Parsing flows in the Sacramento-San Joaquin watershed:

what we don't know but need to know

Greg Gartrell, Jeffrey Mount, and Ellen Hanak

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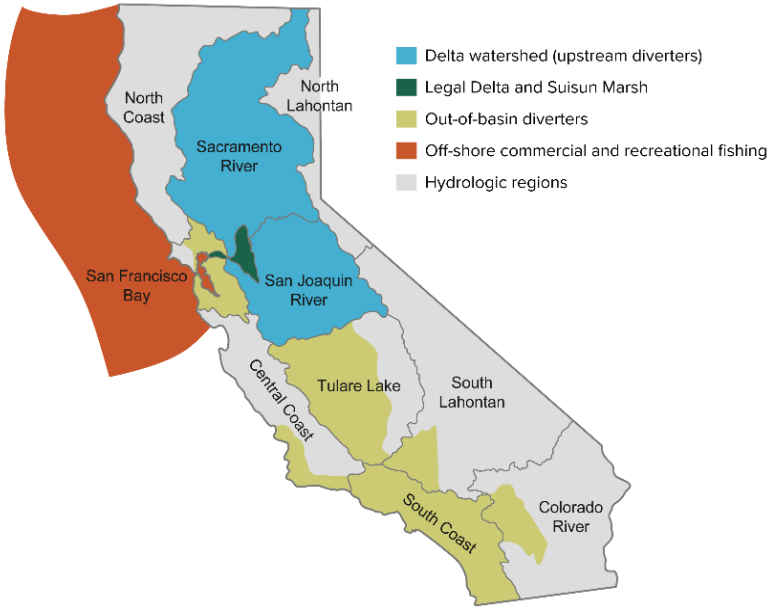
PPIC PUBLIC POLICY INSTITUTE OF CALIFORNIA

Objectives

- **1980-2021**: insights into recent dry and wet years
- **Looks upstream**: runoff, depletions upstream of Delta
- **Unpacks shifting trends**: climatic, regulatory effects
- **Recommends improvements**: for accounting, management

Most Californians rely on the Delta and its watershed



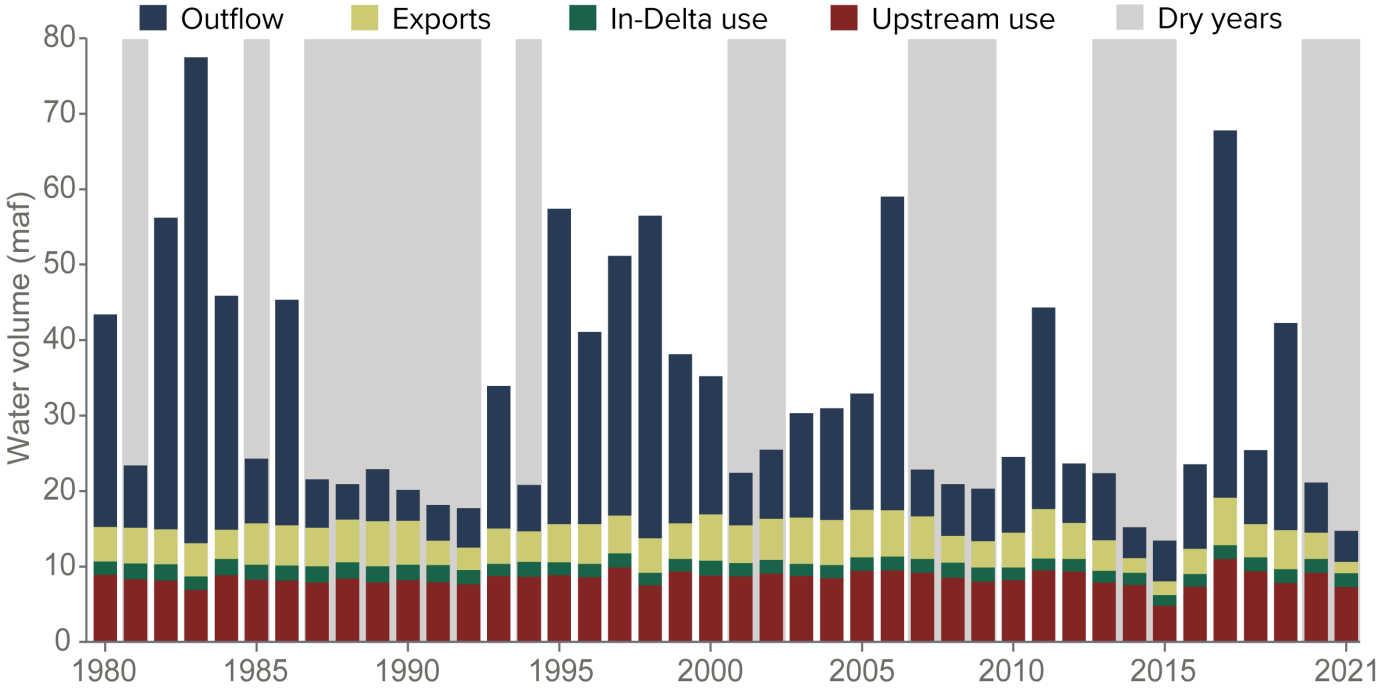
1980–2021 water accounts: sources, uses, outflow

