

**Jay Lund, Ph.D**

**Board Member & Past Chair**

**Delta Stewardship Council  
Independent Science Board**



DELTA STEWARDSHIP COUNCIL  
DELTA SCIENCE PROGRAM



# Sacramento-San Joaquin Delta and its Tributaries

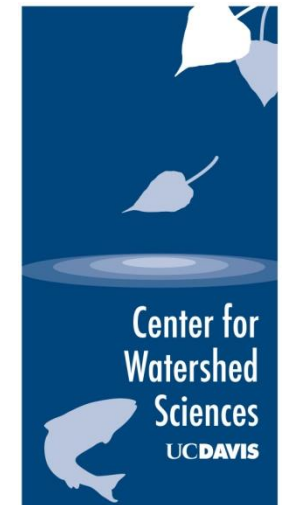
**Jay R. Lund**

**Director, Center for Watershed Sciences  
Professor of Civil and Environmental Engineering  
University of California, Davis**

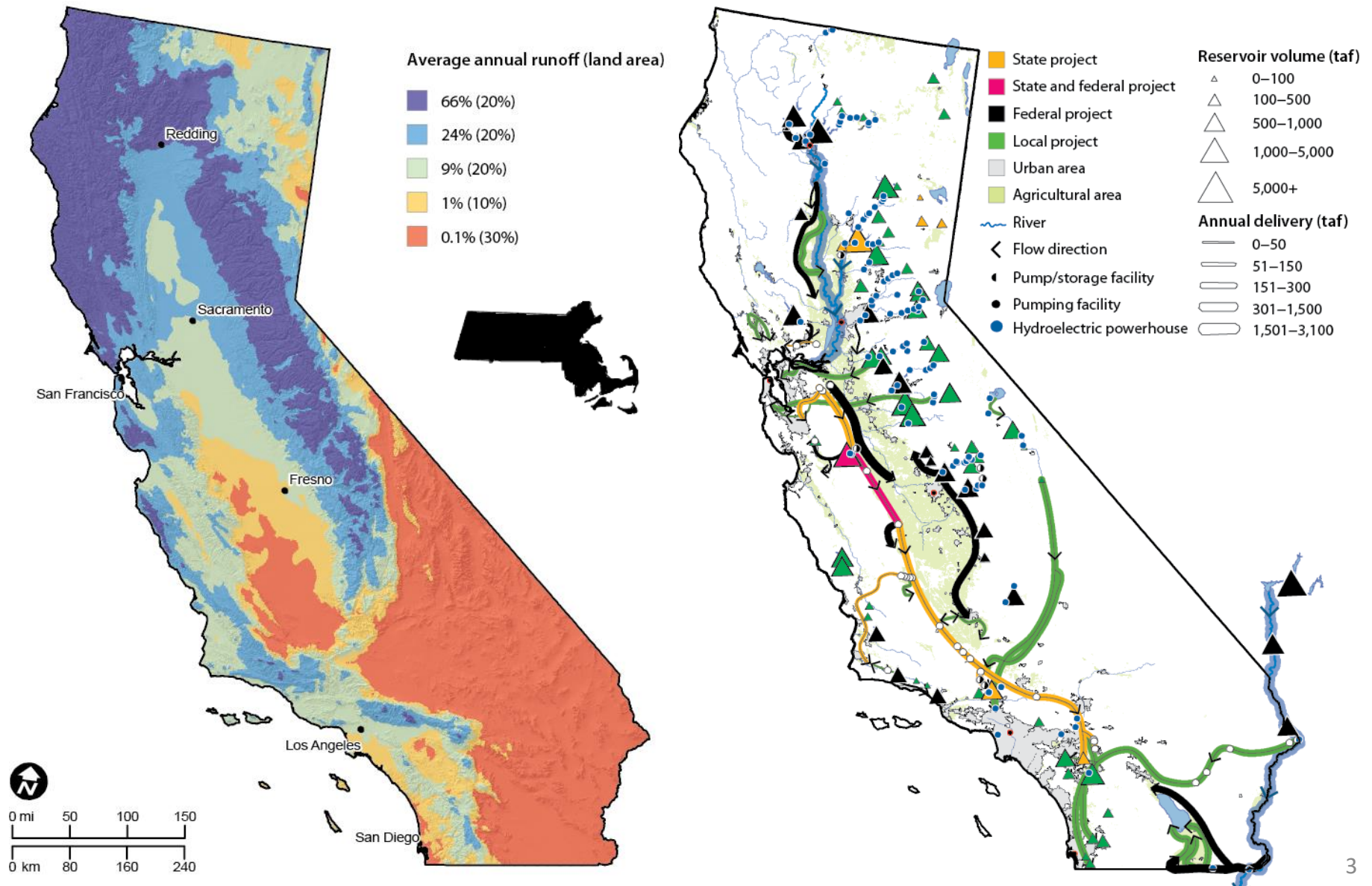
NOBODY LIKES US  
"BIG PICTURE"  
PEOPLE



[watershed.ucdavis.edu/shed/lund/](http://watershed.ucdavis.edu/shed/lund/)  
[CaliforniaWaterBlog.com](http://CaliforniaWaterBlog.com)

