Simulating 50% Unimpaired Flow Requirements in CalSim II and SacWAM

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State Water Resources Control Board, Division of Water Rights
October 19, 2016

Presentation Overview

- Introduction
- Methods
  - New flow requirements
  - Demand / allocation reduction
- Results
  - Non-project tributaries
  - Project tributaries
  - Delta operations
- Conclusions

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Introduction

- Objective of this study was to provide a basis for further validation that SacWAM is a valid tool for use in the type of analyses associated with Phase II update of Bay-Delta Plan
- Implemented new instream flow requirements as % of unimpaired flow throughout the Sacramento Watershed
- Scenarios modeled do not represent actual alternatives for Phase II

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CalSim II

- Advantages
  - Official tool to simulate SWP and CVP operations
  - Been used in all major Bay-Delta planning projects for about 20 years
- Disadvantages
  - Limited representation of non-project tributaries
  - Does not represent upstream diversions and reservoirs
  - Not well documented
  - Difficult to simulate wide range of regulatory requirements
- Baseline – 2015 Delivery Capability Report – Current Conditions

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SacWAM

- Advantages
  - Detailed representation of Project and non-Project tributaries and operations
  - Representation of upstream diversions and reservoirs
  - Well documented
  - Capable of simulating a wide range of regulatory requirements
- Disadvantages
  - New model that has not yet been thoroughly vetted
  - Does not include representation of the San Joaquin River or its tributaries
  - Does not include detailed representation of demands south of San Luis Reservoir
- Baseline – Beta 0.1 – Current Conditions

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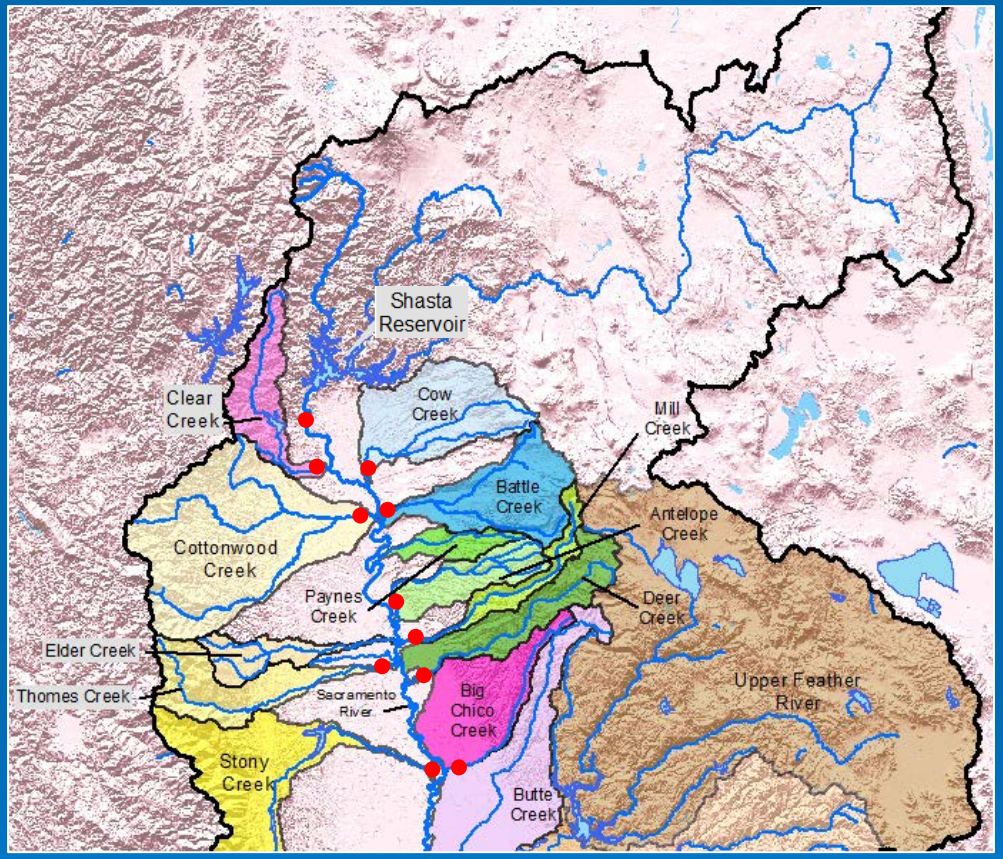
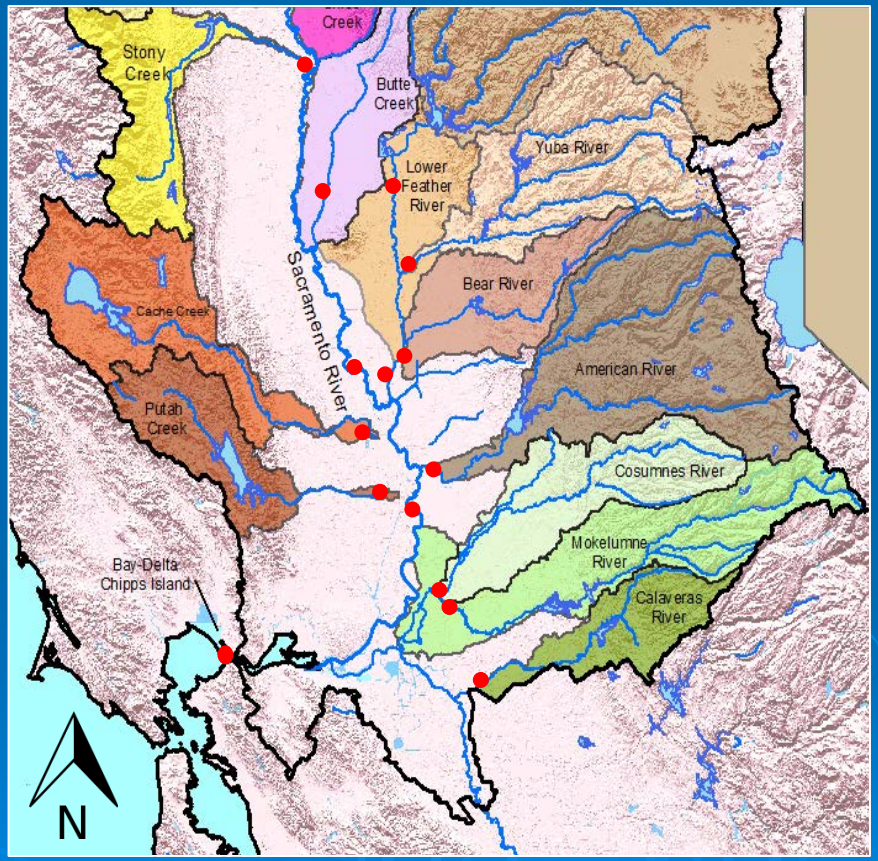
New Flow Requirements





● = 50% Unimpaired Flow Required

Demand and Allocation Reduction

- Maintain similar groundwater pumping levels as baseline
- Maintain sufficient storage to consistently meet new and existing flow requirements

Demand Reduction

- 20% in dry and critical years
- 10% in below normal years
- 0% in above normal and wet years

Allocation Reduction

- Applied to CVP and SWP Settlement Contractors
- 35% in critical years
- 30% in dry years
- 25% in below normal years
- 0% in above normal and wet years

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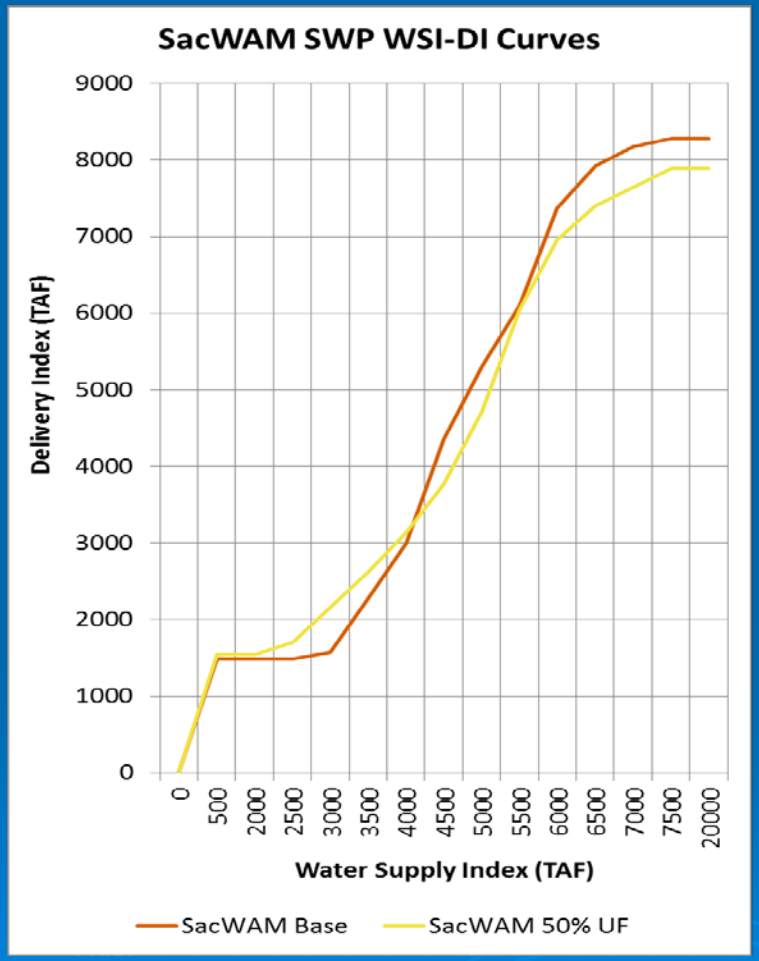
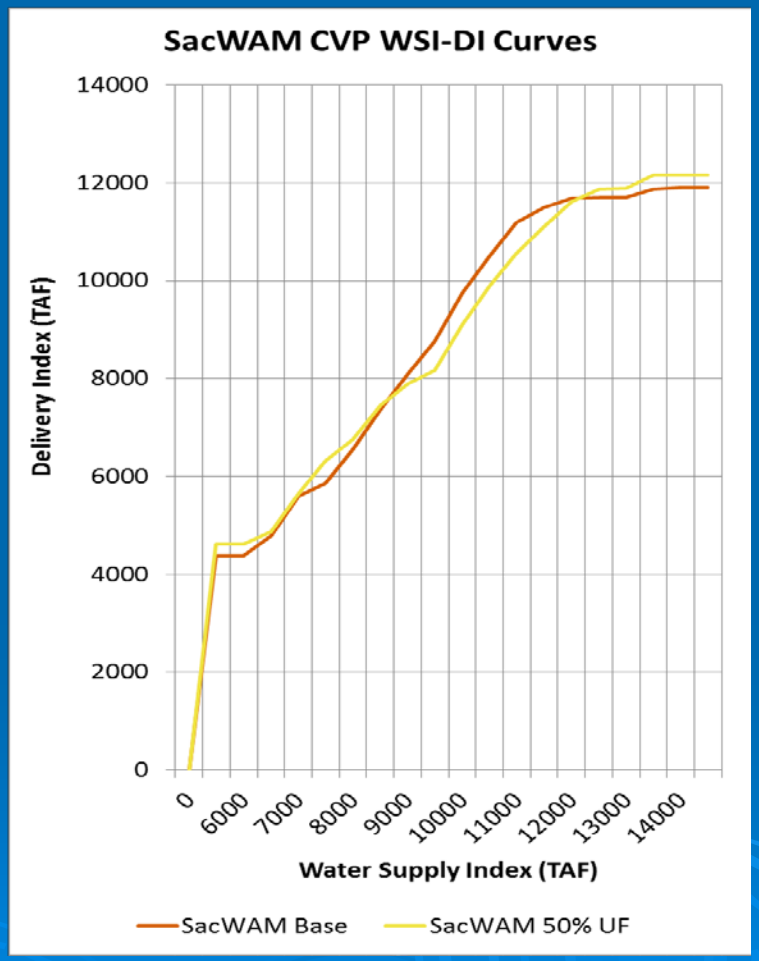
WSI-DI Curves





Results - Frequency of Unmet Flow Requirements

Instream Flow Requirement	SacWAM 50% UF Count of Months with unmet IFRs	CalSim II 50% UF Count of Months with unmet IFRs
American River above Sacramento River	3	6
Antelope Creek above Sacramento River	0	0
Battle Creek above Sacramento River	0	0
Bear River above Feather River	0	0
Big Chico above Confluence	0	0
Butte Creek above Butte Slough	0	0
Cache Creek above Yolo Bypass	69	N/A
Calaveras River above Delta	0	9
Clear Creek above Sacramento River	20	0
Cosumnes River above Mokelumne River	0	0
Cottonwood Creek above Sacramento River	0	0
Cow Creek above Sacramento River	0	0
Deer Creek above Sacramento River	0	0
Feather River below Oroville Reservoir	1	2
Feather River above Sacramento River	0	5
Mill Creek above Sacramento River	0	0
Mokelumne River above Cosumnes River	0	0
Putah Creek above Yolo Bypass	6	N/A
Stony Creek above Sacramento River	0	9
Thomes Creek above Sacramento River	0	0
Yuba River above Feather River	1	3
Sacramento River below Keswick	0	0
Sacramento River at Knights Landing	0	0
Sacramento River at Freeport	0	0
Delta Outflow	0	0

