Long-Term Operations - Concepts for BDCP

May 20, 2009

Background of BDCP Ops Effort

- December 19, 2008, issued Overview Document
  - Left the issue of Delta outflow unresolved;
  - Recognized that appropriate targets for Delta outflow have been vigorously debated;
  - Used D-1641 for DRERIP purposes;
  - Committed to evaluate a range of targets.

Delta Flow Complexities

- Changes to Delta flow affect to varying degrees:
  - Upstream coldwater management
  - Outflow and X2 location
  - Water supply volumes and reliability
- Tradeoffs are unavoidable
- Delta flow can be achieved through changes in:
  - Outflow
  - Inflow
  - Reservoir Releases
- Small fraction of the Delta flow is manageable by Projects.

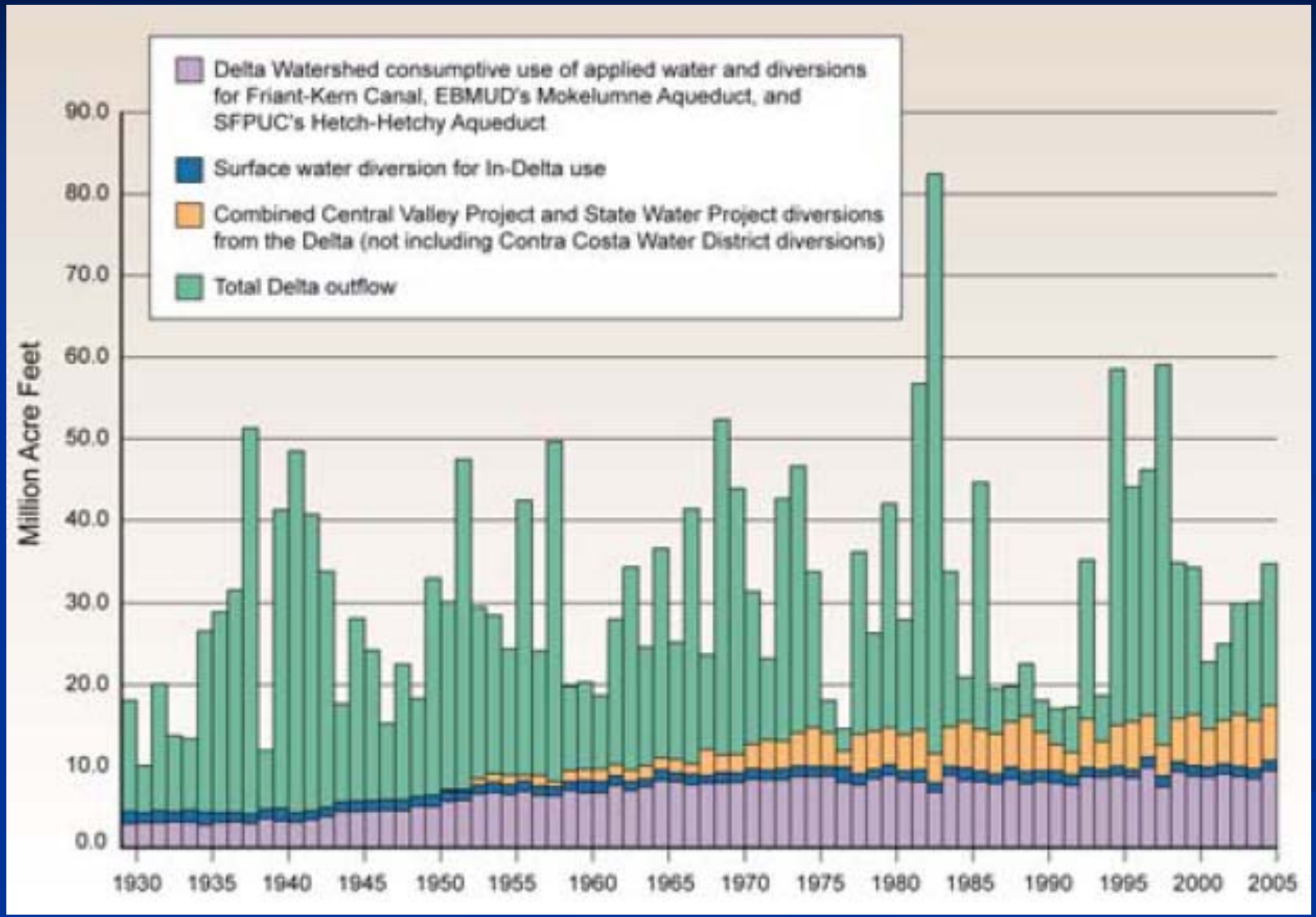
BDCP Approaches for Delta Flow

- Explore a range of inflow/outflow approaches for consideration in BDCP planning

- Consider improved, **simplified** methods for providing Delta inflows/outflows that better **balance** competing needs

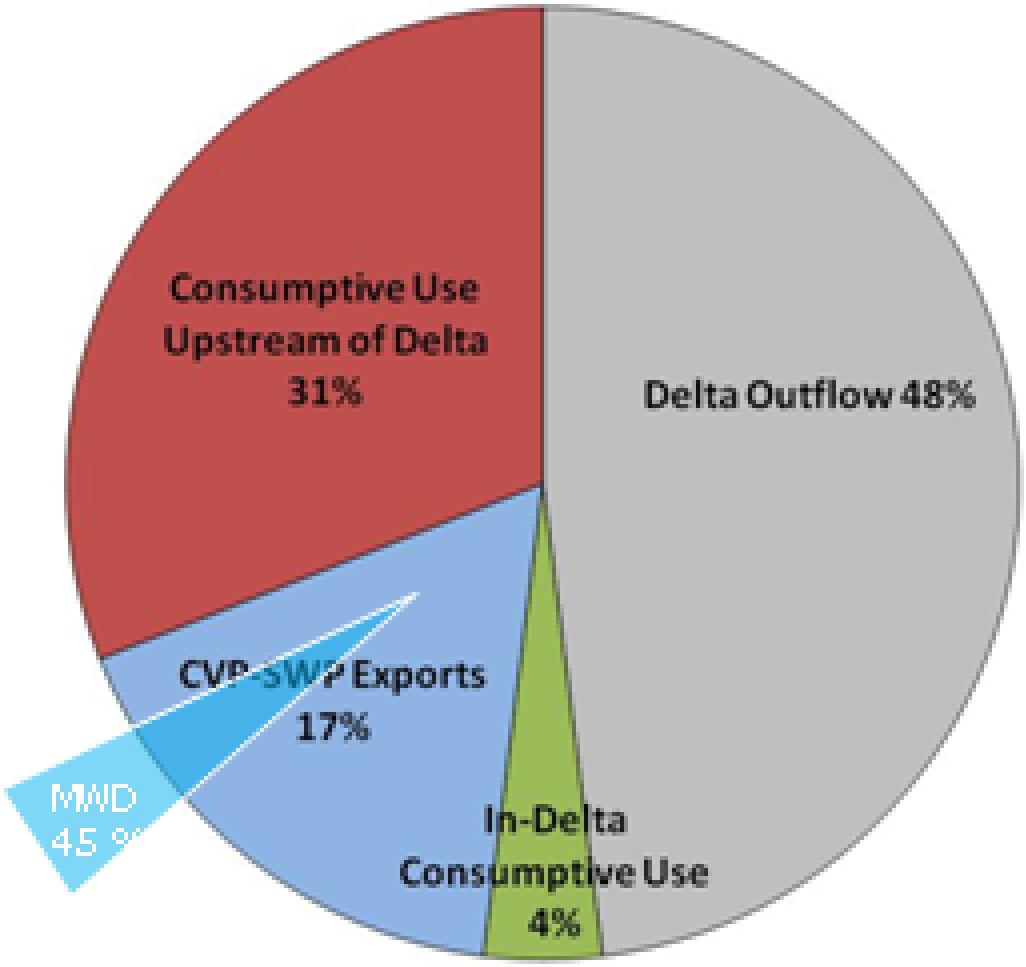
Delta Flow Planning Principles

- Work with water volumes manageable by SWP and CVP in the Sacramento Valley;
- Protect upstream conditions;
- Maintain X2 within region best-suited for estuarine function and primary productivity;
- Consider biological mechanisms and risk principles;
- Utilize best scientific and forecasting information;
- Improve synchrony with natural flows.


Delta Watershed consumptive use of applied water and diversions for Friant-Kern Canal, EBMUD's Mokelumne Aqueduct, and SFPUC's Hetch-Hetchy Aqueduct
Surface water diversion for In-Delta use
Combined Central Valley Project and State Water Project diversions from the Delta (not including Contra Costa Water District diversions)
Total Delta outflow
Million Acre Feet
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005

