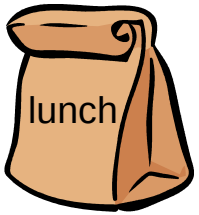
The Delta Science Program and the Ecosystem Restoration Program Joint Brown Bag Seminar Series



Analytical Tools to Evaluate System-wide Changes since the 2006 Water Quality Control Plan

Delta Watershed Unimpaired Flow Index

December18, 2012

Walter Bourez, P.E.

MBK ENGINEERS

Overview of Presentation

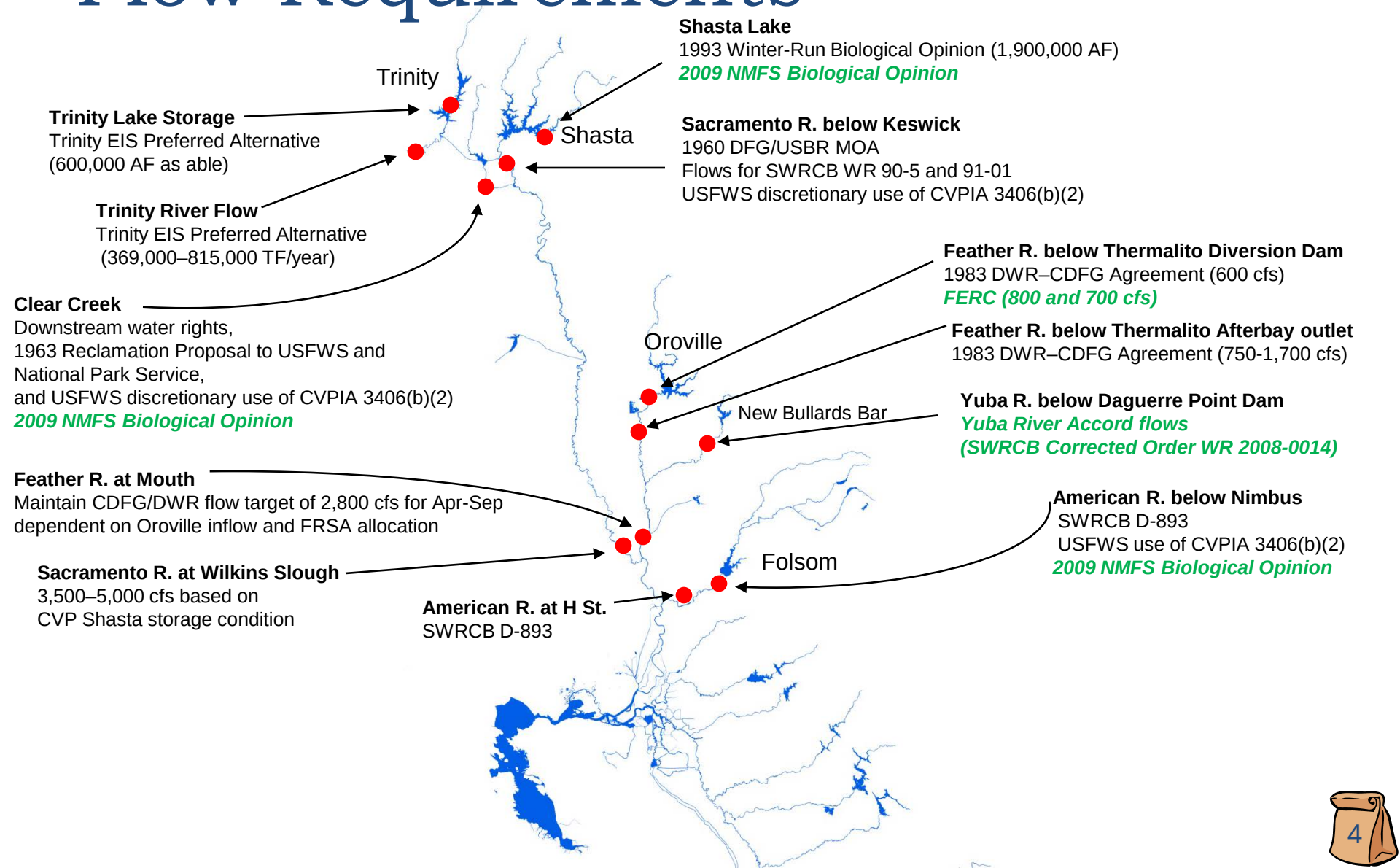
- System-wide changes within the Bay-Delta watershed since 2006 WQCP
  - Post-2006 Biological Opinions ("BiOps")
  - Need for analytical tools to recognize changes
- Explanation of available analytical tools with application to the BiOps and potential short duration spring pulse flows in the Sacramento River.
- Limitations on use of estimated unimpaired flow index
  - Conceptual quantity based on many assumptions, correlations, and projections
  - One example: Sacramento Basin unimpaired flow

What Has Changed Since 2006?

- Since adoption of the 2006 WQCP there have been significant changes in water system operations within the Bay-Delta watershed.
  - Changes to Yuba River pursuant to Yuba Accord
  - Changes to Feather River pursuant to Oroville FERC relicensing proceeding
  - Others

- The most significant changes have resulted from implementation of the BiOps.
  - On average, the BiOps have resulted in approximately 1,000,000 acre-feet of additional Delta outflow over the levels required under the 2006 WQCP.

Existing Sacramento Basin Flow Requirements



Shasta Lake
1993 Winter-Run Biological Opinion (1,900,000 AF)
2009 NMFS Biological Opinion

Trinity Lake Storage
Trinity EIS Preferred Alternative
(600,000 AF as able)

Sacramento R. below Keswick
1960 DFG/USBR MOA
Flows for SWRCB WR 90-5 and 91-01
USFWS discretionary use of CVPIA 3406(b)(2)

Trinity River Flow
Trinity EIS Preferred Alternative
(369,000–815,000 TF/year)

Feather R. below Thermalito Diversion Dam
1983 DWR–CDFG Agreement (600 cfs)
FERC (800 and 700 cfs)

Clear Creek
Downstream water rights,
1963 Reclamation Proposal to USFWS and National Park Service,
and USFWS discretionary use of CVPIA 3406(b)(2)
2009 NMFS Biological Opinion

Feather R. below Thermalito Afterbay outlet
1983 DWR–CDFG Agreement (750-1,700 cfs)

Yuba R. below Daguerre Point Dam
Yuba River Accord flows
(SWRCB Corrected Order WR 2008-0014)

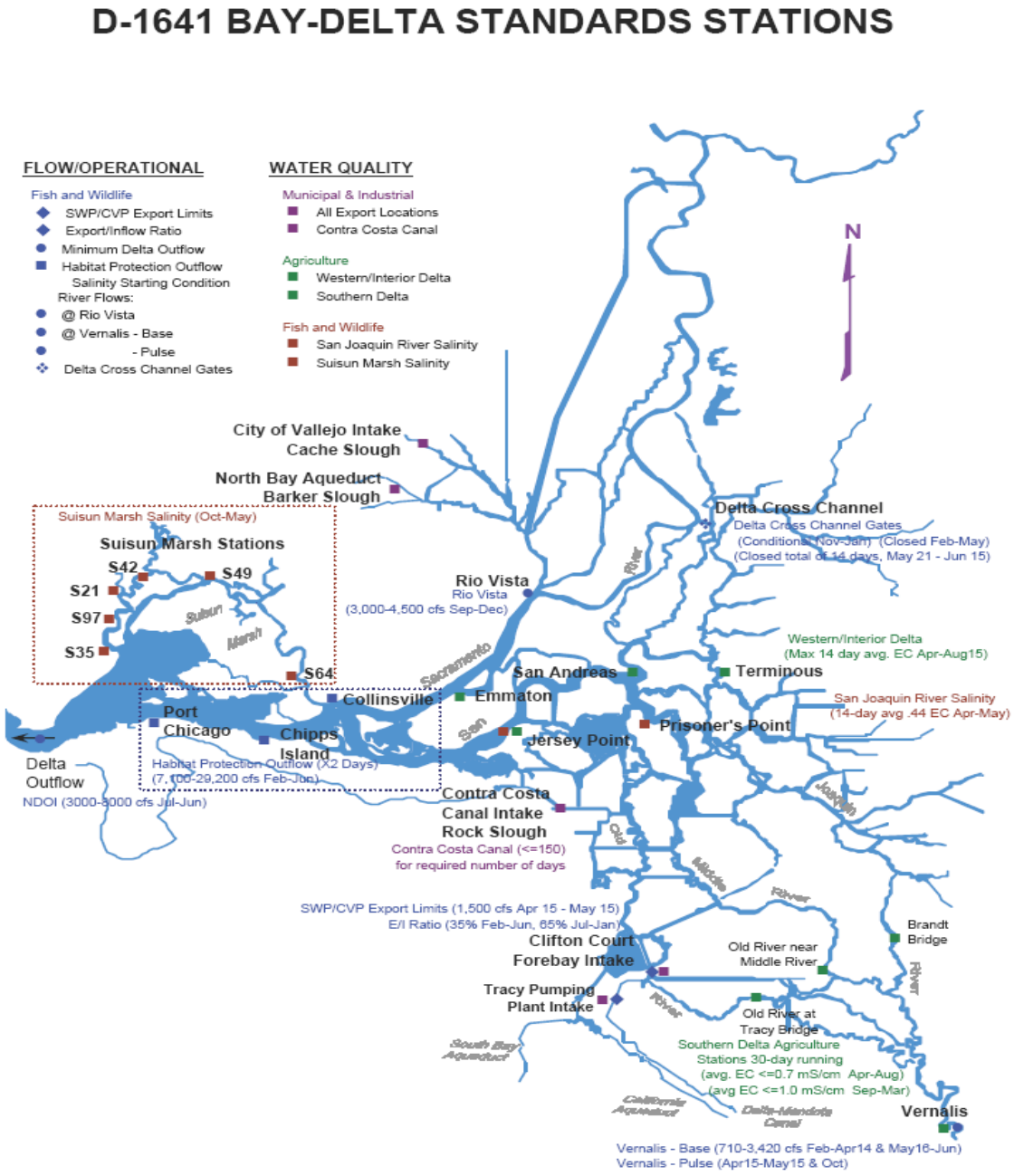
Feather R. at Mouth
Maintain CDFG/DWR flow target of 2,800 cfs for Apr-Sep dependent on Oroville inflow and FRSA allocation

American R. below Nimbus
SWRCB D-893
USFWS use of CVPIA 3406(b)(2)
2009 NMFS Biological Opinion

Sacramento R. at Wilkins Slough
3,500–5,000 cfs based on
CVP Shasta storage condition