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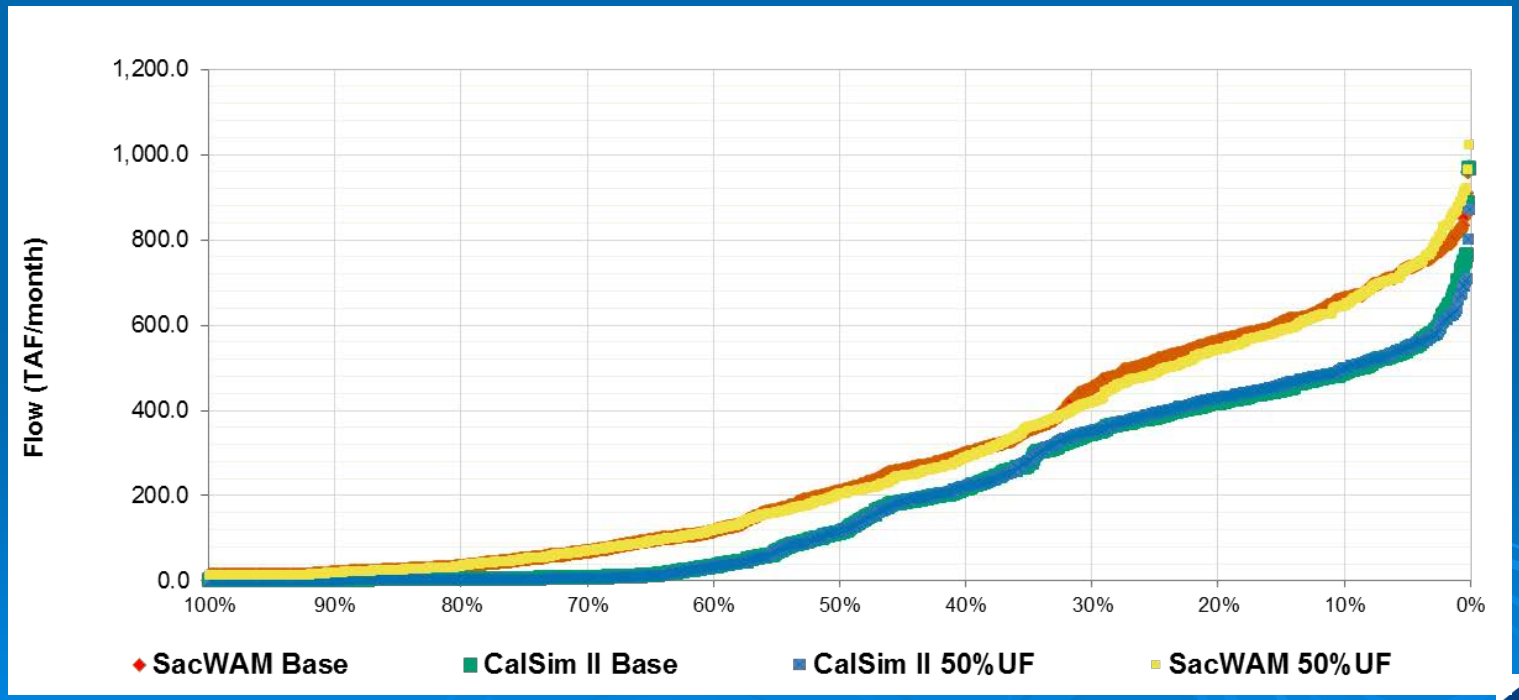
Results – Groundwater Pumping

- Both models show very little change to groundwater pumping



Results – Tributaries without Large Reservoirs (Non-regulated)

- Both models show little change to smaller non-regulated tributaries

		CalSim II				SacWAM			
		Mean Annual Values WY 1922-2003		Mean Annual Difference WY 1922-2003		Mean Annual Values WY 1922-2003		Mean Annual Difference WY 1922-2003	
		CalSim-II Base	CalSim-II 50% UF	Change from Base		SacWAM Base	SacWAM 50% UF	Change from Base	
		TAF	TAF	TAF	Percent	TAF	TAF	TAF	Percent
Non Project - Non Regulated Tributaries									
Cottonwood Creek at Confluence	#	599	602	3	0%	549	548	0	0%
Thomes and Elder Creeks at Confluence	#	274	272	2	-1%	325	329	4	1%
Cow Creek at Confluence	#	453	456	3	1%	411	413	2	0%
Battle Creek at Confluence	#	337	337	0	0%	353	353	0	0%
Paynes Creek at Confluence	#	46	49	3	8%	53	53	0	0%
Mill, Deer and Antelope Creeks at Confluence	#	497	519	23	5%	509	520	11	2%
Big Chico Creek at Confluence	#	97	97	0	0%	102	102	0	0%
Cosumnes River at Confluence	#	361	362	1	0%	344	344	0	0%
Total Unregulated Tributary Streamflow	#	2,663	2,695	31	1%	2,815	2,830	15	1%

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Results - Non-Project Tributaries with Large Reservoirs

- CalSim II adds water to system from regulated non-project tributaries on annual scale

		CalSim II				SacWAM			
		Mean Annual Values WY 1922-2003		Mean Annual Difference WY 1922-2003		Mean Annual Values WY 1922-2003		Mean Annual Difference WY 1922-2003	
		CalSim-II Base	CalSim-II 50% UF	Change from Base		SacWAM Base	SacWAM 50% UF	Change from Base	
		TAF	TAF	TAF	Percent	TAF	TAF	TAF	Percent
Non Project - Regulated Tributaries									
Stony Creek at confluence	#	237	266	29	12%	264	275	11	4%
Butte Creek above Butte Slough	#	207	216	9	4%	725	673	-52	-7%
Yuba River at Confluence	#	1,453	1,624	171	12%	1,506	1,568	62	4%
Bear River at Confluence	#	268	325	58	21%	218	214	-5	-2%
Cache Creek above Yolo Bypass	#	-	-	-	-	325	371	46	14%
Putah Creek above Yolo Bypass	#	-	-	-	-	78	178	100	128%
Mokelumne River above Cosumnes	#	304	467	164	35%	421	518	97	23%
Calaveras River at Confluence	#	104	111	7	7%	52	72	20	38%
Total Non-Project Regulated Inflow to Sacramento River/Delta		2,572	3,009	437	17%	3,589	3,867	278	8%

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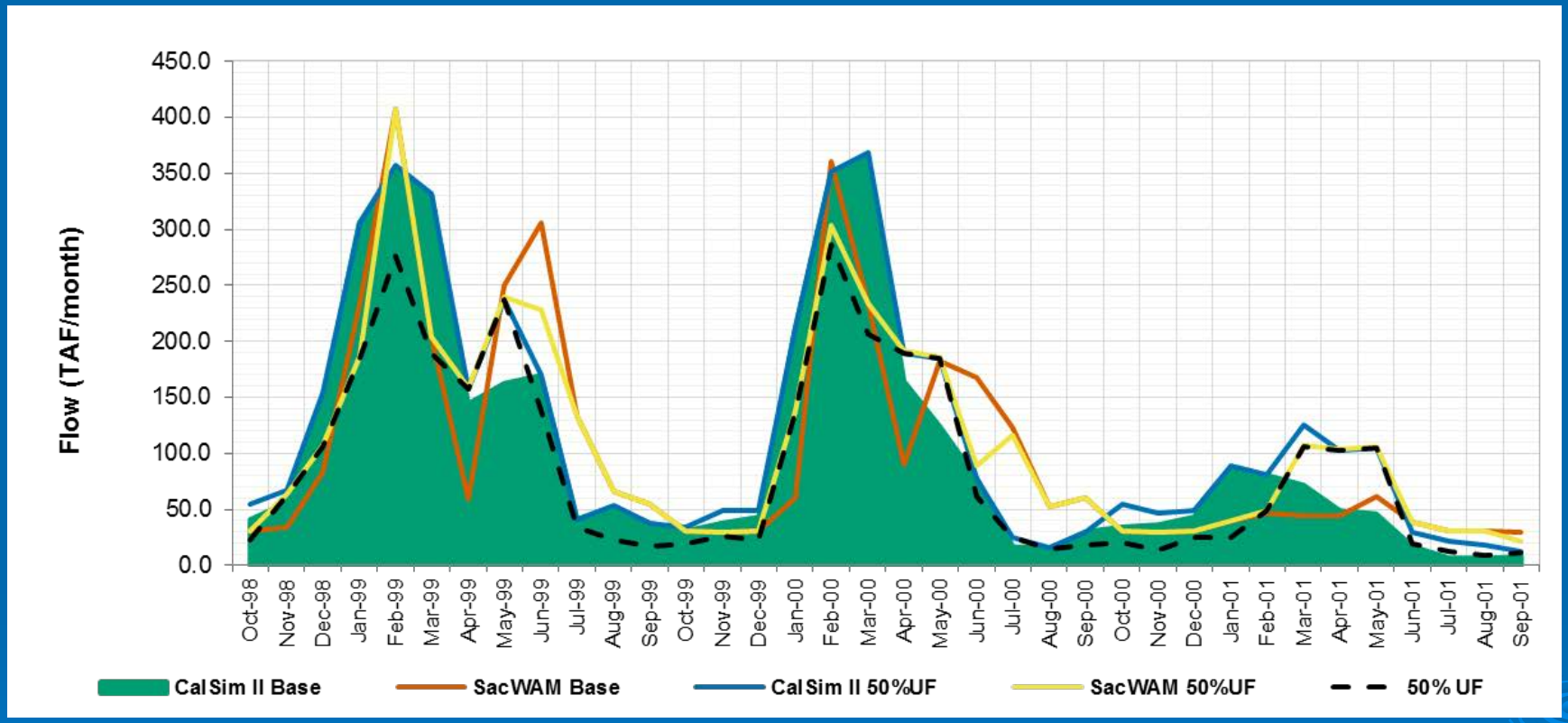
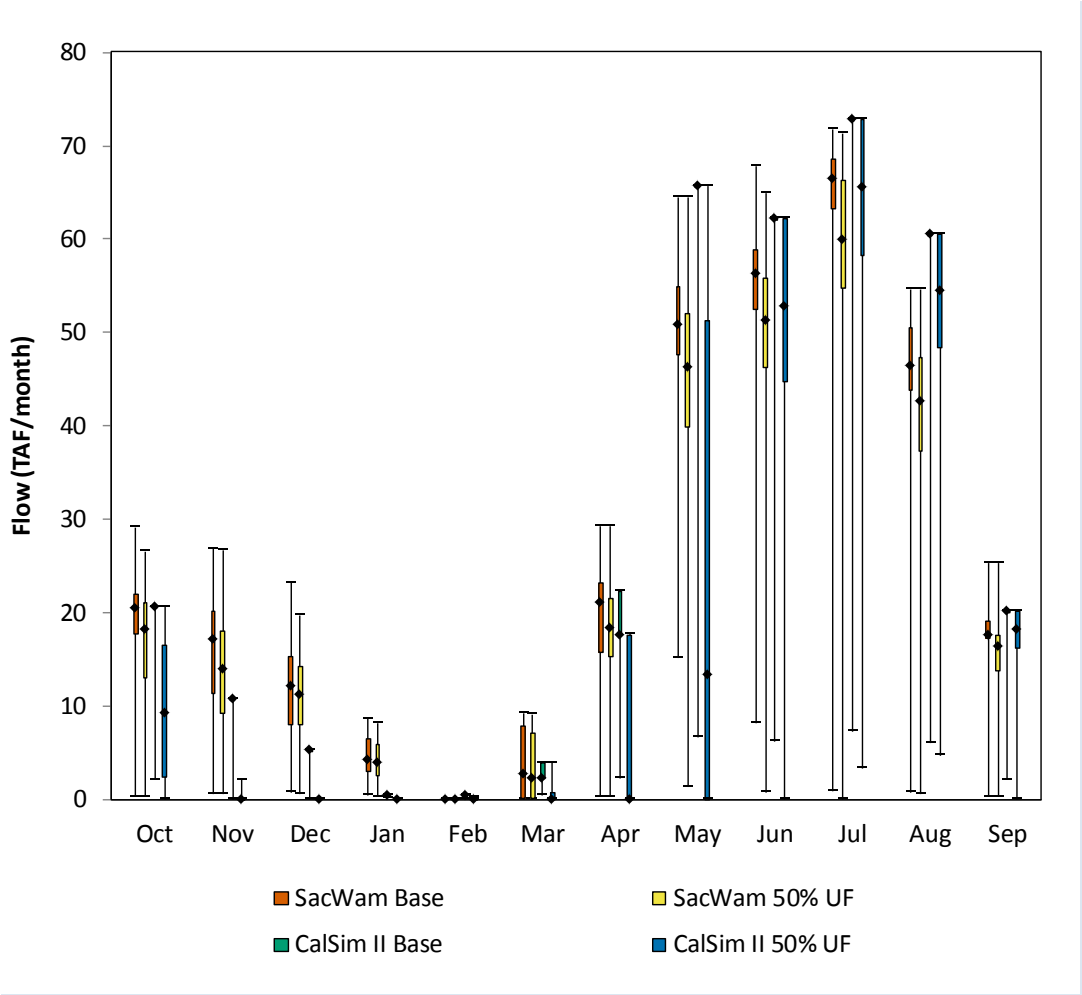
Yuba River above Feather River



