Protecting and Restoring Floodplains to Manage Stream Health

Chris Bowles, Ph.D., cbec

SWRCB Training Academy - Stream Channel Naturalization

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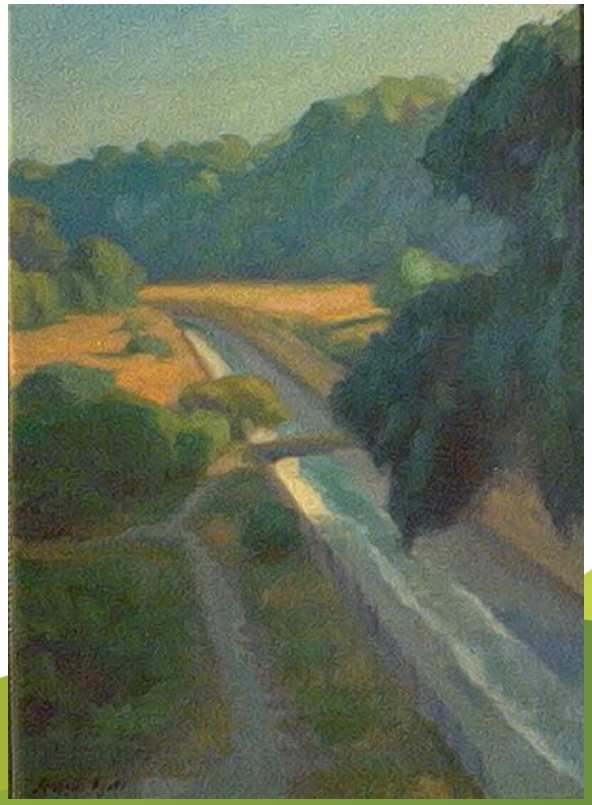
2701 Del Paso Road, Suite 130/232, Sacramento, CA 95835, USA
T/F 916 570 2502 C 916 243 8290 chrisbowles@mac.com

cbec eco engineering

Hydraulics | Hydrology | Geomorphology | Design



Environmentally sustainable solutions for the water resources industry

Overview of Presentation

1. Floodplains and where have they gone?
2. The importance of floodplains.
3. Multi-objective floodplain management.
4. Examples of what we are trying to do and what we have done (success?)

Photo: Roman Loranc

1. Floodplains and where have they gone?

Traditional Flood Engineering

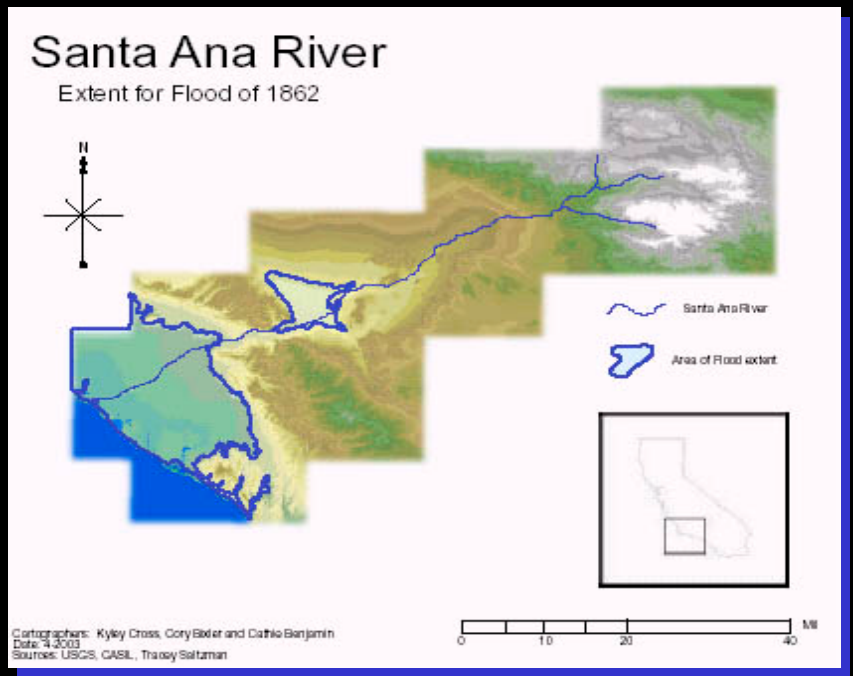
Floods Have Been Around For A Long Time…

The Floodplain Management Association

Southwest Flooding

Great Flood of 1862

- ✓ Inundated the Sacramento and San Joaquin Valleys for 300 miles with an average breadth of 20 miles
- ✓ Four weeks of rain
- ✓ Inland Sea in Orange County

