

# Water and Drought in California

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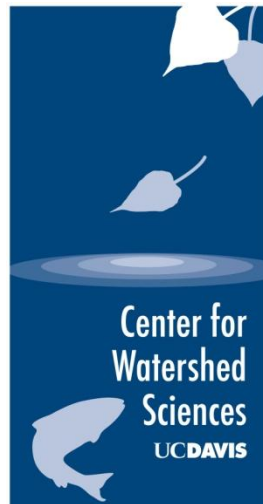
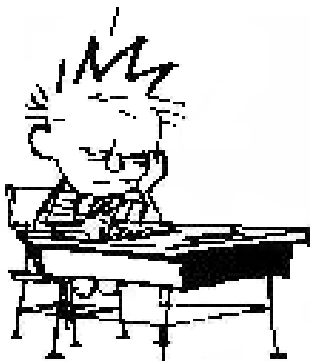
**University of California, Davis**

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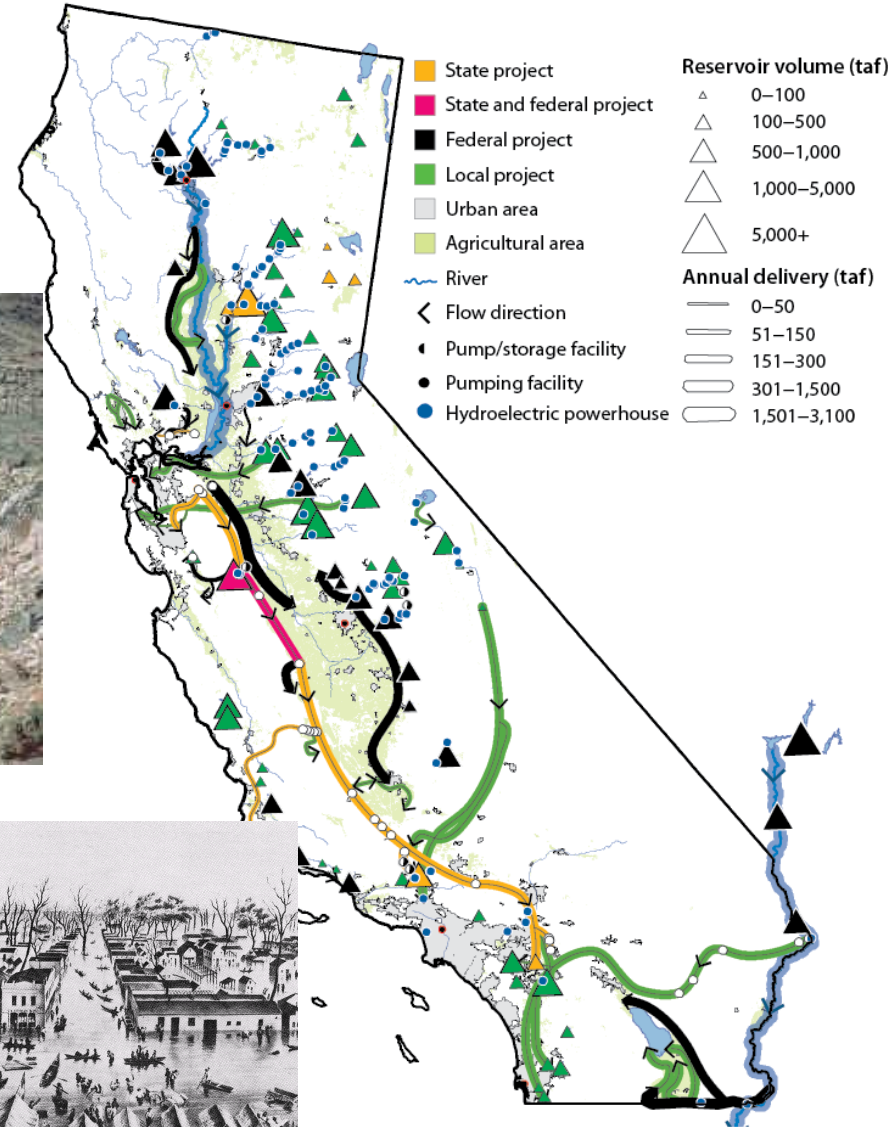
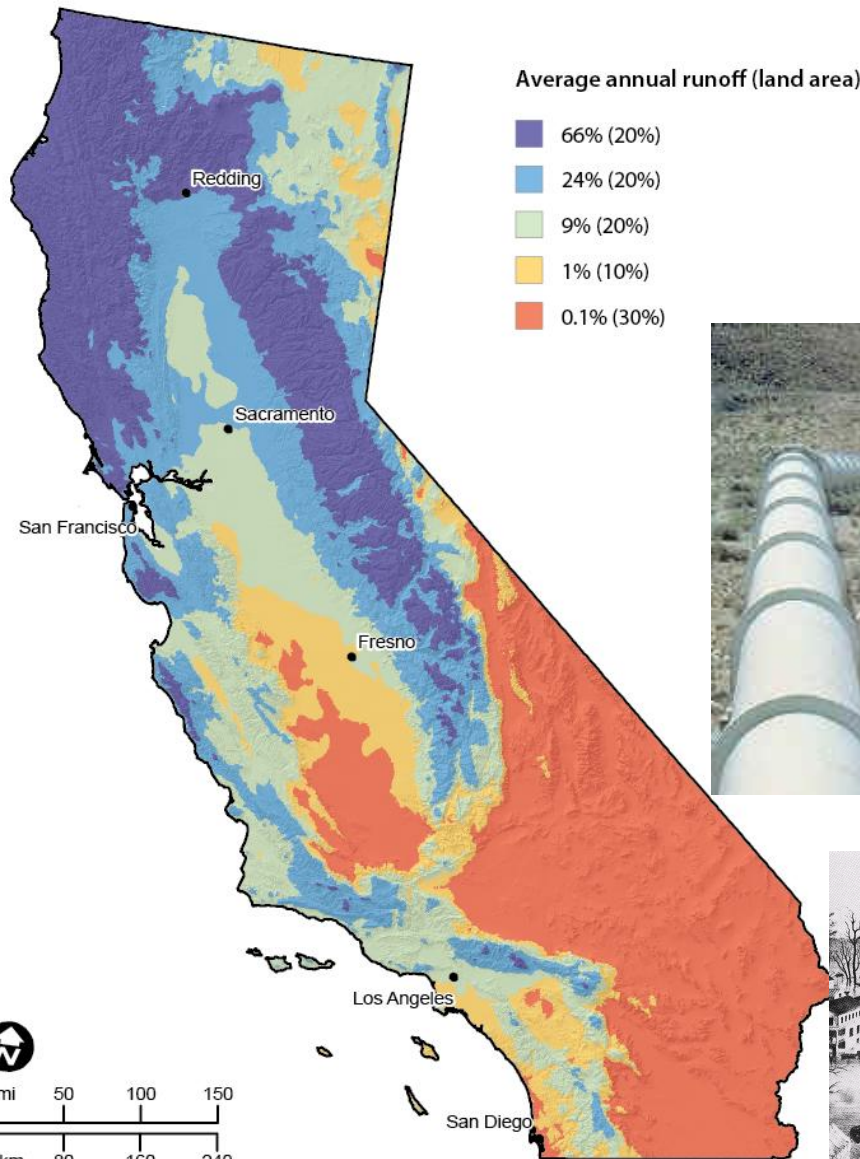
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[CaliforniaWaterBlog.com](http://CaliforniaWaterBlog.com)

NOBODY LIKES US  
"BIG PICTURE"  
PEOPLE

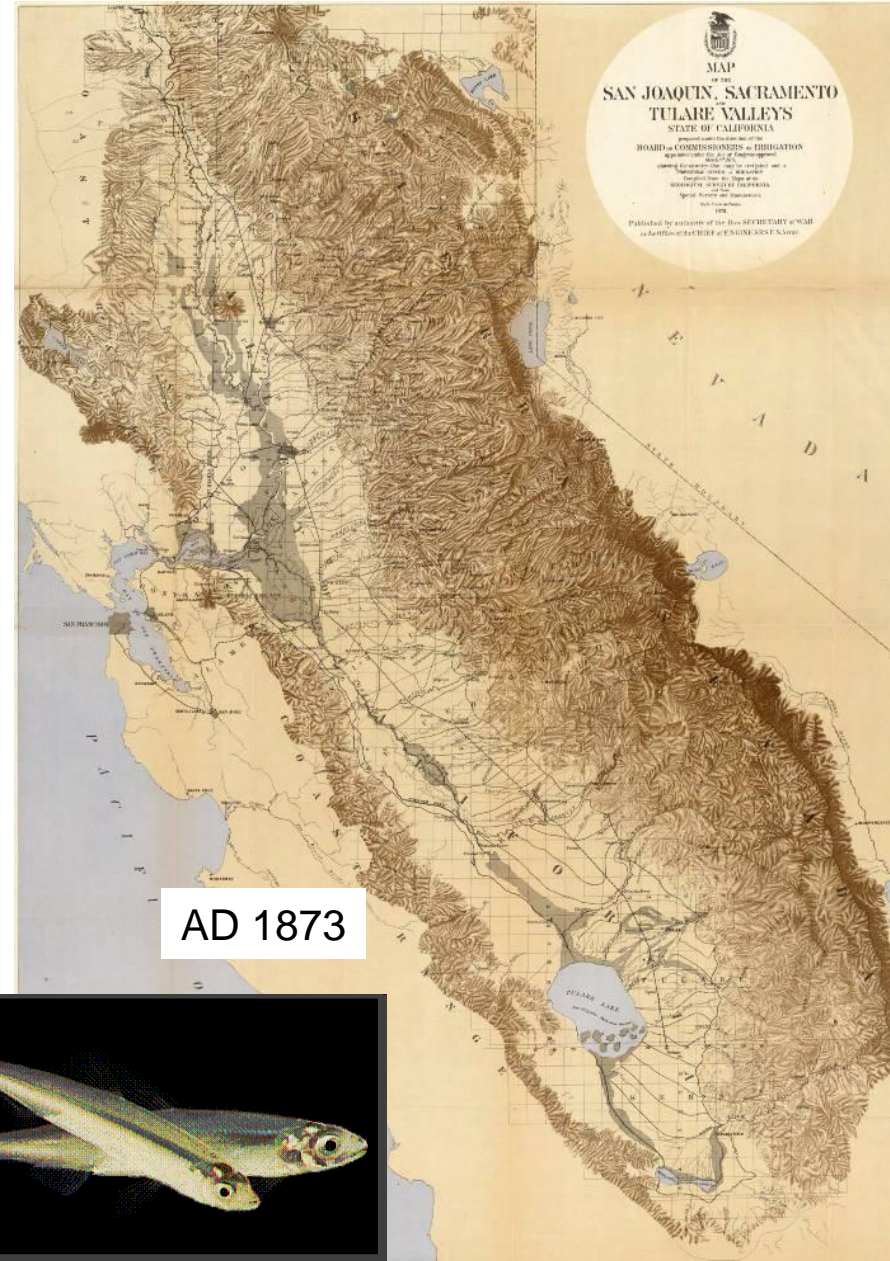
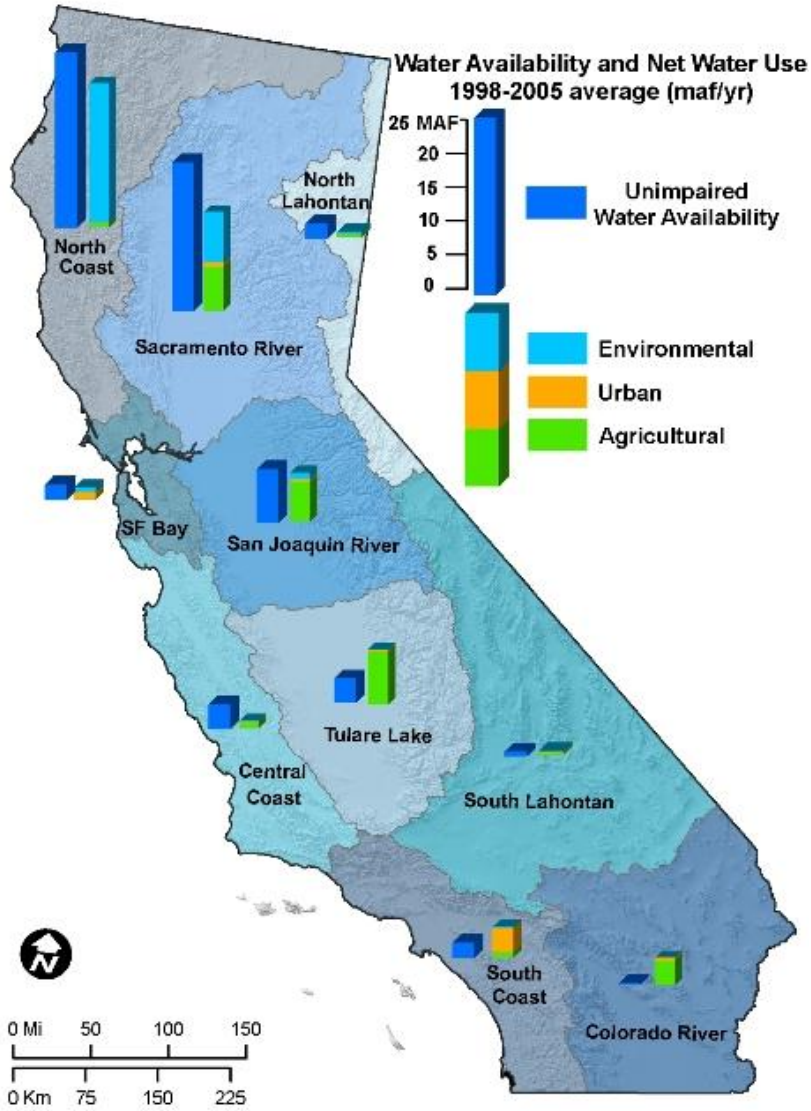


