

Water Storage in California



NOBODY LIKES US
"BIG PICTURE"
PEOPLE



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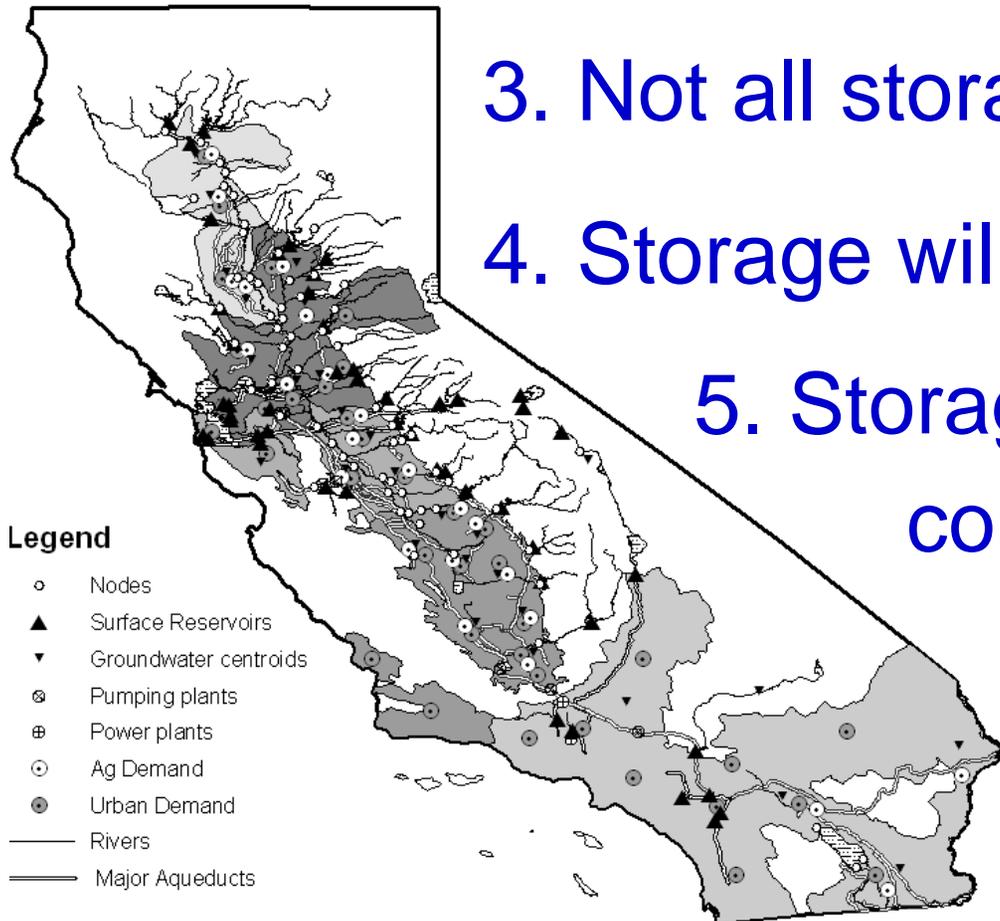
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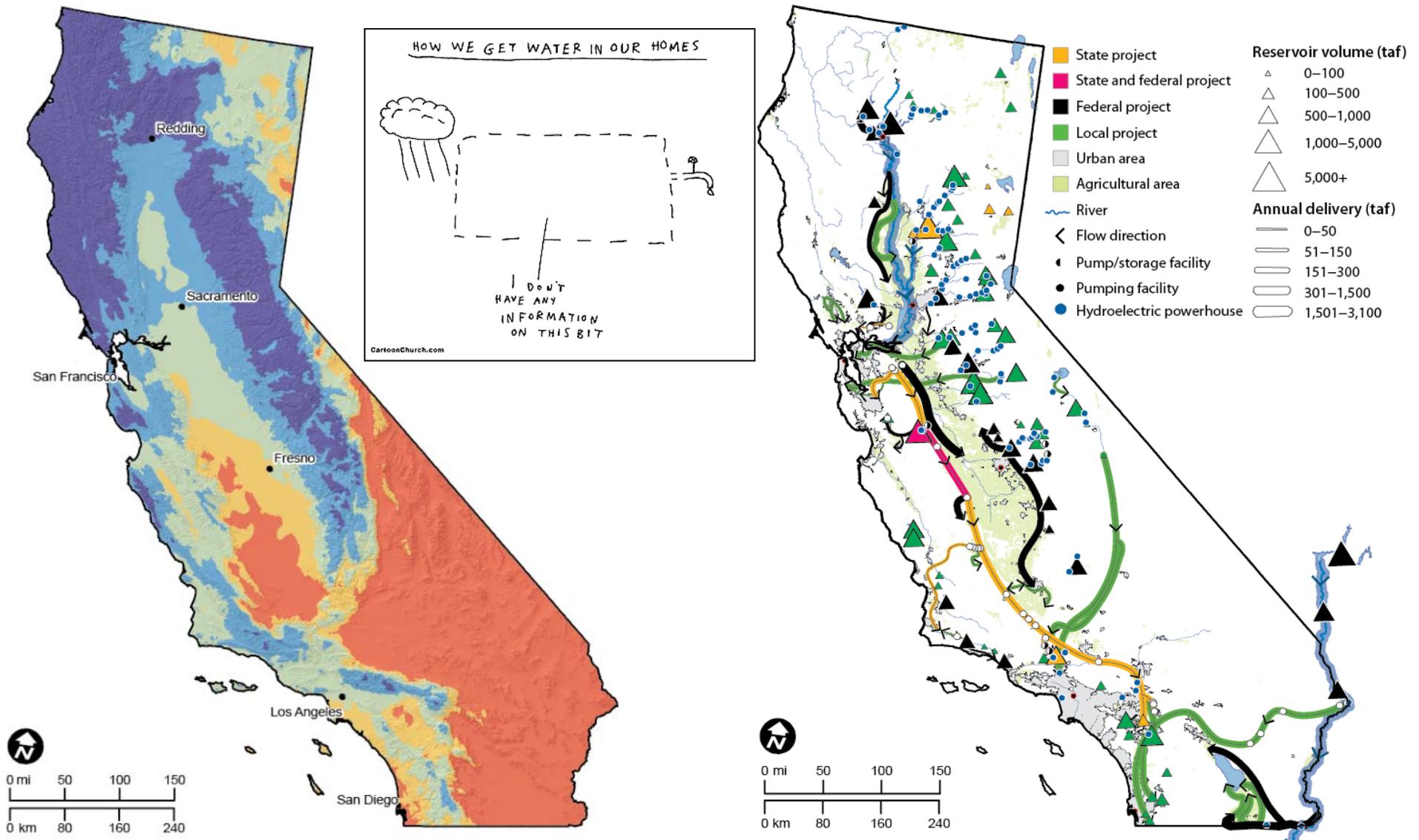
Main Ideas



