Hydrology and Decision Making at Bonneville Power Administration

HEPEX 10th anniversary Workshop
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Columbia River Power System

- 300,000 sq mi (777,000 sq km)
- Market power from 31 federal dams and 1 nuclear plant – over 1/3 of electricity used in Pacific Northwest
- Roughly 80% of BPA power came from hydro in 2014.
- Protect, mitigate & enhance fish & wildlife in the Columbia River Basin

US Army Corps of Engineers®

Inventory Process

Streamflows

CGS

Residual Hydro Load

Load Forecasts

Trading Floor Deals

Decision Support System

Operational Constraints

Operational Objectives

Project Constraints, Biological Opinon Objectives, Plant Outages, Flood Control, etc…

Monthly Streamflows, Initial and Ending Forebay Elevations

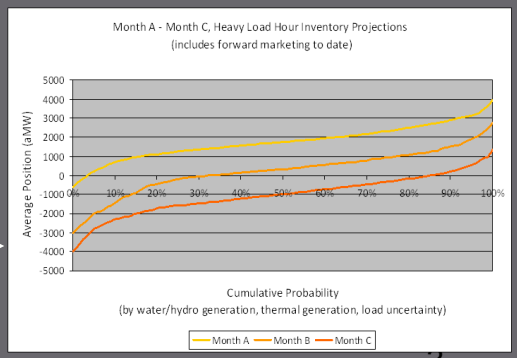
Hourly t/s Model

Use of Flexibility/Uncertainty

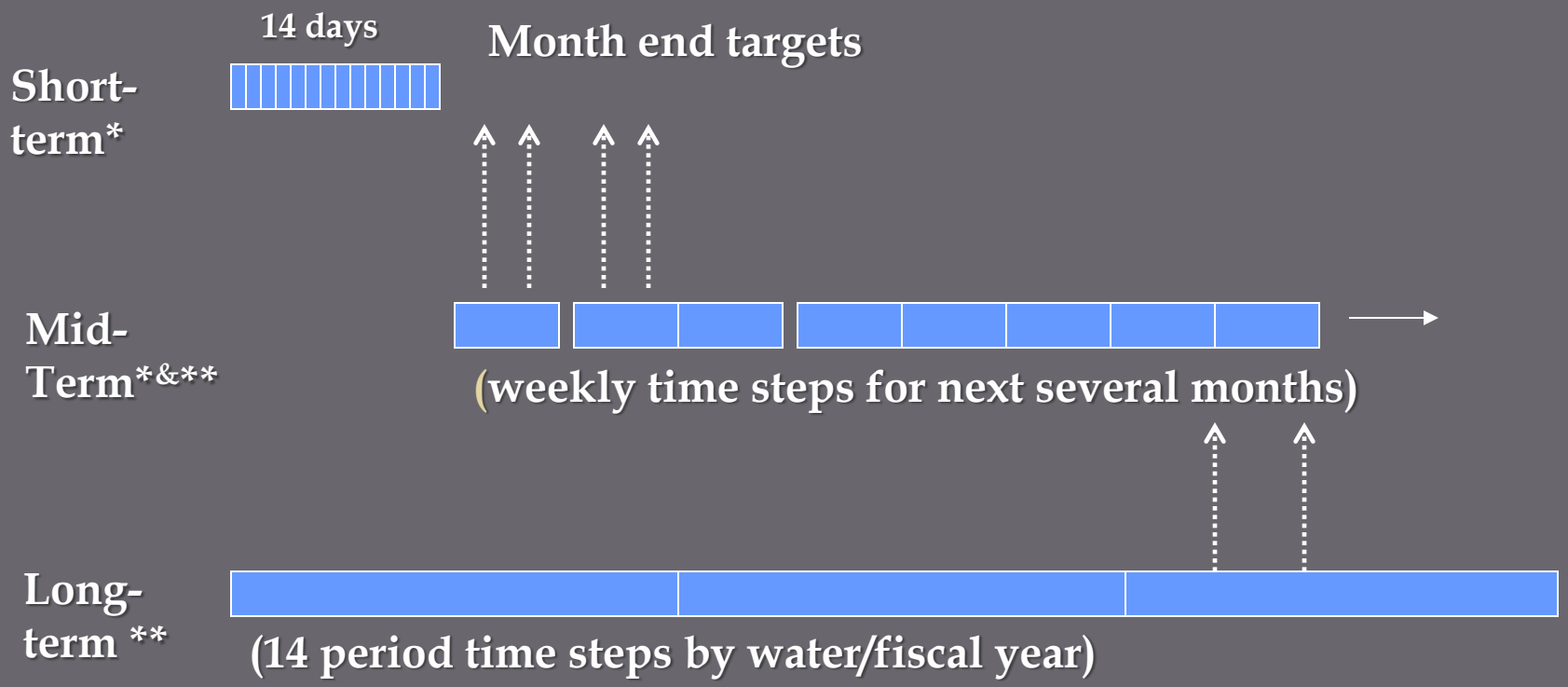
Generation and Inventory

(HLH, LLH, Super-Peak, etc…)

Inventory Spreadsheet



Connecting Short and Long-term models

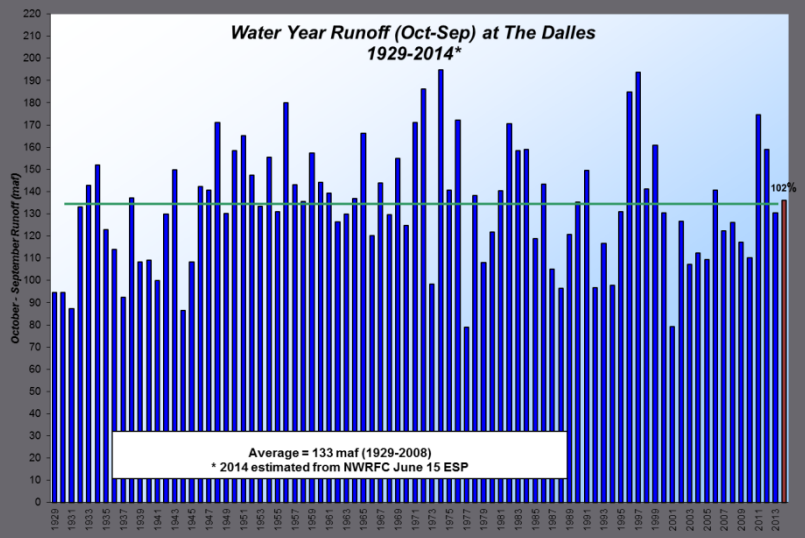


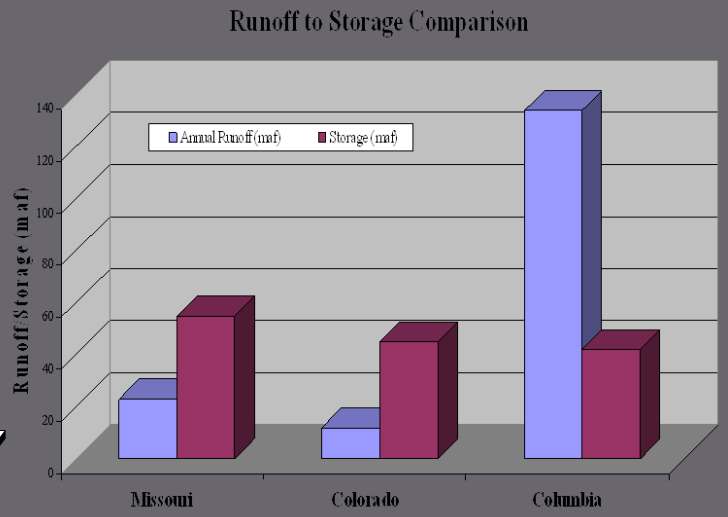
*Single scenario (deterministic)