- **Sources**
  - Runoff
  - Reservoir storage/releases
  - Delta inflow
  - Delta precipitation
- **Uses**
  - Upstream depletions (*annual, calculated by difference*)
  - In-Delta uses (farms, cities, nature)
  - Exports (SWP, CVP)

- **Delta outflow** (building block approach)*
  - "System" outflow for salinity
    - Export water quality
    - Delta M&I, ag standards
  - Ecosystem outflow (net increment)
    - Flows (D1641, CVPIA, VAMP, ESA)
    - Water quality (spring, fall X2)
    - Export pumping limits (various)
  - Uncaptured outflow

*Although system outflow also supports habitat, *it would be needed even if there were no ecosystem objectives for the Delta*.

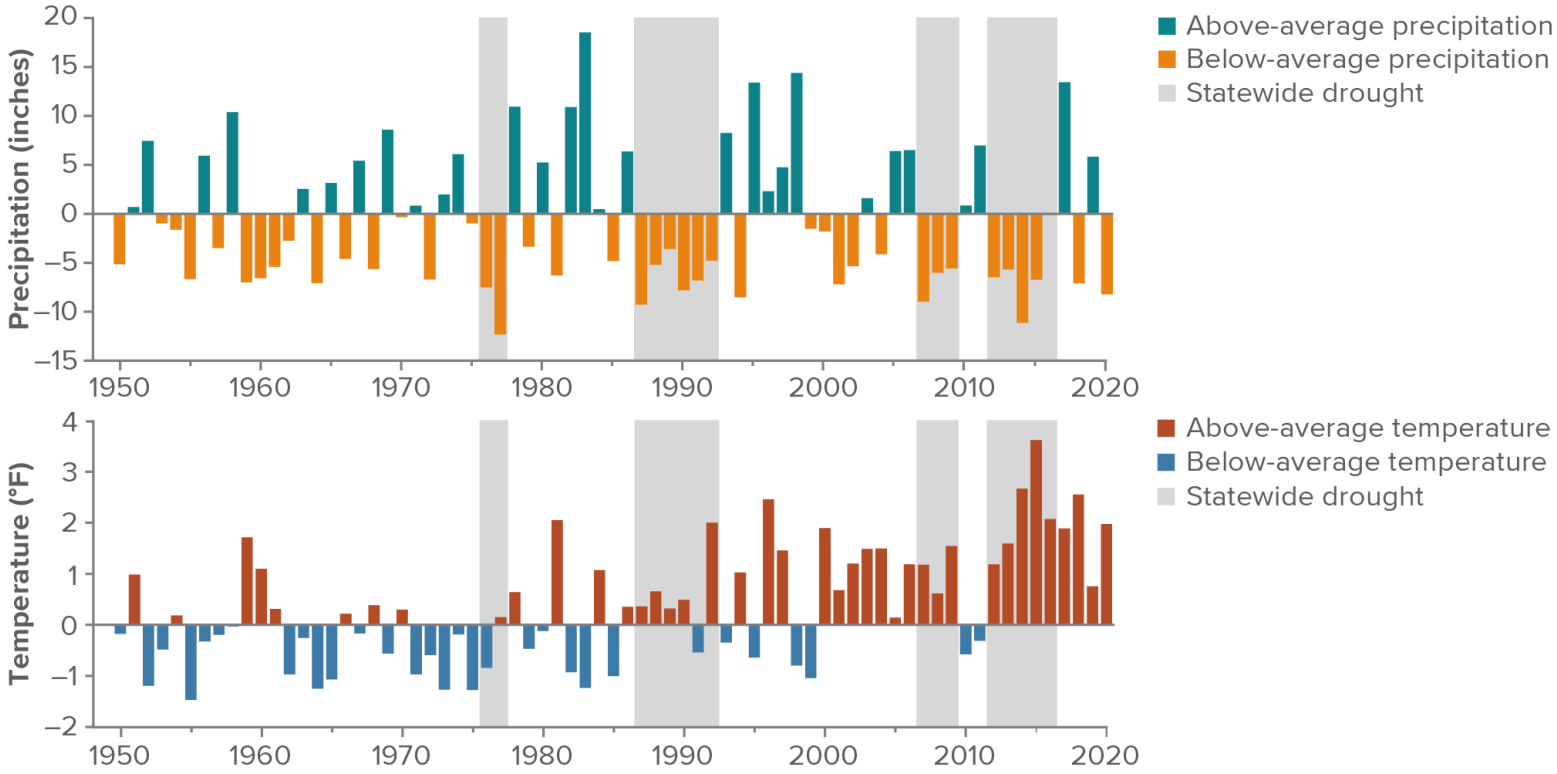
Water availability and uses in the Delta watershed have been changing