American R. at H St.
SWRCB D-893

D-1641 Bay-Delta Standards Stations



Operations Compliance and Studies Section

5/7/2002

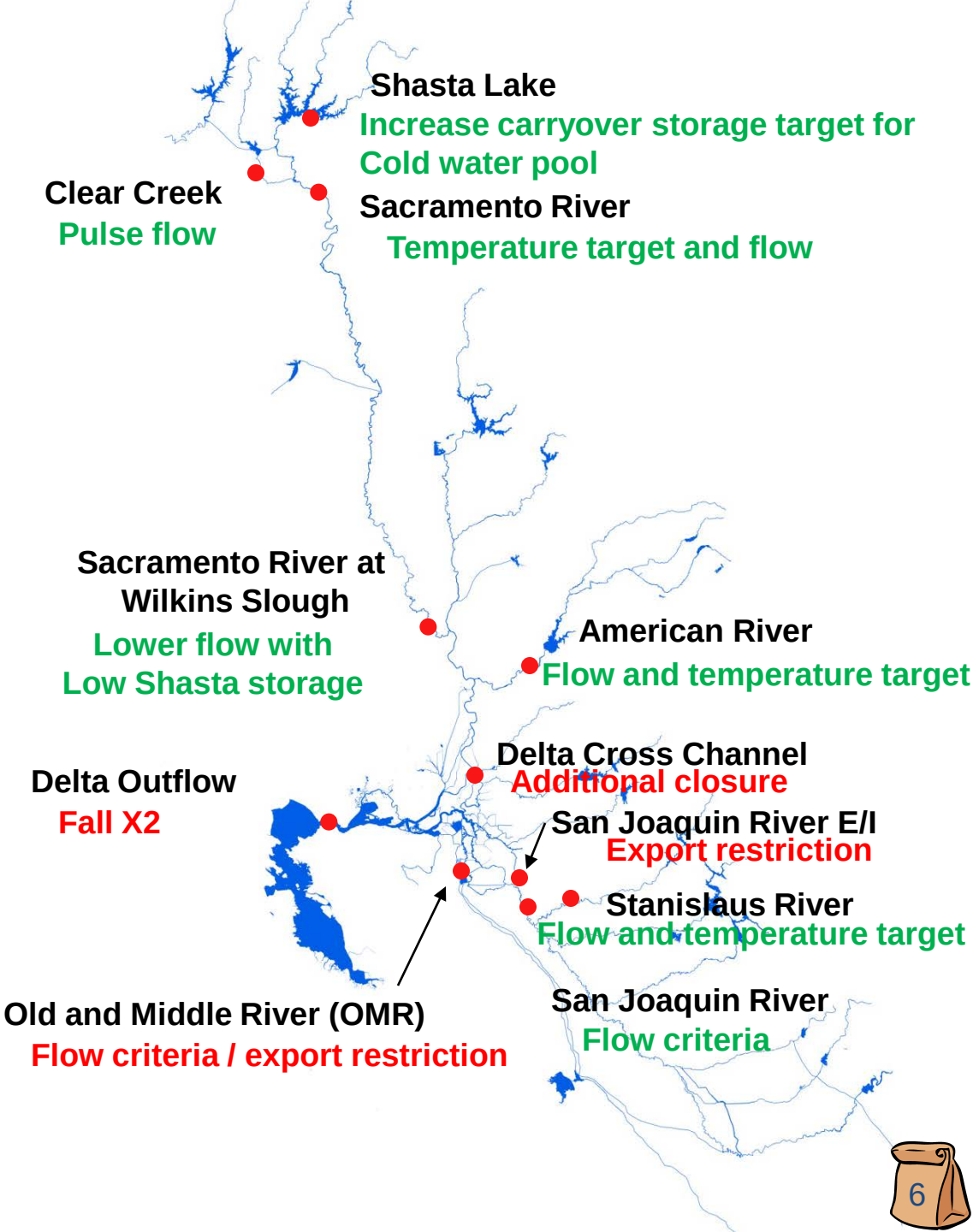
Preliminary: Subject to Revision

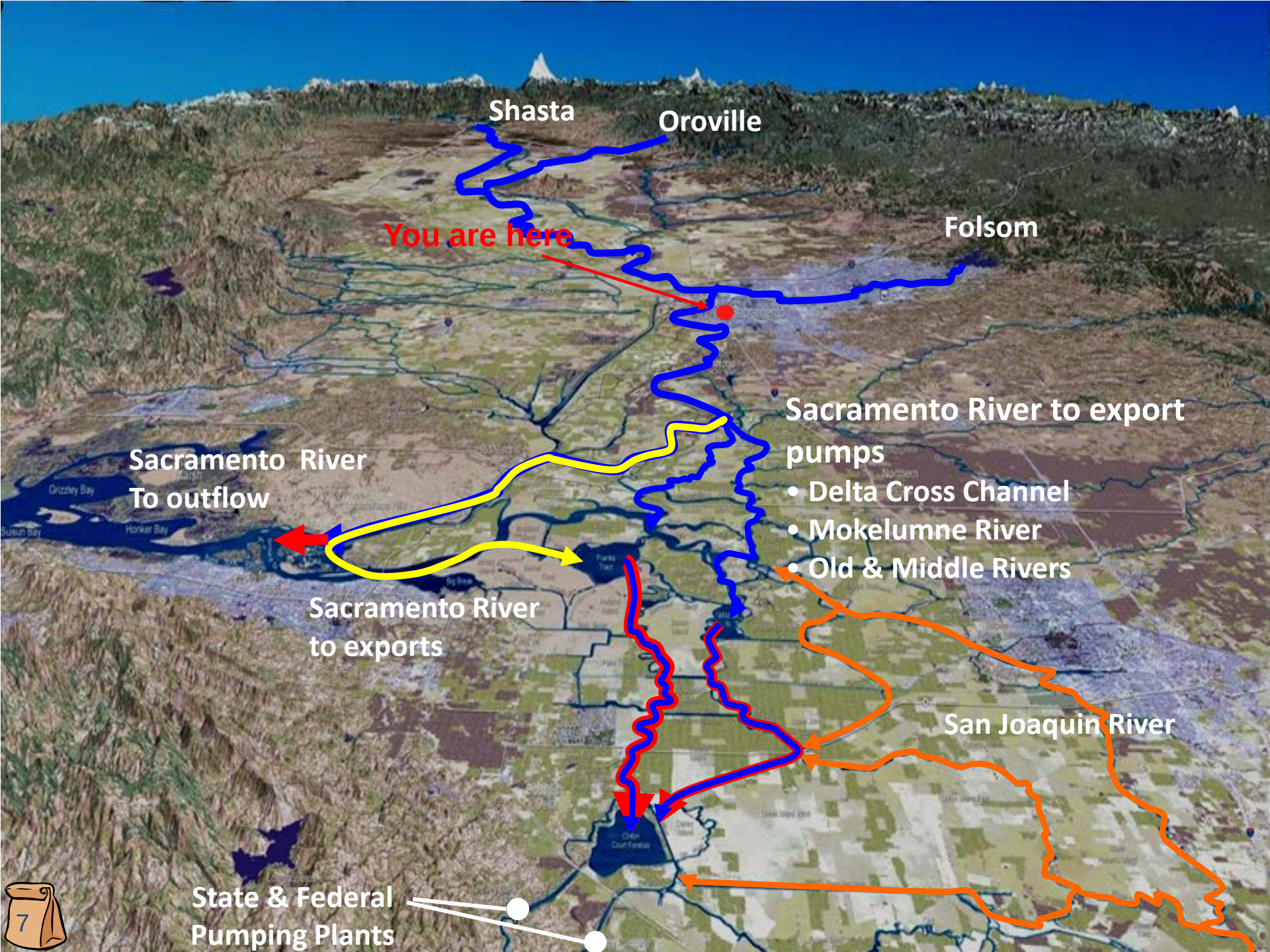
New Terms From BiOps

- **Salmon BiOp RPA**
- **Smelt BiOp RPA**

Addressed in analysis

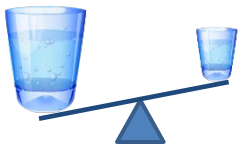
Not addressed in analysis




Shasta
Oroville
You are here
Folsom
Sacramento River to export pumps
• Delta Cross Channel
• Mokelumne River
• Old & Middle Rivers
Sacramento River To outflow
Sacramento River to exports
San Joaquin River
State & Federal Pumping Plants

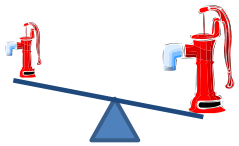
Key Features of CVP/SWP

CVP 8 MAF | SWP 3.5 MAF

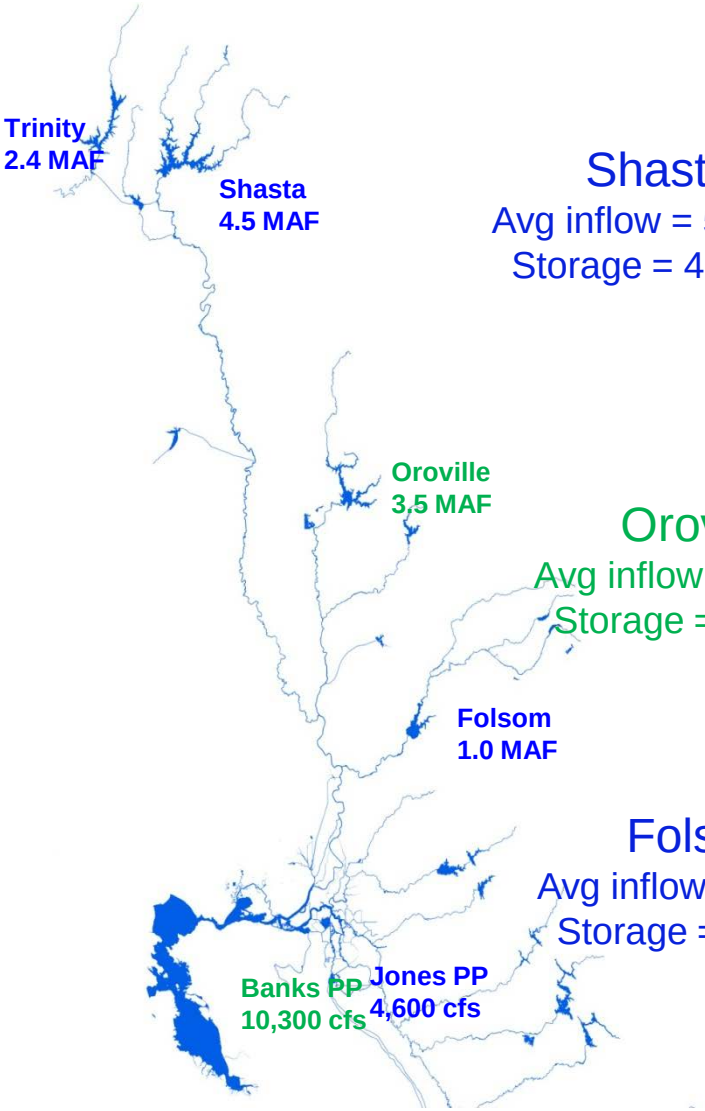


Upstream storage

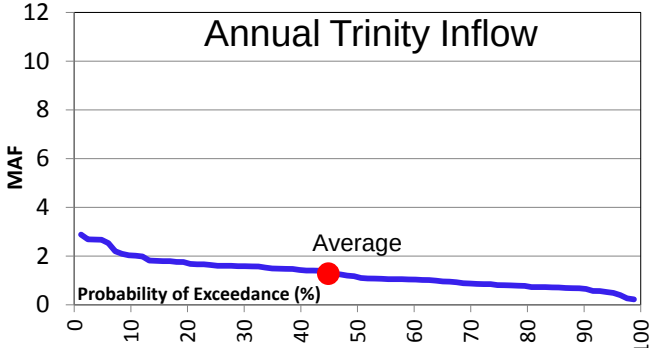
CVP 4600 cfs | SWP 6680 cfs 8500 cfs



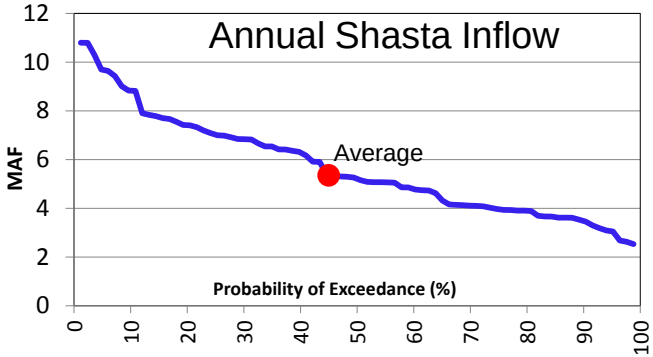
Export Capacity



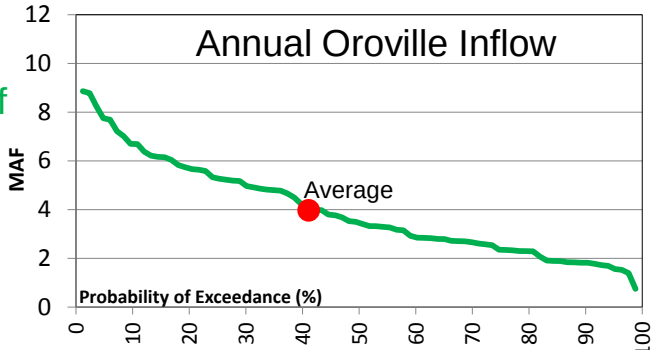
Trinity
Avg inflow = 1.3 maf
Storage = 2.4 maf



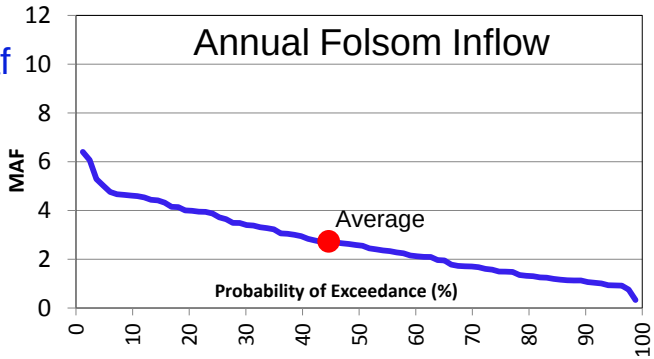
Shasta
Avg inflow = 5.7 maf
Storage = 4.5 maf