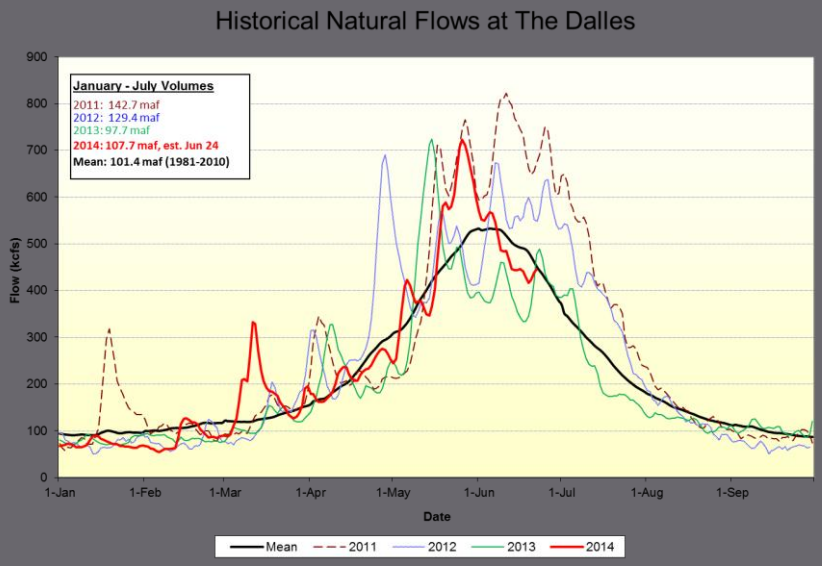
**Multiple scenarios (probabilistic)

Why does BPA care about ensembles?

- Significant annual runoff variation from year to year
- No discernible pattern (high years followed immediately by low years)
- Available storage on system only captures ~ 1/3 of the annual runoff