Prior to 1995, exports were highest in dry years, now they are lowest, especially since 2010

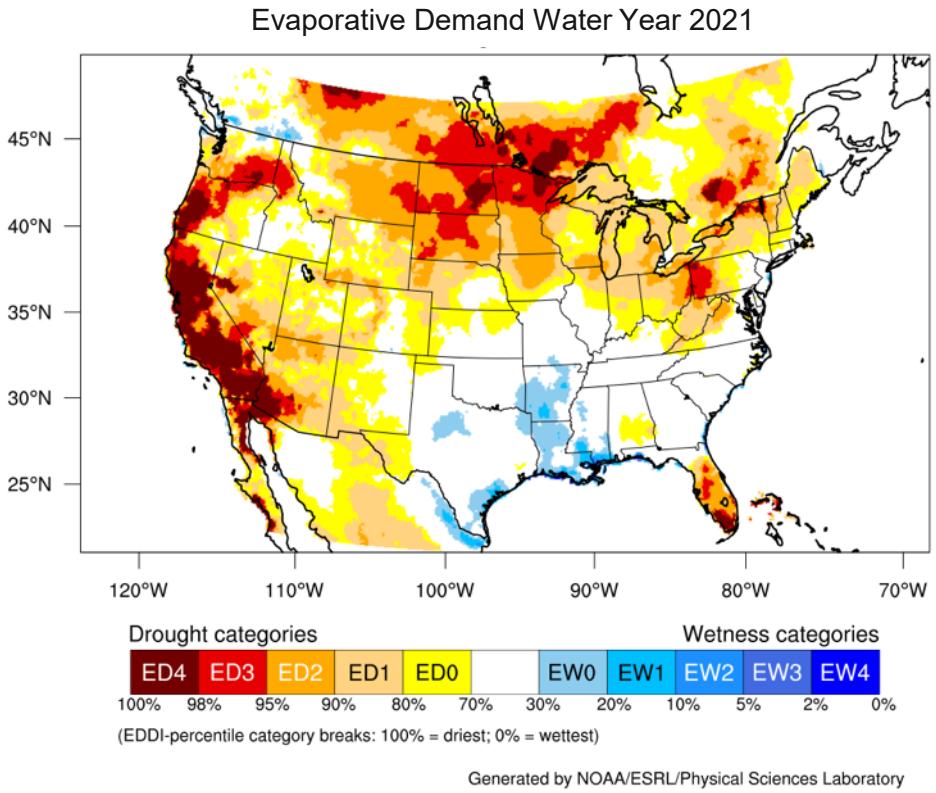
SOURCE: Uses and outflow: Technical Appendix A to this report and *PPIC Delta Water Accounting* spreadsheets; dry years: Department of Water Resources.

