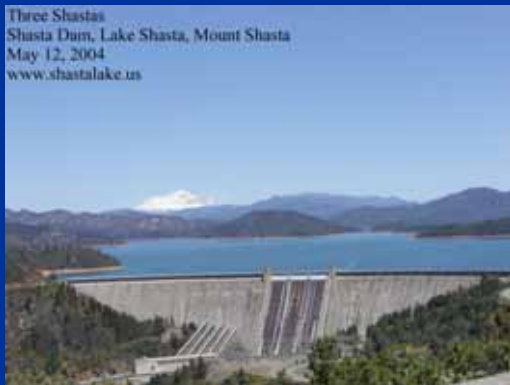


Reservoir Re-assessment and Re-allocation for Changing Climate



Stu Townsley, CESPCK; Rolf Olsen, CEIWR;
Ann Fissekis, CESPCK



Water Management Section, Sacramento District,
US Army Corps of Engineers

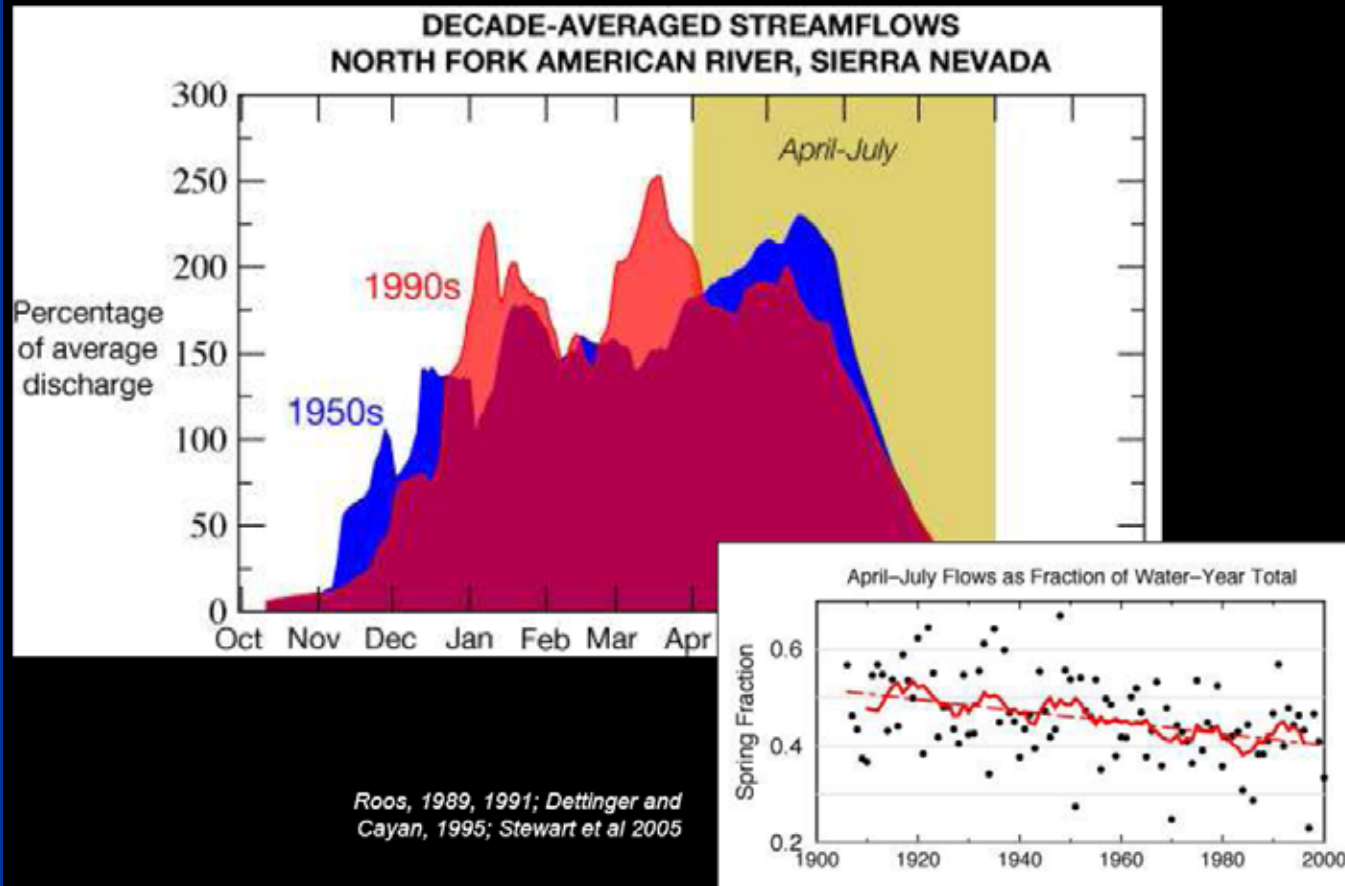
Why consider climate?

- Scientific literature shows potential climate-related trends
- Climate change is of interest to our sponsors, especially in the West and along the coasts
- Corps obligation to consider future conditions



The future challenge for SPK

As a result of these trends, the warm-season fraction of annual streamflow has declined.



