Scientific and Structural Challenges to River Management in the U.S.

John Stella
SUNY College of Envir. Science and Forestry, Syracuse, NY (USA)

Com'Eau Labo Workshop:

Improving communication between river managers and scientists for a better collaboration

25 June 2012, Lyon

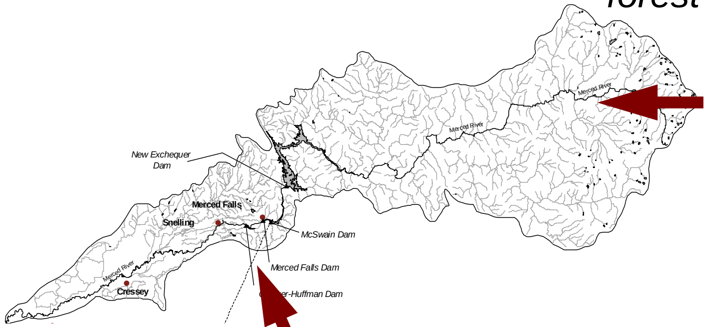
My Hybrid Background

Academic experience:

- Focus on riparian ecology
- UC Berkeley, PhD 2005
- SUNY-ESF faculty, 2006 - present

Environmental consulting:

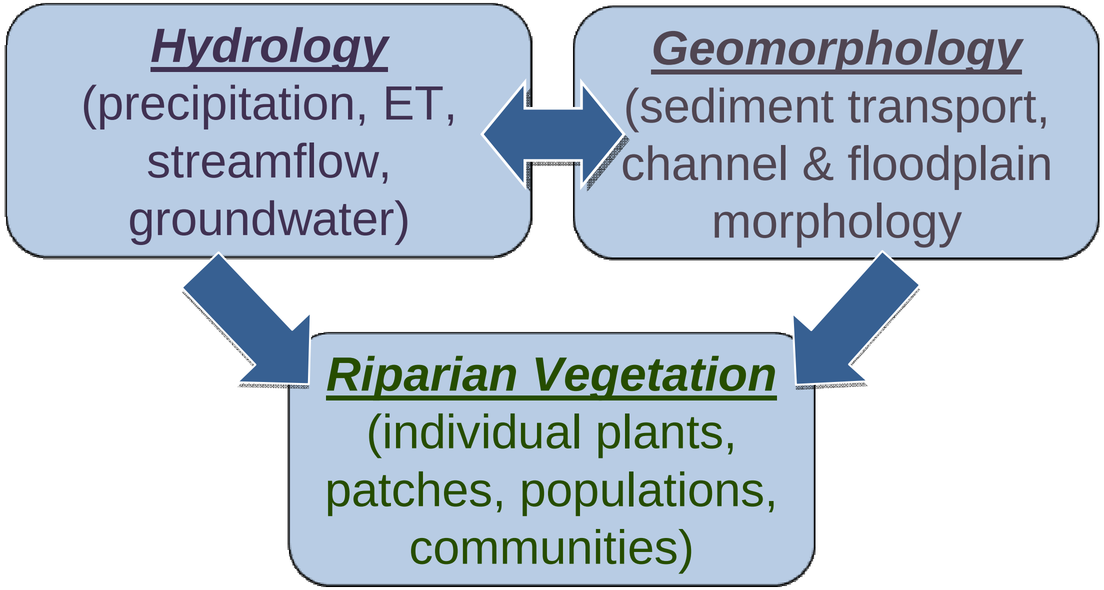
- Stillwater Sciences, Berkeley, CA, 1998-2006
- Riverine ecology and applied resource management
- Restoration plans for California rivers and watersheds



Montane conifer forest

Hardwood riparian forests, vallley alluvial reaches.

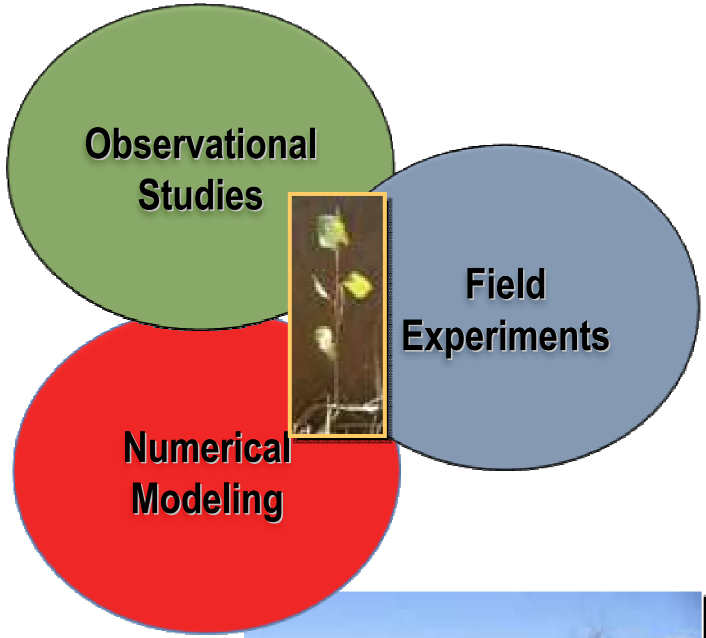
Motivating Questions



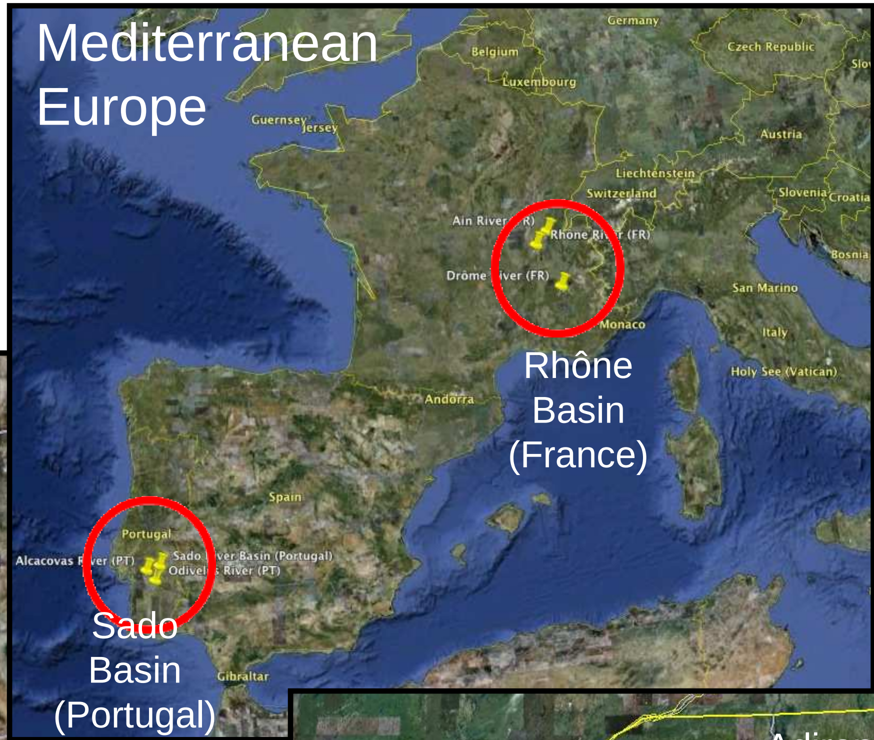
- *How do riparian plants respond to altered physical drivers in river ecosystems?*
- *How can we use this knowledge to design cost-effective restoration strategies for arid-land rivers?*

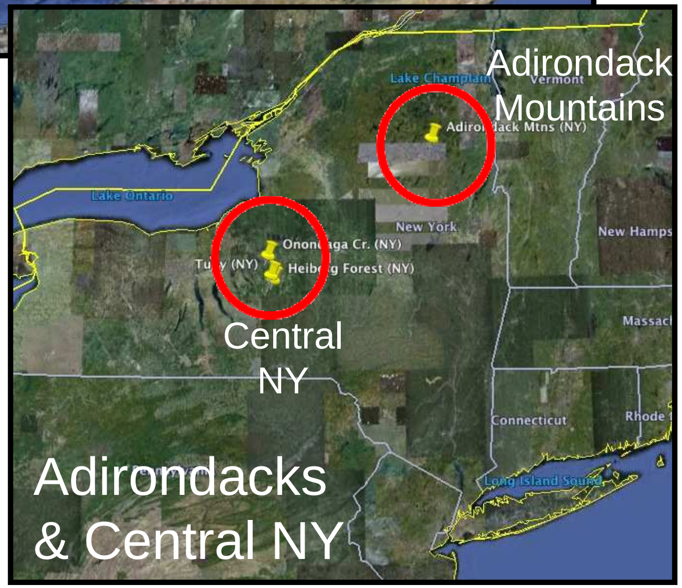
Methods

- Observational studies
  - *Stella et al. (2011) Ecosystems 14, 776*
  - *Rodríguez-González, Stella, et al. (2010) For. Ecol. Mgt. 259, 2015*
  - *Schifman, Stella, Volk, Teece (2012) Biomass & Bioenergy 36, 316*
- Field experiments
  - *Stella & Battles (2010) Oecologia 164, 579*
  - *Stella et al. (2010) Rest. Ecol. 9, 1200*
- Numerical modeling
  - *Harper, Stella, Fremier (2011) Ecol. App. 21, 1225*
  - *Stella et al. (2006) Ecosystems 9, 1200*



Project Sites





Outline

- What is the political and legal context of river management in the U.S.?
- How do the structure and composition of river management (i.e., stakeholder) groups vary?
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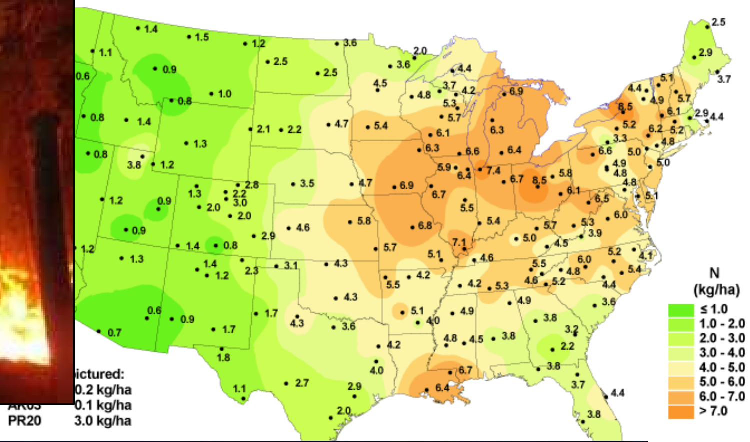
Multiple stressors pose tough challenges to management