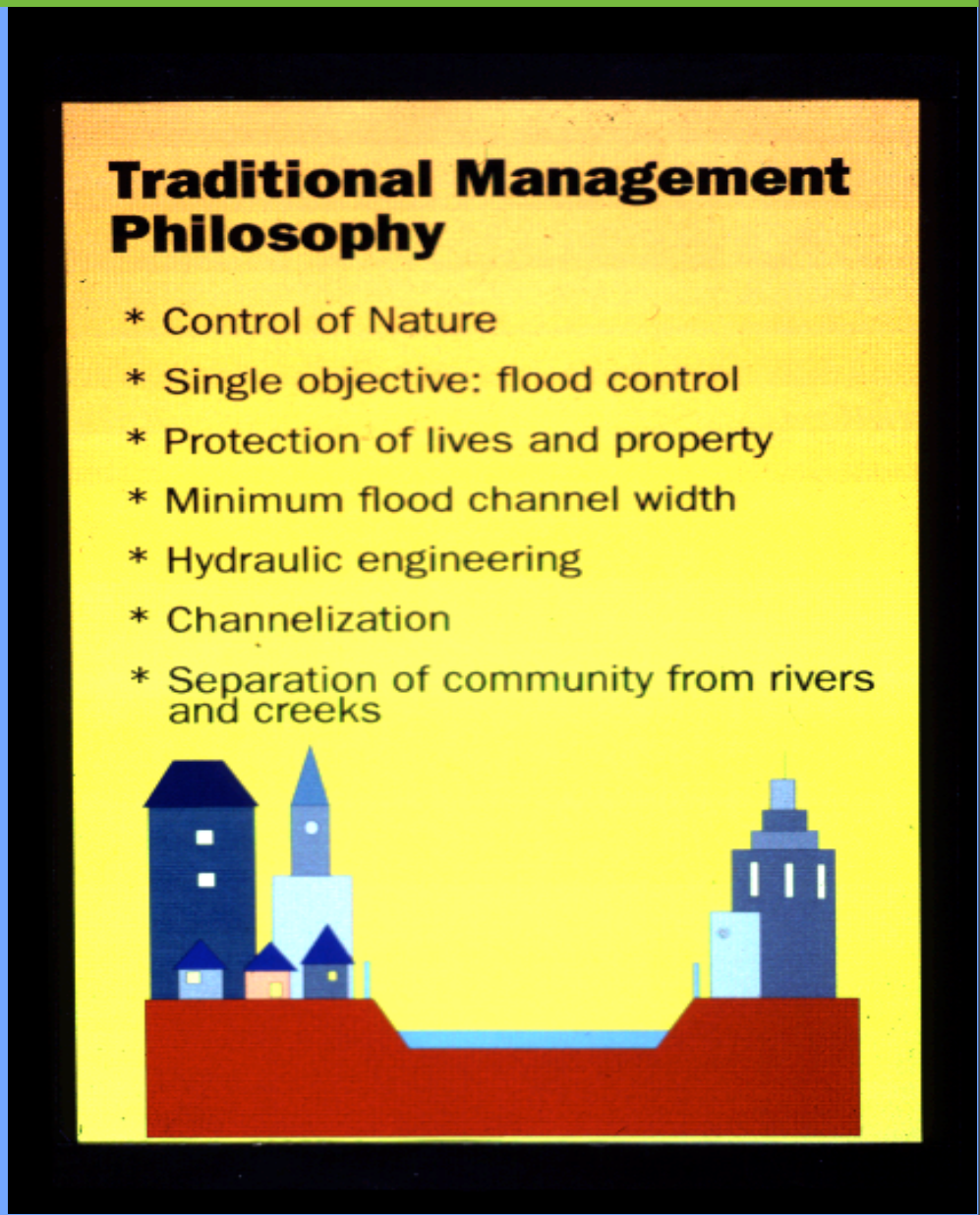


The Floodplain Management Association

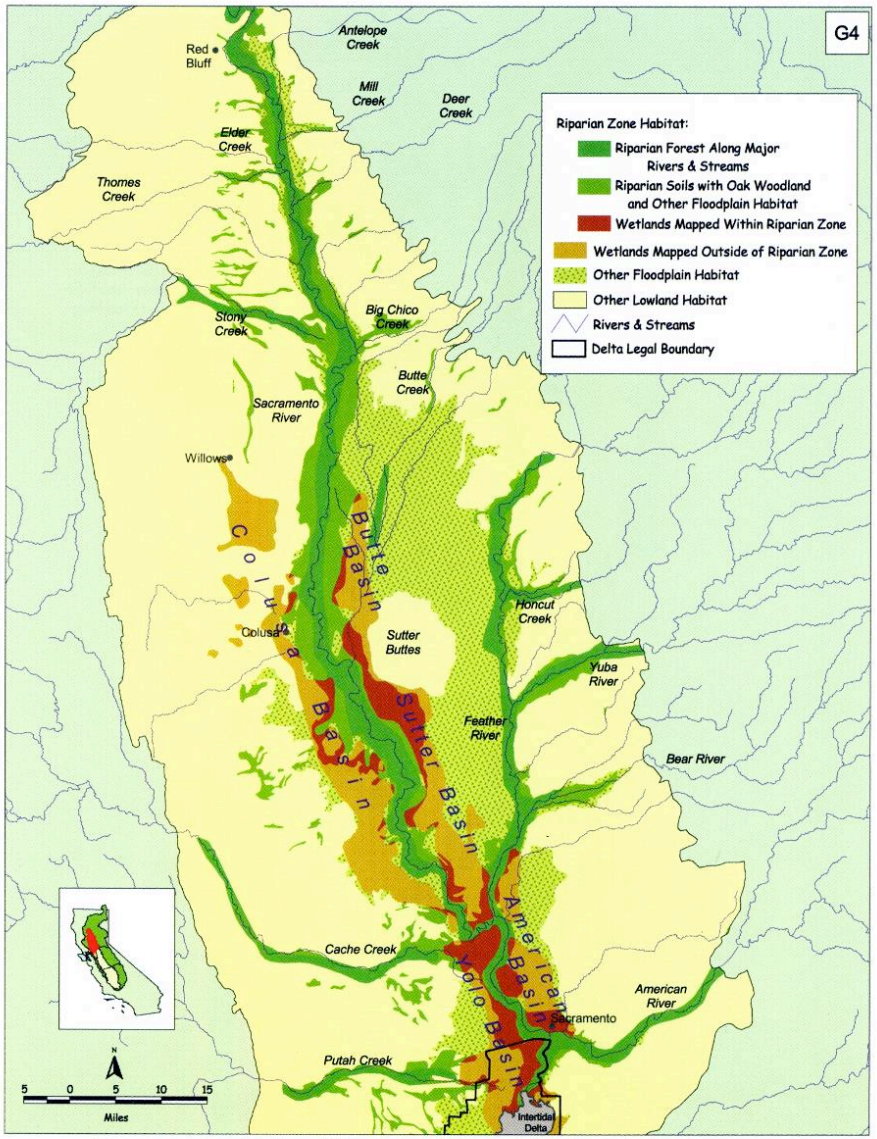
Traditional Flood Engineering

THAMES WATER - ANNUAL REPORT, 1974

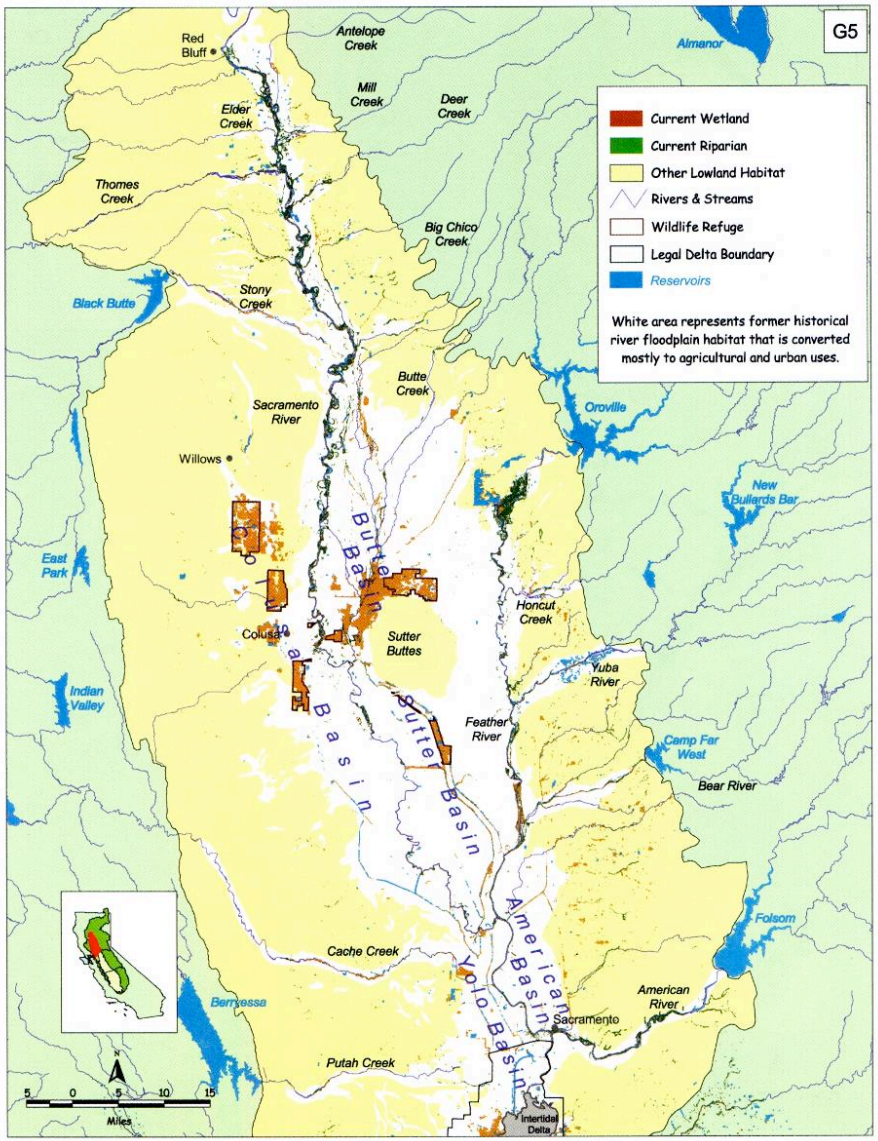
- **Rivers as formed by nature are seldom ideally suited for our work.**
- **...Ditches and streams must often be straightened.**



The Sacramento River's Wetlands, Then and Now

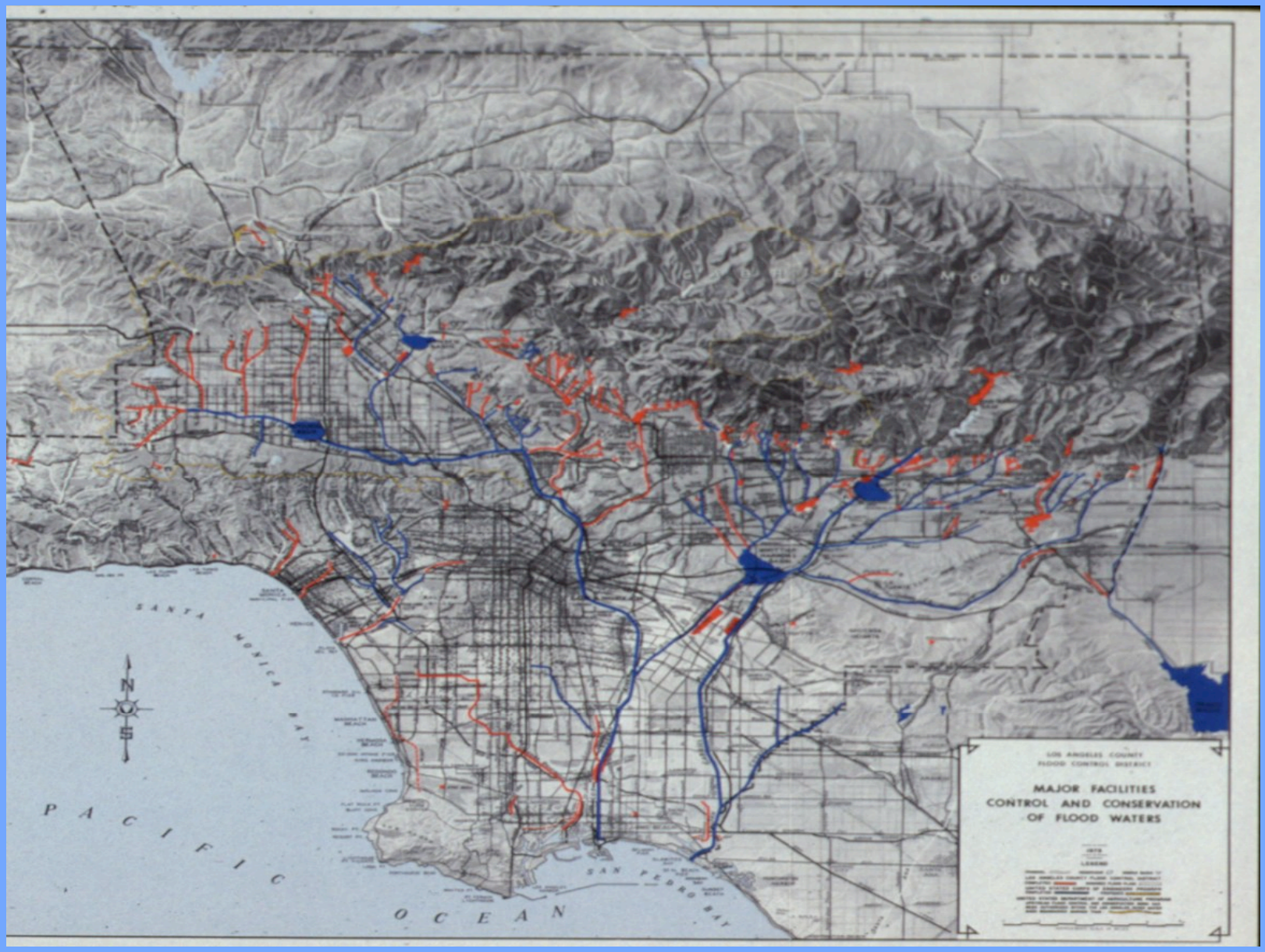


Sacramento Valley Historical River Floodplain Ecosystem



Sacramento Valley Current River Floodplain Ecosystem

Traditional Flood Engineering



Traditional Flood Engineering

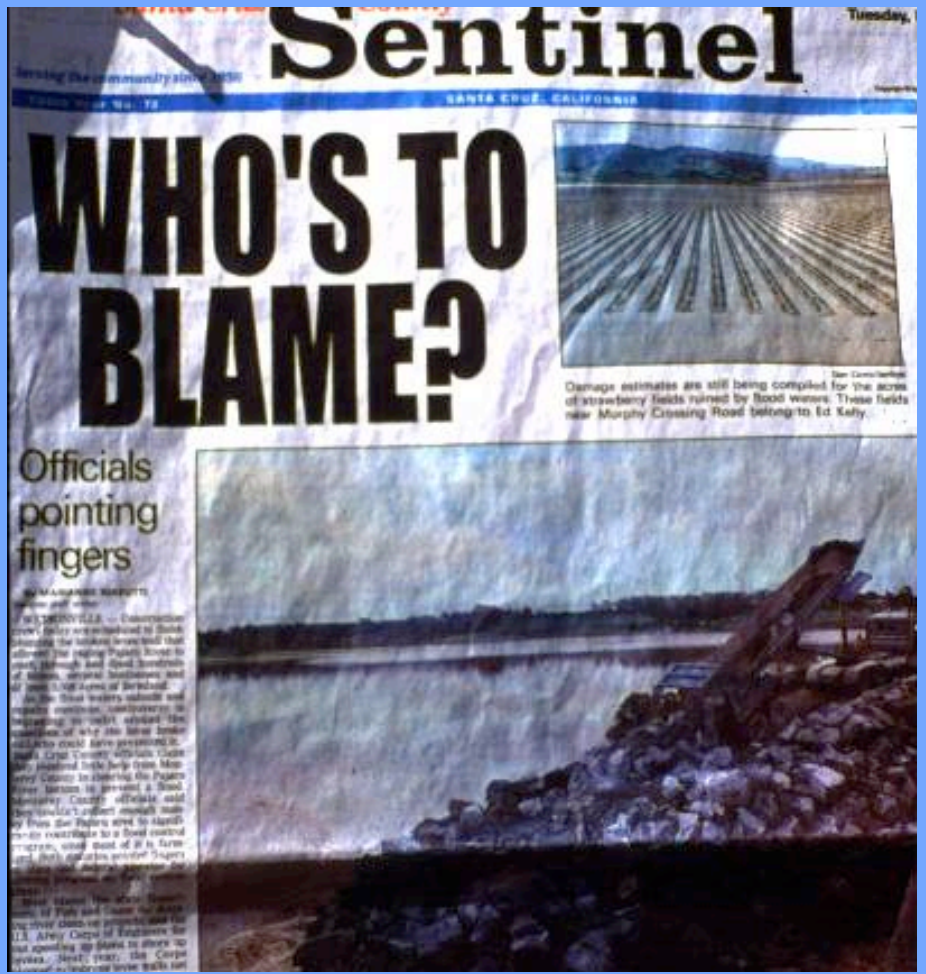
Hansen Dam

Traditional Flood Engineering

Traditional Flood Engineering

21. Los Angeles River – View upstream from above Victory Boulevard showing breaches in rock-paved levees in and below a sharp curve in channel alignment. River mile 32.0.

