

Successes, Failures and Suggested Future Directions for Ecosystem Restoration of the Middle Sacramento River, California

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Outline

- Intro to middle Sacramento River restoration efforts
- Goals and strategies
- Need for assessment
- Our indicator-based assessment
 - status and trends of ecosystem elements
 - progress in achieving CALFED ERP goals
- Results (highlights)
- Suggested future directions and conclusions



Great Central Valley Riparian



Riparian habitats have been reduced and degraded over the past 150 years

~5 % remains on the Sacramento River

~10% remains in the Colusa to Red Bluff Stretch

Riparian = the interface between land and water

Restoration Focus on the Sacramento River



Fishes



Central Valley steelhead trout
(*Oncorhynchus mykiss*)



Chinook salmon
(*Oncorhynchus tshawytscha*)



Green sturgeon
(*Acipenser medirostris*)



Sacramento spittail
(*Pogonichthys macrolepidotus*)

Birds



Blue grosbeak
(*Guiraca caerulea*)



Song Sparrow
(*Melospiza melodia*)



Swainson's Hawk
(*Buteo swainsoni*)



Yellow-breasted Chat
(*Icteria virens*)



Yellow-billed Cuckoo
(*Coccyzus americanus*)



Yellow Warbler
(*Dendroica petechia*)

- once common species are now only patchily distributed as breeders in the North Valley

And Other Special-status Species



Giant garter snake
(*Thamnophis gigas*)



Western pond turtle
(*Actinemys marmorata*)



California Red-legged frog
(*Rana draytonii*)



Valley elderberry long-horned beetle
(*Desmocerus californicus*)



Western mastiff bat
(*Eumops perotis*)



Yuma myotis
(*Myotis yumanensis*)

CALFED's 2000 Vision for the middle Sacramento River Ecological Management Zone:

“To improve, restore, and maintain the health and integrity of the Sacramento River riverine-riparian and tributary ecosystems to provide healthy conditions for sustainable fish and wildlife populations and the plant communities on which they depend”



How to achieve this:

*“To protect and expand the quantity and quality of the stream **meander corridor**; protect the associated riparian forest and allow it to reach maturity; to maintain flows that **emulate the natural hydrology** to the extent possible”*

Conservation Strategies

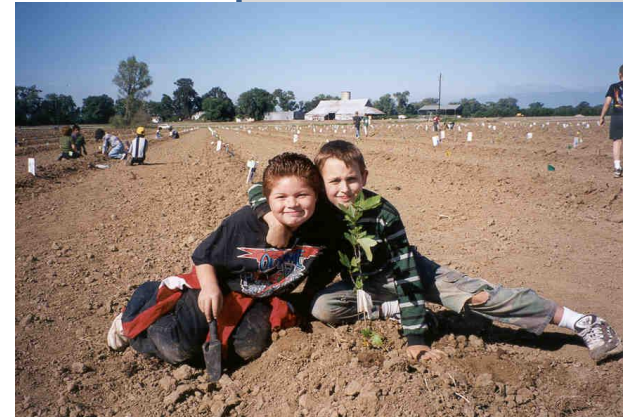
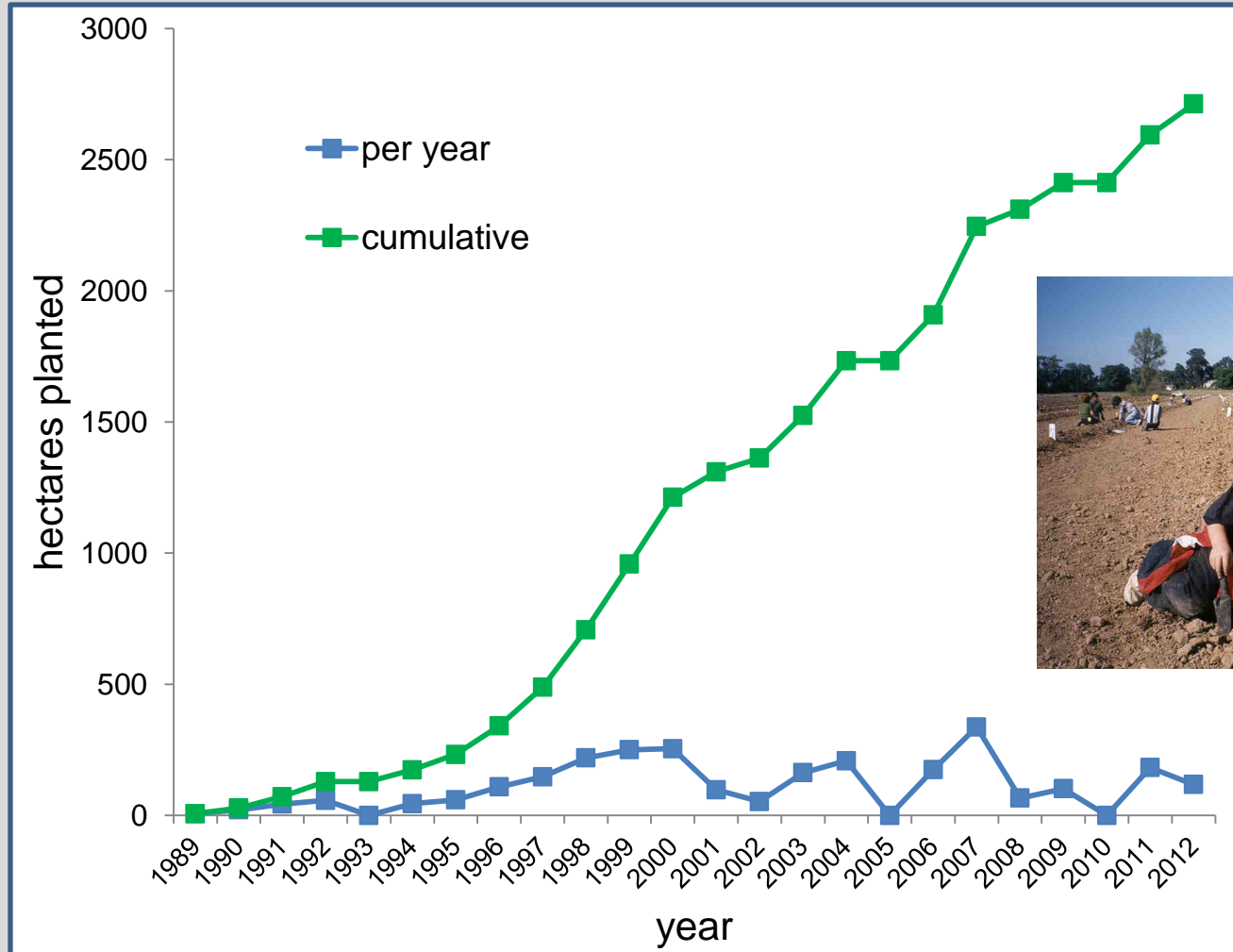
- 1) Acquire flood-prone lands
(priority to those with river frontage
and that contain and/or border
remnant riparian habitats)