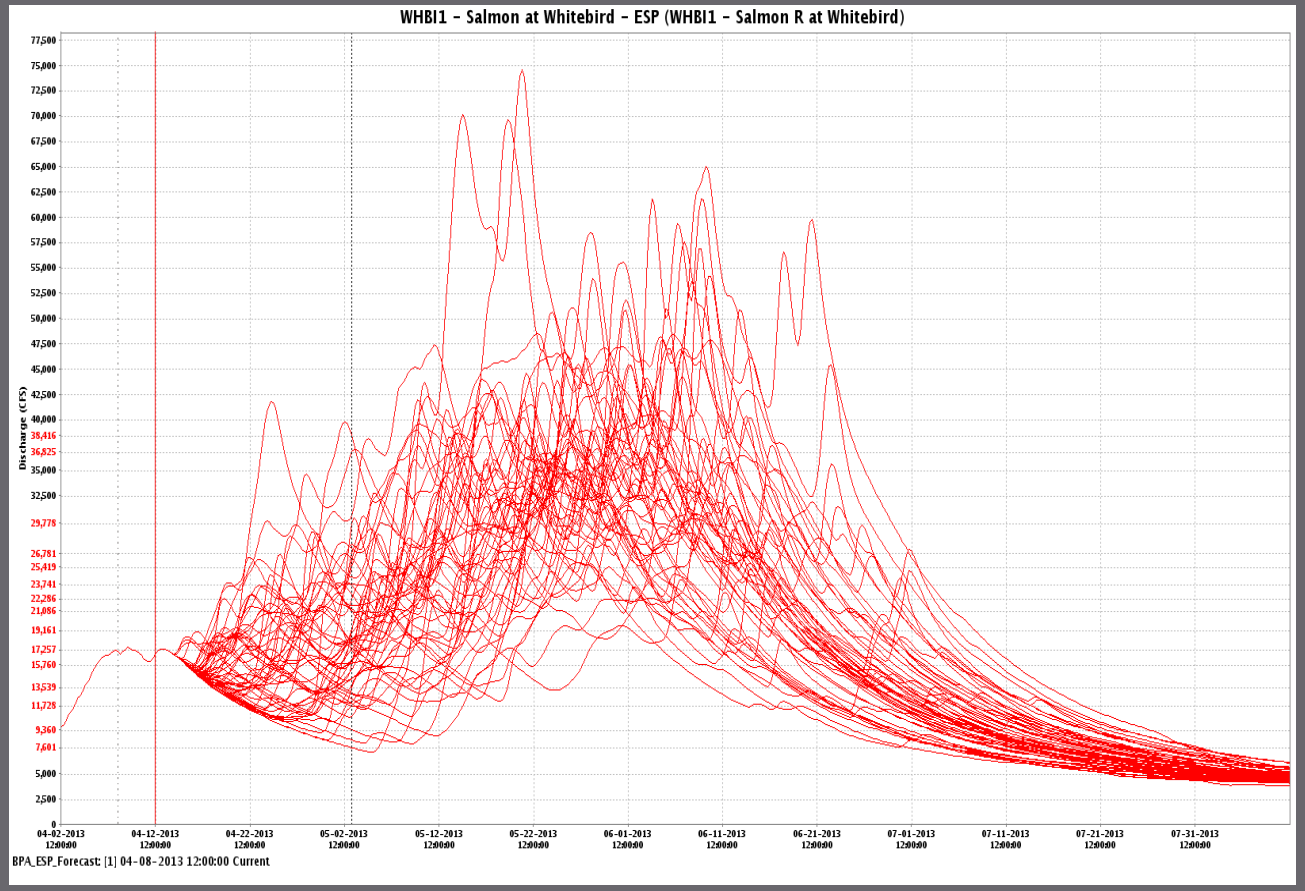
Ensemble Streamflows

- Typical ESP

Historical weather sequences from calibration (‘49-’03)