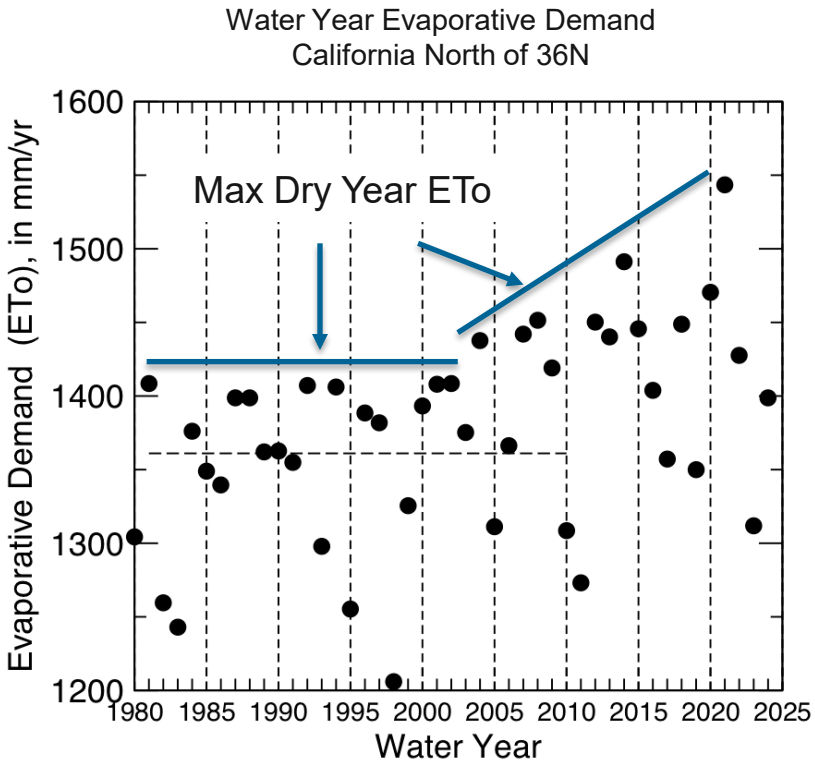
We are in the era of the hot drought



Source: Climate Tracker, Western Regional Climate Center 1980-2001 baseline

The big change: evaporative demand



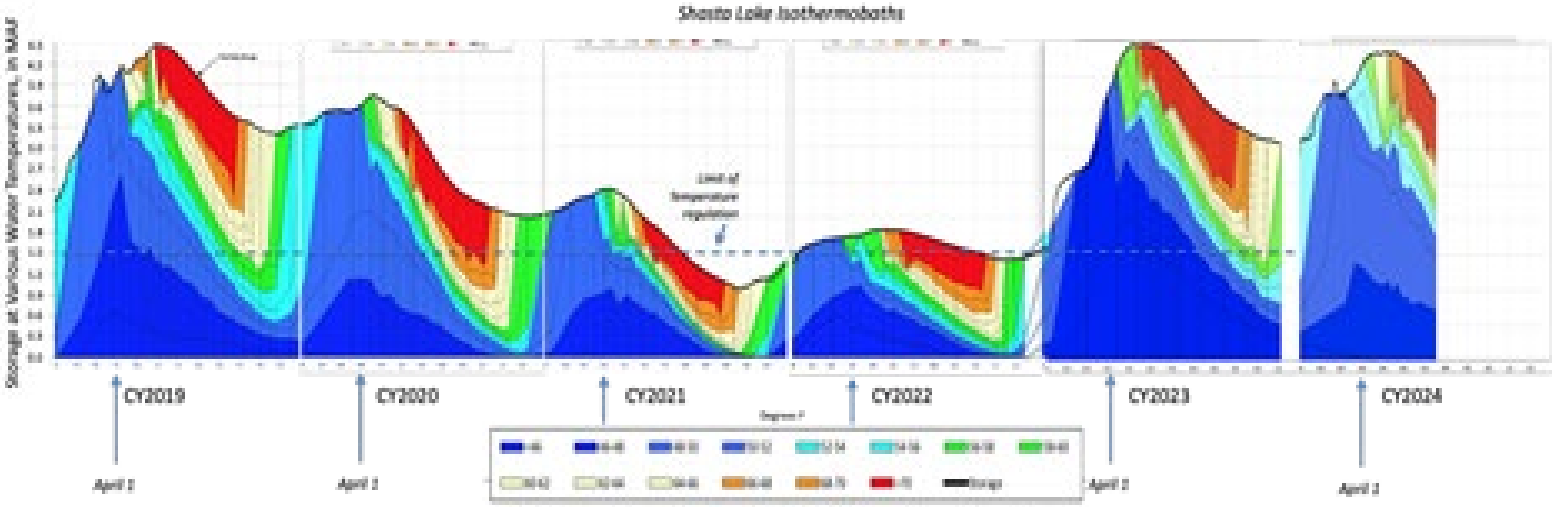


Source: Mike Dettinger, using data from Albano et al. (2022)

