Changing Delta Inflows
A Historical Analytical Perspective

CWEMF Annual Meeting
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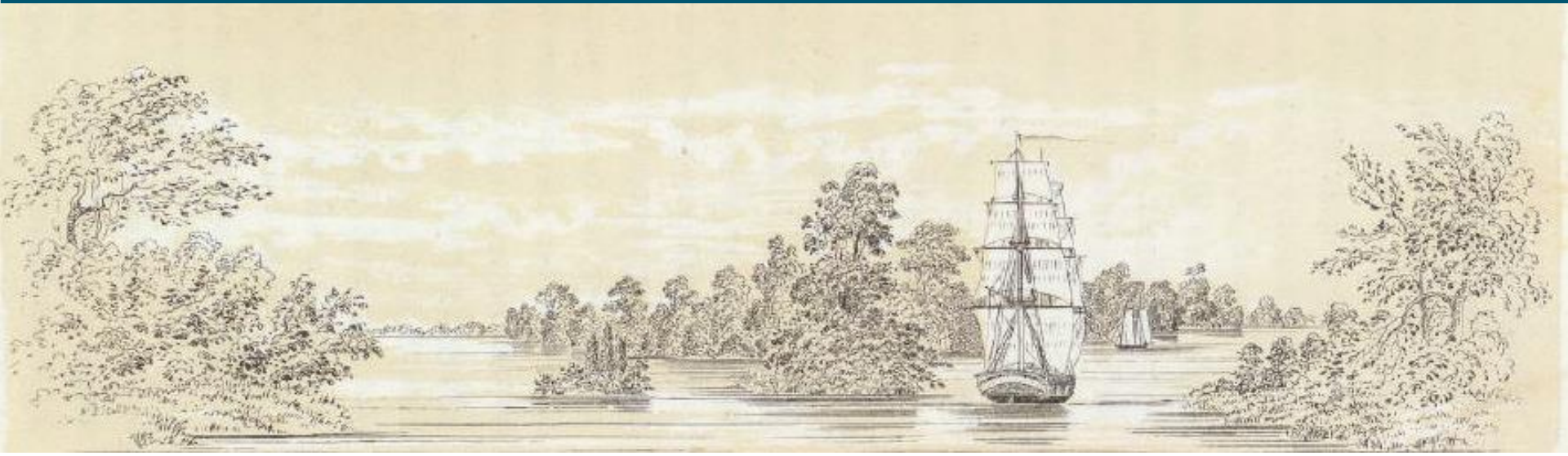
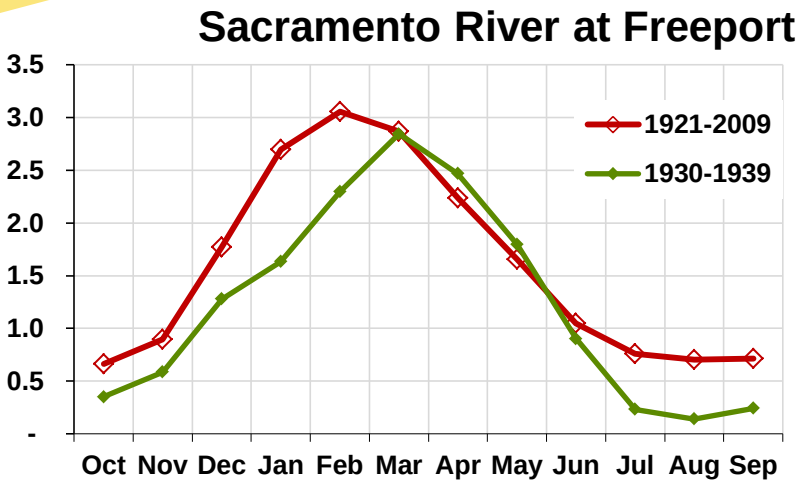
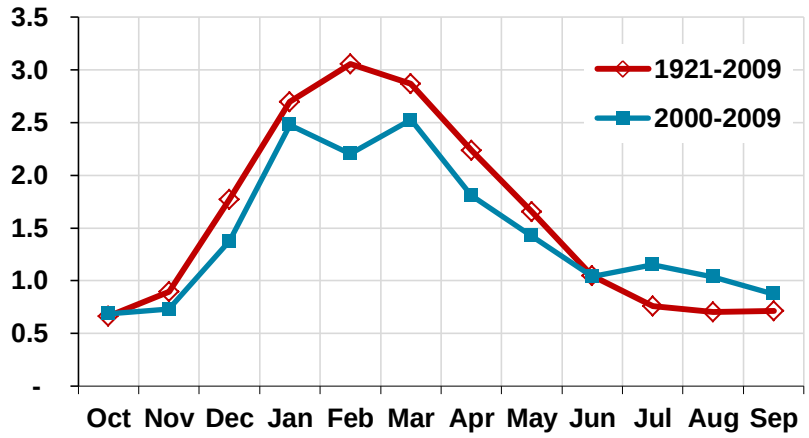
Andy Draper, MWH
Study funded by: Metropolitan Water District



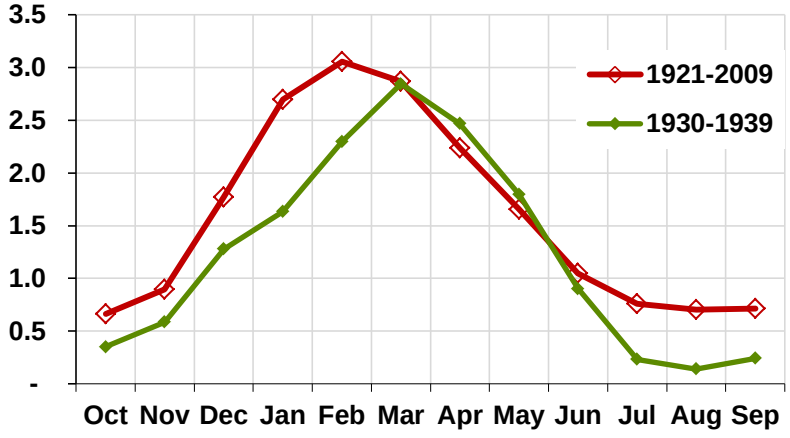
Historical Observed Average Monthly Flows

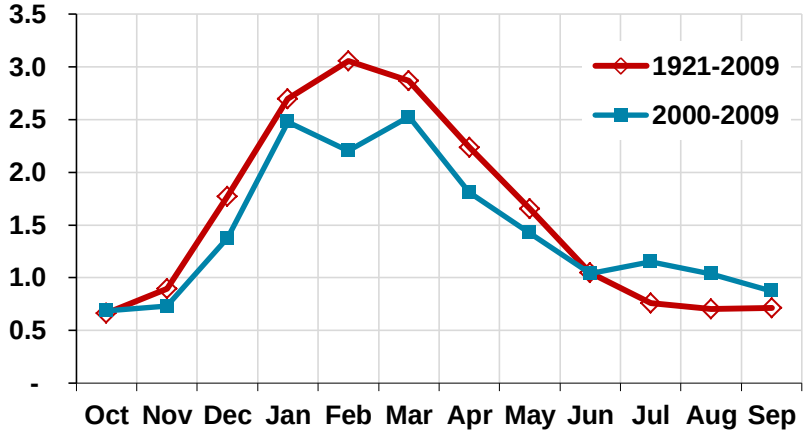




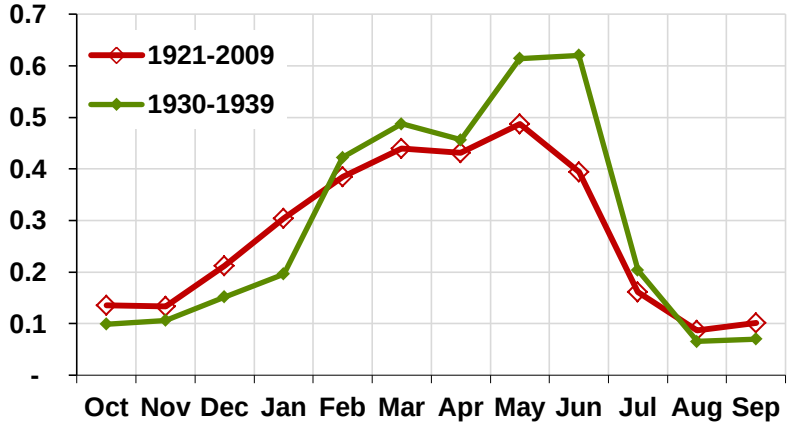
Historical Observed Average Monthly Flows

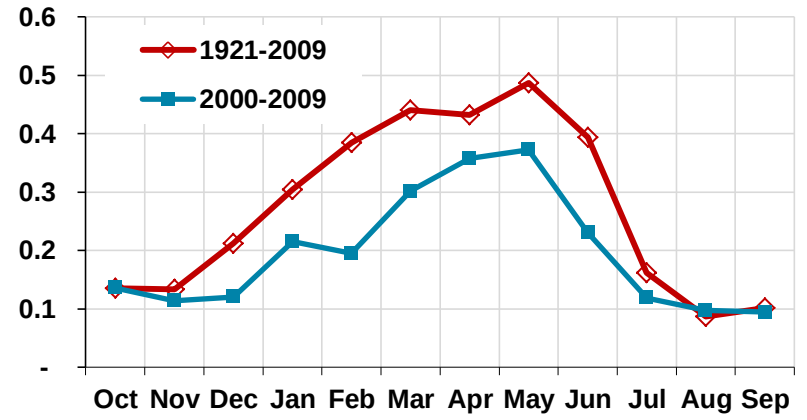
Sacramento River at Freeport + Yolo Bypass at Lisbon (MAF)