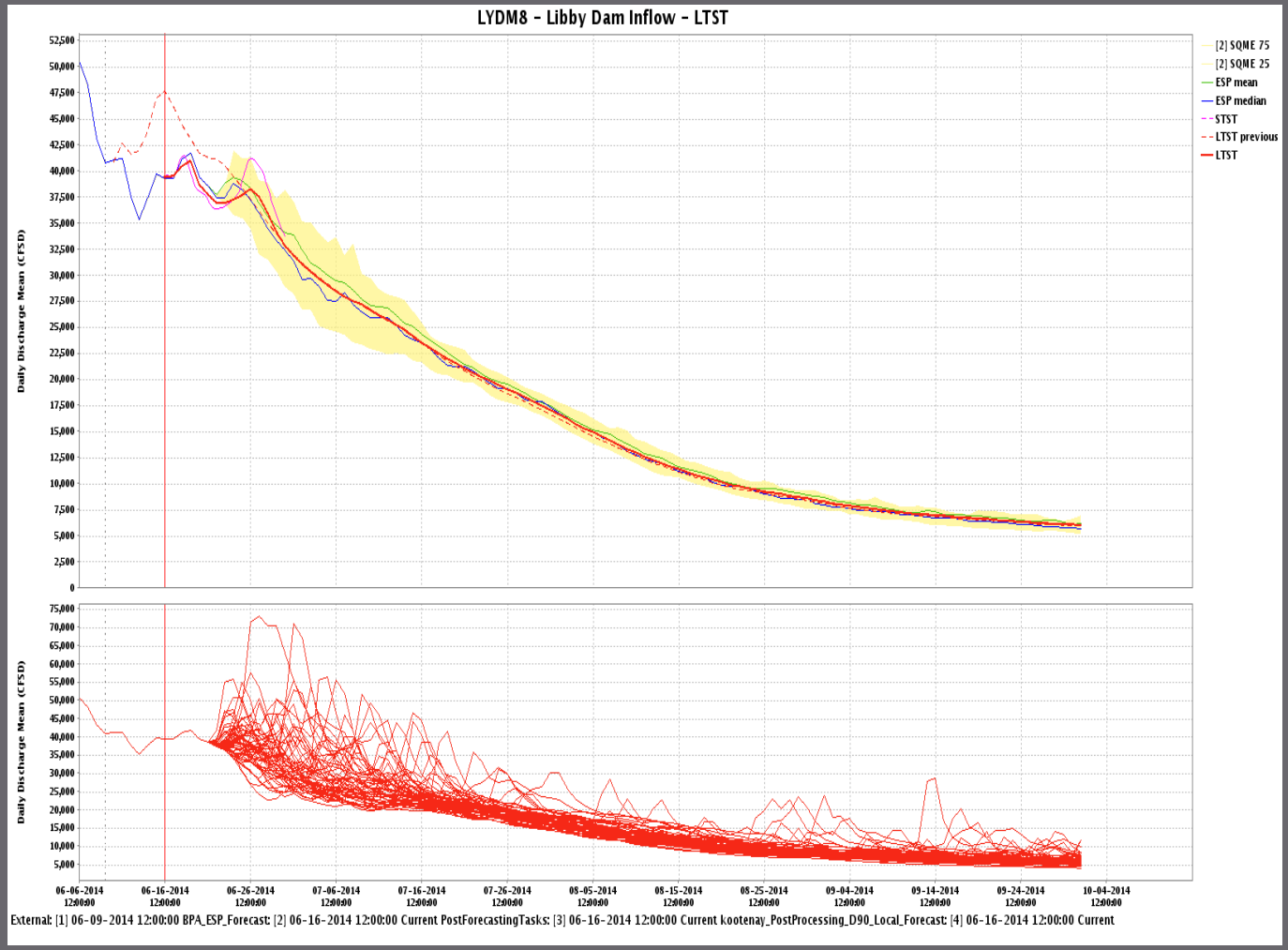
- Climate Index ESP

Subset of historical weather sequences selected for having user designated similar climate signals and then the record is completed with synthetic sequences generated from the historical record