Oroville
Avg inflow = 4.0 maf
Storage = 3.5 maf



Folsom
Avg inflow = 2.7 maf
Storage = 1.0 maf



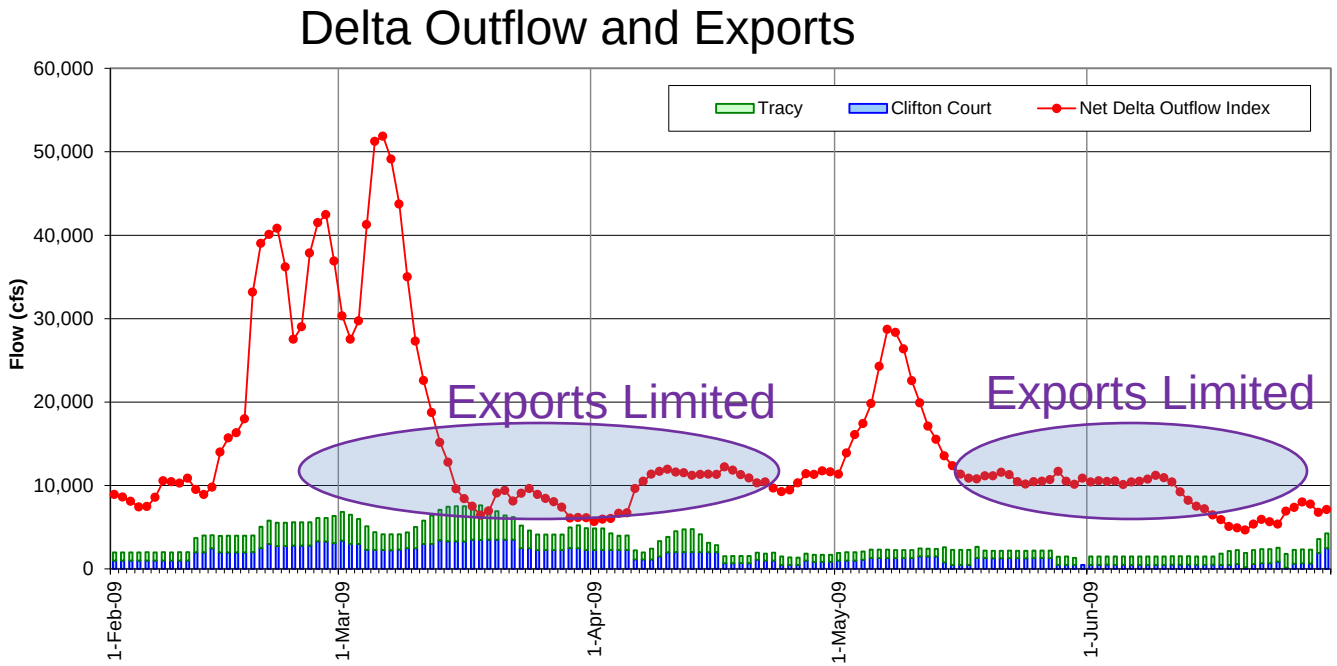
Recent Operations With Court Ordered OMR Requirements

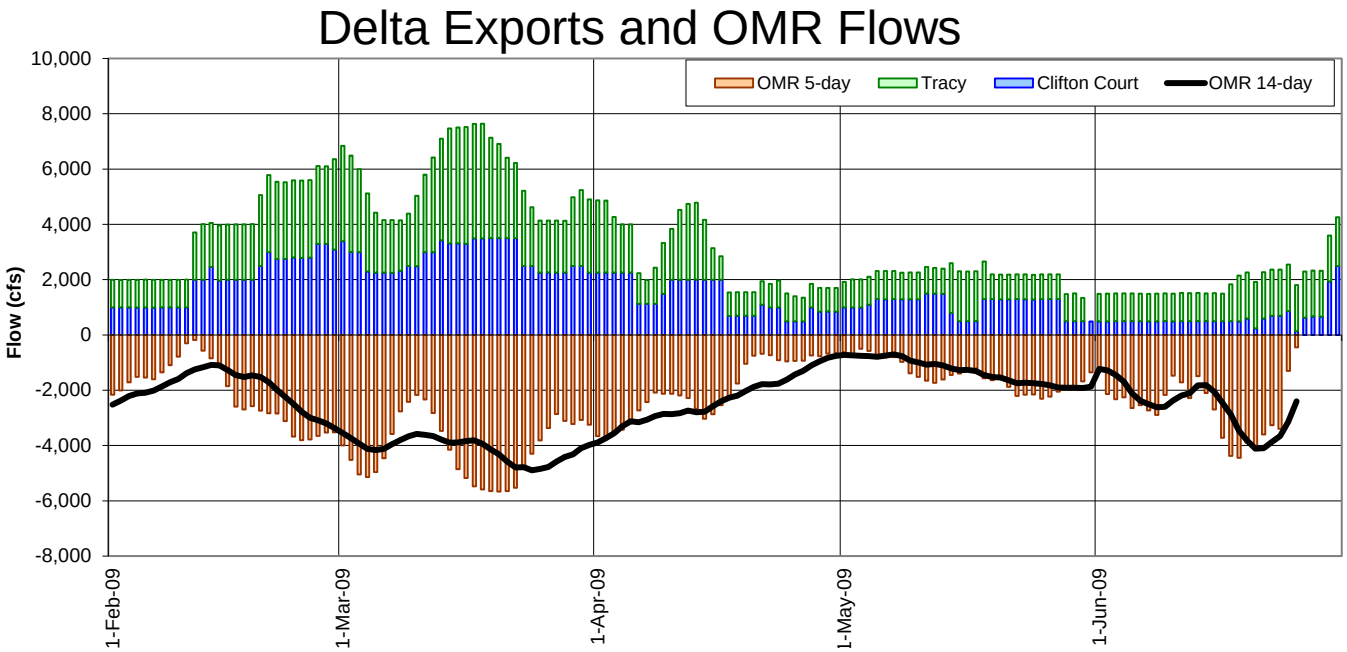
Daily from

February 1, 2009

To

June 28, 2009





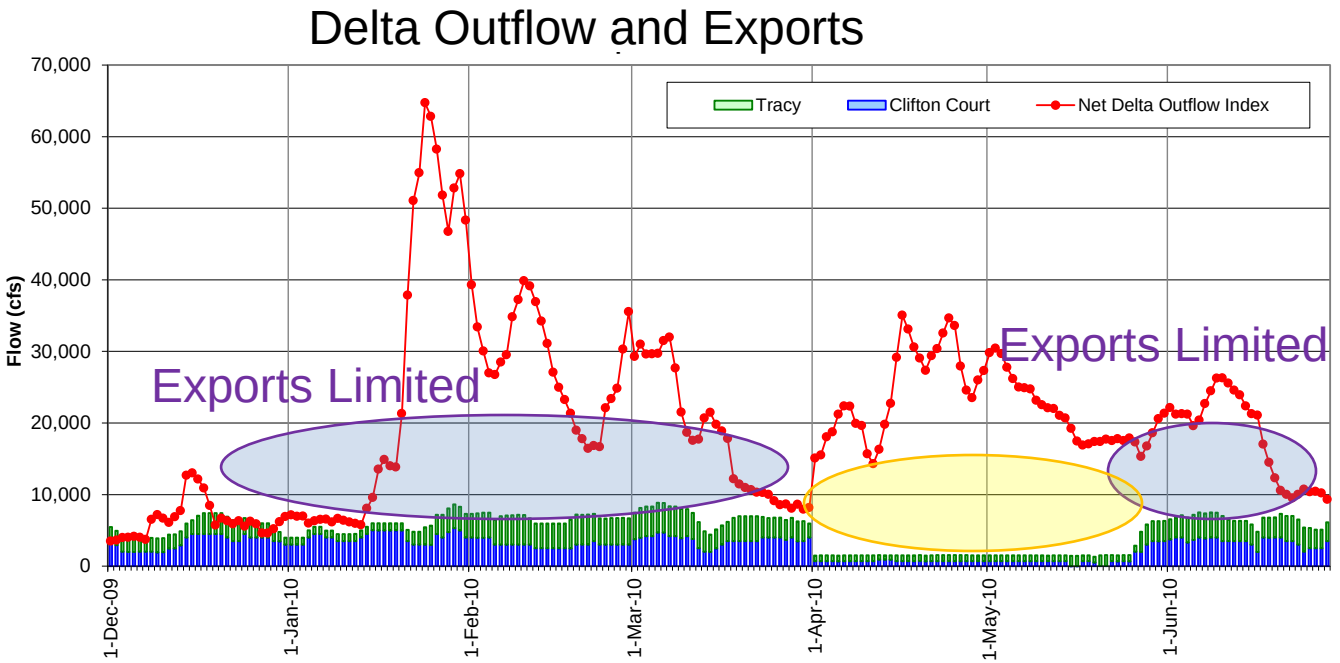
Recent Operations With OMR Requirements

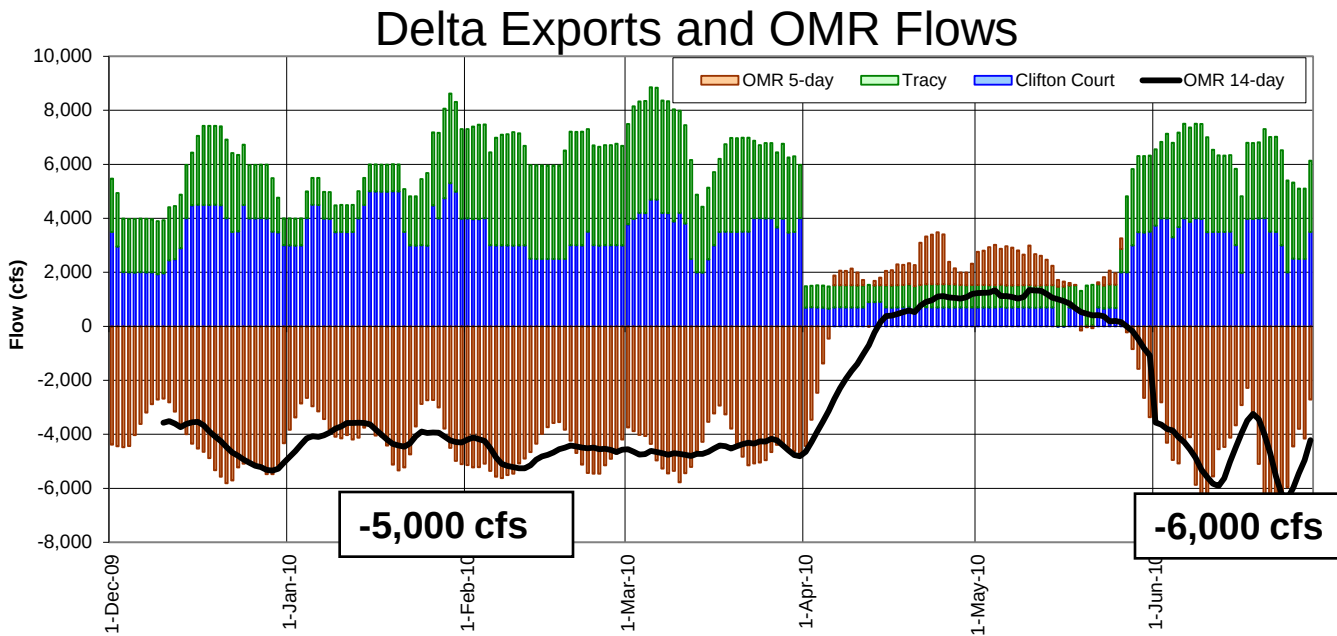
Daily from

December 1, 2009

To

June 28, 2010





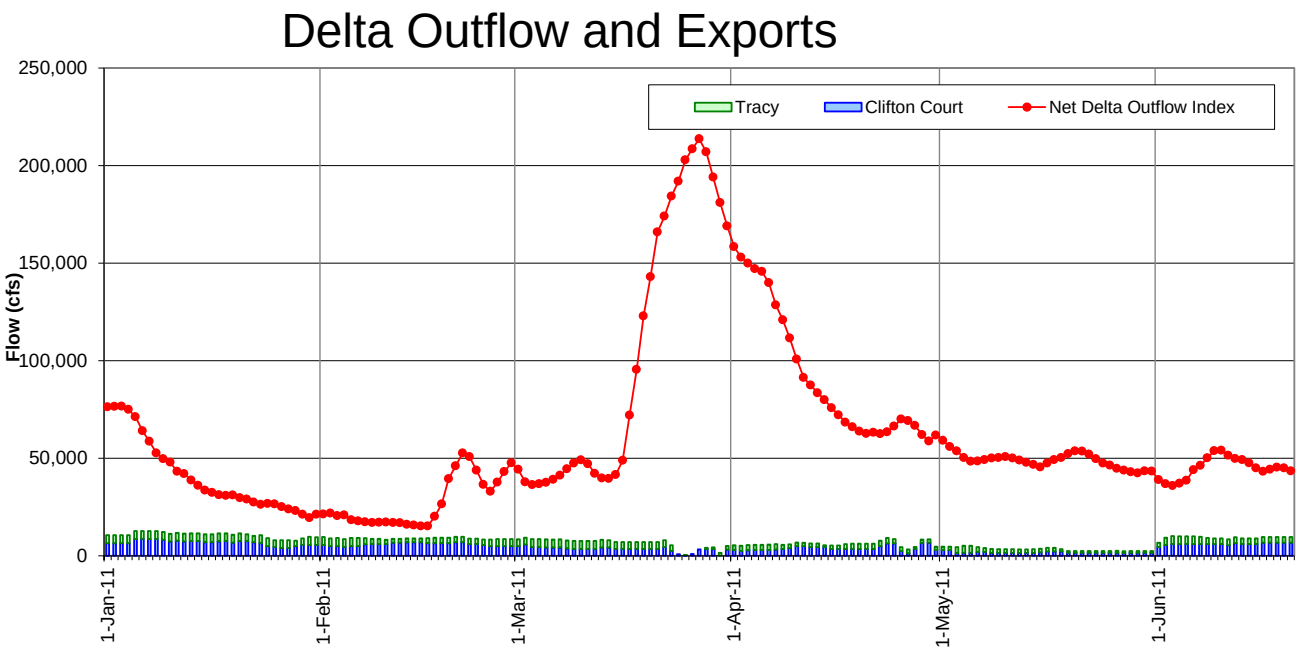
Recent Operations With Court Ordered OMR Requirements