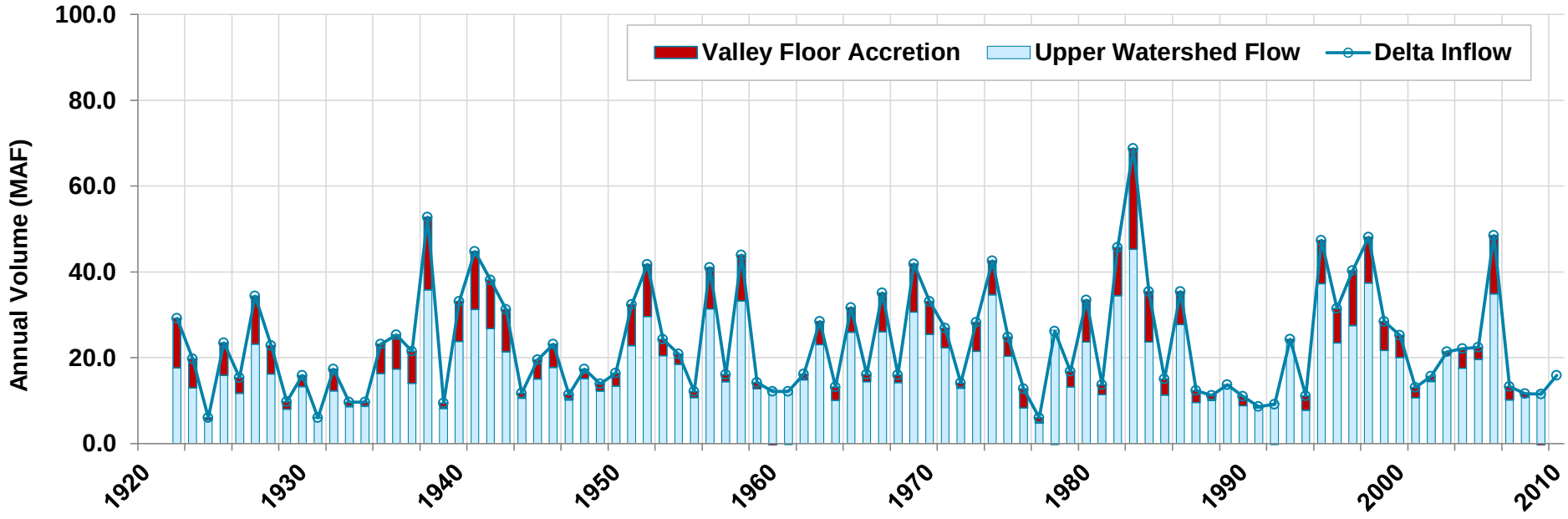


San Joaquin River at Vernalis (MAF)