Storage and temperature: 2nd Law of Thermodynamics

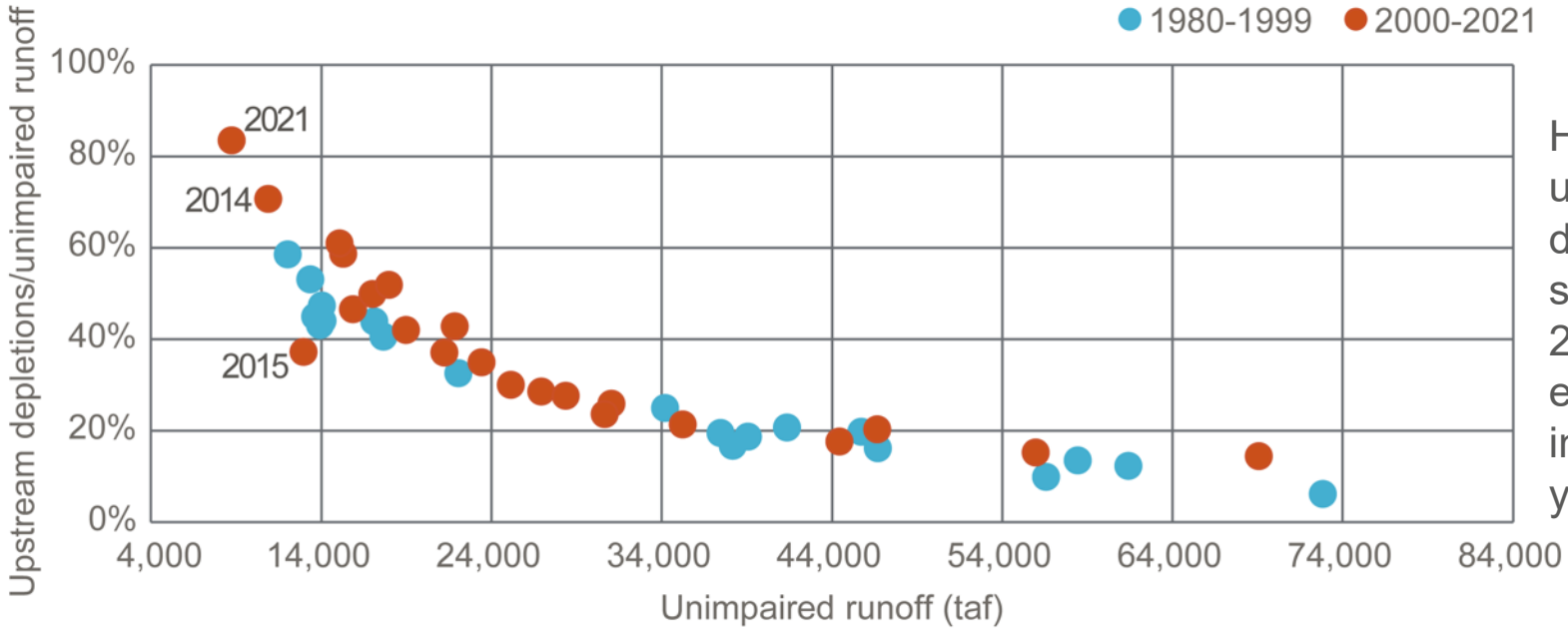
Cold-Water Drought in Lake Shasta

Here is how water temperatures & volumes in Lake Shasta have evolved (with depth) over the past several yrs.



Data source: https://www.usbr.gov/mp/cvo/temperature.html

Upstream depletions are increasing in dry years, reducing inflow to the Delta



Higher upstream depletions since 2000, especially in drier years

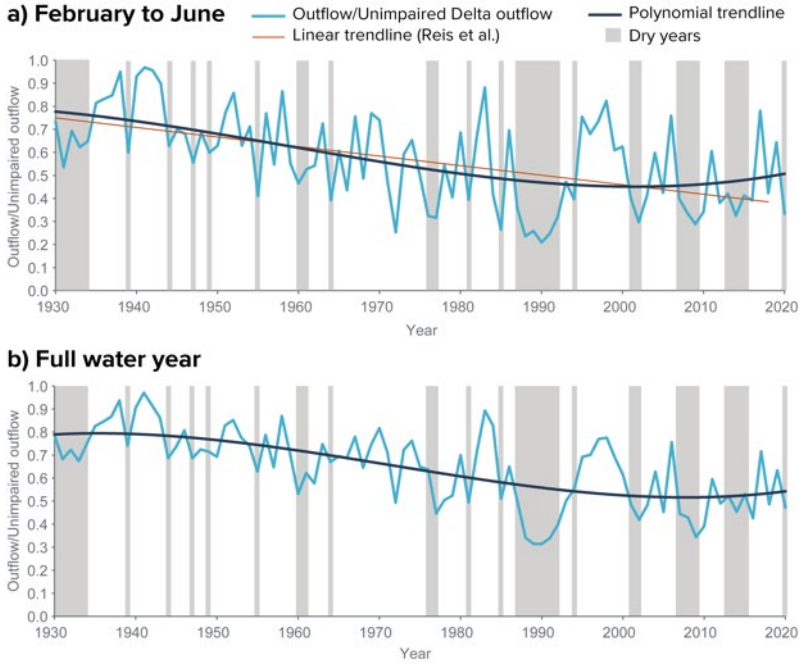
Comparing 1977 and 2021: Watershed Balance