- 2) Revegetate land with native
trees, shrubs and understory

- 3) Restore natural river
processes:
 - connection to floodplain
 - meander migration
 - naturalized flow regime

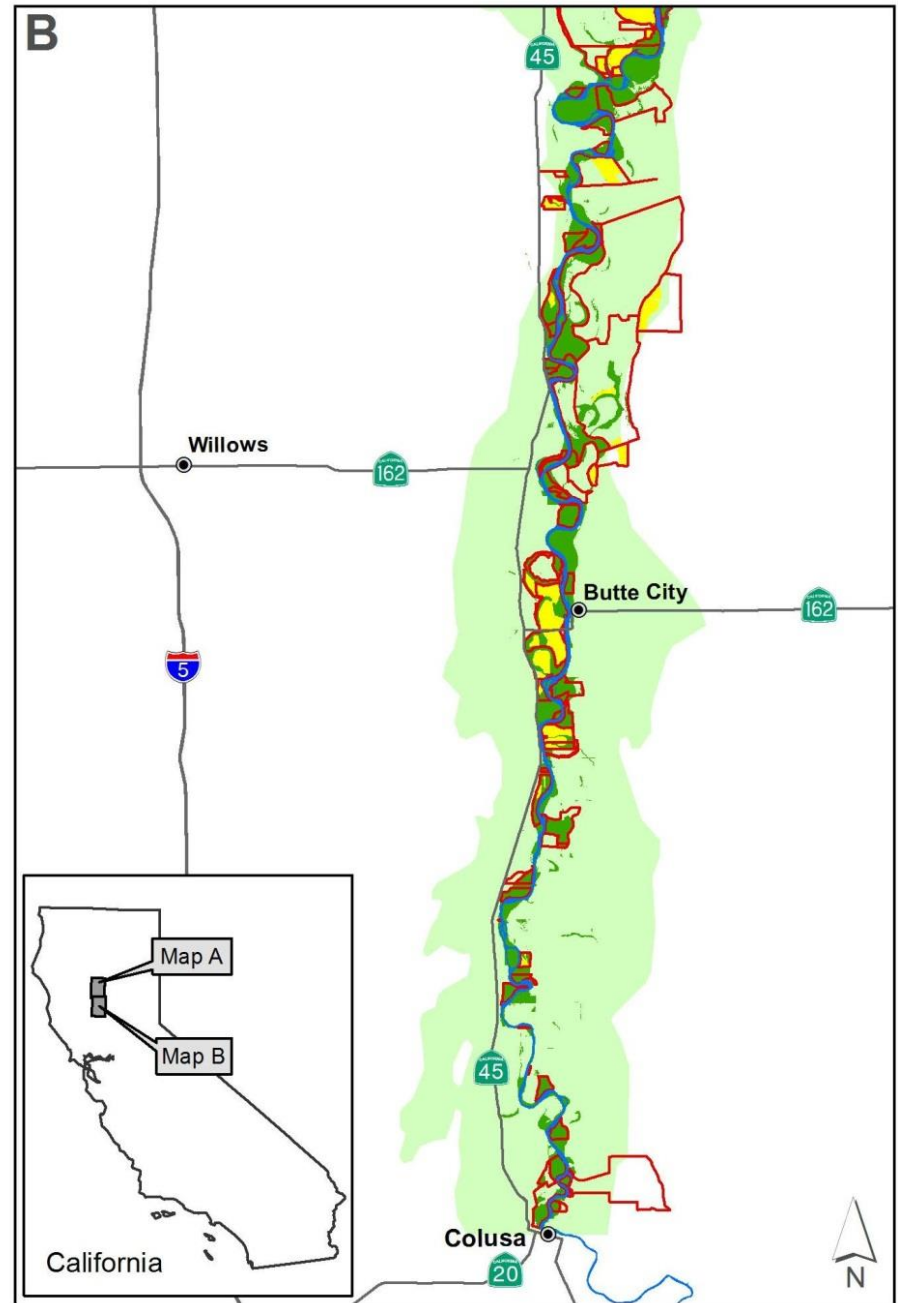
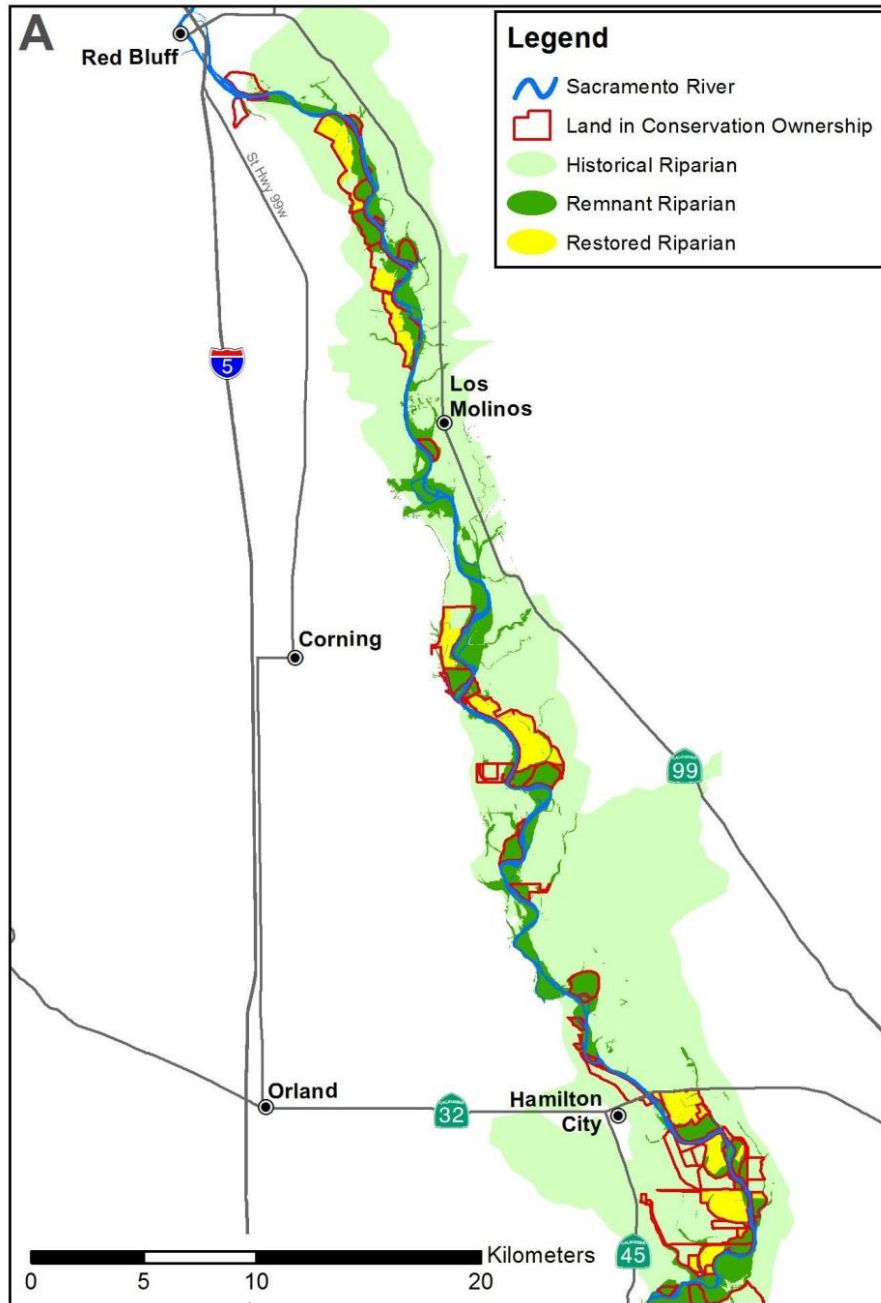