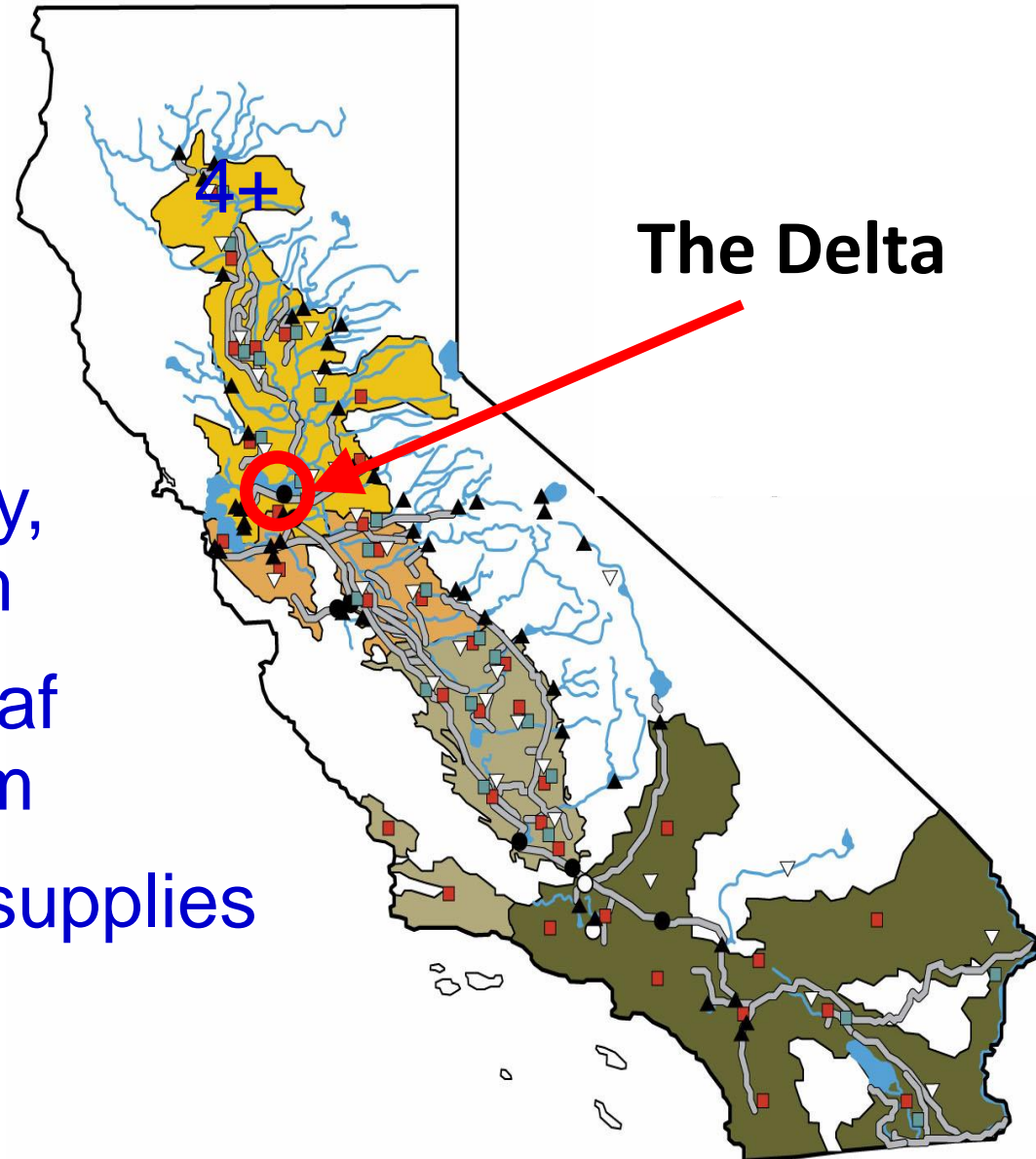


# Complexity of Water in California



# Sacramento-San Joaquin Delta

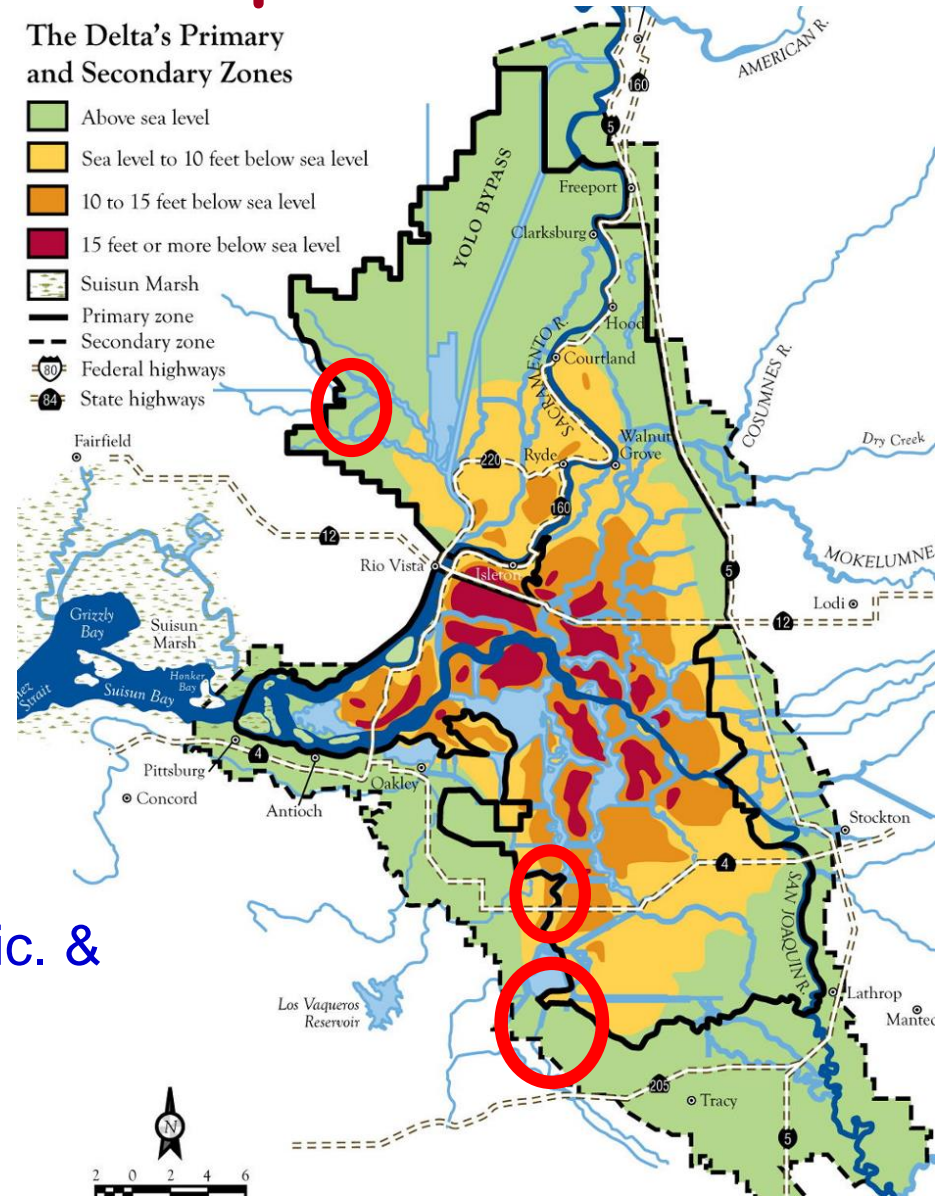
- Sacramento Valley - maf taken upstream
- Delta farmers – 1+ maf
- Bay Area – 30% directly, another 40% upstream
- S. Central Valley – 4 maf directly; 4 maf upstream
- S. California – 30% of supplies