Historical Diversions Within the Delta Watershed

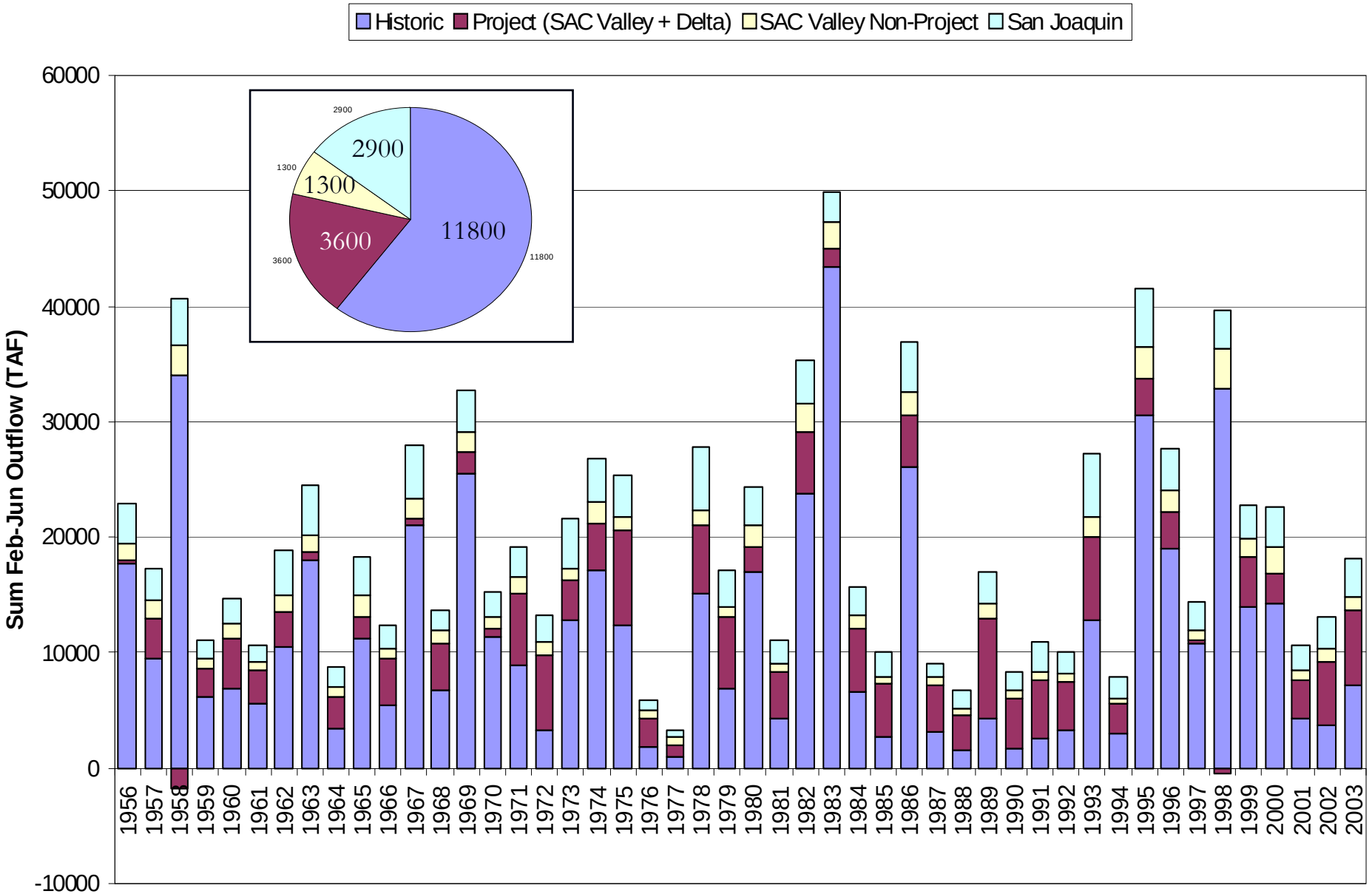
1970-89



Reference: Delta Vision Task Force

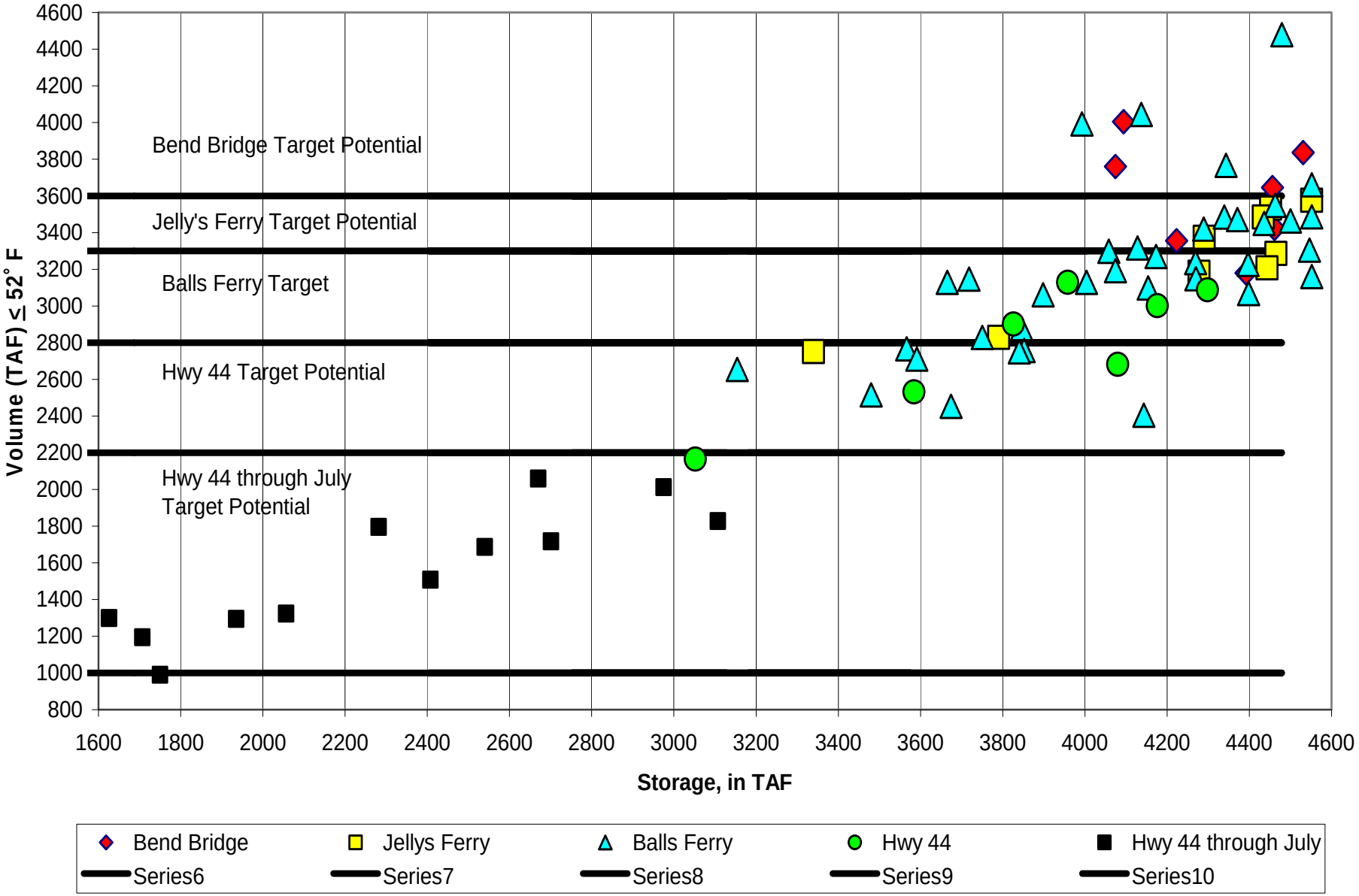
PRELIMINARY DRAFT—NOT FOR DISTRIBUTION

Comparison of Delta Outflow under Different Levels of Impairment
Sum Feb-Jun (1956-2003)

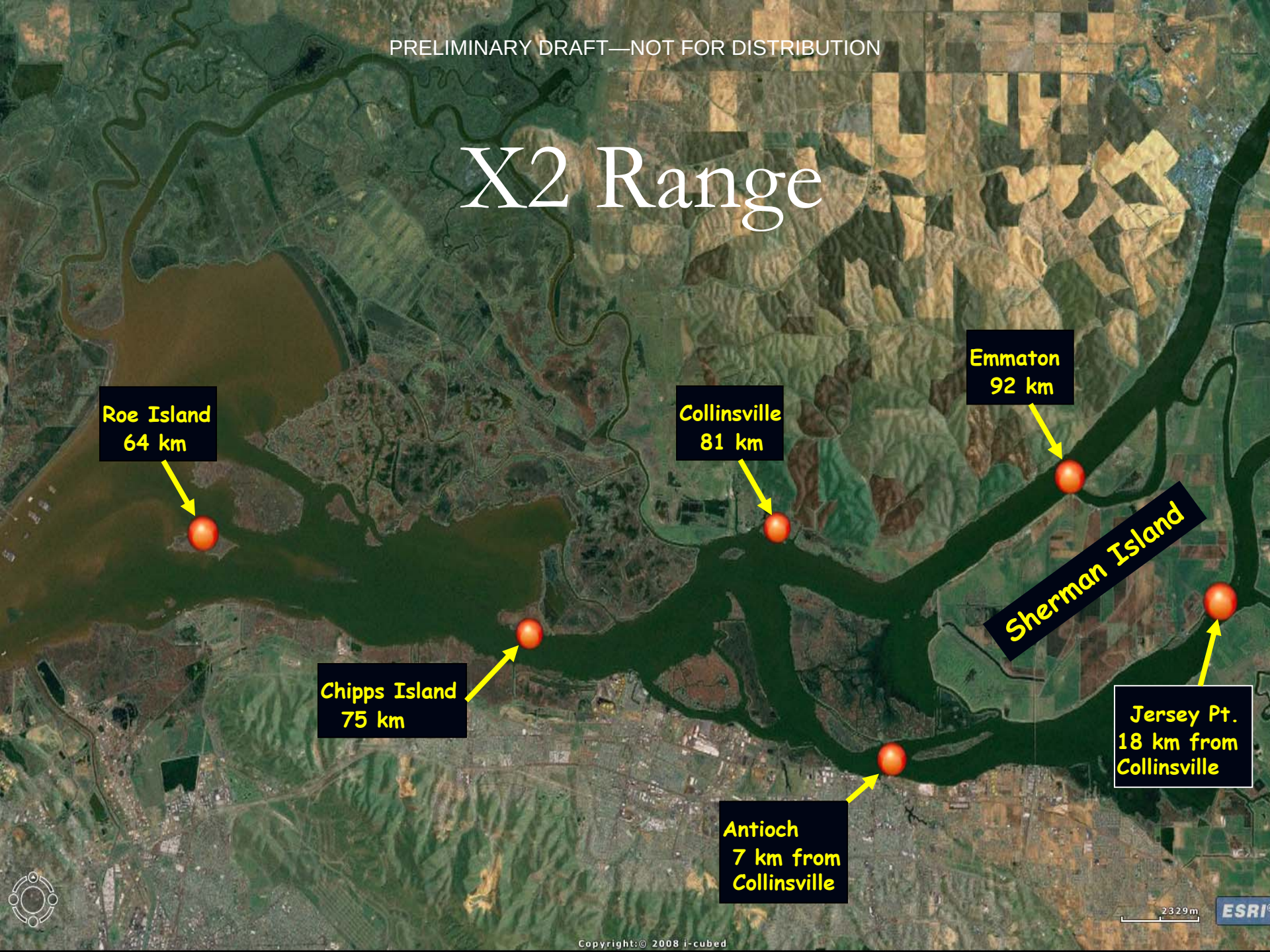


Shasta End of April Storage

Coldwater Pool Management Considerations

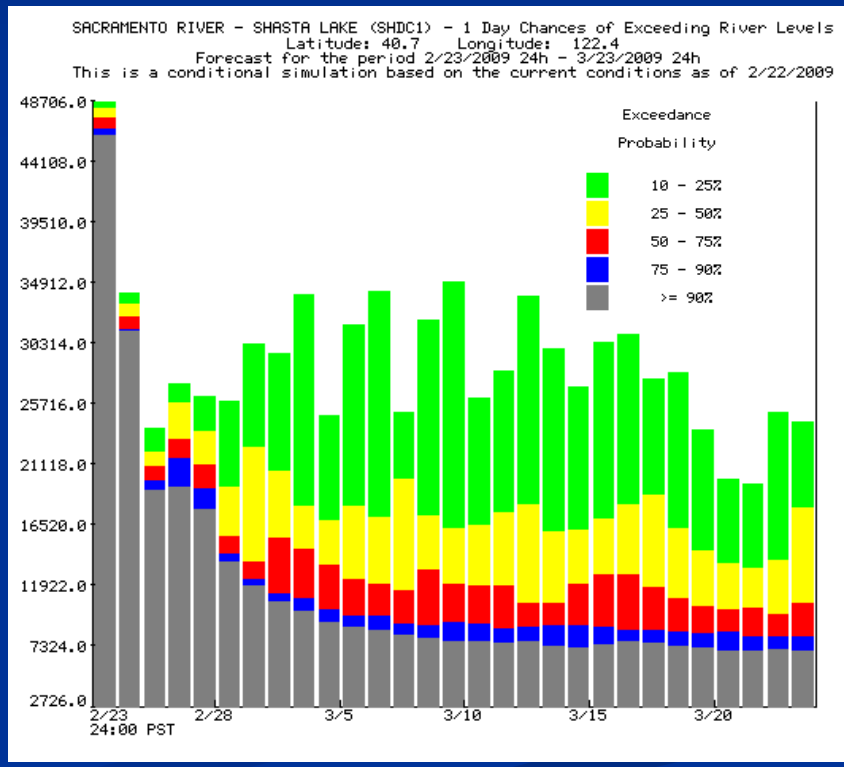


X2 Range



Forecast and Risk Principles

- Utilize best-available forecasts
  - Bulletin 120 Seasonal forecasts
  - NWS CNRFC Monthly forecasts
  - AHPS and ESP (5-day to 14-day ensemble forecasts)
- Use risk levels consistent with water allocation and other regulatory standards
  - 90% exceedance levels for Jan-May
  - 50% exceedance levels for Jun