Decrease in Spring Runoff

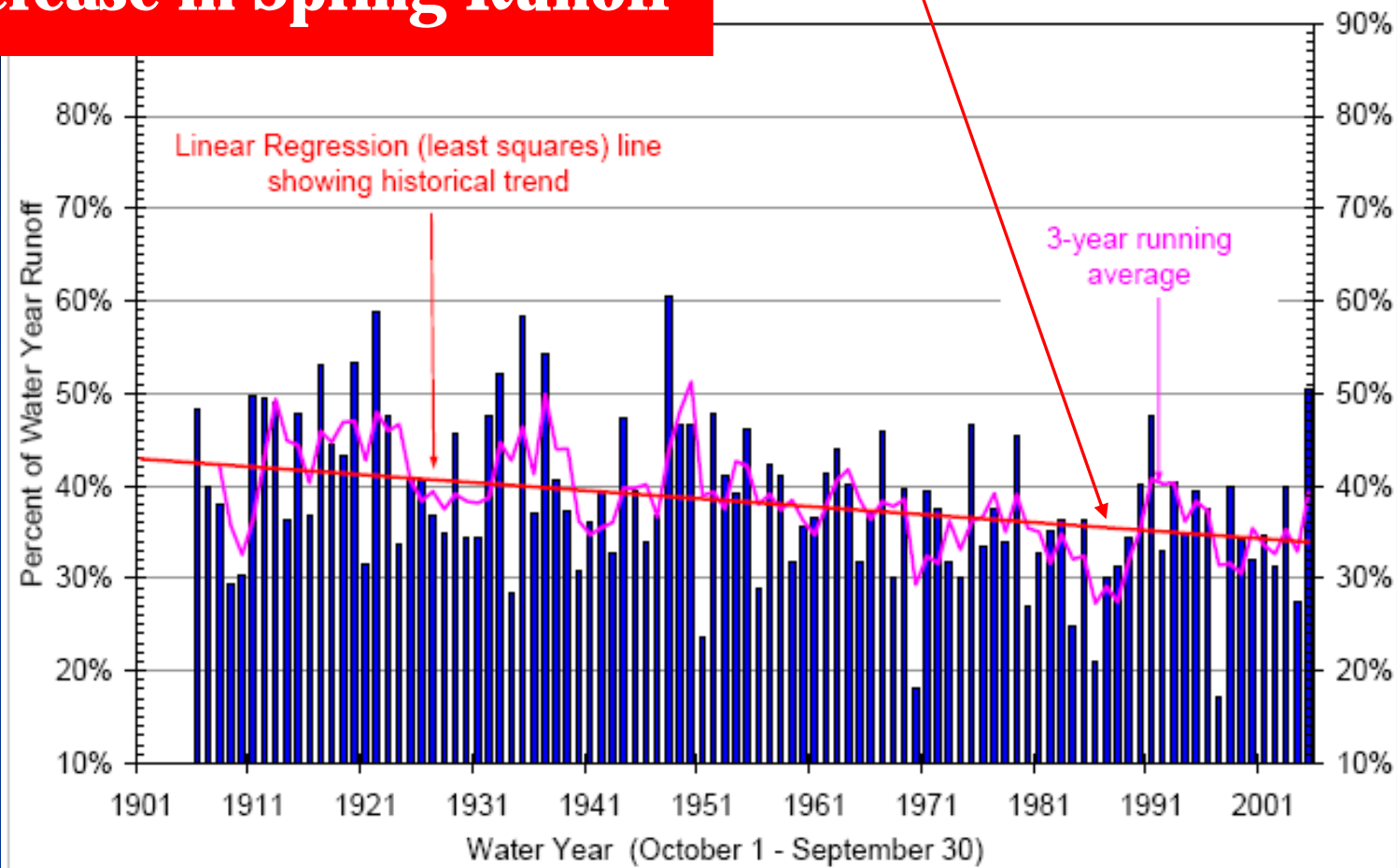


Figure 2-13 Annual April through July Unimpaired Runoff for Four Sacramento Valley Rivers Compared to Total Unimpaired Annual Runoff*

*Based on the flows of four rivers in the Sacramento Valley; Sacramento River at Bend Bridge (near Red Bluff), Feather River into Lake Oroville, Yuba River at Smartville, and American River below Lake Folsom.

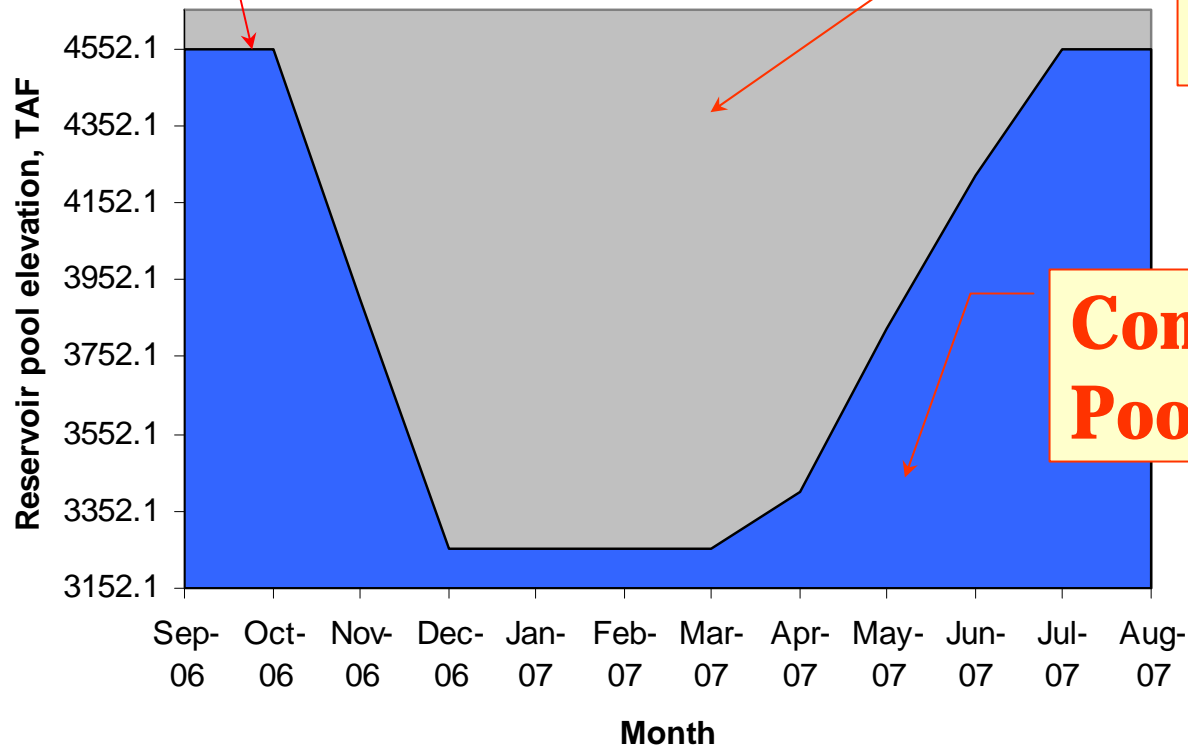


Conceptual rule curve

Rule Curve

Flood Control Pool

Basic Flood Control Diagram



Conservation Pool



Western States Watershed Study Pilot

- Corps will systematically and strategically examine the extent of changes in Corps flood control rule curves that would be needed to mitigate the loss of snow pack storage throughout the West..