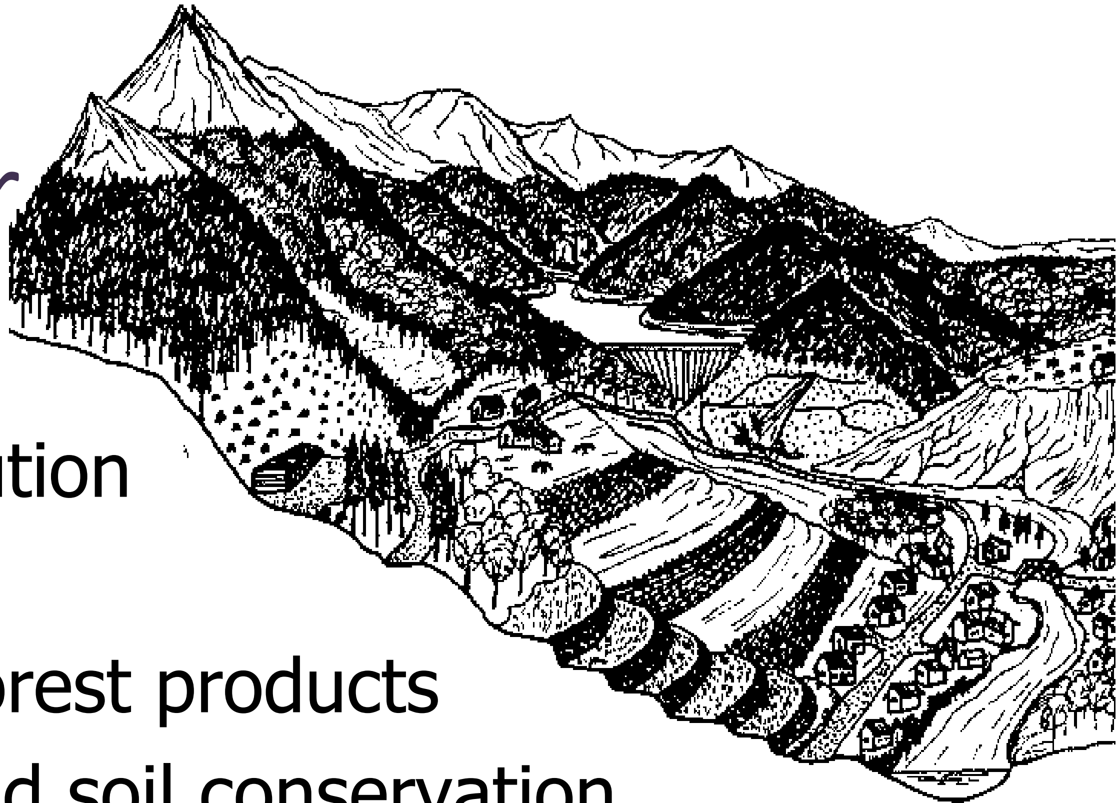
Changing fire regimes

Forest Pests

N Deposition



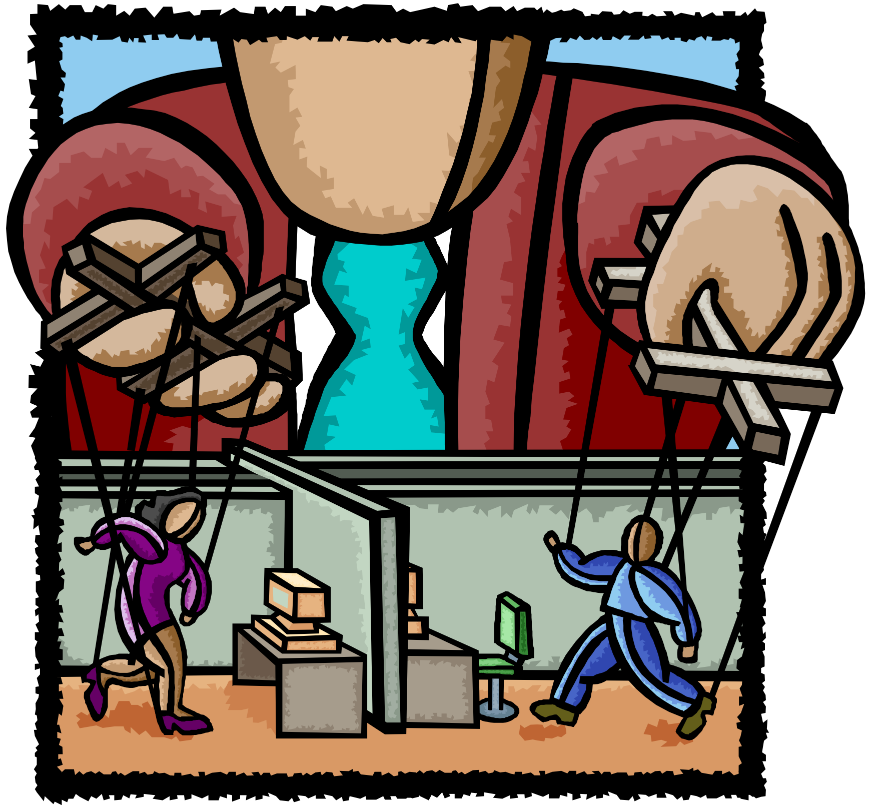
Managing Multi-use River Basins



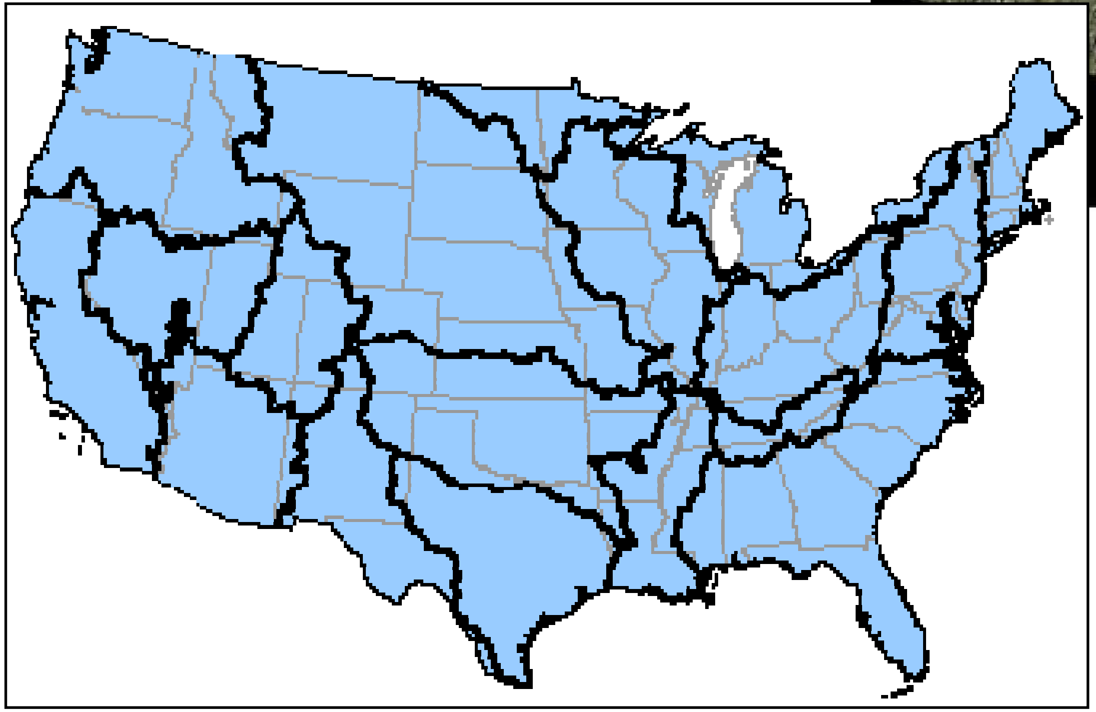
- Water distribution
- Road building
- Timber and forest products
- Agriculture and soil conservation
- Mineral resources
- Urban & suburban development
- Industrial processes and pollution management

The Problem of (Lack of) Central Coordination

- In practice, natural resource decisions are made by individuals (foresters, farmers, engineers, developers), not a central authority.



Political boundaries rarely follow river basin boundaries

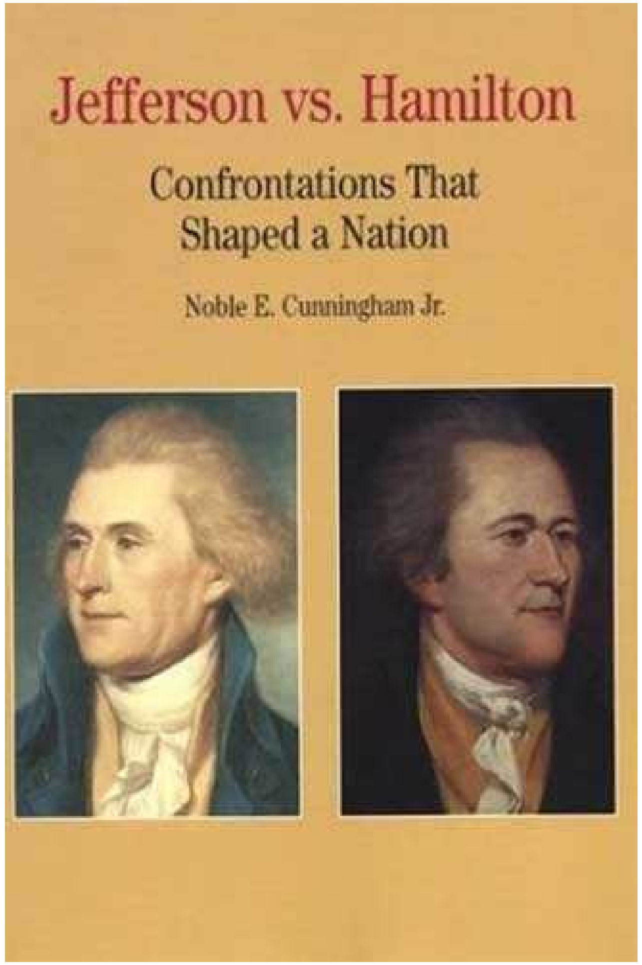


U.S. Water Law Context

- Water quantity: numerous allocation laws
  - Riparian Doctrine (from England)
  - Prior Appropriation Doctrine ("1st in time; 1st in right")
  - Groundwater allocation
  - Interstate and international compacts
    - Colorado River compact: 5 states + Mexico
    - St. Laurence River Int. Joint Commission: U.S. + Canada
- Water quality
  - Clean Water Act
  - Regulated by the U.S. Environmental Protection Agency

U.S. history of centralized vs. dispersed powers (ca. 1780's)

- States' Rights
  - Dispersed powers (Jefferson)
  - Local control, agrarianism
- Federalism
  - Centralized powers (Hamilton)
  - Assumed states' war debts and guided foreign policy
- This conflict has shaped U.S. domestic politics, from slavery to water rights and river management



National, State and local agencies with overlapping mandates

- USACE – flood control, navigation
- USBOR – water supply (esp. in arid west)
- FERC – dam relicensing
- EPA, USDA Forest Service, BLM – water quality, watershed protection
- USFWS, NOAA – fish and wildlife habitat
- USGS – hydrology, geology, mapping
- State agencies

Some with scientific research branches

- USACE – flood control, navigation
- USBOR – water supply (esp. in arid west)
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- USGS – hydrology, geology, mapping
- State agencies

Other stakeholders

- Private/quasi-public irrigation districts and power companies
- Indian tribes
- Regional agency cooperatives (e.g., California Bay-Delta)
- NGO's, advocacy groups
- Media
- Resident groups

Case Study: Environmental Flow Releases for Science and River Management Studies

John C. Stella (SUNY-ESF)
Andrew C. Wilcox (U. Montana)
Anne Lightbody (UNH)
Pat Shafroth (USGS)

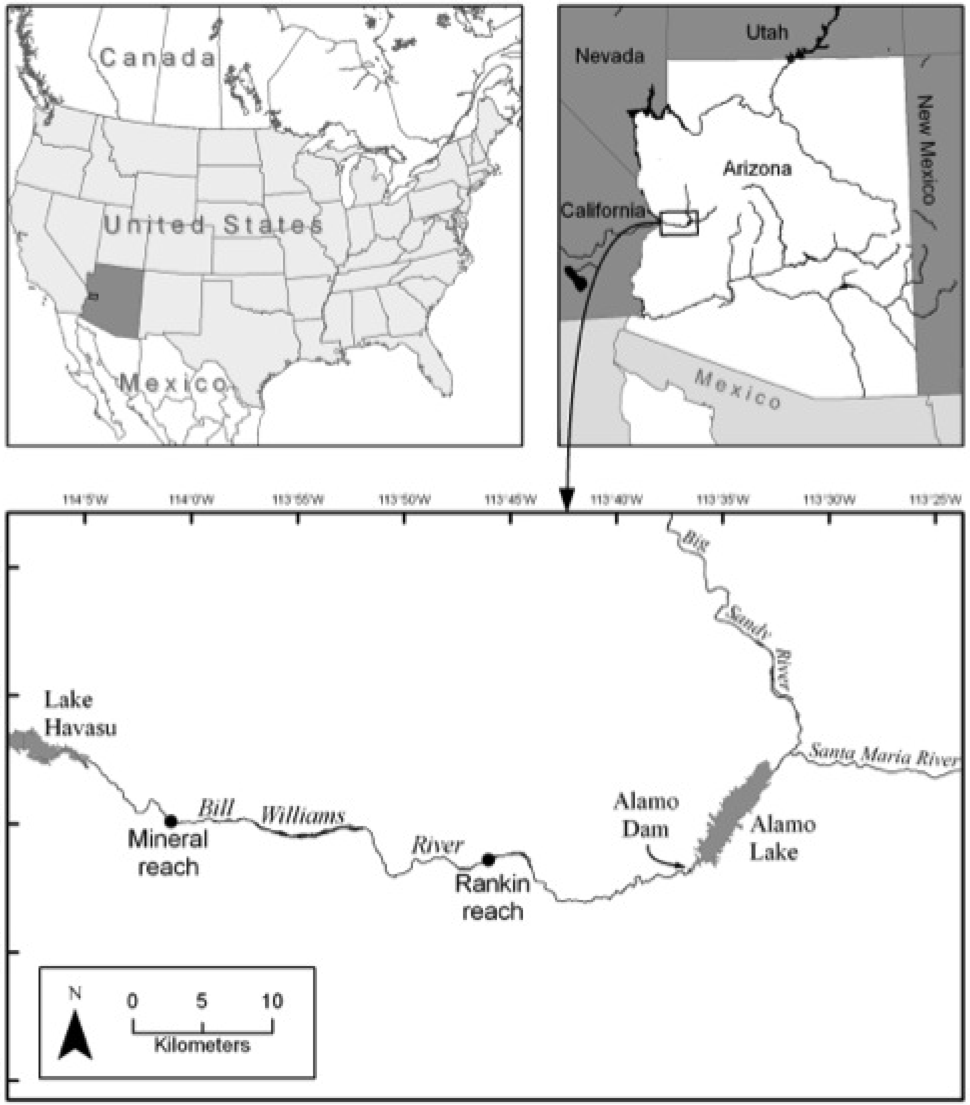
Award Abstract #1024820
Collaborative Research: Quantifying feedbacks between fluvial morphodynamics and pioneer riparian vegetation in sand-bed rivers
J.C. Stella, A.C. Wilcox, A.F. Lightbody