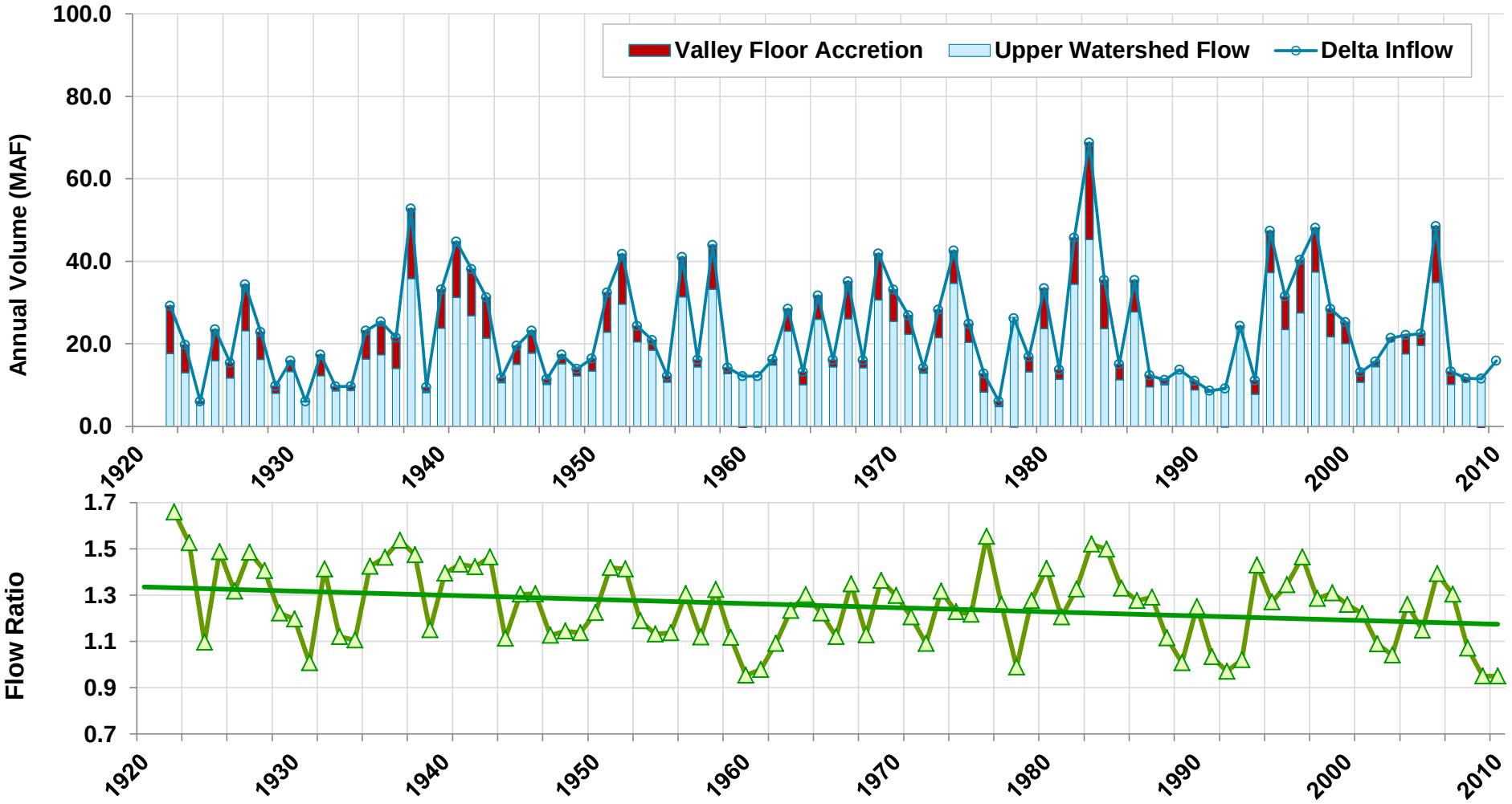




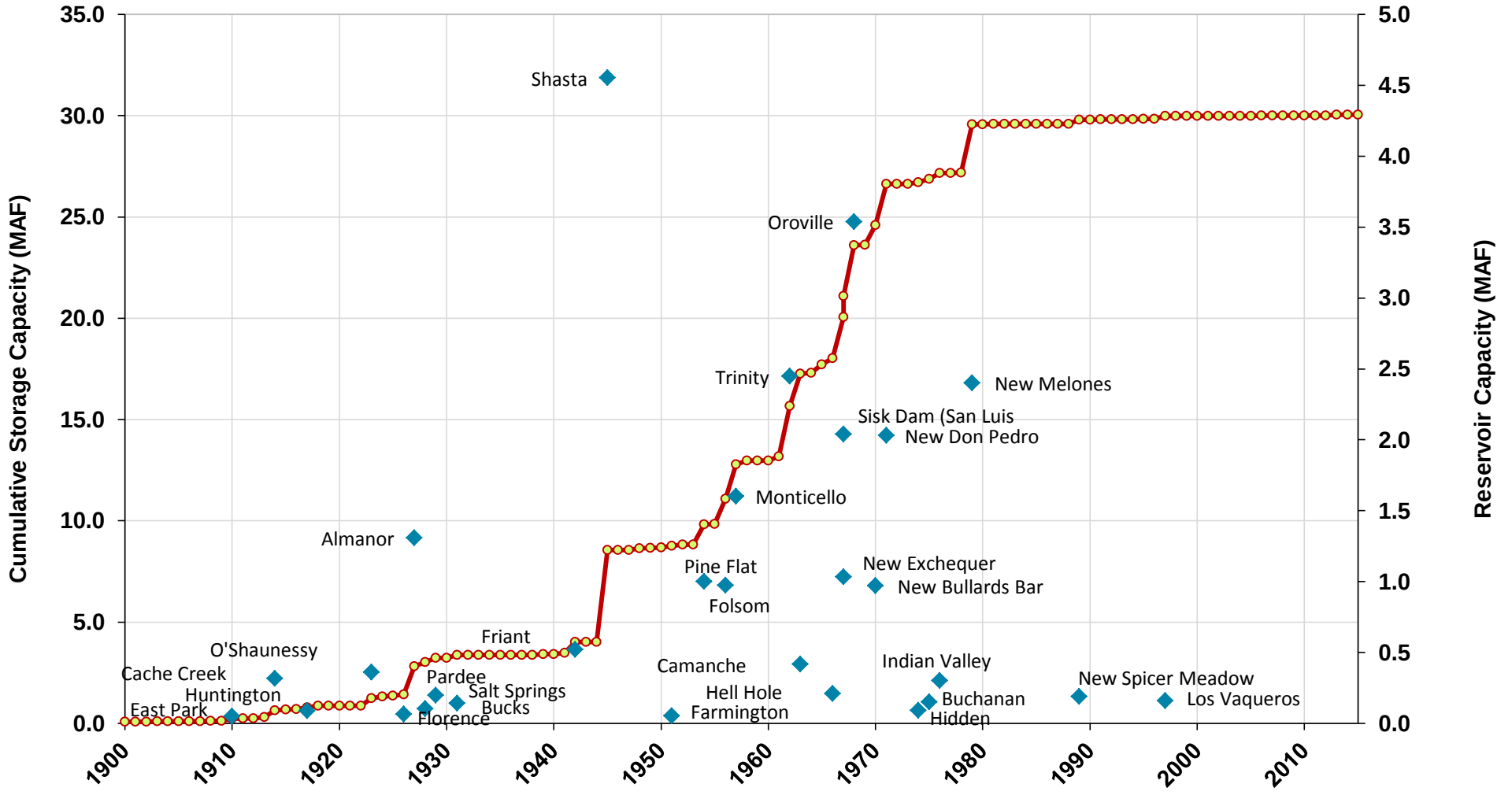
Historical Observed Annual Flows



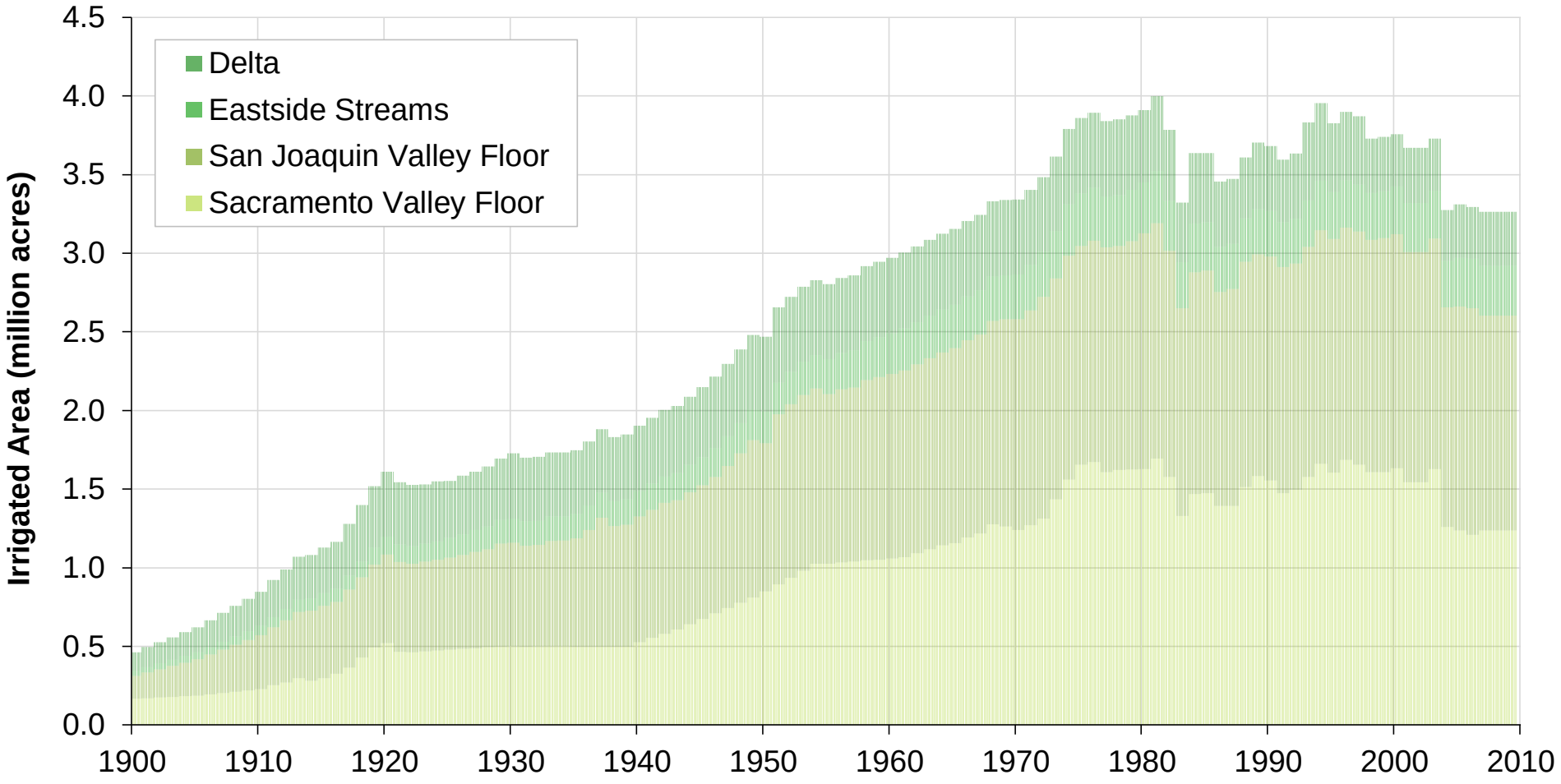
Historical Observed Annual Flows



Changing Central Valley – Storage Regulation

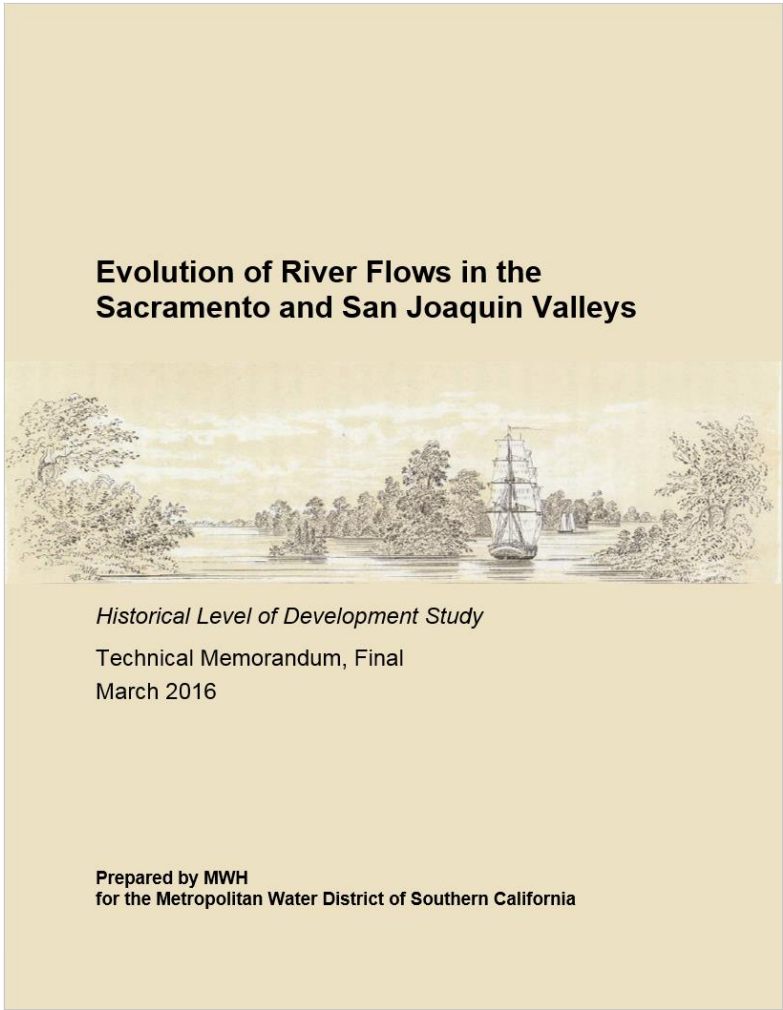


Changing Central Valley – Irrigation



Study Approach

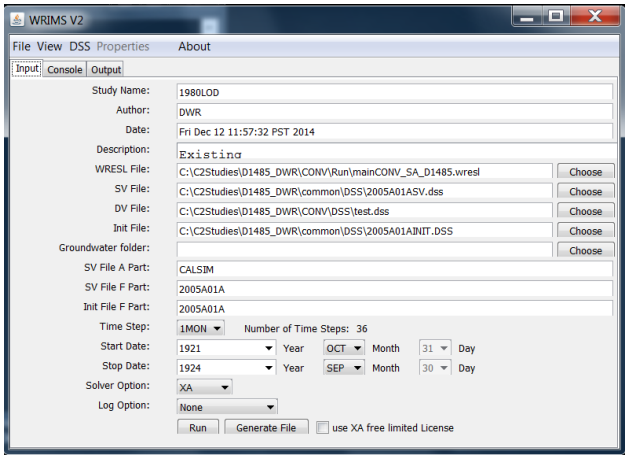
- Point of departure for the study was the development of model that simulates water conditions in the Central Valley at historical levels of development.
- Under a fixed level of development, water facilities, land-use, water supply contracts, and regulatory requirements are held constant over the period of simulation. The historical climate trace from October 1921 to September 2009 is used to represent the possible range of water supply conditions.

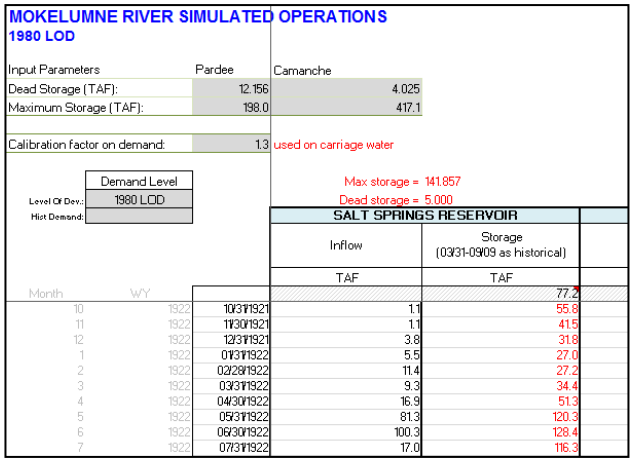


Level of Development Studies

< 1848	**European settlement** Spanish missionary period (1769-1821). Mexican period (1821-1848)
1900	**Introduction of irrigation.** End of wheat era. Growth of specialty crops. Formation of irrigation districts following Wright Irrigation Act (1887). 1880 first flood control plan developed by Hall, State Engineer
1920	**Growth of irrigation development and industrialized agriculture. Early dam construction.** Almanor Dam (1914). Clear Lake (1914).
1940	**Further growth of irrigation development and agribusiness. Increased storage in upper watersheds.** O'Shaughnessy (1923). Old Don Pedro (1923). Old Bullards Bar (1924). Old Melones (1926). Bowman (1927). Bucks (1927). Pardee (1929). Salt Springs (1931). Old Exchequer (1930). Old Hogan (1930).
1960	**Construction of initial CVP. Continued construction of local projects.** Friant (1942). Shasta (1944). Delta-Mendota Canal (1951). Beardsley Dam (1957). Cherry (1956).
1980	**Expansion of CVP. Construction of SWP. Delta protections.** Trinity Dam (1962). Oroville Dam (1967). Banks PP (1967). Cross-Valley Canal (1975). New Melones (1978). Little Grass Valley (1961). Camanche (1963). Camp Far West (1963). Union Valley (1963). Hell Hole (1966). New Bullards Bar (1970). New Don Pedro (1971). Indian Valley (1976). WR Decision 1485 (1978)
2000	**Regulatory change.** CVPIA (1992). Bay-Delta Accord (1994). Decision 1641 (1999). Trinity ROD (2000)
2010	**Increased fishery protections** USFWS BO for Delta smelt (2008). NMFS BO Chinook salmon, steelhead (2009)