Source: NOAA, http://www.cnrfc.noaa.gov

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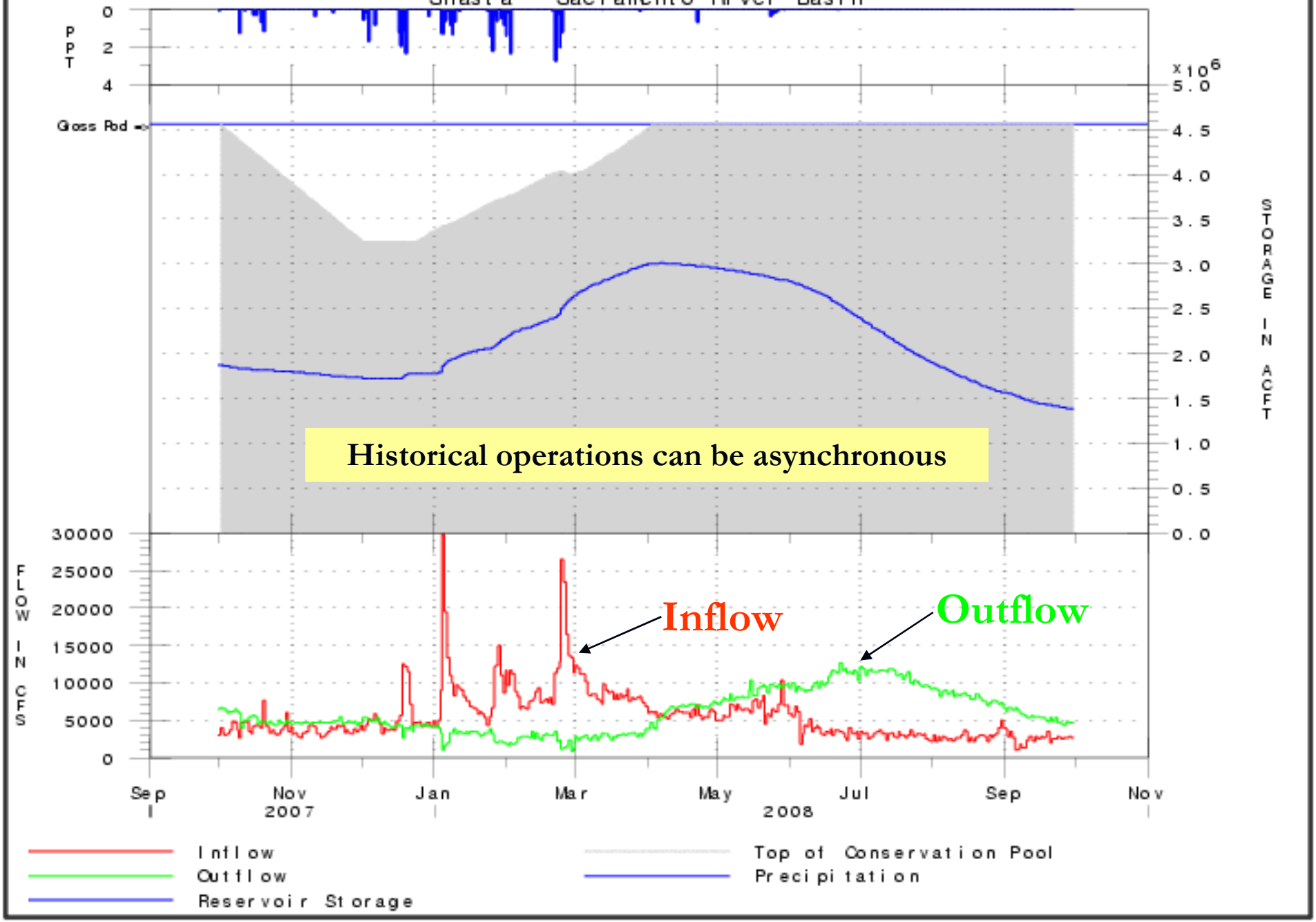

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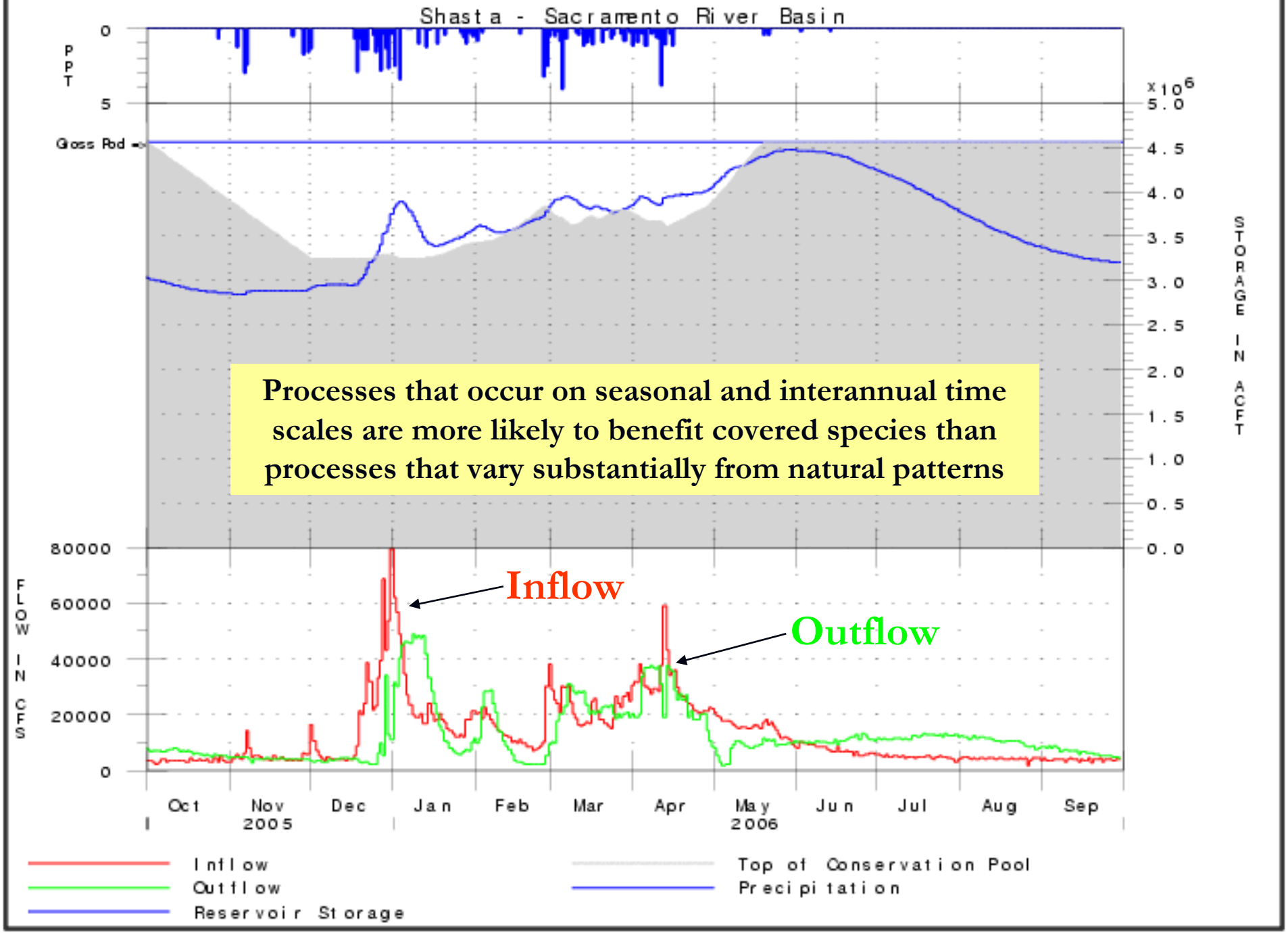
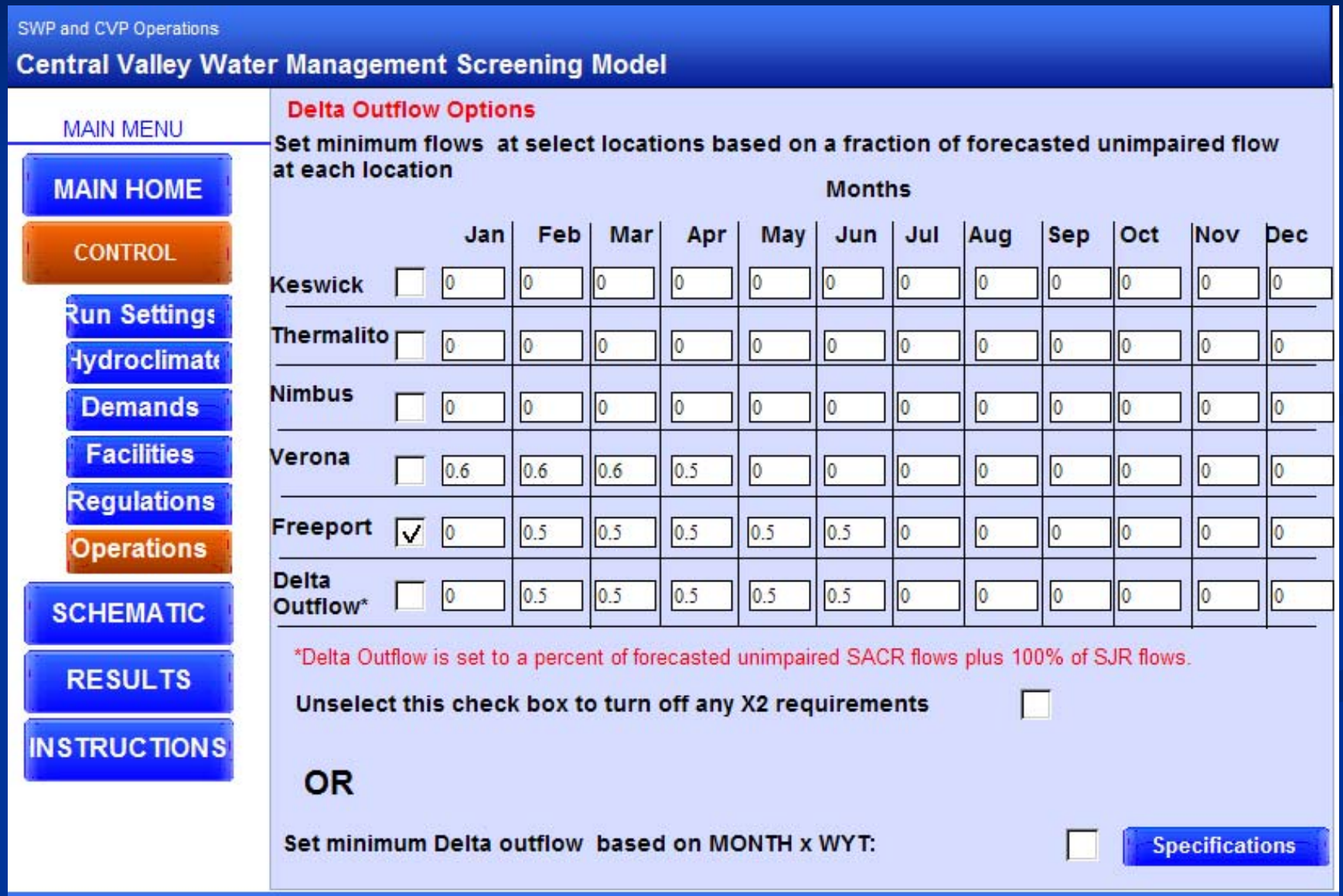


2 Step Analytical Process

- Necessary considerations:
  (1) Delta flows, (2) coldwater management, (3) water supply
- Pass 1
  - Evaluate operations of upstream reservoirs under the assumption that releases would only occur for upstream requirements, Delta requirements, and water rights and exchange contractors.
  - Illustrates the capability of the system to satisfy a given Delta flow objective.
- Pass 2
  - Includes allocation decisions to evaluate the operations of the projects for both water supply and environmental purposes.
  - Trade-offs between these deliveries, storage, and outflow can be ascertained.