The University of Montana
ESF
UNH

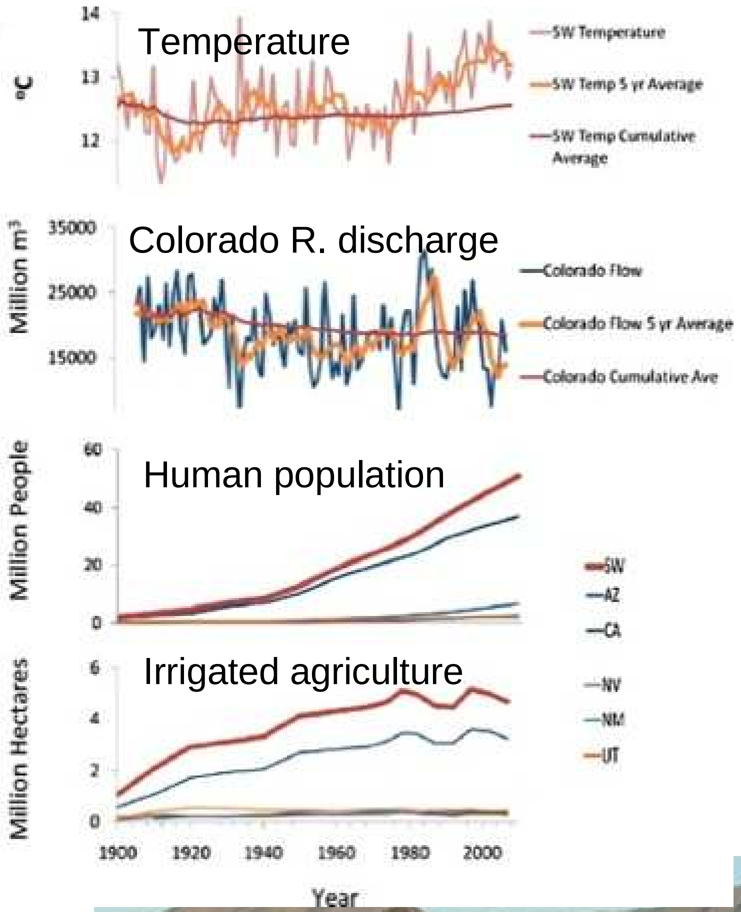
Ecogeomorphic Feedbacks, Tamarisk, and Native Trees in Arid-Land Rivers

- Quantify relationships between flood hydraulics, geomorphic processes, riparian trees
- Investigate differential flood effects on native vs. nonnative (tamarisk) seedlings
- Use ‘environmental flow releases to mimic natural feedbacks between vegetation & morphodynamics

Bill Williams River, Arizona (USA)