Modeling Tools





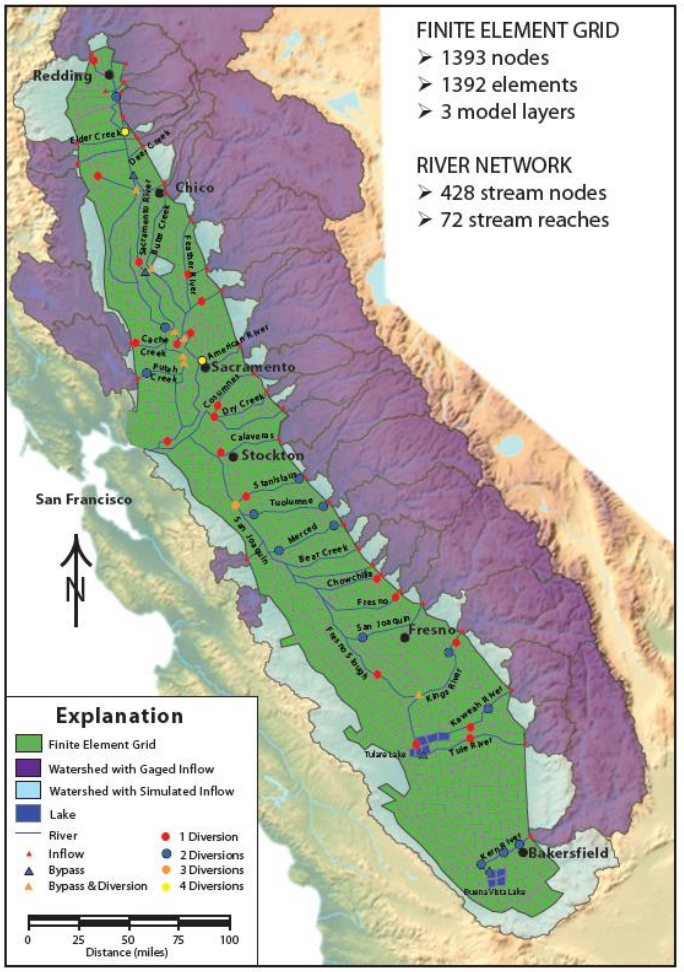
MOKELUMNE RIVER SIMULATED OPERATIONS
1980 LOD

Input Parameters	Pardee	Camanche
Dead Storage (TAF):	12.156	4.025
Maximum Storage (TAF):	198.0	417.1
Calibration factor on demand:	1.3	used on carriage water

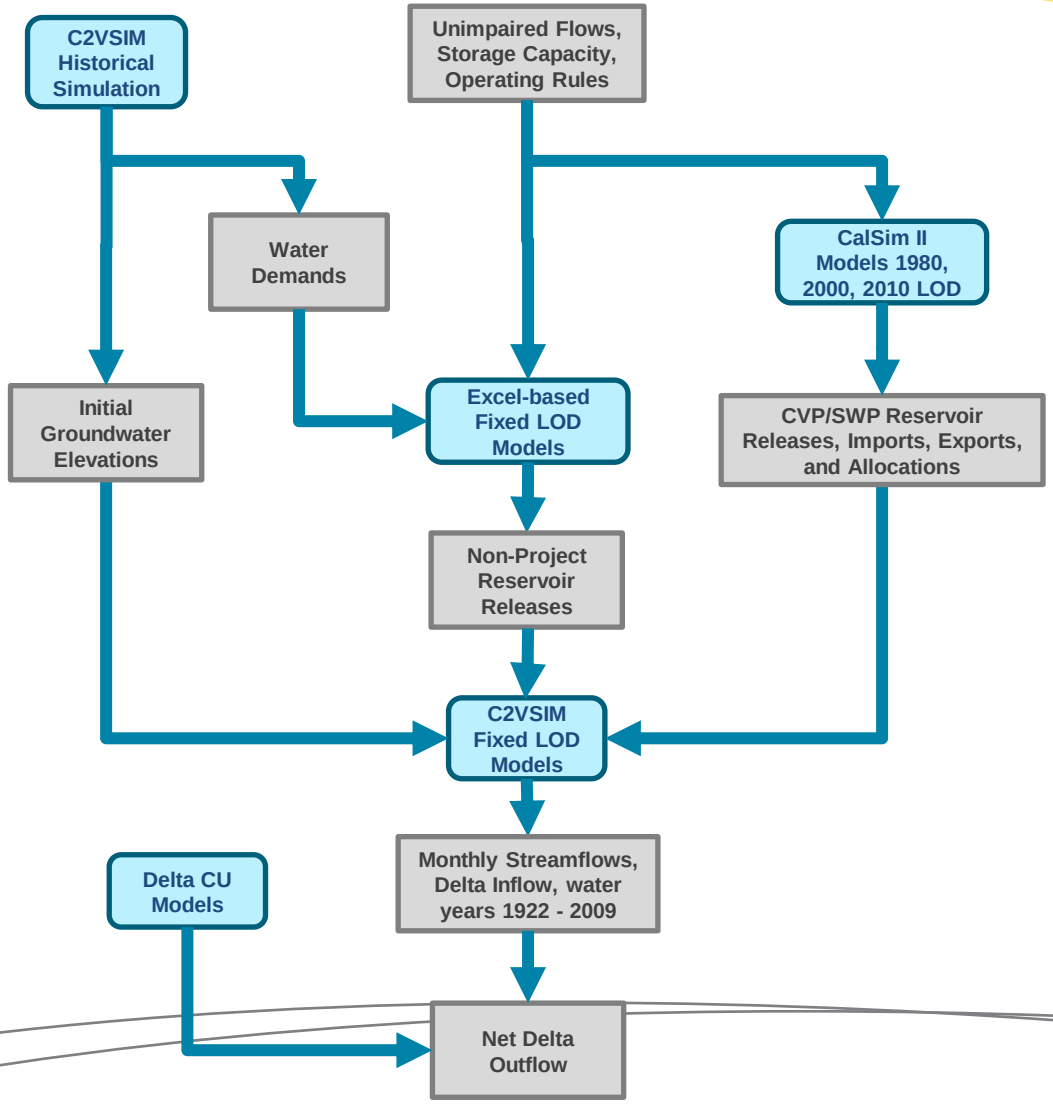
Demand Level
Level Of Dev.: 1980 LOD
Hist Demand:

Max storage = 141.857
Dead storage = 5.000

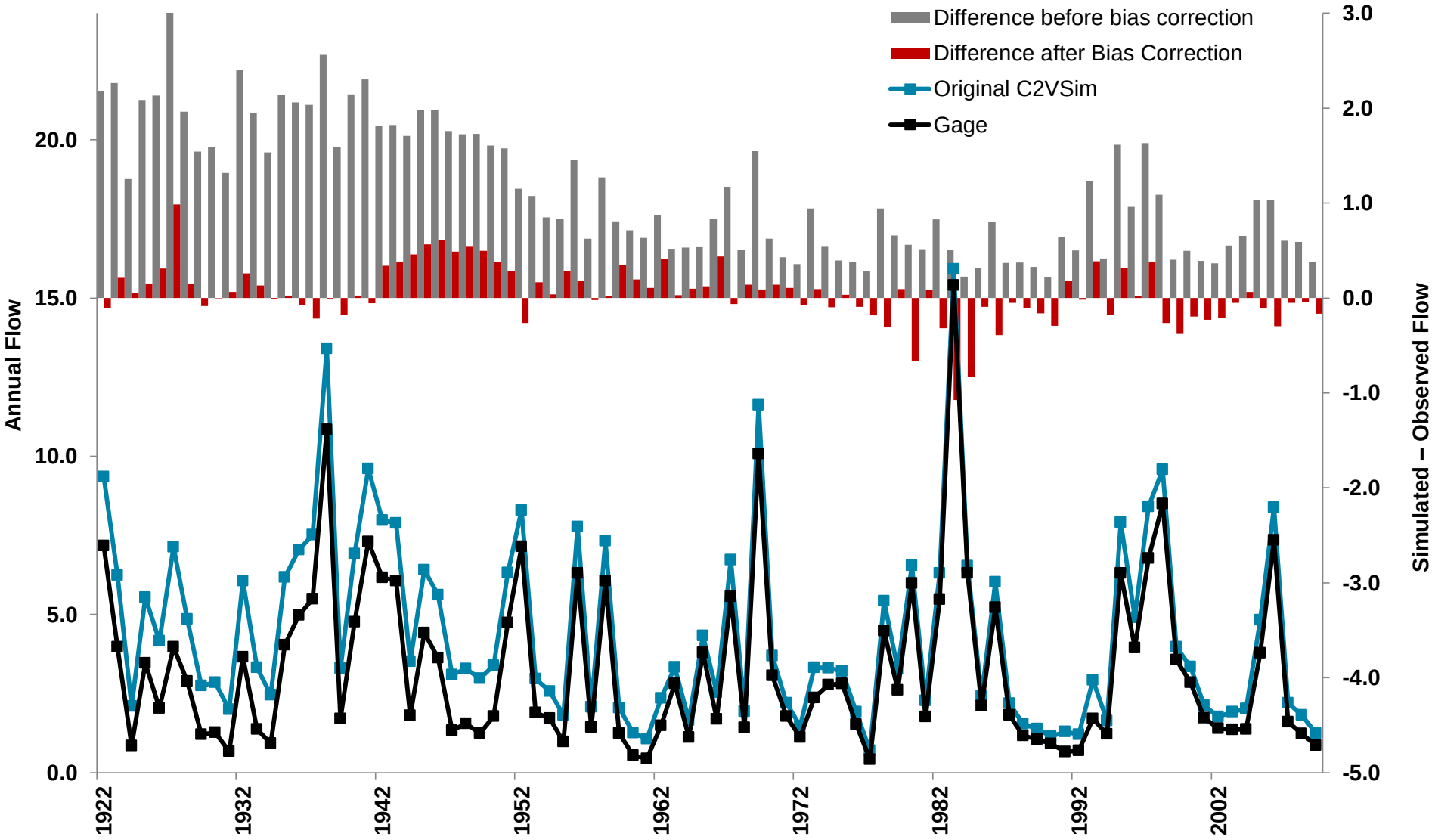
			SALT SPRINGS RESERVOIR	
			Inflow	Storage (03/31-09/09 as historical)
Month	WY		TAF	TAF
				77.2
10	1922	10/31/1921	1.1	55.8
11	1922	11/30/1921	1.1	41.5
12	1922	12/31/1921	3.8	31.8
1	1922	01/31/1922	5.5	27.0
2	1922	02/28/1922	11.4	27.2
3	1922	03/31/1922	9.3	34.4
4	1922	04/30/1922	16.9	51.3
5	1922	05/31/1922	81.3	120.3
6	1922	06/30/1922	100.3	128.4
7	1922	07/31/1922	17.0	116.3