- SacWAM shifts flows from summer/fall to spring while CalSim II only increases spring flows

Total Diversions from the Lower Yuba River

- CalSim II reduces diversions in uneven monthly pattern



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		CalSim-II Base	CalSim-II 50% UF	Change from Base		SacWAM Base	SacWAM 50% UF	Change from Base	
		TAF	TAF	TAF	Percent	TAF	TAF	TAF	Percent
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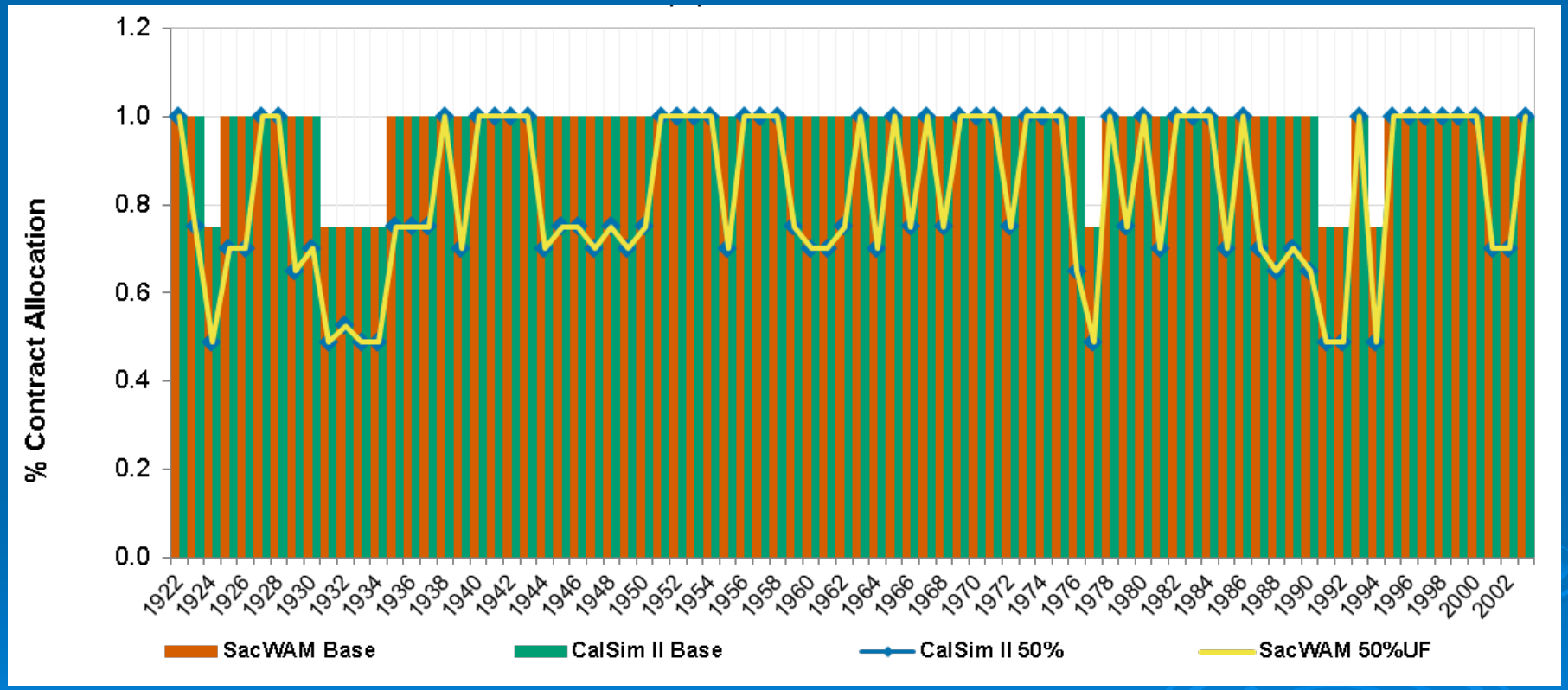
Results - Project Tributaries – Sacramento River

- Both models show similar response

		CalSim II				SacWAM			
		Mean Annual Values WY 1922-2003		Mean Annual Values WY 1922-2003		Mean Annual Values WY 1922-2003		Mean Annual Values WY 1922-2003	
		CalSim-II Base	CalSim-II 50% UF	Change from Base		SacWAM Base	SacWAM 50% UF	Change from Base	
		TAF	TAF	TAF	Percent	TAF	TAF	TAF	Percent
Project Operations and Flows									
Trinity River Import	#	542	544	2	0%	613	613	0	0%
Shasta Reservoir Release	#	5,556	5,567	11	0%	5,556	5,559	3	0%
Sacramento River below Keswick Dam	#	6,262	6,187	-75	-1%	6,333	6,270	-63	-1%
Clear Creek at Confluence	#	127	215	88	69%	148	215	67	46%
Sacramento River at Knights Landing (below Colusa Basin Drain)	#	7,095	7,411	316	4%	6,926	7,197	271	4%
Sacramento River below Freeport	#	15,709	16,405	696	4%	15,470	16,017	546	4%
Sacramento River Settlement Contractor Diversions	#	1,862	1,535	-327	-18%	1,989	1,744	-245	-12%

CVP Settlement Contract Allocations



Results - Project Tributaries Feather and American Rivers

- Both models show similar response except for differences in streamflows on the lower Feather and diversions from the American River

		CalSim II				SacWAM			
		Mean Annual Values WY 1922-2003		Mean Annual Values WY 1922-2003		Mean Annual Values WY 1922-2003		Mean Annual Values WY 1922-2003	
		CalSim-II Base	CalSim-II 50% UF	Change from Base		SacWAM Base	SacWAM 50% UF	Change from Base	
		TAF	TAF	TAF	Percent	TAF	TAF	TAF	Percent
Feather River below Oroville Dam	#	3,931	3,948	18	0%	4,161	4,185	25	1%
Feather River Diversions Oroville to Confluence	#	1,343	1,141	-202	-15%	1,147	980	-167	-15%
Feather River at Confluence with Sacramento River	#	5,357	5,728	371	7%	5,183	5,407	224	4%
Folsom Reservoir Release	#	2,412	2,447	35	1%	2,579	2,602	23	1%
Diversions from Folsom Reservoir	#	210	189	-21	-10%	117	111	-6	-5%
Lower American River Diversions	#	491	455	-37	-7%	290	292	2	1%
American River at Confluence	#	2,168	2,211	43	2%	2,413	2,428	14	1%

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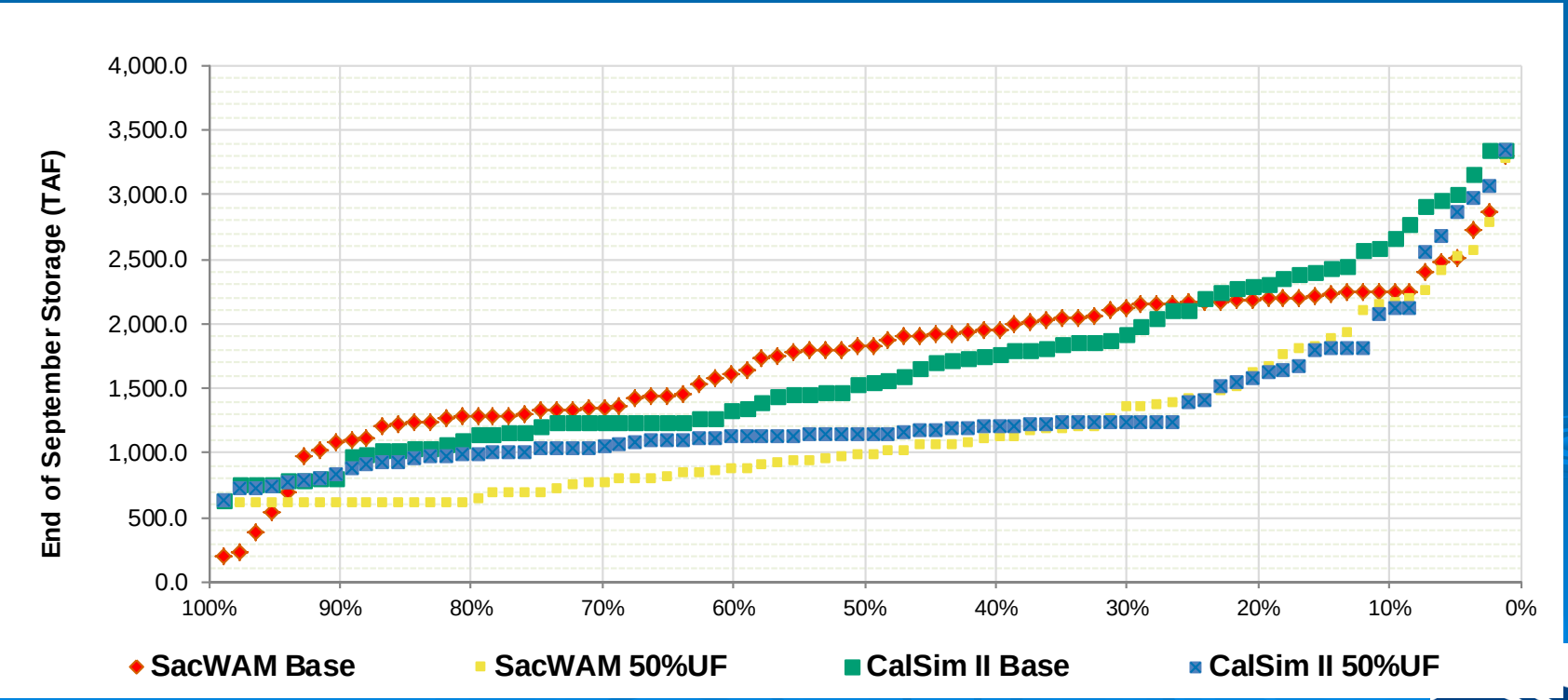
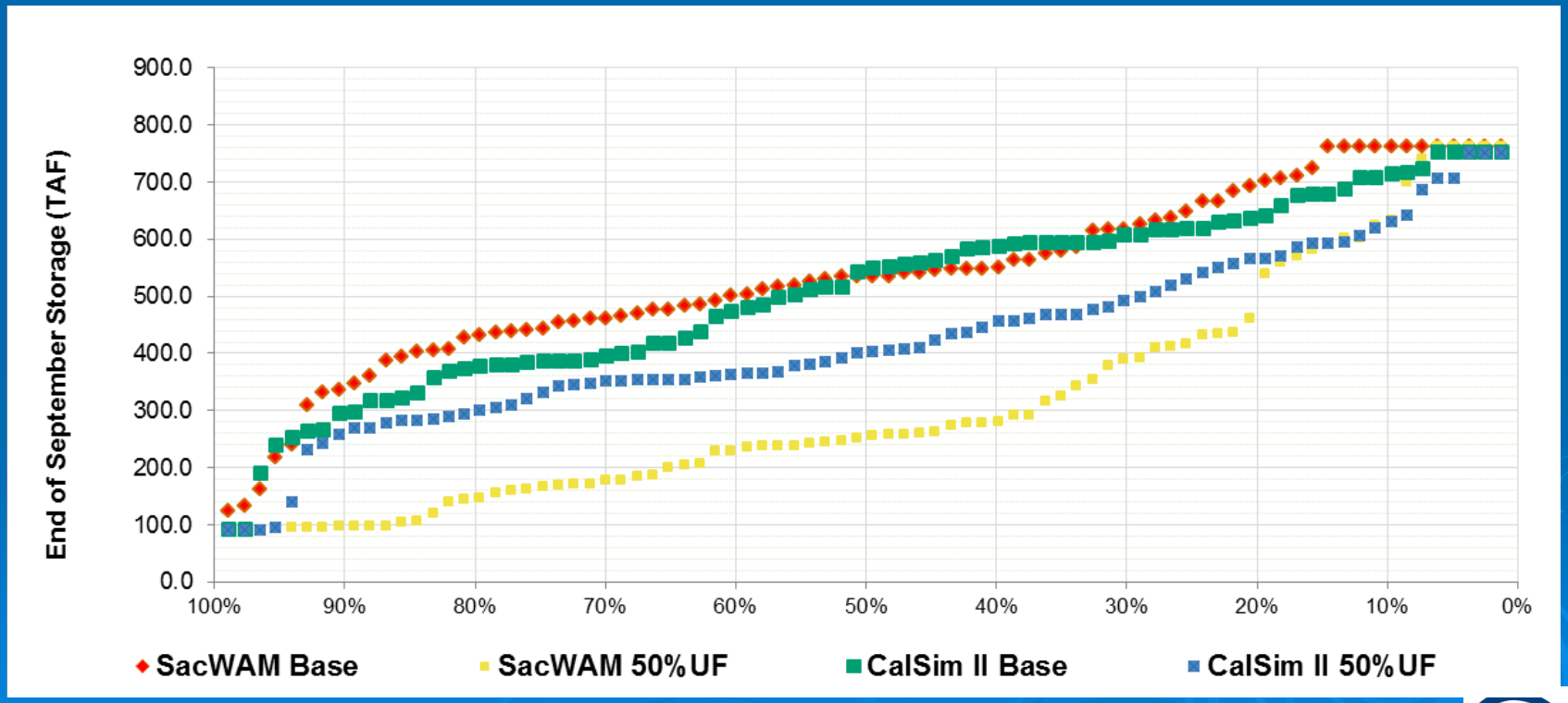
Oroville Carryover Storage