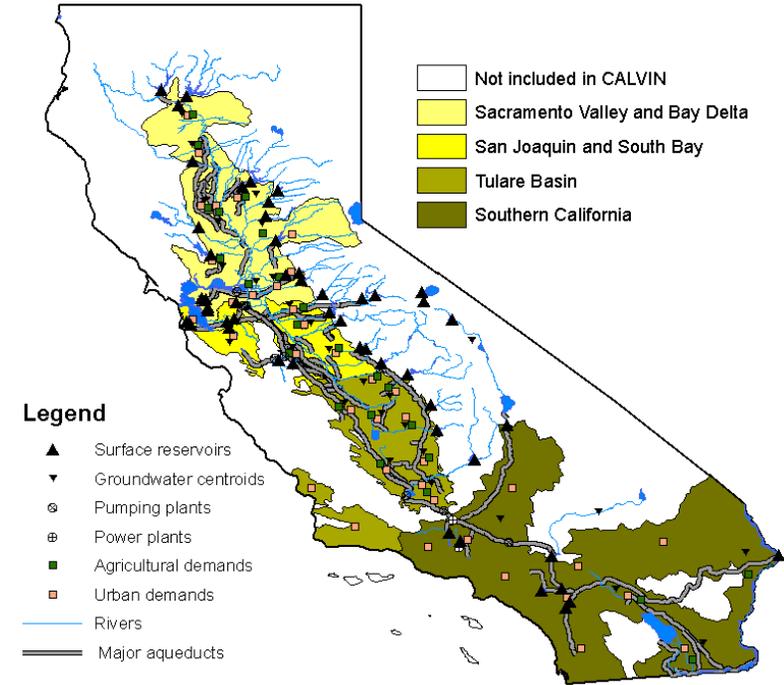
1. Water storage is part of a system
2. We use lots of storage in California
3. Not all storage is equal
4. Storage will be used differently
5. Storage decisions should be cold and calculating