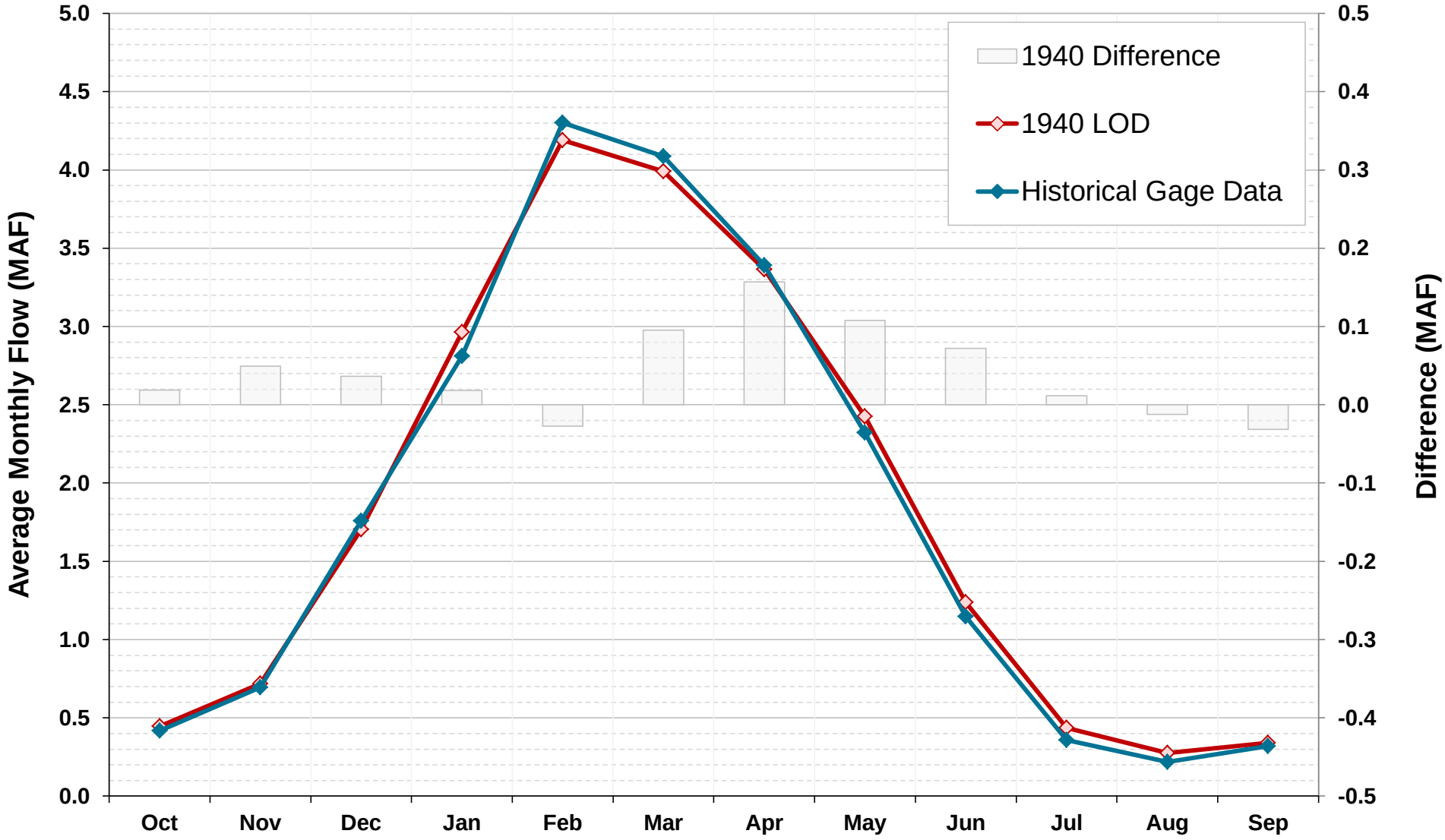
Data Flow between Models



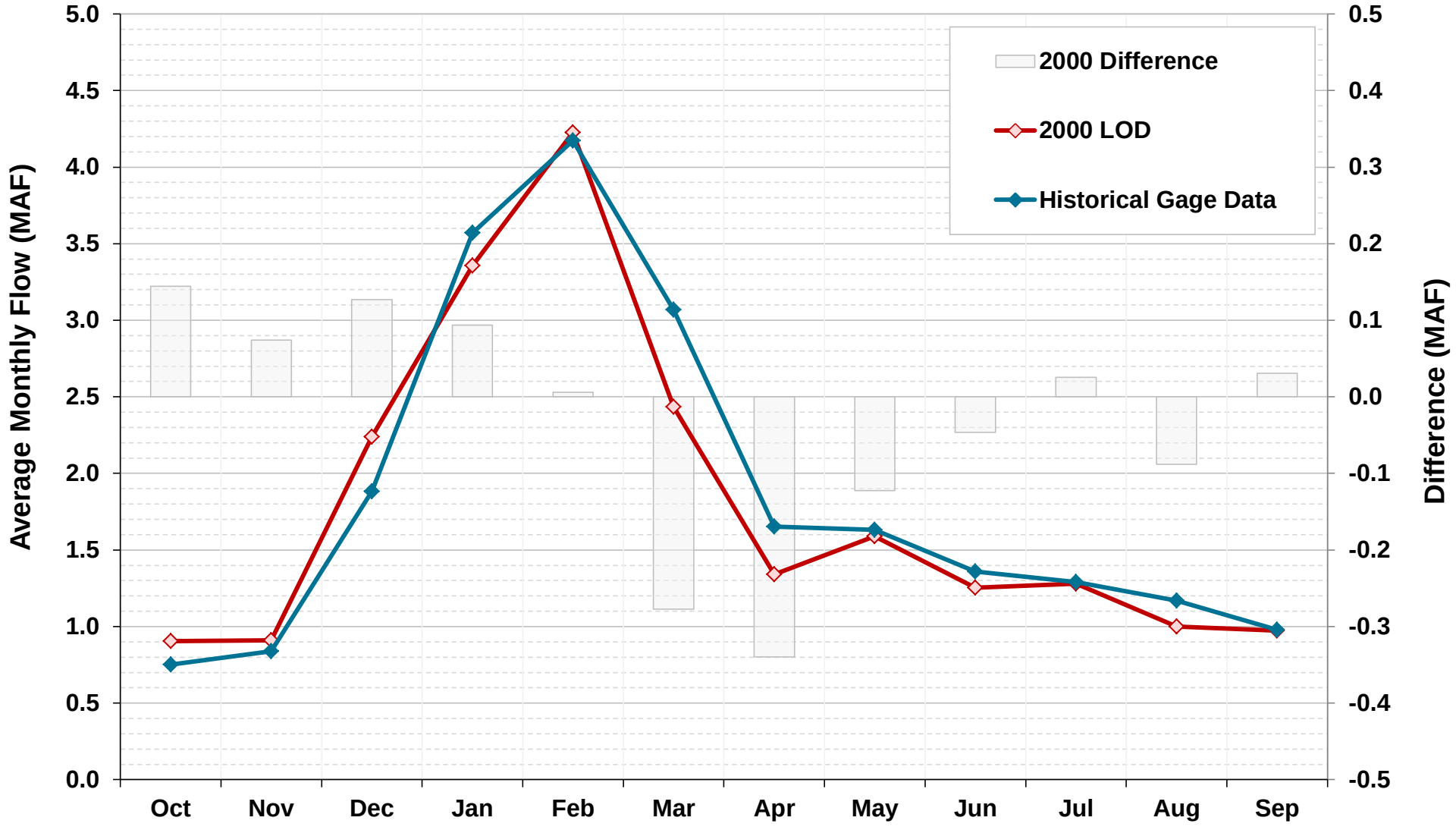
C2VSim Bias Correction: San Joaquin nr Vernalis