# Mostly dry, but many demands



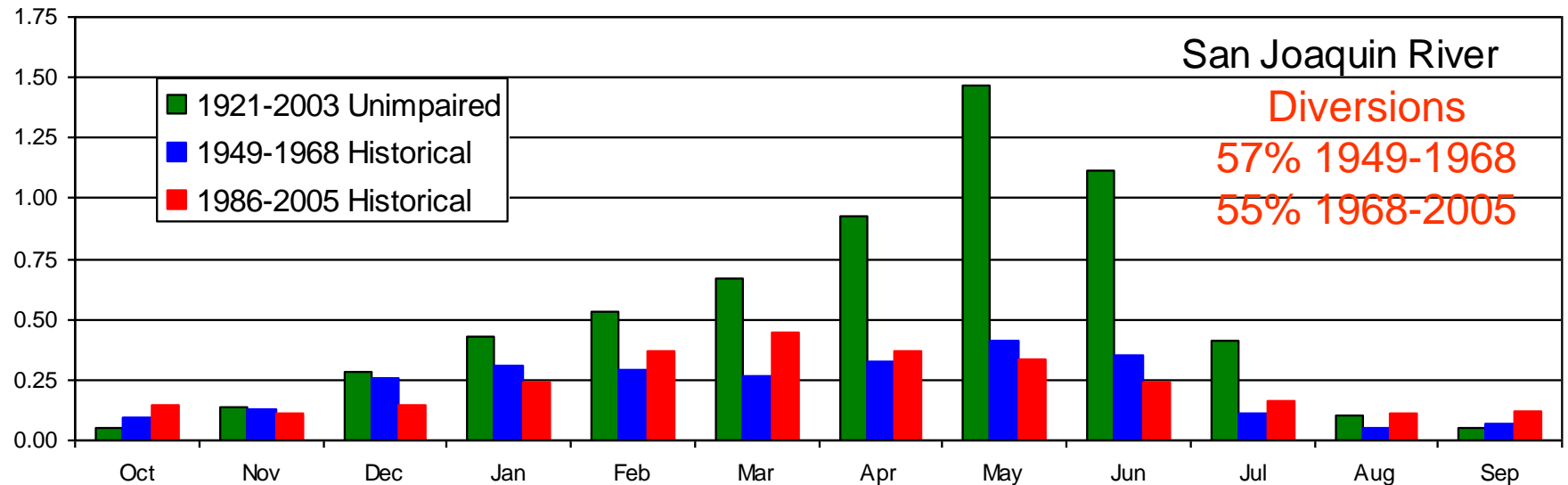
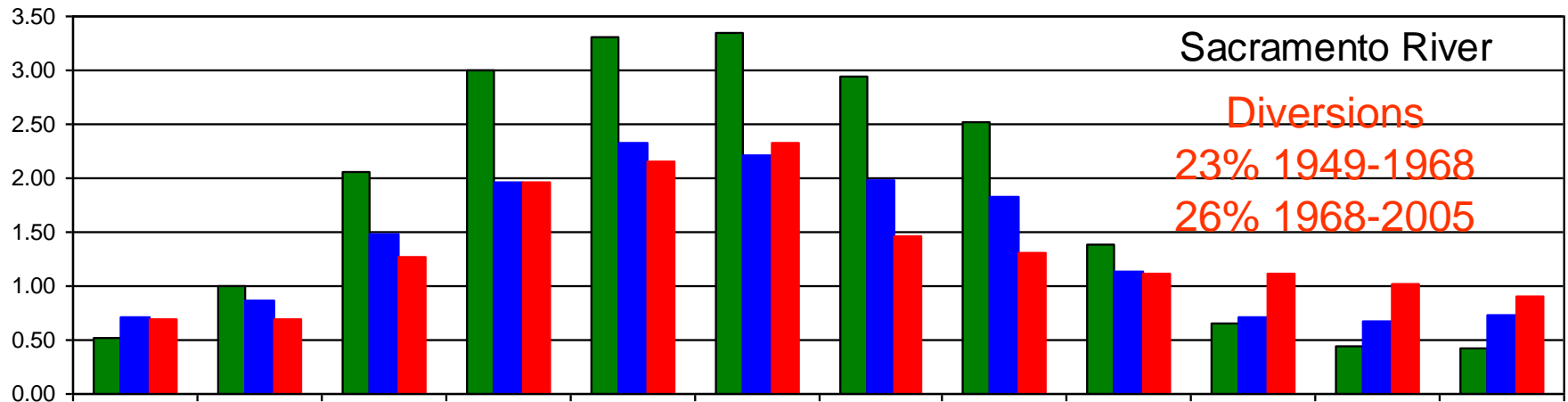


# Water use has changed California



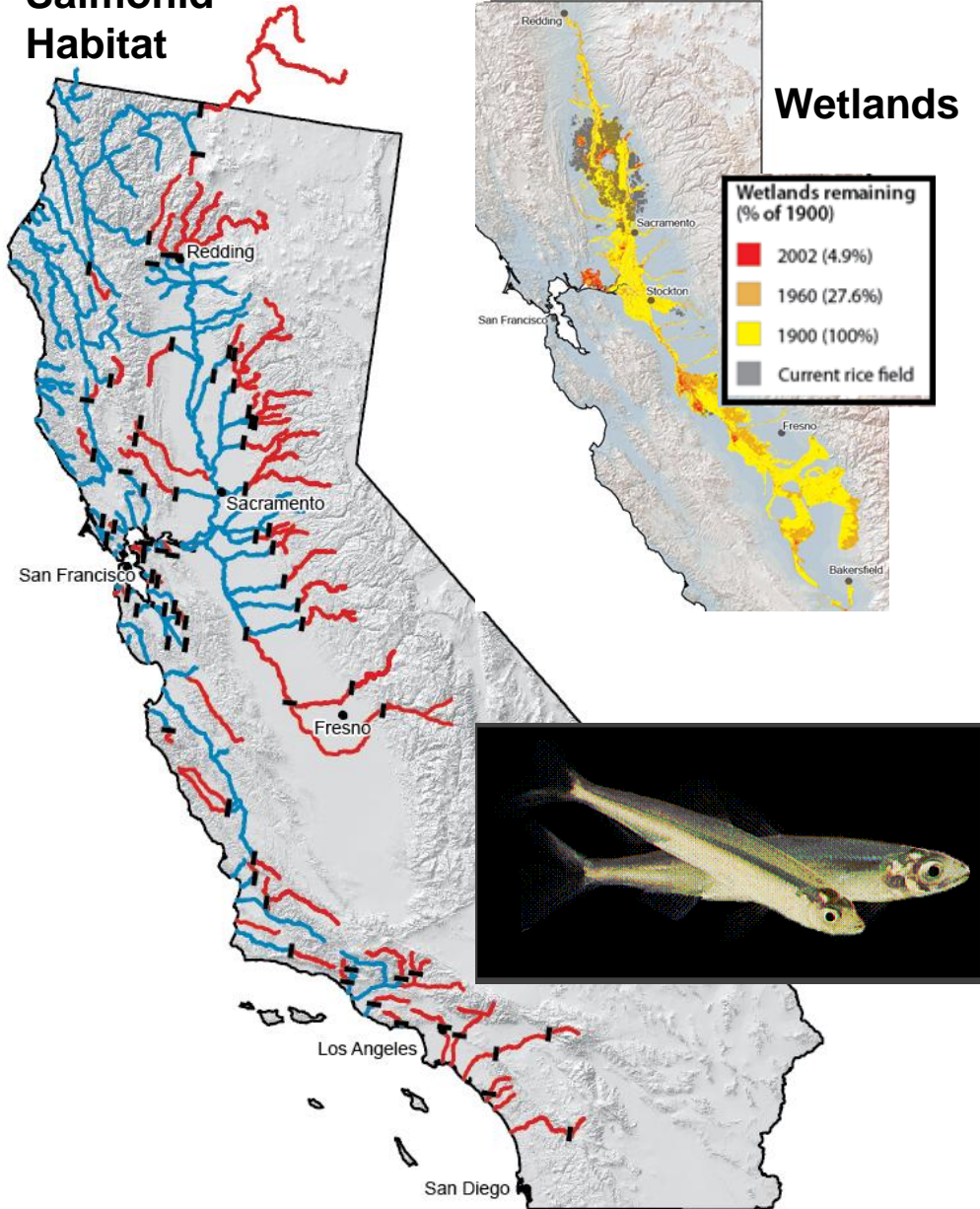
# Major Inflows to Delta (maf/month)

(mean annual flows, 1 maf = 1.23 bcm)