- Both models show moderate reductions in carryover storage



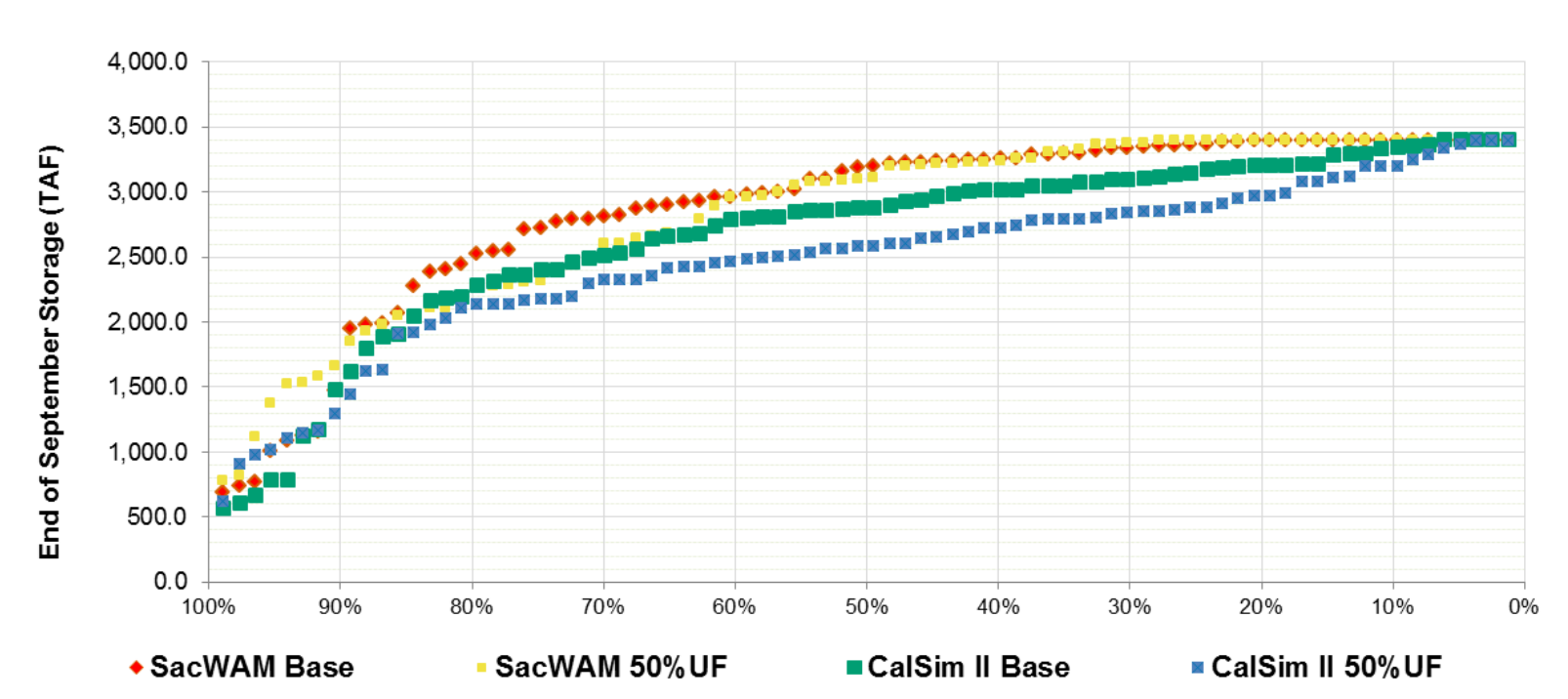
Folsom Reservoir Carryover Storage

- SacWAM shows a larger reduction in Folsom storage than CalSim II



Shasta Carryover Storage

- Both models show the smallest changes in reservoir storage occur at Shasta Reservoir



Results – Delta Operations

- Both models show a similar response

		CalSim II				SacWAM			
		Mean Annual Values WY 1922-2003		Mean Annual Values WY 1922-2003		Mean Annual Values WY 1922-2003		Mean Annual Values WY 1922-2003	
		CalSim-II Base	CalSim-II 50% UF	Change from Base		SacWAM Base	SacWAM 50% UF	Change from Base	
		TAF	TAF	TAF	Percent	TAF	TAF	TAF	Percent
Project Operations and Flows									
Total Delta Inflow	#	21,836	22,721	886	4%	22,092	22,792	700	3%
Total Delta Outflow	#	15,700	17,078	1,378	9%	15,870	16,982	1,112	7%
Delta SOD Exports	#	4,940	4,484	-456	-9%	4,897	4,510	-387	-8%
North Bay Aqueduct	#	101	97	-4	-4%	85	82	-3	-3%
Jones Pumping Plant	#	2,233	2,240	7	0%	2,171	2,140	-31	-1%
Banks Pumping Plat	#	2,708	2,244	-463	-17%	2,726	2,370	-356	-13%
Total SWP SOD Table A Deliveries	#	2,410	1,950	-461	-19%	2,573	2,191	-382	-15%
CVP Exchange Contractor Deliveries	#	853	853	0	0%	819	816	-3	0%
CVP SOD Deliveries Including Losses	#	2,328	2,349	21	1%	2,430	2,397	-33	-1%

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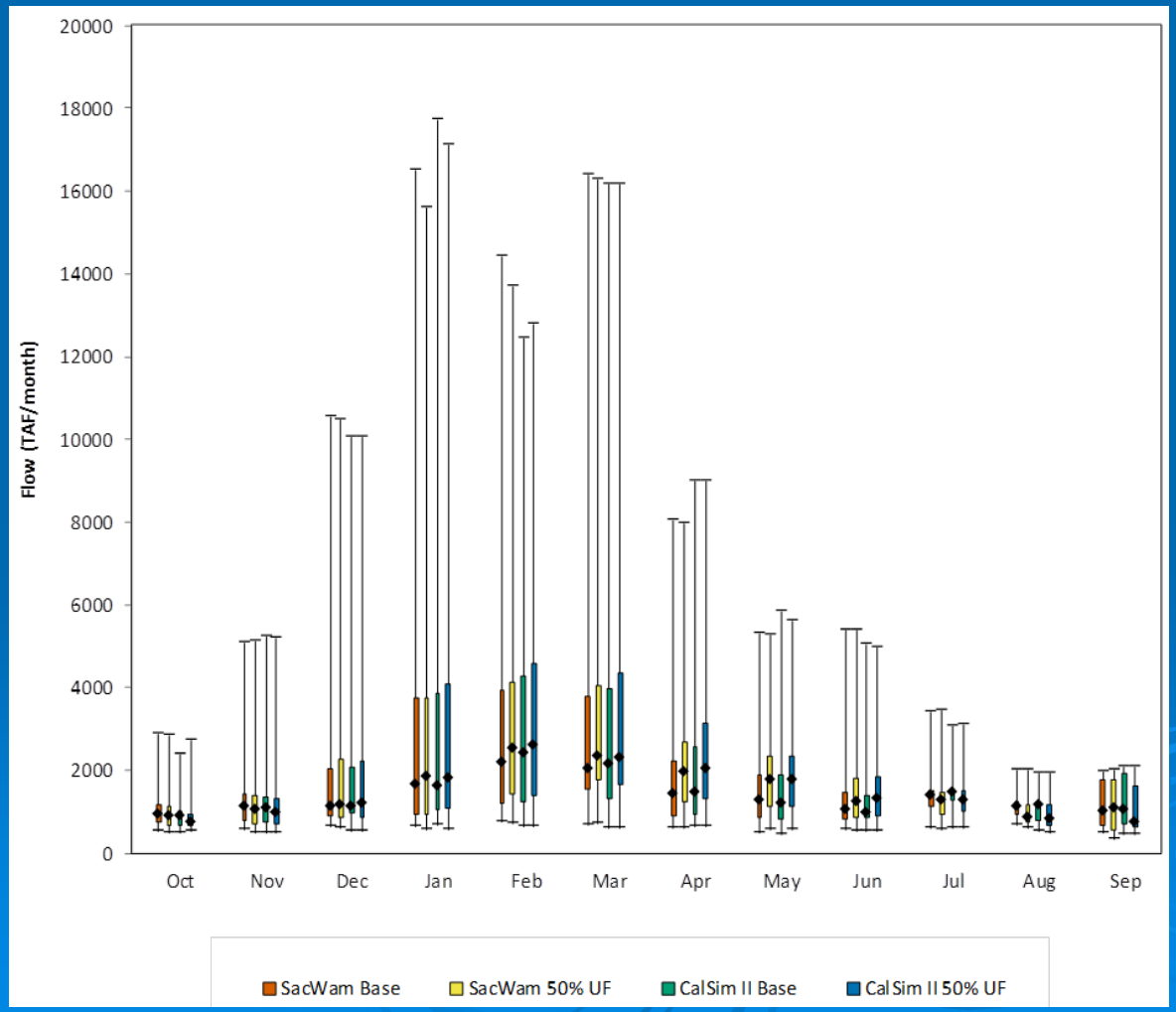
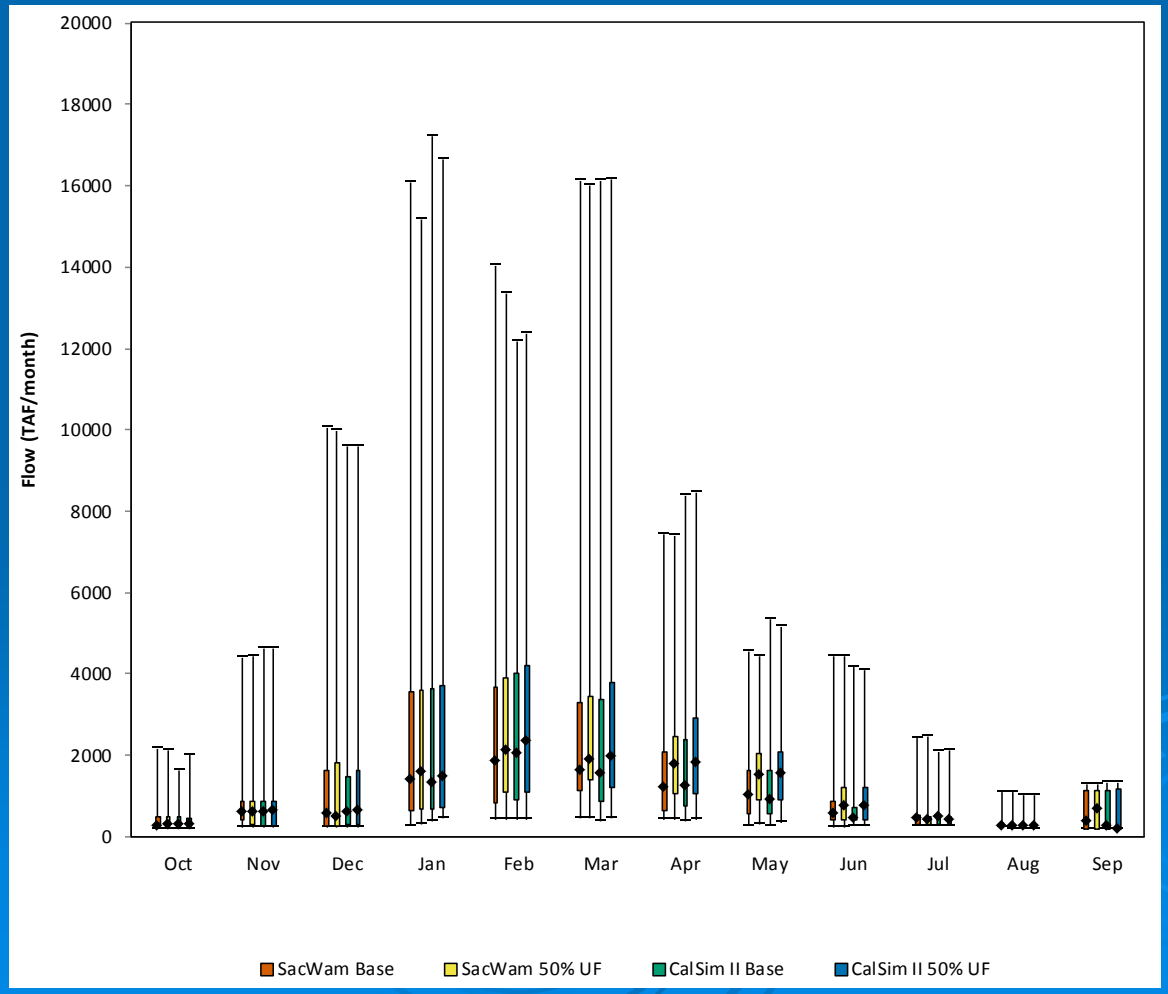
Total Delta Inflow