Horticultural Restoration History



TNC and River Partners Contributions

Middle Sacramento River Project Footprint



Restoration Projects are Typically not Adequately Monitored

Only 10% of U.S. river restoration projects had any form of assessment or monitoring (Bernhardt et al. 2005)

→ missed opportunities for learning and strategy refinement

On the Sac:

- Isolated studies have been useful in examining the response of specific ecosystem components
- Integrated assessments of progress toward goals have been lacking



CALFED's Performance Assessment was Limited

“A lack of agreed-upon indicators and the absence of an overall framework for evaluation made it difficult to assess performance” (Kleinschmidt and Jones & Stokes 2003)

“Even where performance measures were adopted...it was too difficult to get consensus on outcome-level metrics, so the program relented and measured outputs instead” (Layzer 2008)

Outputs: # of projects funded, total \$ spent, etc.

This resulted in an inability to demonstrate return on investment, a failing that ultimately contributed to CALFED losing much of its funding (Little Hoover Commission 2005)

Our Assessment with Ecological Indicators

Synthesis of 36 quantitative ecological indicators (outcome-level metrics)

Derived from remote sensing and field-based monitoring

Newly collected data and existing information

Individual indicators characterize the status of:

- terrestrial and floodplain resources (including flora and fauna)
- channel dynamics (including planform, geomorphology, and flow regime parameters)
- not aquatic resources such as fish

Included indicators represent:

extent and condition of different riparian habitat types, wildlife species abundances, species richness, percent occupancy, community composition, species distribution, fecundity, growth, survival, reproductive success, geomorphic and hydrologic attributes

Synthesis of Ecological Indicators

Done in two complementary ways. Both involved evaluations of trend data derived from quantitative ecological indicators.

First, indicators were associated with six broad ecosystem elements to evaluate status and trends of the Sacramento River ecosystem.