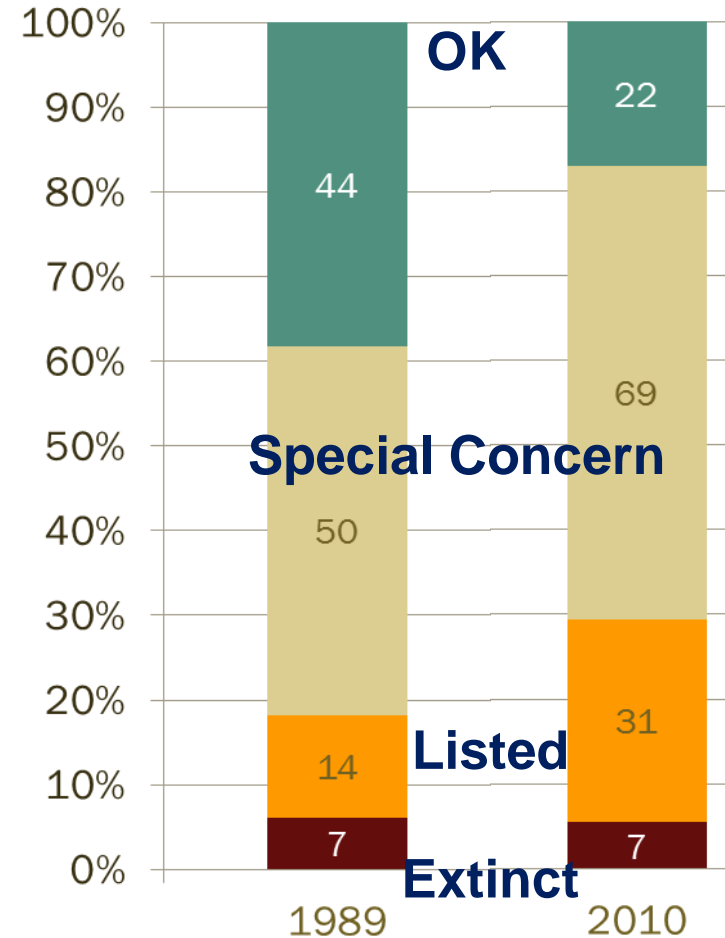


# Native Habitat and Fishes

## Salmonid Habitat

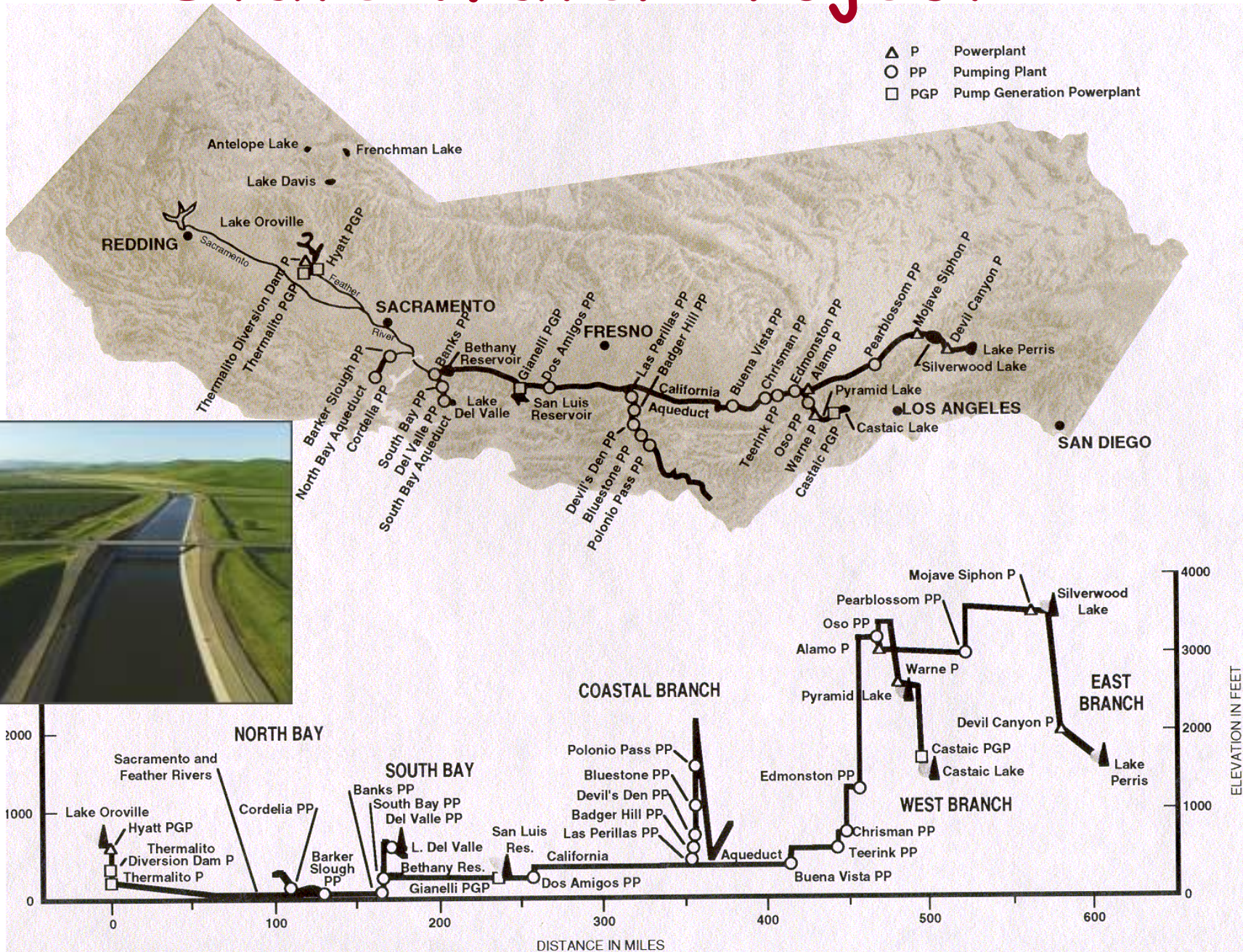


## California's freshwater fishes are losing



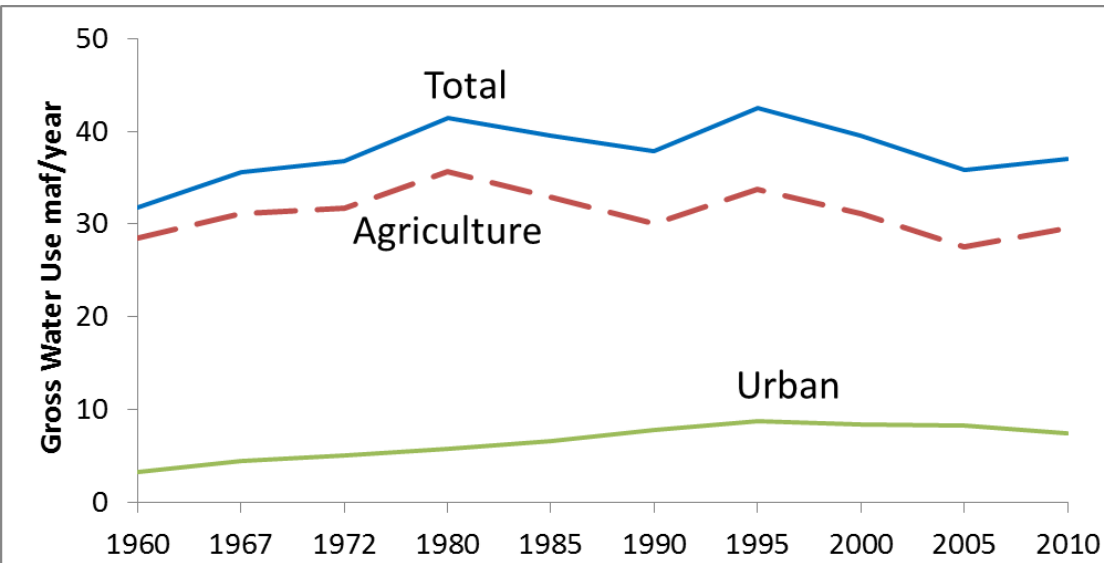


# State Water Project

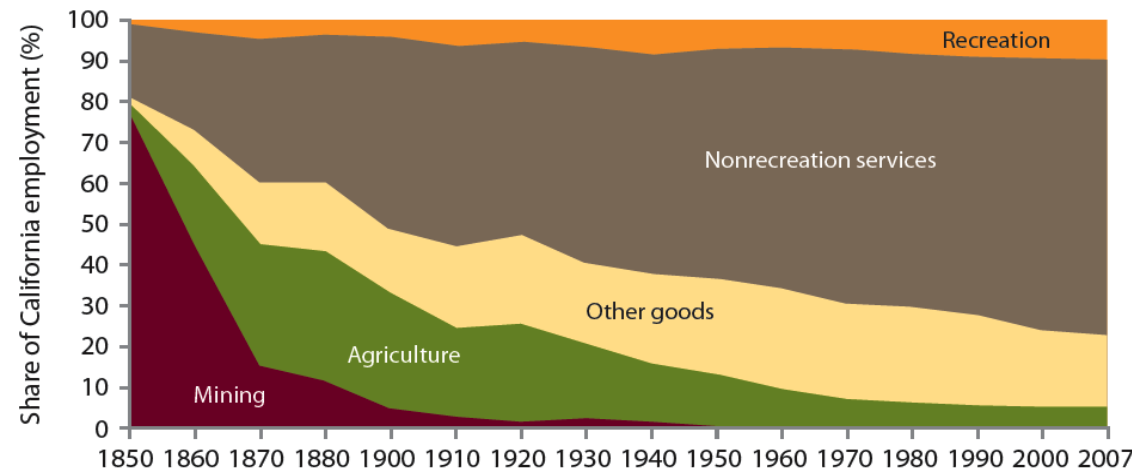




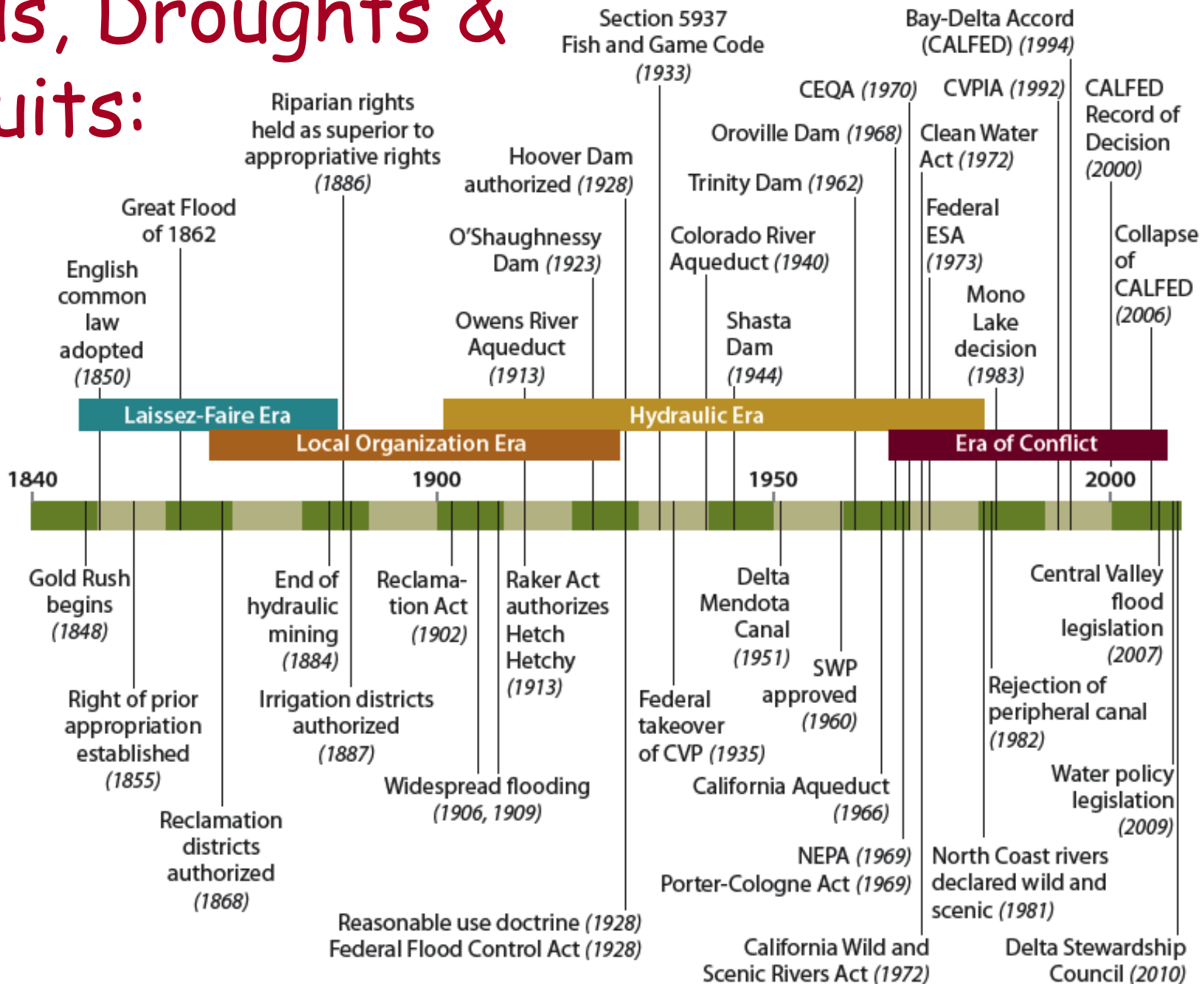
# Changing Problems and Reasons for Hope