- Both models show very similar monthly changes to Delta inflow



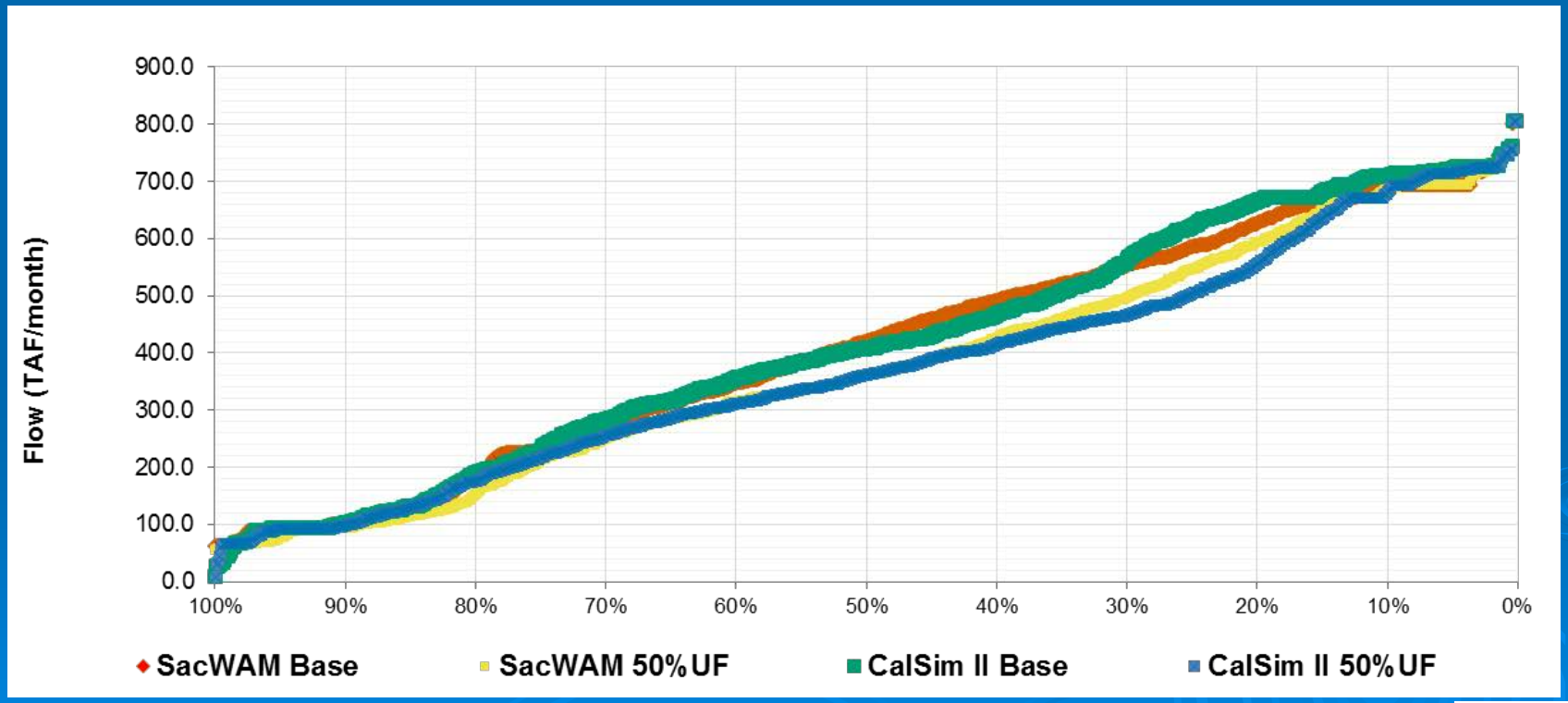
Total Delta Outflow

- Both models show very similar monthly changes to Delta outflow



Total Project Exports

- Both models show small reductions in Project exports



Conclusions

- CalSim II is not able to accurately simulate % of unimpaired flow on non-project tributaries
- Assumptions required in CalSim II to implement new flow requirements have unintended consequences in the Delta
- Given the differences in non-project tributaries and study assumptions, changes in Project operations are similar between the two models

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- Matt Holland – SWRCB
- Andy Draper – MWH
- Chuck Young -- SEI

Draft Report

- http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/sacwam/ or just google "SacWAM"

SacWAM is used in a comparative manner in which a model scenario is compared to a model base condition and the difference in model outputs is used to assess potential impacts of proposed regulatory actions.

The SacWAM model domain is shown below. The model represents the Sacramento River Hydrologic Region, the Trinity River watershed above the Lewiston gauge, and the northern part of the San Joaquin River Hydrologic Region downstream from the gauge at Vernalis. The model includes the entire Sacramento-San Joaquin Delta (Delta), and the Delta Eastside streams comprising the Cosumnes, Mokelumne, and Calaveras rivers. The model simulates Project Pumping Plants in the Delta, upper reaches of California Aqueduct and Delta Mendota Canal as well as San Luis Reservoir.

Downloads

To download and load SacWAM, first download and install the WEAP software from the link below. Then download SacWAM and load it through the WEAP interface. To run SacWAM, you must obtain a WEAP license and an XA license, license information is found below.

- September 2016 SacWAM Draft Model Documentation
- WEAP Software Platform
- SacWAM Beta Version 0.2
- Hydrological and Operations Modeling Considerations for the Phase 2 Update of the 2006 Bay-Delta Plan

News and Events

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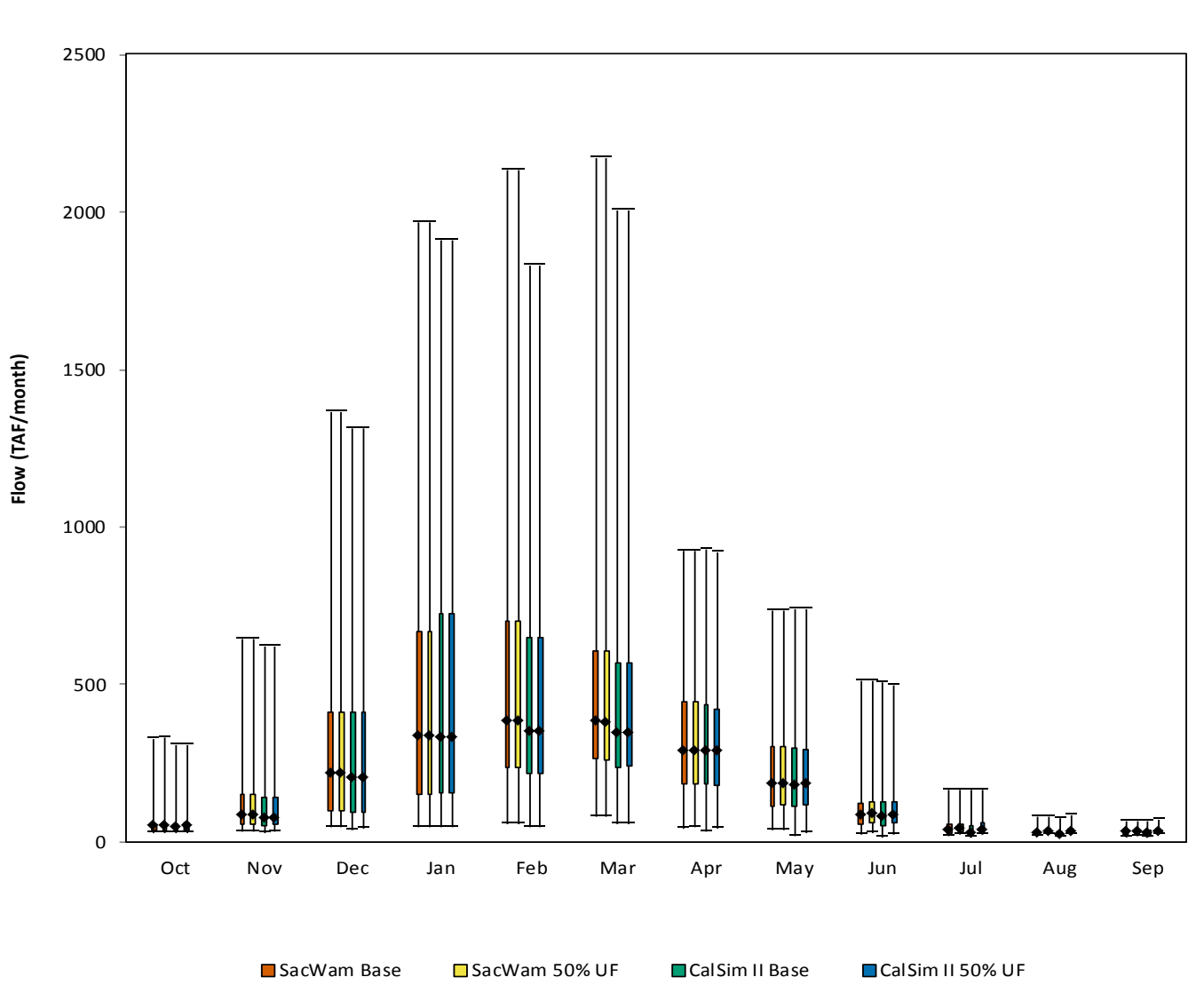
Additional Slides