Storage works in an engineered statewide network



California's Water System



42 maf surface reservoirs

150 maf+ groundwater

Vast conveyance network

9 million irrigated acres

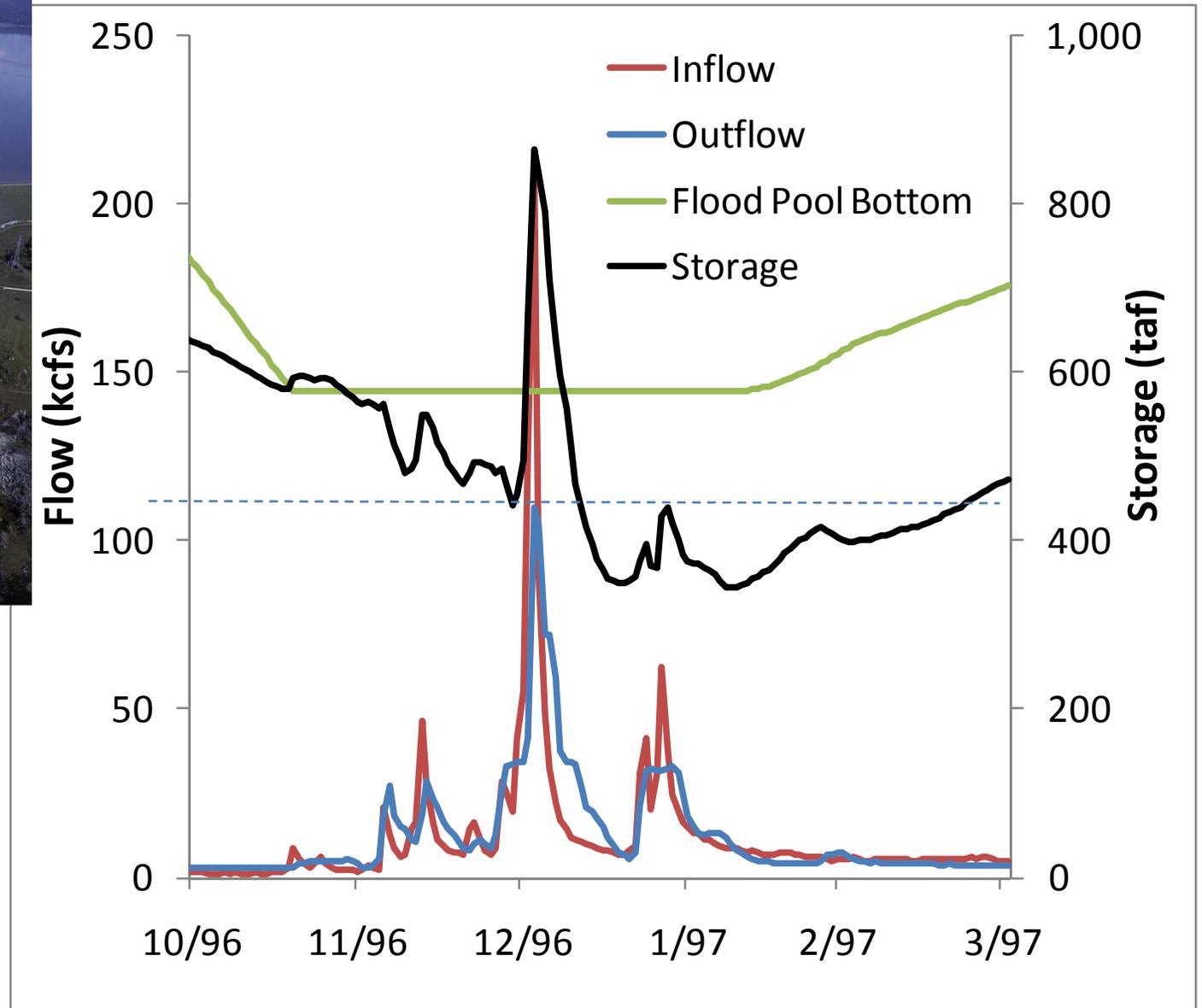
38 million people

Not enough fish