- 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



# Floods, Droughts & Lawsuits:

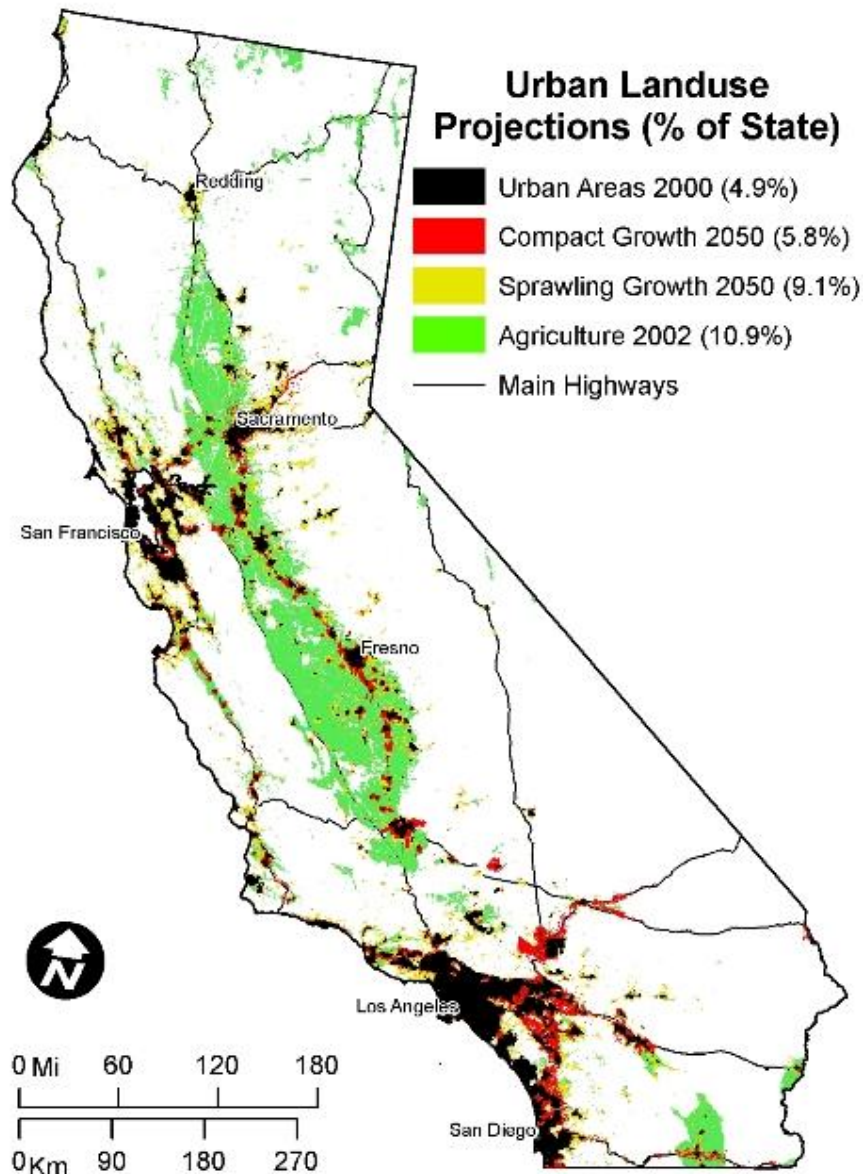




# Water Rights in California - a bit

1. Riparian water rights – English Common Law – riparian land - shared shortages
2. Appropriative water rights – “first in time, first in right” - “use it or lose it”
3. Post-1914 Appropriative Rights – like before, but registered with State
4. Groundwater rights – nominally correlative with land ownership, little enforced
5. Water contracts – contract law
6. Environmental regulations – ESA, CWA, <sup>9</sup>...

# Agriculture in California



- 1) 400+ crops
- 2) \$45 billion/year sales
- 3) Most agricultural value of any US state
- 4) 4 million irrigated hectares
- 5) 40 BCM water use/yr (80% human use)
- 6) <4% of labor force and state GDP



# Agriculture in California

<b>Crop</b>	<b>Irrigated Crop Area (1000 hectares)</b>	<b>Applied Water (MCM)</b>	<b>Application rate (m)</b>
Alfalfa	443	7,356	1.7
Almonds, Pistachios*	416	5,174	1.2
Vine*	365	2,413	0.7
Vegetables (“truck”)	354	1,965	0.6
Corn	345	3,329	1.0
Pasture	328	4,558	1.4
Grain	288	1,649	0.6
Orchards*	270	3,314	1.2
Field (other)	270	2,407	0.9
Rice	230	3,478	1.5
Subtropical*	185	2,013	1.1
Processing Tomato	121	1,047	0.9
Cotton	111	1,117	1.0
Safflower	46	291	0.6
Cucurbits	39	259	0.7
Onion Garlic	31	305	1.0
Dry Bean	30	230	0.8
Tomato (fresh)	15	109	0.7
Potato	15	119	0.8
Sugar Beet	15	201	1.4
<b>Grand Total</b>	<b>3915</b>	<b>41,331</b>	<b>1.1</b>

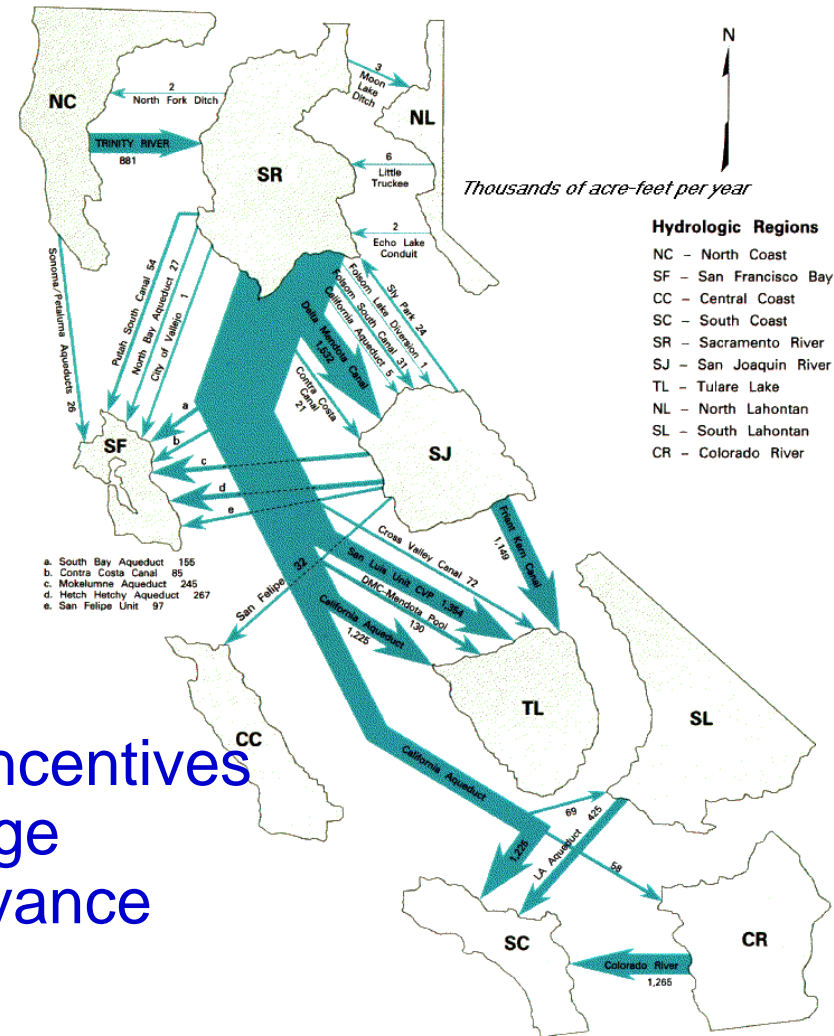
# Local and Statewide Activities

## 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

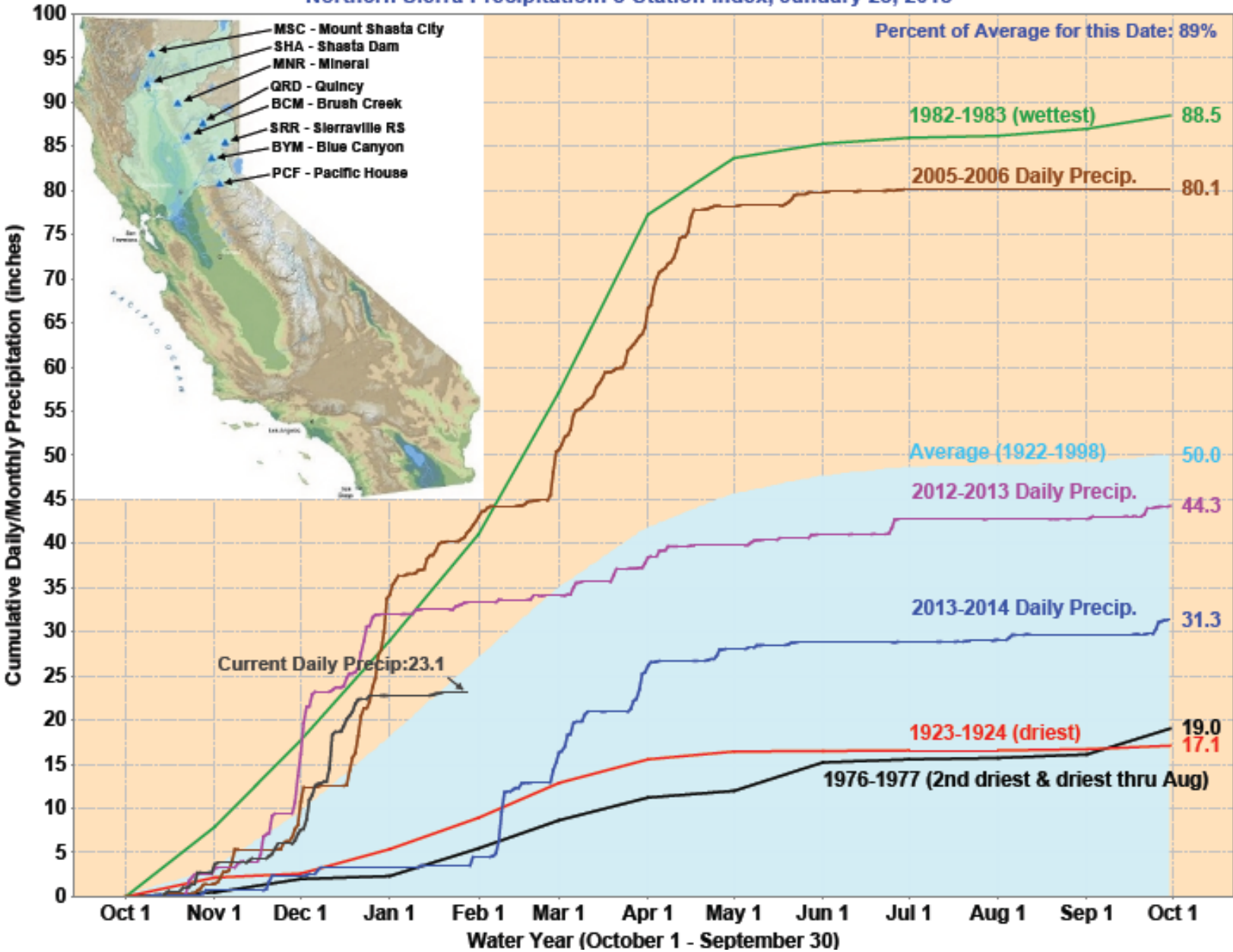


Integrating mix of actions – portfolio planning.