CalLite Model Modifications



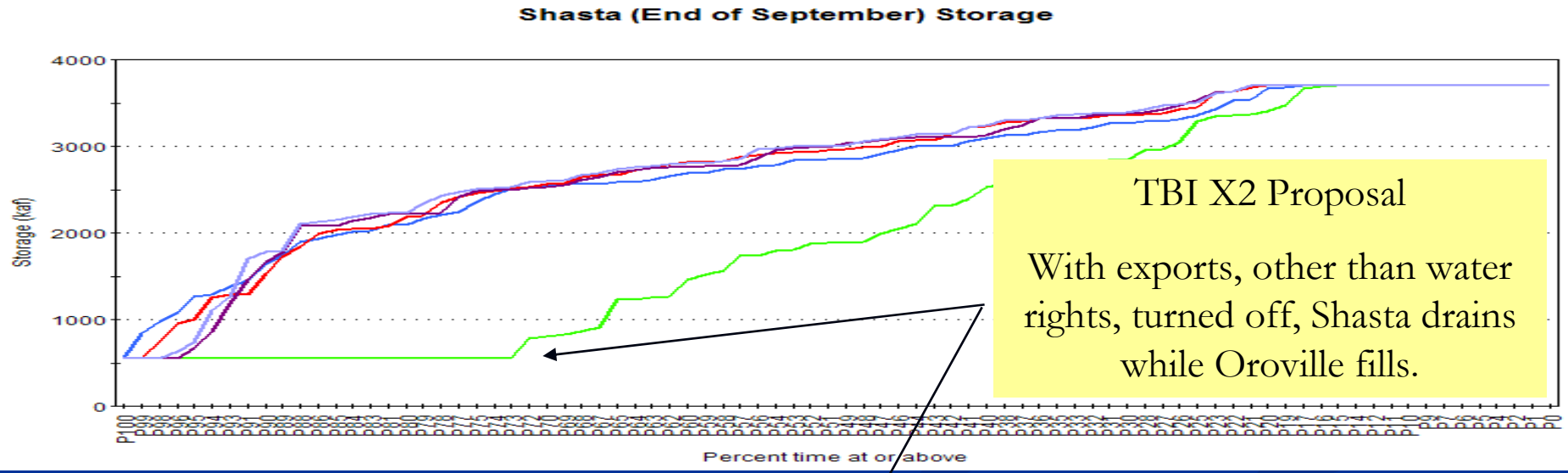
Key Performance Metrics

- Cold water management potential
- Upstream Synchrony
- Hood Diversion Ratio (Bypass Flows)
- OMR Reverse Flows
- Water supply volume and reliability
- Outflow volume and X2 location

Initial Exploratory Observations

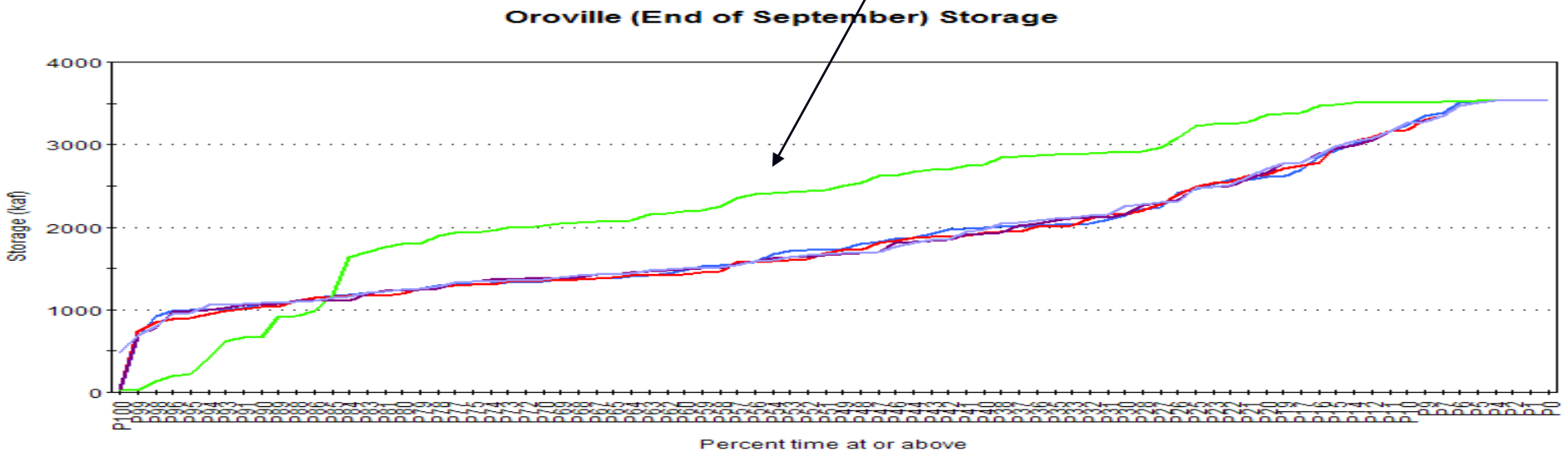
- Cold water management potential is controllable;
- Managing for a single metric (e.g. outflow) can produce unintended effects (e.g. unacceptably impact storage and water supply);
- Upstream flow synchrony can be improved;
- Avg. X2 location largely insensitive to change under varying scenarios.

Example of Unintended Results



TBI X2 Proposal

With exports, other than water rights, turned off, Shasta drains while Oroville fills.



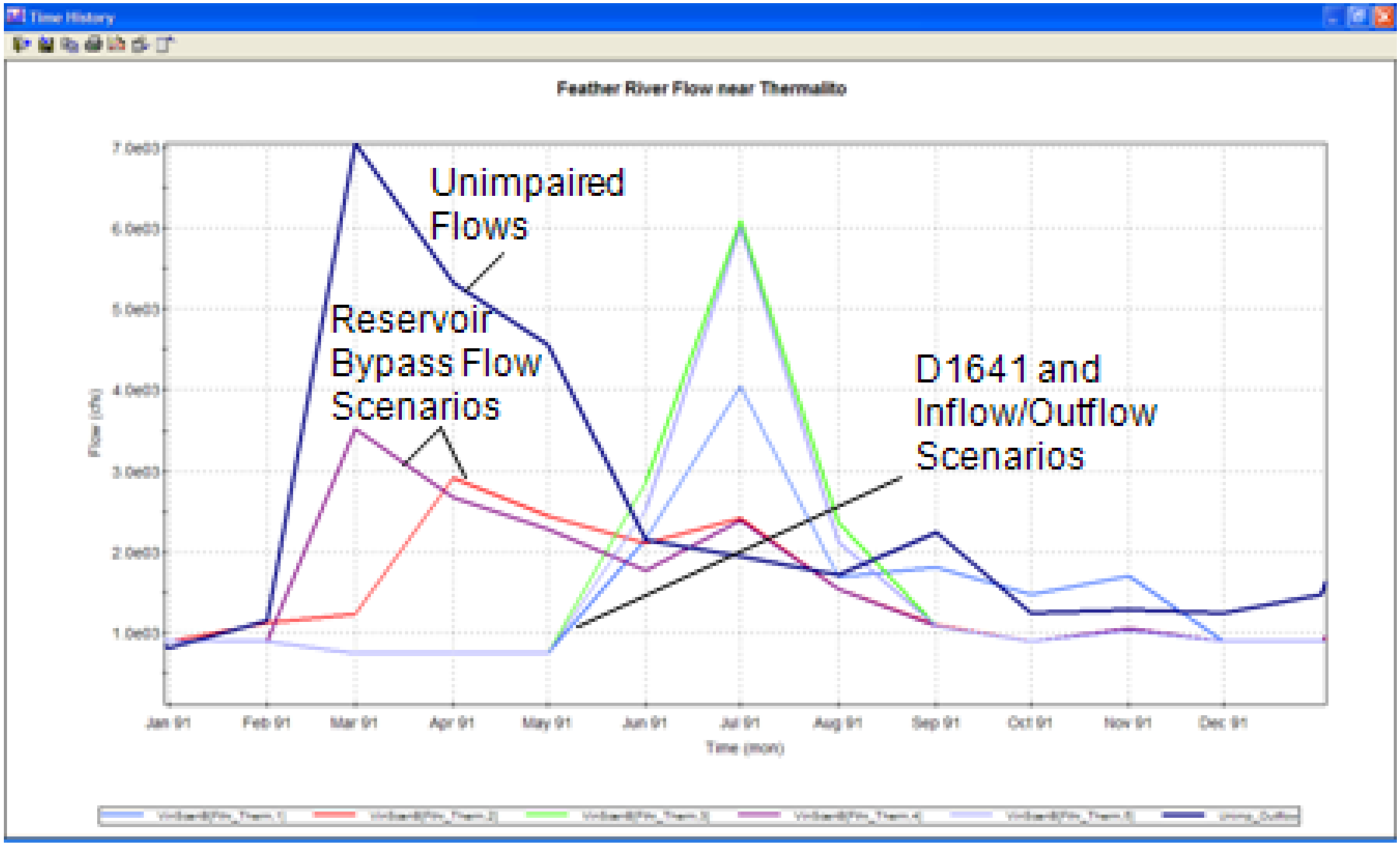
Potential Benefits of Changing Flow Management Approach

- Minimize unintended consequences on upstream reservoirs and rivers due to changing Delta operations;
- Enhance spring inflows to the Delta to more closely approximate natural hydrograph;
- Provide simpler approach to balance upstream and downstream objectives;
- Improve results for ecological objectives that are dependent upon flow magnitude, duration, or timing.

BDCP Flow Objectives

- **Objective ECSY1.1:** Provide hydrodynamic conditions that support the movement of larval and juvenile life stages of native fish species to downstream rearing habitats.
- **Objective ECSY1.2:** Provide hydrodynamic conditions that support the movement of adult life stages of native fish species to upstream natal spawning habitats.
- **Objective ECSY1.4:** Provide flows through the Delta that reflect the annual and interannual variability present in the natural hydrograph to maintain or increase life history diversity of native fishes and to provide for a diversity of rearing conditions for native fishes over time.
- **Objective NACO1.1:** Increase hydrologic connectivity of Delta waterways with existing and historical floodplains to support habitat and food production for associated native species.

Changing Approach to Flow Management Can Improve Upstream Synchrony



Potential Improved Synchrony Benefits

- Increase frequency and duration of Yolo Bypass inundation;
- Inundate side channel and floodplain habitat for fish rearing and primary production;
- Facilitate transport of fish and food resources from upstream in key spring months;
- Moderate temperature for outmigrating salmonids in spring shoulder months

Avg. X2 Location Insensitive to Approaches

Feb-Jun X2 (km)

Scenario	All	W	AN	BN	D	C
D1641	69	60	65	70	75	79
BDCP Op. #1	69	61	66	71	75	79
NGO X2	68	59	65	70	74	79
Prop. Outflow	68	60	65	70	74	79
Prop. Res. Release	69	61	66	71	75	80

Recent Exploratory Scenarios

- D-1641

  Our comparative standard

- BDCP Option #1

  Assumes higher Hood Bypass flows (i.e. more restrictive)

- TBI X2 approach as modified by EDF

  X2 as function of 8 River Index with Storage off-ramps

- Proportionate Outflow approach

  50% of unimpaired Sac Valley runoff ***and***

  100% of impaired San Joaquin Valley runoff

- Proportionate Reservoir Release approach

  Bell shape release % with flow caps and storage off-ramps

Current Gaming Assumptions

- Hood Bypass

  Utilized BDCP Option #1 for all scenarios except D1641

- South of Delta

  Utilized BDCP OMR constraints:

  -3,500 cfs Dec – Jun

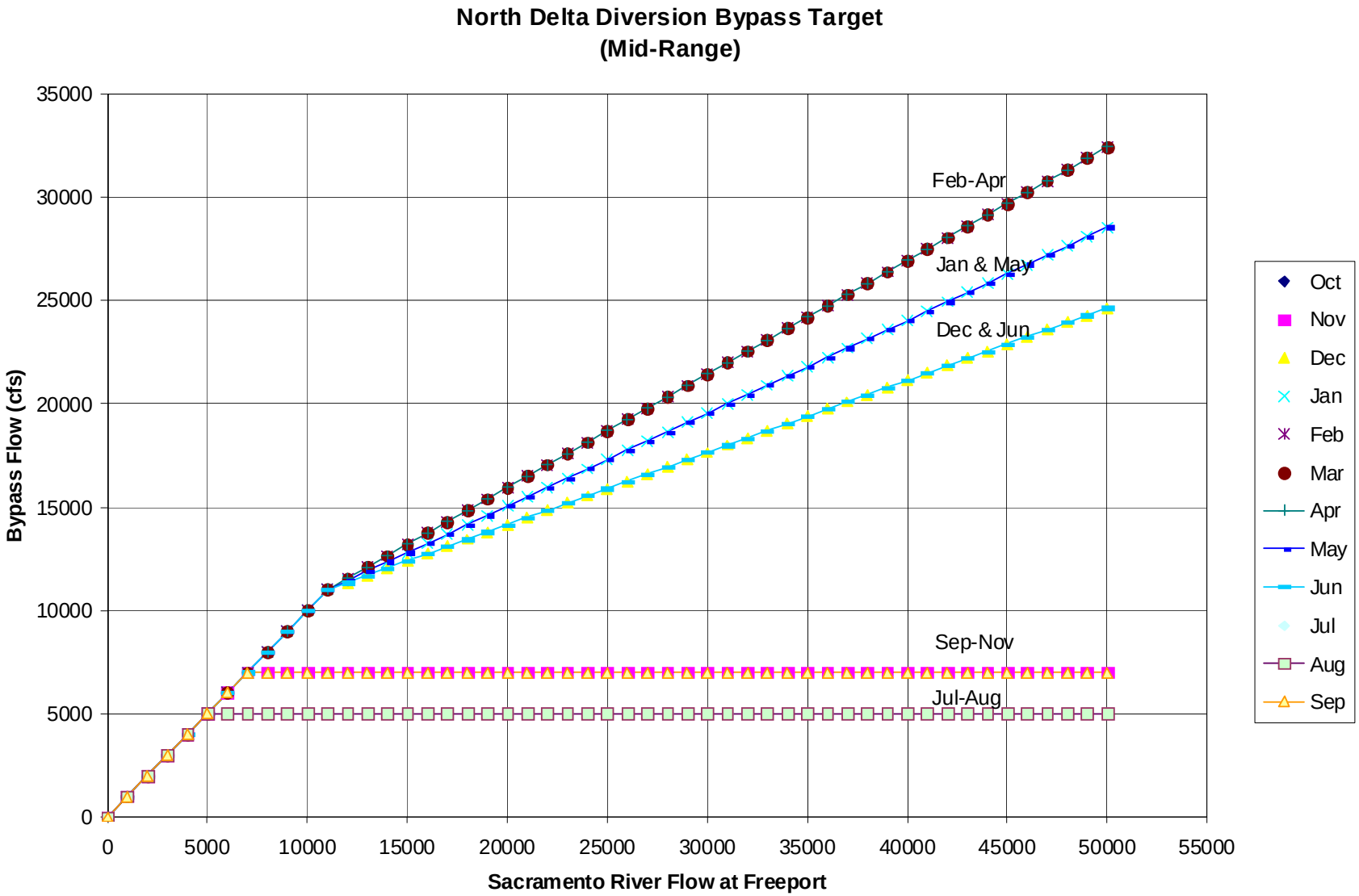
  -5,000 cfs Jul – Nov

- San Joaquin River Inflow

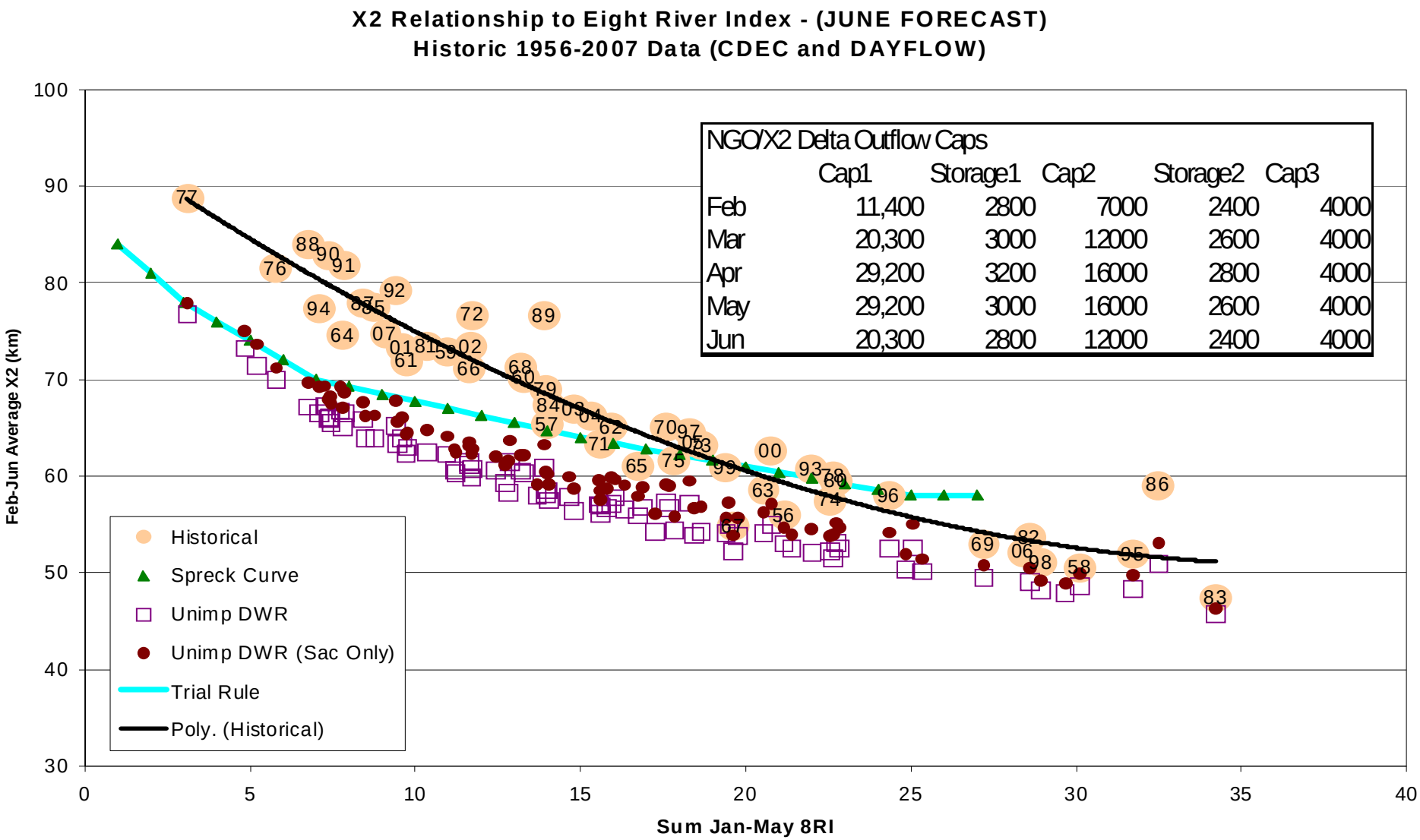
  Fully impaired current condition

- All other current standards assumed to exist.

BDCP Option #1 Hood Bypass Assumption



Modified NGO X2 Approach



NGO/X2 Delta Outflow Caps

	Cap1	Storage1	Cap2	Storage2	Cap3
Feb	11,400	2800	7000	2400	4000
Mar	20,300	3000	12000	2600	4000
Apr	29,200	3200	16000	2800	4000
May	29,200	3000	16000	2600	4000
Jun	20,300	2800	12000	2400	4000

Proportionate Reservoir Release Approach

Delta Outflow Options

Set minimum flows at select locations based on a fracti
at each location

Months

		Jan	Feb	Mar	Apr	May	Jun
Keswick	☑	0	0.2	0.4	0.6	0.6	0.4
Thermalito	☑	0	0.2	0.4	0.6	0.6	0.4
Nimbus	☑	0	0.2	0.4	0.6	0.6	0.4
Verona	☐	0.6	0.6	0.6	0.5	0	0
Shasta Storage trigger for Low%		0	2600	2600	2800	2200	2200
Freeport	☐	Low % 0	0.3	0.3	0.3	0.3	0.3
		High % 0	0.5	0.5	0.5	0.5	0.5
Delta Outflow*	☐	0	0.4	0.4	0.4	0.4	0.4

*Delta Outflow is set to a percent of forecasted unimpaired SACR flows plus 100% of SJR

Minimum flow caps based on storage

Reservoir Bypass Flow Caps (Shasta)

	Cap1	Storage1	Cap2	Storage2	Cap3
Feb	10,000	2800	6,625	2400	3250
Mar	10,000	3000	6,625	2600	3250
Apr	10,000	3200	6,625	2800	3250
May	10,000	3000	6,625	2600	3250
Jun	10,000	2800	6,625	2400	3250

Reservoir Bypass Flow Caps (Oroville)

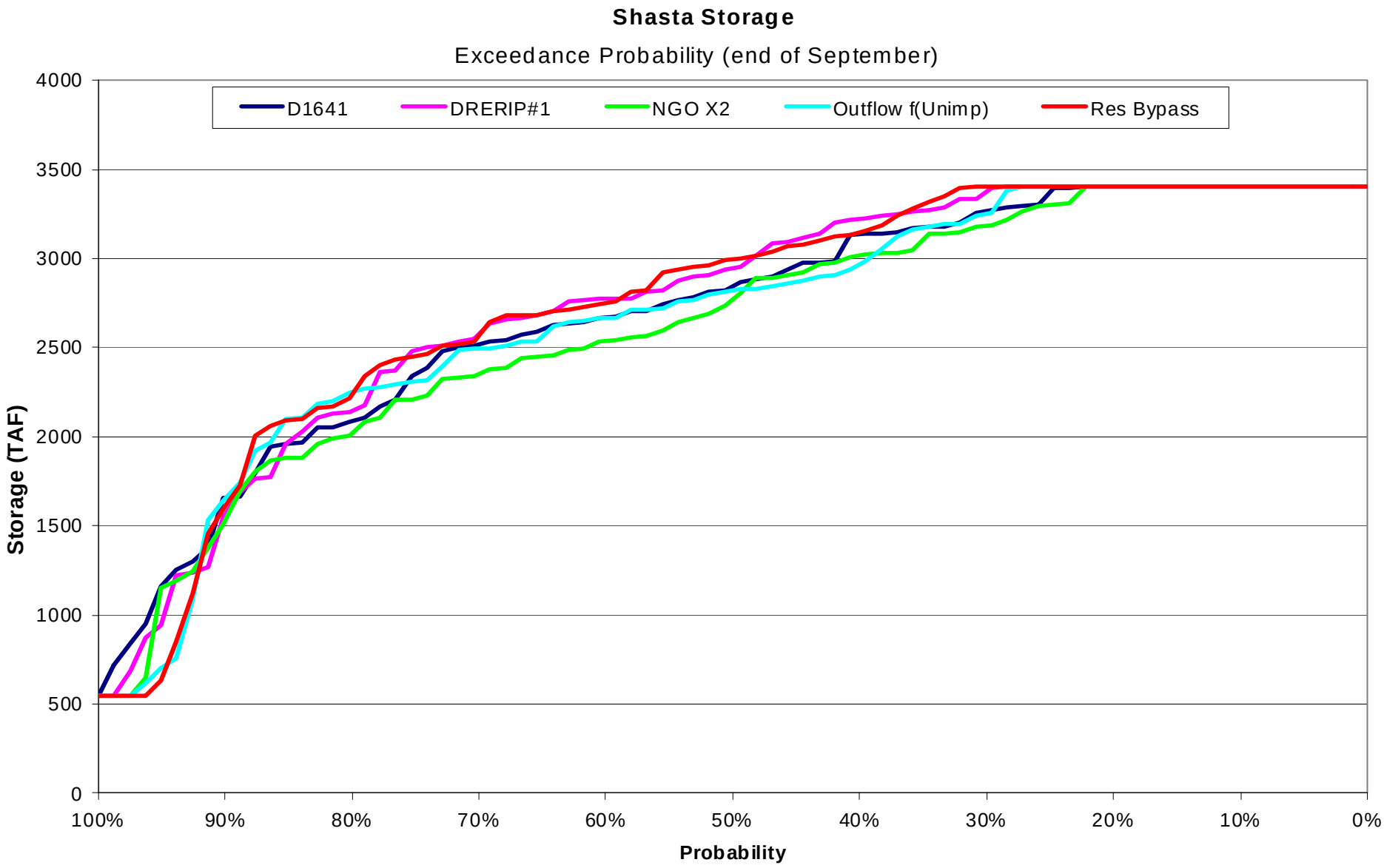
	Cap1	Storage1	Cap2	Storage2	Cap3
Feb	4,000	2000	2,375	1300	750
Mar	4,000	2200	2,375	1500	750
Apr	4,000	2400	2,375	1700	750
May	4,000	2200	2,375	1500	750
Jun	4,000	2000	2,375	1300	750