Storage moves water in time



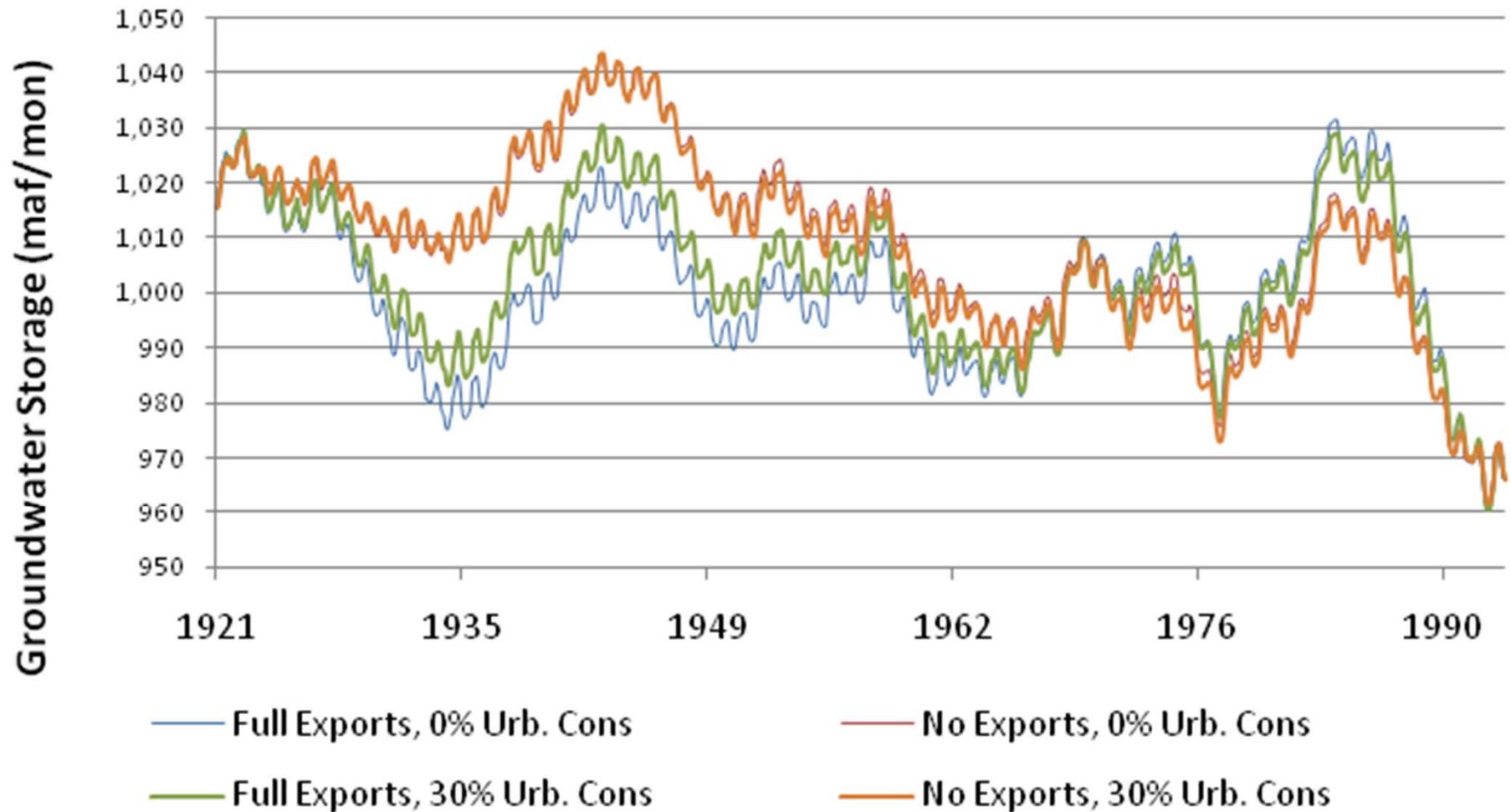
1997
flood at
Folsom



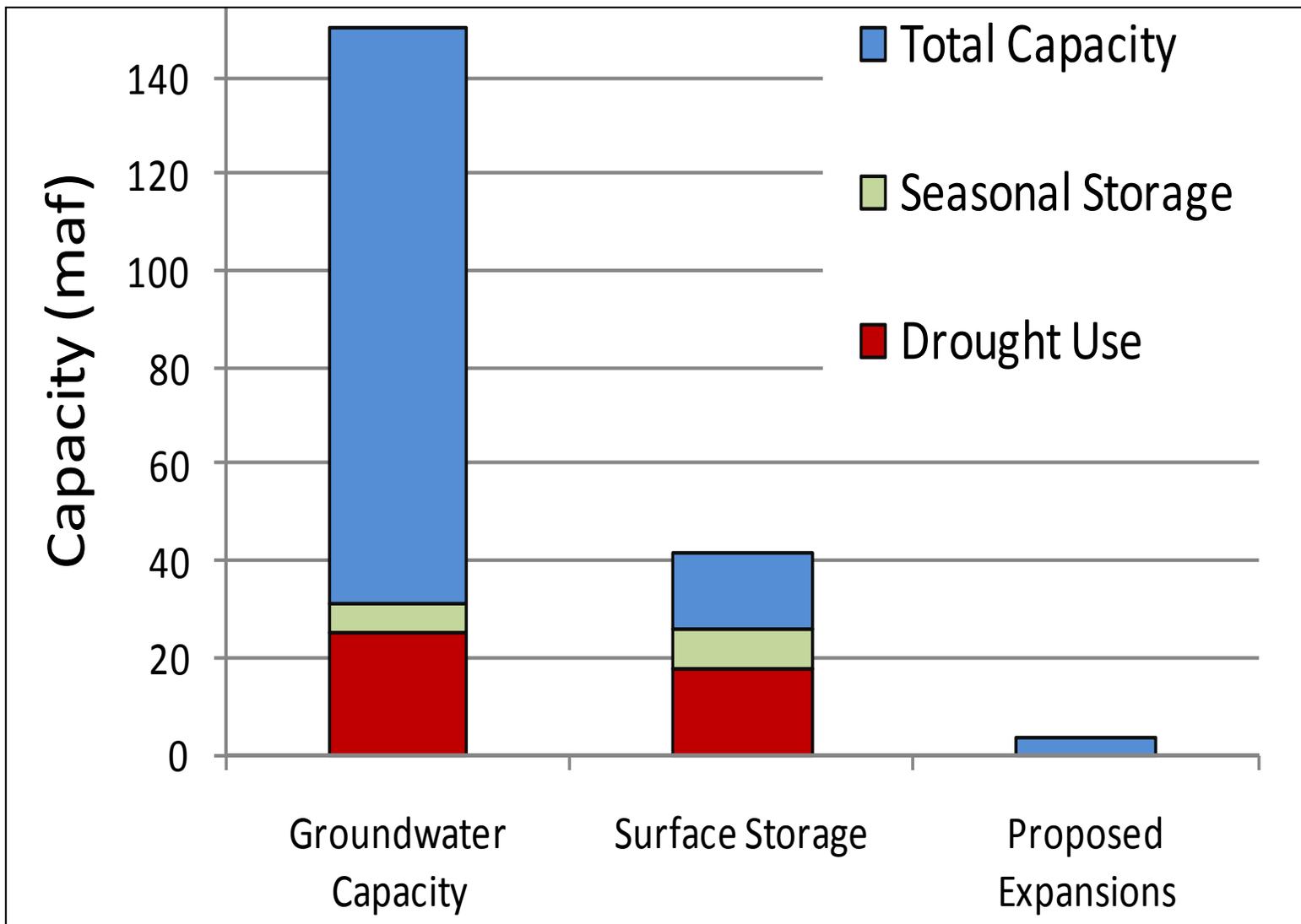