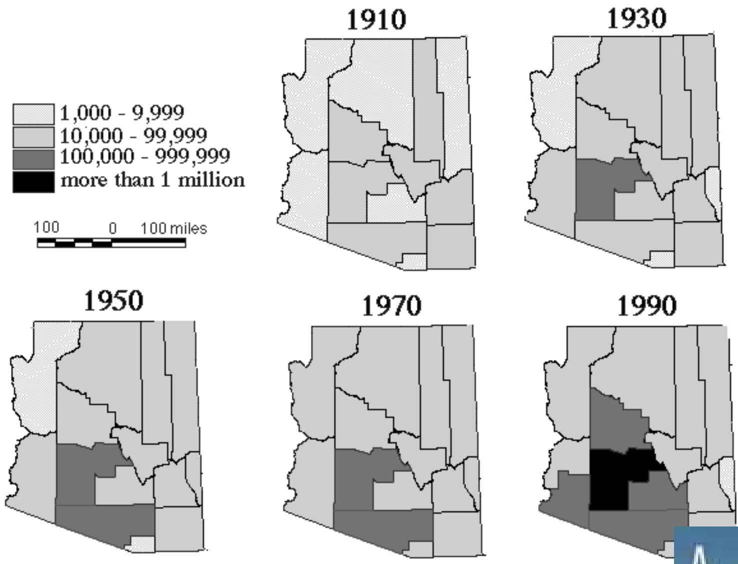


Human water demand in the U.S. Southwest



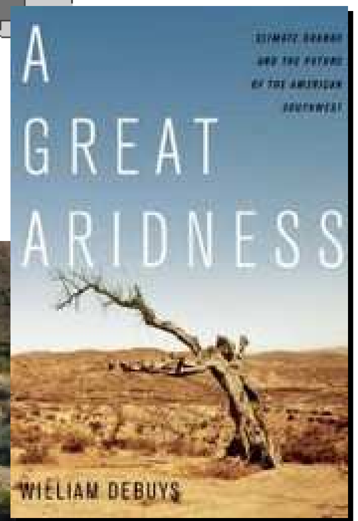
MacDonald G M PNAS 2010;107:21256-21262

Population of Arizona Counties



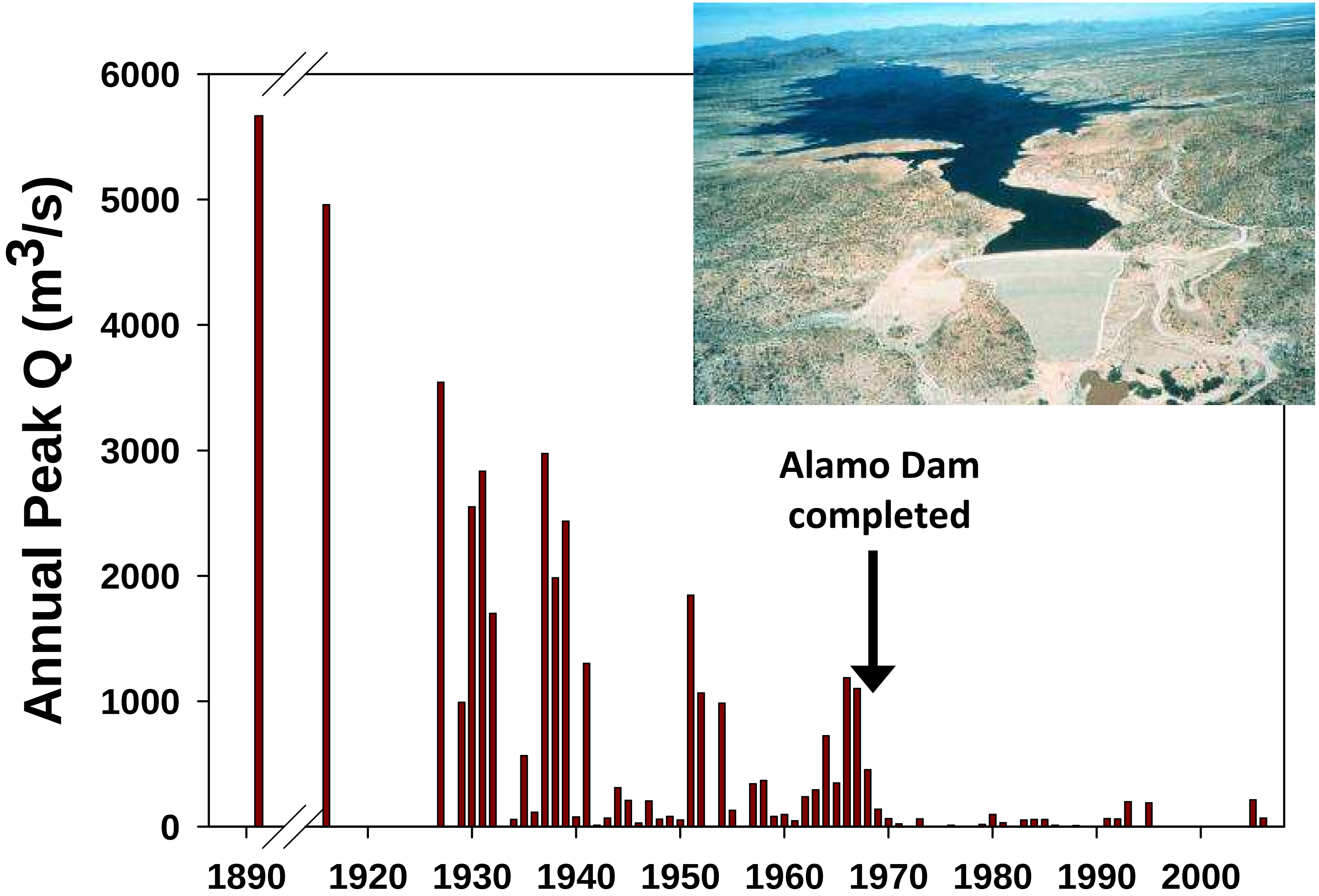
Arizona Geographic Alliance/US Census

Central Arizona Project

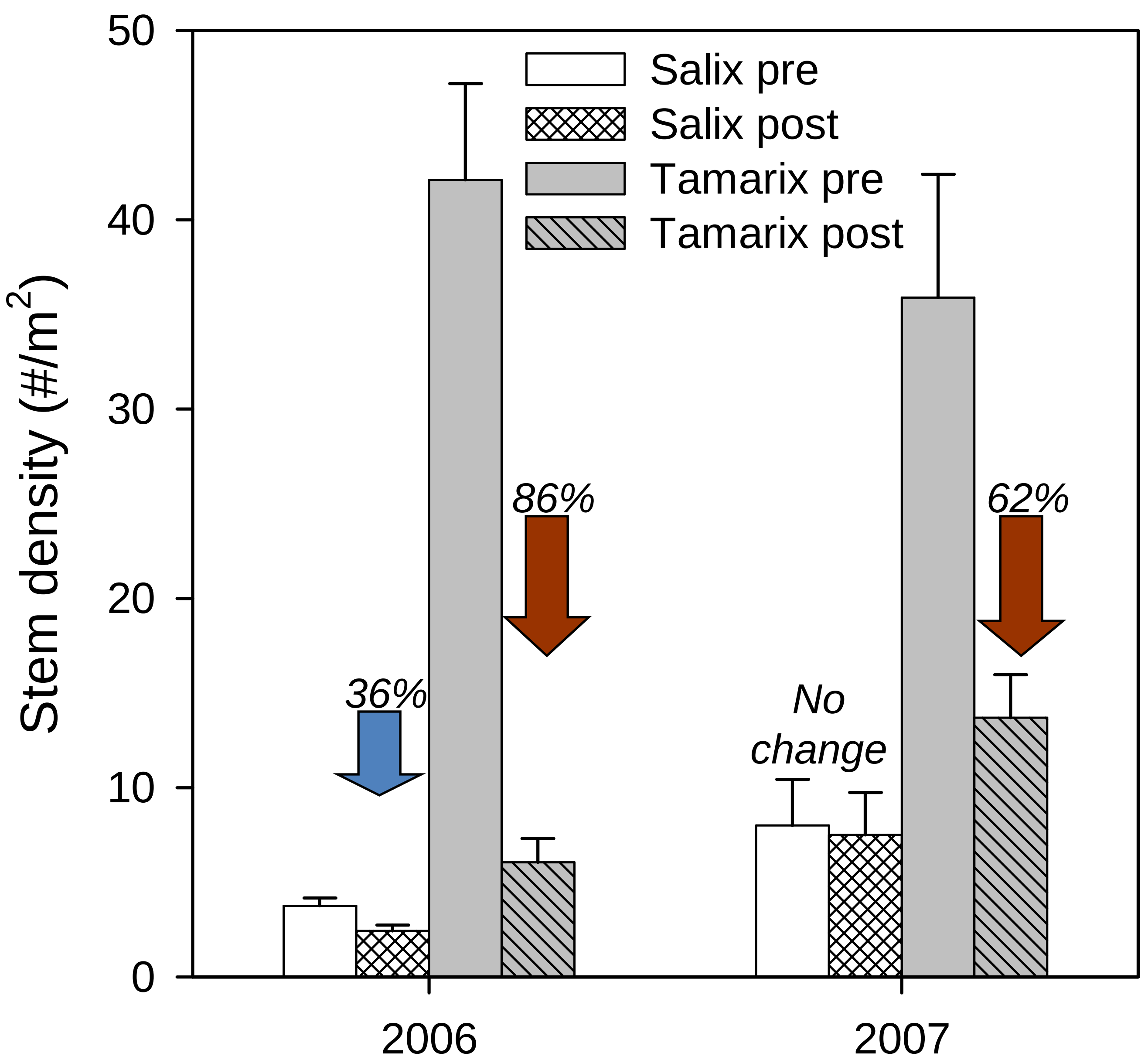


www.cap-az.com

BWR below Alamo Dam: Peak flows



2006 & 2007 flood effects on seedlings



Tamarisk seedlings > willow (*Salix*)

Floods cause much greater Tamarisk mortality

Sequencing important

The River Management Team denied our request for a 2012 environmental flow release.

- Bad luck (x2)
  - No precedent; our request was the first in a new process
  - Low precipitation year meant conflict over water
- No science representative at the RMT meeting
  - No face-to-face contact, or chance to break the ice
  - Managers did not appreciate the research's value
- We did not properly understand managers' concerns
  - State park agencies were concerned about lost fishing revenue
  - Federal agencies were concerned about turbidity for downstream drinking water intakes

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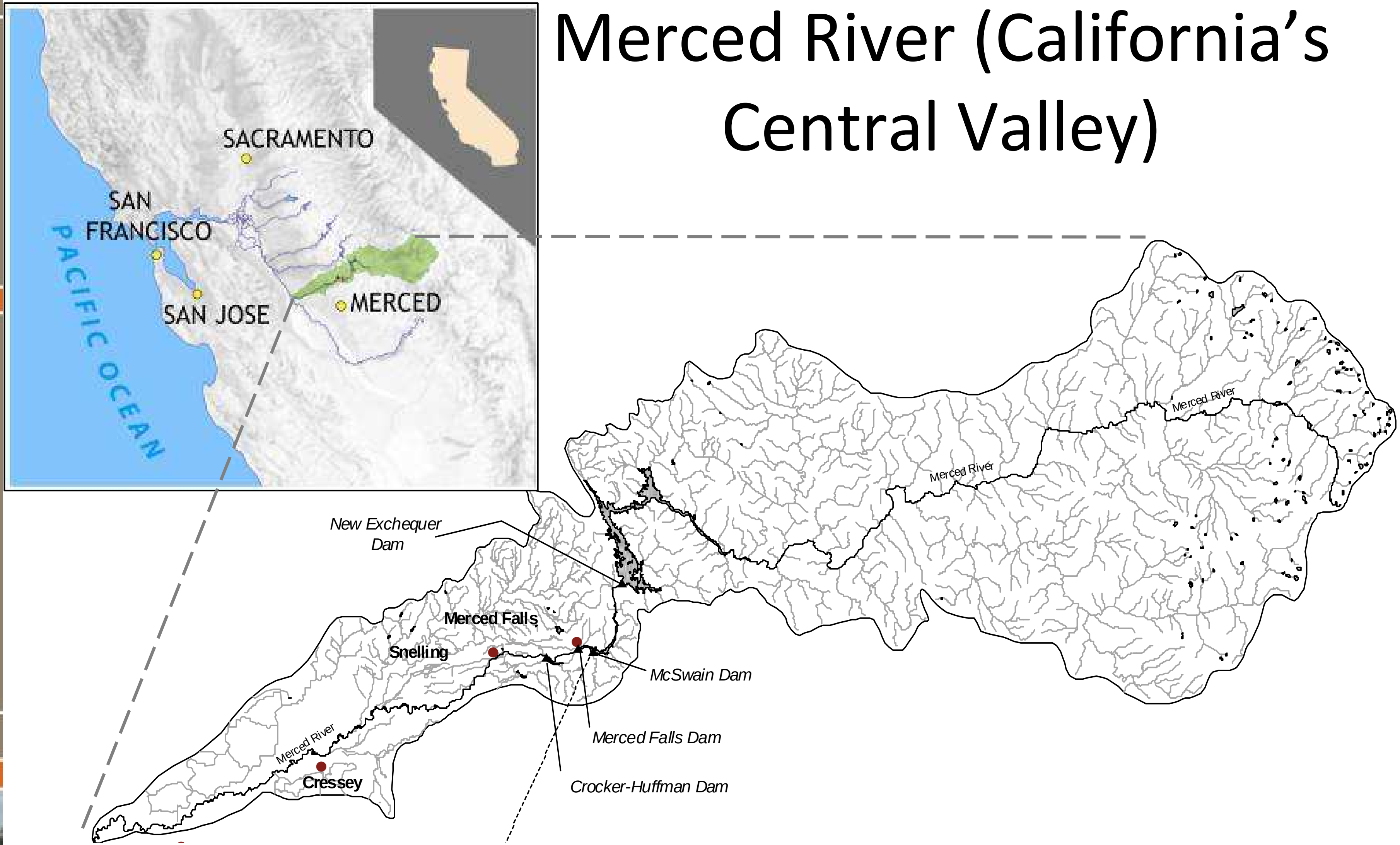
Stakeholder Processes

- Need to agree on problem(s) and goal(s)
  - Often a legislative mandate (e.g., dam relicensing, enforcement of environmental law)
  - Goals define group composition, funding, constraints
- Need all the relevant parties at the table
  - Stakeholder roles must be clearly defined
  - No outside deals, or external vetoes
  - Process must be inclusive
- Strong direction and leadership
  - Outsider facilitators are neutral, can focus the process
  - Need to balance inclusion vs. efficacy
  - Need to set clear deliverables and timelines

Case Study: Restoration Planning on the Merced River (California's Central Valley)



Gold Dredging
Early 20th Century

Merced River Floodplain

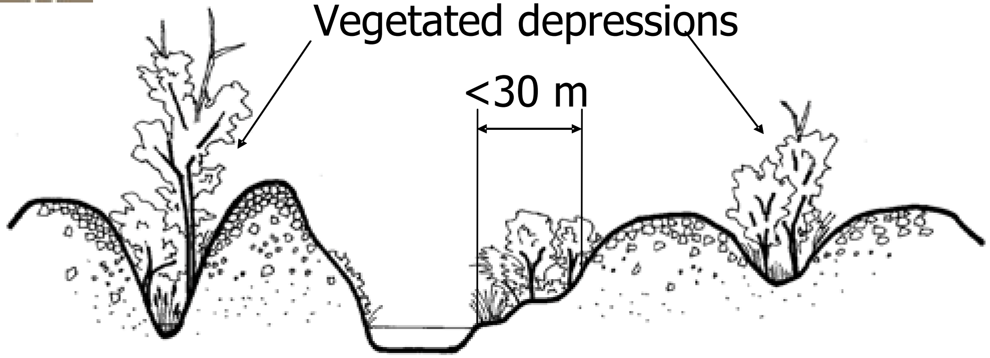
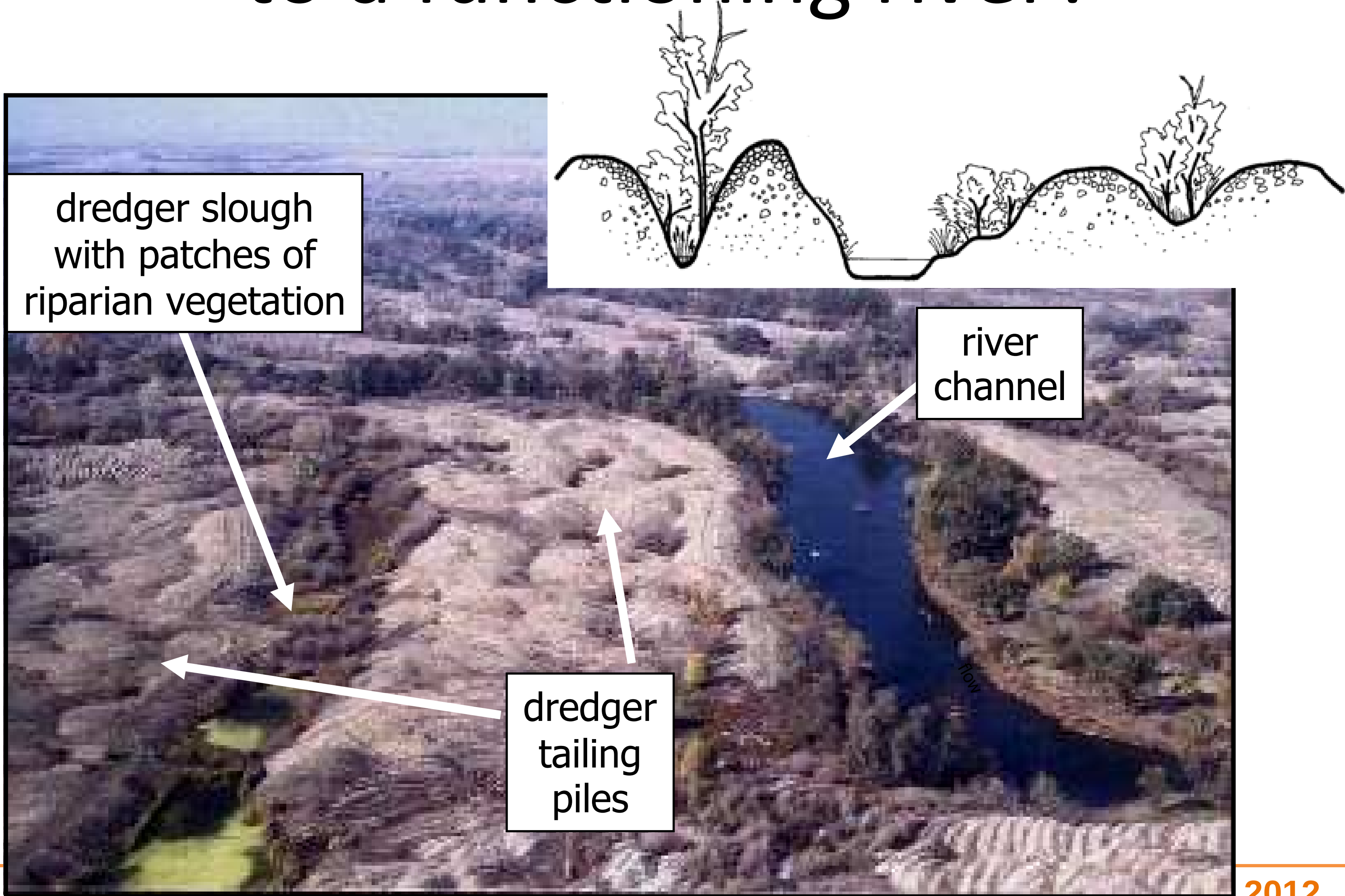