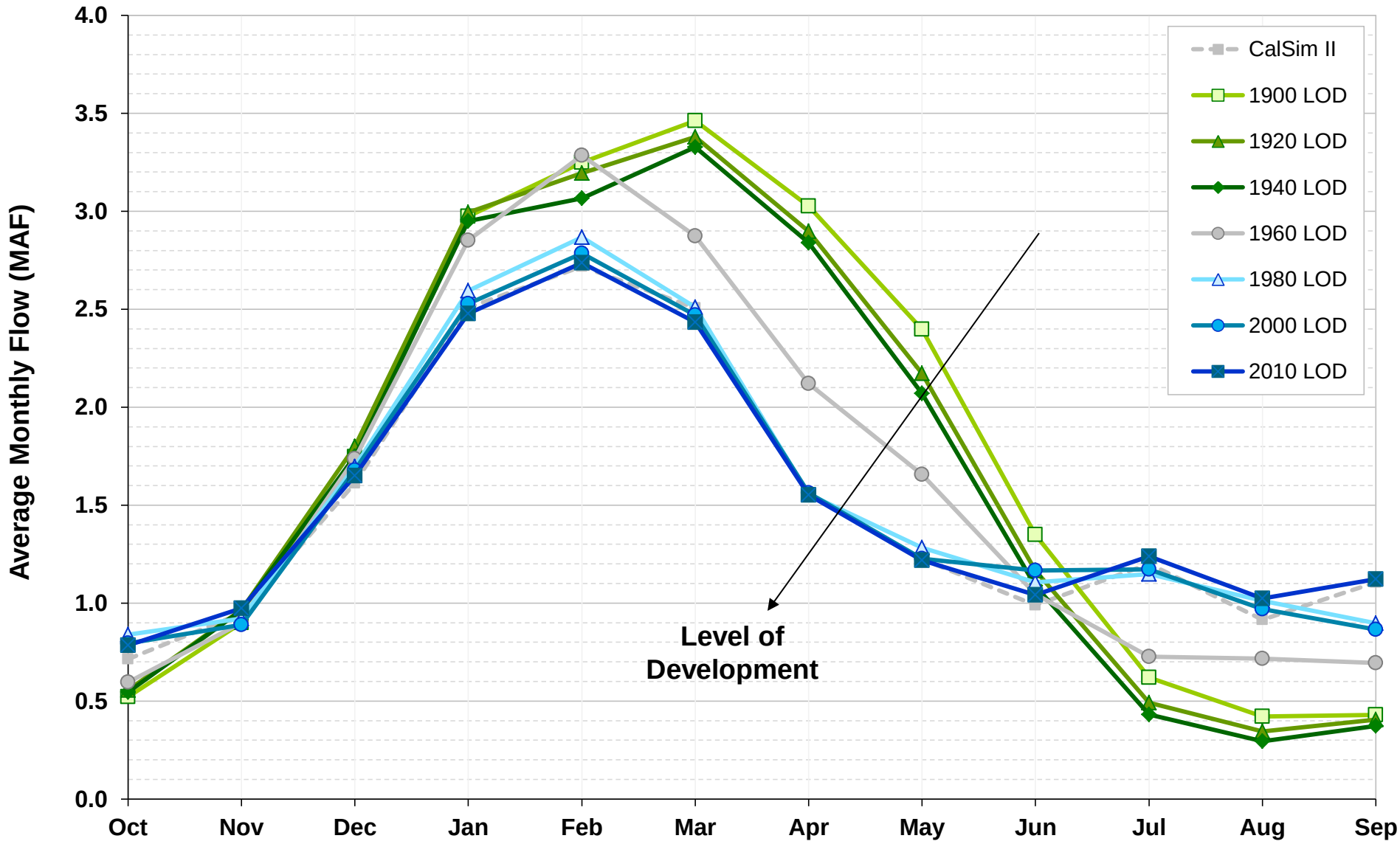
Model Validation: Sacramento Valley Outflow



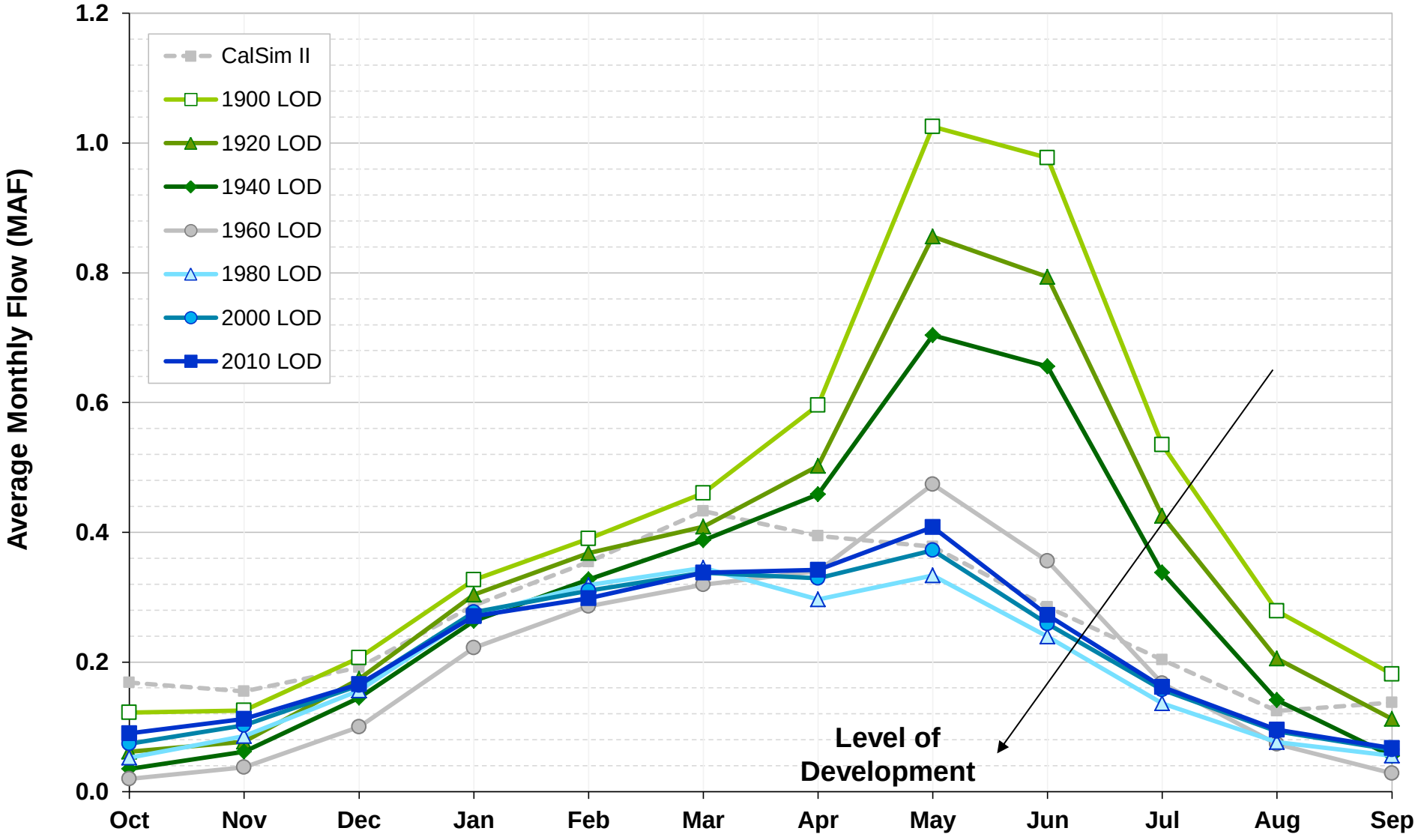
Model Validation: Sacramento Valley Outflow