Traditional Flood Engineering



Traditional Flood Engineering

San Lorenzo River

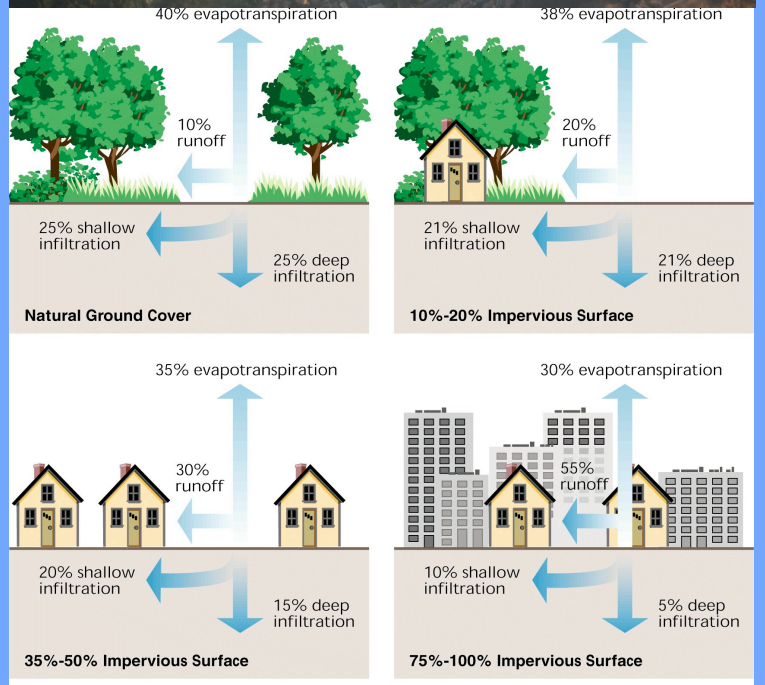
Anticipated maintenance = 300,000 yd^3

Actual = X3

Case Studies - We have got better…but

How Floodplains Have Been Disconnected from the River

- Landscape modifications
  - Levee construction
- Hydrologic changes:
  - Upstream reservoir ‘flatlining’ flood flows
  - Diversions and watershed changes upstream
  - Climate change
- Geomorphic changes:
  - Channel degradation:
    - Reservoir bed load capture
    - Gravel and sand mining
  - Floodplain aggradation
- Hydraulic changes
  - Channelization
  - Riparian vegetation removal



2. The importance of floodplains

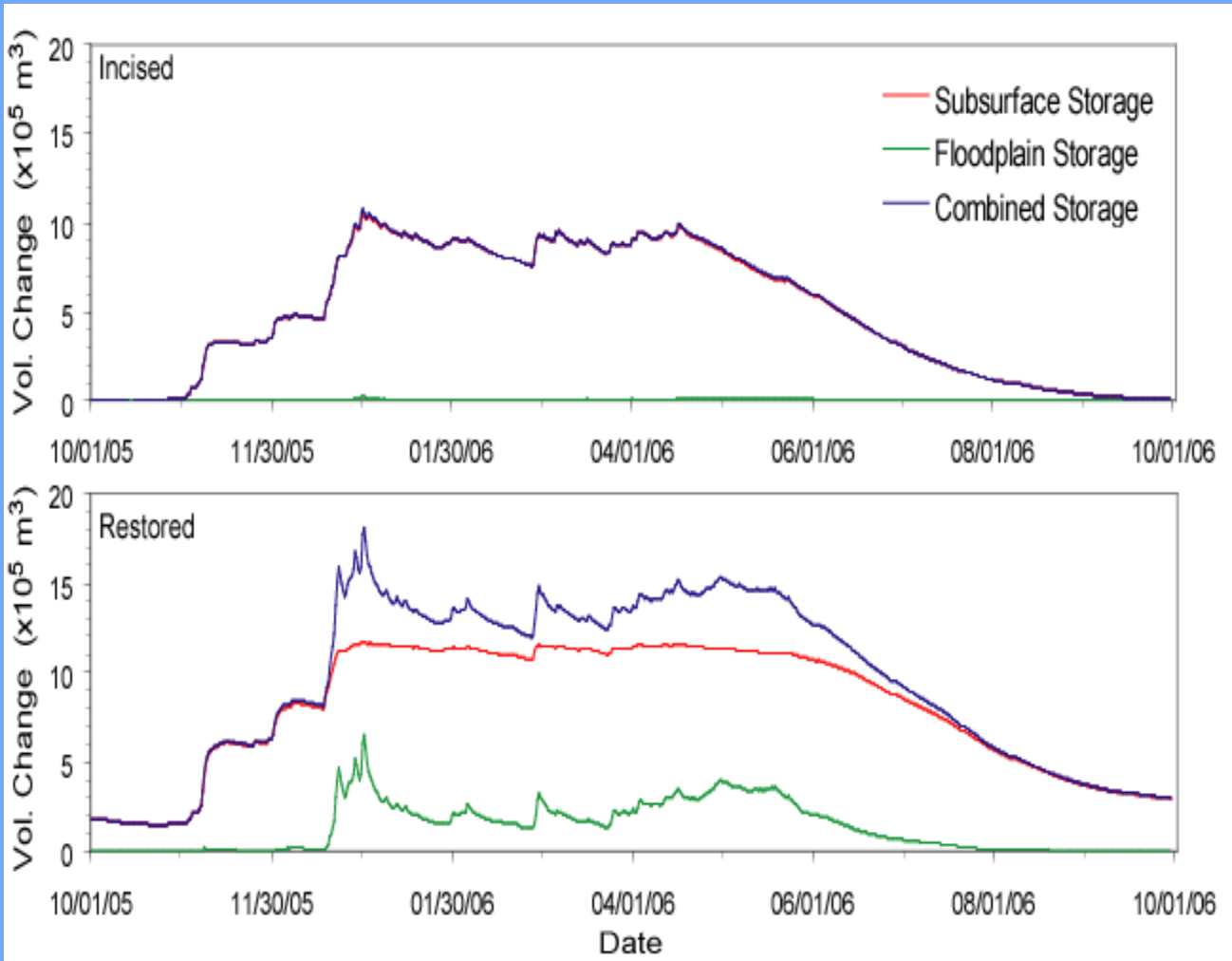
Floodplains – so what?

CHRIS BOWLES, 2006

- Floodplains are the sponges of our ecosystems.

Floodplains – so what?

- Floodplains are the sponges of our ecosystems.

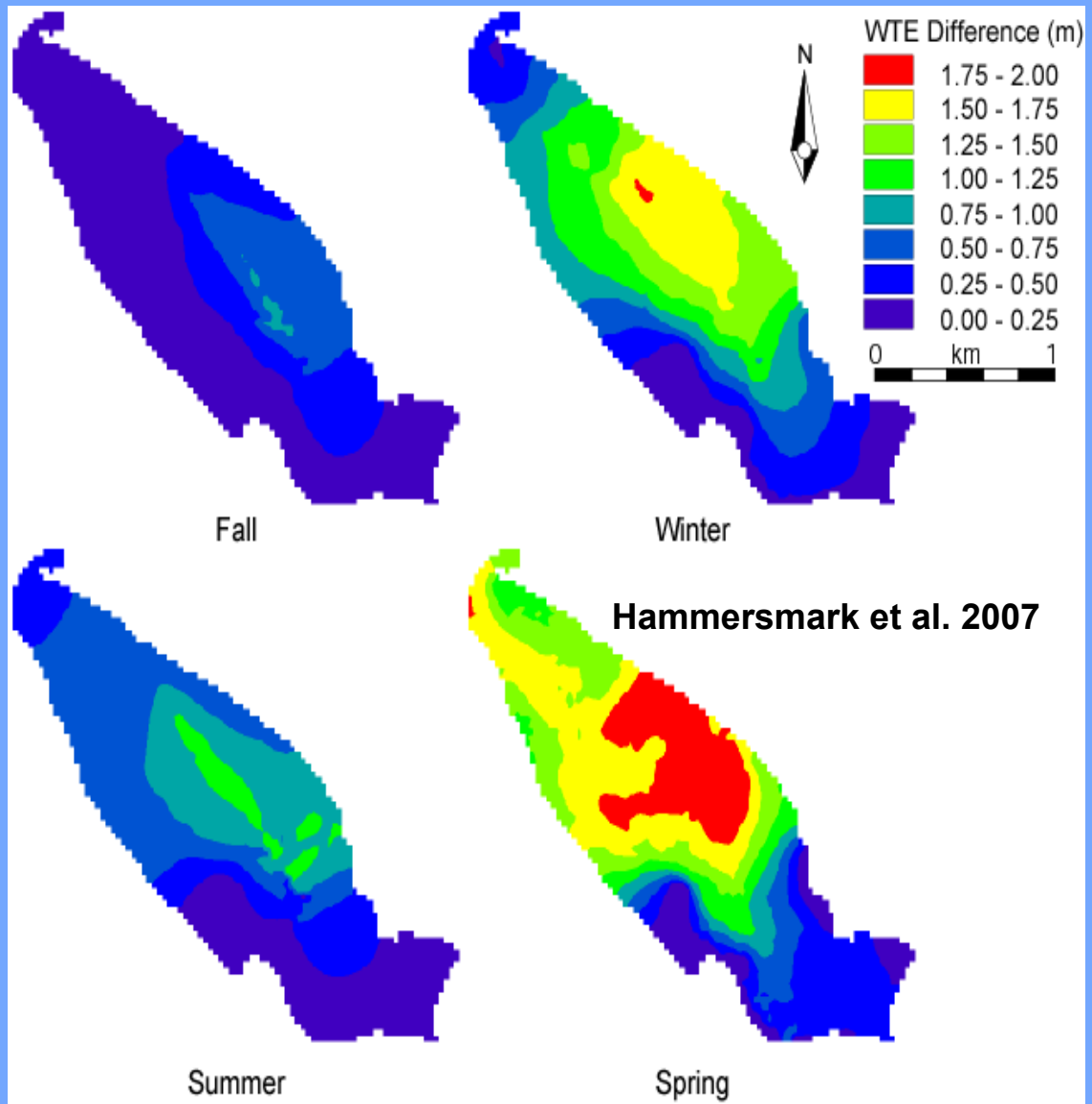


Bear Creek, California

Hammersmark et al. 2007

Groundwater

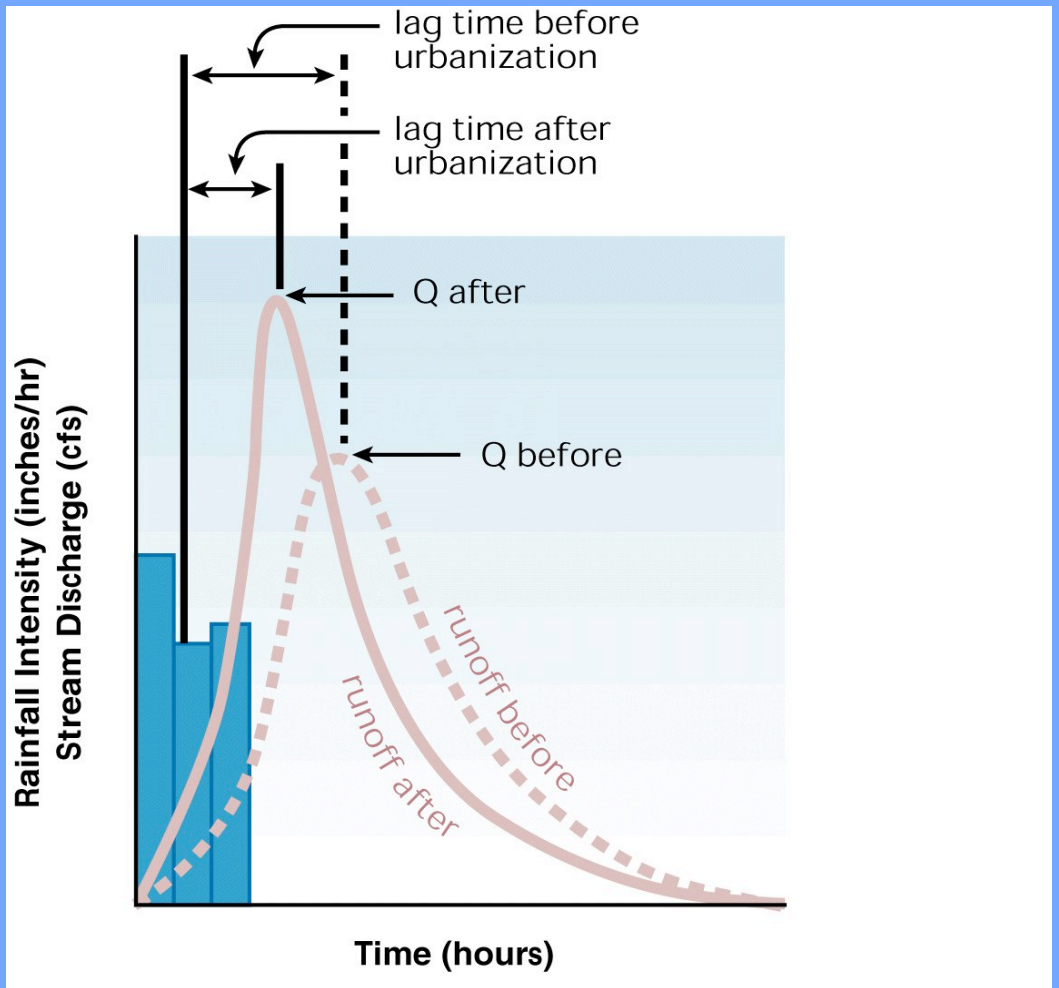
- Groundwater levels raised
- Largest difference in winter and spring
- Complex response due to channel realignment
- Larger maximum and residual volume stored