Seasonal & drought storage



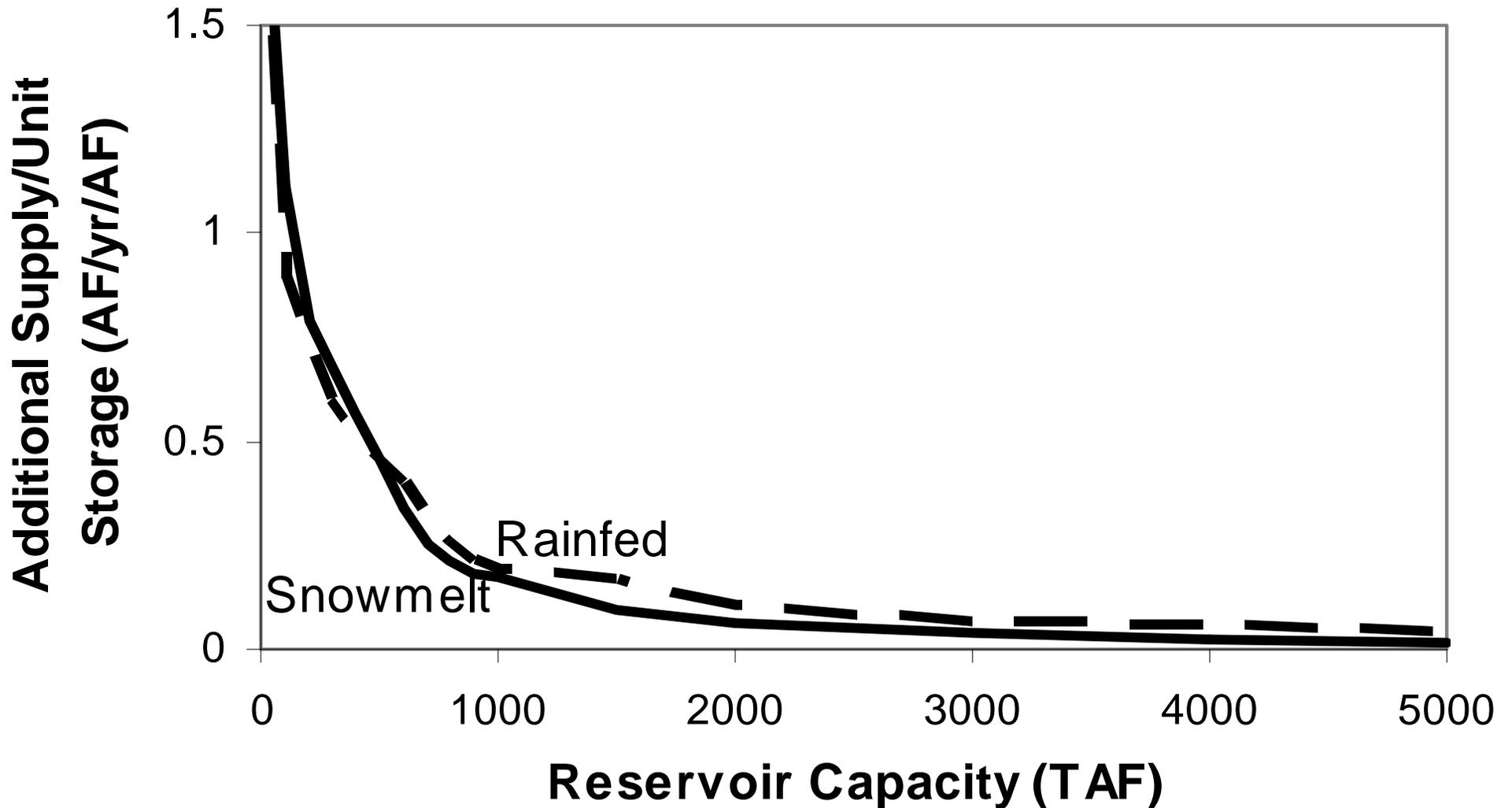
Groundwater Storage in a Historical Climate