Major Central Valley watersheds

- Shasta mean elevation: 4576 ft.
- Oroville mean elevation: 5030 ft.
- New Bullards Bar mean elevation: 4898 ft.



Corps Authority

- Section 7 of the 1944 Flood Control Act
- 33 CFR 208.11
- Authoring legislation for water resource projects

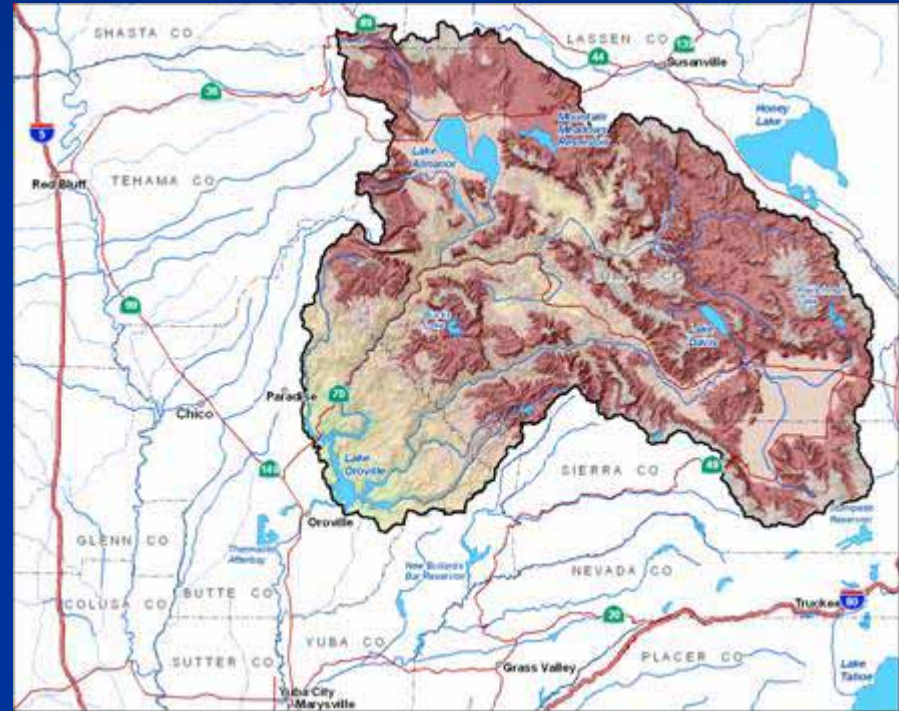
If Federal dollars for flood damage reduction, then Corps has responsibility

But Corps does not own water, just reservoir space



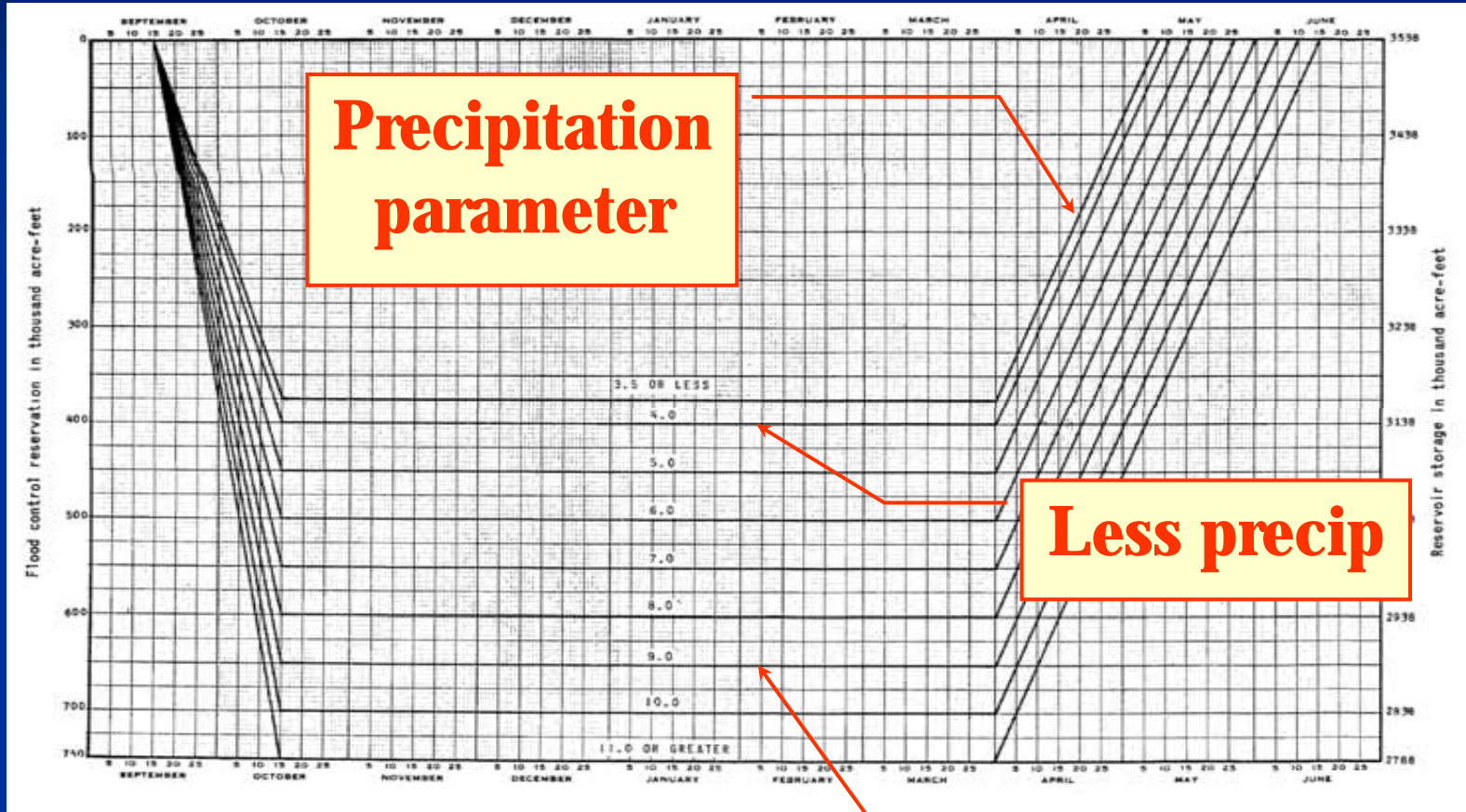
Oroville drainage

- State – Department of Water Resources
- Reservoir storage: 3.5 MAF
- Mean annual flow: 4.5 MAF
- Precipitation parameter
- Revised 1971