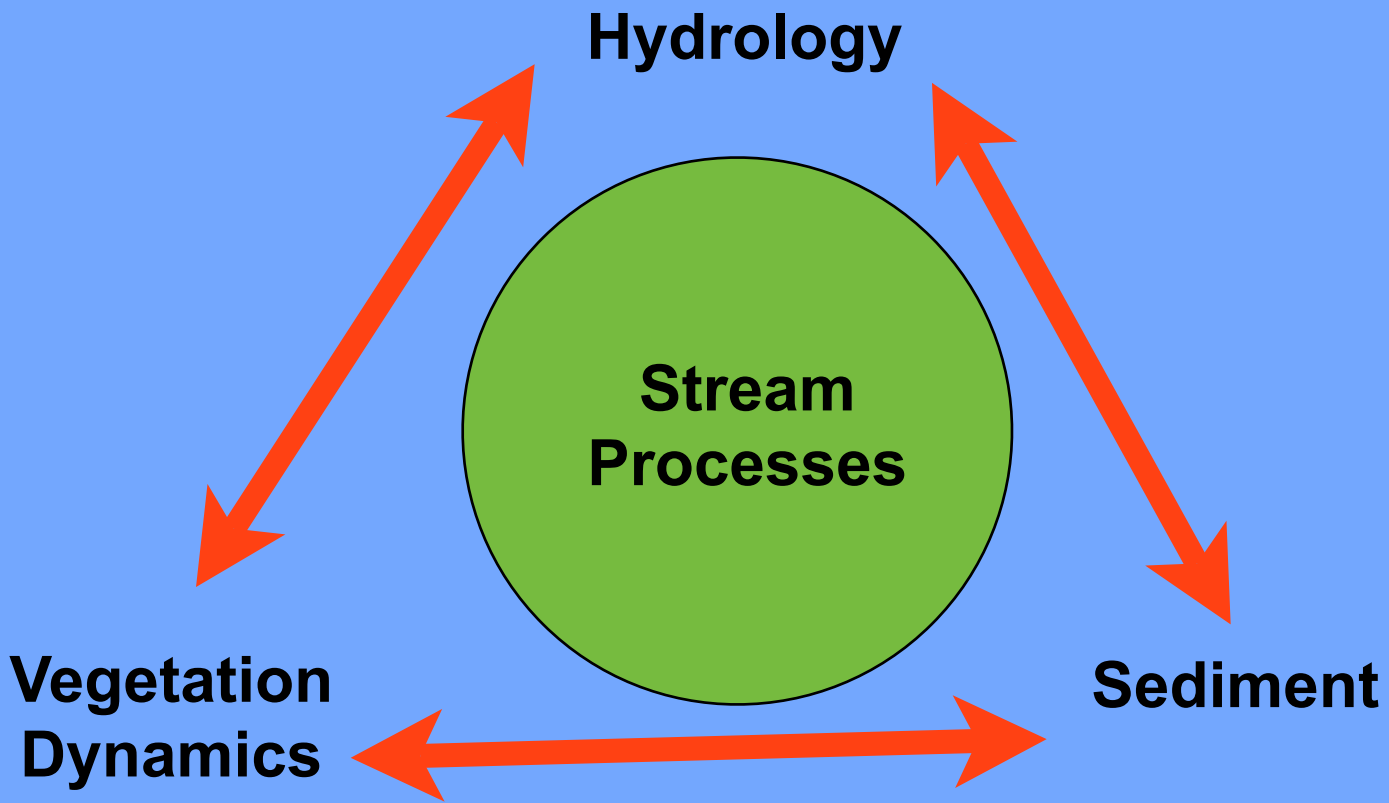
HYDROGRAPH PROCESSES

Urbanization tends to increase stormwater runoff:

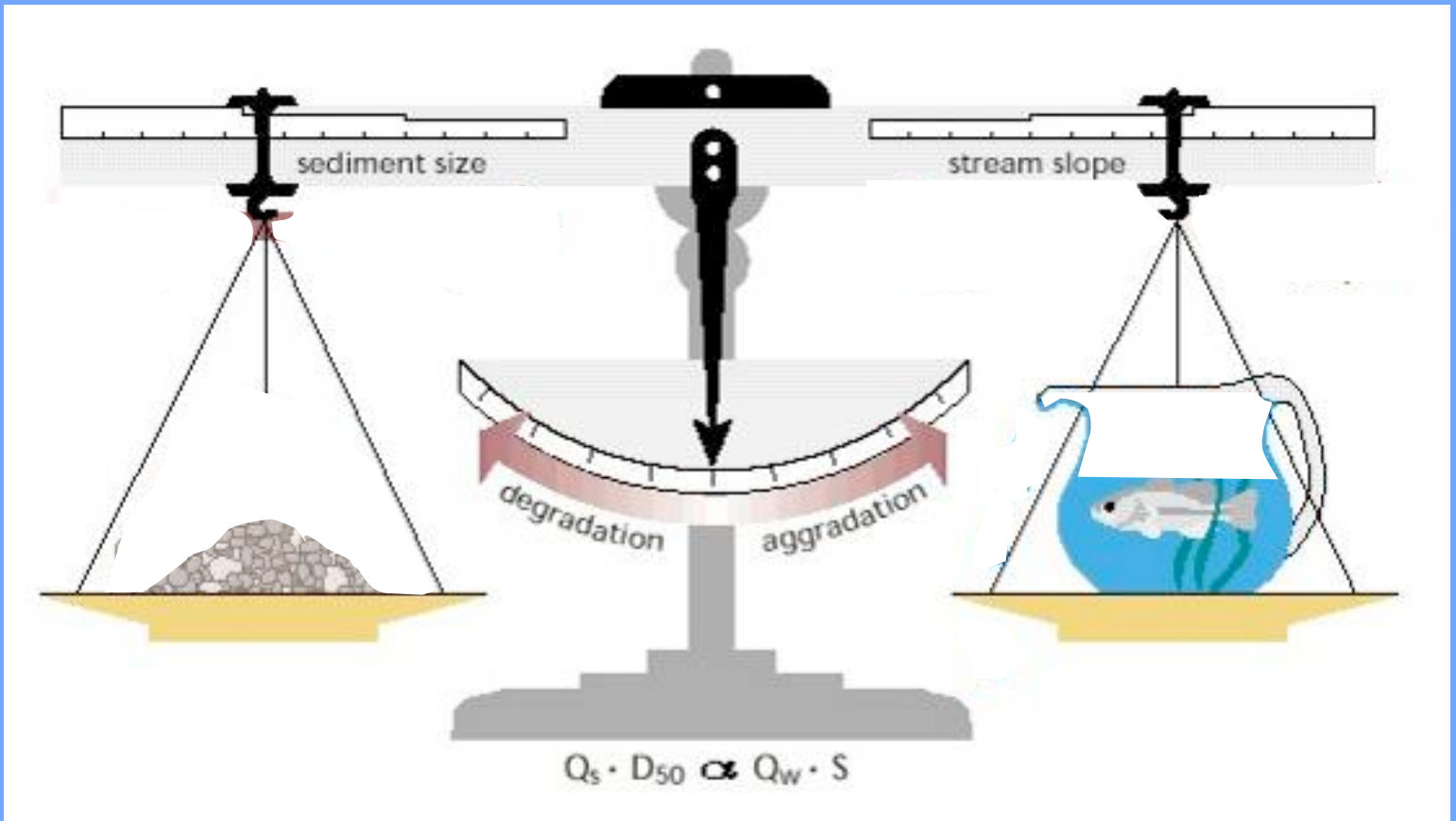
- peak flows
- volume
- frequency



It's not just about the hydrology...

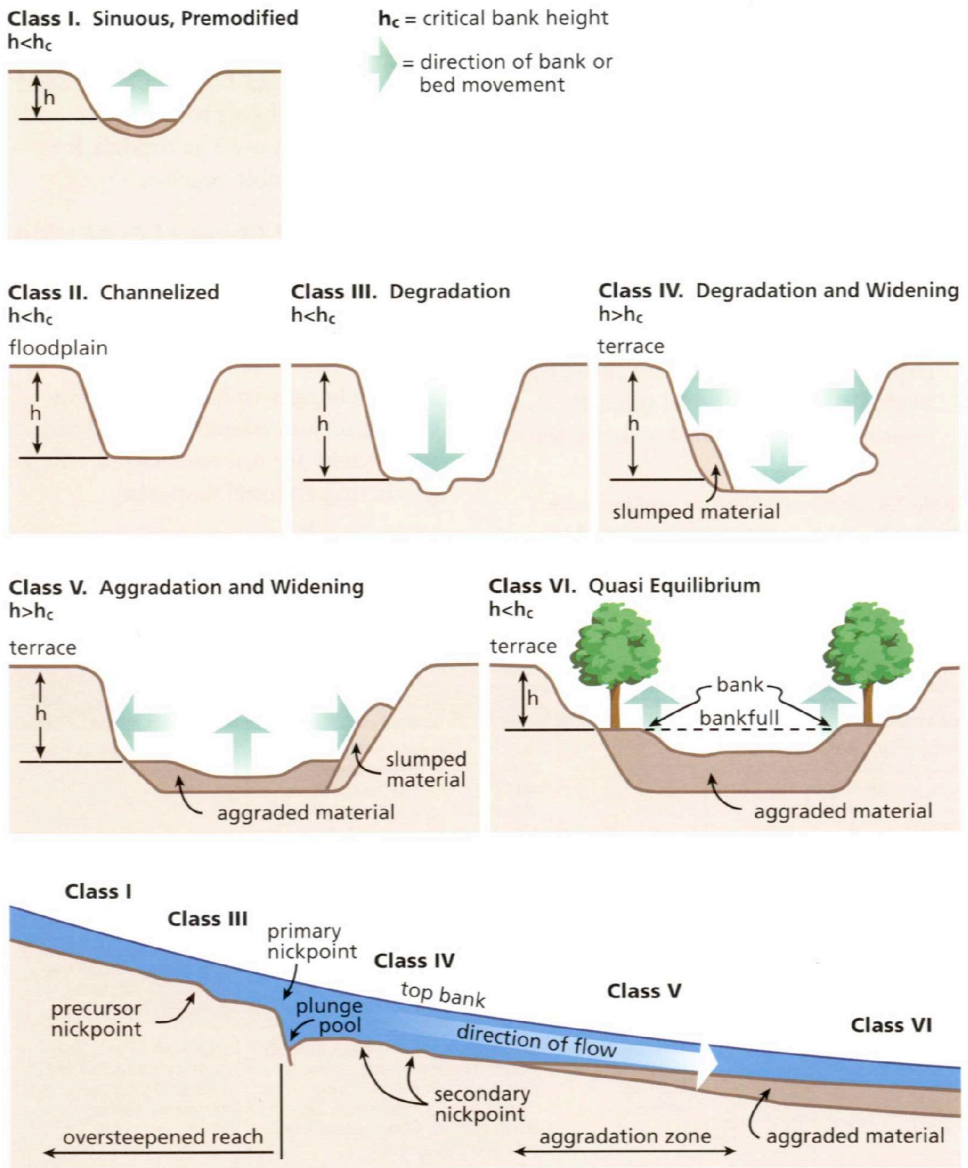


Lane's Diagram by Rosgen, 1996



Over time channel geometry (width, depth, gradient) adjusts to be in equilibrium with water and sediment load