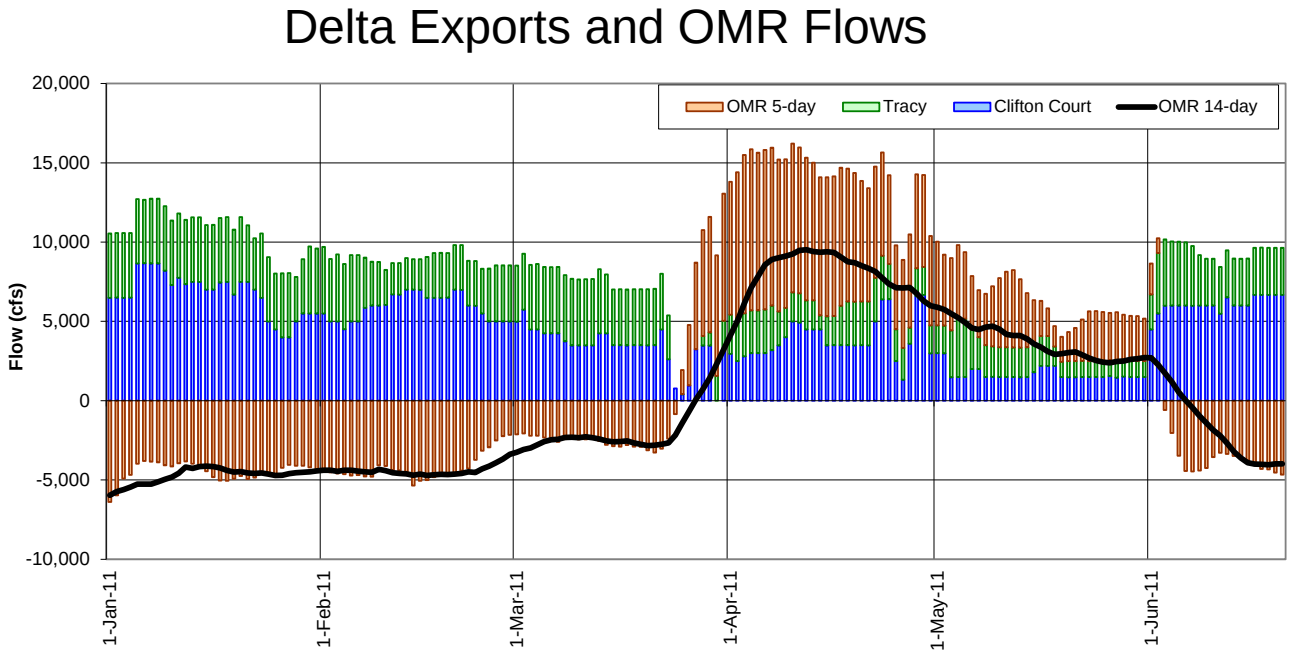
Daily from

January 1, 2011

To

June 20, 2011





Recent Operations With Court Ordered OMR Requirements

Daily from

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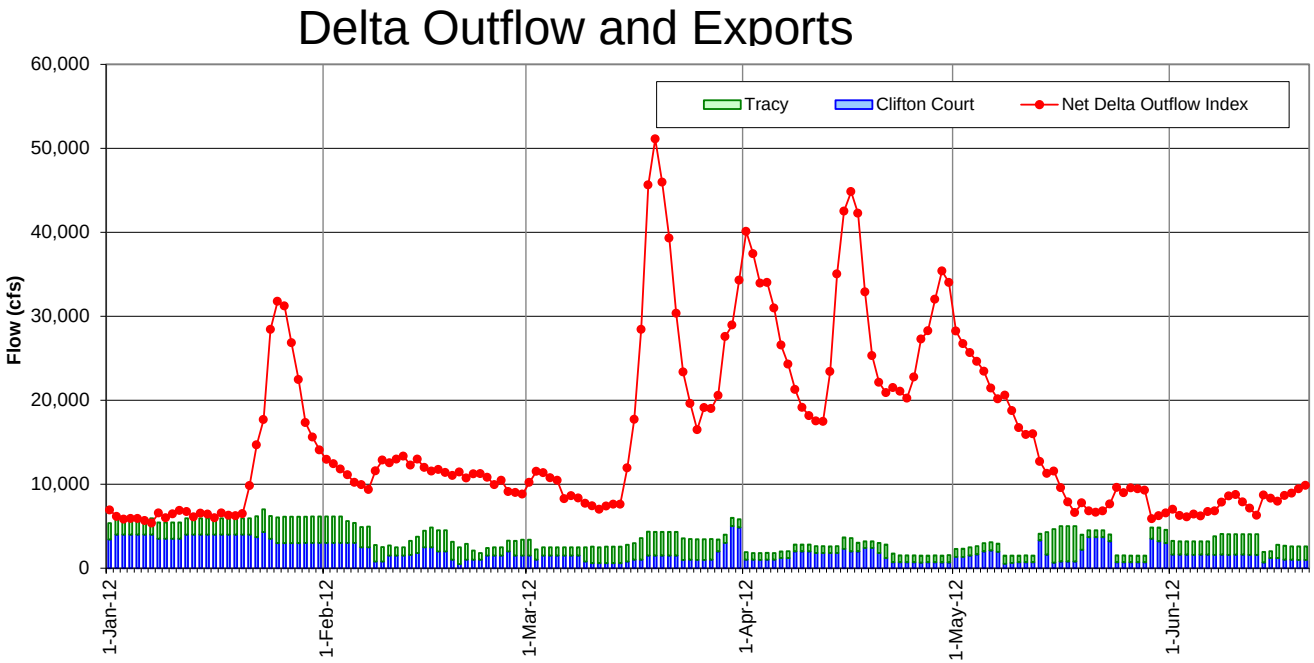
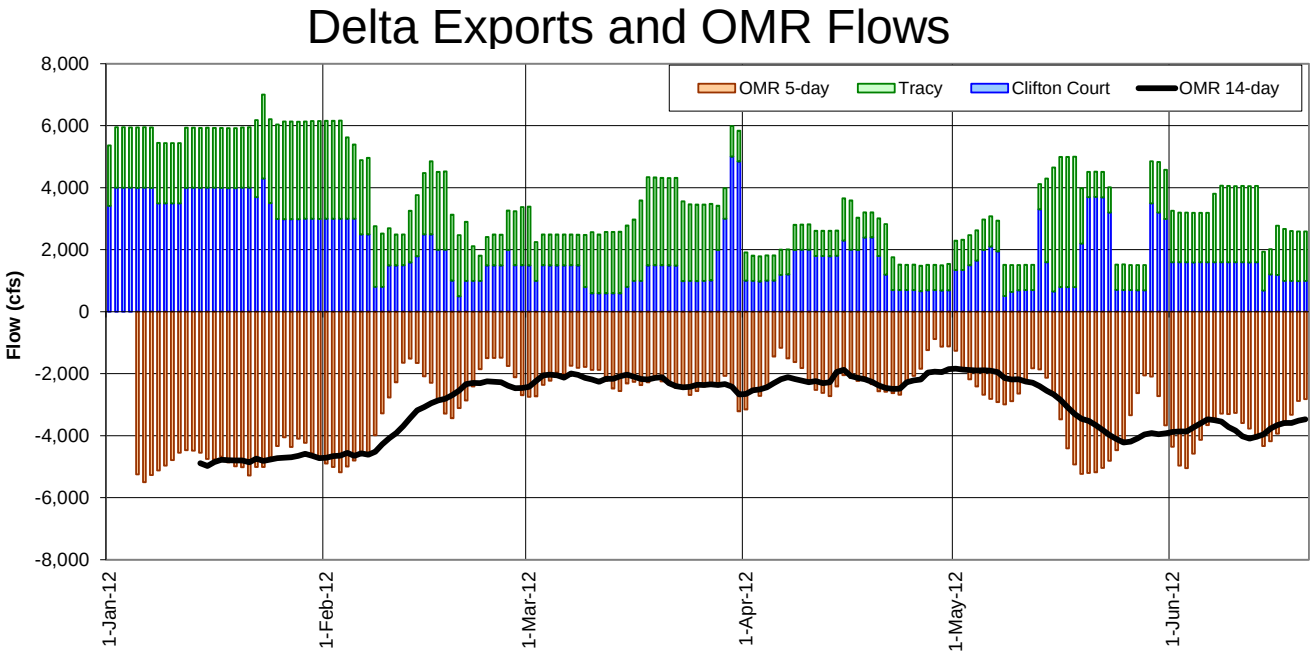
To

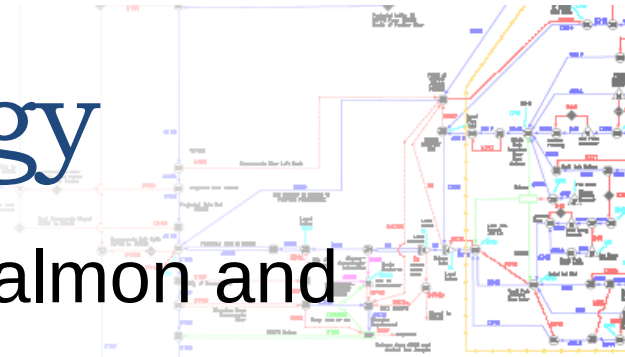
June 20, 2012





Modeling Methodology

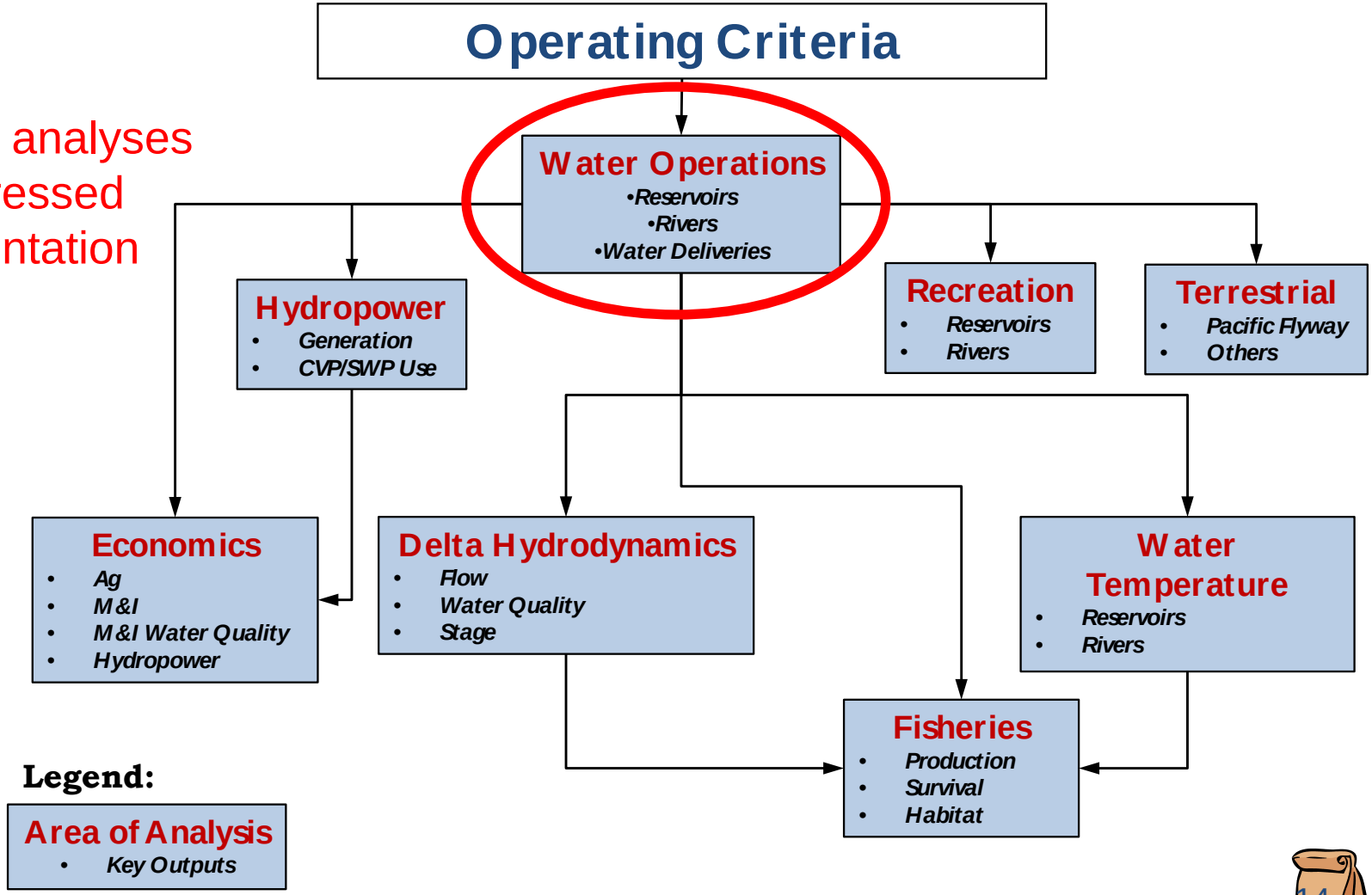
- Model system operations without Salmon and Smelt BiOps
- Model system operation with Salmon and Smelt BiOps
- Compare model runs to assess operational changes to CVP/SWP system
- Use 2011 State Water Project Delivery Reliability Report CalSim II modeling