Oroville rule curve

Flood pool elevation



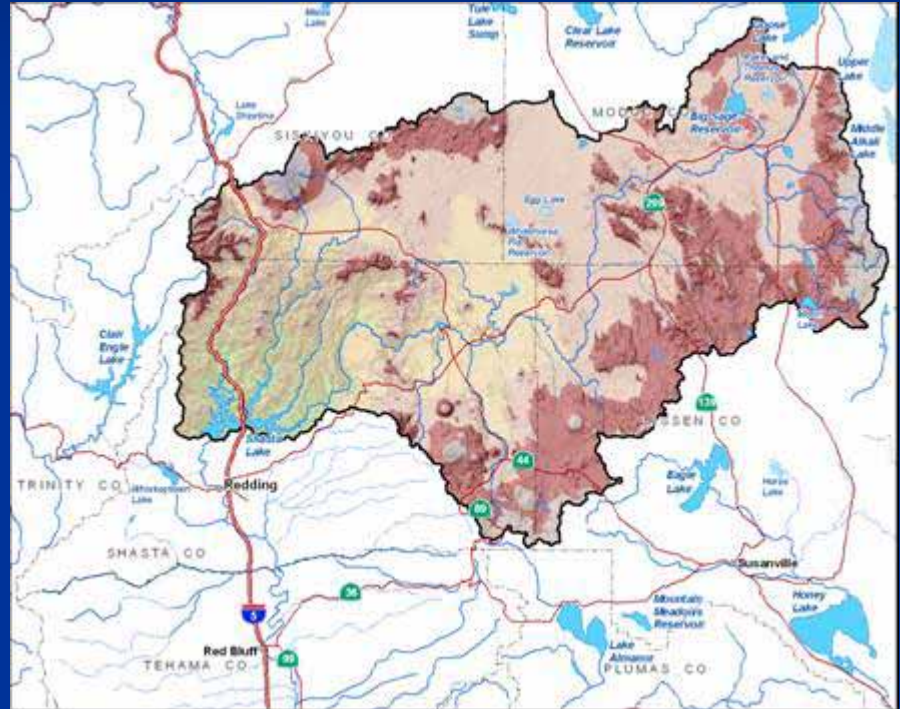
Time of year

More precip



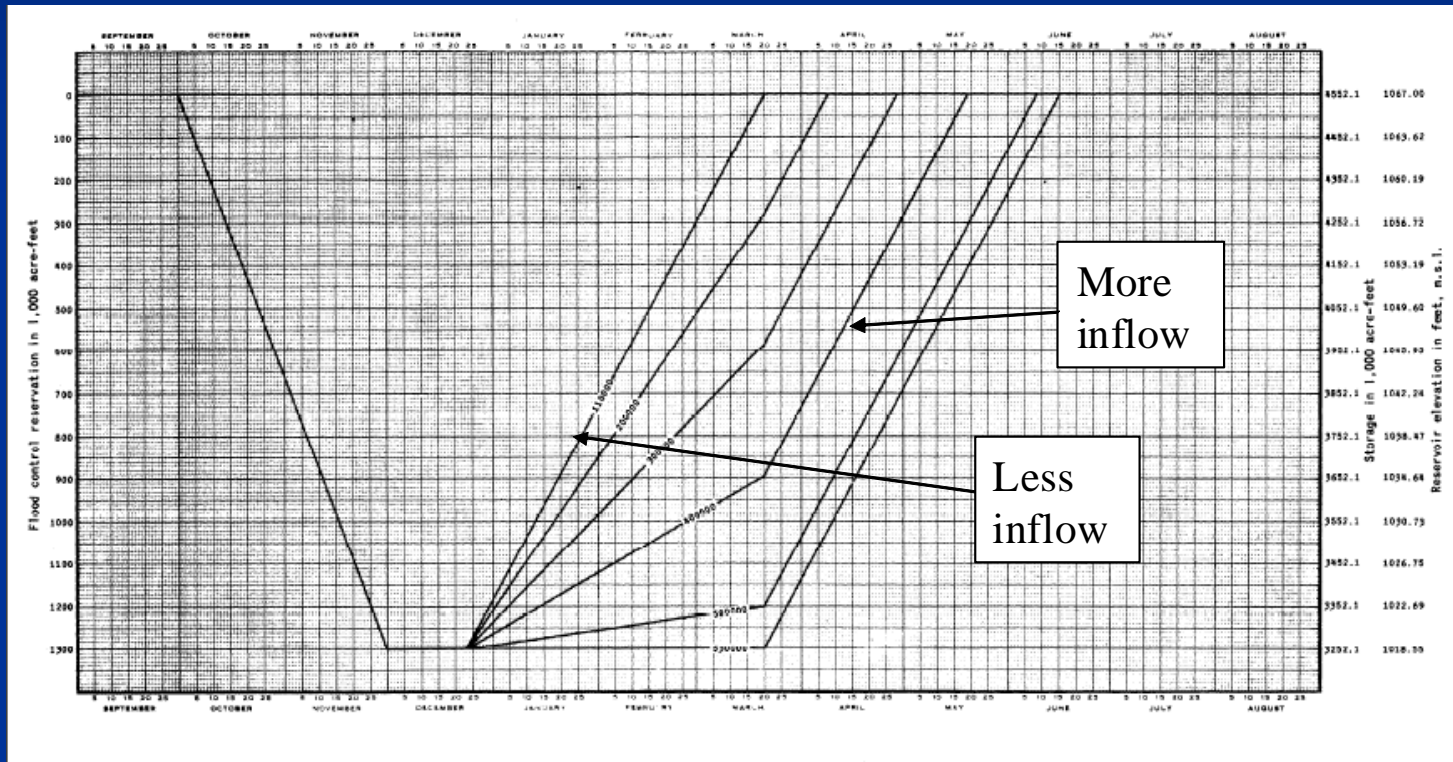
Shasta drainage

- Federal – Bureau of Reclamation
- Reservoir storage: 4.5 MAF
- Mean annual flow: 5.7 MAF
- Inflow parameter
- Revised 1977