Ecological Elements:

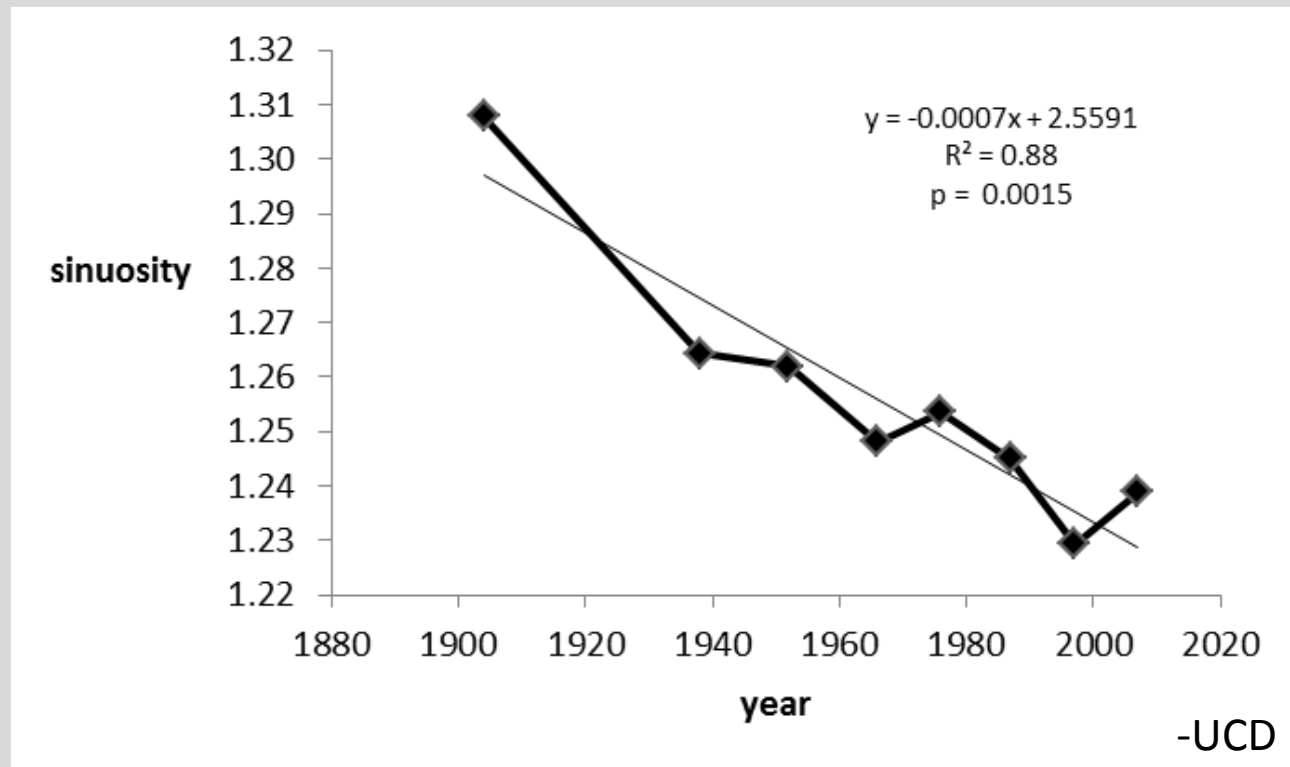
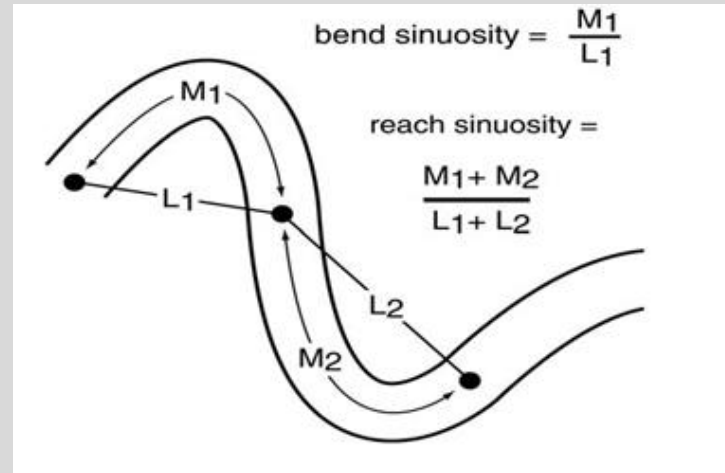
- 1) RIPARIAN HABITATS
- 2) NATIVE PLANT SPECIES AND COMMUNITIES
- 3) INVASIVE RIPARIAN AND MARSH PLANTS
- 4) BIRDS AND OTHER WILDLIFE
- 5) STREAMFLOWS AND FLOOD PROCESSES
- 6) RIVER PLANFORM AND GEOMORPHIC PROCESSES

6. RIVER PLANFORM AND GEOMORPHIC PROCESSES

Ecological Indicators	Geographic Study Area	Temporal Horizon	Results	Data Source	Trend ^a
Area of Floodplain Reworked	Riparian zone between Red Bluff and Colusa	1906 - 2007	Declined in recent decades; Highly variable over long term, although trending downward	Larsen (unpublished)	- (-)
Length of Bank with Riprap	Main river channel between Red Bluff and Colusa	1936 - 2002	Increased in recent decades; Dramatic increase over long term, especially since the 1960s	Henderson (unpublished)	- (- -)
Length of River with Conservation Ownership on Both Banks	Main river channel between Red Bluff and Colusa	1999 and 2007	Increased by at least 71% (from 40,806 meters)	Golet and Paine (unpublished)	+
Whole River Sinuosity	Main river channel between Red Bluff and Colusa	1906 - 2007	Increased slightly between 1997 and 2007 Decreased significantly (by 6%, from 1.31) over the period of record	Larsen (unpublished)	0 (-)
Average Bend Entrance Angle	Main river channel between Red Bluff and Colusa	1906 - 2007	Declined since 1987; at lowest value ever in 2007 Decreased significantly (by 13%, from 46 degrees) over the period of record	Larsen (unpublished)	- (-)
Total Channel Length	Main river channel between Red Bluff and Colusa	1906 - 2007	Declined in recent decades; Decreased significantly (by 4%, from 160,529 meters) over the period of record	Larsen (unpublished)	- (-)
Overall					- - (- -)

Whole River Sinuosity

- Definition
- Rationale
- Methods
- Results
- Interpretation



Synthesis of Ecological Indicators

Second, indicators were aligned with CALFED ERP goals for the Sacramento River Ecological Management Zone

ERP Goals Evaluated:

1. RIPARIAN AND RIVERINE AQUATIC HABITATS
2. NATIVE PLANT SPECIES AND COMMUNITIES
3. INVASIVE RIPARIAN AND MARSH PLANTS
- 4. NEOTROPICAL MIGRATORY BIRDS
 - Yellow-billed cuckoo
 - Bank swallow
5. VALLEY ELDERBERRY LONGHORN BEETLE
6. CENTRAL VALLEY STREAMFLOWS
7. NATURAL FLOODPLAIN AND FLOOD PROCESSES
8. STREAM MEANDER
9. LEVEES, BRIDGES, AND BANK PROTECTION

ERP Goals and Associated Ecological Indicators

NEOTROPICAL MIGRATORY BIRDS:

to maintain their diversity, abundance and distribution by protecting and restoring riparian and riverine aquatic habitats upon which they depend.