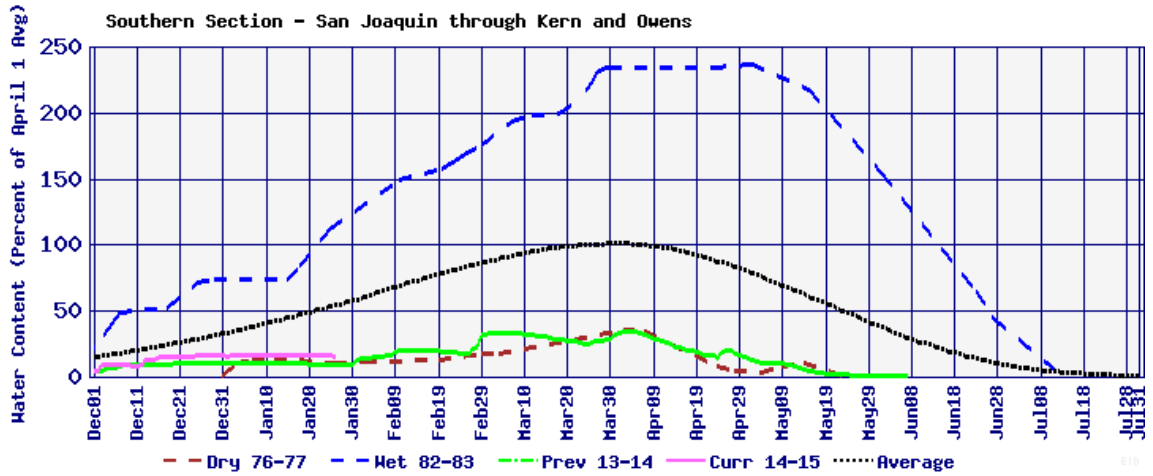
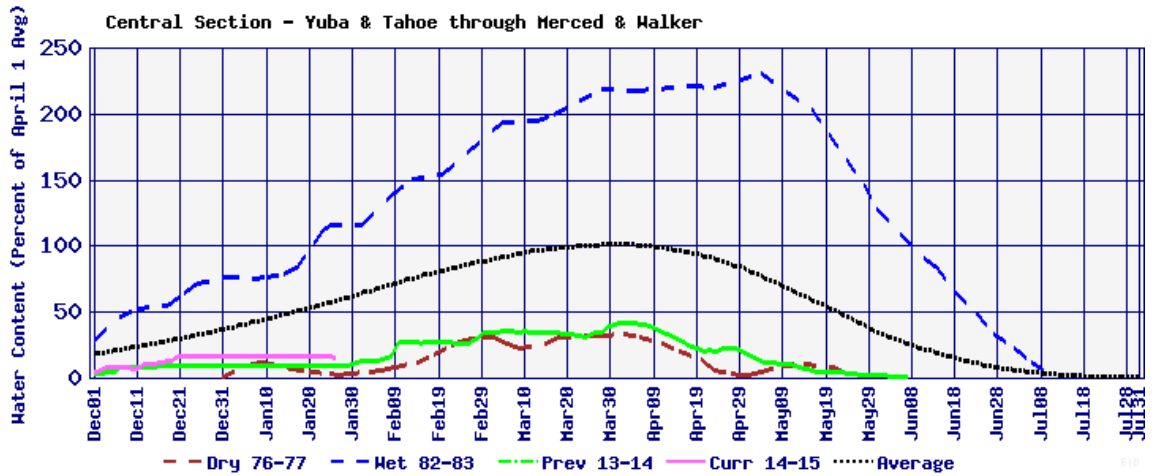
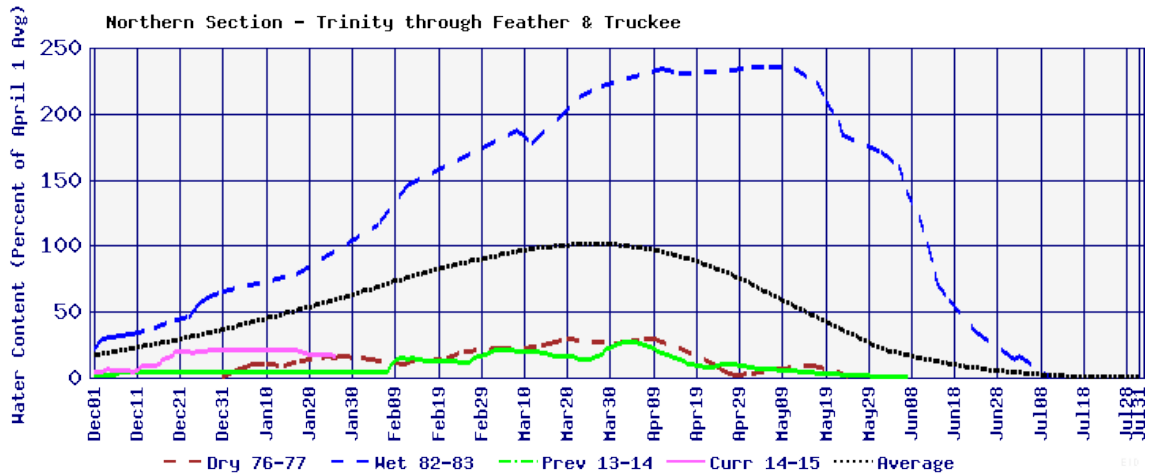
# Sac. Valley Precipitation index

Northern Sierra Precipitation: 8-Station Index, January 28, 2015



2014:  
8<sup>th</sup> driest  
in 106  
years

Snowpack -  
Jan 26, 2015:  
 Trinity/  
 Feather/  
 Truckee.  
 Yuba-Tahoe-  
 Merced-  
 Walker.  
 San Joaquin-  
 Kern-Owens.





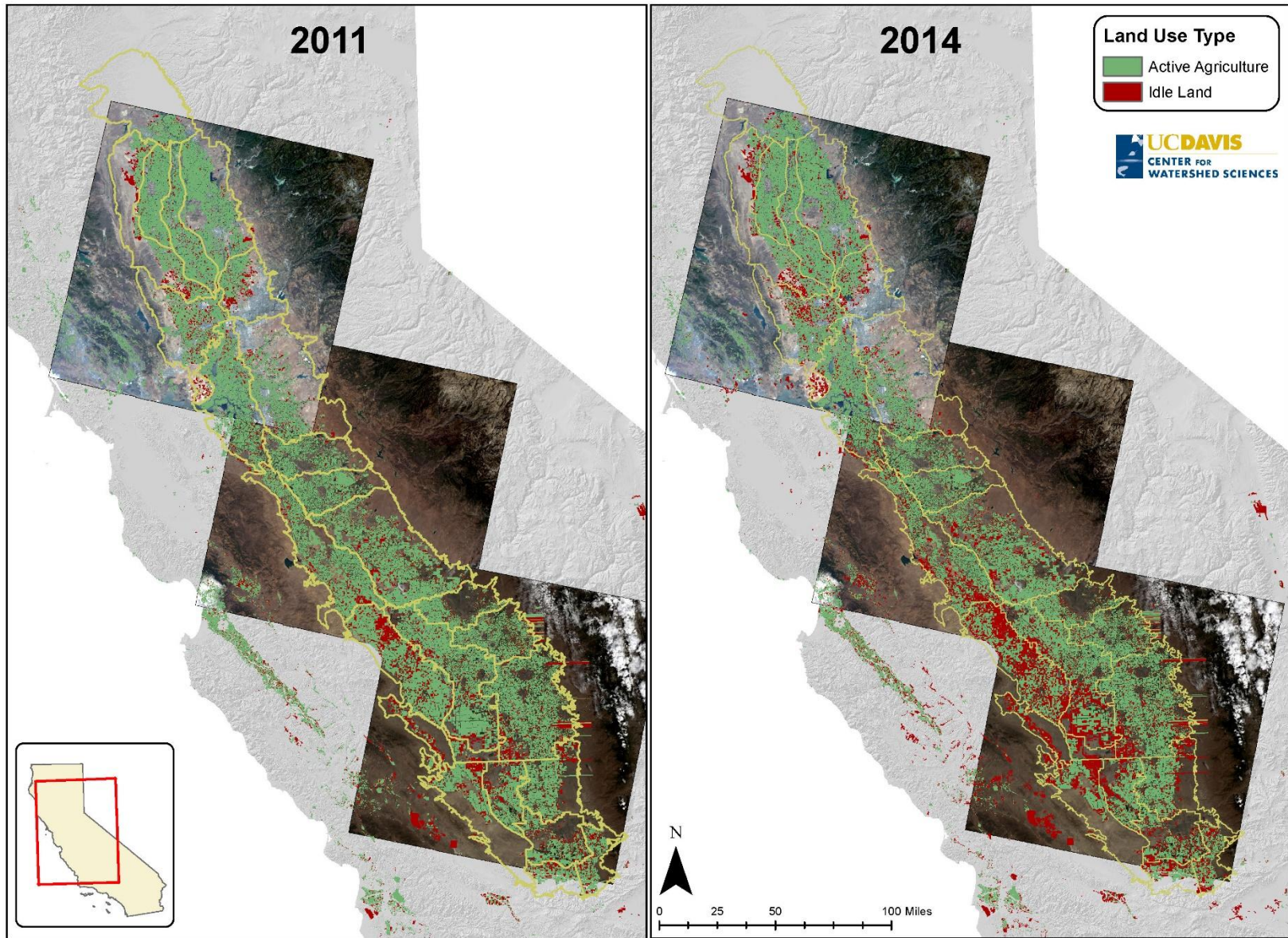
# Droughts test water systems!