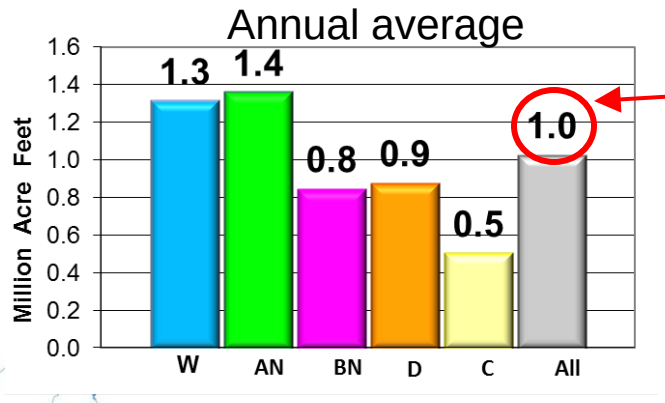
Example: Hydrologic and Effects Modeling

This analysis focuses on water operations using CalSim II

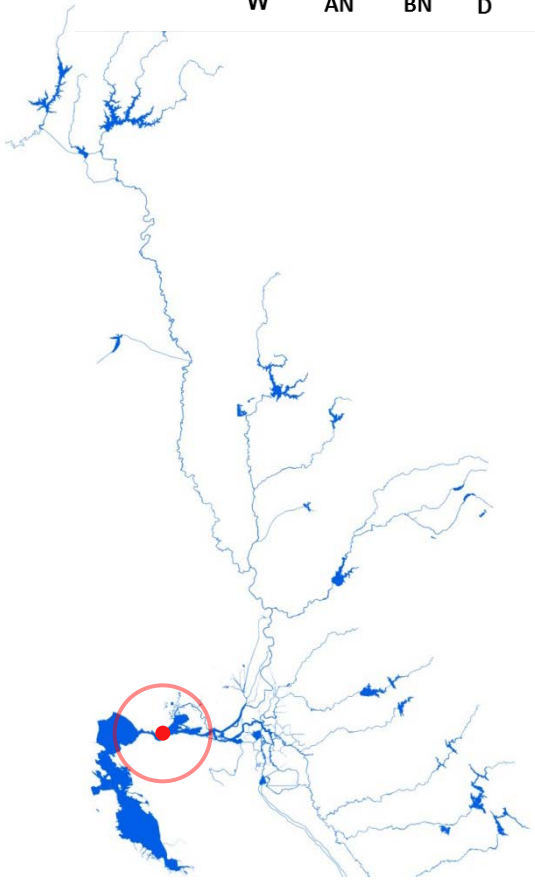
Subsequent analyses are not addressed in this presentation