Water	1977	2021
Unimpaired runoff + Delta Precip	7.2 maf	9.1 maf
Reservoirs and Imports	4.8 maf	5.6 maf
Upstream Depletions	6 maf	7.6 maf
Delta inflow	6 maf	7.1 maf
Delta Depletions	1.7 maf	1.7 maf
Exports	2.1 maf	1.5 maf
Delta Outflow	2.5 maf	4.1 maf

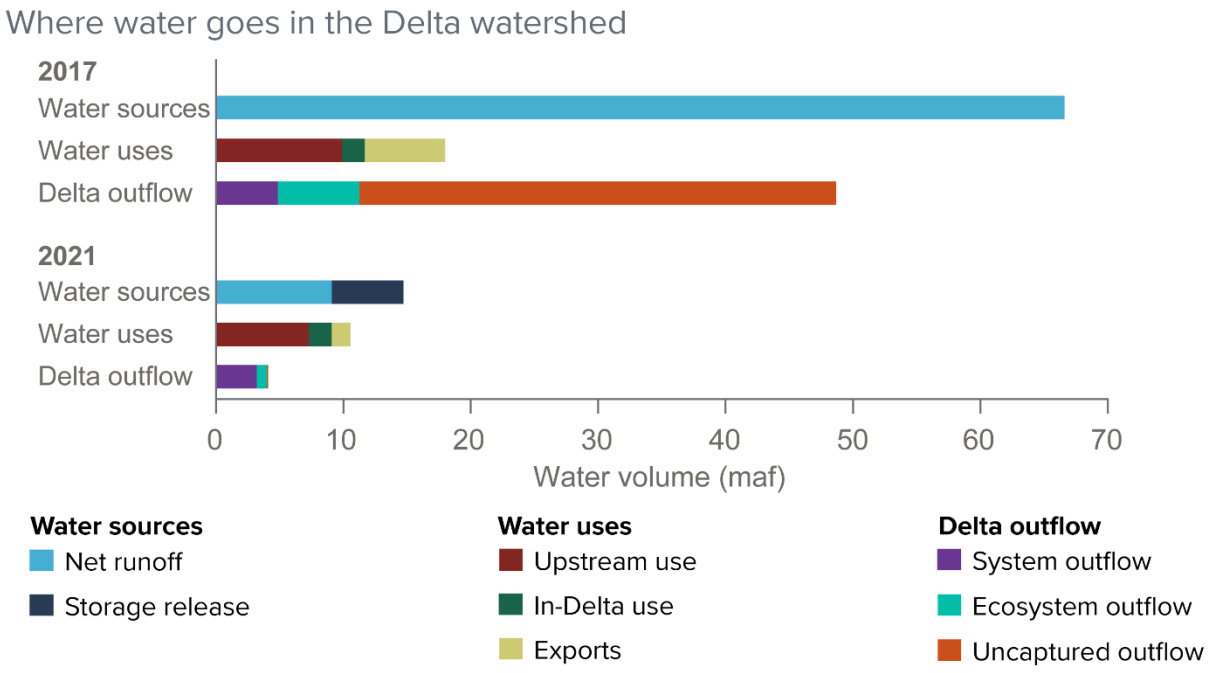
Outflow trends have changed

- Since early 1990s, more outflow is needed to meet salinity standards
- Ecosystem regulations post 1995, 2008 also increased outflow share; species declines continue
- Both trends—plus increases in upstream use—are increasing pressure on CVP, SWP reservoirs
- Uncaptured outflow makes up the bulk of outflow during wet years