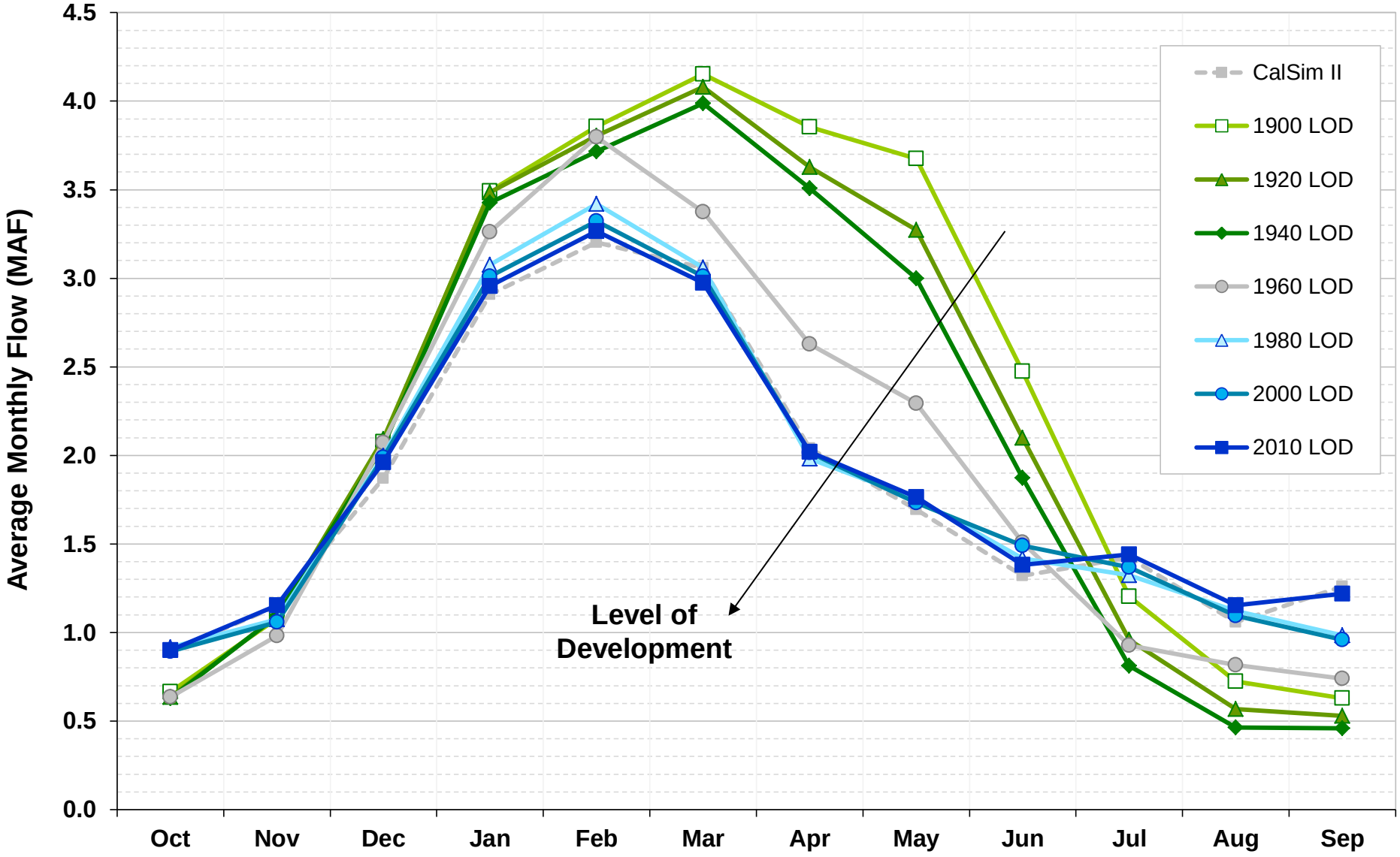
Simulated Sacramento Valley Outflow



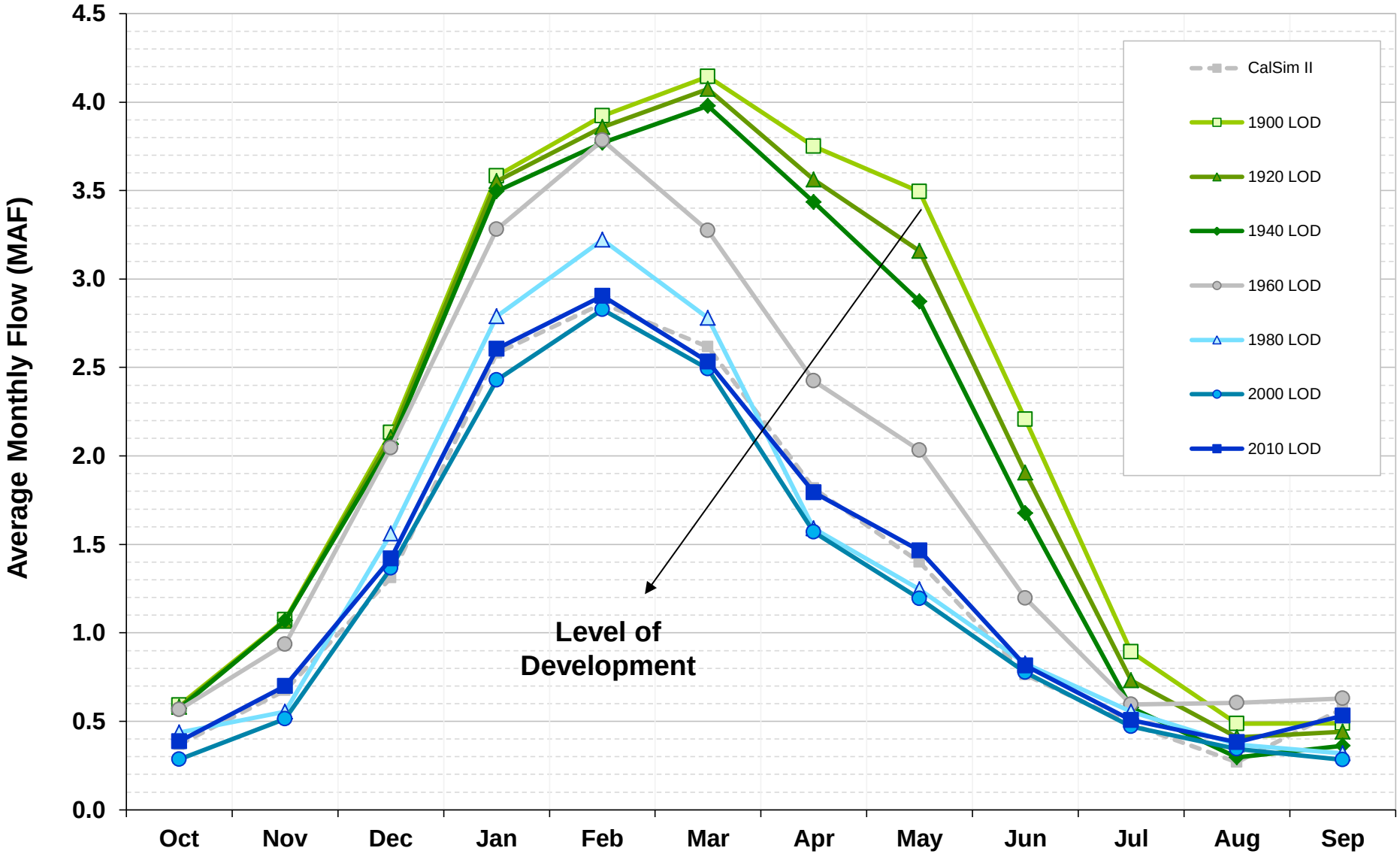
Simulated San Joaquin River nr Vernalis



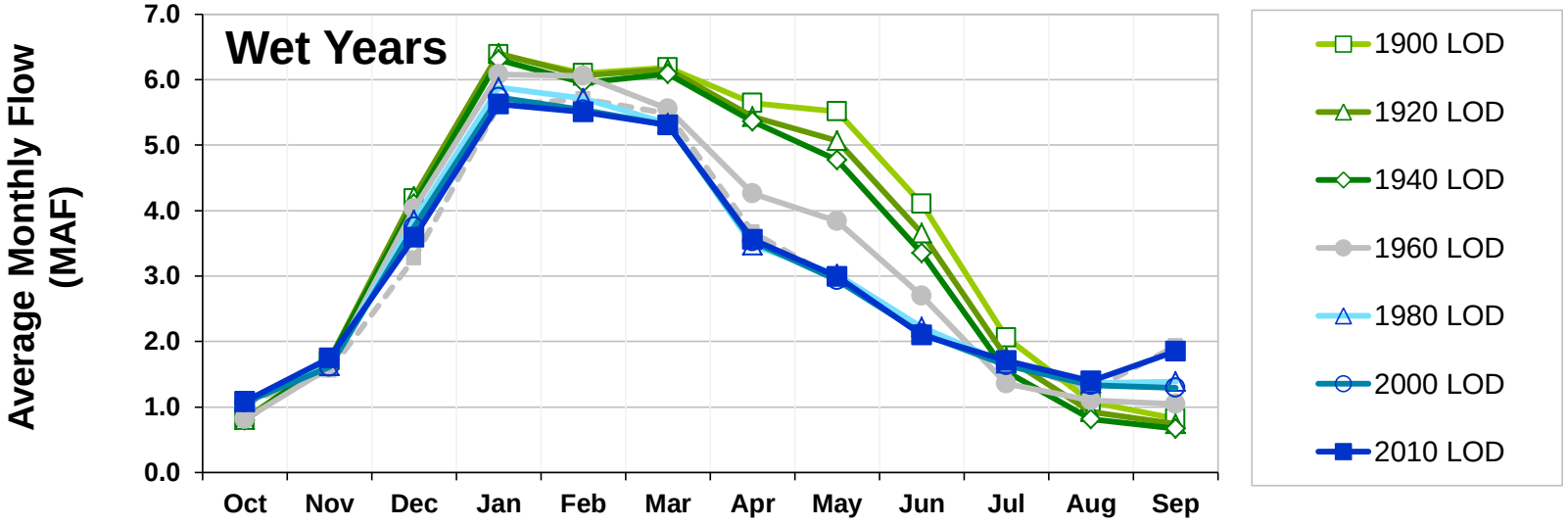
Simulated Total Delta Inflow

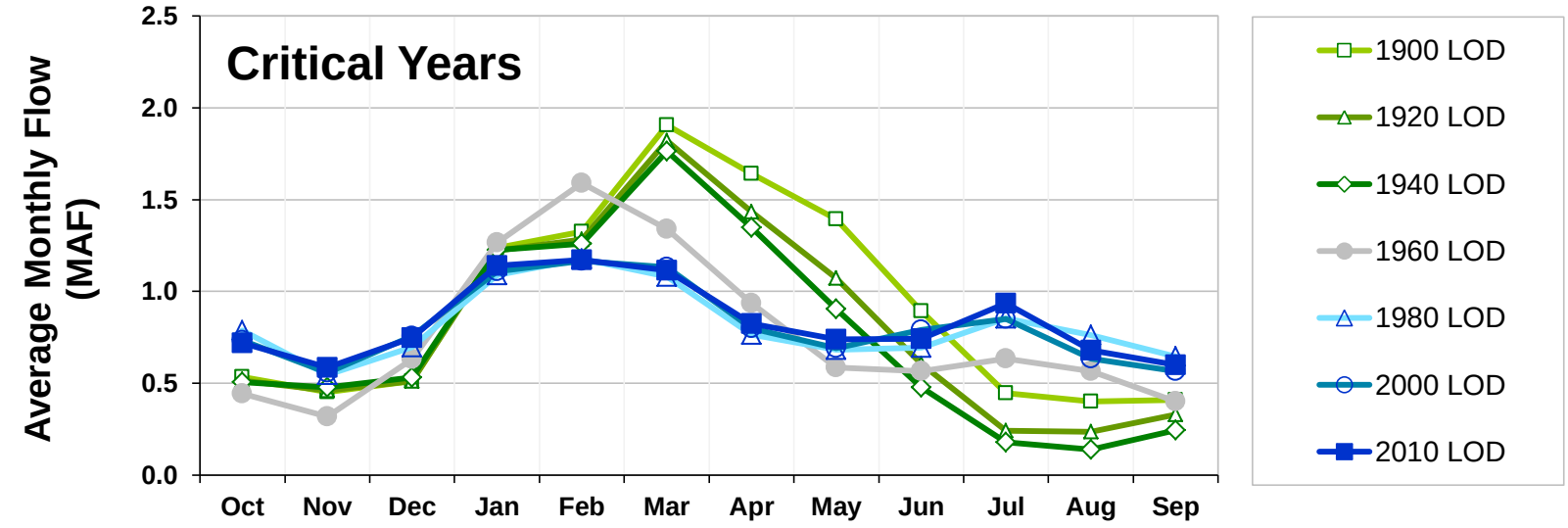


Simulated Net Delta Outflow

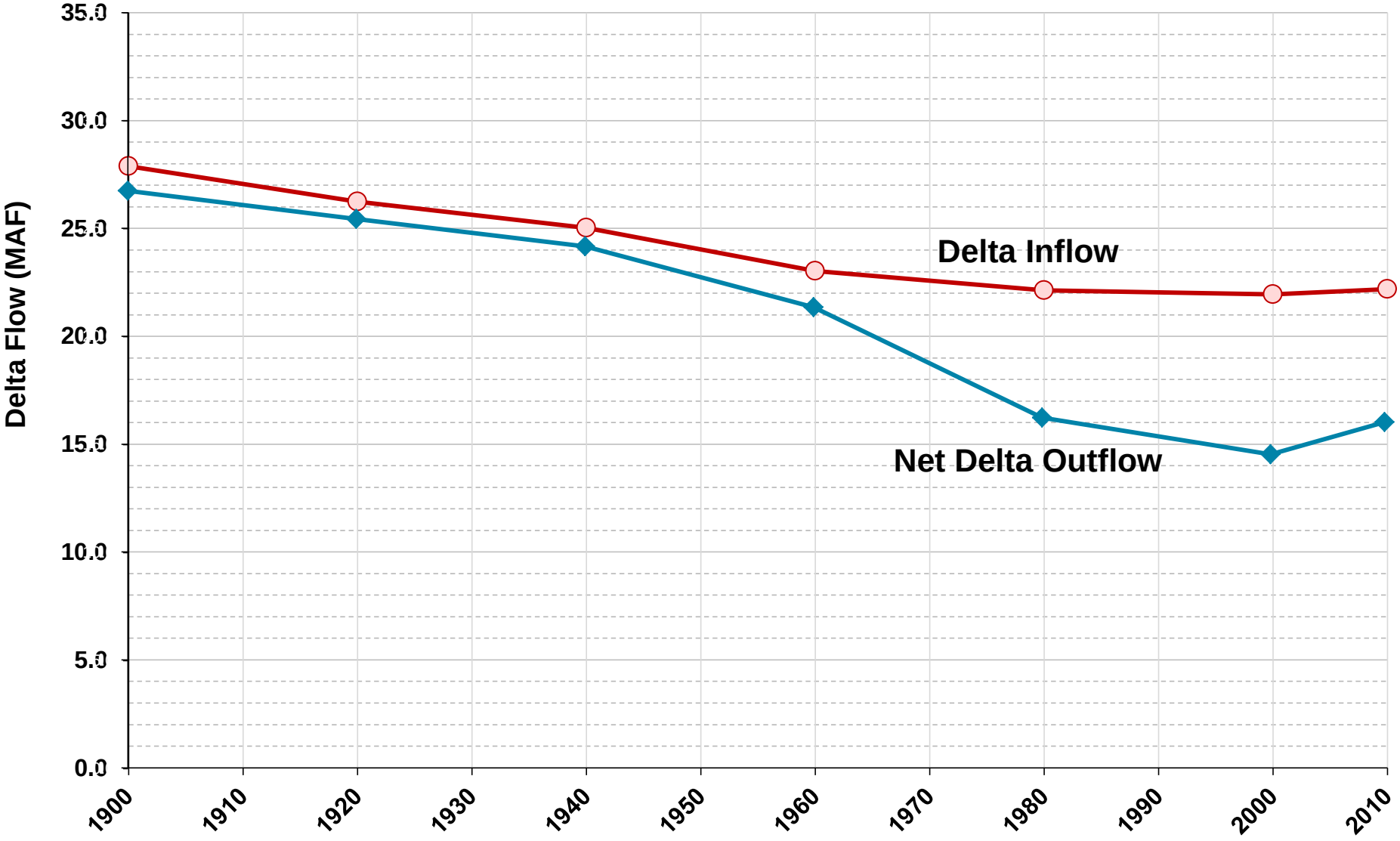


Simulated Net Delta Outflow

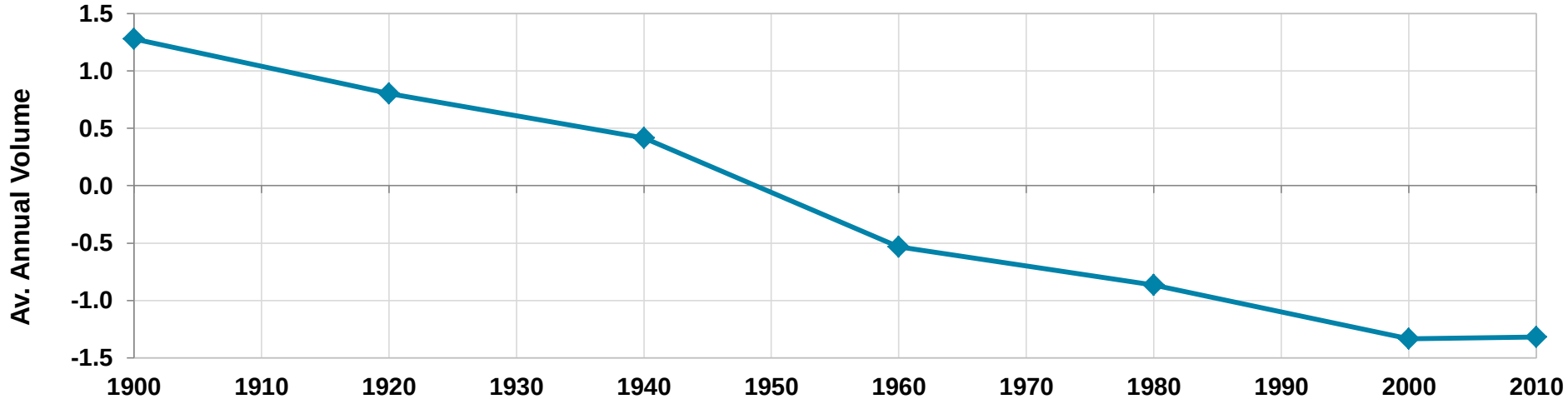