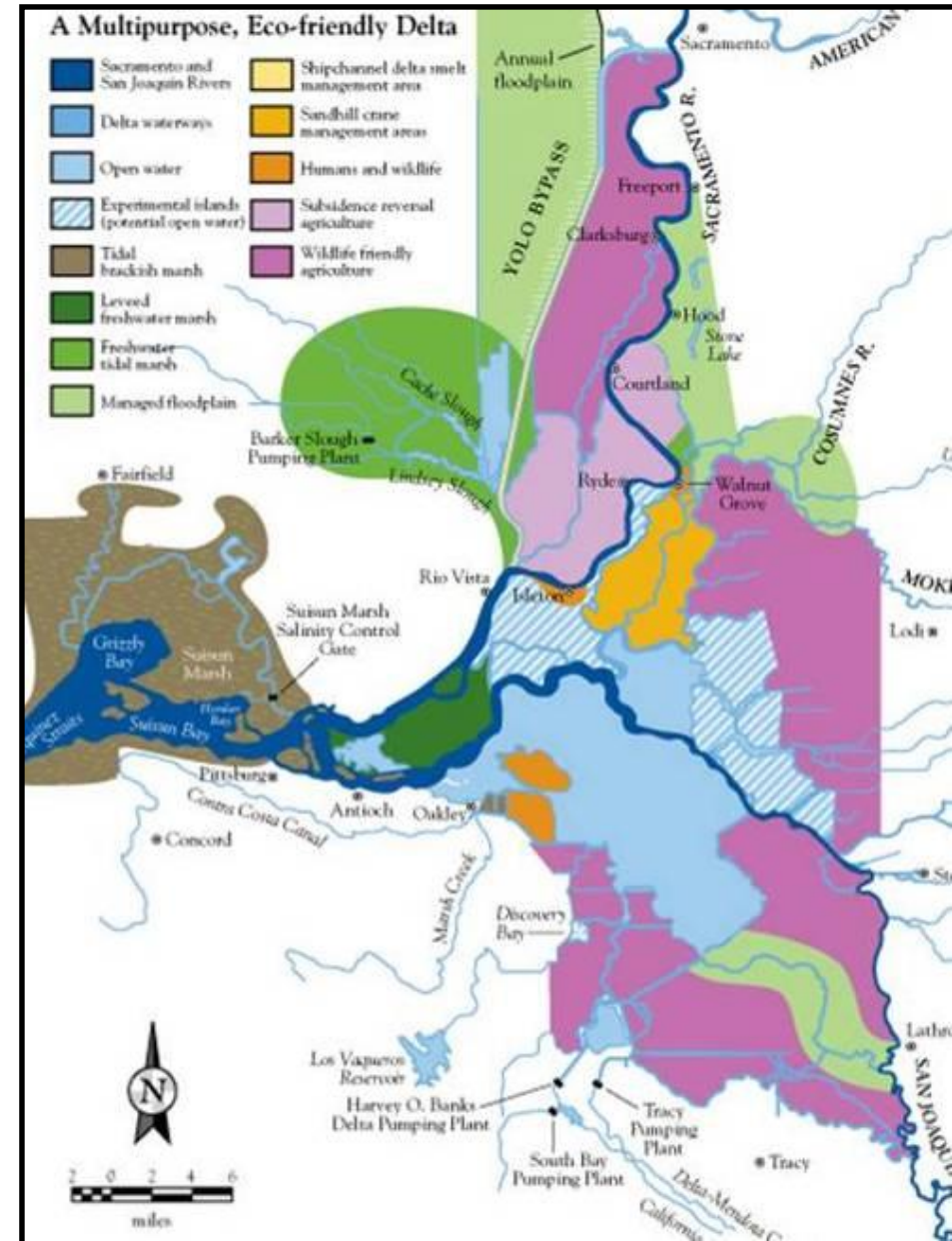
# Problems of California's Sacramento-San Joaquin Delta

- Physical instability
  - Land subsidence
  - Sea level rise
  - Floods
  - Earthquakes
- Ecosystem instability
  - Habitat alteration
  - Invasive species
- Economic instability
  - High costs to repair islands
  - Worsening water quality for agric. & urban users



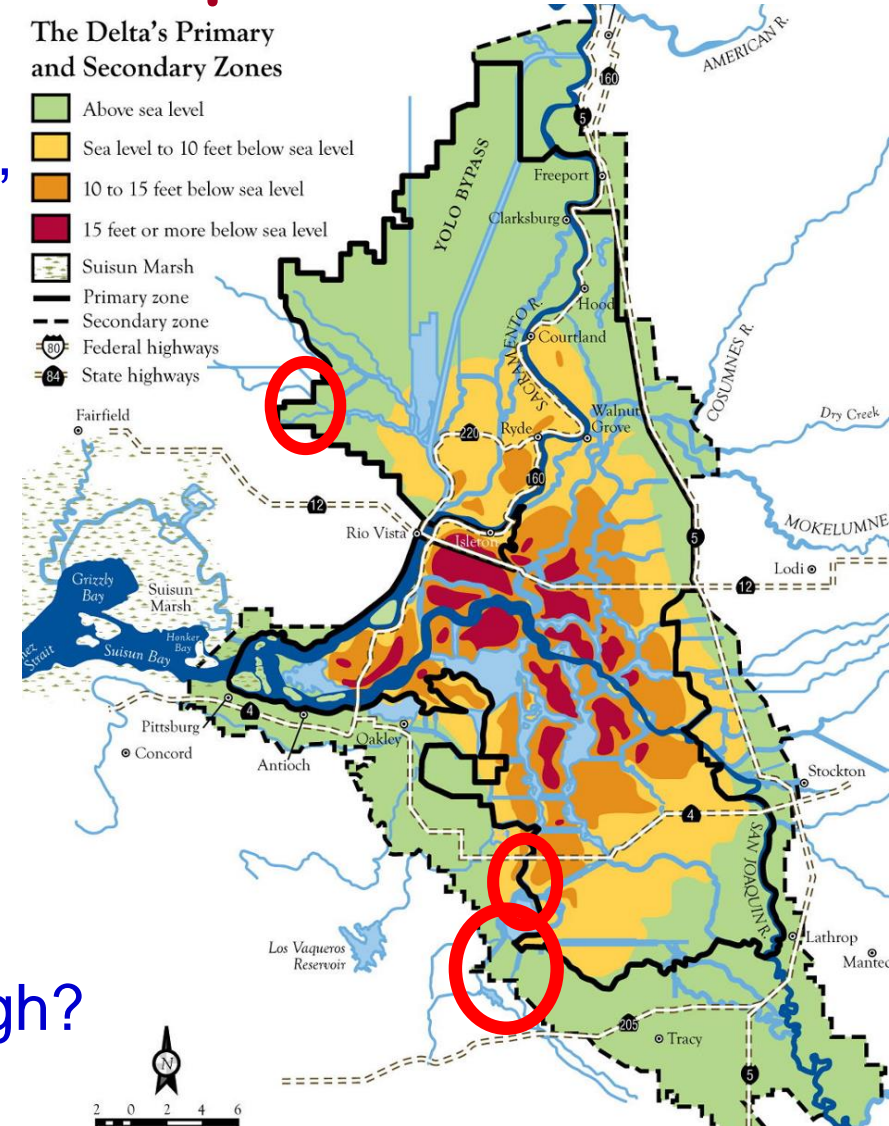
# Changes for Delta

- Climate – sea level rise, warmer
- SGMA – More Delta export demand
- Declining native ecosystems
- Subsided island failures
- Others ...