Reservoir Bypass Flow Caps (Folsom)

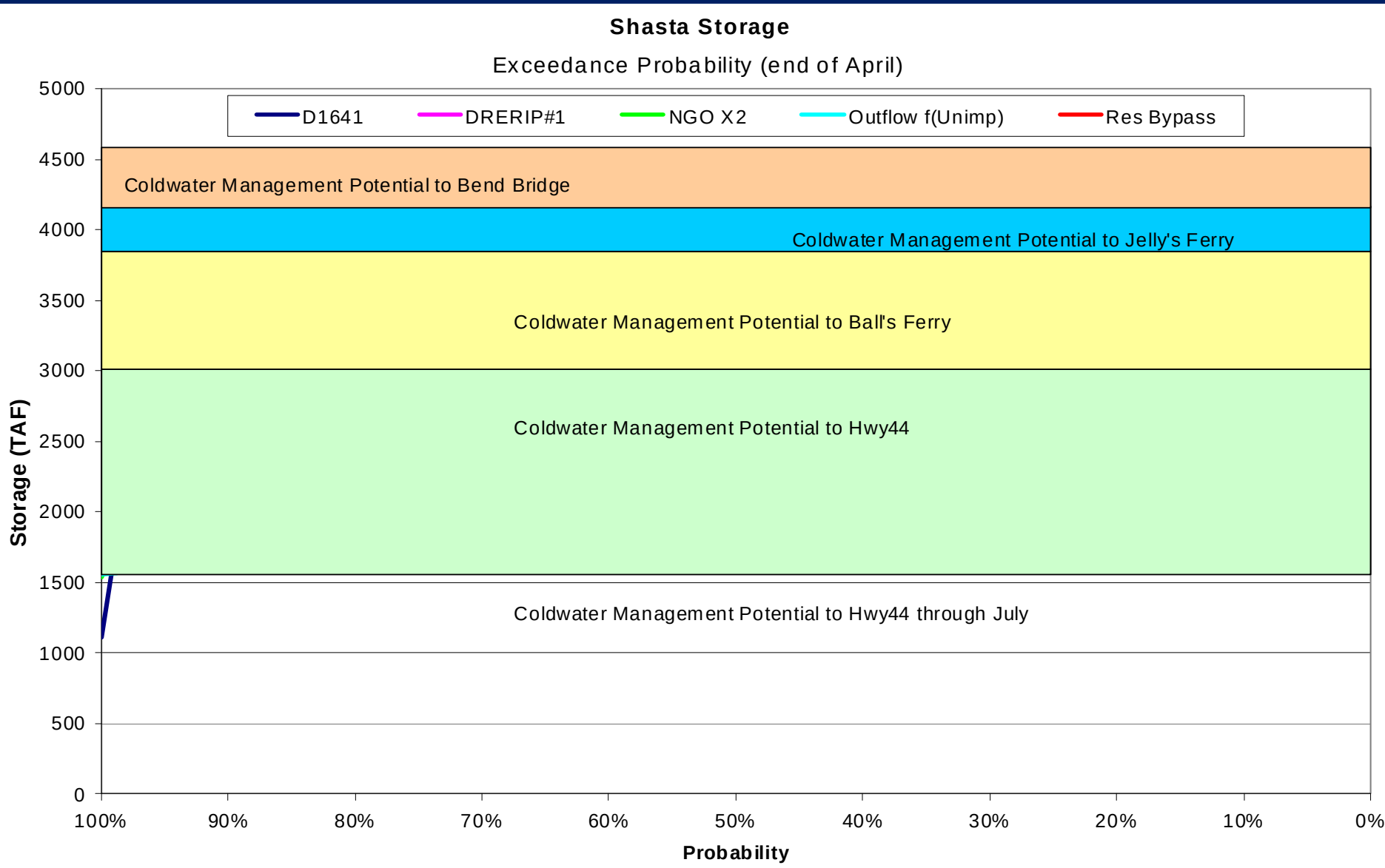
	Cap1	Storage1	Cap2	Storage2	Cap3
Feb	3,000	350	1,900	250	800
Mar	3,000	400	1,900	300	800
Apr	3,000	450	1,900	350	800
May	3,000	400	1,900	300	800
Jun	3,000	350	1,900	250	800