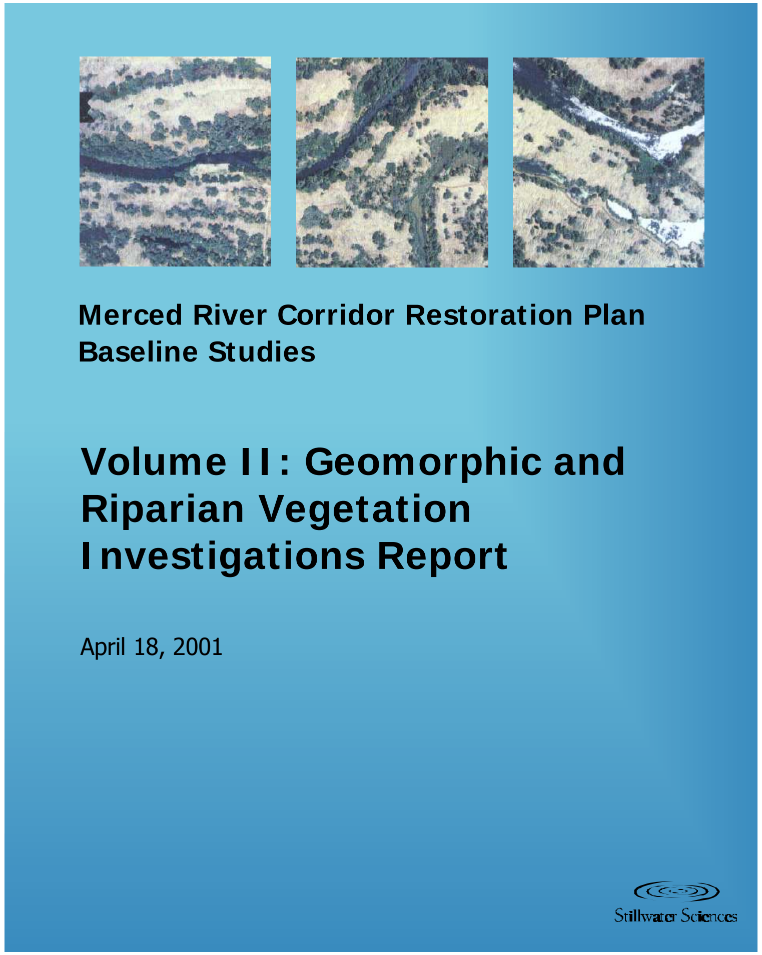
Image courtesy of Stephen Johnson

How do we restore a moonscape to a functioning river?



Research Objectives for Restoration Planning Studies

- Identify social, institutional, and infrastructural opportunities and constraints to restoration
  - land ownership patterns, land use and zoning
  - water supply, water rights, flood control laws
- Develop a quantitative biophysical understanding of the river corridor
  - river & floodplain hydrology
  - sediment dynamics
  - riparian vegetation status



Main Stakeholders

- Merced County Planning and Community Development Department
- Stillwater Sciences (private consultant)
- California Department of Fish and Game,
- California Department of Water Resources
- Merced Irrigation District
- Merced River Stakeholder Group and Technical Advisory Committee

Participants and Roles

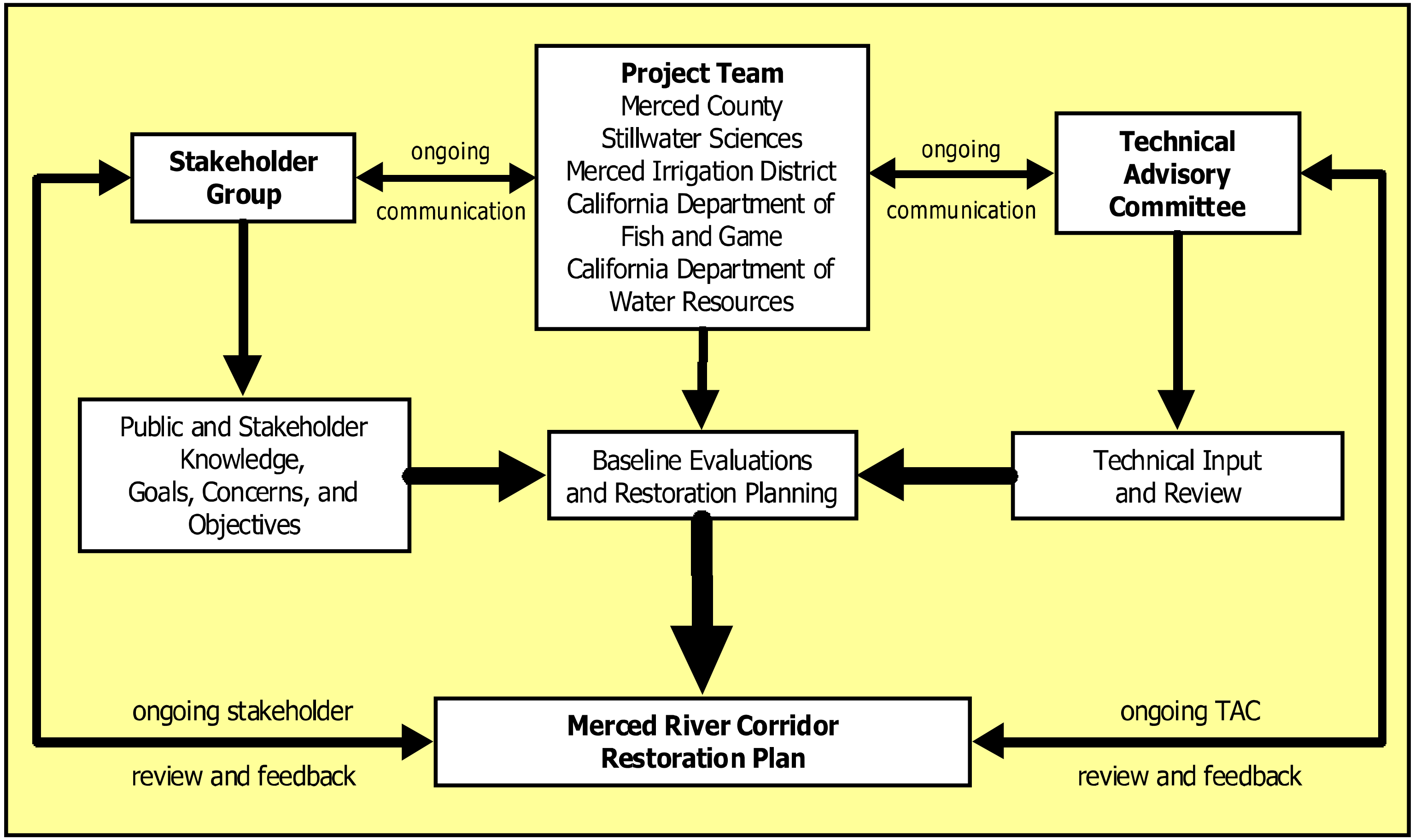


Figure 1. Merced River corridor restoration plan participants and roles.

Stakeholder-driven recommendations

- Design and implement flow-related experiments.
- Preserve existing floodplain vegetation and establish riparian buffers on river-wide scale.
- Develop general guidelines for urban and industrial setbacks from the river.
- Monitor water quality, and fish, avian, and macroinvertebrate communities
- Control non-native, invasive plant species throughout the river corridor.
- Fund and hire a river-keeper to monitor the river.

Merced River Riparian Tree Planting Experiment

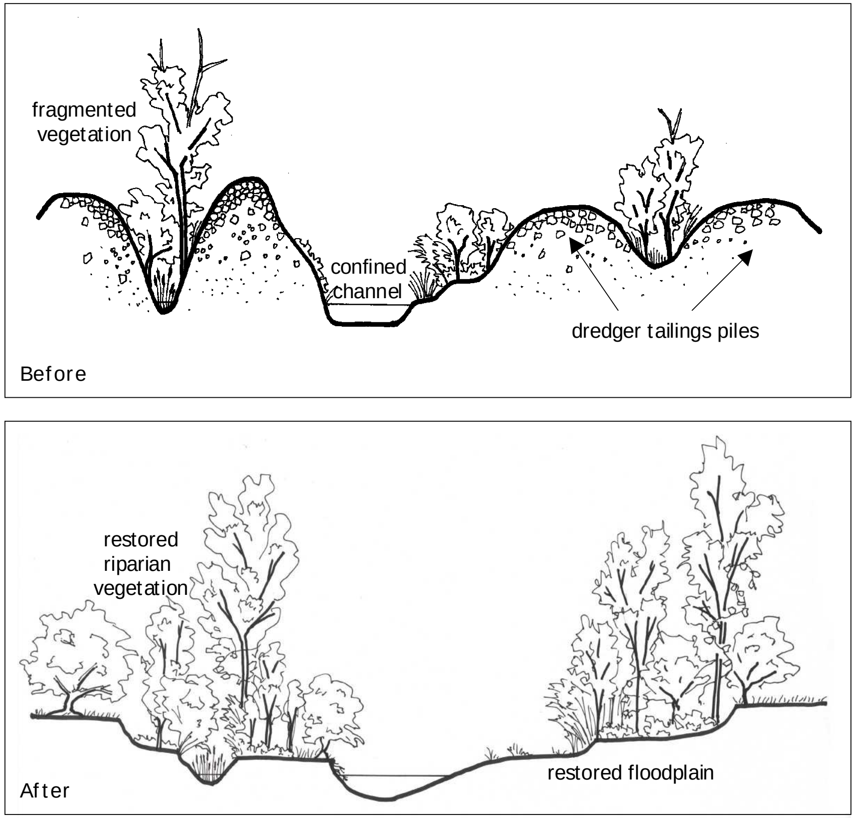


Figure 4-5. Conceptual restoration approach for the Dredger Tailings Reach. (not to scale)

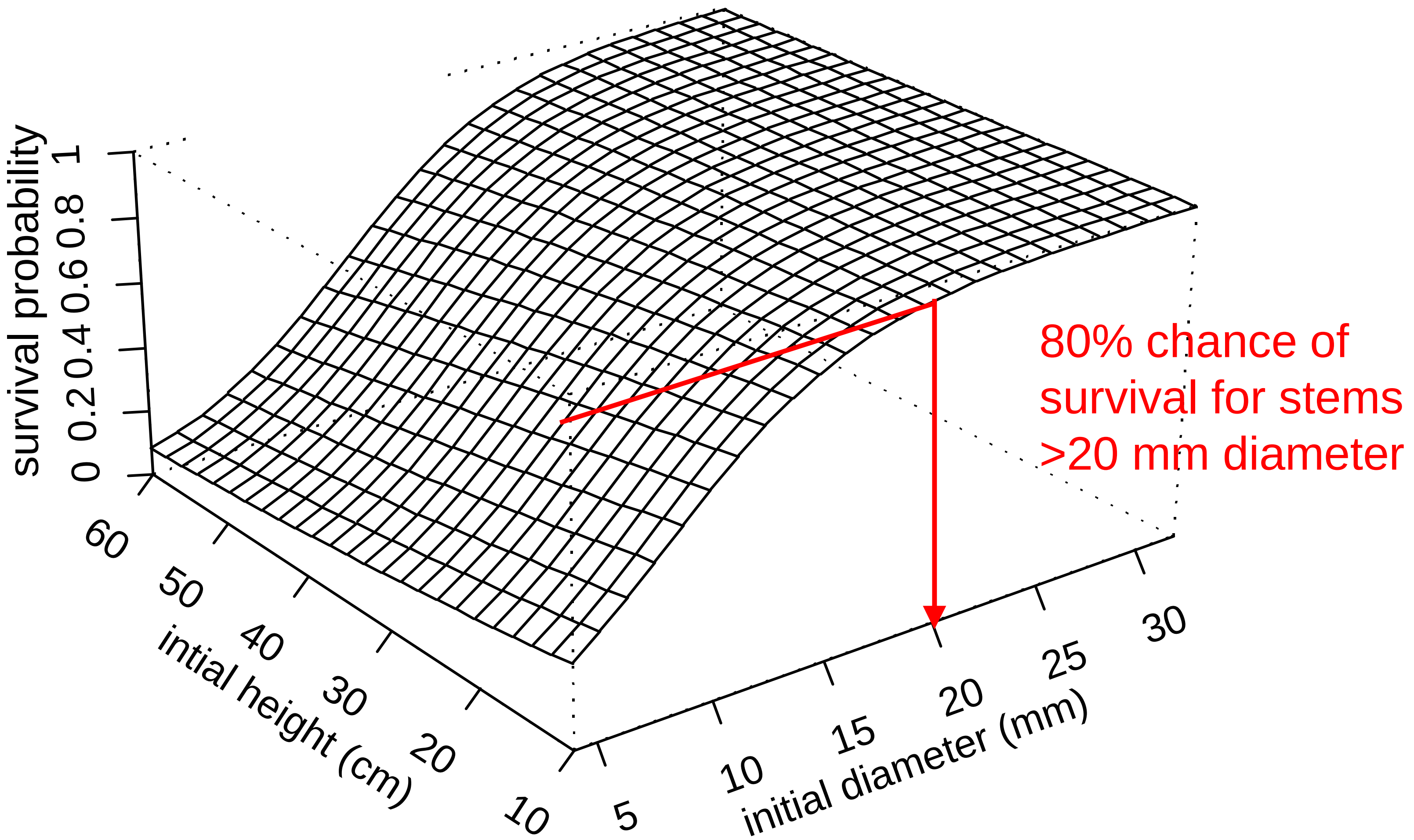
- How do riparian species respond differently to horticultural restoration
  - depth to groundwater (abiotic)
  - irrigation (abiotic)
  - weed control
- How can we set recommendations for management?
  - Quantitative metrics to predict tree survival.
  - Cost-benefit analyses for various restoration methods.