Delta Outflow/Unimpaired Outflow

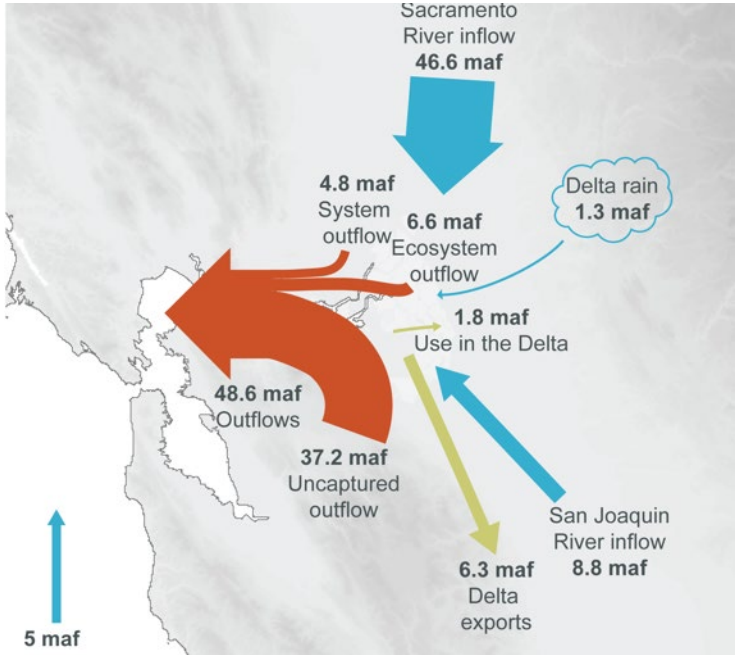


Comparing Delta flows in recent wet and dry years



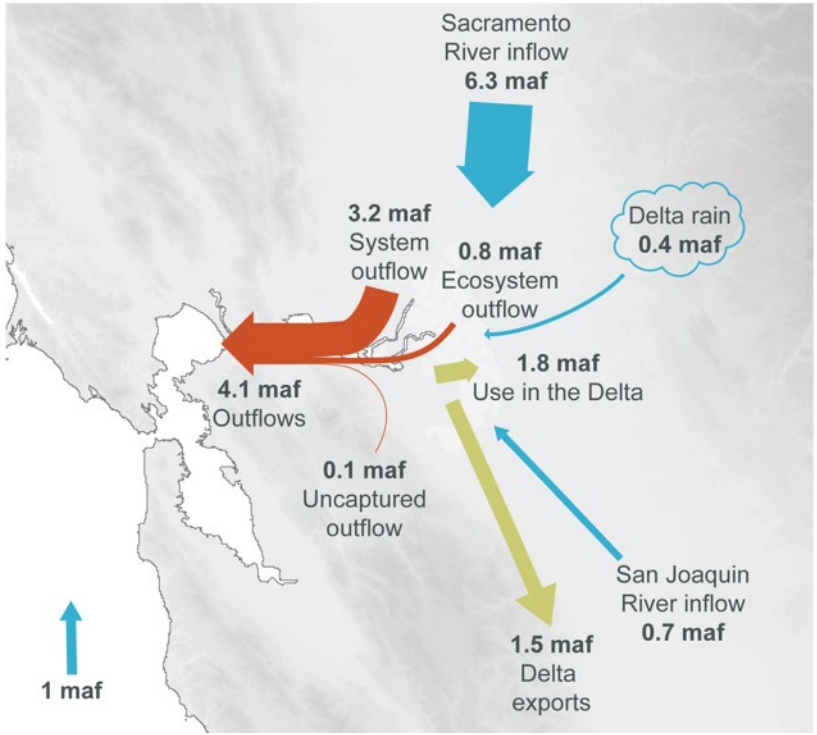
Wet year sources and uses: 2017

- Just over a quarter of runoff went to uses: upstream (15%), in-Delta (3%), exports (10%)
- Less than a fifth went to regulatory outflow: ecosystem (10%), system (7%)
- More than half (55%) became uncaptured outflow
- Lack of storage south of Delta limited export pumping by > 400,000 af



Dry year sources and uses: 2021

- 84% of unimpaired runoff was used upstream of the Delta
- 16% of unimpaired runoff was used in-Delta
- Ecosystem + system outflow, exports came from CVP, SWP reservoirs
- Salinity barrier and Temporary Urgency Change orders helped