Shasta Rule Curve

Flood pool elevation



Time of year



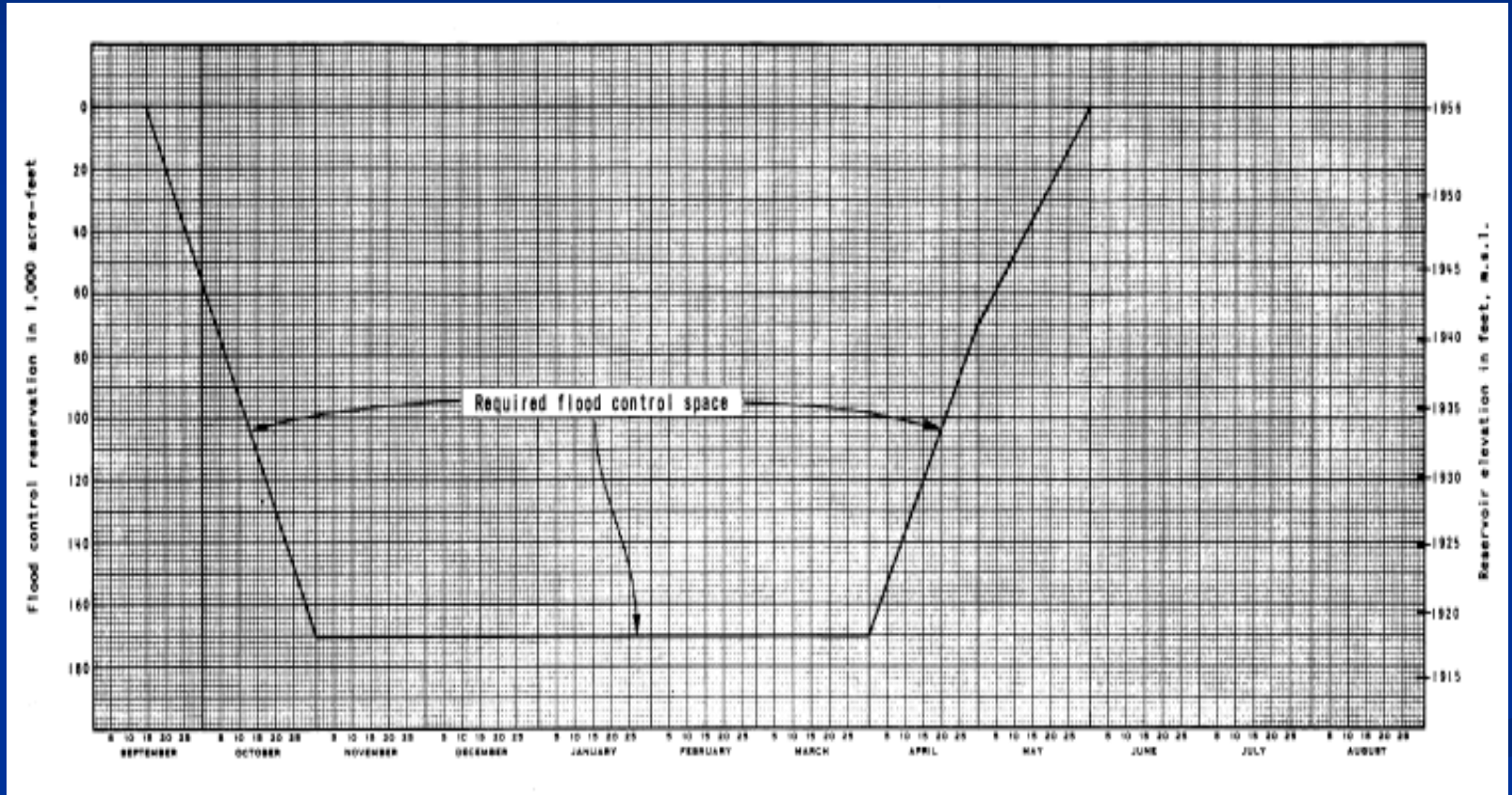
New Bullards Bar

- Local – Yuba County Water Agency
- Reservoir storage: 0.97 MAF
- Mean annual flow: 1.3 MAF
- No revisions
- No decision parameter