Yellow-billed Cuckoo: Restoration of riparian woodlands along the Sacramento River for cuckoos should focus on **natural stream meander, flow, and natural succession.**



Bank Swallow: Potential habitat for bank swallows will be improved by sustaining the river meander belt and increasing the coarse sediment supply to **support meander and natural sediment erosion and deposition processes.**



ASSOCIATED ECOLOGICAL INDICATORS:

- *Number of Occupied Yellow-billed Cuckoo Territories*
- *Number of Bank Swallow Nest Burrows*
- *Number of Bank Swallow Nesting Colonies*
- *Nest Survival of Black-headed Grosbeak, Lazuli Bunting, Spotted Towhee*
- *Adult Survival of Black-headed Grosbeak and Spotted Towhee*
- *Bird Species Richness*
- *Abundance of Black-headed Grosbeak, Common Yellowthroat, Yellow Warbler, and Yellow-breasted Chat*

Results *Good progress in the restoration of riparian habitats*

From 1999-2007:

- >600% increase in forest patch core size
- 43% increase in the percent of the river bordered by natural habitat >500 m wide

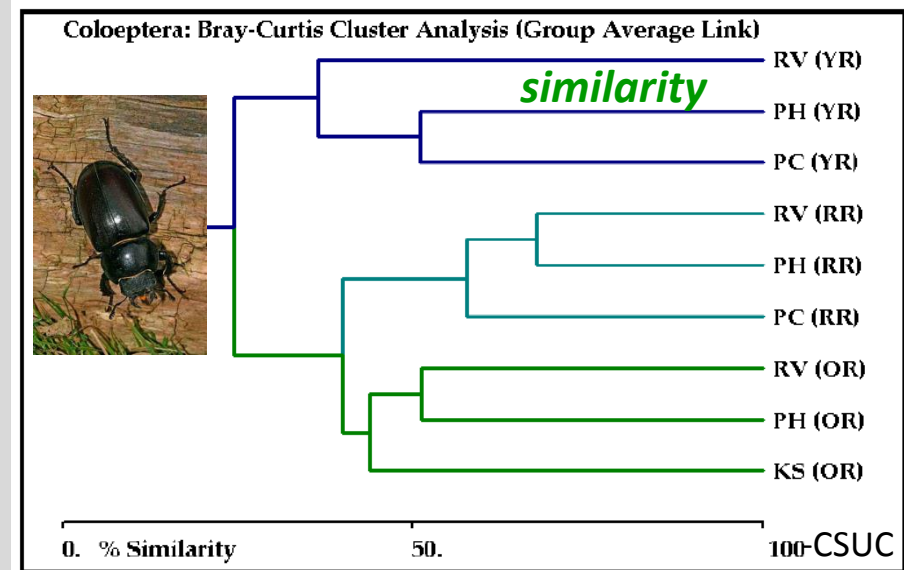
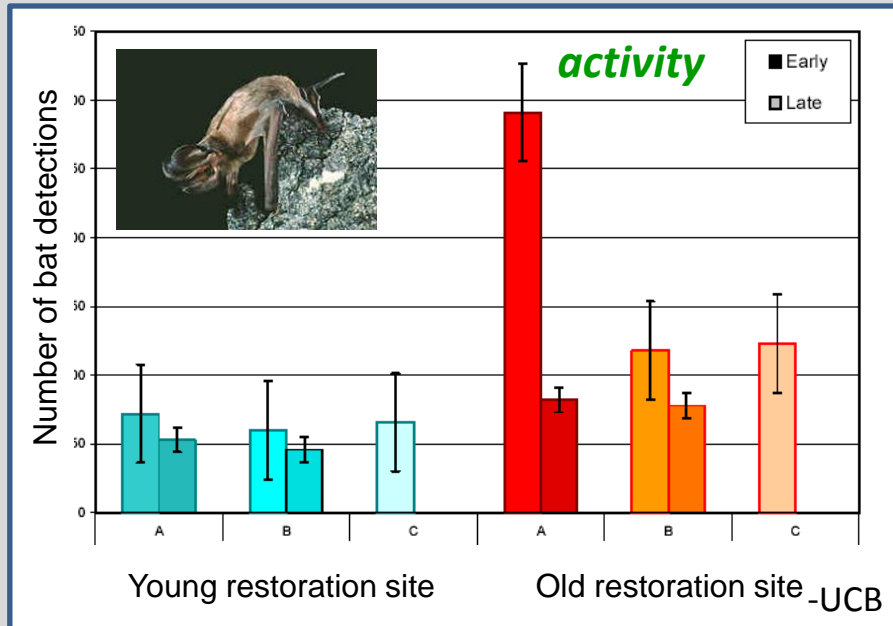
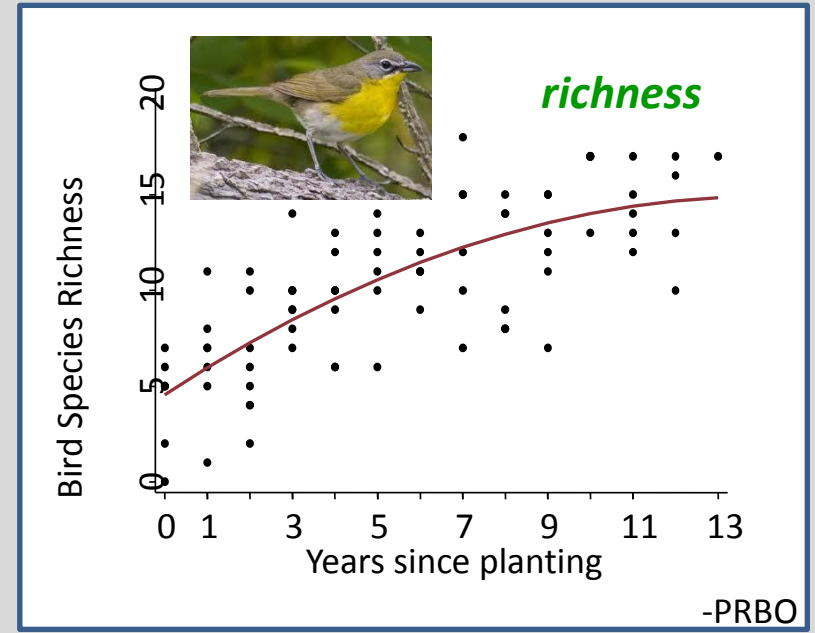
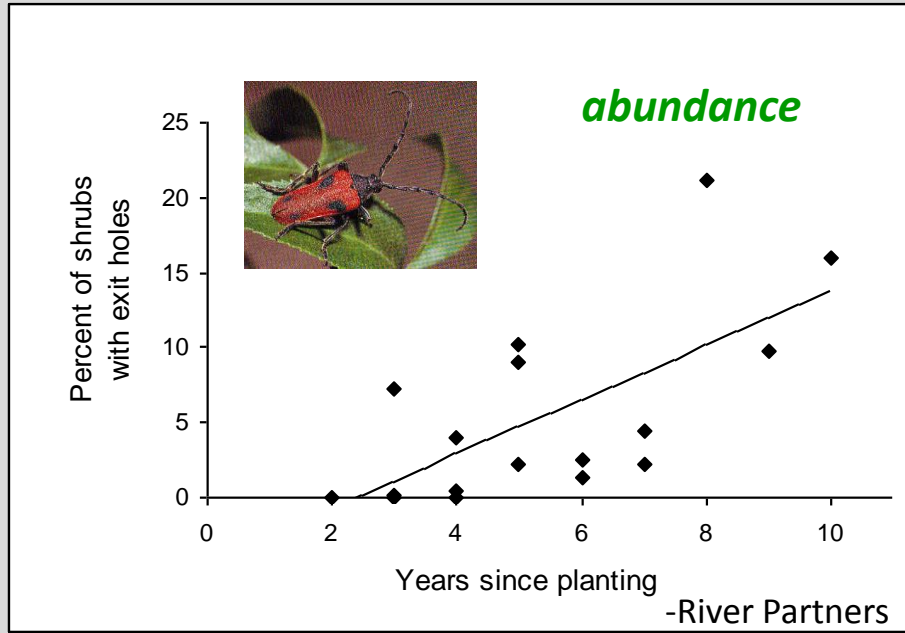