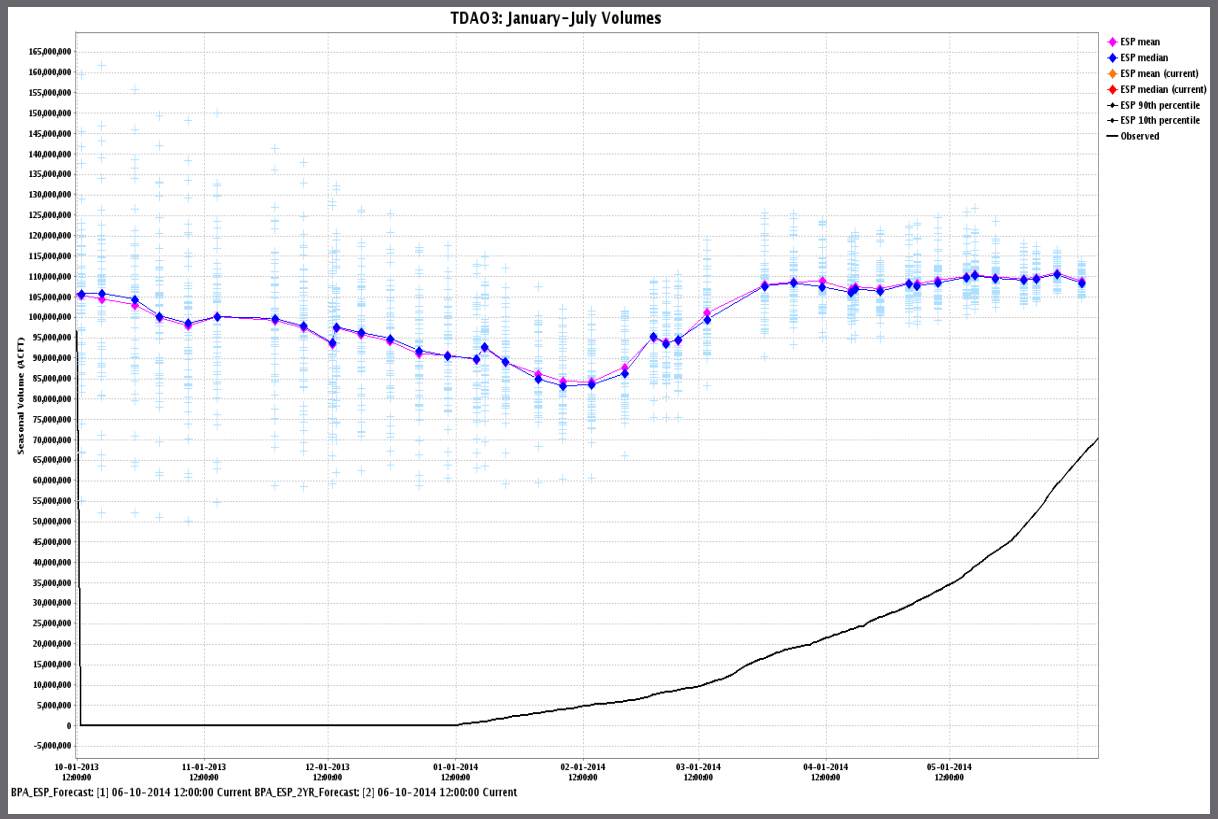
Long-term single trace

- Ability to blend short-term and long-term forecast
- Ability to blend single-trace between mean and median of ESP set
- Bounds are 25-75 percent exceedence probability of ESP set



Seasonal Volume Comparison

- For our internal users, we compute seasonal and monthly statistics
- These provide us with an internal understanding of how much water we think is likely to be available
- BUT, system is operated using forecast by others.



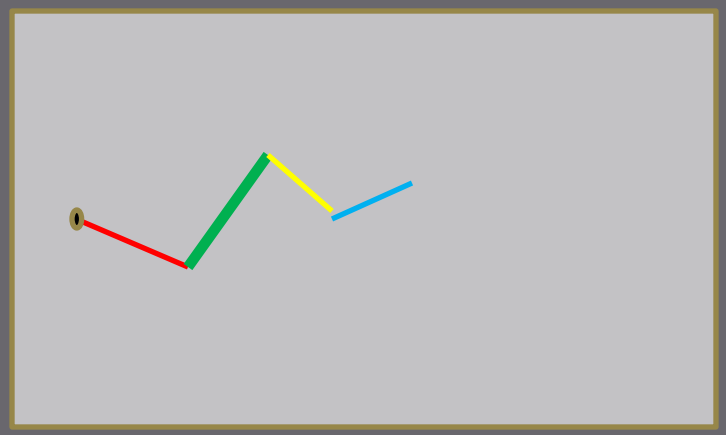
Operational constraints

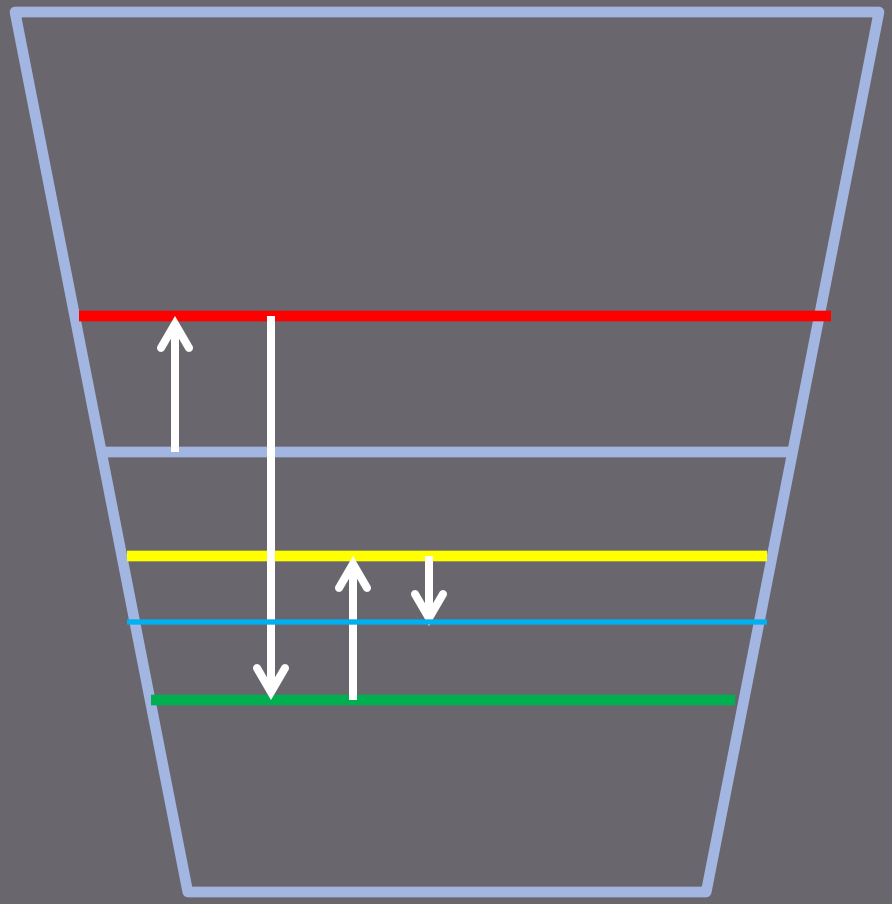
- System operations vary by month and season
- Many are based upon current water supply forecast
- In order to plan our future operational constraints, we need to forecast how the current forecast will change through time.