New Bullards Bar rule curve

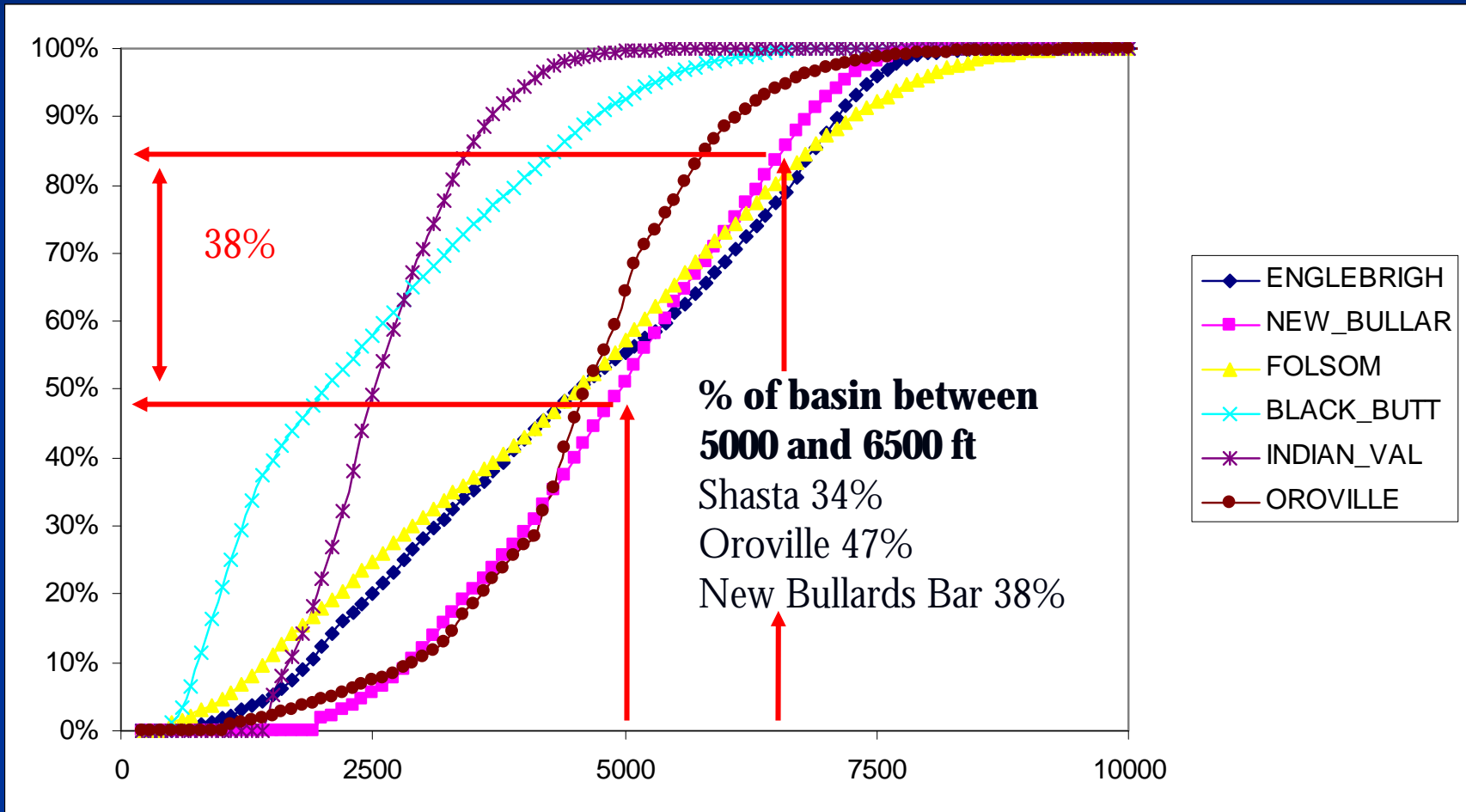
Flood pool elevation



Time of year



Sacramento Reservoir Elevation Percentages



Potential Flood Implications

- Literature suggests
 - Warmer regime, about the same annual precipitation
 - Smaller snowpack, earlier melt, flow shift
 - Greater storm variability/intensity
- Implications?
 - Need more rainflood space?
 - Allow earlier fill?



Methodology

- Analyze 22 GCM simulations for 2030 projected temperature and precipitation ranges under two climate scenarios
- Determine 10th, 50th and 90th temperature and precipitation percentiles by subbasin
- Generate reservoir inflows using perturbed temperature and precipitation input using NWS-RFS
- Test flood control curves using ResSim

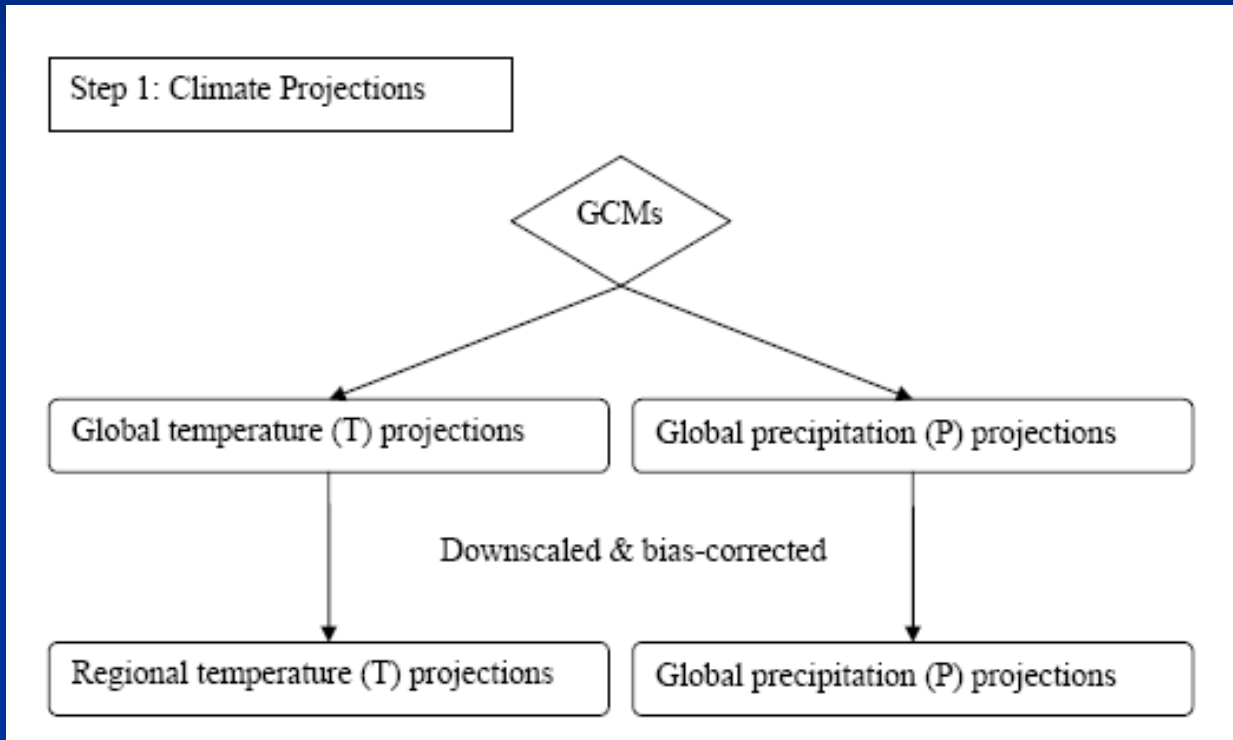


Climate change scenarios

	Percentile		
	10 th	50 th	90 th
Temperature	0.8 deg F	1.8 deg F	2.5 deg F
Precipitation	-6.6 %	+4.5 %	+16.8 %