# Policy Decisions for Sacramento-San Joaquin Delta

- Levees
  - “Should I stay or should I go?”
  - Who pays?
- Ecosystem management
  - Manage for what?
  - Where and how?
  - With what resources?
- Water supply
  - Over, under, around, or through?
  - Who loses how much?



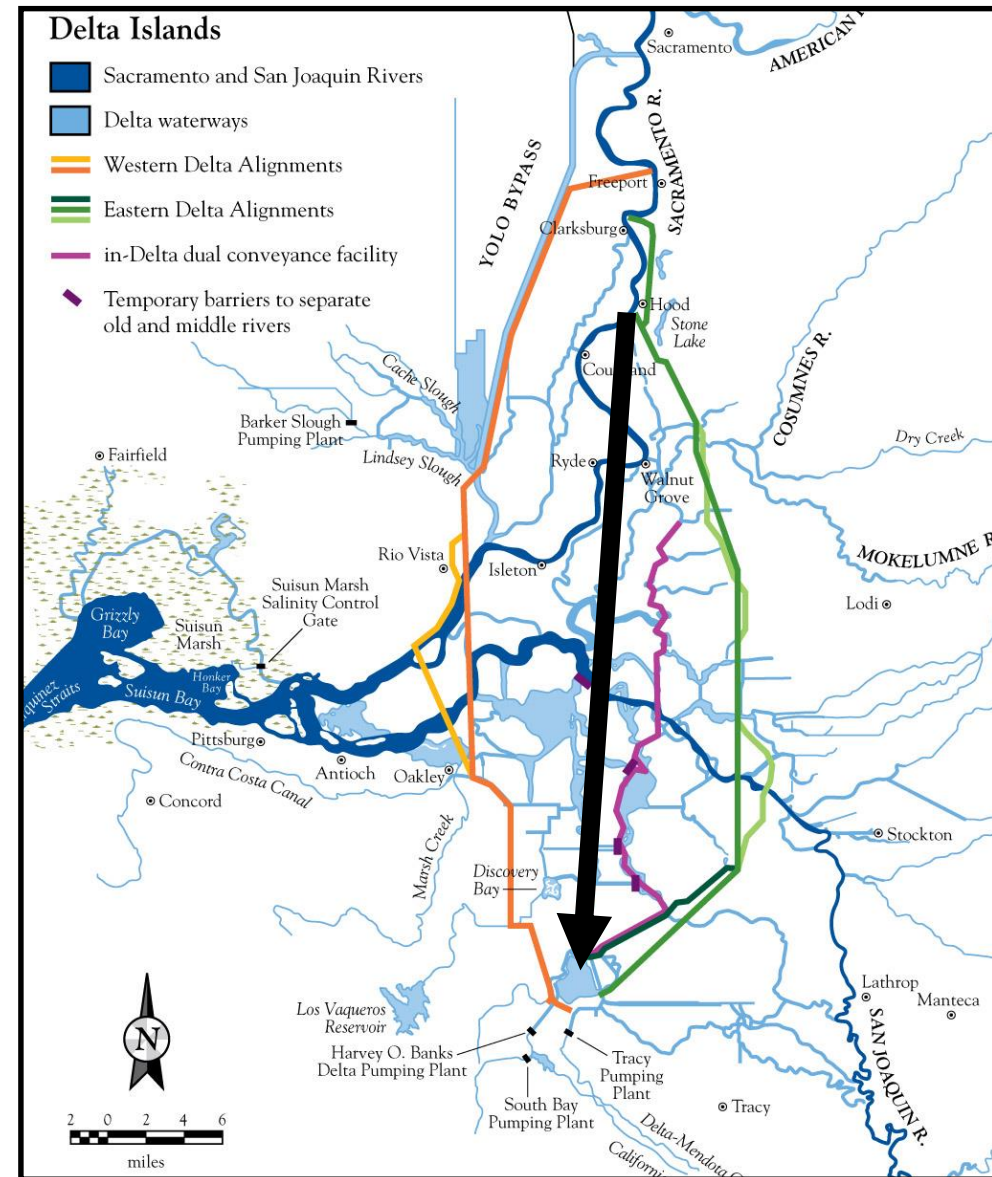


# Long-term Water Supply Strategies

1. Through Delta
2. Around Delta
3. Dual conveyance
4. End Delta exports

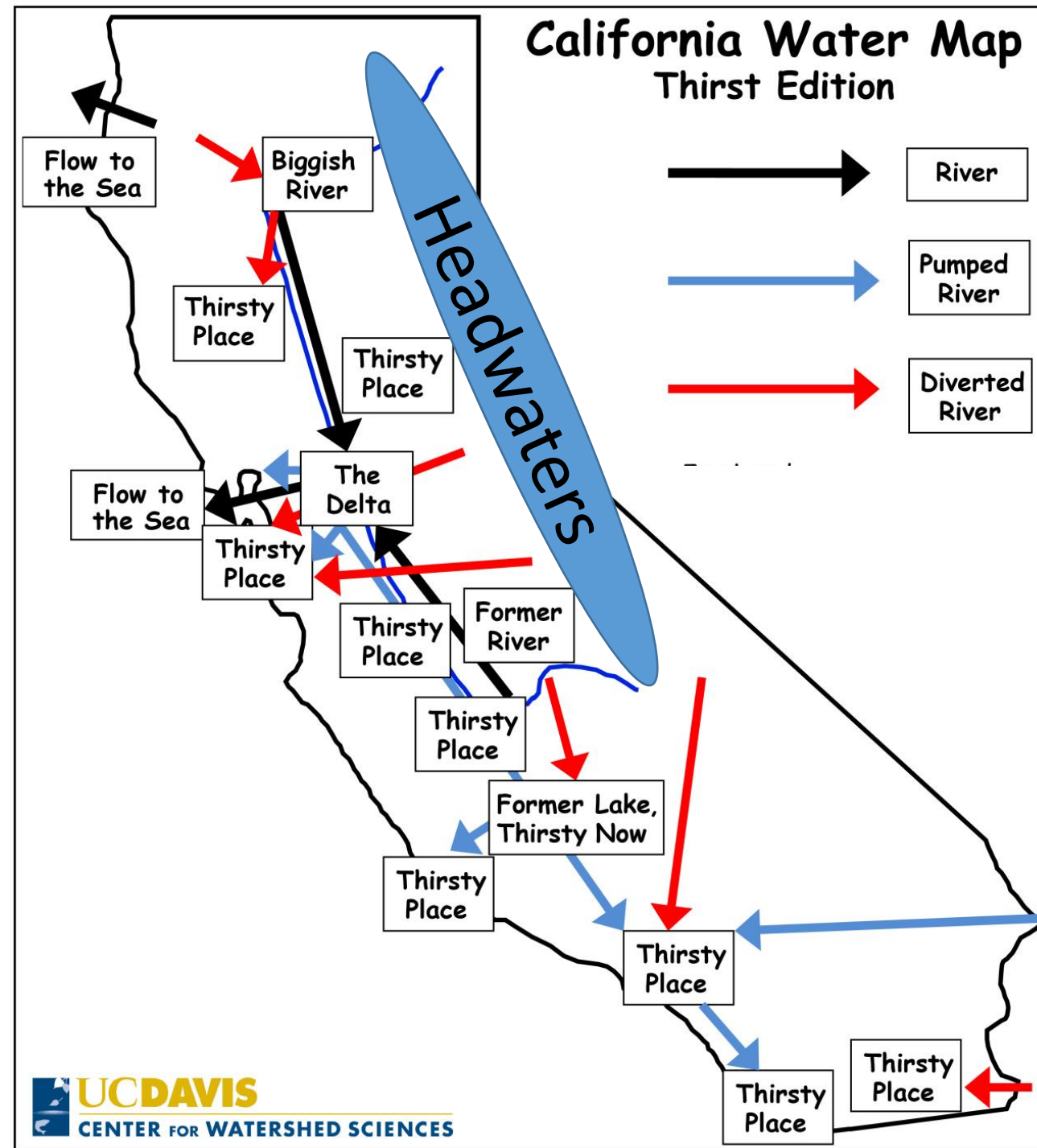
How & how much around?