Initial Exploratory Modeling Results

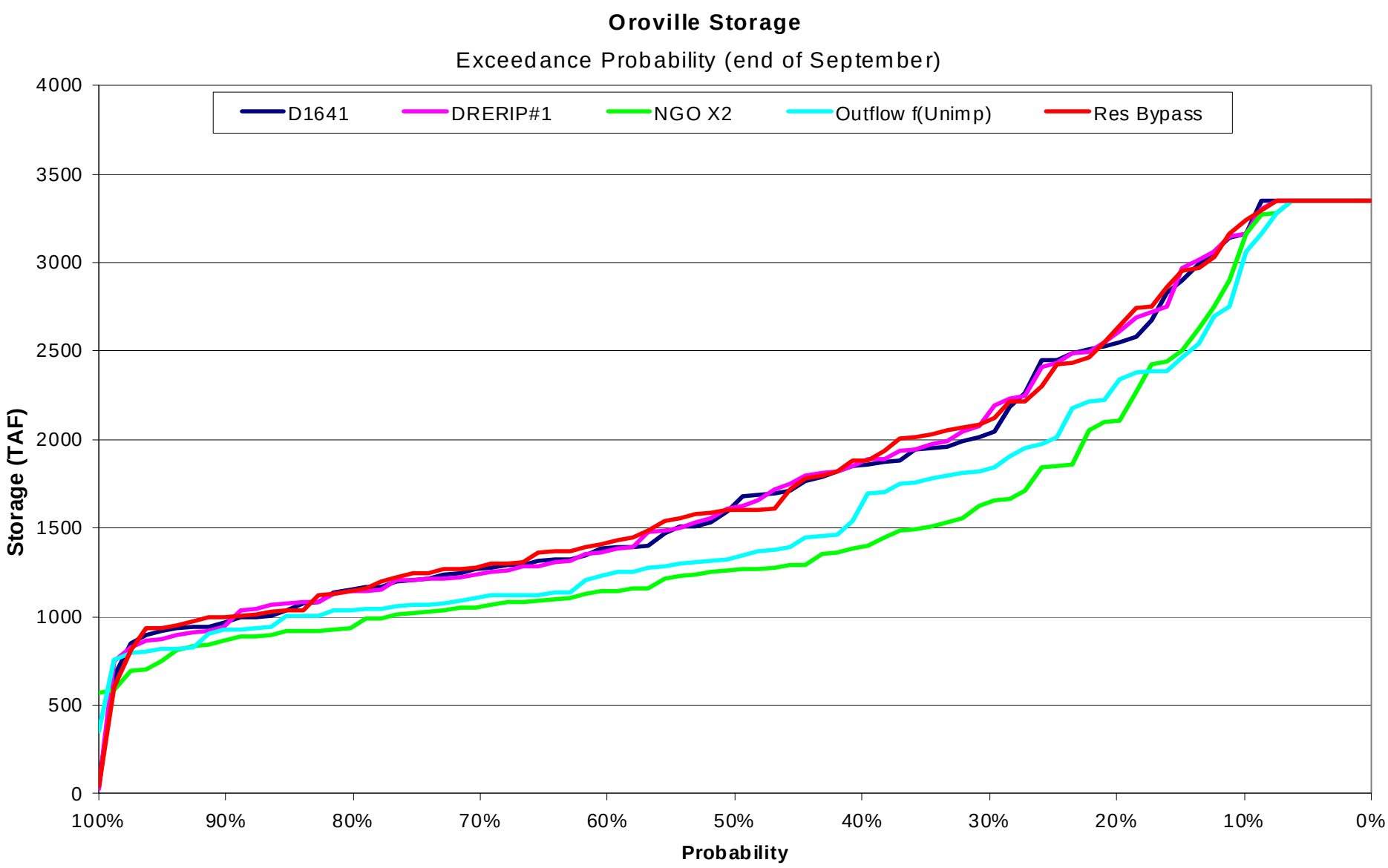
Shasta Carryover Storage



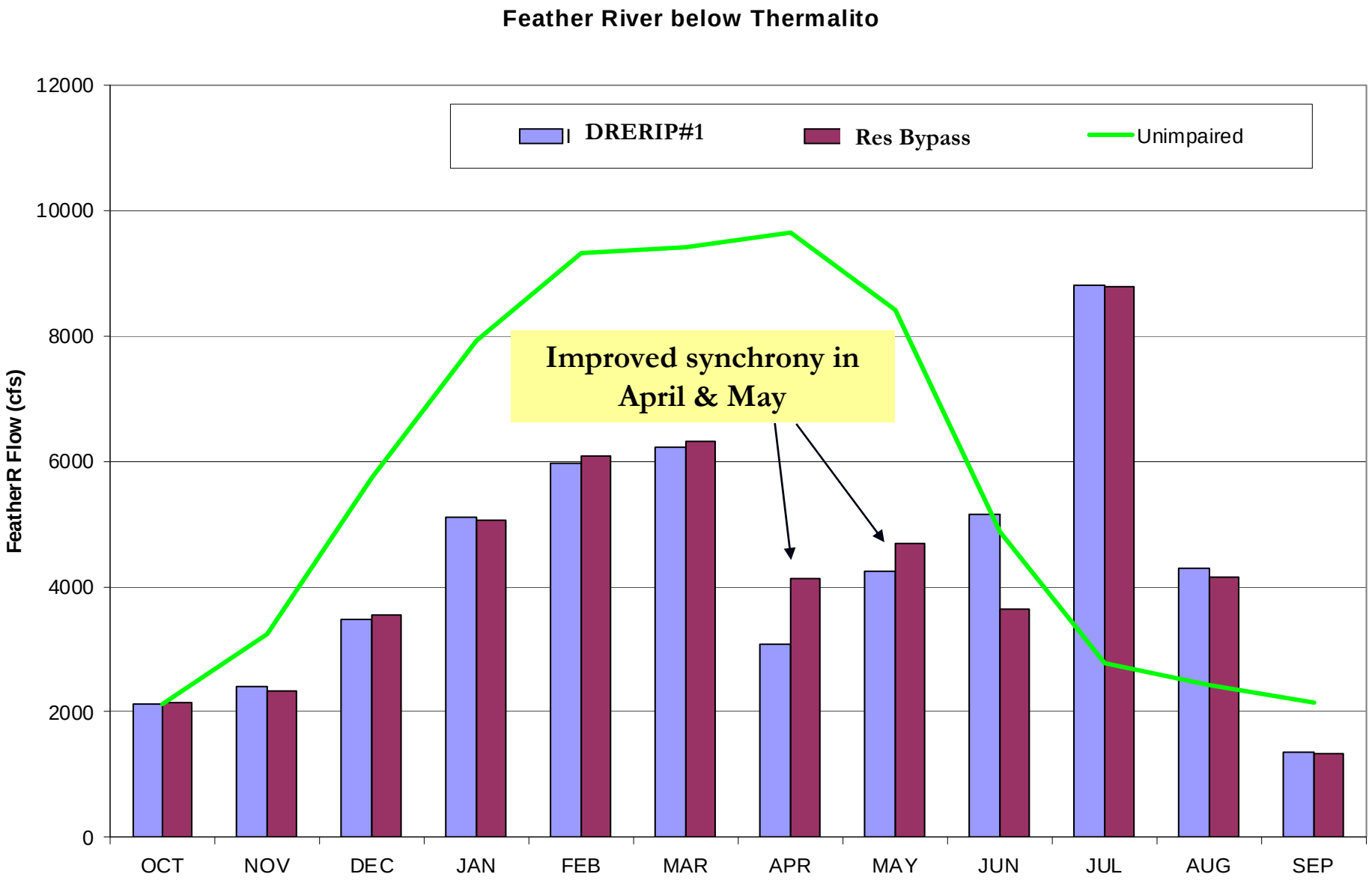
Shasta Coldwater Management Potential



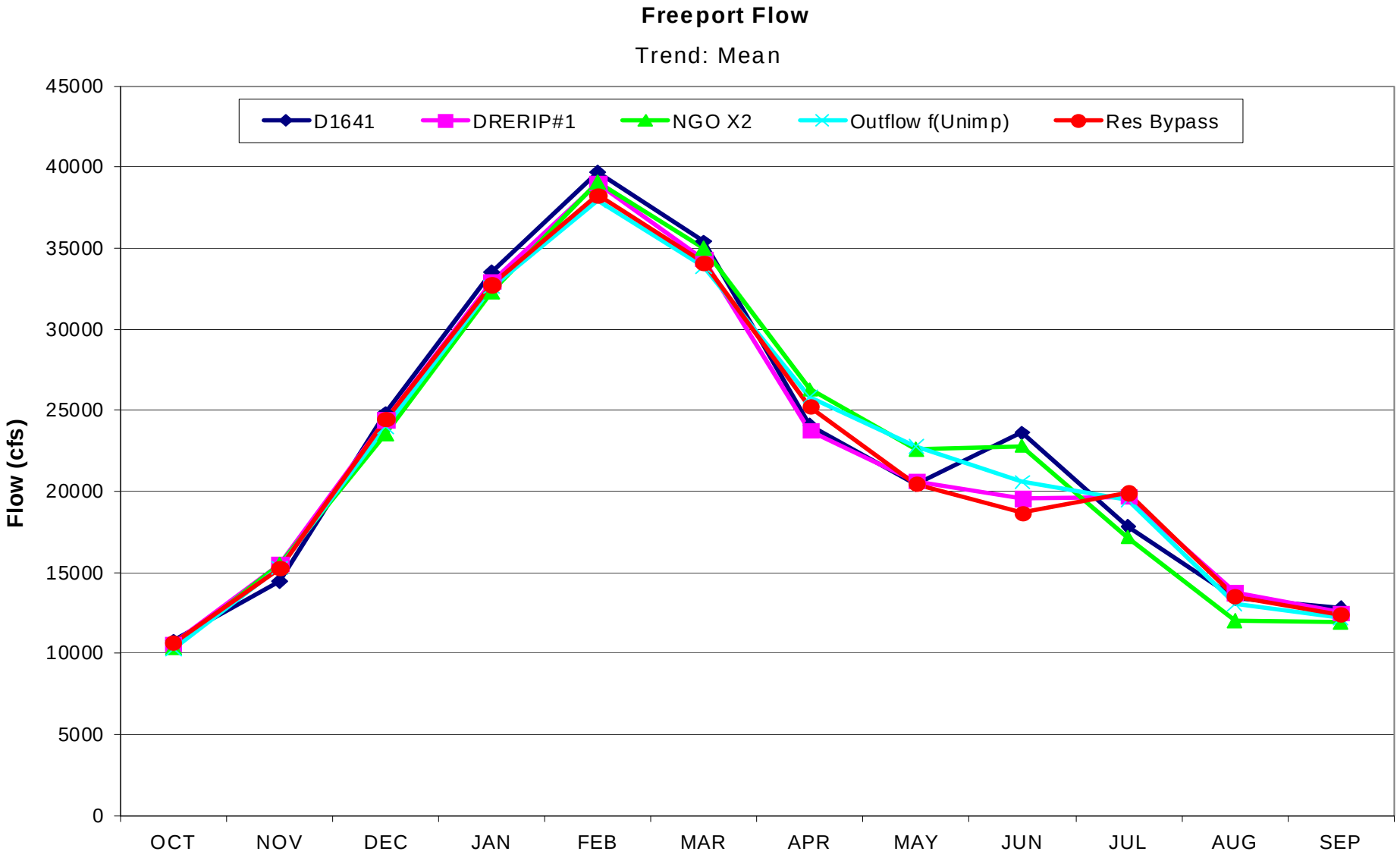
Oroville Carryover Storage



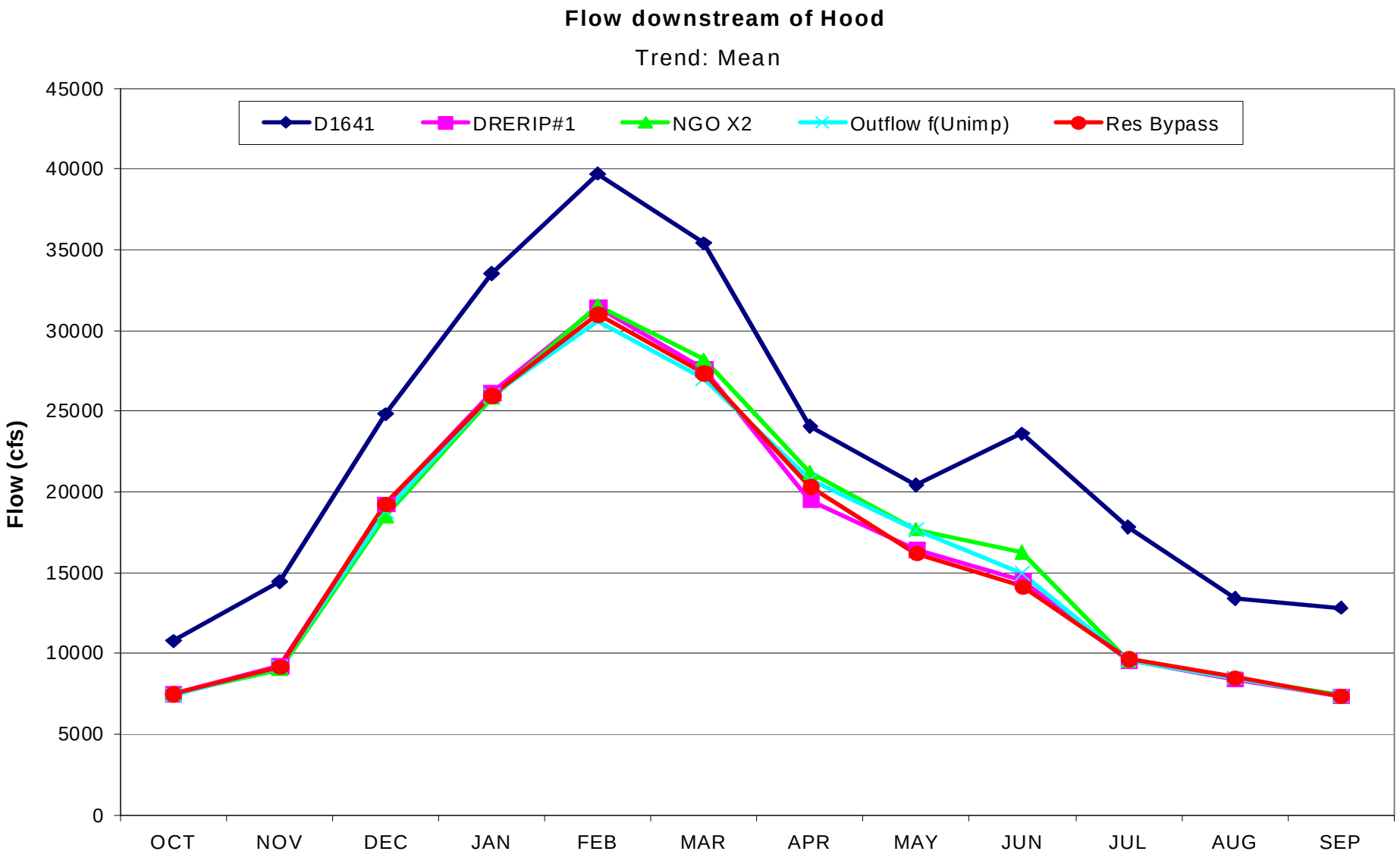
PRR Upstream Flow Synchrony



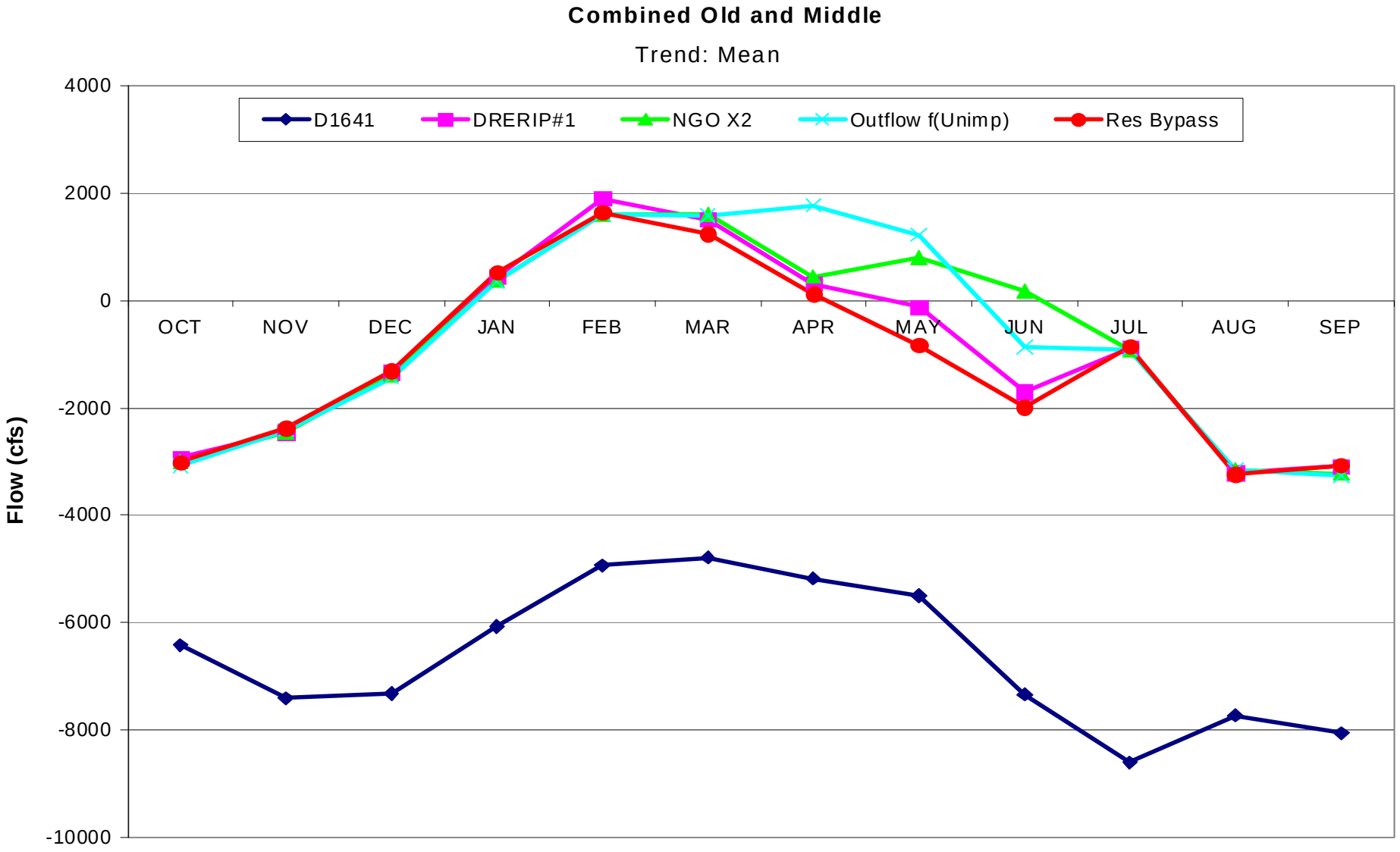
Hood Flow Upstream of Diversion



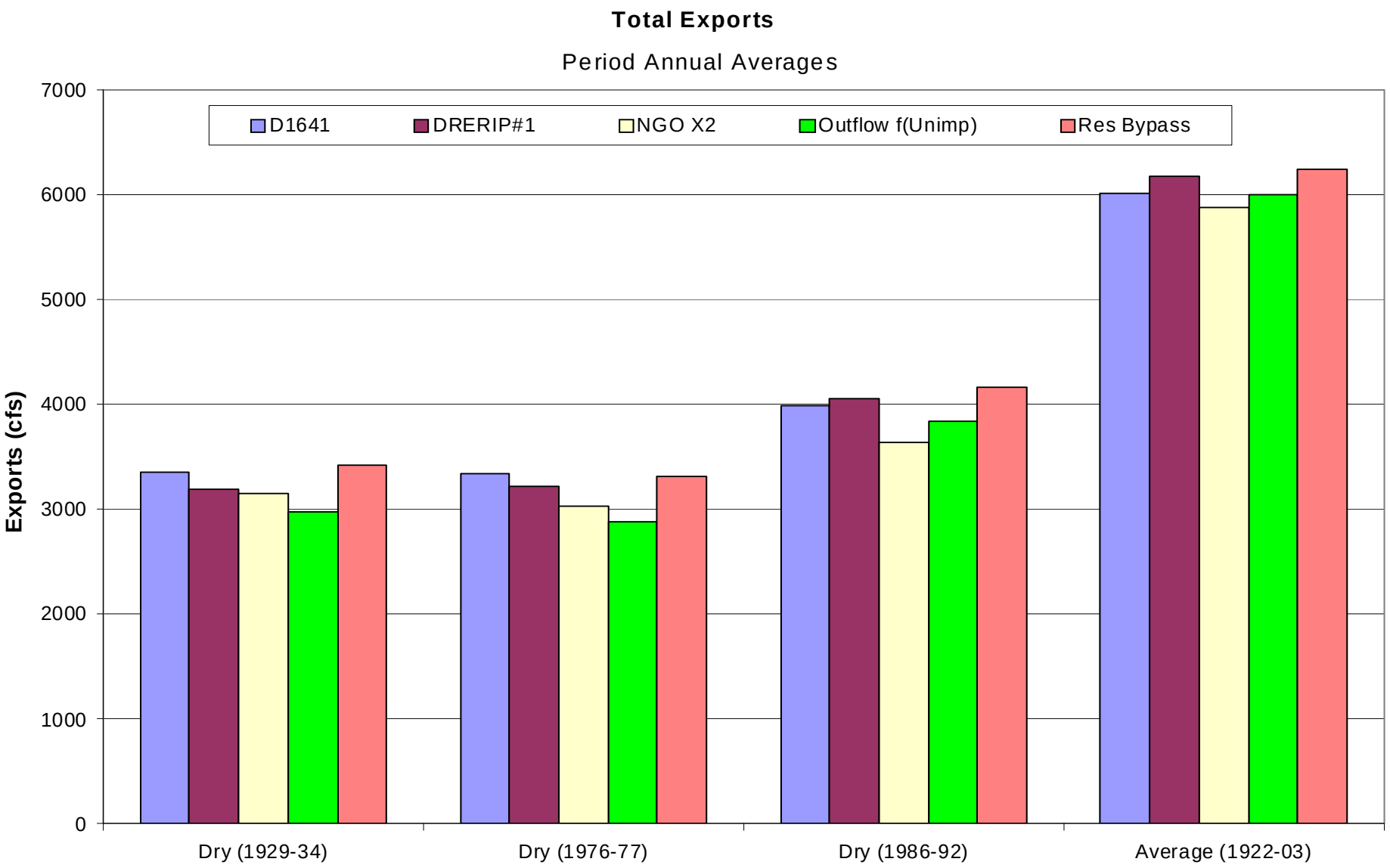