Modeling Process

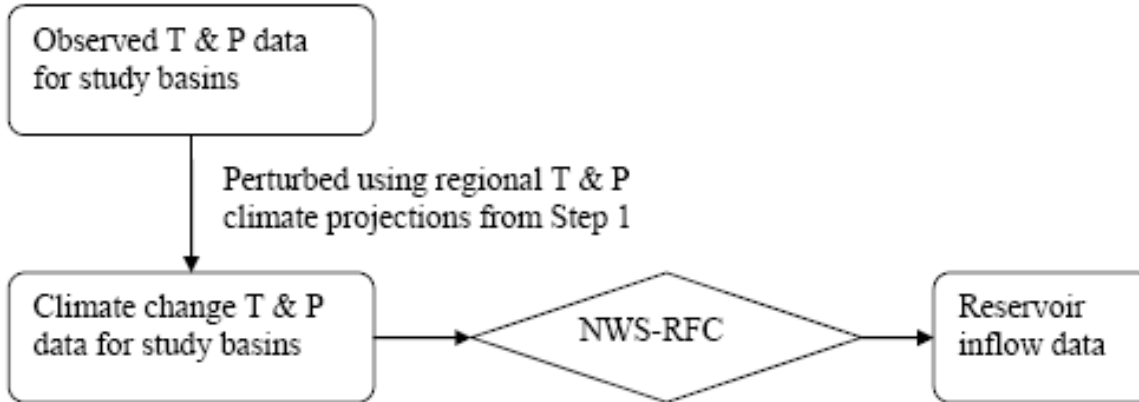


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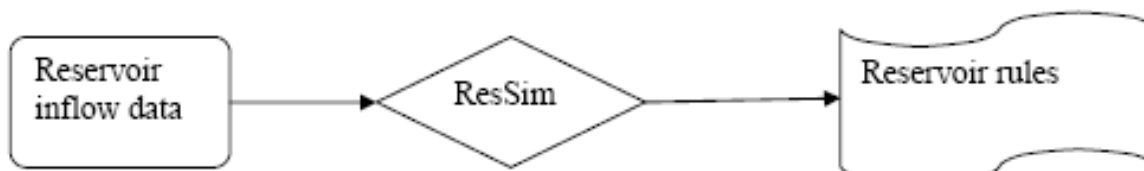
Modeling Process