- Peripheral canals
- Under Delta
- Two tunnels
- One tunnel





Water  
connects us,  
for better  
and for  
worse



# Tributary linkages to Delta

- Water supply quantity
  - Seasonal shift, lost snow
  - Greater extremes
  - Likely less on average
- Water supply quality
  - Probably similar
- Floodwater
  - Greater extremes from more extreme storms and less snowpack



# Changes coming to Tributaries

- More people upstream
- Climate change
  - Warmer
  - Greater extremes
  - Probably some loss of average flow
- Environmental flows
- Changes to forests
  - Thinner? Less ET? More fires?
- Changes in hydropower, recreation, economy?

# Potential for Delta funding for Tributary Activities

- Probably less than people would like
  - Most water flows downstream anyway
  - Forest thinning might reduce watershed ET
  - Increase runoff 1 maf/yr @ \$300/af = \$300m/y
  - Accounting and bill collection difficult
- Water quality benefits likely smaller and harder to assess
- Flood benefits dampened by large reservoirs, perhaps worsened by forest thinning



# Support for Mountain Counties

- Water supply – water rights, funding
- Forest management
- Land restoration
- Environmental flows
- Legacy water quality problems

Part of larger California water management

- Needn't be entangled with Delta, but might benefit from larger solutions

# System Integration

- California's water system is inescapable – provides benefits and controversies
- California's extensive, diverse, variable, water storage and conveyance network encourages broader portfolio management
- Portfolio management is successful, but takes persistent effort to organize.

# Water supply system portfolio actions

| Water supply  |   |
|---|---|
| Water Source availability   | Treatment                               |
| Capture of fog, precipitation, streams, groundwater, wastewater   | Existing water and wastewater treatment |
| Protection of source water quality                                | New water and wastewater treatment      |
| Conveyance capacities   | Wastewater reuse                        |
| Canals, pipelines, aquifers, tankers (sea or land), bottles, etc. | Ocean Desalination                      |
|   | Contaminated aquifers                   |
| Storage capacities  | Operations                              |
| Surface reservoirs, aquifers and recharge, tanks, snowpack, etc.  | Reoperation of storage and conveyance   |
|   | Conjunctive use                         |
| Water demands and allocation                                      |   |
| Agricultural water use efficiencies and reductions                | Ecosystem demand management             |
| Urban water use efficiencies and reductions                       | Recreation water use efficiencies       |
| Incentives  |   |
| Pricing   | Subsidies, taxes                        |
| Markets   | Education                               |

# Building an Integrated Ecosystem Portfolio

## Salmon Life-cycle support Institutional support

- Ocean harvesting
- Return spawners
- Eggs
- Rearing juveniles
- Return to sea

Population only as strong  
as its weakest stage

Assets and organization to  
give flexibility

- Local groups
- Local government
- State government
- Federal government
- NGOs
- Professional societies
- Organized science and education
- Funding for each level
- Common framework



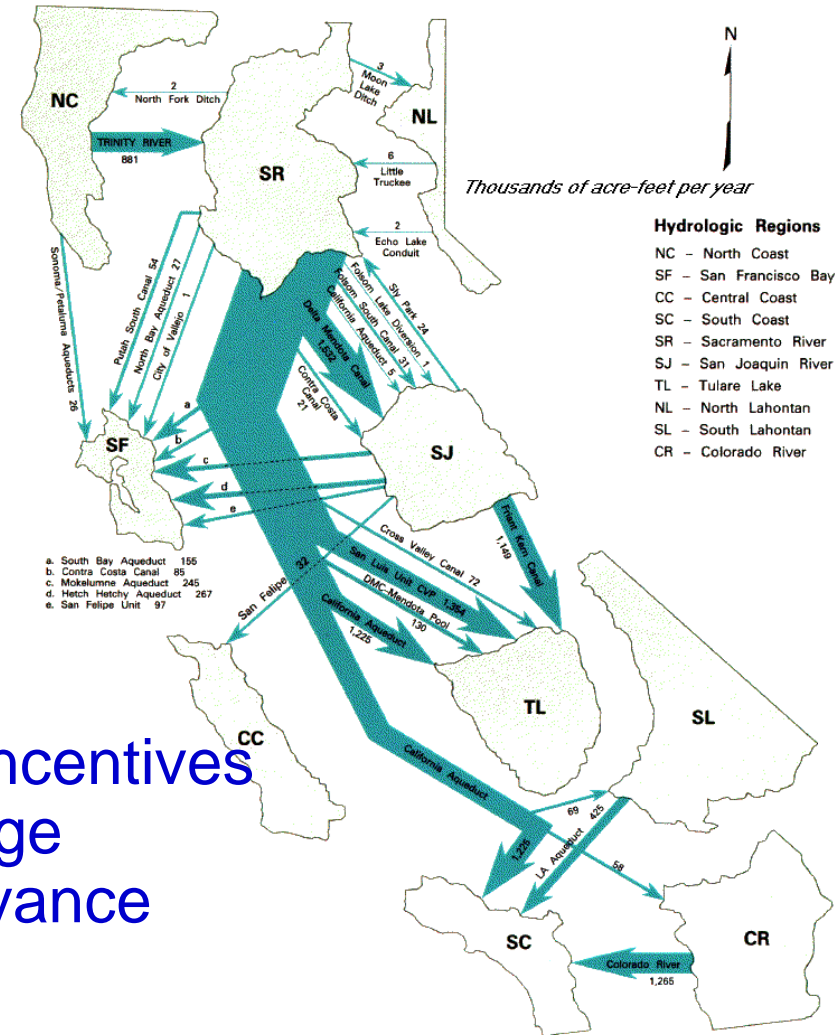
# Local and Statewide Portfolio

## Local Activities:

- Conservation and use efficiency
- Wastewater reuse
- Desalination (brackish & ocean)
- Groundwater use and recharge
- Surface reservoir operations
- Water markets and exchanges