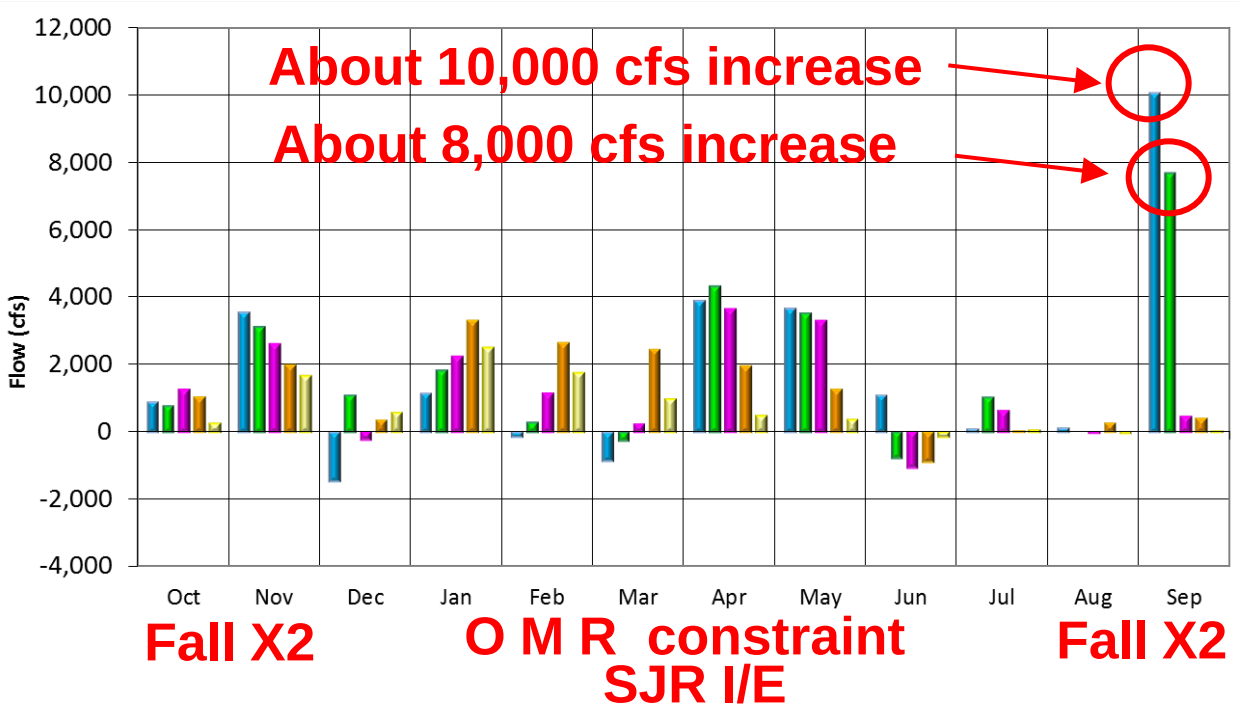


Delta Outflow Changes with BiOps

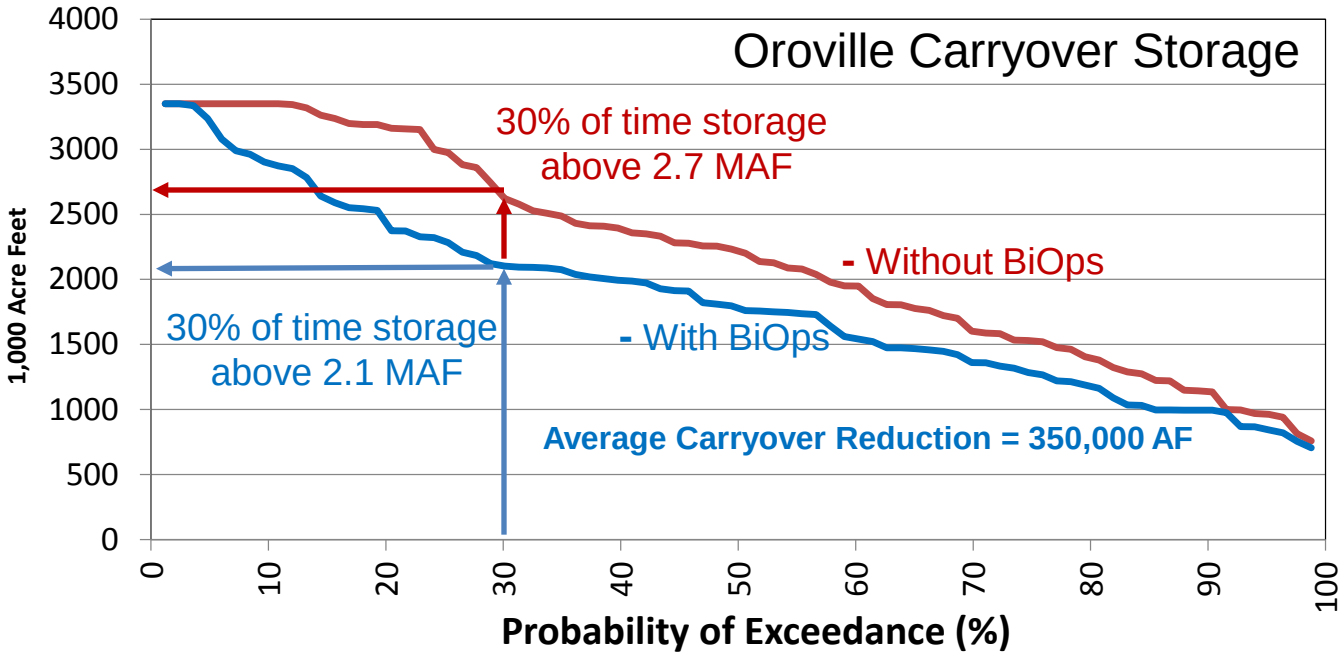


Delta outflow is increased about 1,000,000 acre feet per year



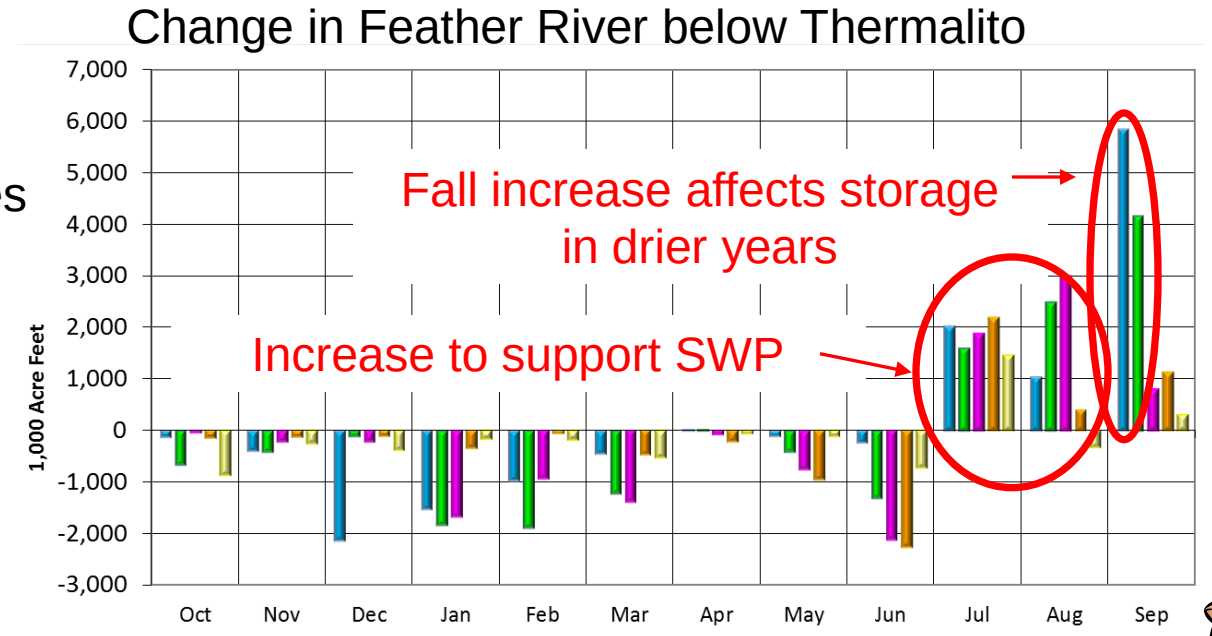


SWP Changes with BiOps

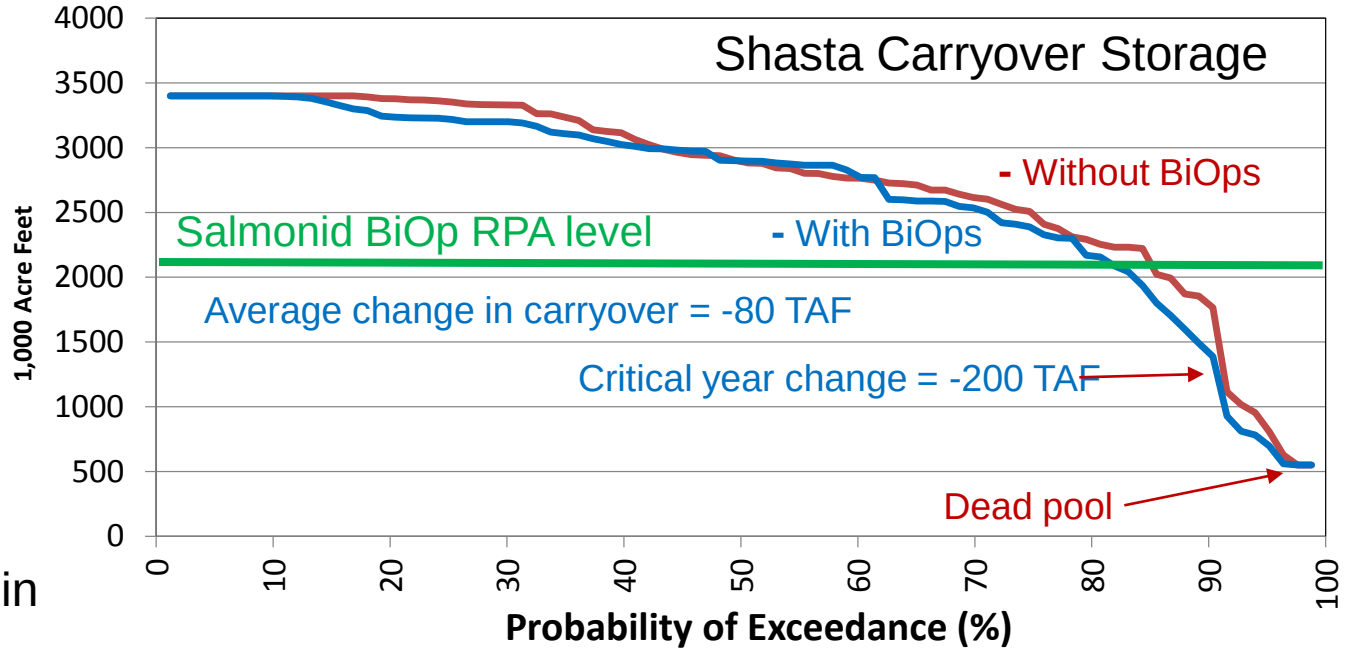


Average annual changes in SWP South of Delta deliveries (acre feet)

Table A = -350,000
Article 21 = -280,000
Article 56 = -80,000
Total = -710,000



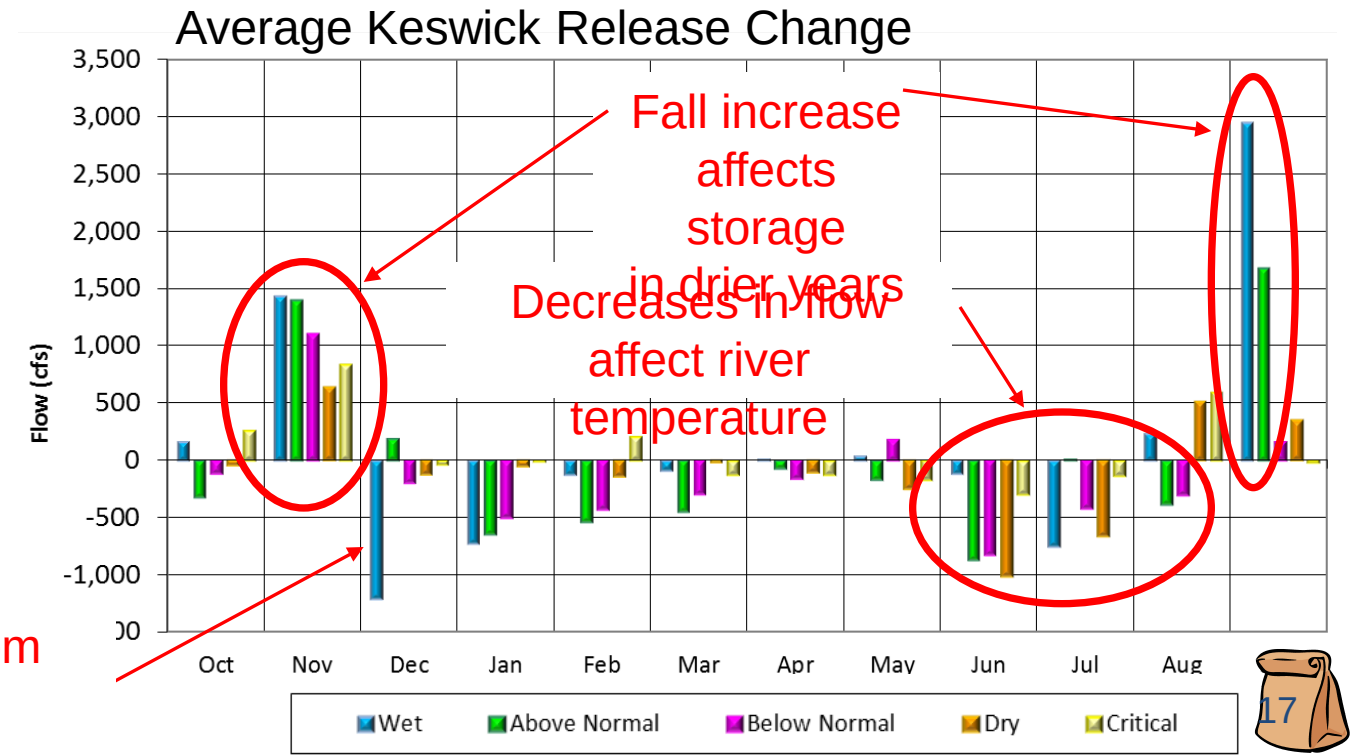
CVP Changes with BiOps



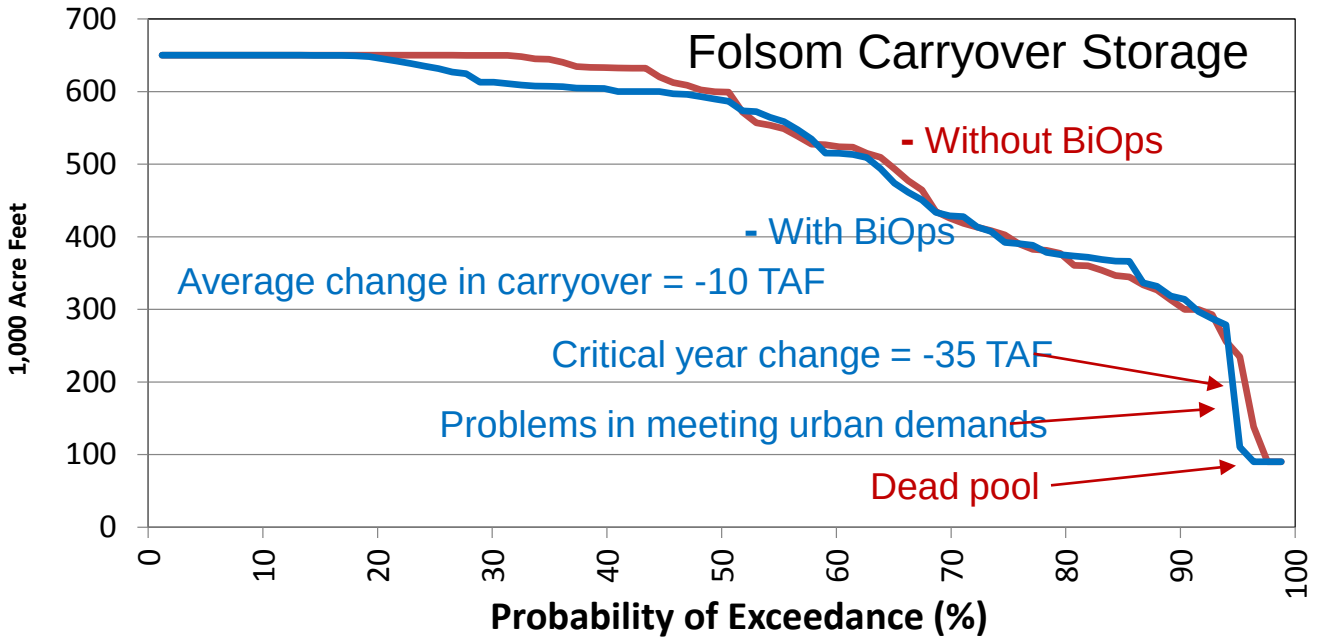
Average annual changes in CVP deliveries (acre feet)

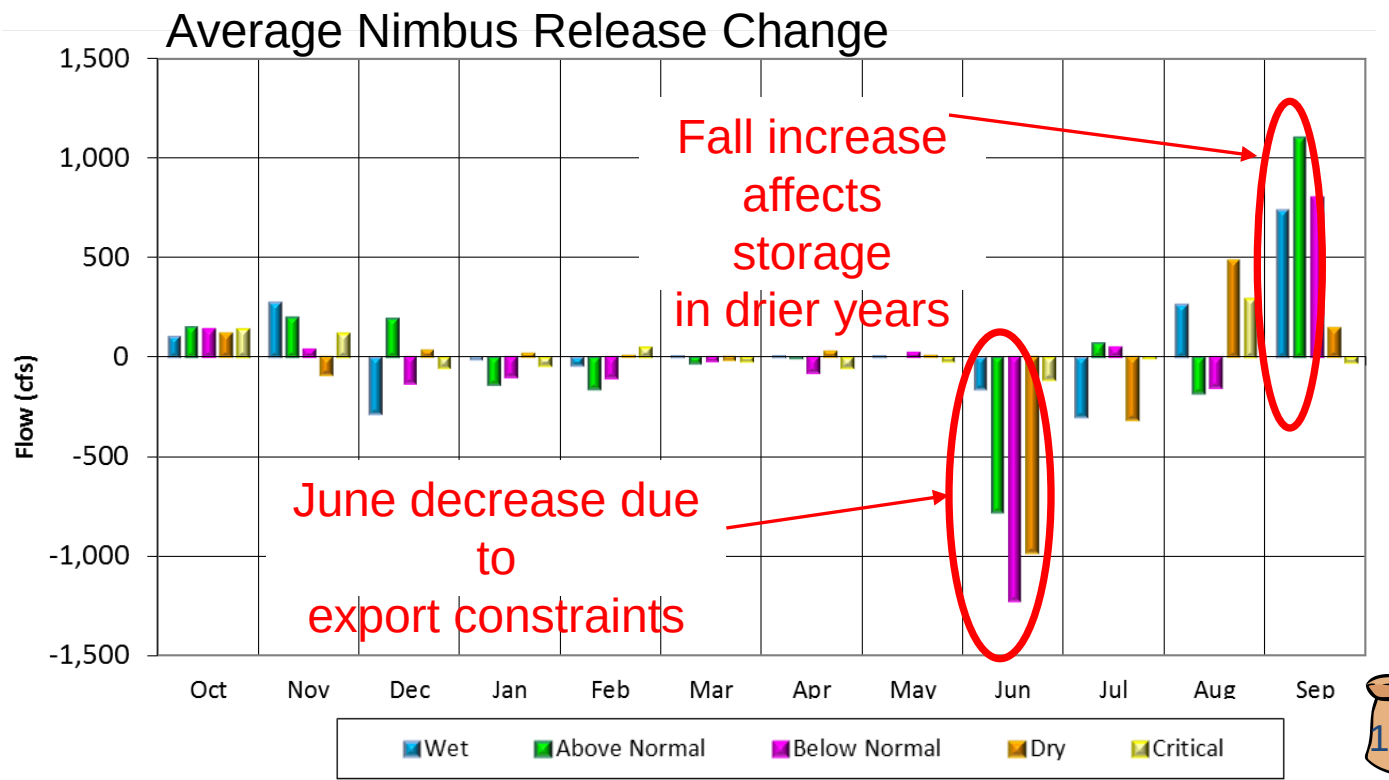
North of Delta = -20,000
South of Delta = -250,000
Total = -270,000

The BiOps result in the opposite of a natural flow pattern



CVP Changes with BiOps (cont.)