Step 2: Hydrology modeling for study basins

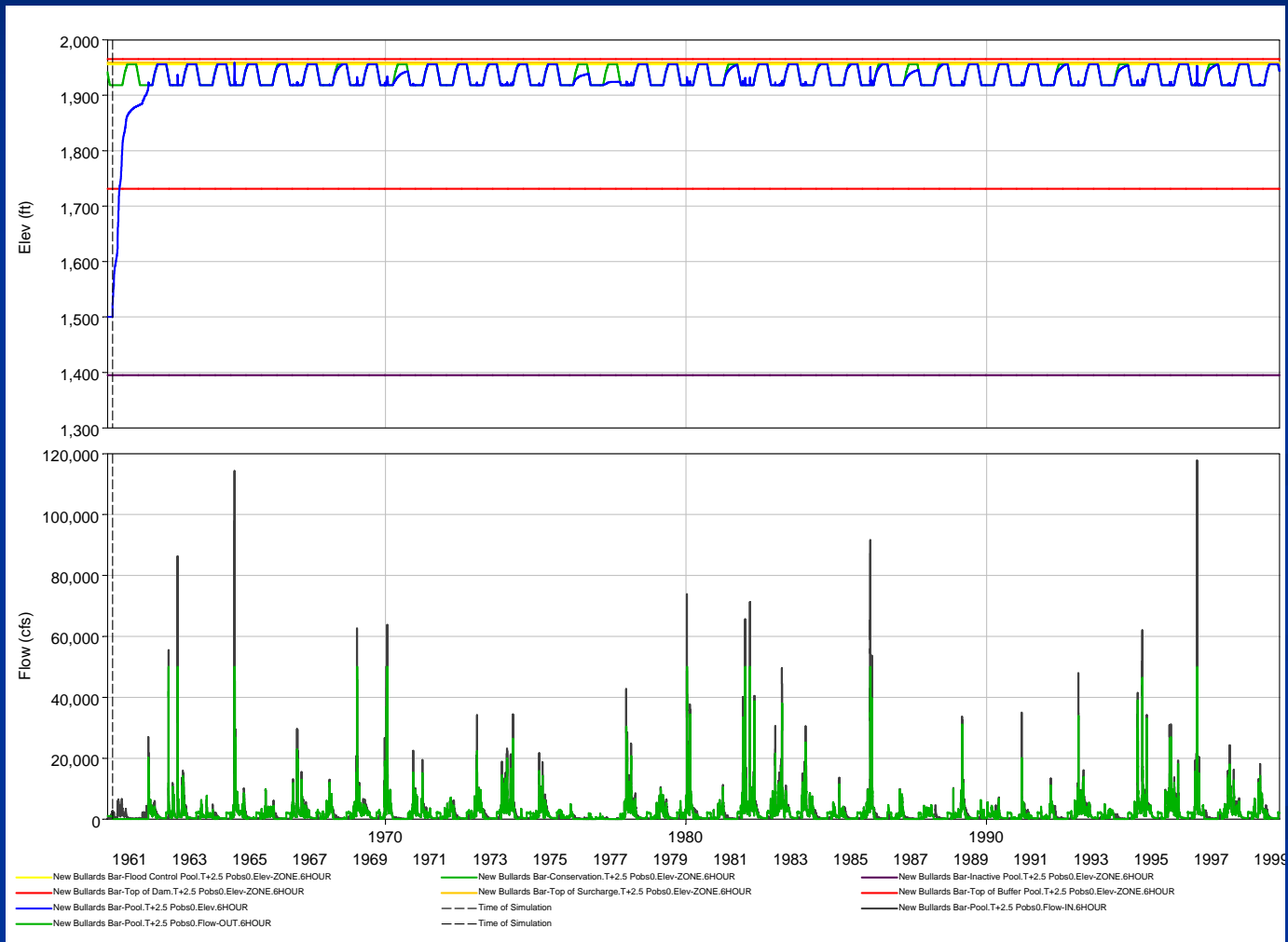


National
Weather
Service River
Forecast
Center

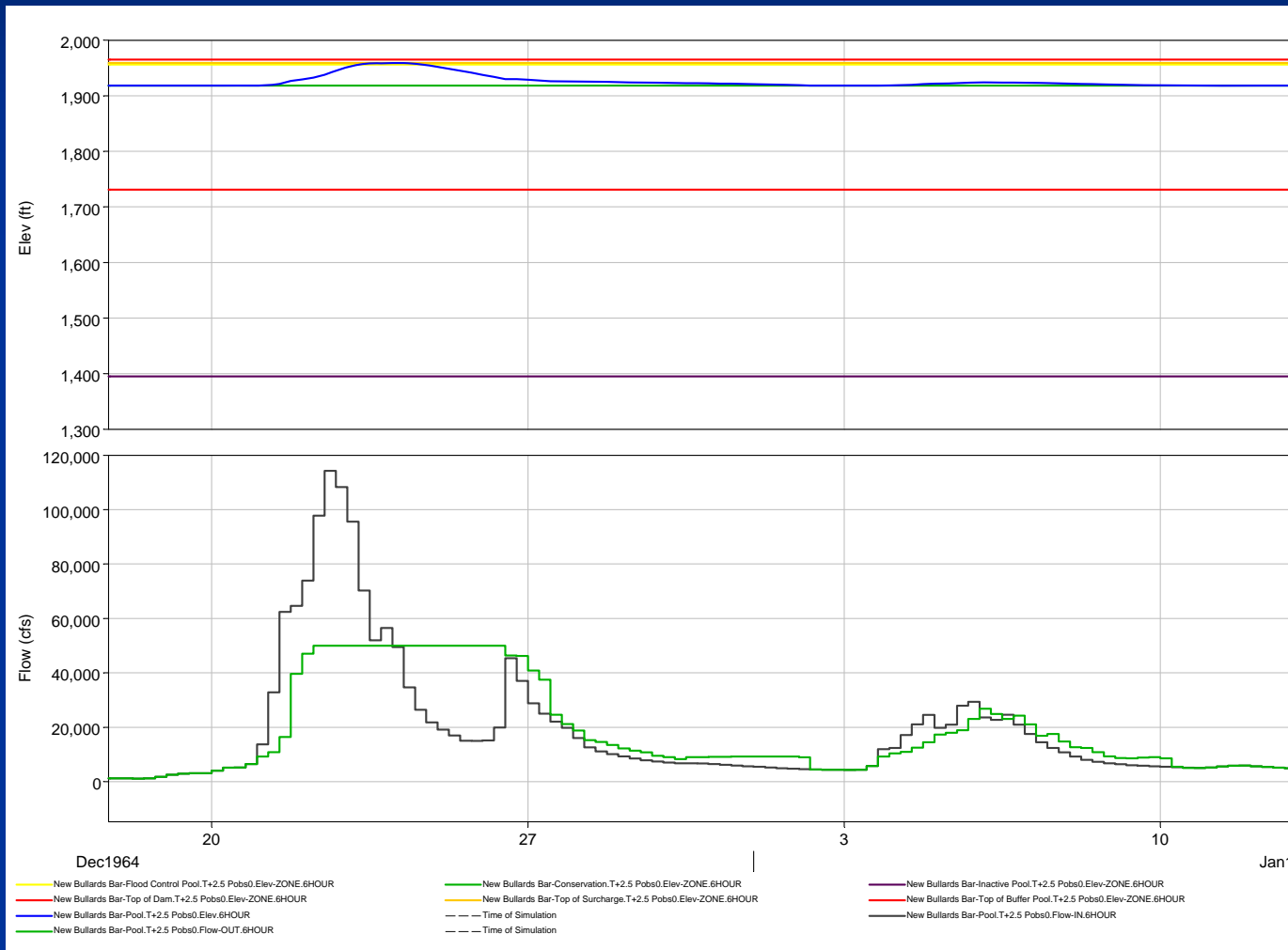
Step 3: Rule curve modeling



ResSim output



January 1965 event: Temp. +2.5 deg F, Precip. observed



Results

- For New Bullards Bar, reservoir pool elevations exceeded flood pool zone during 19 of 144 sampled and overtopped the dam during eight sampled flood events, indicating a need for more flood control space in the reservoir.

New Bullards Bar Dam: Zone location of peak pool elevation for sampled flood events								
event	scenario							
	observed	T _{obs} , P- 6.6%	T _{obs} , P+4.5%	T _{obs} , P+16.8%	T+0.8, P- 6.6%	T+0.8, P _{obs}	T+0.8, P+4.5%	T+0.8, P+16.8%
Jan-63	Flood	Flood	Flood	Flood	Flood	Flood	Flood	Flood
Dec-64	Top of Surcharge	Flood	Top of Dam	Overtop	Flood	Top of Dam	Overtop	Overtop
Jan-69	Flood	Flood	Flood	Flood	Flood	Flood	Flood	Flood
Jan-80	Flood	Flood	Flood	Flood	Flood	Flood	Flood	Flood
Dec-82	Flood	Flood	Flood	Flood	Flood	Flood	Flood	Flood
Mar-83	Flood	Flood	Flood	Flood	Flood	Flood	Flood	Flood
Feb-86	Flood	Flood	Flood	Flood	Flood	Flood	Flood	Flood
Mar-95	Flood	Flood	Flood	Flood	Flood	Flood	Flood	Flood
Jan-97	Flood	Flood	Flood	Top of Dam	Flood	Flood	Top of Surcharge	Top of Dam

Conclusions

- Water control plans should be reviewed and adjusted, when possible, to meet changing local conditions.
- Changes in reservoir operations can be time-consuming and expensive, often requiring an Environmental Impact Statement with public participation by stakeholders with different objectives.