1. Water systems and the societies they serve are always changing.
2. Droughts bring attention to needs for change
3. This drought is helping California improve water management
4. Every generation needs at least a threatening drought, and a threatening flood

# 2014 Impact Summary of Drought Impacts

<b>Impact</b>	<b>Quantity</b>
<b>Water supply, 2014 drought</b>	
Surface water reduction	6.6 million acre-feet
Groundwater pumping increase	5 million acre-feet
Net water shortage	1.6 million acre-feet
<b>Statewide Economic Impacts</b>	
Crop revenue loss	\$810 million
Additional pumping cost	\$454 million
Livestock and dairy revenue loss	\$203 million
Total direct costs	\$1.5 billion
<b>Total economic costs</b>	<b>\$2.2 billion</b>
<b>Total job losses</b>	<b>17,100</b>

# NASA Summer Idle Land Estimates Early August



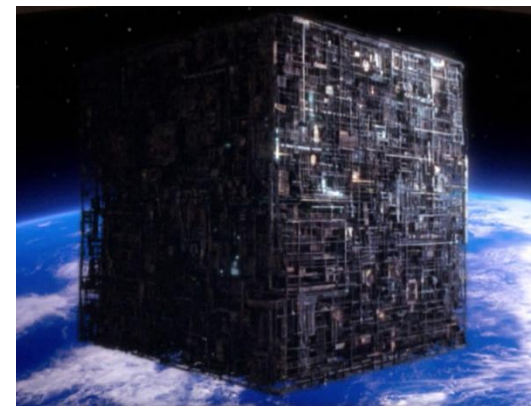


# Lessons for water policy

- Droughts are inevitable in California
- Portfolio approach
- Groundwater
- Water markets
- Need for state agencies to work better together
- Information
  - Better water accounting and water use data, made more available with better modeling
  - Potential of remote sensing estimates
  - Retrospective assessment of drought



# Changes for Agriculture



- 1) More permanent & high value crops
- 2) More environmental flows
- 3) Tighter groundwater management
  - a) More wet-year recharge (field and artificial recharge)
  - b) More reliable wells and drought supplies
- 4) Nitrate groundwater contamination is inevitable
- 5) Some land lost to salinization and Delta flooding
- 6) Less landscape ET:
  - a) Longer fallowing rotations and more permanent fallowing
  - b) More habitat
- 7) Irrigation efficiency? Recharge vs. NO<sub>3</sub> and salts

# Today's Challenges

1) Limits of traditional management

2) Major problems

- Native species and their habitats (esp. wetlands)
- Reconciling for permanent scarcity – esp. for agriculture
- Groundwater – depletion, degradation, rights
- Weak state and federal governments

3) Modernizing statewide system

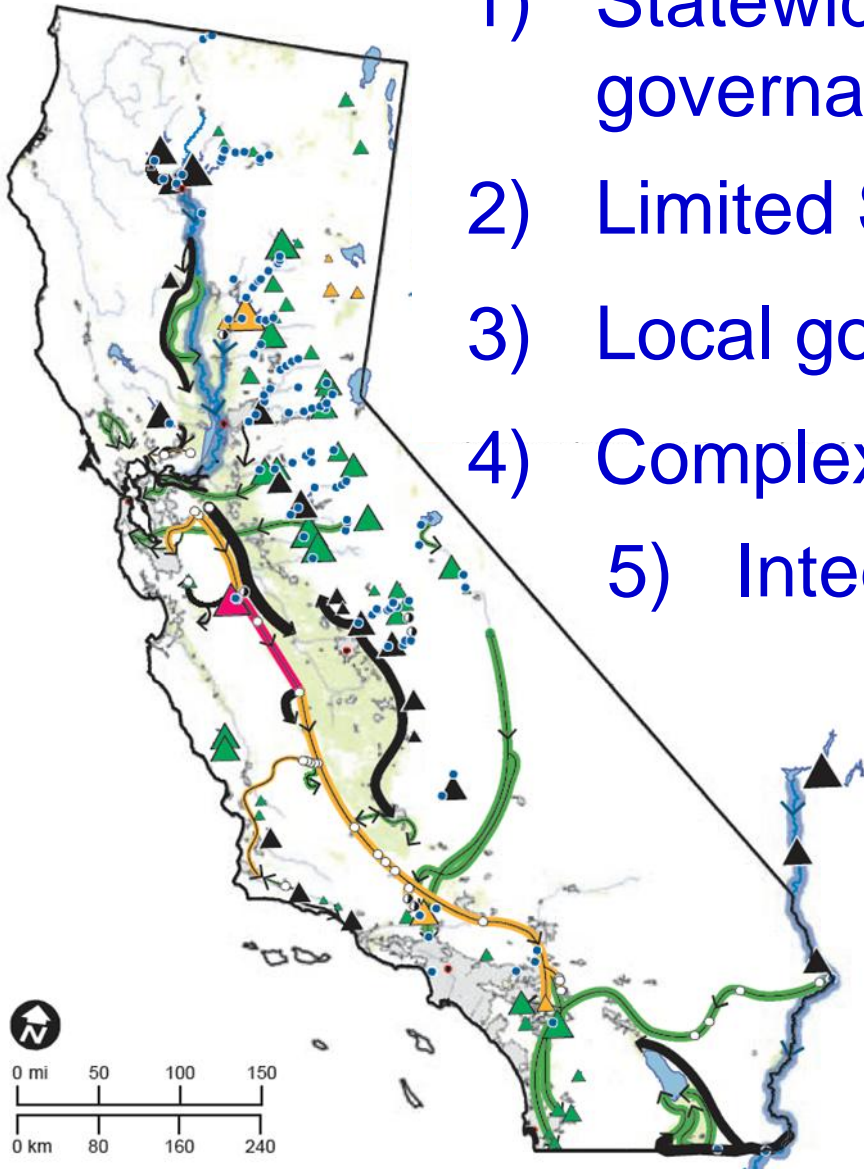
- Serving many goals (conflict and mutual need)
- Rebuilding or abandoning the Delta
- Locally-driven portfolios in a statewide system
- Challenges for state government and regulation



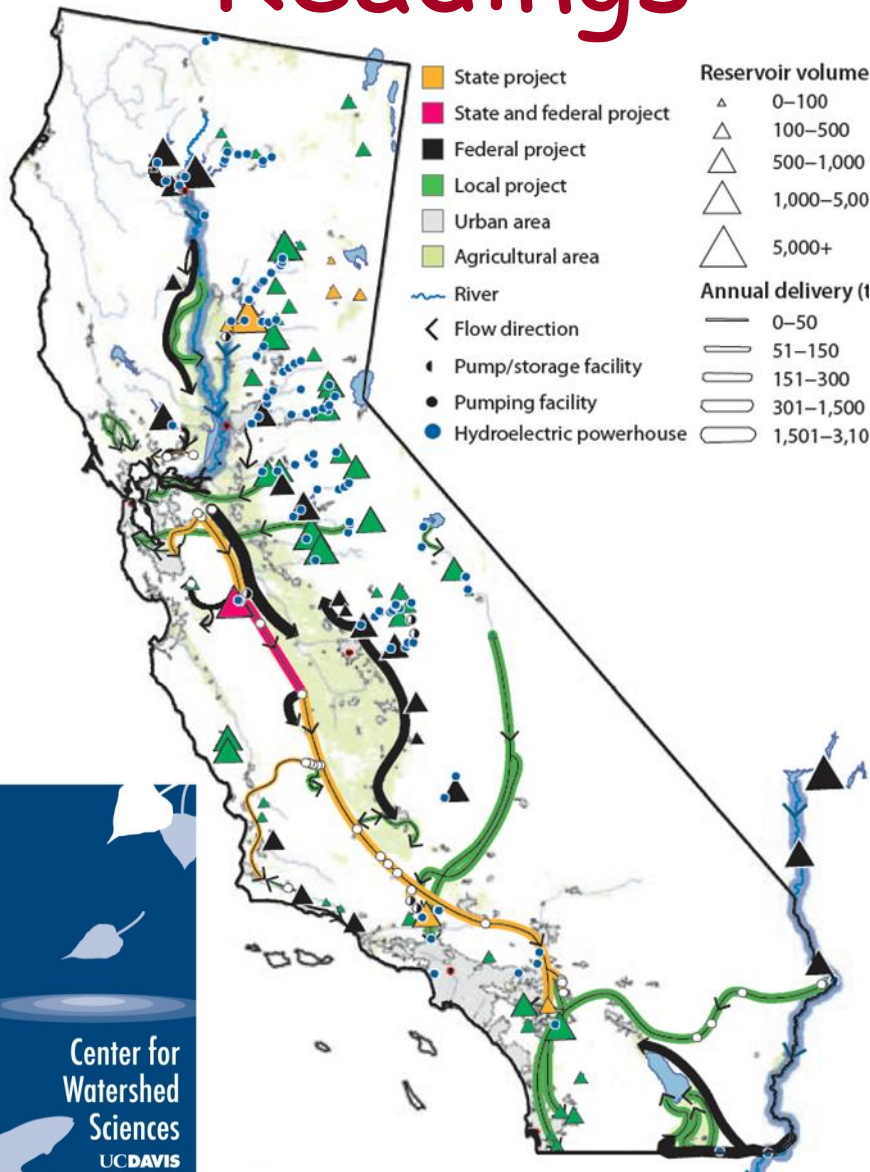


# Conclusions

- 1) Statewide water system, with local governance and fragmented regulation
- 2) Limited State and Federal abilities
- 3) Local government is most important
- 4) Complexity enriches possibilities
- 5) Integrated portfolios are the future
- 6) Nature and economics eventually prevail over indecision and existing law
- 7) Droughts remind us to change, and prepare.



# Suggested Readings



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

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

Hundley (1992), *The Great Thirst*, UC Press.

Kelley (1989), *Battling the Inland Sea*, UC Press.