IMPACTS TO RIVERS AND CREEKS



Simon, 1989
Schumm, 1977

IMPACTS TO RIVERS AND CREEKS

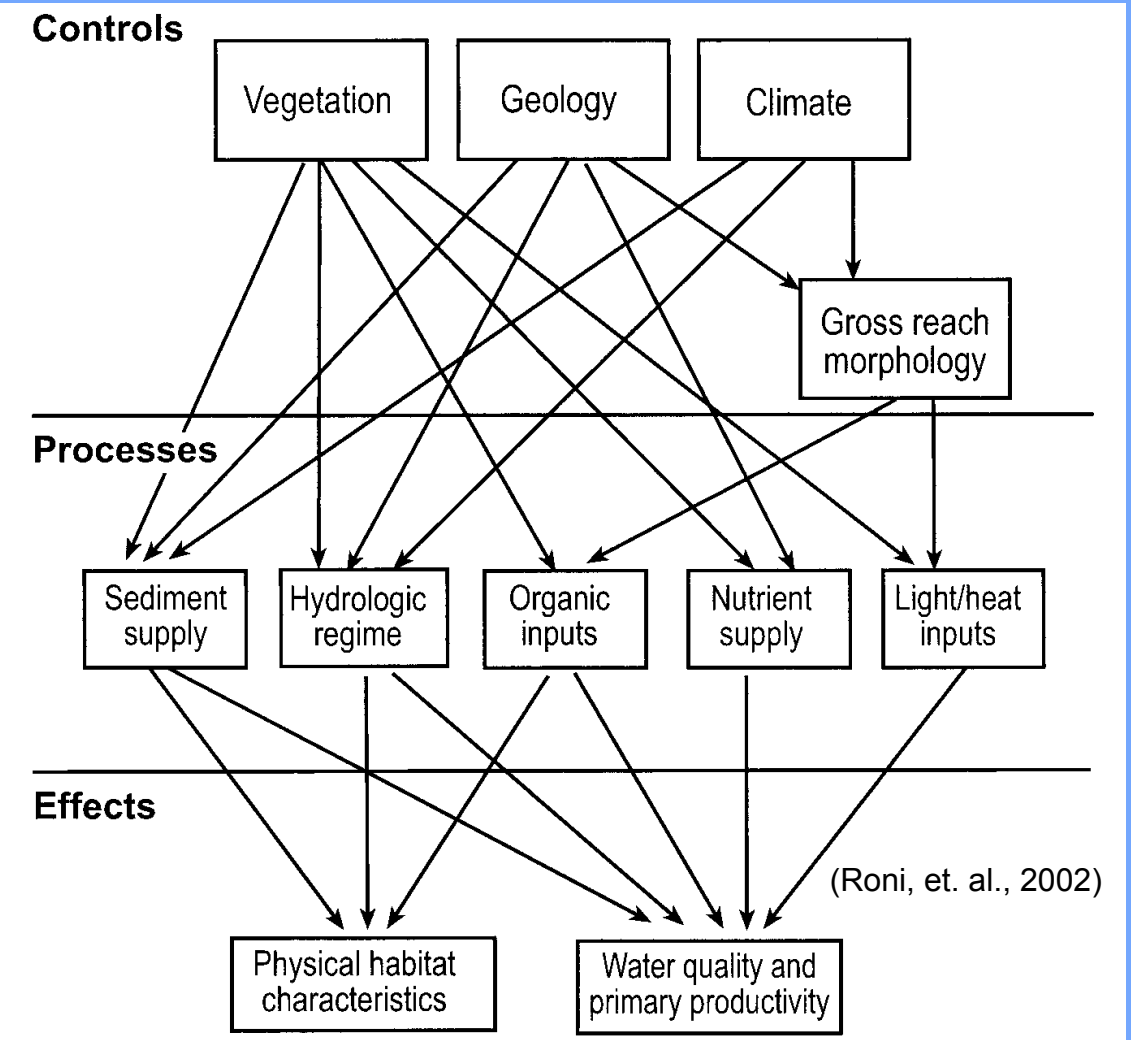
Aliso Creek,
Orange County
(Geosyntec)

IMPACTS TO RIVERS AND CREEKS

Thompson/Lower Silver Creeks (San Jose)
(Geosyntec)

Ecological Importance of Floodplains

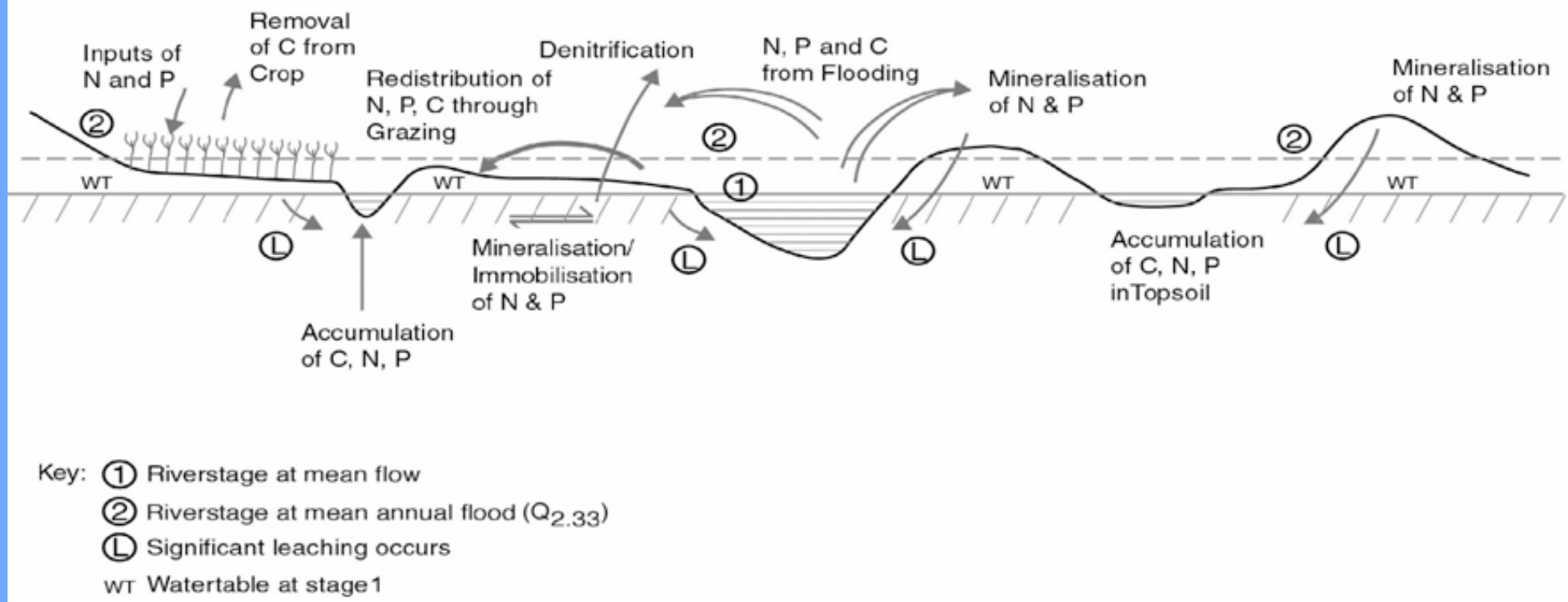
- Magnitude
- Timing
- Frequency
- Duration
- Rate of change



Real data – other benefits of multi-objectives…

FIGURE 4. Schematic of nitrogen, phosphorus and carbon behaviour at sites.

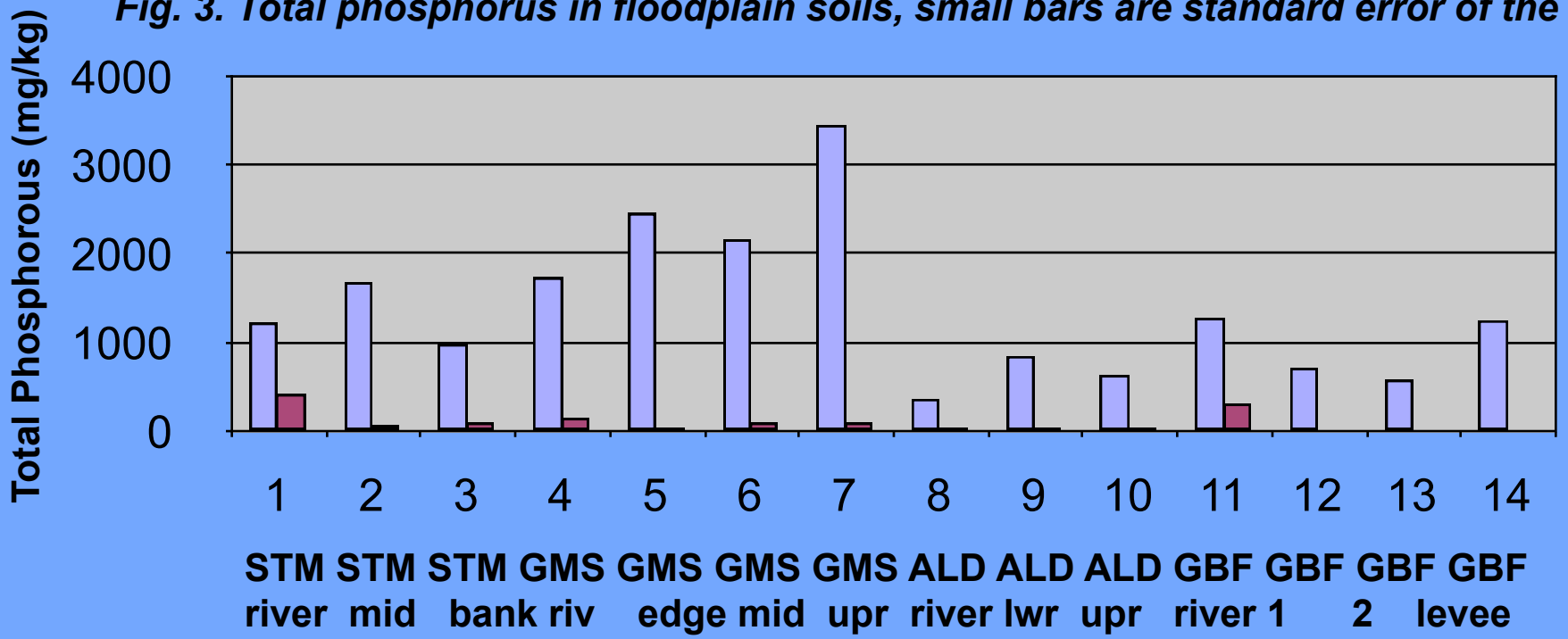
Topographic Feature	Floodplain	Drainage Ditch	Floodplain Meadow	River Channel	Natural Levée	Flood Plain 'Basin'	Flood Embankment
Land Use	Arable		Grazing			Grazing	
Inundation	Average	Average	Common		Infrequent	Common	Rare



Cook, et al,, 2007 (Dr Hadrian F Cook MCIWEM, Harnham Water Meadows Trust, UK)

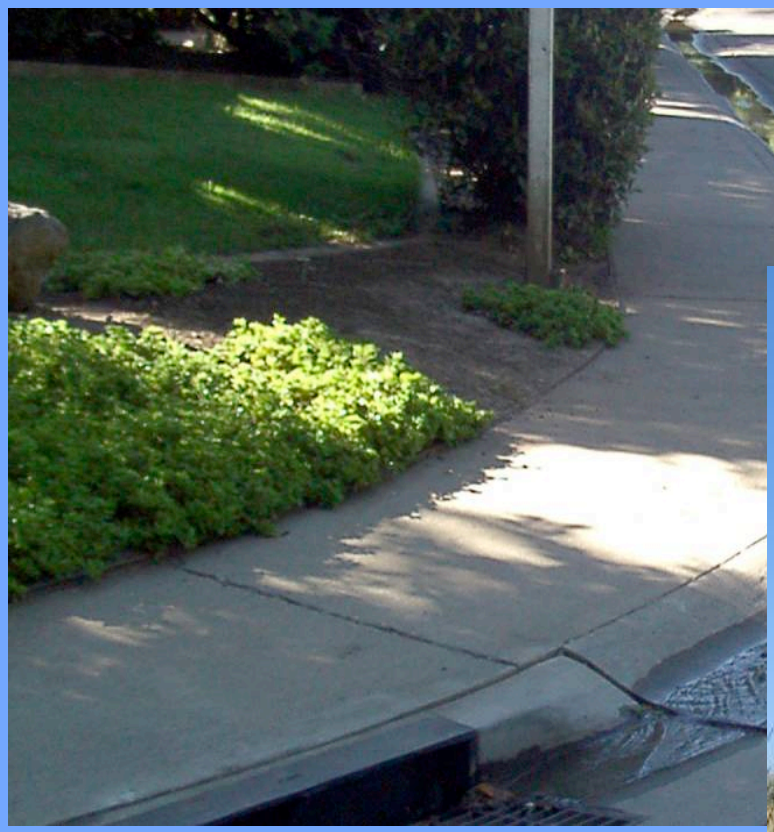
Real data…from the UK

Fig. 3. Total phosphorus in floodplain soils, small bars are standard error of the mean