## Statewide Activities:

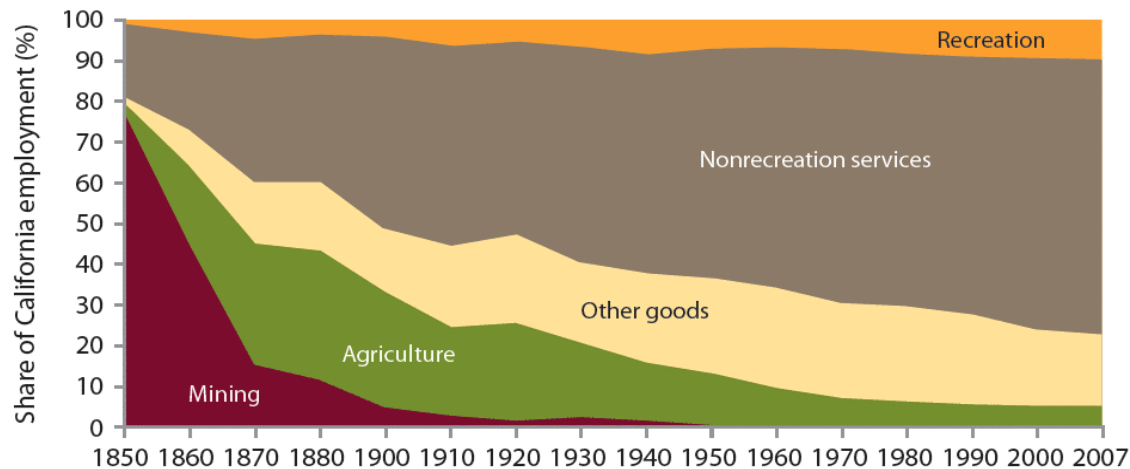
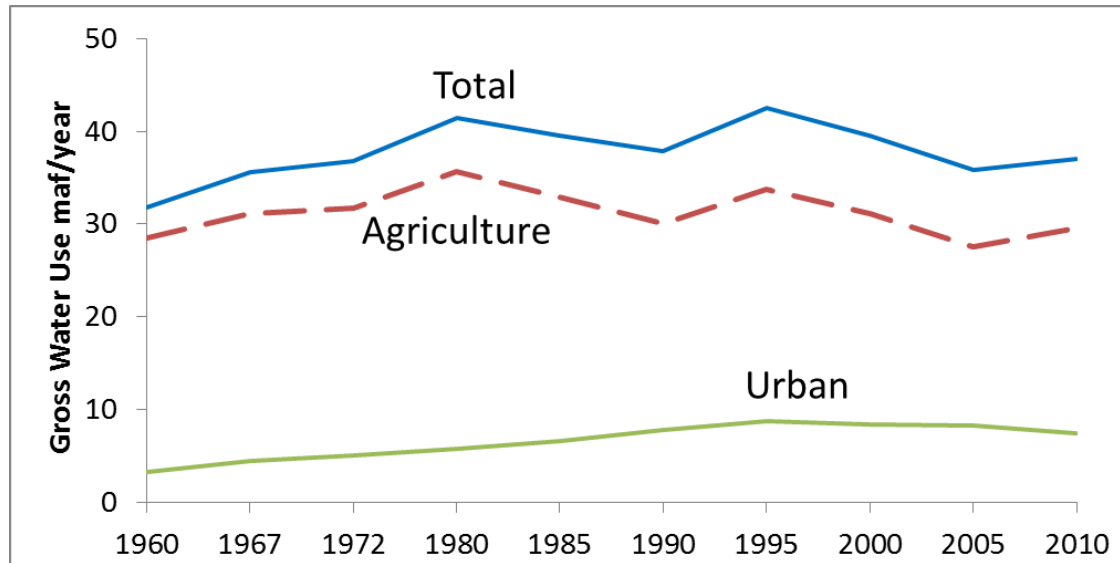
- Inter-regional water conveyance
- Surface reservoir operations
- Plumbing codes & conservation incentives
- Groundwater banking and recharge
- Water market support and conveyance
- Wastewater reuse subsidies