Water Storage Capacity and Uses in California



Not all storage is equal



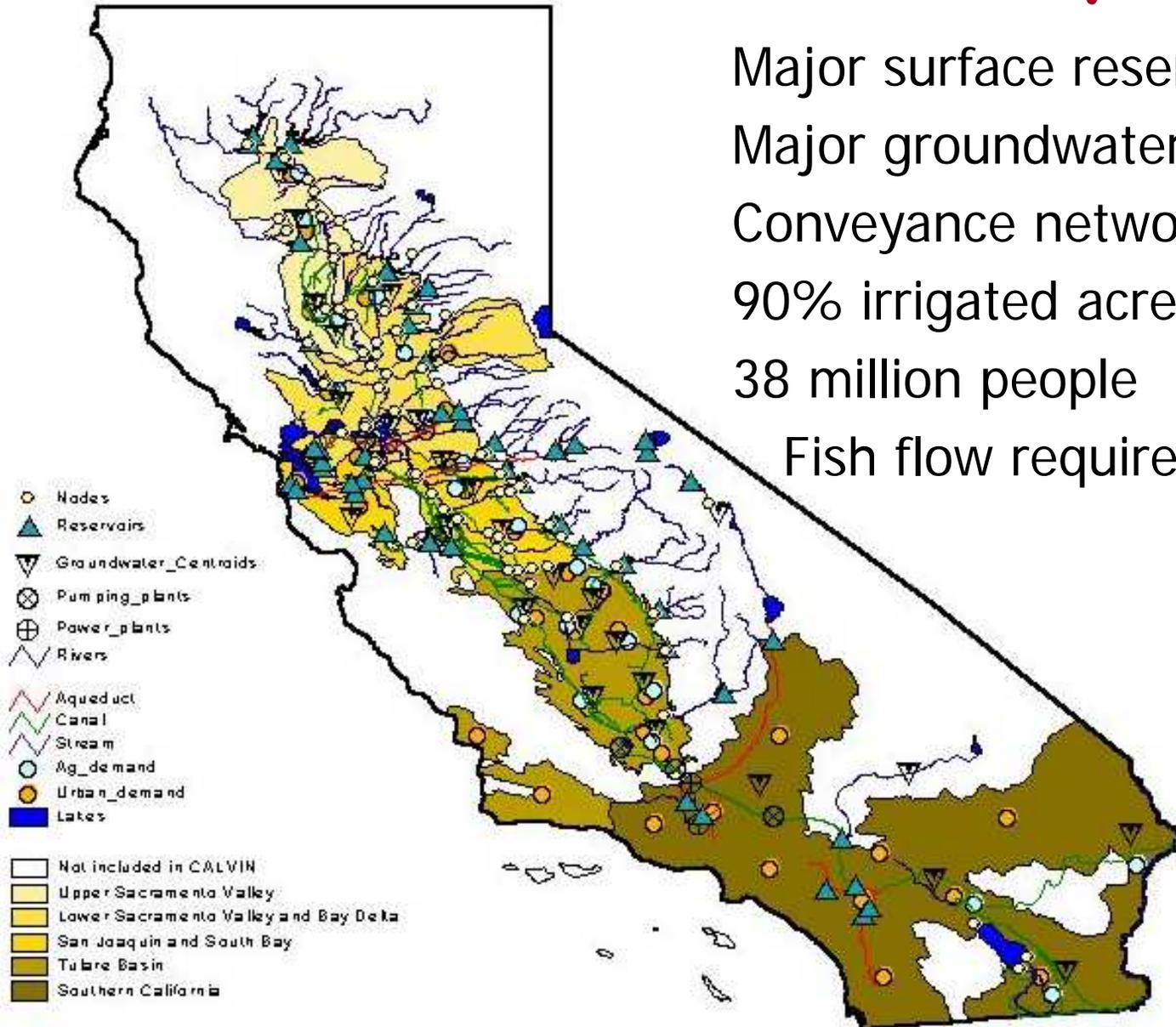
"With a larger reservoir, there is some increasing gain with further size, but in a diminishing ratio." - Alan Hazen (1914)

Storage being used differently

1. Cold water for fish
2. Pulse flows for habitat
3. Regional conjunctive use (Kern, Yolo, elsewhere)
4. Statewide conjunctive use (e.g., Sac Valley conjunctive use supplies water stored in Tulare for MWD)
5. Market motivations - Creativity isn't over yet.



California's Water System



Major surface reservoirs

Major groundwater basins

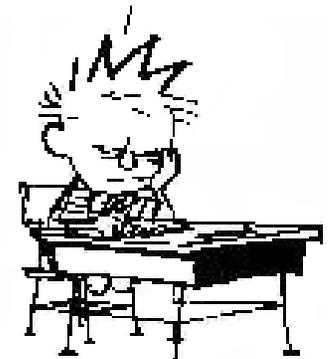
Conveyance network

90% irrigated acreage

38 million people

Fish flow requirements fish

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Value of added storage capacity (\$/af-yr)

Ragatz, 2013	Historical climate				Warmer, drier climate			
	0% urban conservation		30% urban conservation		0% urban conservation		30% urban conservation	
	Full exports	No exports	Full exports	No exports	Full exports	No exports	Full exports	No exports
Claire Engle	3	3	3	3	39	30	32	32
Shasta	8	8	8	8	67	34	51	34
Oroville	15	11	13	10	78	18	66	17
N. Bullard's Bar	18	17	17	17	156	19	90	19
Folsom	13	10	11	9	153	20	85	15
Pardee	2	5	1	1	14	32	20	41
New Melones	9	10	9	10	3	3	3	5
Hetch Hetchy	6	7	5	7	7	6	5	7
New Don Pedro	8	9	8	8	4	3	4	5
Millerton	6	95	5	62	37	120	56	33
Pine Flat	6	95	5	62	20	103	51	95
Kaweah	56	457	47	379	269	263	225	254
Success	49	403	42	340	361	361	308	357
Isabella	4	46	1	15	32	76	32	5
Grant Lake	52	116	44	76	0	0	0	0

More Storage for California?