Cook, et al,, 2007 (Dr Hadrian F Cook MCIWEM, Harnham Water Meadows Trust, UK)

Real data…from UC Davis



Photos provided by Dr. Loren Oki, Department of Plant Sciences, UC Davis

And shouldn't these chaps know about this…

3. Multi-objective floodplain management

Overview of Presentation

Multi-Objective Flood Corridor Management
=
Flood Risk Reduction
(aka - OFFLOAD VOLUME WHEREVER POSSIBLE!!!)
+
Socio-Economic Issues (Development, etc.)
+
Maintenance
+
Water Quality
+
Ecosystem
+
Recreation

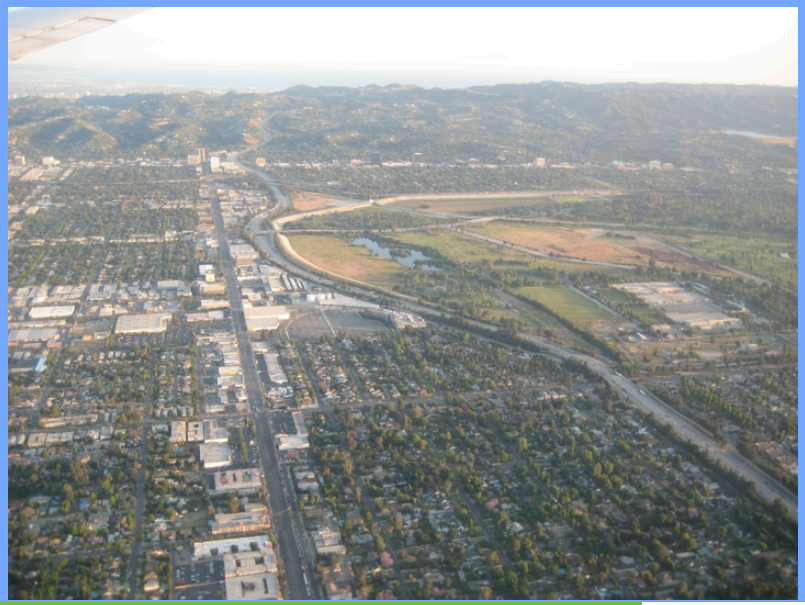
Floodplains – so what?

Multi-Objective Floodplain Management

1. Alleviates flood risks.
   a) Protects lives and properties up to the design flood.
   b) Minimizes damages for larger floods.

2. Preserves natural channel morphology and character.

3. Minimizes long-term maintenance
   a) Sediment excavation costs.
   b) Vegetation management
   c) Structural repair



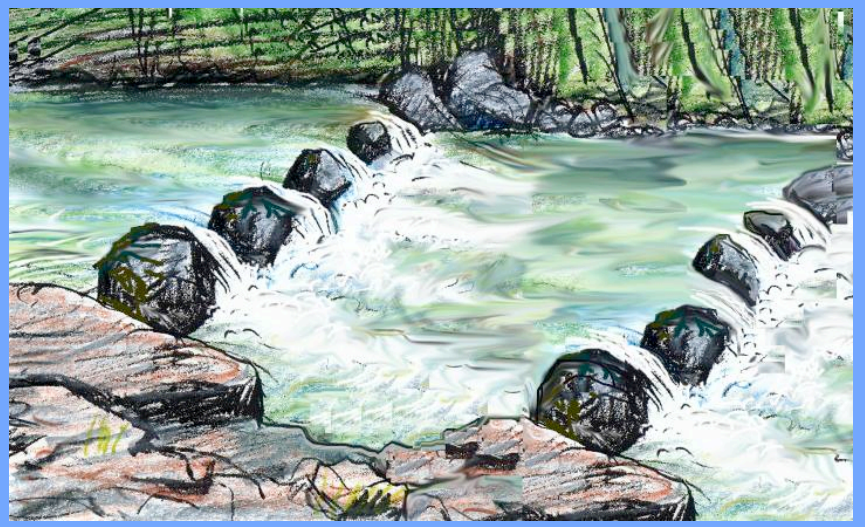
Multi-Objective Floodplain Management - Cont.

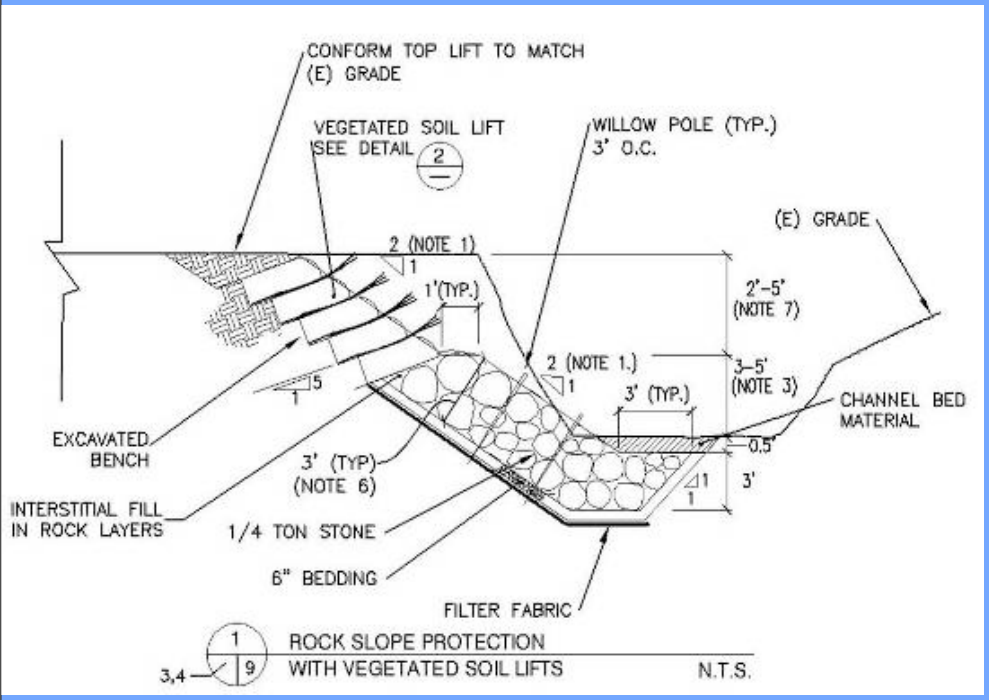
4. Enhances biological resources
5. Improves water quality
6. Mitigates ecological impacts within project boundaries
7. Accounts for watershed evolution and accounts for river as a system
8. Integrates recreational and aesthetic opportunities
9. Is supported by community and regulatory agencies

4. Examples of what we are trying to do and what we have done (success?)

In-Stream Approaches

- **Grade Controls**
- **Bank Stabilization**
- **Floodplain Restoration**





Lowering the Floodplain or Raising the Bed

Photos: Pasternack, UC Davis

Santa Clara River Parkway
Ventura, California

A project of the State Coastal Conservancy

Science Team:
Stillwater Sciences
URS
SFEI

SCC Project Manager:
Peter Brand

Coastal Conservancy

Stillwater Sciences

Southern California Watersheds

Jan 25, 1969: peak flow 4,672 m^3s^{-1}; area 4,128km^2

SANTA CLARA RIVER PARKWAY

SWRCB Urban Stream Workshop, May 30, 2008

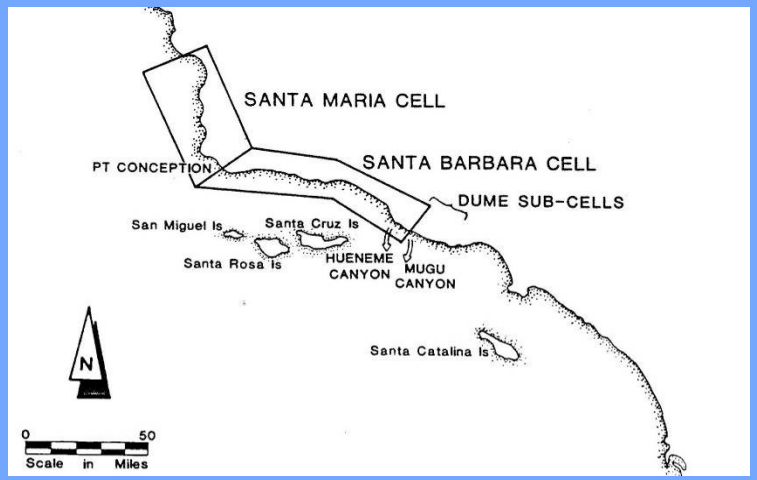
Conversion of Santa Clara River Estuary
1938 – 1969 - Current


1983 Santa Clara

THE RIVER-OCEAN CONNECTION

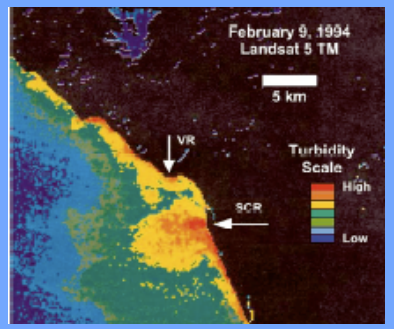
Approximately 65% of sediment delivered to the Santa Barbara littoral cell derives from the Santa Clara River (PCR Toups 1980)

Approximate littoral cell locations



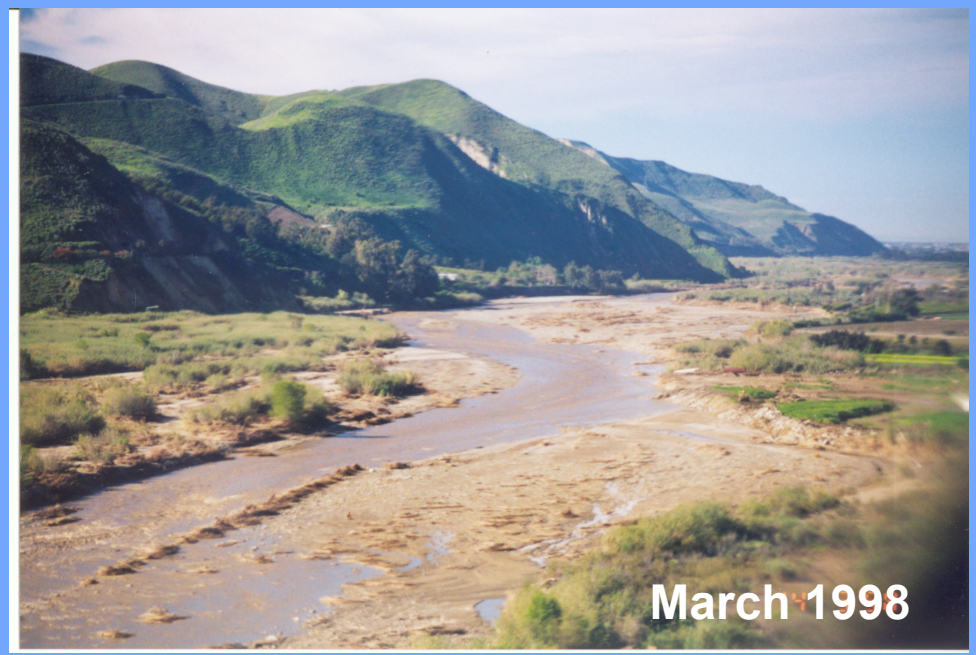
Noble Consultants 1989

Sediment plumes in the Santa Barbara Channel



Warrick et al 2004

Santa Clara River



- A Resource of Local, State and National Importance
- Largest river in southern California and most significant (ie. One of the last in a relatively natural state)
- River Parkway: the largest river restoration project in southern California