Merced River Riparian Tree Planting Experiment

- 4 native species
- 3 groundwater levels
- irrigation (+/-)
- weed control (+/-)
- survival and growth analysis

Practical Results: Predicting Tree Survival from Initial Seedling Size

(e.g., diameter of cottonwood cuttings)



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First, recognize the difference between management and academic environments

vs.

The science consulting environment

- Considerable resources, often with well-trained and equipped staff
- Field research is expensive
  - High 'burn rate'
  - No second chances at data collection
- Scope, budget, and schedule set by contract; little room for adaptation
- Scientific insight is only one of many competing priorities
- Data often proprietary → publishing difficulties

Academic research environment

- Hypothesis-driven science focus (hopefully)
- Cheap labor, (often) abundant data, high adaptability
- Research project timelines are limited
  - Grant funds are limited, and hard to renew
  - 2-5 years max. for grants and student degrees
- Personnel have multiple objectives
  - PI's: split attention between teaching & research
  - Rotating student researchers
  - Constant retraining, data quality issues
  - Deadline are difficult to maintain
- Often bureaucratic impediments and inefficiencies (universities ≠ companies, and have multiple goals)
- Must be able to publish (to keep our jobs)

How can academic training better address these discrepancies?

- Make sure the research question is relevant to river management objectives
- Stress hypothesis-driven research—an important contribution by academics
- Understand the differences between academic scientific standards and management realities
  - Managers want clear answers in a timeframe and budget
  - Science investigations must be hypothesis driven; recognize that they do not wrap up so neatly
  - Work with your academic mentor to establish clear expectations for each of these realities.

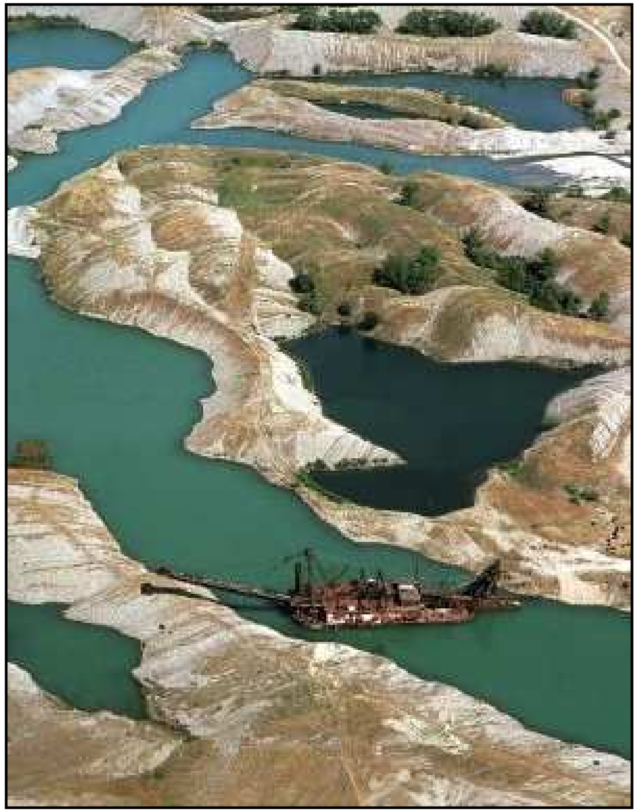
How to work with managers

- Who is paying for the study?
  - What are legal requirements, agency missions and management constraints?
  - What are the deliverables, and when are they due?
  - Know the stakeholders' motivations, personalities, and and history (e.g., who plays nice and who doesn't).
- What is the scientist's role in guiding the study?
  - A 'hired gun' to best answer a well constrained question?
  - A guide or coach, to help managers' prioritize issues?
- Be clear about your own motivations
  - Scientific/professional, financial, and personal

How to work with managers (cont.)

- Clarify project goals, roles, and expectations at the start
  - Project scope must be clear; how will changes be handled?
  - Establish a realistic budget and schedule tied to scope
    - Underestimating cost and schedule are not in anyone's best interest
  - Write a workplan early and update it often
- Communicate straightforwardly and establish trust
  - Make your motivations and constraints clear
  - Make only realistic commitments
  - Try to meet in person and schedule joint field meetings if possible
    - Helps visualize the project and establish a common vision
    - Allows for more informal (unstructured, undocumented) conversations
- Be professional
  - Fulfill deadlines and budgets
  - Prepare and practice thoroughly for meetings
  - Written products and communications must be clear and concise
    - Be mindful of your audience's technical level and time
    - Prepare a written 'executive summary' and verbal 'elevator talk'

Case study in how NOT to work with managers:
Lower Yuba River riparian studies



A bad project fit, all around

- Assumed goal: improve riparian habitat
- Dam relicensing with strict scope and budget limitations
- Legacy gold mining made impact assessment difficult
- Many entities with overlapping responsibilities
- Managers had bad experiences with academics in the past
- Biggest concerns were about endangered species (salmon), not riparian areas

Case Study:
Forest regeneration and succession on large regulated rivers

Stella, Hayden, Battles, Piégay, Dufour & Fremier. 2011 <u>Ecosystems</u> 14:776-790.

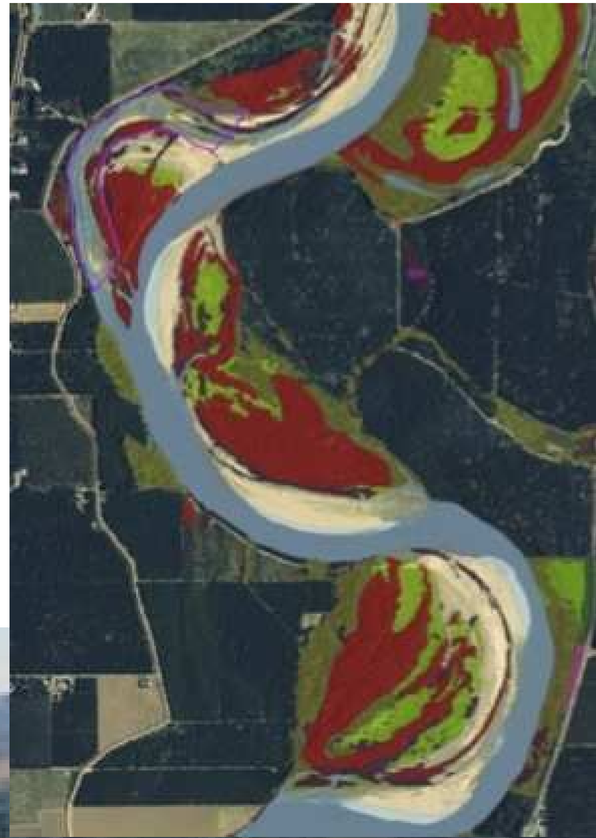
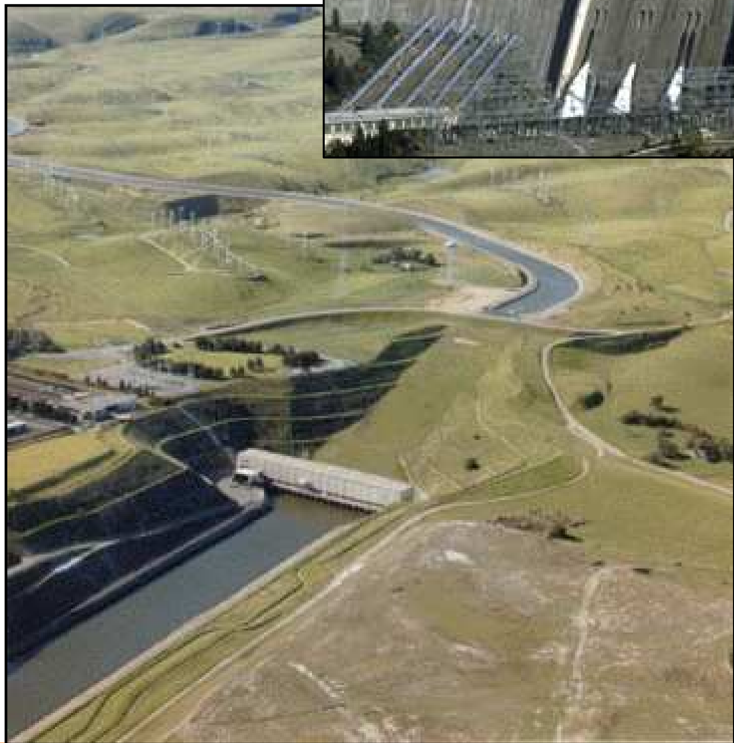


Image: Sacramento River Conservation Area Forum

Water Development in California's Central Valley (1930-present)

Major Federal and State Water Projects
(CA Dept of Water Resources)

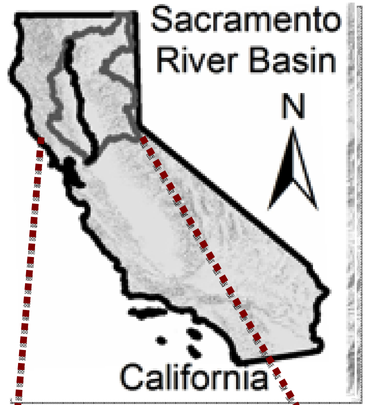
Shasta Dam, Sacramento River

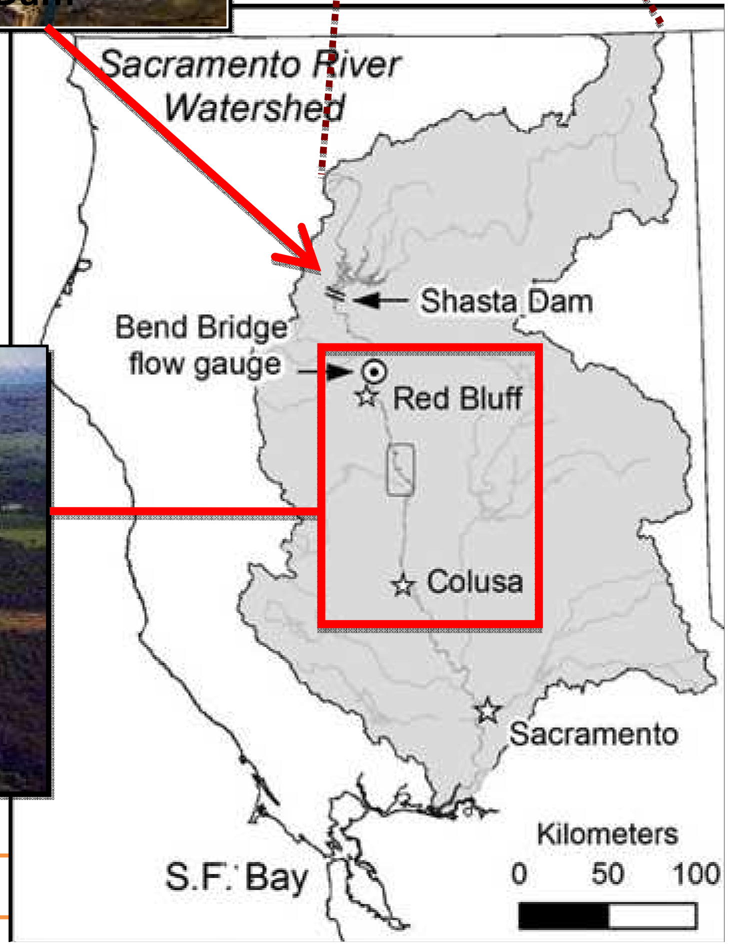


California Aqueduct

Sacramento River, CA

- Basin area: 75,000 km^2
- Dammed since 1942
- Still meandering for 160 km
- Reduced channel migration
  (Michalková et al. 2010)





Middle Reach (Red Bluff → Colusa)

Study Objectives

- Species composition and size structure of the current riparian forest
- Temporal pattern of stand establishment and forest succession
- Forest responses to river management.