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

Pisani (1983), *From Family Farms to Agribusiness*, UC Press

Mavensnotebook.com

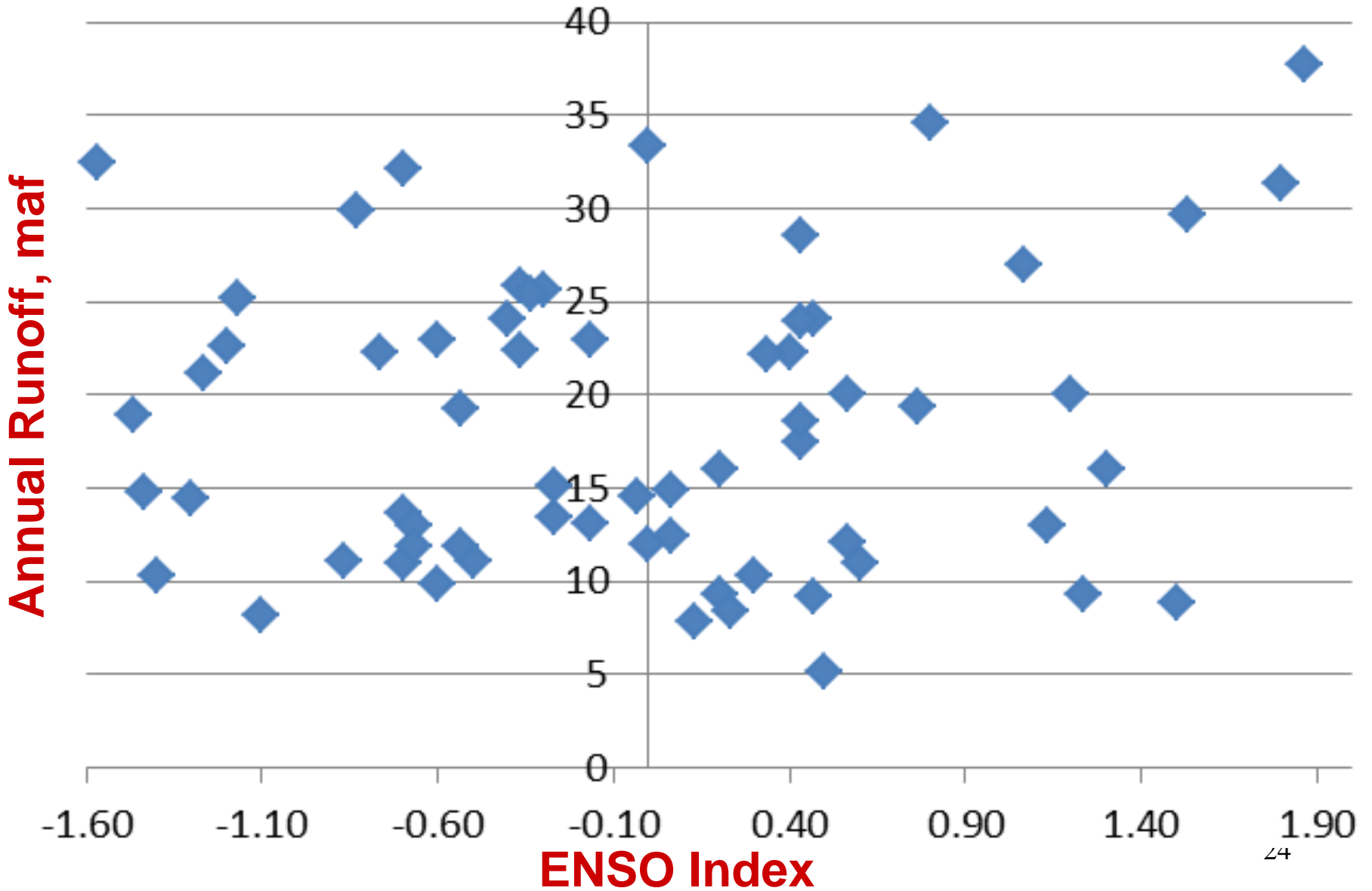
CaliforniaWaterBlog.com

# Will next year be dry? (from historical data, 1906-2013)

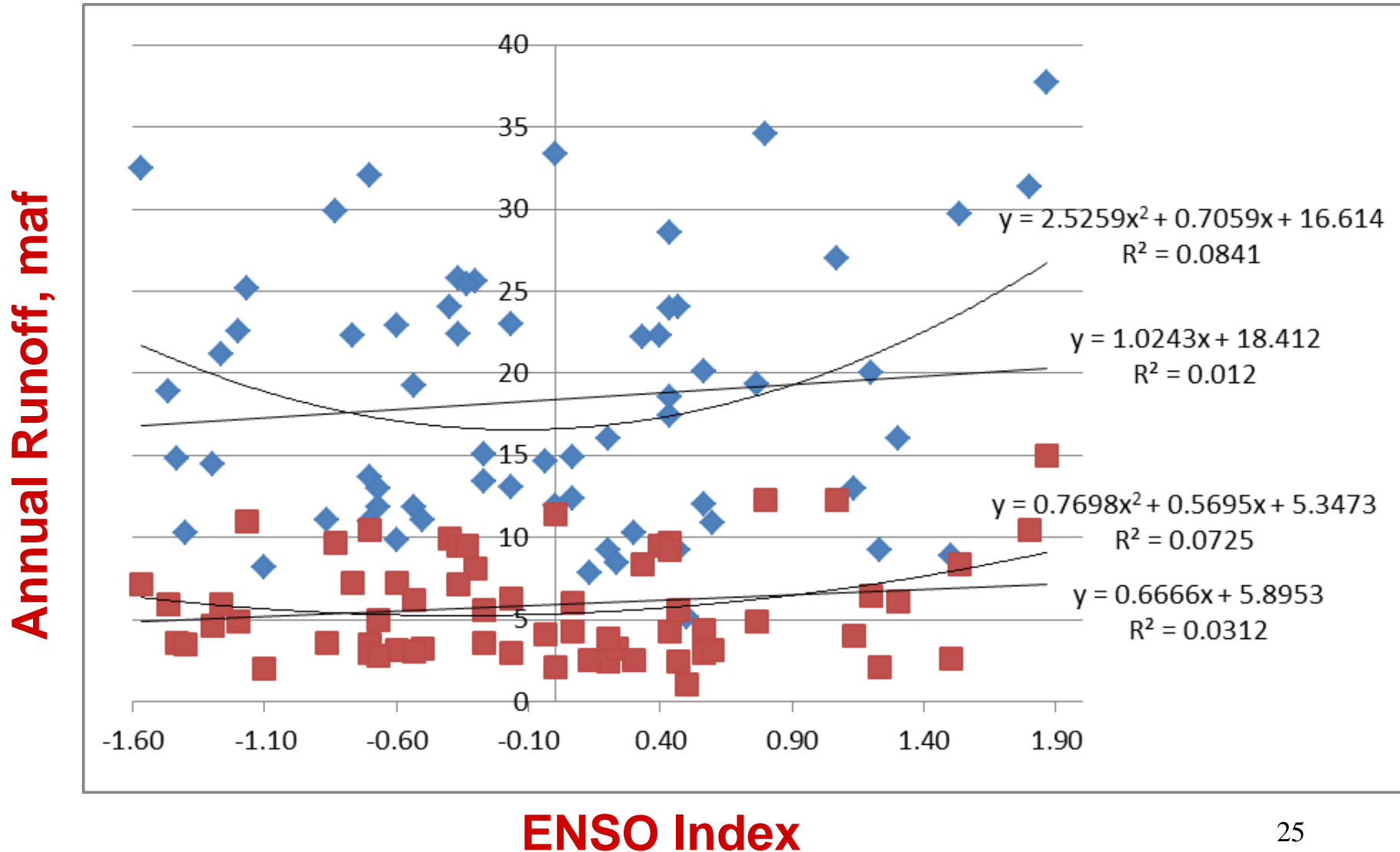
	<u>Probability next year</u>			
	<u>Sacramento Valley</u>		<u>San Joaquin Valley</u>	
<u>Next Year</u>	<u>Historical</u>	<u>Critical now</u>	<u>Historical</u>	<u>Critical now</u>
Critical	0.13	0.29	0.18	0.55
Dry	0.21	0.35	0.14	0
Below Normal	0.18	0.07	0.16	0.15
C,D	0.34	0.64	0.32	0.55
C,D, BN	0.52	0.71	0.48	0.7
AN, W	0.48	0.29	0.52	0.3



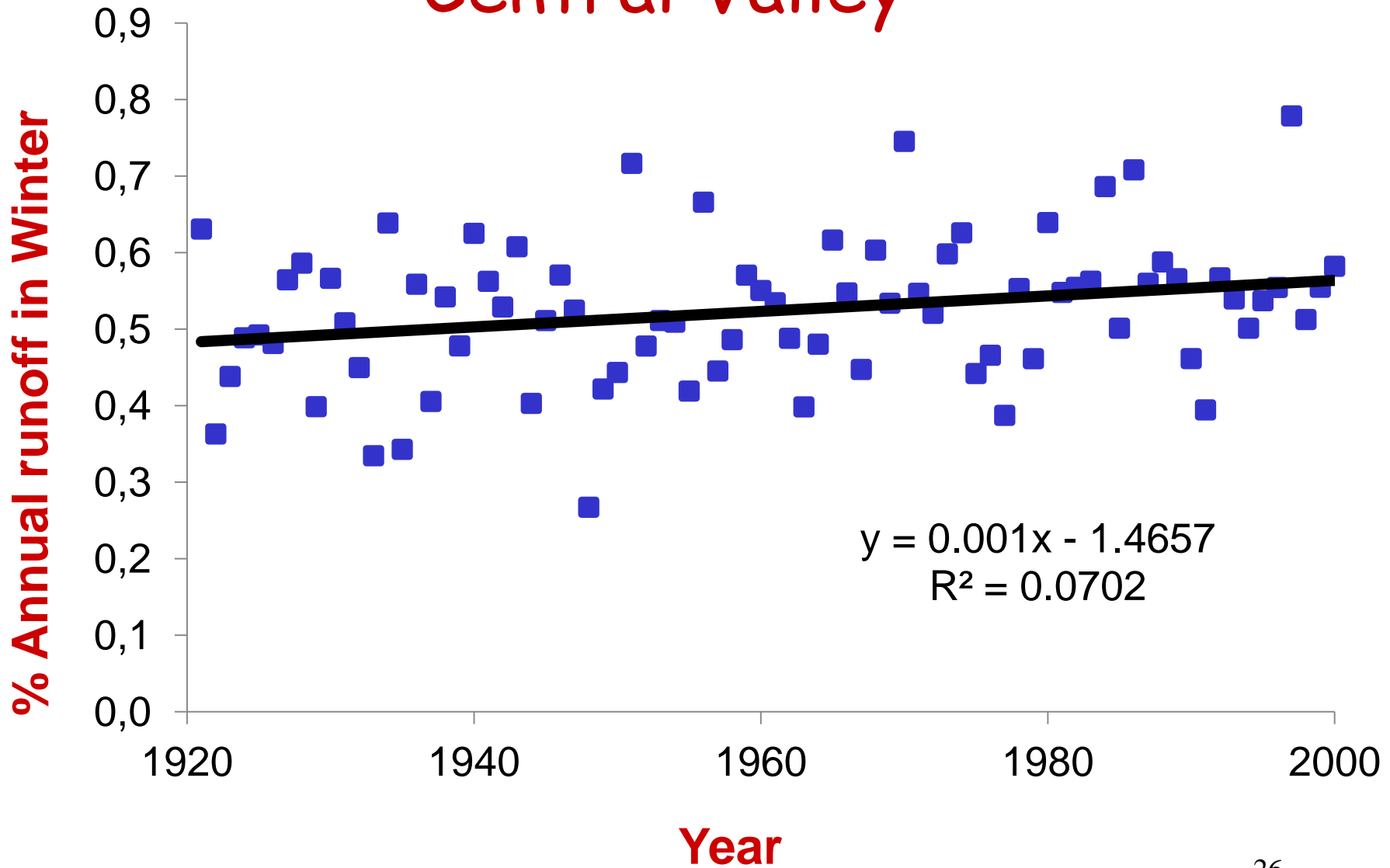
# Streamflow and El Nino (maf)