Santa Clara River Enhancement and Management Plan Issues

- Private Property Rights
- Agricultural Land Use Preservation
- Permit Streamlining
- Flood Protection
- Preservation/Enhancement of Species Habitat
- Aggregate Harvesting
- Beach Erosion and Replenishment
- Recreation
- Cultural Resources
- Water Supply/Water Quality/Water Recharge

Santa Clara River Parkway

A Coastal Conservancy Project

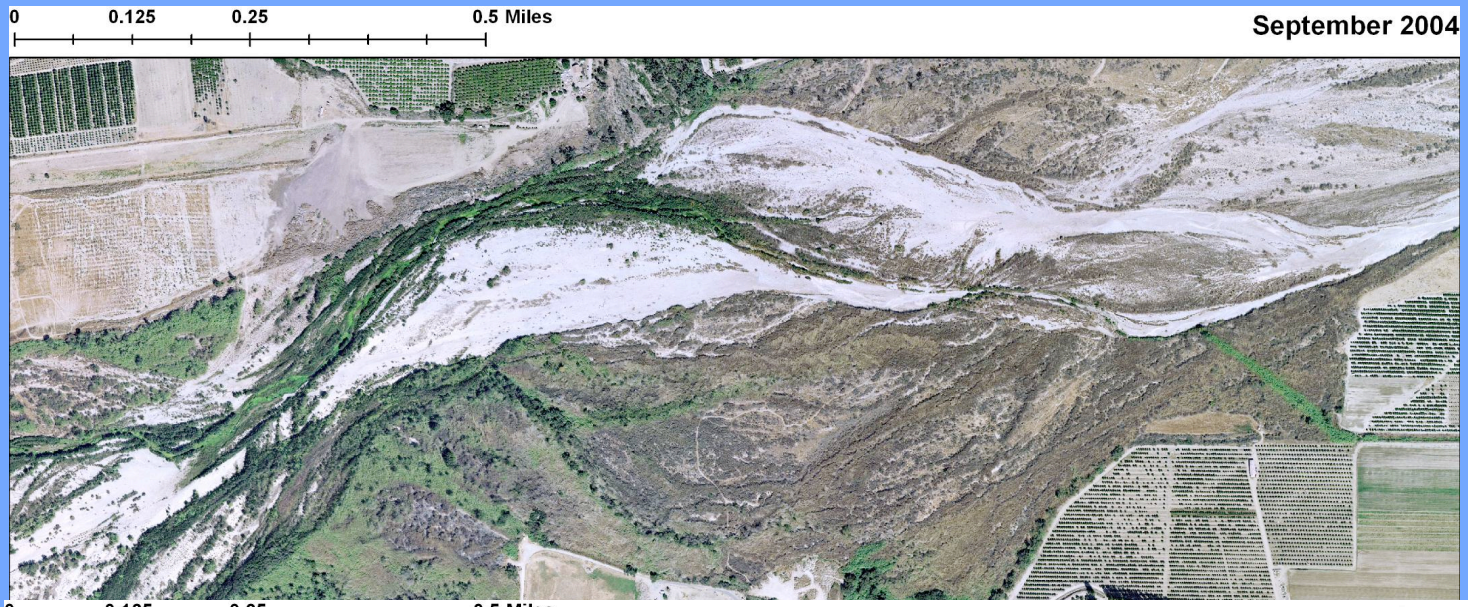
Developed with property owners of the Santa Clara River

and in partnership with the Nature Conservancy

River Parkway Concept

- Acquisition and public management of the river corridor for habitat restoration, flood management, public enjoyment and environmental education
- Restoration of the natural processes of the river to prevent continued catastrophic losses of habitat, farmland, and public facilities

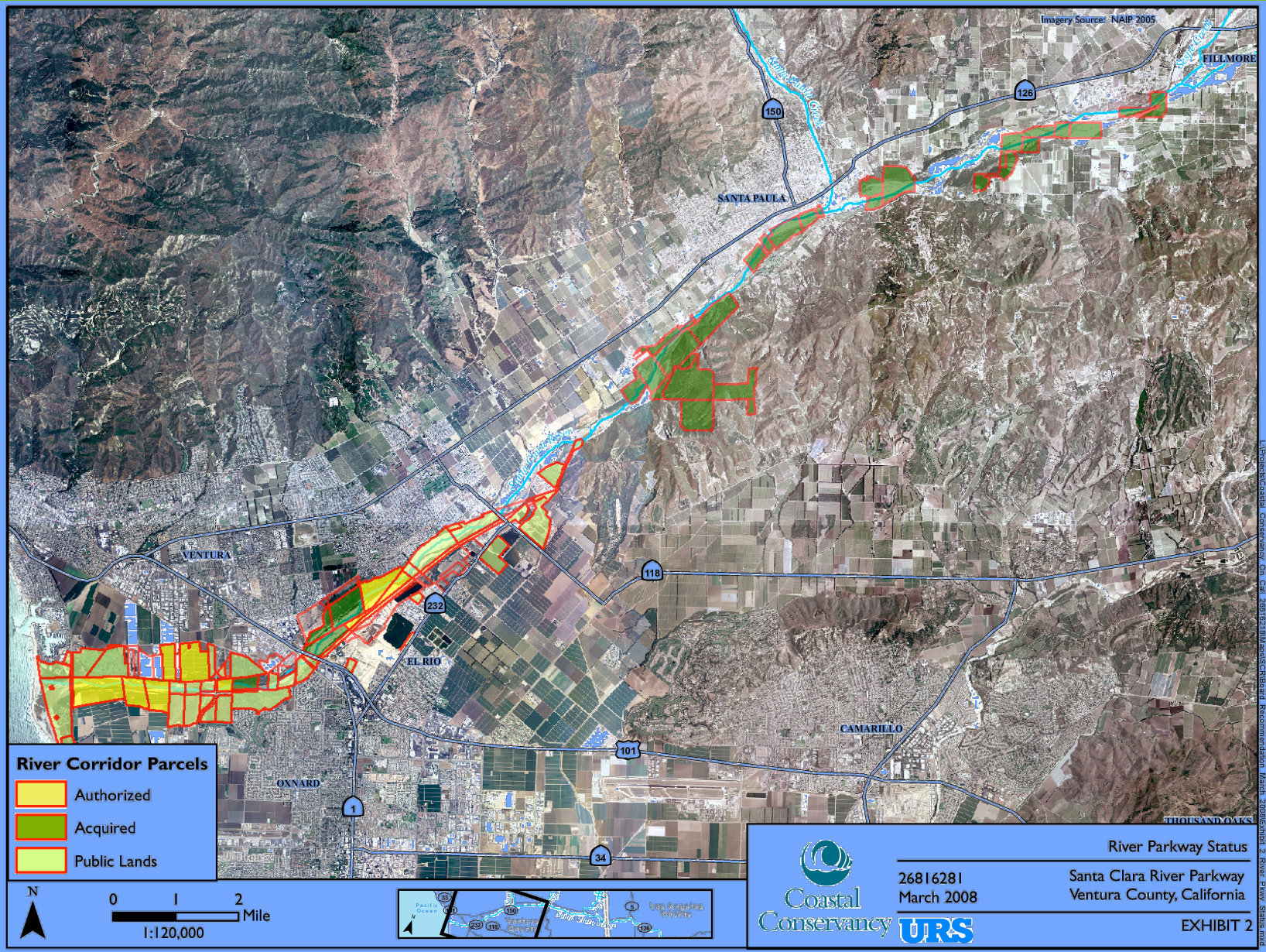
Dynamics


0
0.125
0.25
0.5 Miles
September 2004

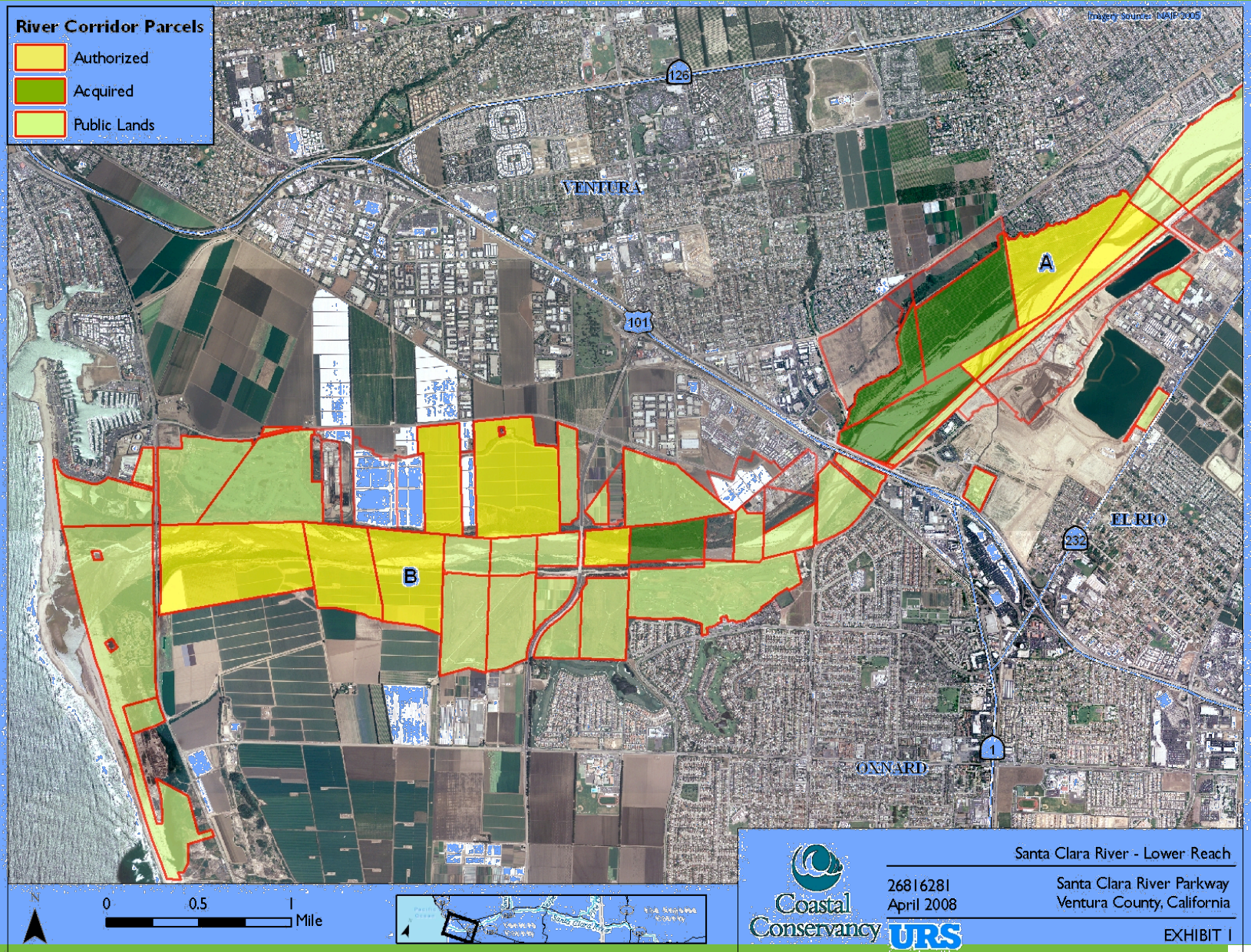

0
0.125
0.25
0.5 Miles
February 2005 (post flood)