Scientific Collaborators:

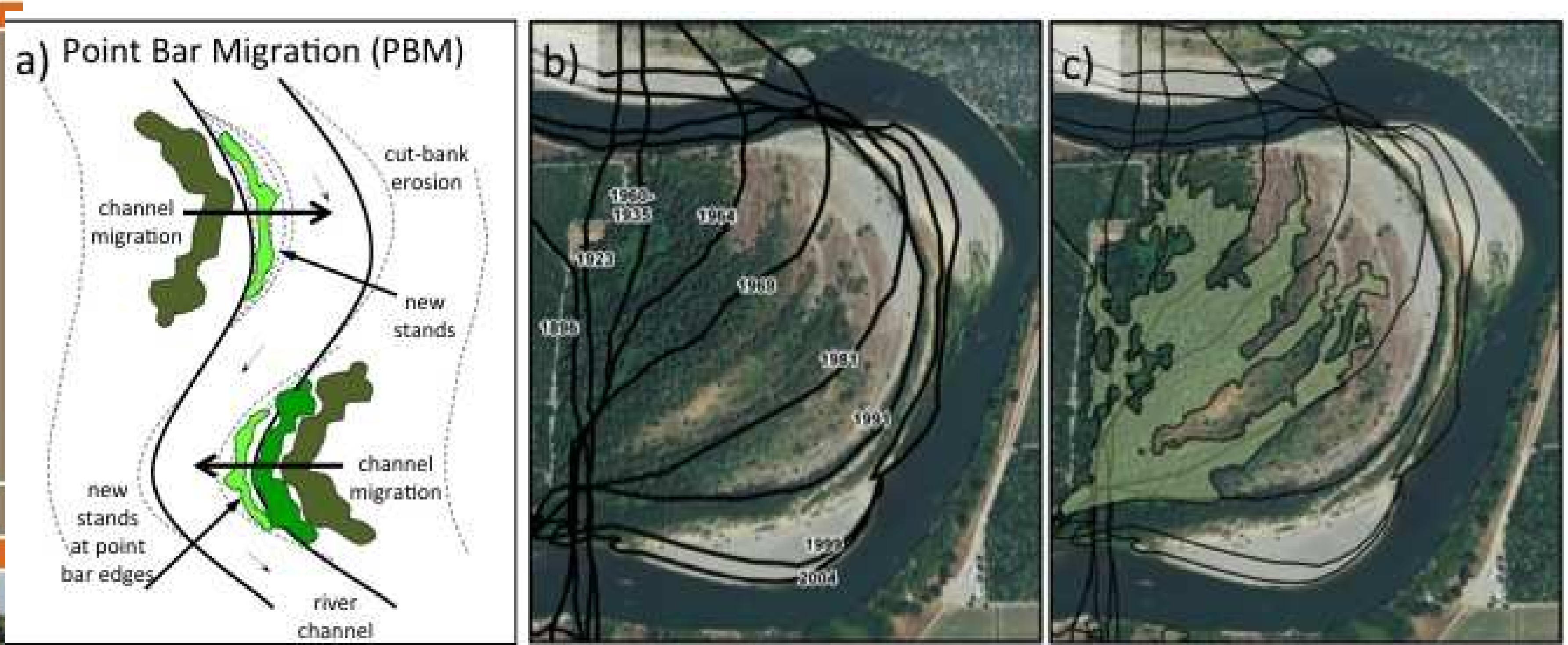
The Nature Conservancy
California Department of Water Resources
U.S. Fish and Wildlife Service
Hervé Piégay (Univ. Lyon and CNRS, France)
Simon Dufour (Univ. de Rennes, France)
John Battles, Matt Kondolf (UC Berkeley, USA)
Alex Fremier (Univ. of Idaho, USA)

Funding:

CALFED/Sea Grant Science Program
CNRS PICS Grant Program
National Science Foundation

Dams & channelization → less river migration → less frequent forest regeneration on point bars

Channel migration	Successive stages of point bar formation	Riparian trees colonize in parallel stands



Stella et al. 2011 *Ecosystems* 14:776-790.

Abandoned river channels support rich, complex habitats

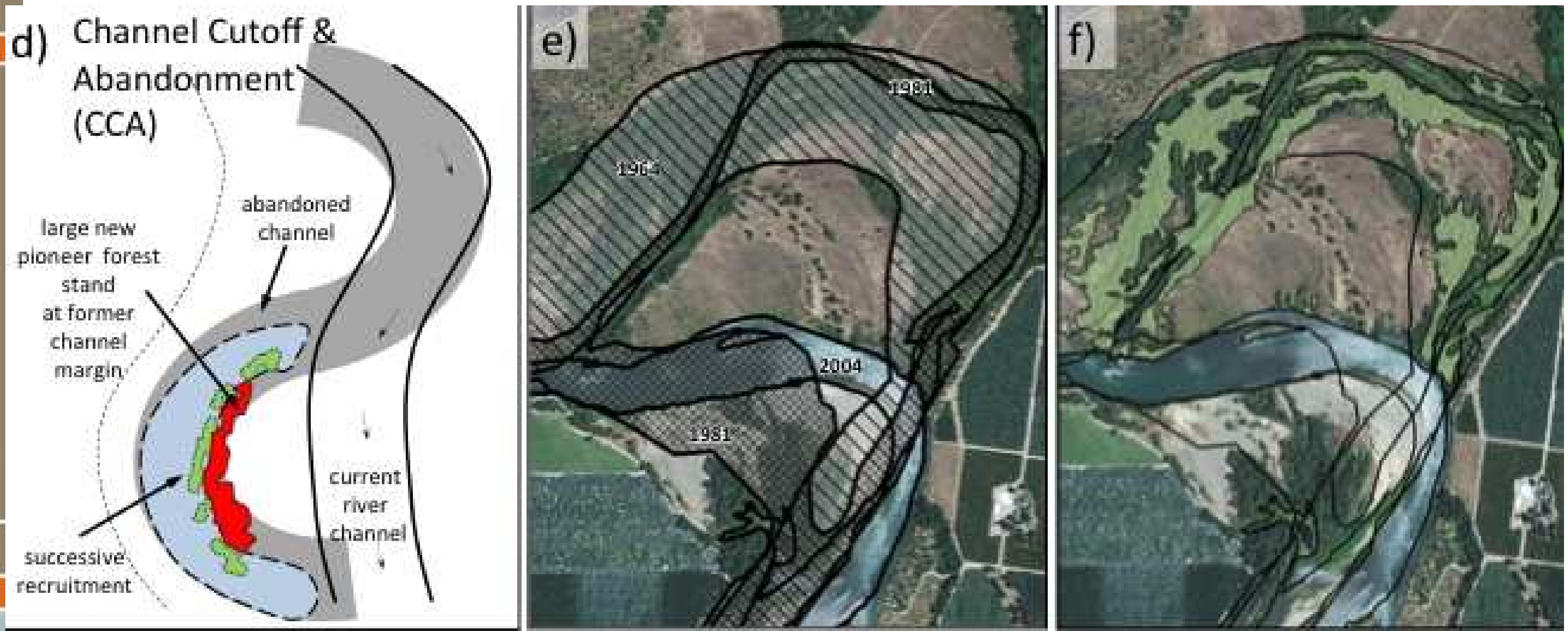
- Are they also important areas for forest regeneration?

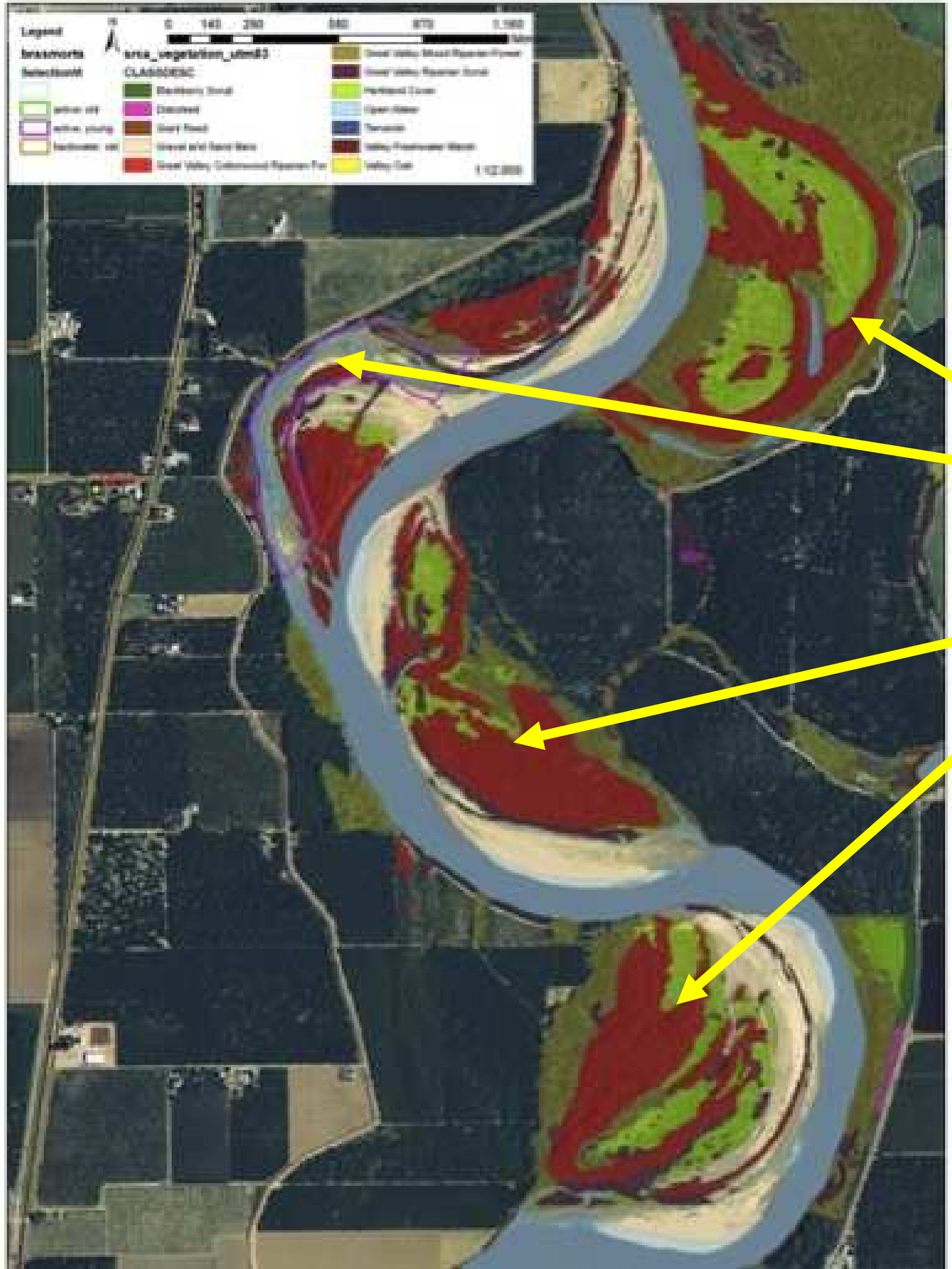
An alternative initiation pathway in abandoned channels