# Delta, Tributaries, & Portfolios

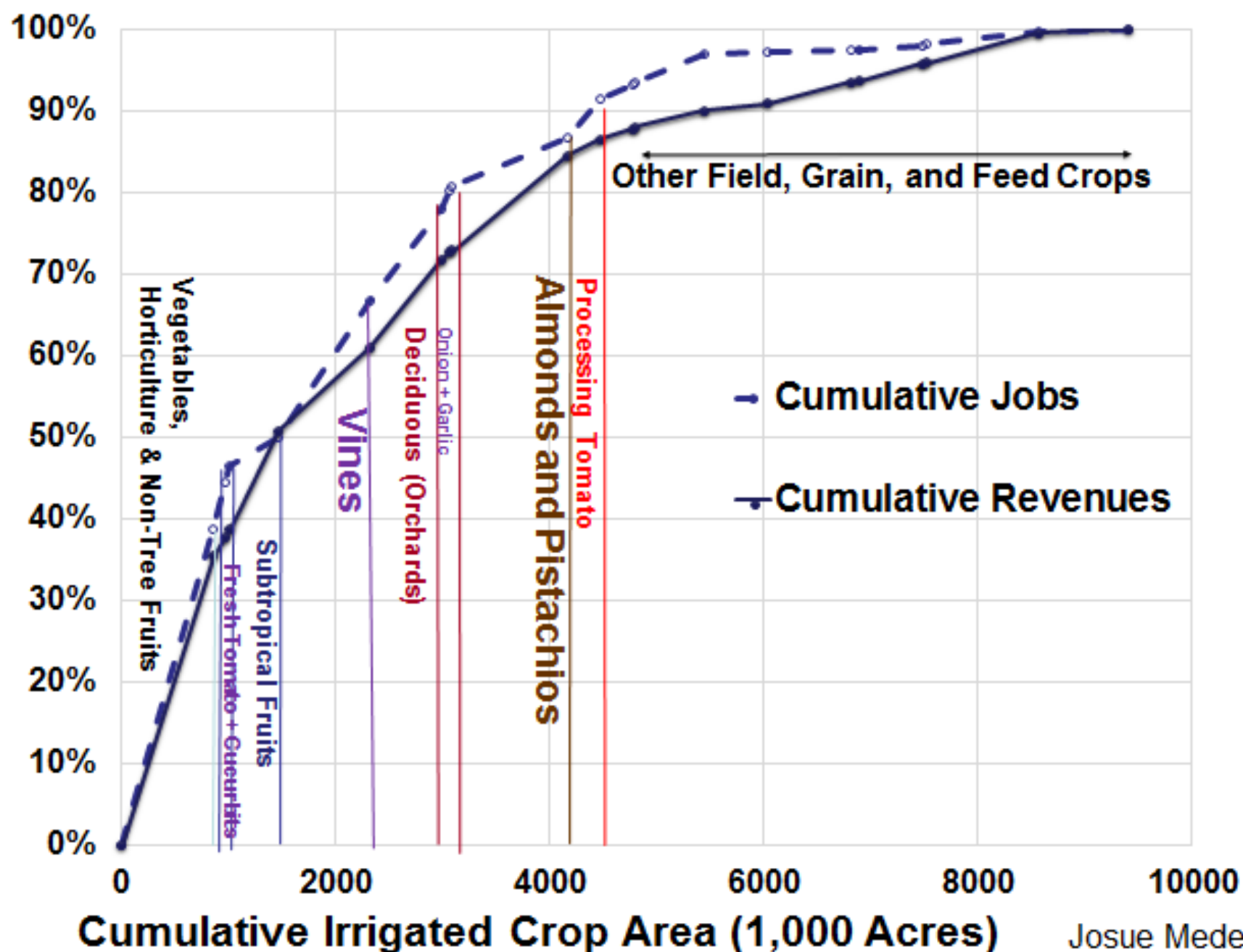
- Integrating complex systems is hard, but has benefits
- Few interests get all that they want
- Most must employ portfolio of local, regional, statewide actions
- Common analysis and data helps
  - Water accounting
  - Models and databases
  - Access, quality control, transparency

# Reasons for Hope



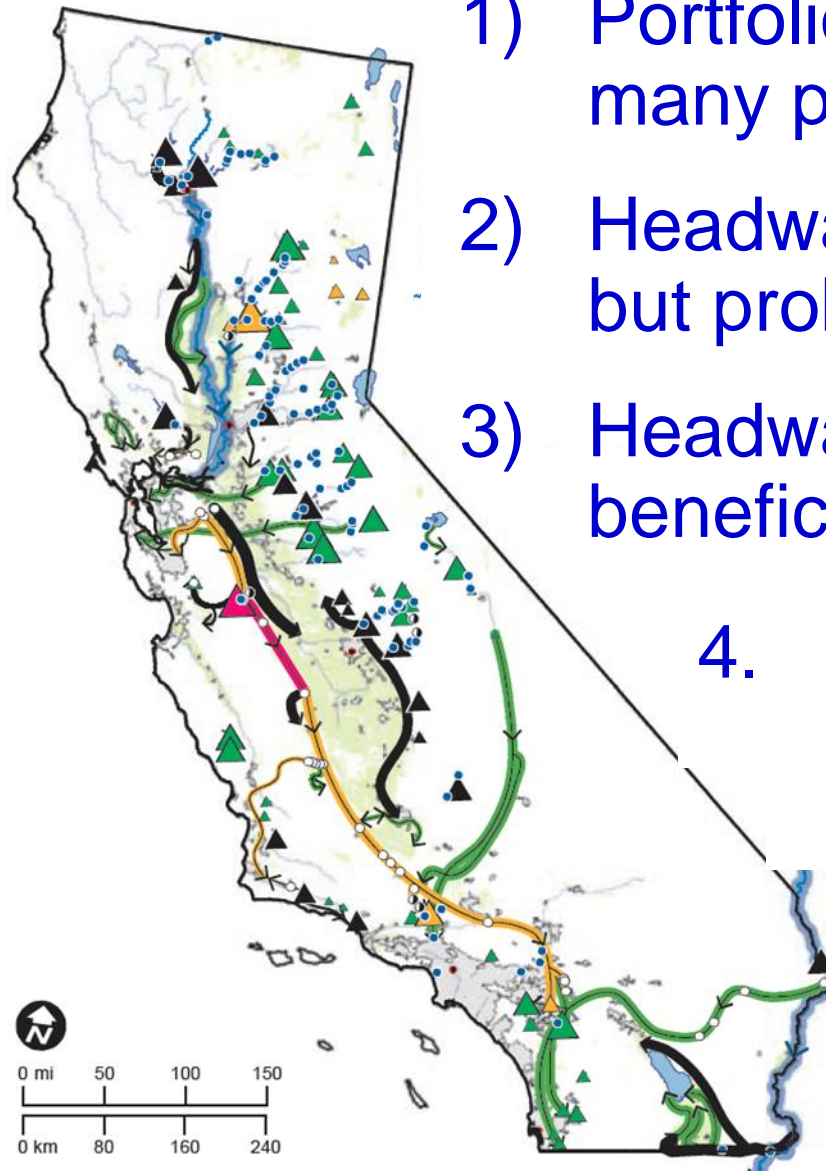
- 1) Human water use peaked?
- 2) Economy depends less on water abundance
- 3) Water markets can shift use and civilize change
- 4) We agree we have a problem

# Cumulative Jobs and Revenues





# Conclusions

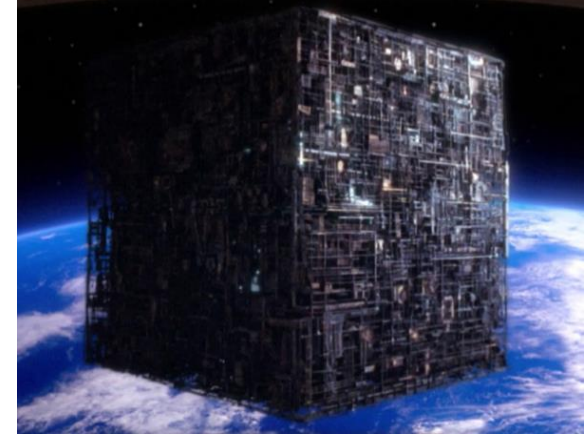


- 1) Portfolios core of water success for many purposes
- 2) Headwater management is important, but probably less than most would like
- 3) Headwaters have many bigger beneficiaries than the Delta
4. Integration is will include broader local environmental benefits
- 5) Better water accounting
- 6) Change will occur, and must be prepared