Why?

- More water supply, flood management
- Increasing water demands
- More flexibility for integration
- Climate warming – snowpack effect
- Climate warming – water temperature & salmon



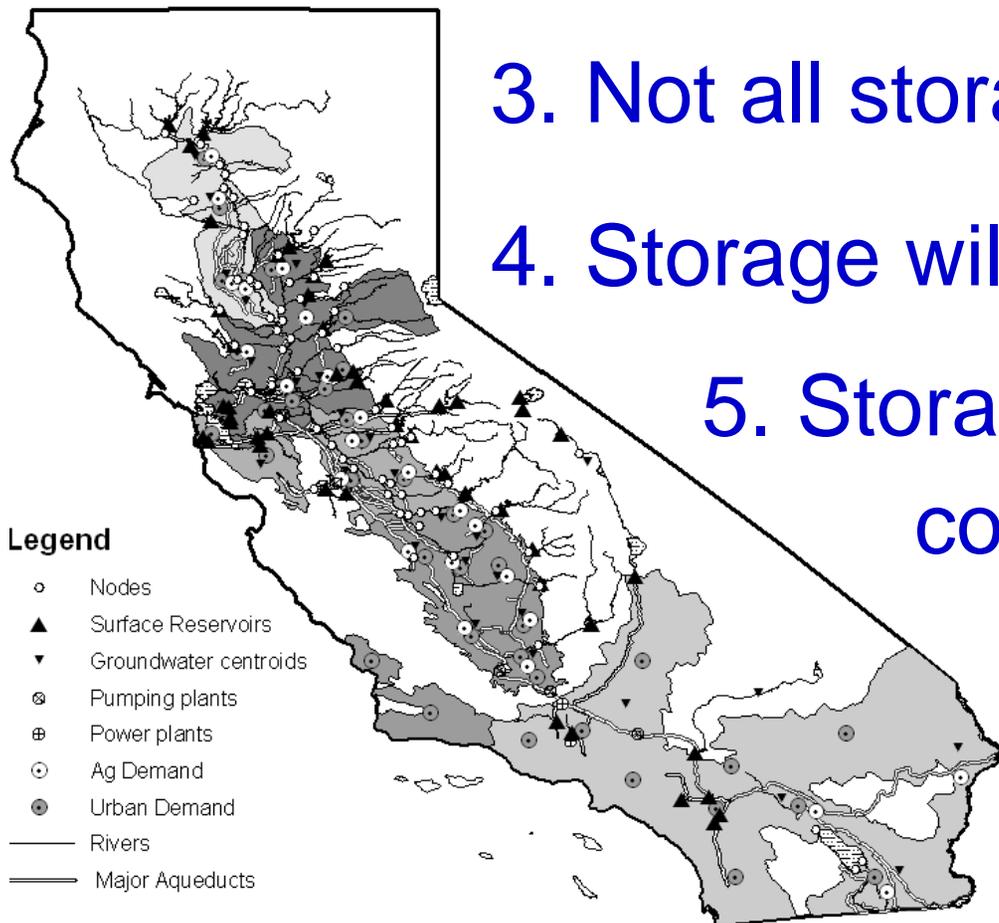
Why not?

- Diminishing additions to supply and value
- Expense
- Environmental impact
- Opportunity costs (distraction from integrating system management)

Conclusions



1. Water storage is part of a system
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5. Storage decisions should be cold and calculating



Views of Storage at 50%

- 1) Pessimist – The glass is half empty
- 2) Optimist – The glass is half full
- 3) Engineer - The glass is too big
- 4) Flood control engineer - The glass should be 40% larger
- 5) Water supply engineer – I prefer a larger glass
- 6) Dam safety engineer - The glass needs a larger spillway
- 7) Delta engineer – Can you pump out my glass?
- 8) Delta engineer - Why is water rising outside of my glass?
- 9) Environmental engineer - I wouldn't drink that stuff
- 10) Water marketing engineer – I'll buy water to fill my glass