Channel cutoff and blockage

Sediment filling and terrestrialization

Forest regeneration within former channel





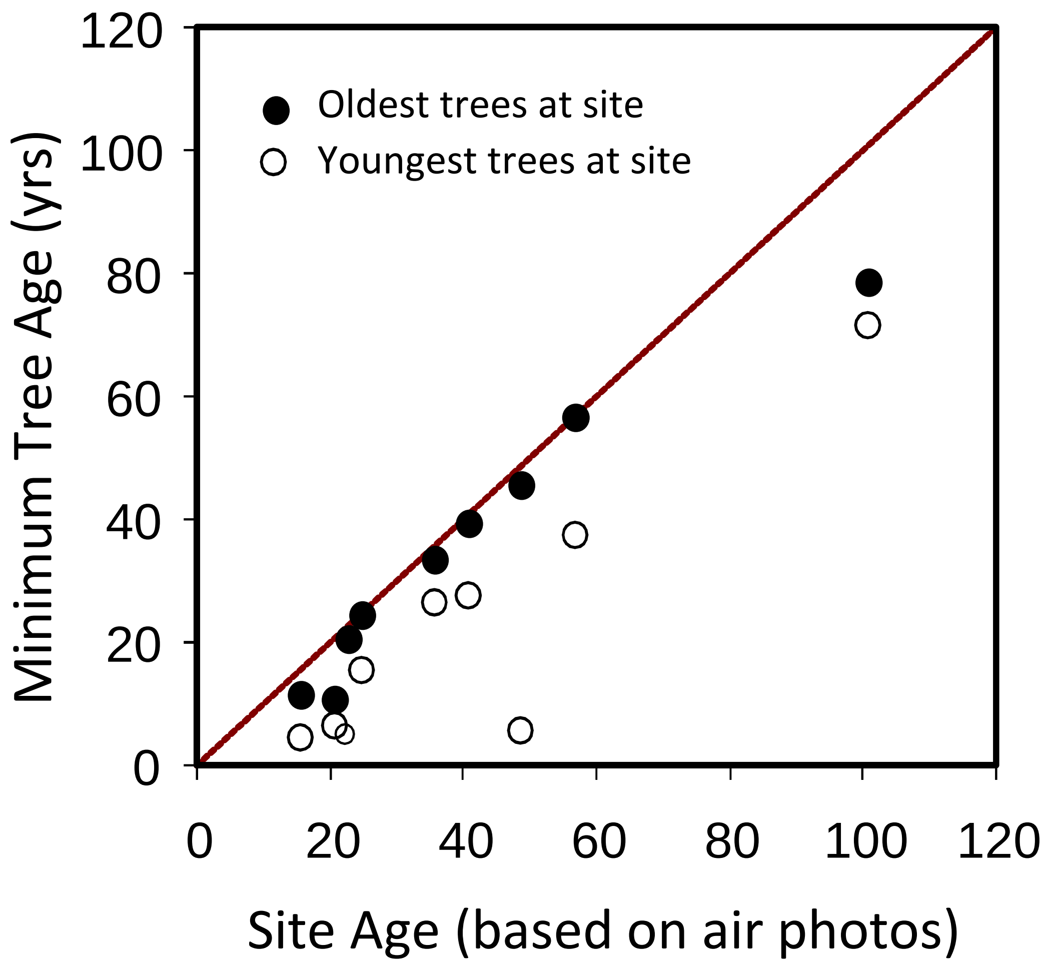
Air photo analysis shows that *__more than 50% of pioneer forest area occurs in former channels__*

Former channels

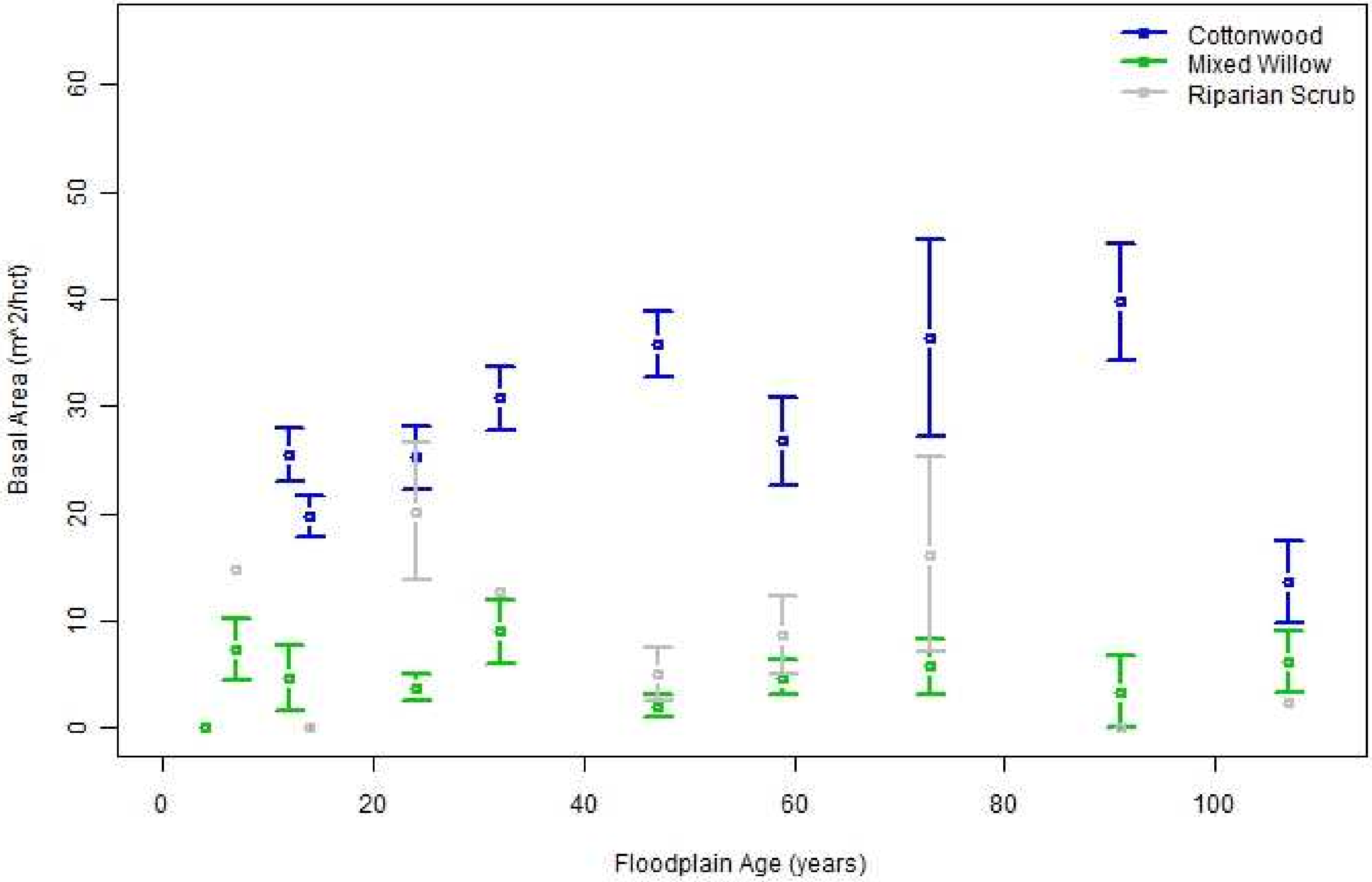
Mature cottonwood forest stands

Stella et al. 2011 __Ecosystems__ 14:776-790.

Tree-ring analysis confirms that forest stands establish at the time of cutoff



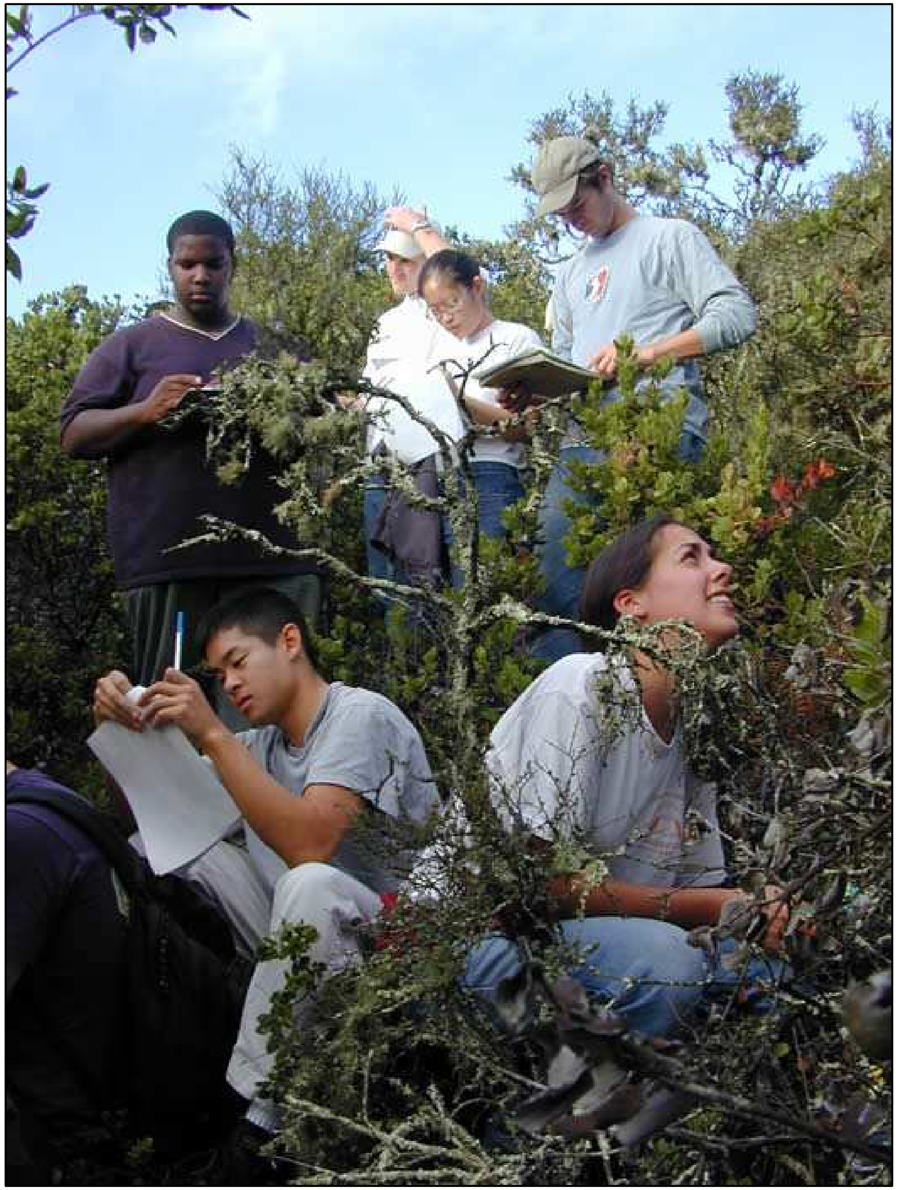
Stand basal area increases with floodplain age



Management Implications

- Allow *channel migration and abandonment* to maximize the middle-aged stands over the long term
- Managers can better *prioritize floodplain areas* for protection
- Scientists can guide restoration actions (e.g., flow releases) to *maximize benefits* with *lowest water costs*.
- Ongoing collaboration helps scientists focus on the most pressing management problems.

How can graduate students improve their educational experience?



Charting your course

1. Be proactive: Take initiative to seek out your mentor and request time and assistance. Don't be invisible.
2. Keep commitments and meet deadlines. Reliability is impressive.
3. Always strive for excellence. Working with self-motivated students is a pleasure (and less work for the mentor).
4. Be open to feedback, and show that you've put it into practice (or at least considered it thoughtfully).

Charting your course (cont.)

5. Communicate honestly and directly: let your mentor know what you need and how he or she can help.
6. Accept increasing responsibility and autonomy. Progress from novice to collaborator with your mentor.
7. Accept imperfection and admit mistakes. Perfection is impossible; triage the important tasks.
8. Be mindful of your mentor's goals. Offer help with projects (e.g., lab, writing, teaching) that will afford you experience and supervision.

Charting your course (cont.)

9. Have reasonable expectations. Your mentor cannot meet all of your needs, know everything about the field, or always offer undivided attention.
10. Maintain a sense of humor, and keep things in perspective. It is never as bad as you think (nor is it ever ideal).
11. Build a mentoring team. Seek out a range of personal and professional support during your program including peers, more advanced students, and other faculty inside or outside your institution.