CVP/SWP Operational Changes with BiOps

Folsom - 1991

Oroville - 1991

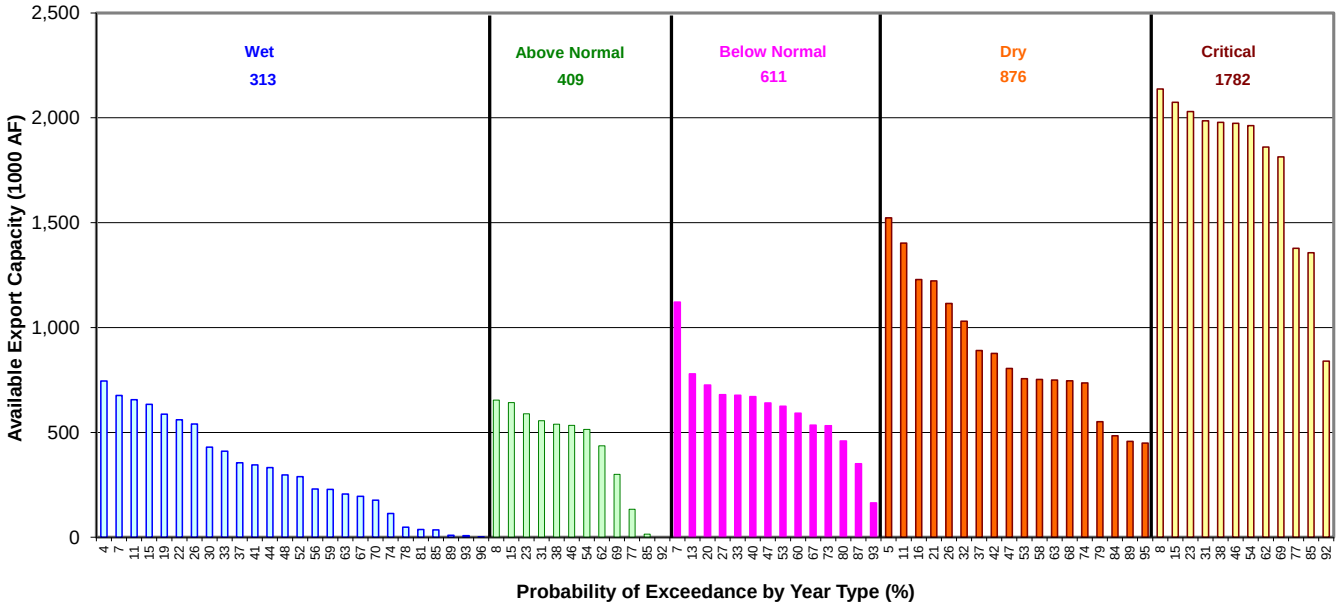
- Without BiOps : CVP/SWP relied on exporting surplus flows and used storage for dry year reliability

- With BiOps : Ability to divert surplus is limited, therefore the CVP/SWP rely on storage releases to meet demands and flow requirements

The BiOps decrease water supply reliability for many beneficial uses

Changes in Water Transfers with BiOps

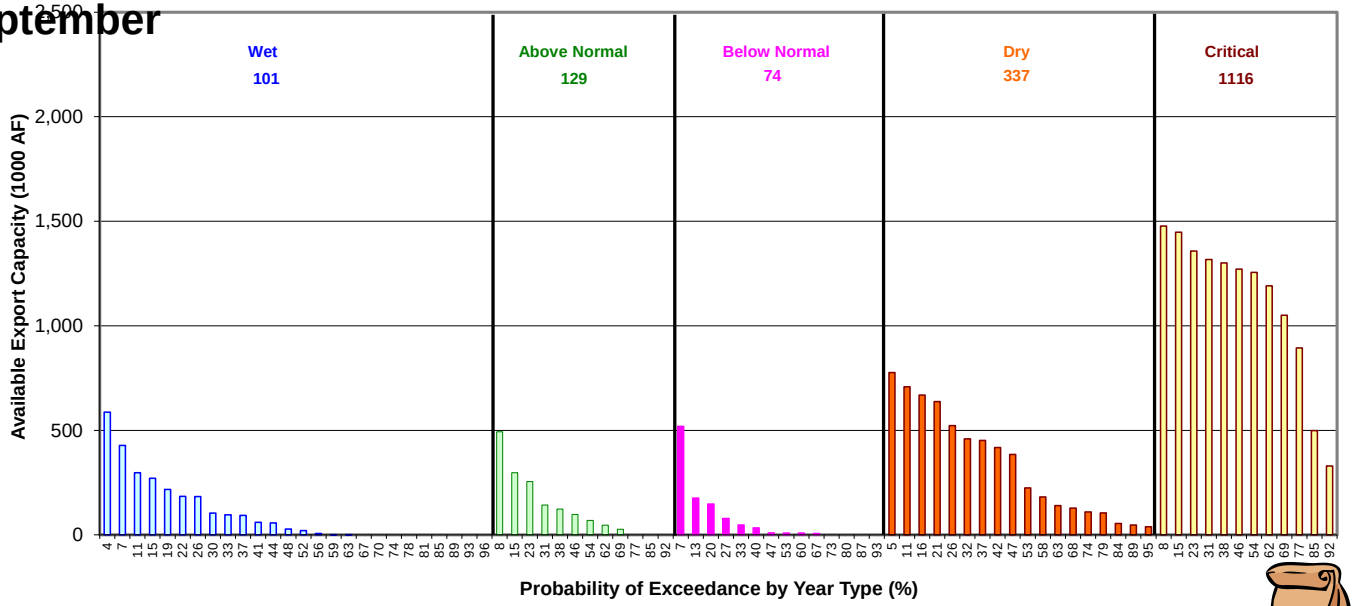
Without BiOps: Delta Export Capacity Available June Through September



With BiOps:

- **No Delta export capacity for transfers prior to July**
- **Decrease in capacity in dry years**
- **Limited capacity in below normal years**

With BiOps: Delta Export Capacity Available June Through September



Why is this important?

- In considering and evaluating possible changes to the Delta or the Delta Watershed we must consider the entire Delta Watershed

- In considering and evaluating possible changes to the Delta or the Delta Watershed we must utilize a baseline that reflects current water system operations.
  - Specifically, the baseline must include an average of 1,000,000 AFY more Delta outflow than under 2006 WQCP due to recent BiOps.

- We must utilize available analytical tools to evaluate the impacts of changes in the WQCP on beneficial uses including both consumptive uses and public trust or instream uses.

- We must also recognize the trade-offs between competing

Tradeoffs

Water Deliveries	Delta Outflow
Delta Flow Requirements	Upstream Environmental Benefit
CVP North of Delta Delivery	CVP South of Delta Delivery
Shasta Storage	Folsom Storage
Oroville Storage	SWP SOD Storage
Urban water supply	Agricultural water supply
North of Delta Storage	South of Delta Storage
Stream Temperature	Stream Habitat
Stream Temperature	Spring Flows
Power	Water Supply
Power	Spring time releases
Species A	Species B
Salmon Habitat	Delta Smelt Flow Criteria
American River fishery	Sacramento River fishery
Fall period flows	Spring time flows
Average annual water supply	Dry year water supply reliability

Analytical Tools

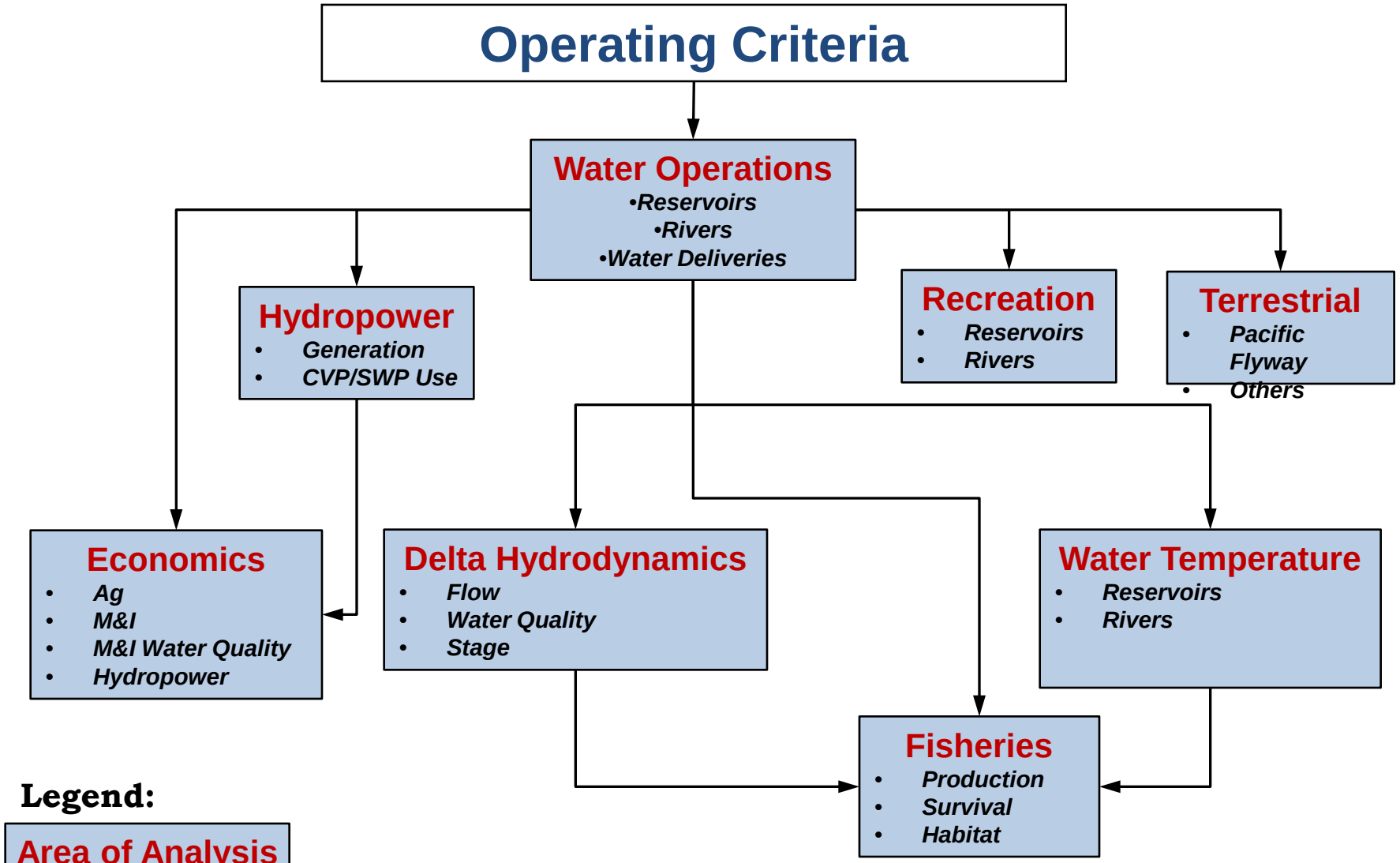
- Since 2006, there have been tremendous advances in the analytical tools available to evaluate the effects of changes in the WQCP.

- These analytical tools represent the current industry standard and best available scientific and commercial information for evaluation of the effects of changes in the Delta and the Delta Watershed.
  - These same tools are commonly used for impact analysis under CEQA & NEPA

Available Analytical Tools

- Water operations
  - CalSim II – California Simulation Model
  - CalLite – scaled down version of CalSim II
  - CalSim III – more detailed version of CalSim II
  - Others – spreadsheets and other models
- Economics
  - LCPSIM – urban economics model
  - CVPM – agricultural economics model
  - SWAP – updated agricultural economics model
- Delta flow and salinity
  - DSM2 - 1d Delta Simulation Model
  - FDM - 1d Fischer Delta Model
  - RMA – 2d Delta simulation model
  - SELFE (DWR), Suntans (Stanford), UnTRIM - 3d
- Water budget
  - IDC – IWFM demand calculator
  - CU – Consumptive Use model
  - Urban demand models
- Water quality
  - DSM2, RMA, FDM
  - Sediment
  - Turbidity
- Groundwater
  - IWFM – Integrated Water Flow Model
  - C2VSIM – Application of IWFM to Central Valley
  - SACFEM - Sacramento Valley Groundwater Model, application of MicroFEM
  - CVHM – Central Valley Hydrologic Model
- Temperature and salmon
  - Trinity, Whiskeytown, Shasta, Oroville, Folsom Lake models
  - Trinity, Clear Creek, Sacramento, Feather, American River models
  - Salmon mortality models
- Power generation and use
  - LTGen – CVP hydropower model
  - SWP_Power – SWP hydropower model
  - Others – upstream tributary models
- Historical data analysis and statistical models
  - Fish abundance statistical models
  - ANN, G-Model - Delta salinity models
- Numerous others
- Common sense

Example: Hydrologic and Effects Modeling



Analytical Process:

