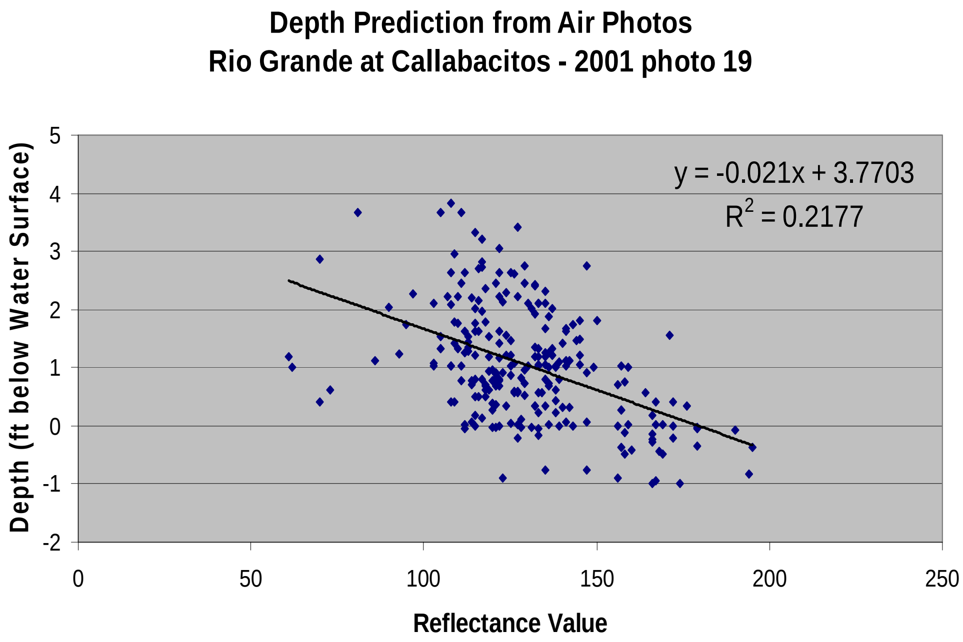
Depths from 2001 Air Photos – Initial Results

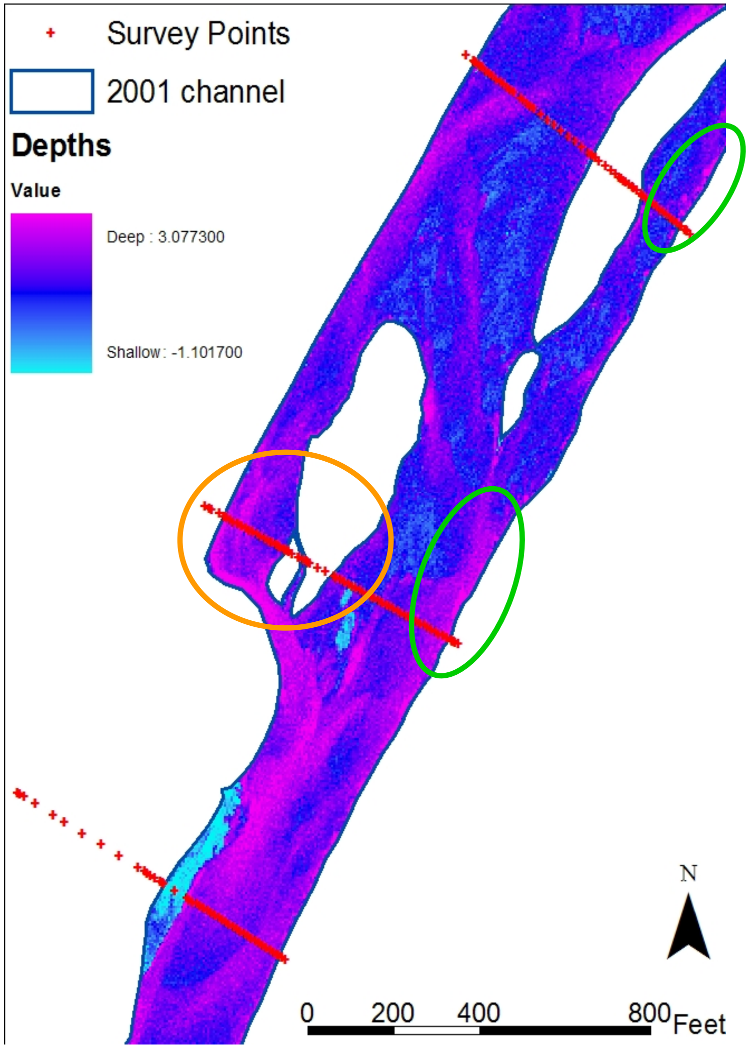
Poor Relationship

R^2 from 0.11 to .42 for 2001 photos - 0.69 and 0.55 for other studies

Issues

- Multiple channels
- Overhanging vegetation and shadows
- Turbidity
- Variable bottom cover
- Sun Glint
- Others





FY06 UNM projects

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- Bank erosion monitoring
- Coupling of hydrologic/hydraulic models and aerial photos through time

Rio Grande Seminar

- Provides regular forum for inter-disciplinary discussion
- Speakers from ERDC, NMSEO, NMF&WS, Sandia Labs, UNM, and others

www.unm.edu/~jcoonrod/rgseminar