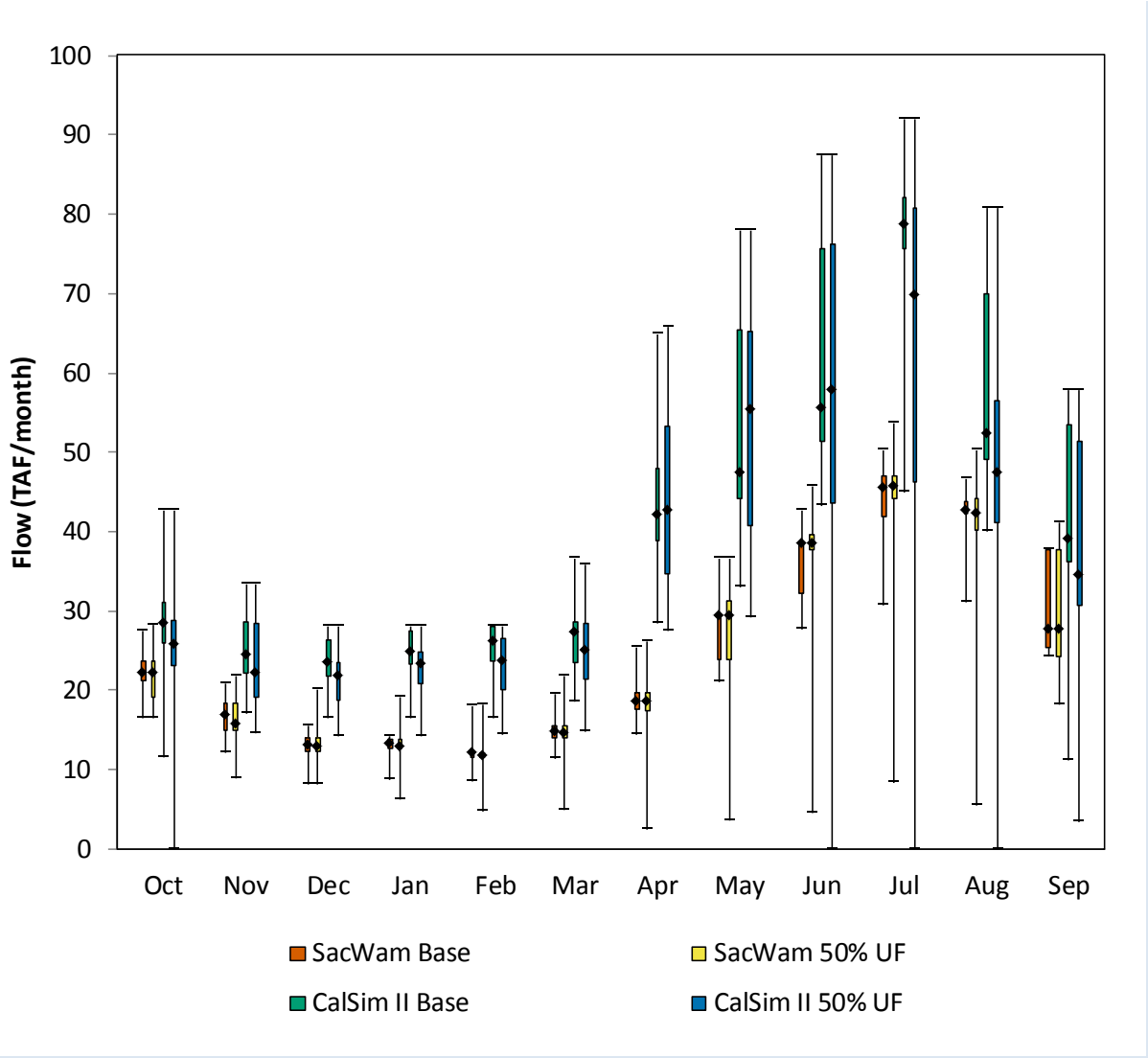
Implementation in CalSim II

- New variables: “UFRATIO”, “DRPCNT”, and “SCAPCNT”
- Inflow time series were adjusted
  - I230_UFRUN = max(I230,UFRATIO*UFC230_YUB002)
- Assume baseline Trinity imports
- To implement these requirements took 30 runs and nearly a year of work by DWR

Total Non-Regulated Tributary Streamflow Monthly Box Plot

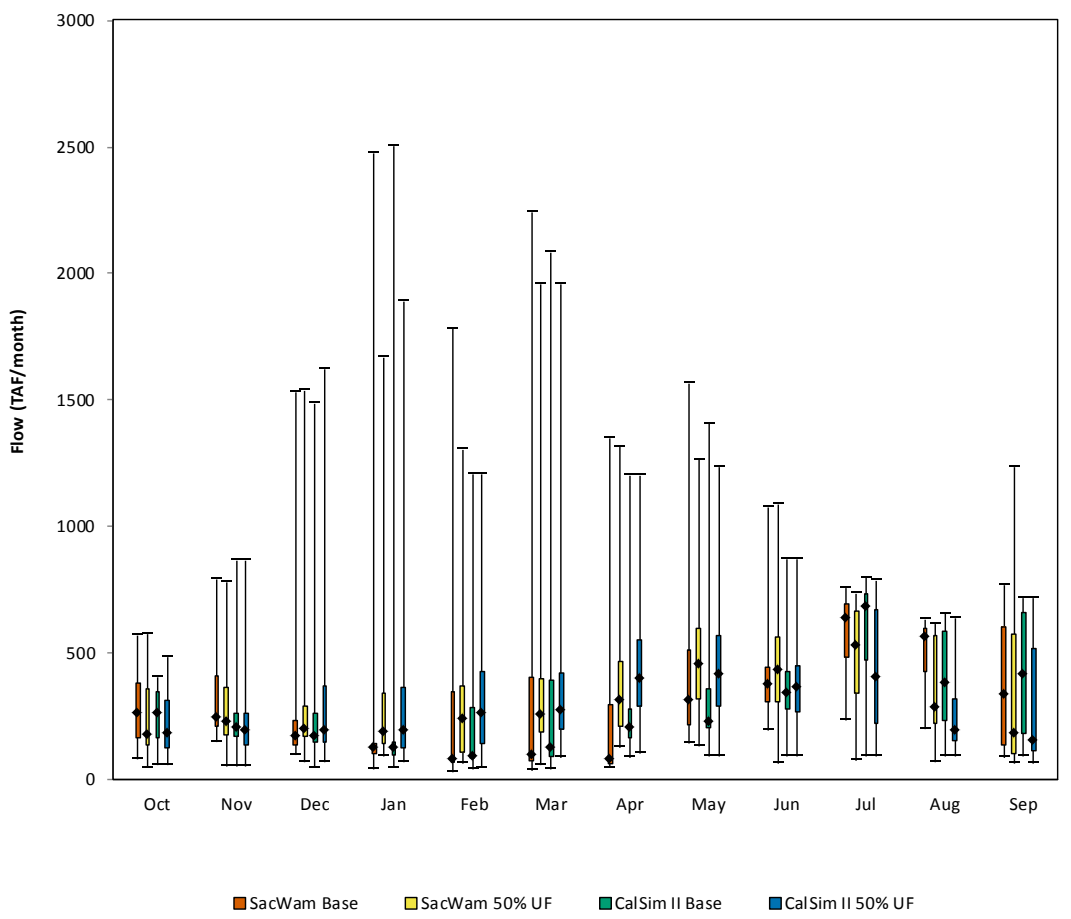


Total Diversions from the Lower American River



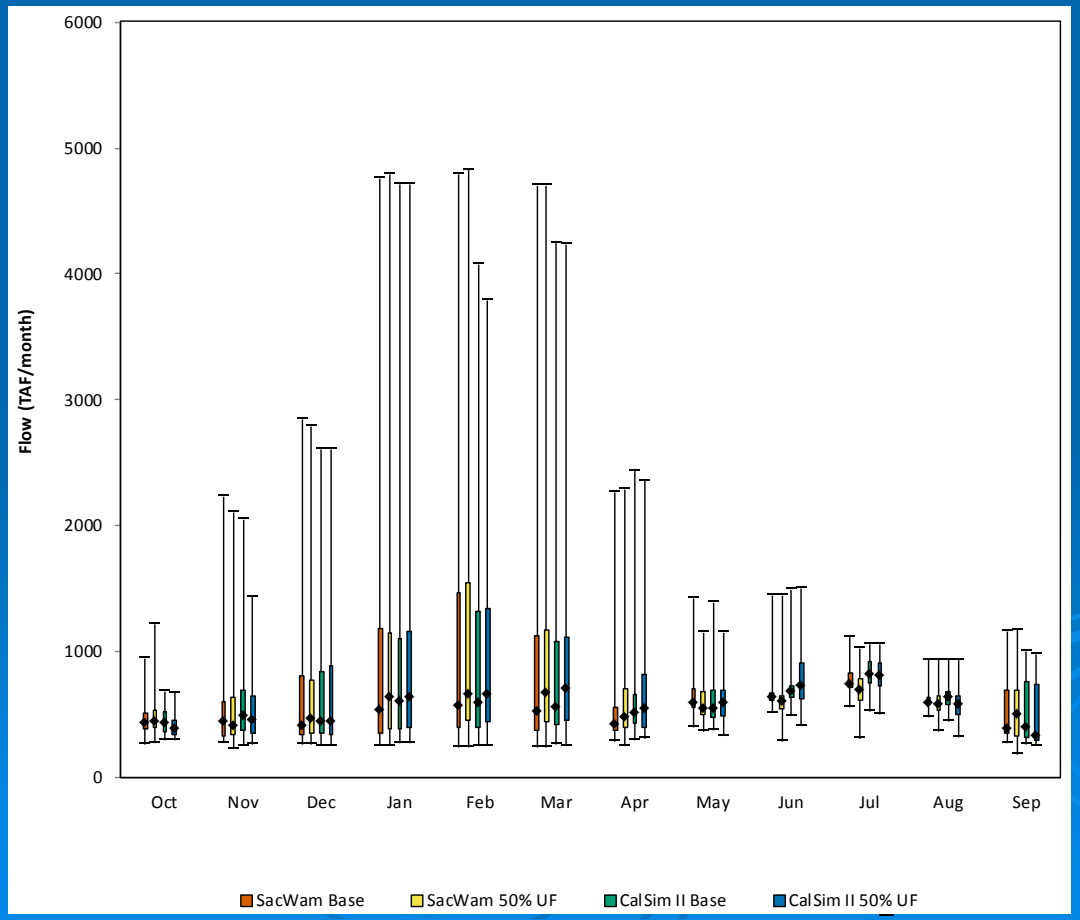
Feather River below Oroville Reservoir

- Both models exhibit similar decreases in July-November and increases December - June



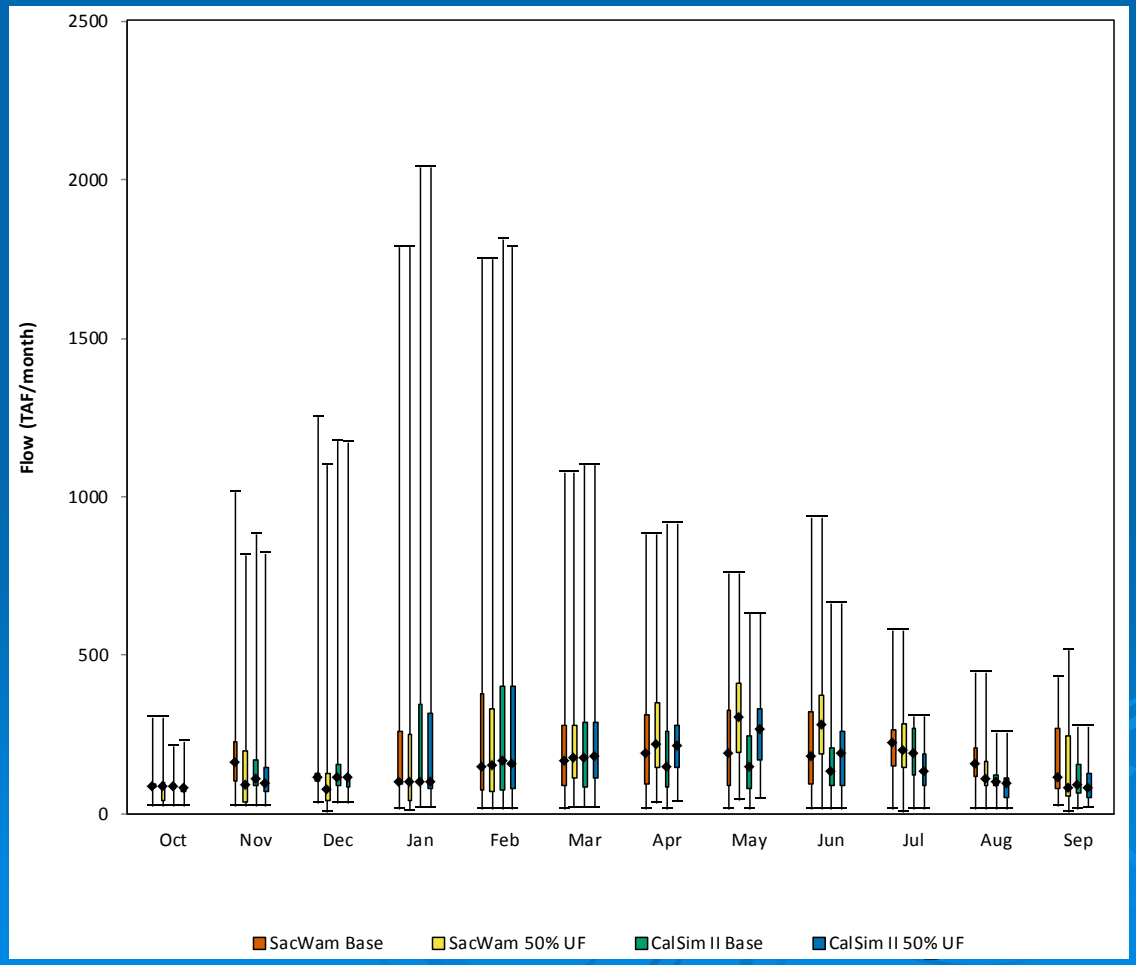
Sacramento River at Bend Bridge

- Both models show similar increases Jan-April but exhibit slightly different trends in the summer