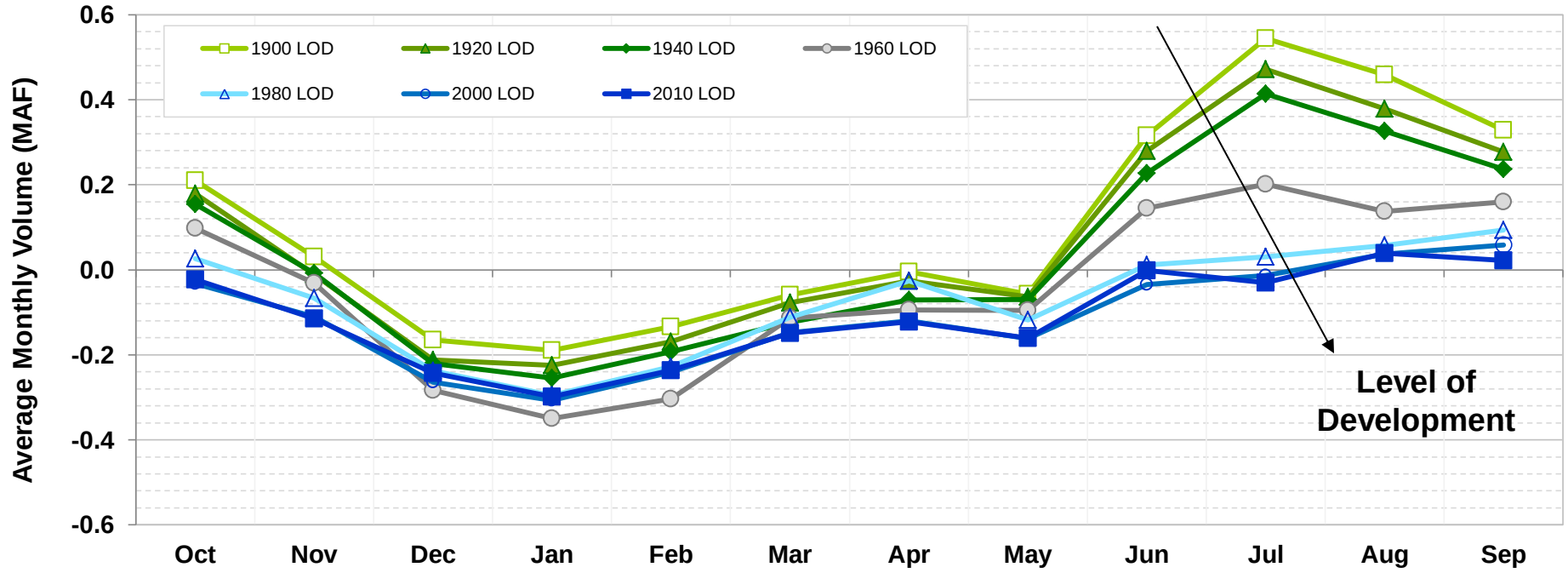


Simulated Delta Inflows and Outflows

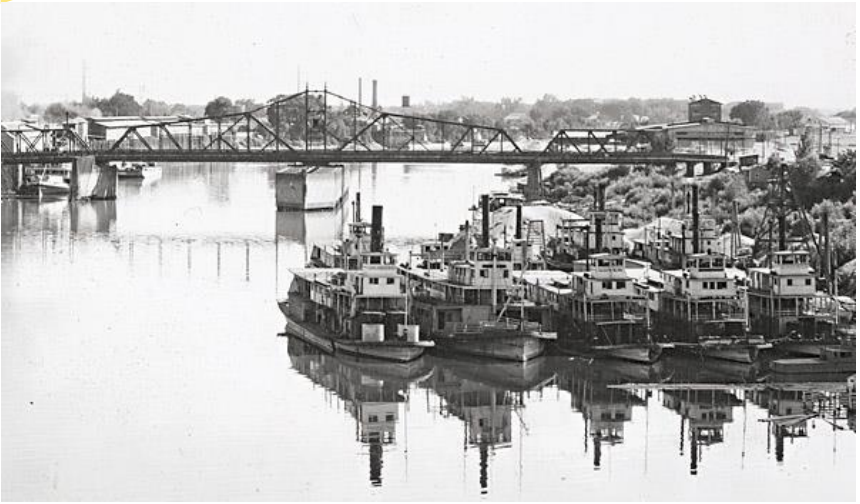


Simulated Groundwater Inflow to Stream System





Conclusions



Hydrologic variability is a dominant feature of the Sacramento-San Joaquin Delta watershed. Fixed LOD simulations can be used to isolate anthropogenic and water management effects from the natural hydrologic variation.