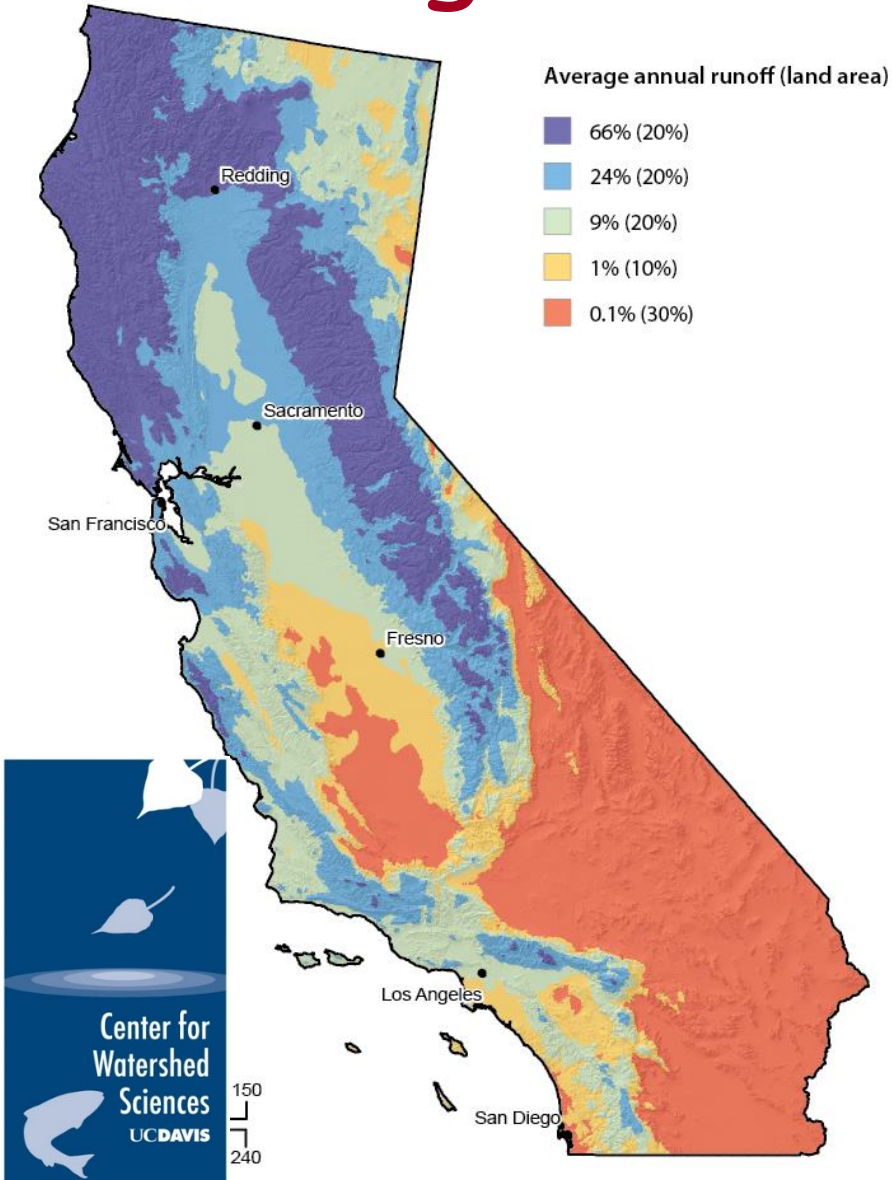
# Resistance is Futile

- 1) Flooding in parts of the Delta
- 2) Reduced Delta diversions
- 3) Less irrigated land in the southern Central Valley
- 4) Less urban water use, more reuse & storm capture
- 5) Some native species unsustainable in the wild
- 6) Funding solutions mostly local and regional
- 7) State's leverage is mostly regulatory, not funding
- 8) Nitrate groundwater contamination is inevitable
- 9) Groundwater will be managed more tightly
- 10) The Salton Sink will be largely restored

How we manage many changes together is key.



# Further Readings



Hanak et al. (2011) *Managing California's Water*, PPIC.org

Hanak et al. (2010) *Myths of California Water*, PPIC.org

Lund et al. (2010) *Comparing Futures for the Sacramento San Joaquin Delta*, UC Press

PPIC, *Improving the Health of California's Headwater Forests*, September 2017

PPIC, *Stress Relief: Prescriptions for a Healthier Delta Ecosystem*, April 2013.

Mavensnotebook.com

CaliforniaWaterBlog.com

# Flood management- portfolio of actions

| Preparatory actions  |  |
|--|--|
| Protection   | Vulnerability reduction<br>(reduced damage and casualty potential)                               |
| Levees   | Relocation of vulnerable human activities  |
| Flood walls and doors  | Floodplain zoning and building codes   |
| Closed conduits  | Floodproofing—raising structures, sacrificial first floor, flood doors                           |
| Channel improvements and flood corridors   | Flood warning and evacuation systems   |
| Reservoirs   | Flood insurance and reinsurance  |
| Bypasses   | Flood risk disclosure  |
| Sacrificial flooding   | Public and policymaker education   |
| Flood easements (bypasses, designated flood areas)   | Flood preparation and training exercises   |
| Local detention basins, drainage, and pumps  | Floodplain mapping, gaging, data collection  |
| Regular inspections, assessments, and maintenance  | Community engagement and multi-hazard planning   |
| Response actions   |  |
| Levee and flood wall monitoring  | Warnings, evacuation calls, and emergency  |
| Flood fighting—sandbagging, sheet pile installation, wave wash protection, splash cap installation, ring levee construction, relief cut, pumping, and breach closure | mobilization   |
| Flood door closure and gate operation  | High water staking   |
| Reservoir operation—including coordinated operations, rule curve operations and encroachment, flash board installation, surcharging                                  |  |
| Recovery actions   |  |
| Reconstruction and repair of flood infrastructure  | Flood damage assessment—flood infrastructure surveys, system performance, damage, response costs |
|  | Flood insurance and reinsurance  |
|  | Reconstruction and repair  |
|  | Relocation/reconstruction to reduce future vulnerability   |



# Water Quality Management Portfolio

| <b>Multiple-barriers<br/>Infrastructure</b> | <b>Institutional<br/>Accountability</b> |
|---|---|
| Banned chemicals, activities                | Local water utility, elected boards     |
| Source protection                           | Public health agencies                  |
| Rivers, reservoirs                          | State regulators                        |
| Aquifers                                    | Federal regulators                      |
| Treatment                                   | Professional societies                  |
| Distribution system                         | Universities                            |
| Public health system                        | NGOs                                    |