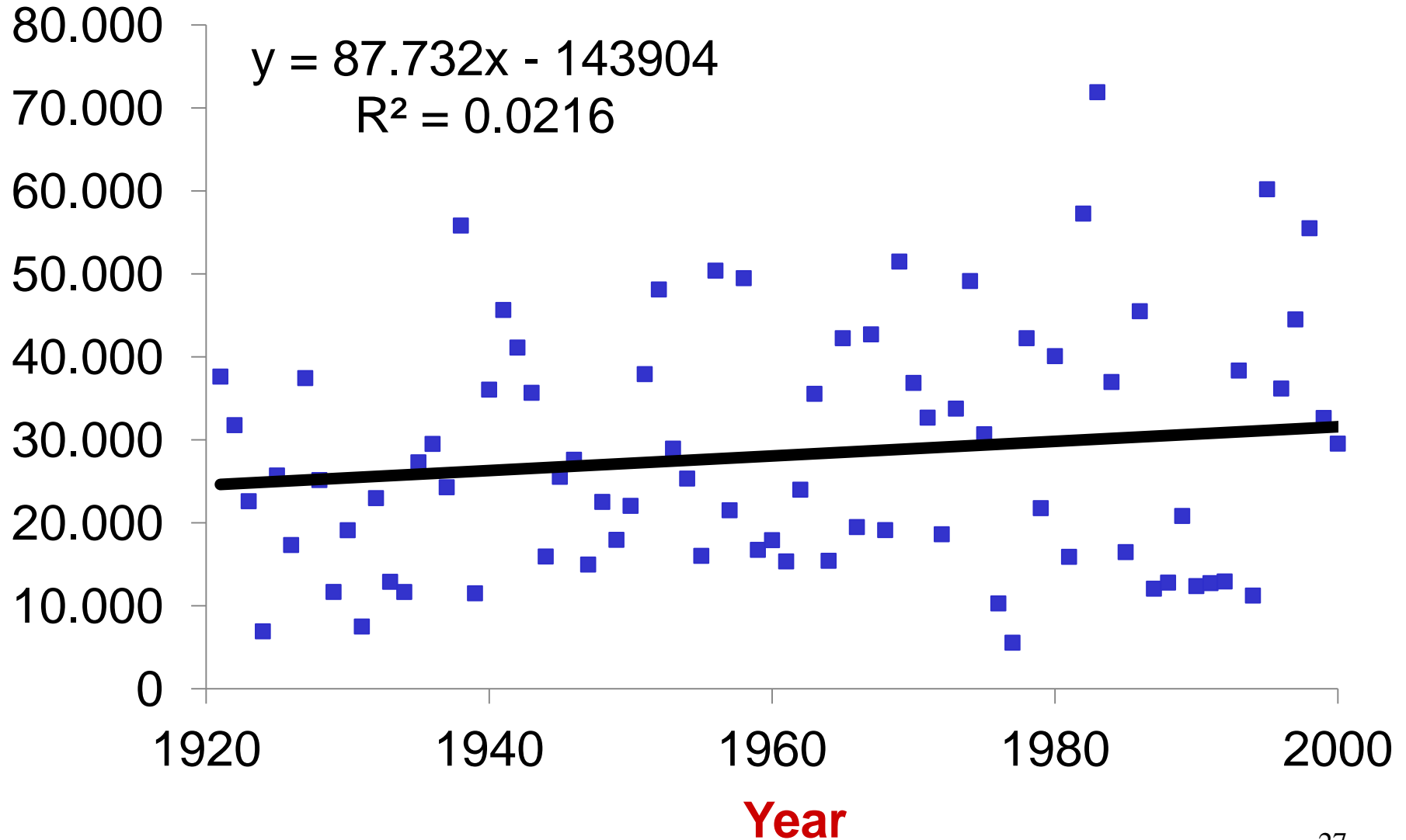
# El Nino and drought



# Nov.-March Runoff as Percent of Annual, Central Valley

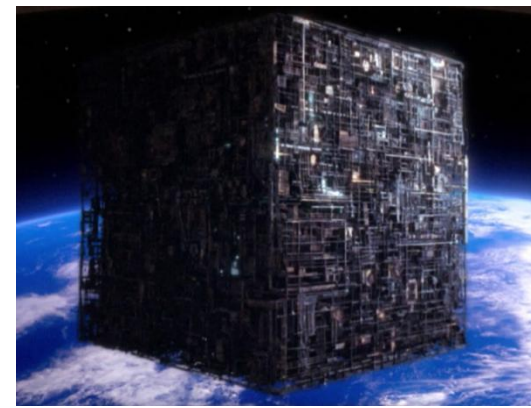


# Annual Runoff of Central Valley, taf





# 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 become more tightly managed
- 10) The Salton Sink will be largely restored

We cannot drought-proof, but we can manage better.<sup>28</sup>

# Mostly dry, but many demands

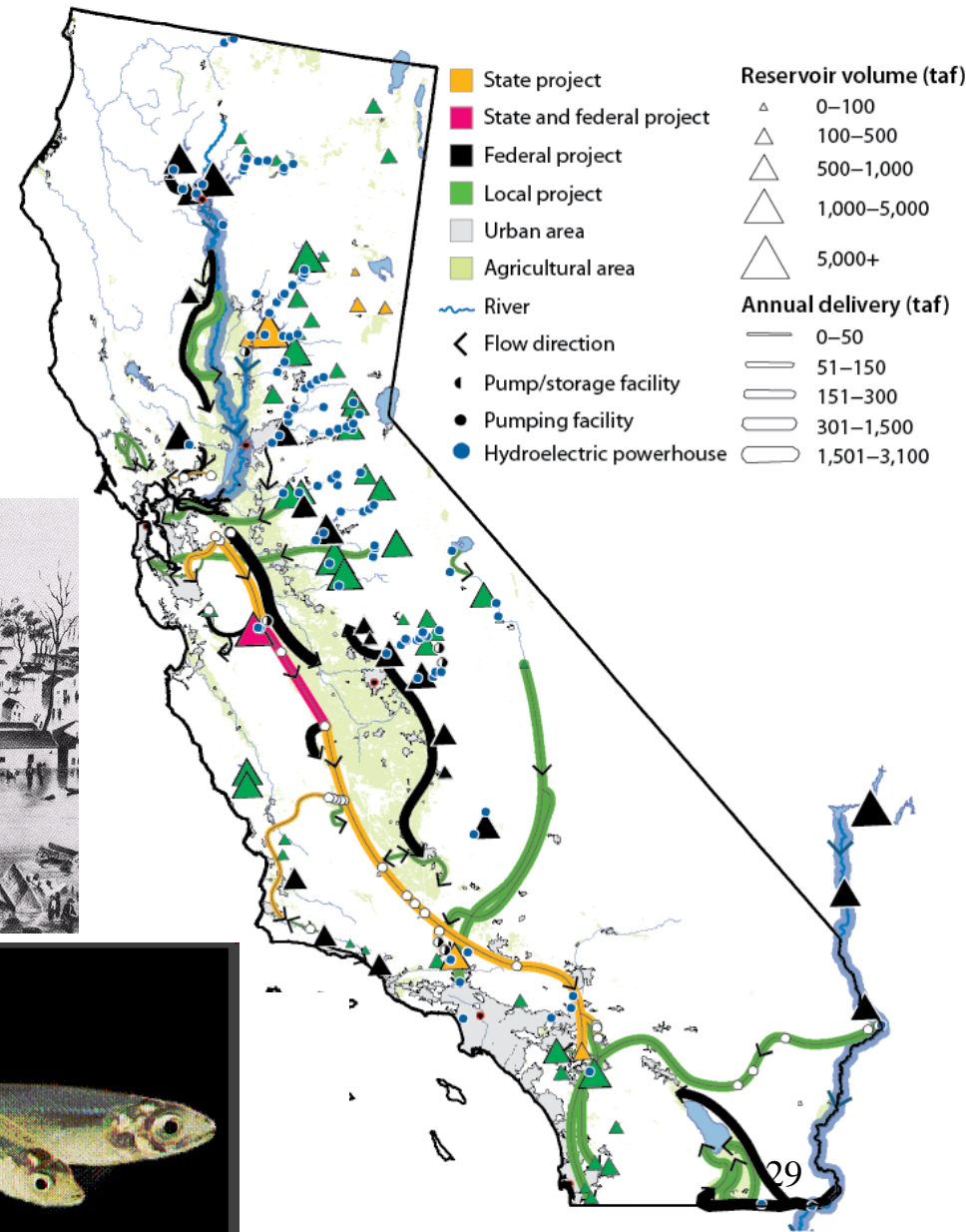
Water supplies

Floods

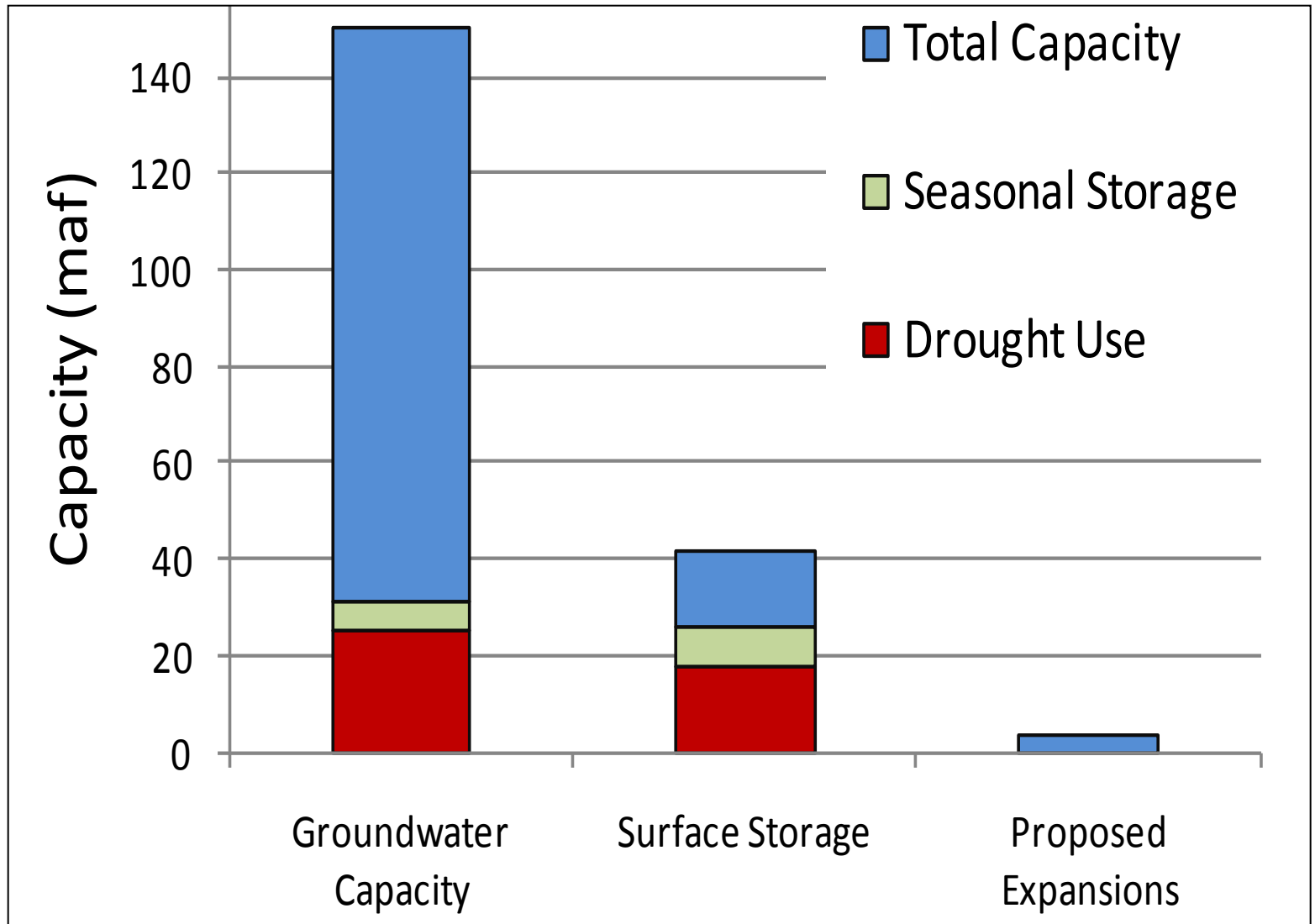
Environmental habitat

Hydropower

Recreation



# Water Storage Capacity and Uses in California



# Water for S. Central Valley

## 1) Outflows

- Total consumptive water use (ET) about 15.3 maf/yr  
Mostly for 5 million acres of irrigated agriculture
- San Joaquin R. outflow average 2.7 maf/year (increasing)

## 2) Supplies

- About 13 maf/year in local inflows (climate change?)
- About 4 maf/year of Delta imports (decreasing)
- 1-2 maf/year in groundwater overdraft (decreasing)

## 3) Difference

- About 2 – 4 maf/year, ~ 1+ million acres
- Some acres retire due to salinity anyway
- Most retire due to water scarcity
- Likely growing profitability anyway