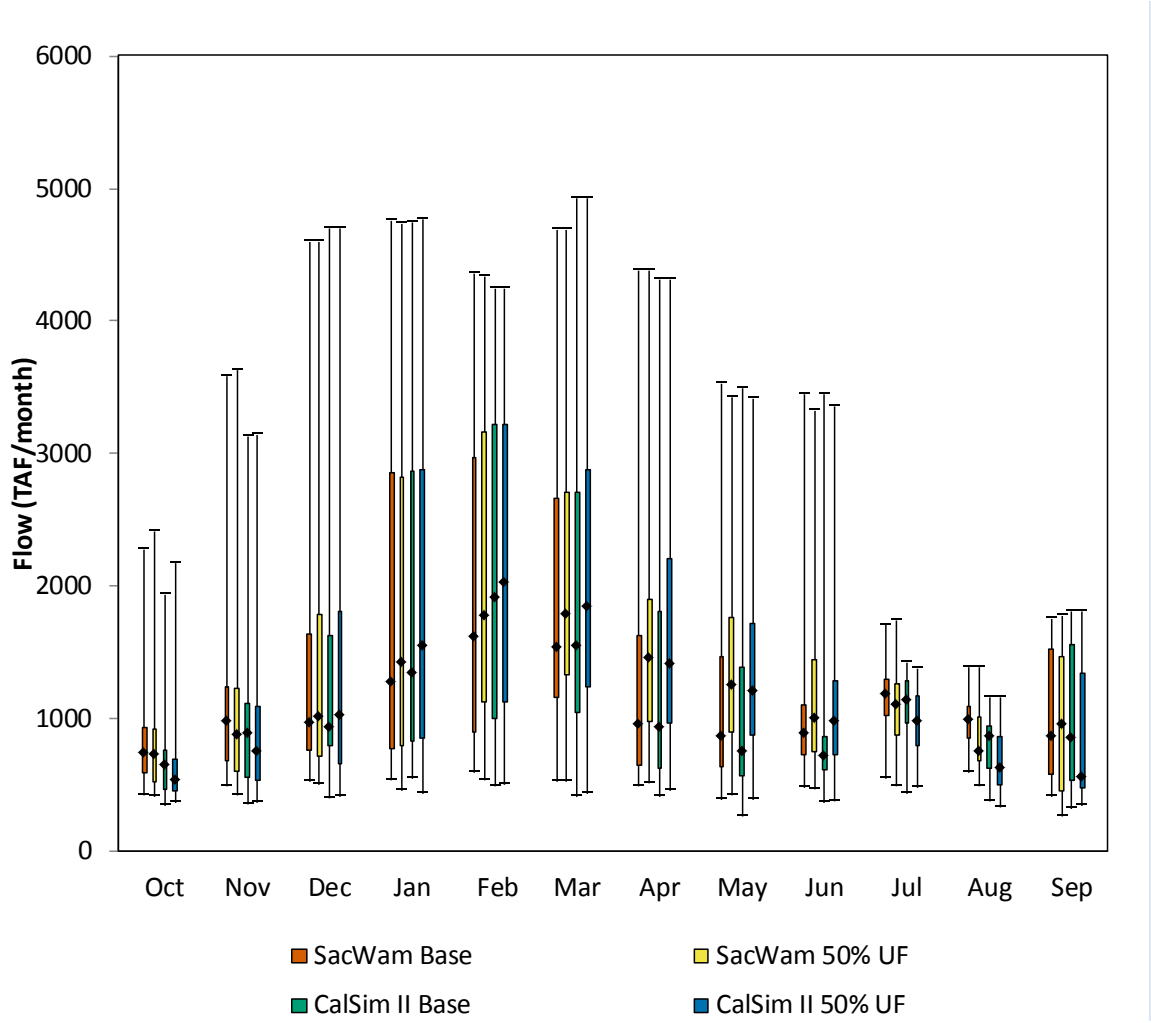
American River above Sacramento River

- Both models show similar increase in spring and decrease in summer flows

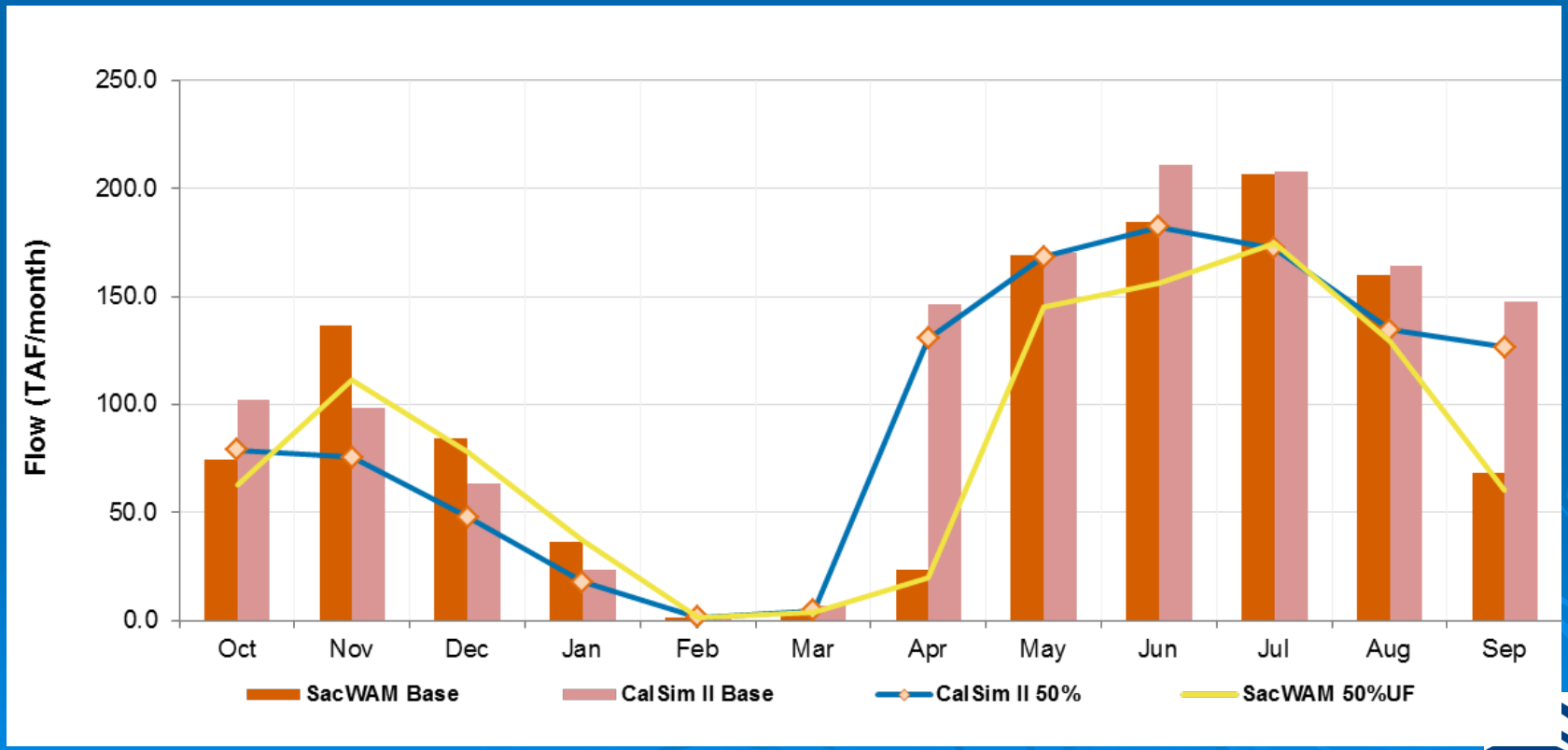


Sacramento River at Freeport

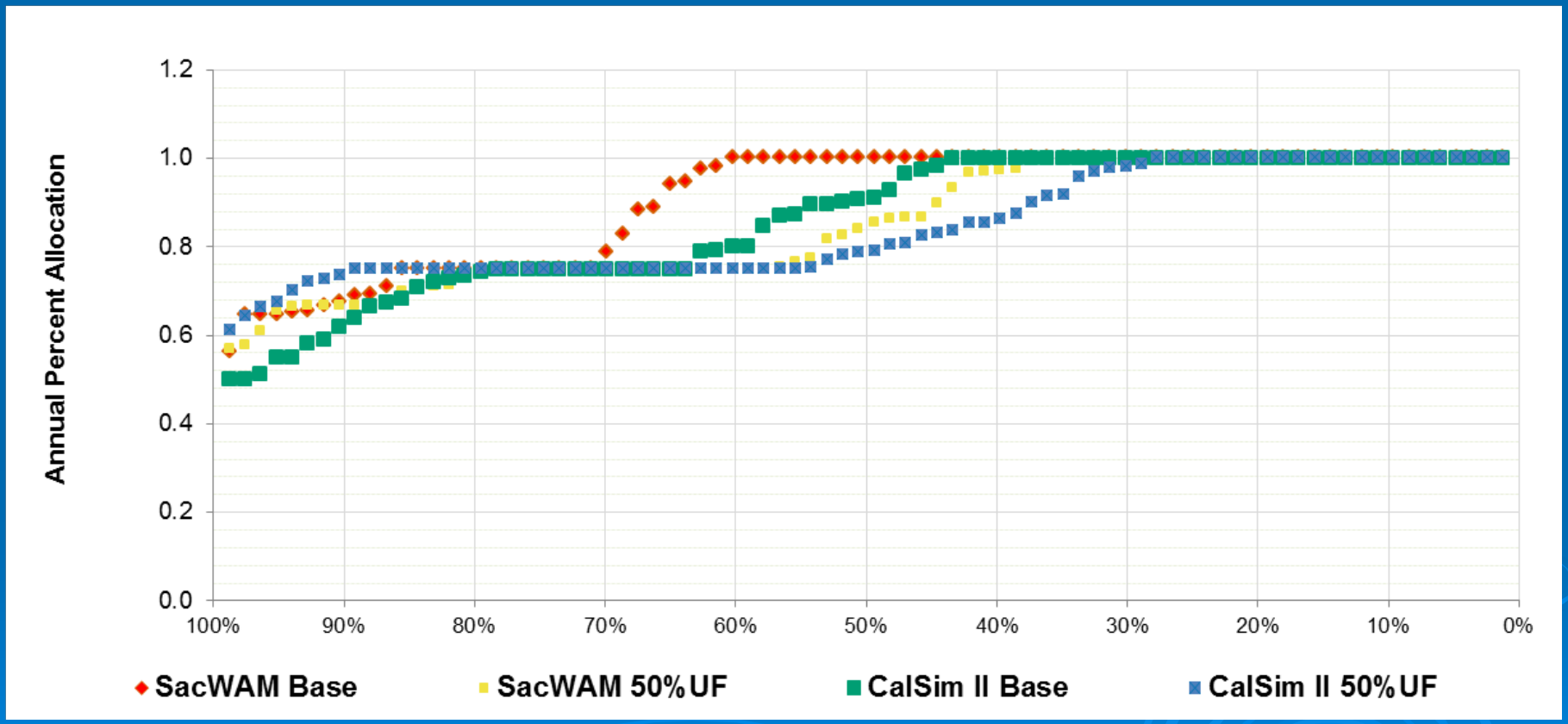
- Both models show very similar increases from December-June and decreases July-November