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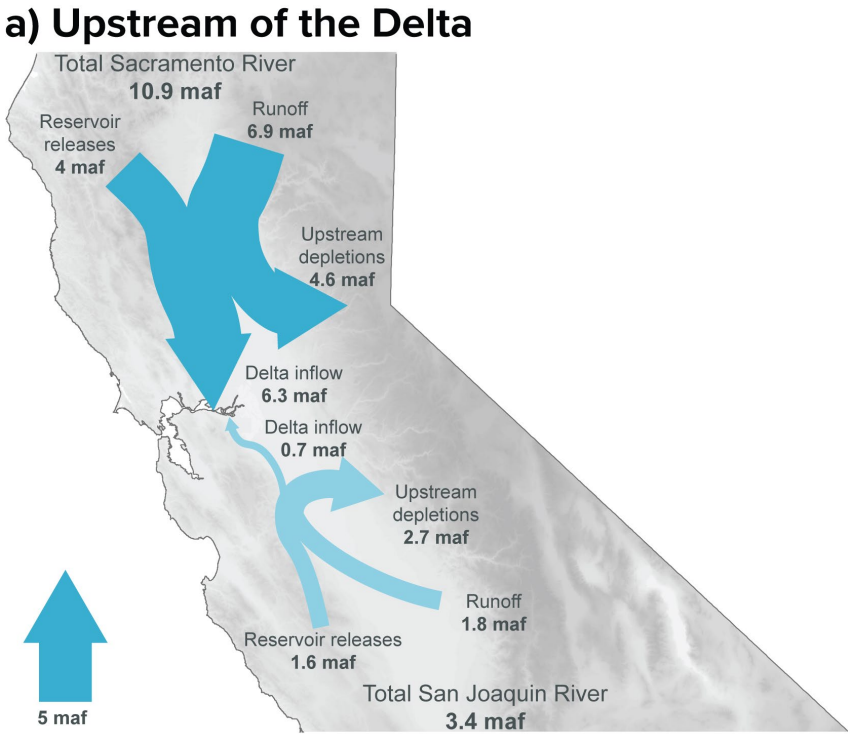

Where we need more information

- **Sources of higher accuracy**
  - Runoff
  - Reservoir storage/releases
  - Delta inflow
  - Delta precipitation
  - Exports (SWP, CVP)
- **Uses: low accuracy or by difference**
  - Upstream depletions
    - Diversions, seepage, ET
  - In-Delta uses (farms, cities, nature)
  - Delta outflow
- **Delta outflow**
  - "System" outflow for salinity
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    - Export pumping limits (various)
    - Requires outflow/salinity relationships
    - Outflow by difference
  - Uncaptured outflow by difference

Depletions vs. Consumptive Use

- **In the Delta**
  - Annual: methods are similar
  - Monthly to daily: differ by ~1000 cfs
  - Matters when salinity is important
  - Matters when outflow controls
- **Uses: low accuracy or by difference**
  - Upstream depletions
    - Diversions, seepage, ET
  - In-Delta uses (farms, cities, nature)
  - Unmeasured sources/sinks
- **Delta outflow**
  - Water quality
  - Modeling water quality
  - High risk of errors or mysteries (1987-88)
  - Annual: CU probably ok
  - Daily or Monthly operations: Depletions
- **Upstream Depletions or CU**
  - Water right monitoring
  - Reservoir operations
  - Effects of Climate Change

How to get better estimates?

1. **Improve upstream water accounting**
   - Overall accretions and depletions
   - Measure and report diversions (all)
   - Measure and report return flows (all)
   - Et real-time estimates
   - Groundwater changes (especially near rivers)
   - Other: precip, valley runoff

2. **Delta accounting**
   - Need for both channel depletions AND consumptive use
   - Seepage
   - Precipitation
   - Direct diversions
   - Return flows
   - Soil moisture changes
   - Et real-time estimates

What does better accounting give us

3. Real-time estimates

- Delta outflow
- Model calibration on a daily basis
- Salinity management
- Water management

4. Dry year management

- Water right priorities
- Extraordinary measures: are they working?
- Management of:
  - HABs
  - Special species
  - Ecosystem
  - Future plans with stressed system

Thank you!

Photo C. Jeffres

For more information about this study

- Policy brief (6 pages)
- Technical appendix (detailed analysis--~50 pages)
- Data Set
- Commentary in CalMatters (1-page highlights)

About these slides

These slides were created to accompany a presentation. They do not include full documentation of sources, data samples, methods, and interpretations. To avoid misinterpretations, please contact:

Greg Gartrell (greggartrell@ix.netcom.com)

Ellen Hanak (hanak@ppic.org)

Jeff Mount (mount.jeffrey@gmail.com)

Thank you for your interest in this work.