Exceptions:

- continued proliferation of invasive riparian and marsh plants in remnant areas
- mixed success in the restoration of understory plant communities at restoration sites

Results

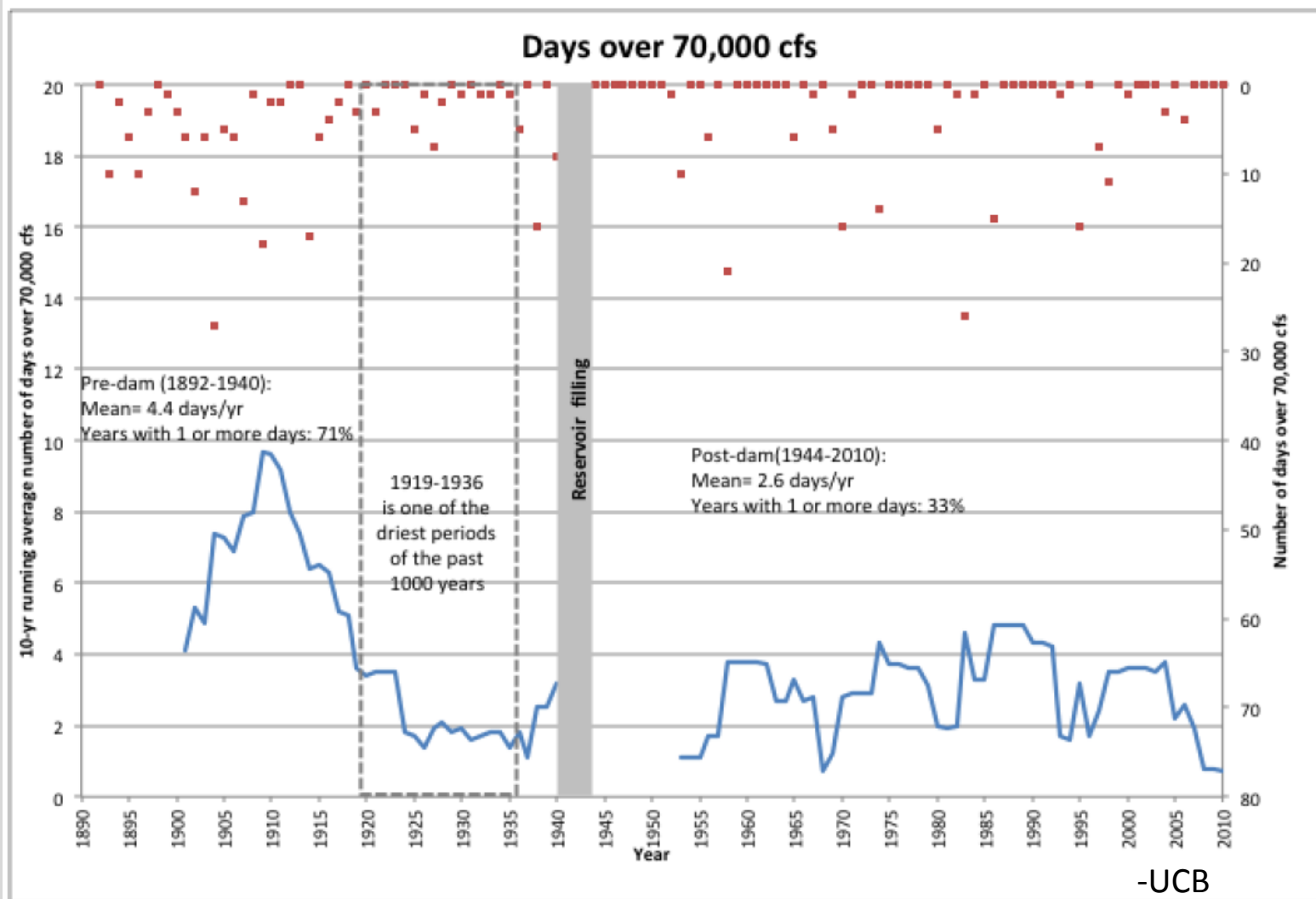
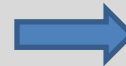
Good progress in restoration of most wildlife