Santa Clara River Parkway: Status

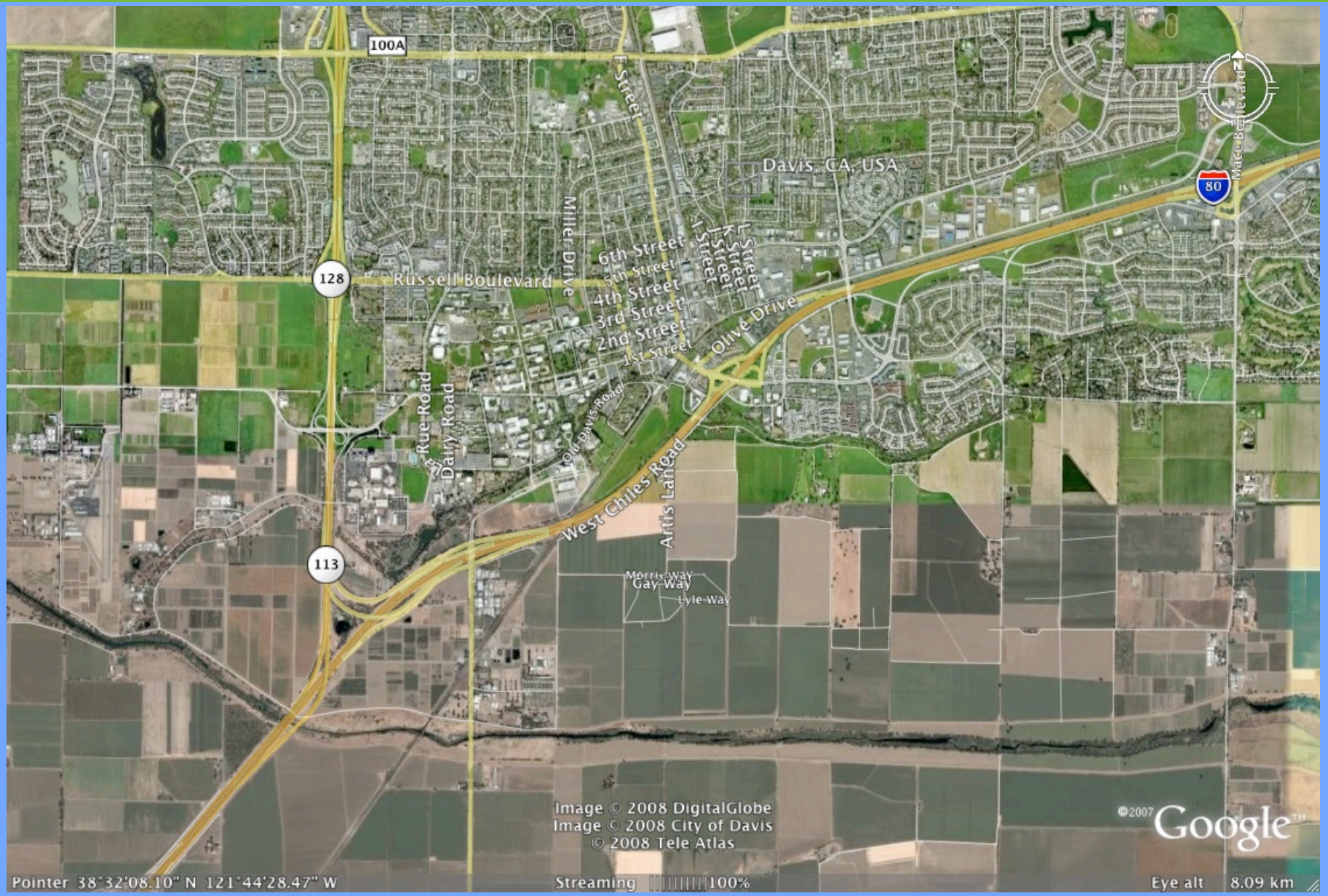
- Acquisition Phase: 17 properties acquired since 2000; 2,700 acres; 12 miles of river
- Coastal Conservancy expended approx. $12 million to date
- SCC Restoration Feasibility Study: $1 million study recently completed.



SWRCB Urban Stream Workshop, May 29, 2008

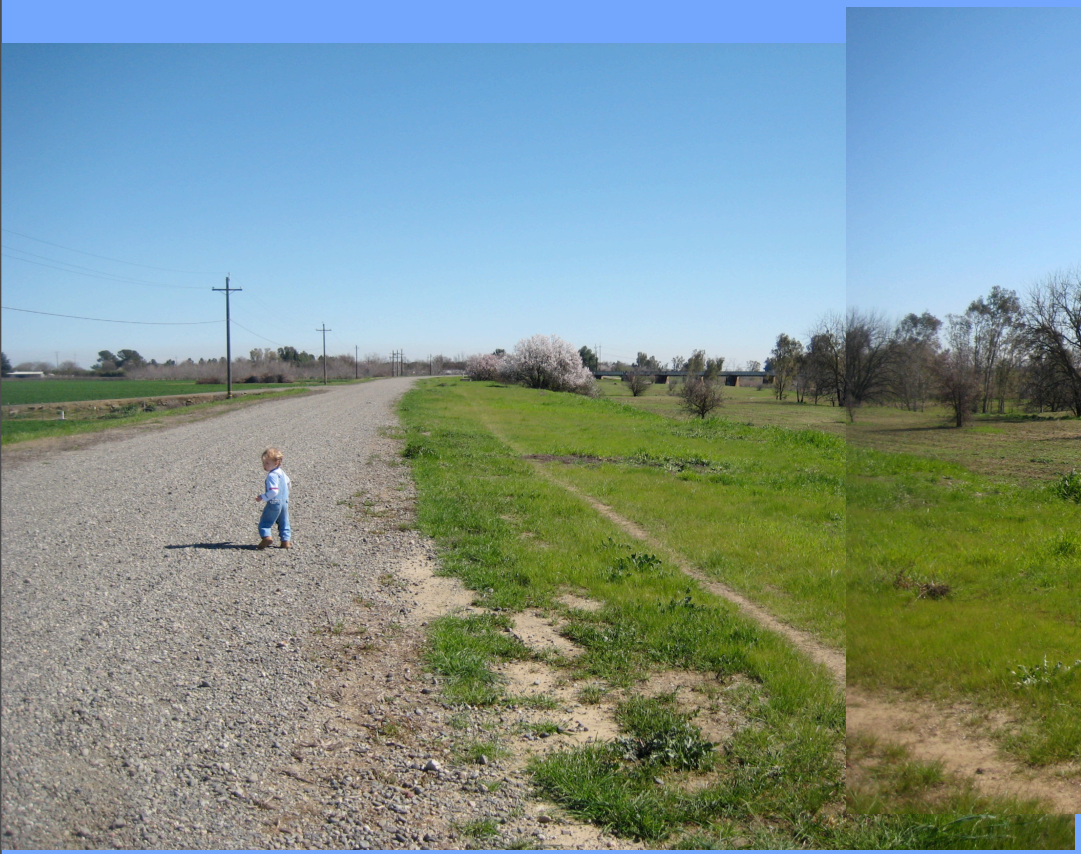

River Corridor Parcels
Authorized
Acquired
Public Lands
Imagery source: NAIP 2005
126
VENTURA
101
A
B
232
EL RIO
1
OXNARD
N
0
0.5
1
Mile
Coastal Conservancy
URS
Santa Clara River - Lower Reach
26816281
April 2008
Santa Clara River Parkway
Ventura County, California
EXHIBIT 1

Floodplain/Channel Restoration - Putah Creek



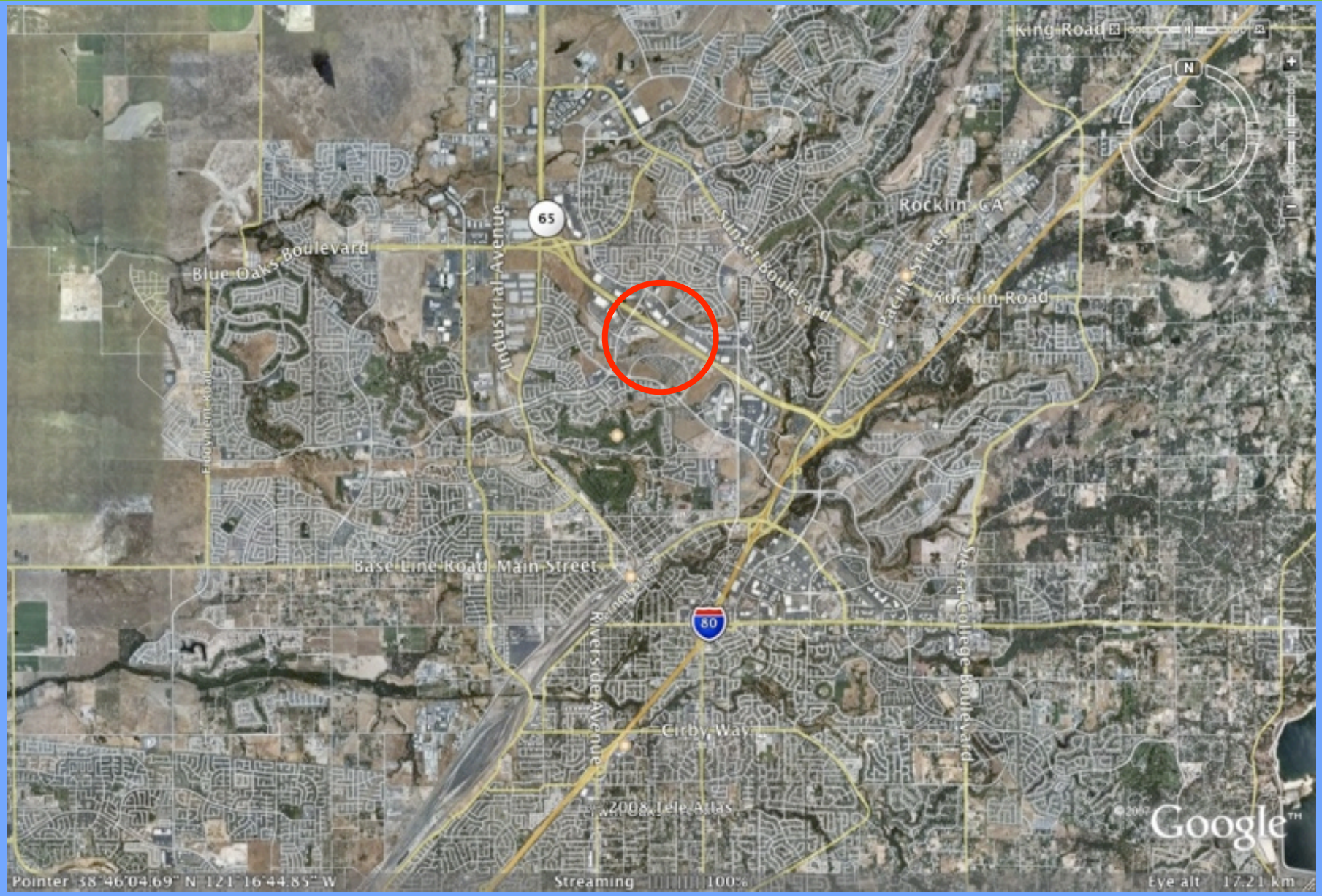
Floodplain/Channel Restoration - Putah Creek

Floodplain/Channel Restoration - Putah Creek



Floodplain/Channel Restoration - Putah Creek

Floodplain/Channel Restoration - Rocklin



Floodplain/Channel Restoration - Rocklin

Floodplain/Channel Restoration - Rocklin

Bringing it all together: Laguna Creek Watershed Council

Conclusions

- Forensic studies have shown that the benefits of channelization and levees have been over-estimated.
- Floodplain restoration can reduce downstream flood risks whilst providing ecological enhancement, recreational opportunities, water quality improvement and economic benefits.
- New technology can allow non-traditional approaches to be evaluated at the local and watershed scale.

Acknowledgements

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- PWA: Chris Campbell, John Stofleth, Eric Ginney, Matt Zelin, Jeff Haltiner, Andy Collison.

Questions?

Dr. Chris Bowles
chrisbowles@mac.com

(916) 570-2502
(916) 243-8290