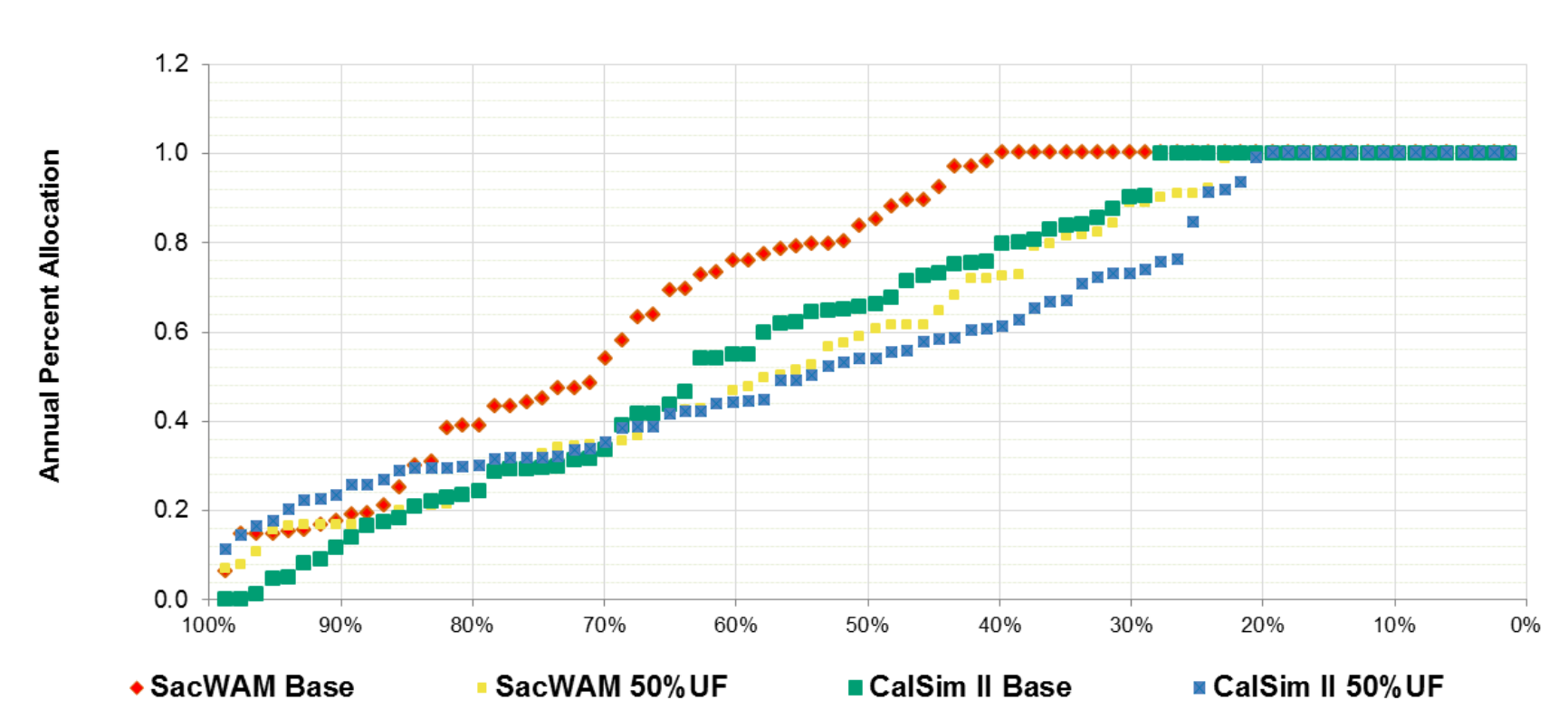
Total Monthly Average Diversions from Lower Feather River



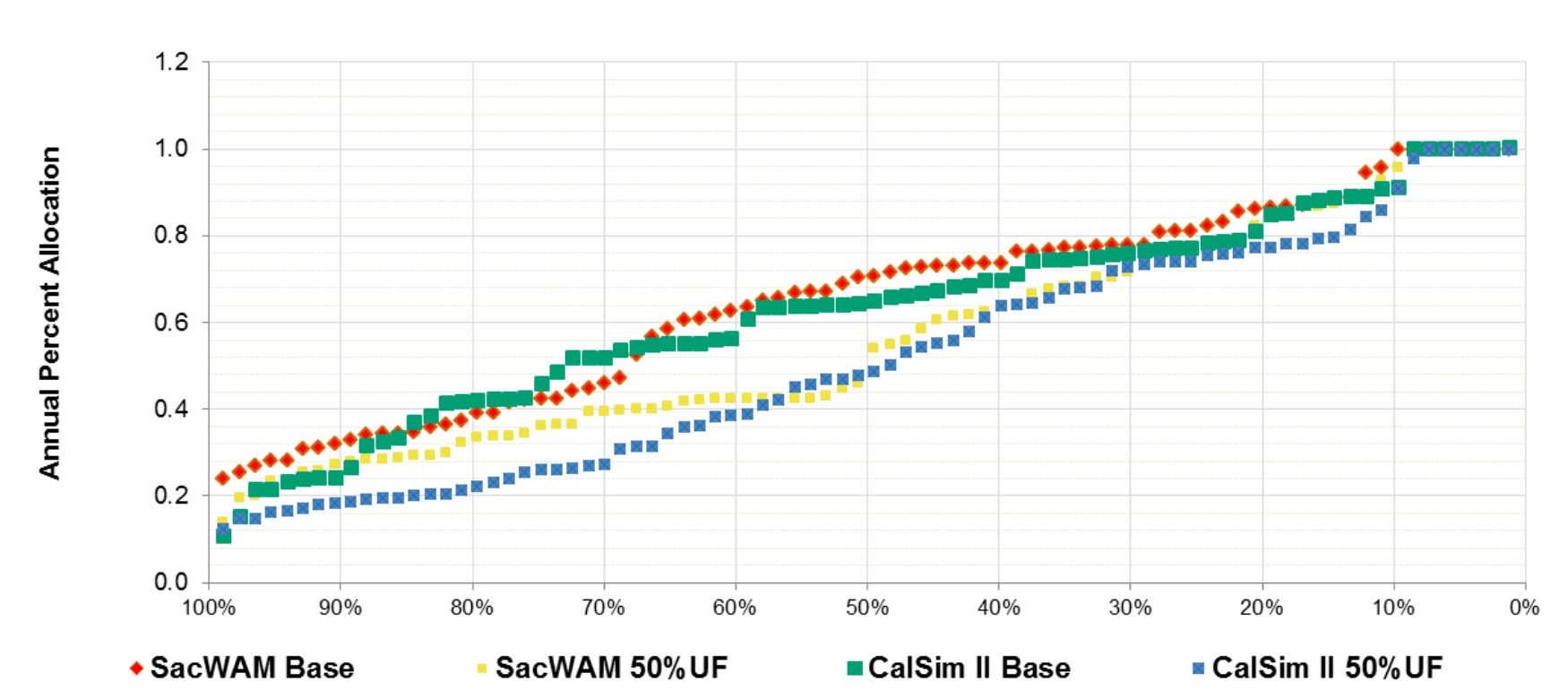
CVP M&I Allocations



CVP South of Delta Agricultural Allocations

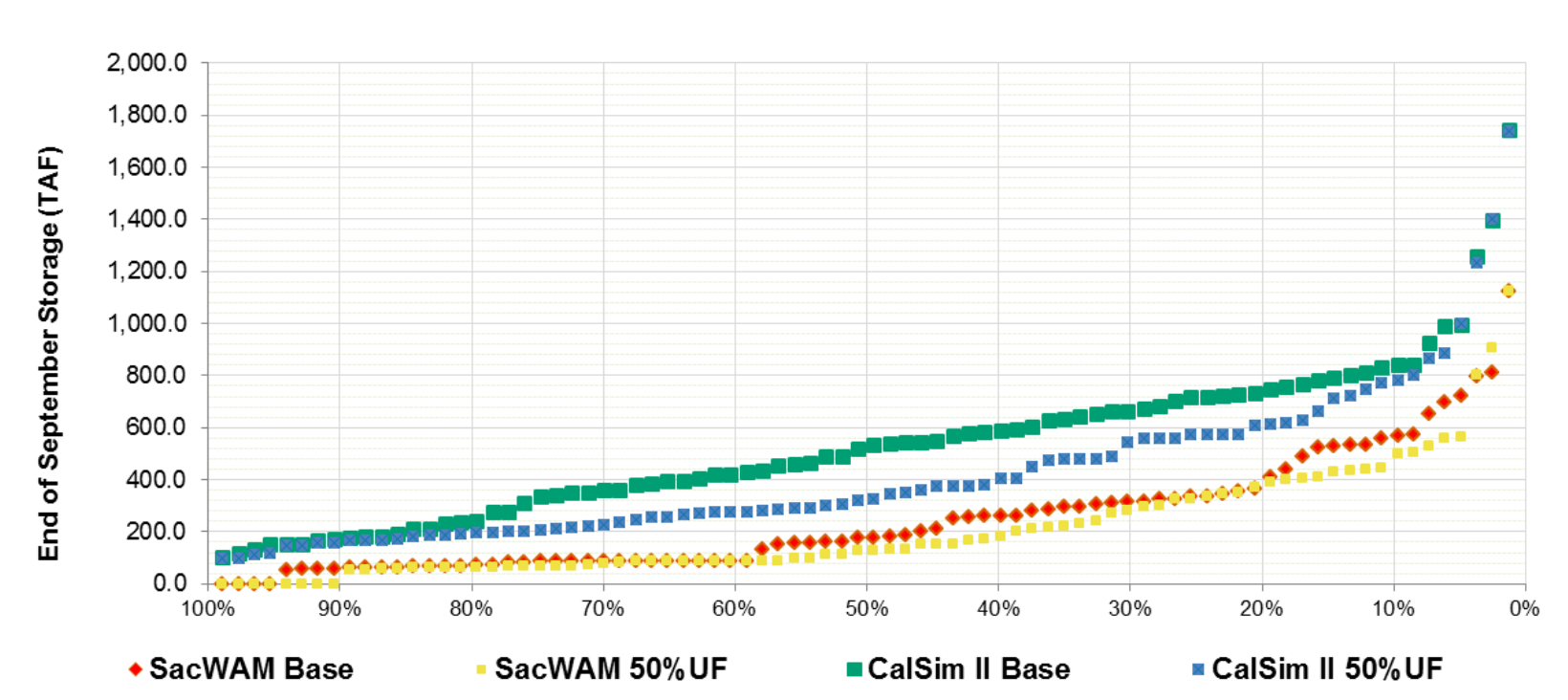


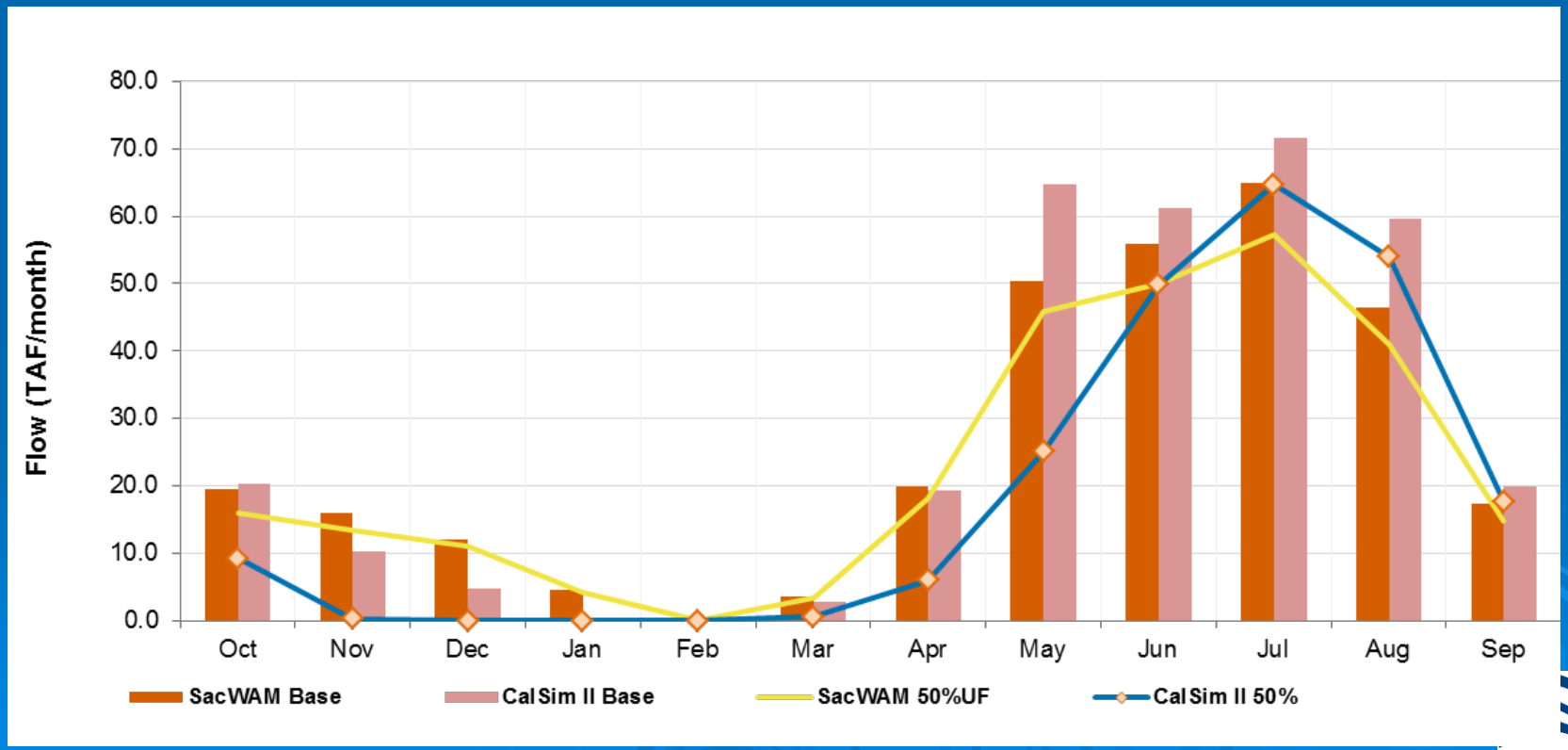
SWP Allocations



San Luis Reservoir Carryover Storage

- Both models show reductions in carryover storage, however the difference is greater in CalSim II



Lower Yuba River Monthly Diversions

- SacWAM reduces diversions throughout the year and CalSim shows greater reductions in fall and spring