Results *Degraded post-Shasta Dam streamflow conditions have continued*

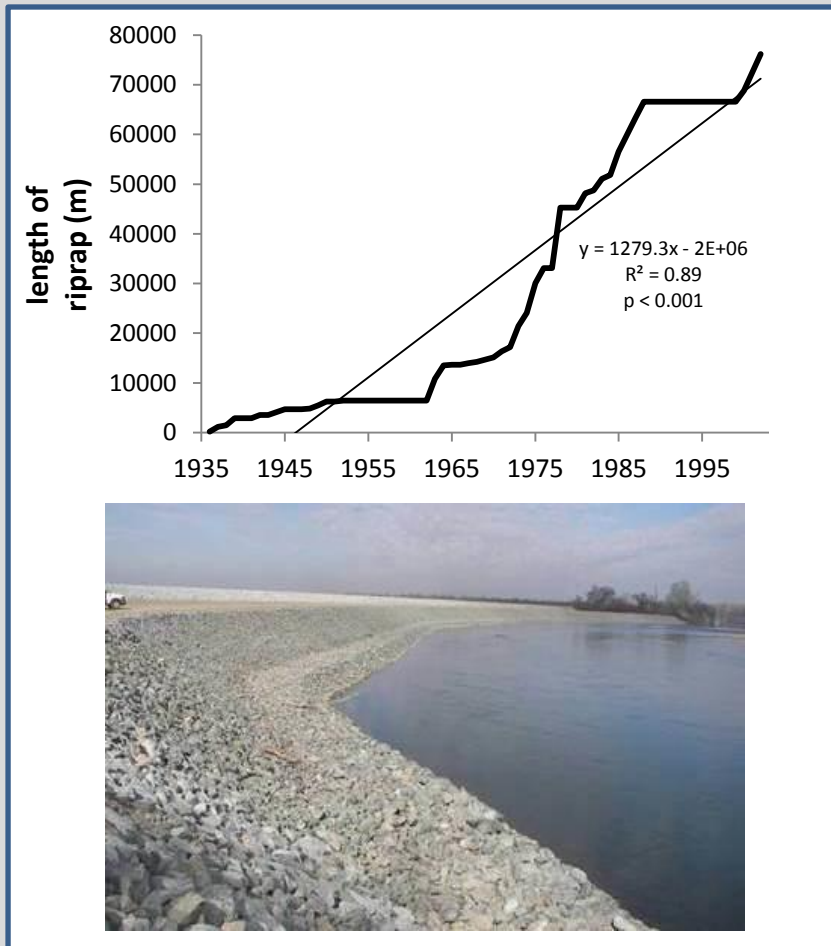
Relative to pre-dam conditions:

- # of years between bed mobilization
 - # of years between floodplain inundation
- Increased by > 100%