Hood Flow Downstream of Diversion



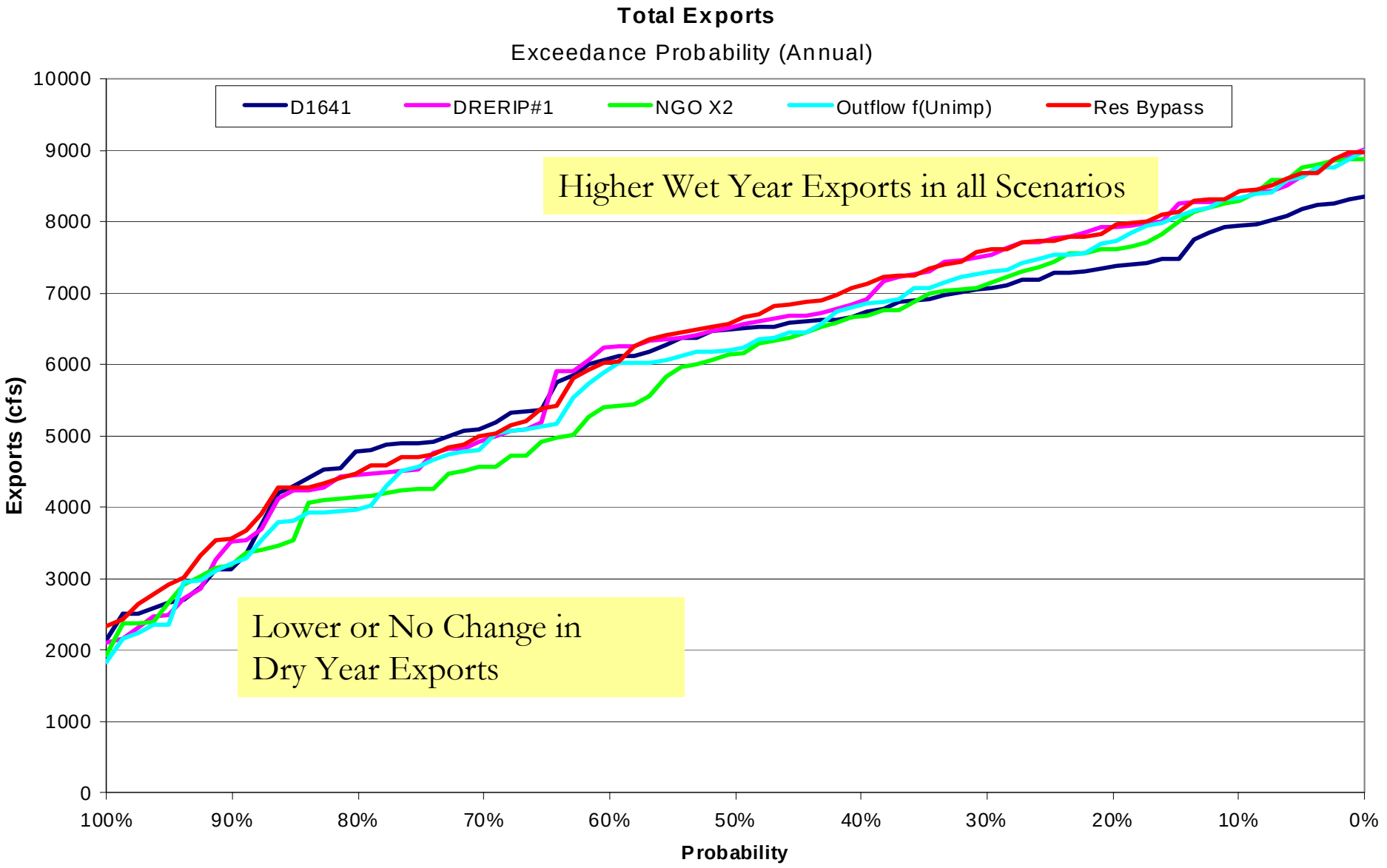
OMR Flows


Combined Old and Middle
Trend: Mean
D1641
DRERIP#1
NGO X2
Outflow f(Unimp)
Res Bypass
4000
2000
0
-2000
-4000
-6000
-8000
-10000
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
Flow (cfs)

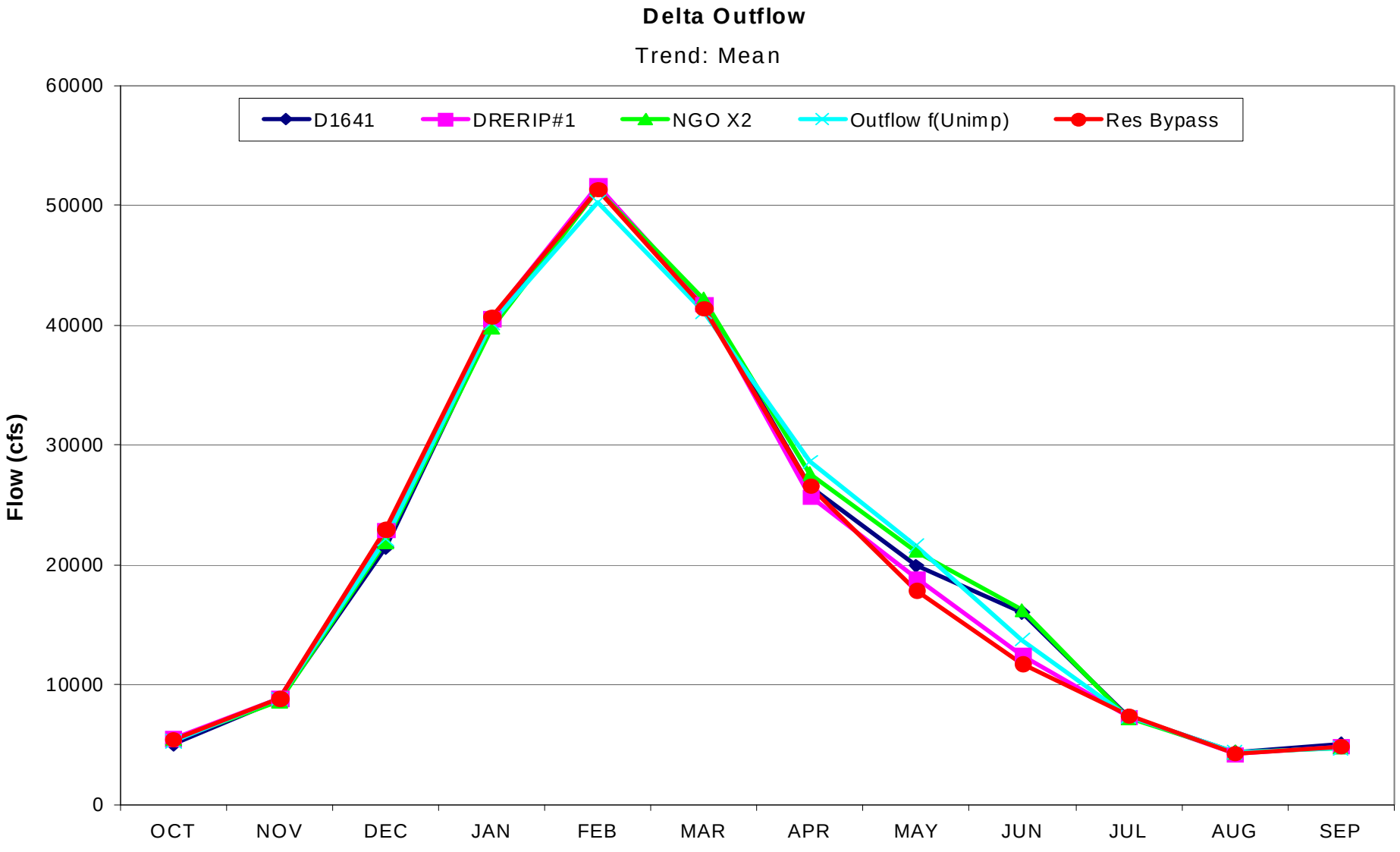
Water Supply Volume



Water Supply Reliability



Delta Outflow



Monthly X2 Changes