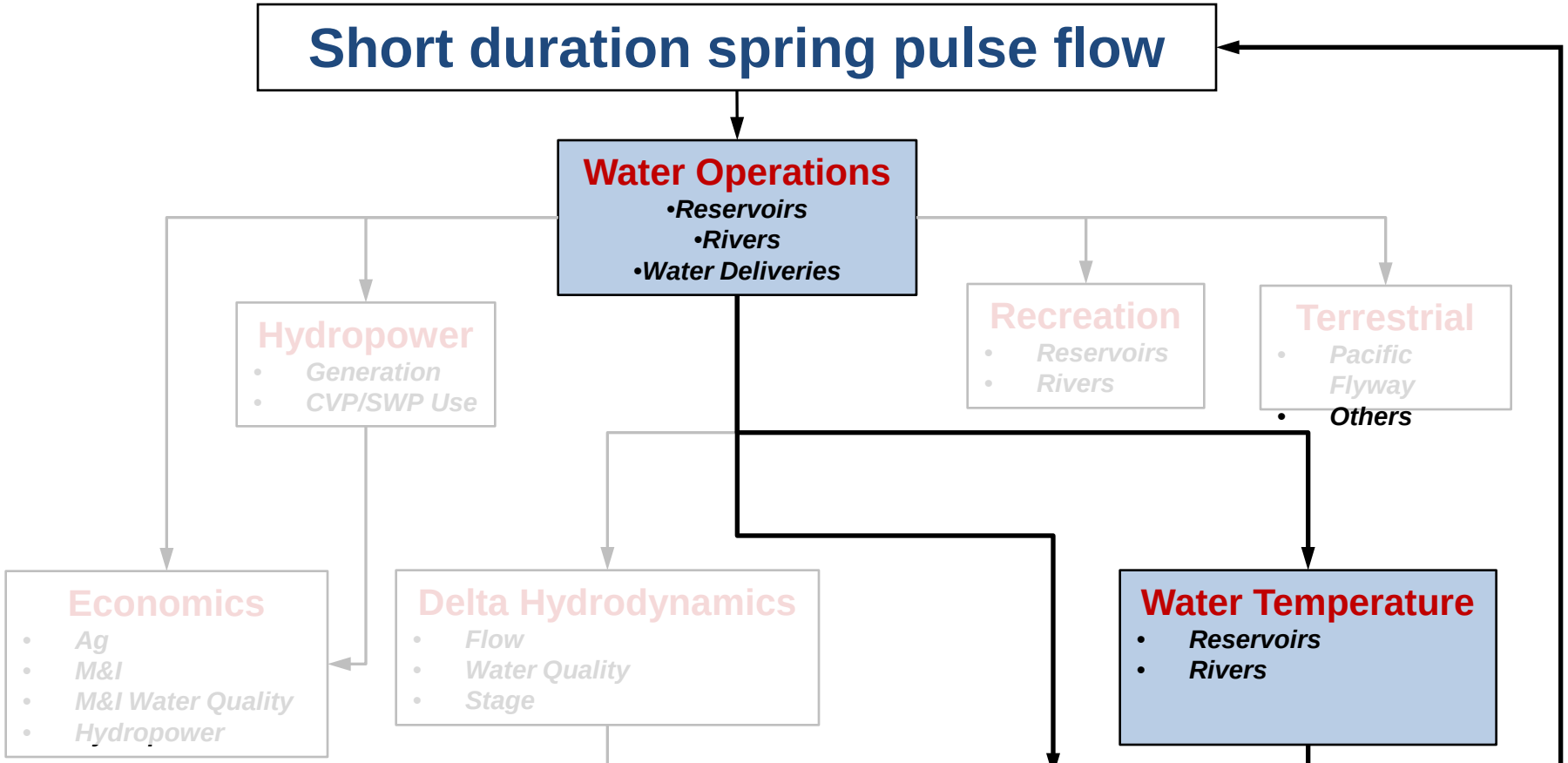
- Evaluate Current and Alternative Operating Criteria across key areas of analysis
- Effects of Alternative Operating Criteria derived from comparison to Current Operating Criteria

Example of the Use of Analytical Tools: Short Duration Spring Pulse Flows

- Based on work by fisheries biologist Dave Vogel, SVWU/NCWA believes that short duration spring pulse flows in the Sacramento River, if combined with a rain event and/or coordinated with the release of fish from the Coleman Hatchery, could have a beneficial effect on salmon returns 3 years later.

- The SWRCB can and should evaluate the water supply and other impacts associated with short duration spring pulse flows utilizing CalSim II and other available analytical tools.

Example: Hydrologic and Effects Modeling



Analytical Process:

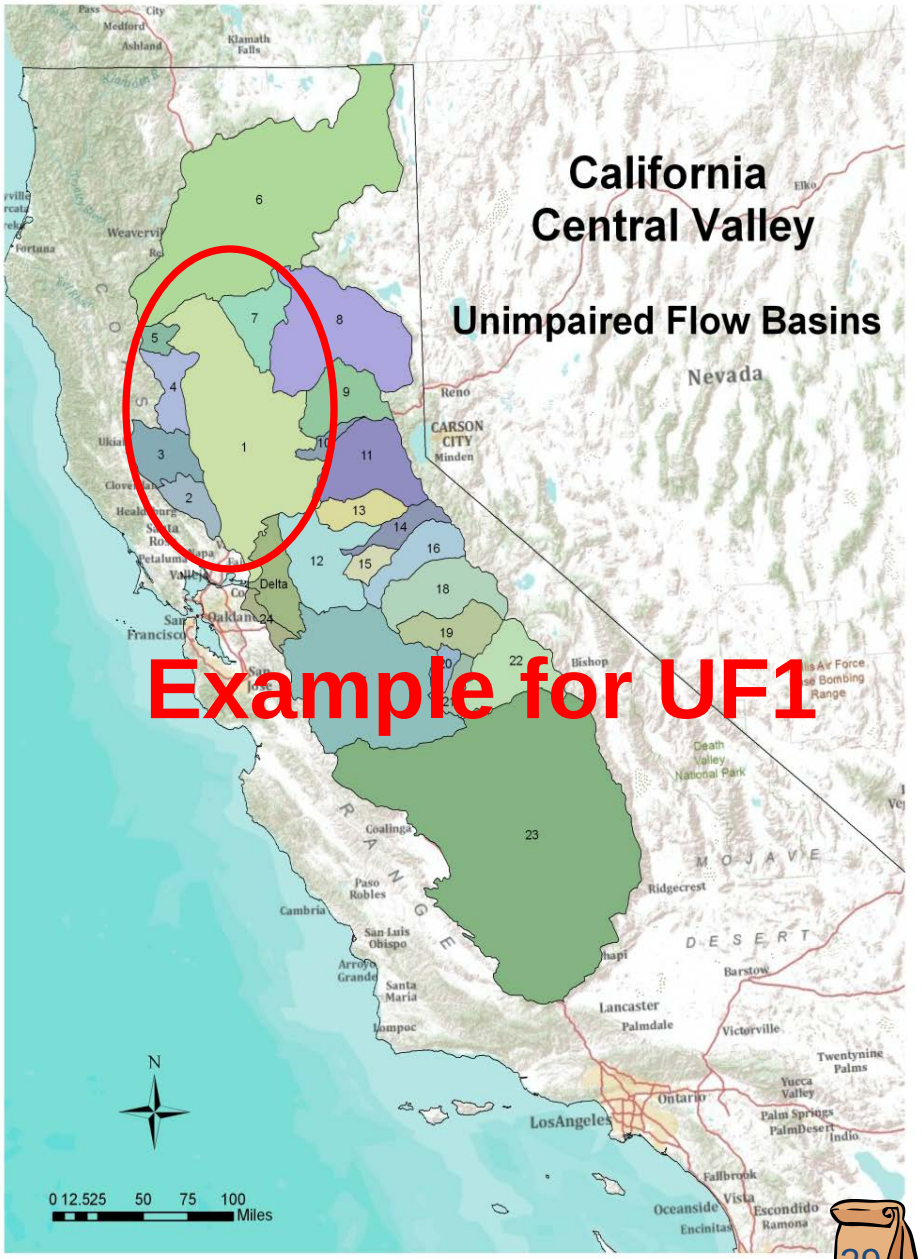
- Development of pulse flow (timing. duration, etc.)
- Analyze current and alternative operating criteria
- Determine benefits and effects
- Revise pulse flow based on benefits and effects
- Continue until benefits and effects are balanced
- Perform analysis for all beneficial uses

Example: Data analysis and common sense Unimpaired Flow (UF) Estimation Methods

- UF is a conceptual quantity estimated with a variety of methods:
  - Calculated based on observed data
  - Flow-gage correlations
  - Extrapolations from other watersheds/basins
  - Computer models
- Methods are not consistent through time
  - Example: discontinued stream gages

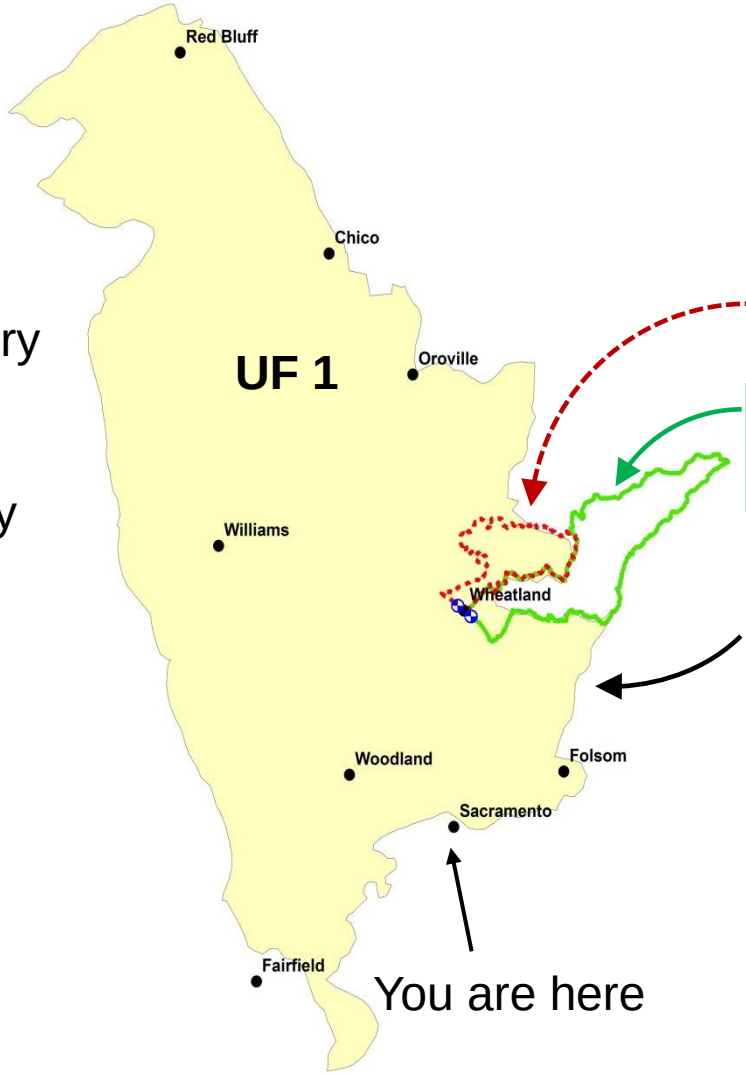
Limitations of UF Estimation Methods

- Observed data
  - Flow, storage, diversion, evaporation
    - Assumes observed data are accurate
    - Gage locations/availability change through time
- Flow gage correlations
  - Developed decades ago and assumed constant



Limitations of UF Estimation Methods (cont.)

Explanations:
- "Unimpairing" Bear R. is very complex
- Characteristics of Bear R. watershed differs from valley
- Not sensitive to variation in geographic distribution of precipitation
- Temporal discontinuity



Dry Crk. near Wheatland
Area: 99.9 sq. mi.

Bear R. near Wheatland
Area: 292 sq. mi.

Unimpaired flow Area 1
Area: 6,400 sq. mi.
- **Lower Sacramento R.**
- **Lower Feather R.**
- **Lower Yuba R.**
- **Others**

1922-1961 Unimpaired flow = 11.0 x Dry Crk.

1962- present Unimpaired flow = 2.18 x estimated unimpaired Bear R.

Limitations of UF Estimation Methods (cont.)

- **Quantitative comparisons between unimpaired and observed flow are an inappropriate use of unimpaired flow estimates**

Conclusions

- Multiple analytical tools are now available for evaluating this water system and balancing beneficial uses.
  - Water operations
  - Delta hydrodynamics
  - Water temperature
  - Water quality
  - Hydropower
  - Common sense

- Use of these tools by qualified personnel now constitutes the industry standard for evaluating the impacts of water-related projects and must be used in developing changes to the Bay Delta Water Quality Control Plan


North Coast
North Lahontan
Sacramento River
San Joaquin River
Tulare Lake
Central Coast
South Lahontan
Colorado River
South Coast

Questions?