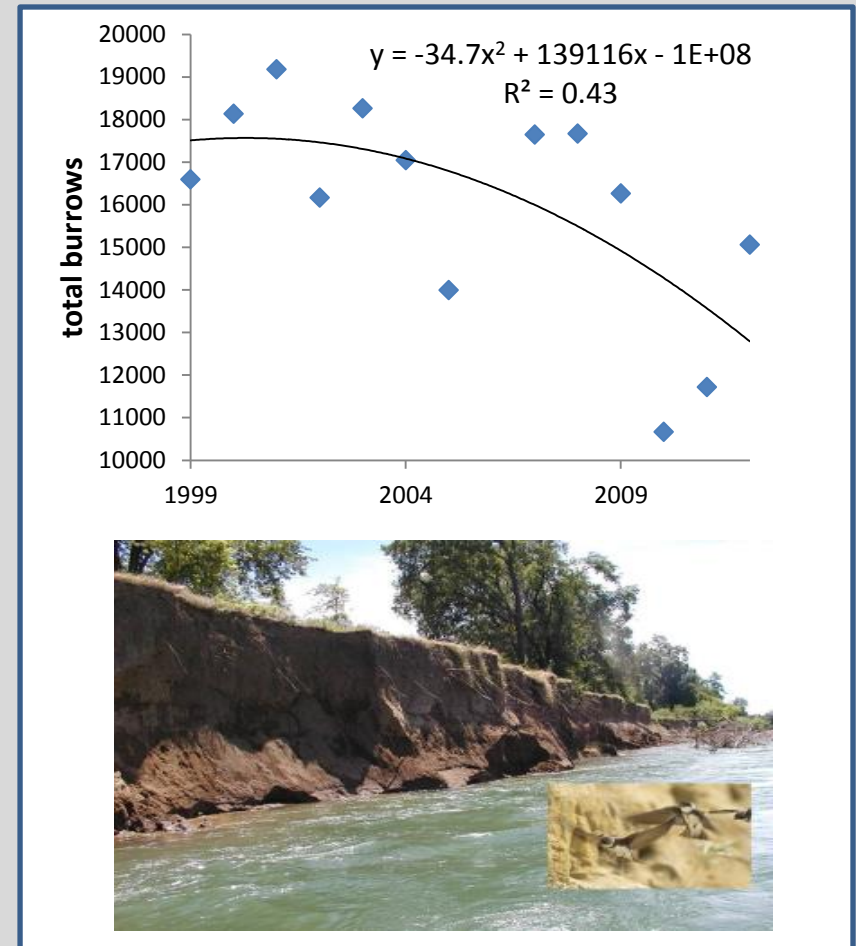


Results *Trends in geomorphic processes were strongly negative*

- channel simplified, becoming less sinuous with reduced overall channel length with increases in the amount of bank hardened with riprap, and decreases in the area of floodplain reworked
- Biological consequences include decline of bank swallows



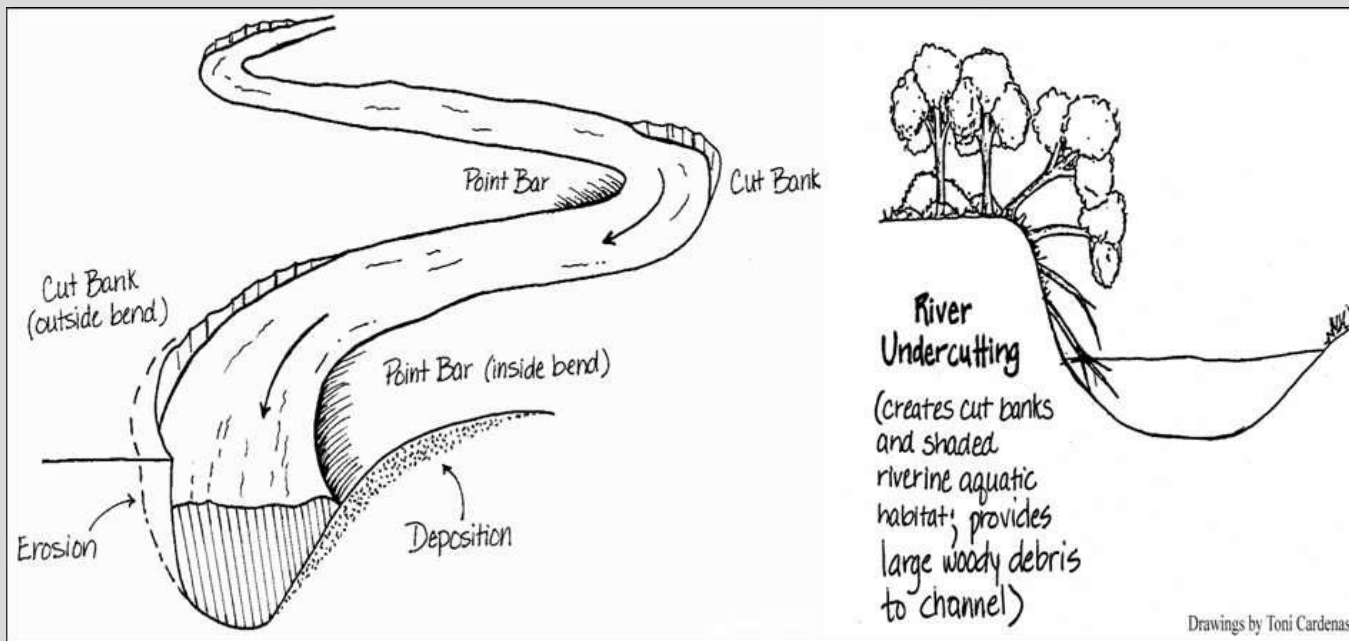
-CDWR



-Bank Swallow TAC

Future Directions

- Continue build out of natural habitats within the riparian corridor
- Promote river meander (riprap removal, levee setbacks)
- Restore components of the river's natural flow regime



Riparian Ecology

Disturbance is not only inevitable in many systems, but is essential to their regeneration (Naiman et al. 2005).

Dynamic river processes:

- Erosion
 - Deposition
 - Overbank flooding
-
- Vertical cutbanks
 - Fresh bar surfaces
 - Large woody debris

Human alterations:

- Installation of riprap
 - Reduction in flood flows
 - Reduction in sediment supply
-
- Net reduction in habitat complexity & riparian and aquatic biodiversity

(Ward and Stanford 1995, Gurnell et al. 2002, Stanford et al. 2005, Florsheim et al. 2008)



Conclusions

General:

- It is possible to assess the success of large-scale restoration projects
- Synthesis of indicator information that can be used to inform strategic decision making

In the case of the middle Sacramento River:

- Horticultural restoration has been effective in creating terrestrial floodplain habitats that are utilized by broad suite of native and special-status species
- Little progress in the restoration of the natural river processes that are required to create and maintain the dynamic landforms and habitat conditions of larger riverine landscape

The path forward:

- Addressing this deficiency will require creative new solutions to old problems
 - novel partnerships
 - new business models
 - experimentation
 - adaptive management



Acknowledgements

Funding sources:

CALFED Bay Delta Program, CSU, TNC, USFWS,
David and Lucile Packard Foundation, William
and Flora Hewlett Foundation, USBR, NRCS,
CDPR, CDFG, David Smith Conservation
Foundation