October	November	December
Local fish requirements	Draft projects to support flows for ESA in lower River	
January	**February**	**March**
Meet load and end of month flood control targets based on changing seasonal water supply forecast		
April	**May**	**June**
Target end of month flood control targets. Spill season begins	Refill of projects to ensure adequate water for support of spill for ESA listed fish	
July	**August**	**September**
Draft projects to ensure adequate water for support of spill for ESA listed fish		Spill season ends. Local fish requirements

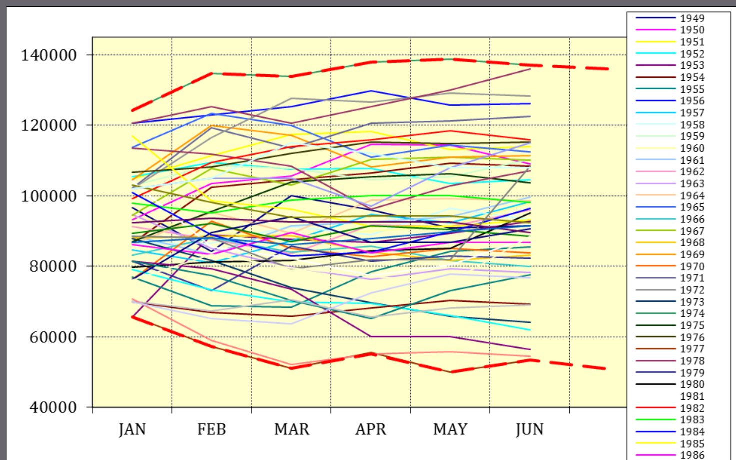
Simple Scenario

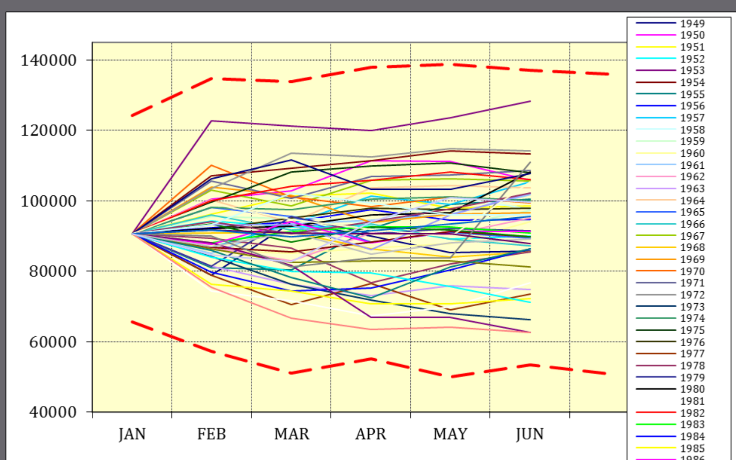
Water supply forecast through the season for a single project

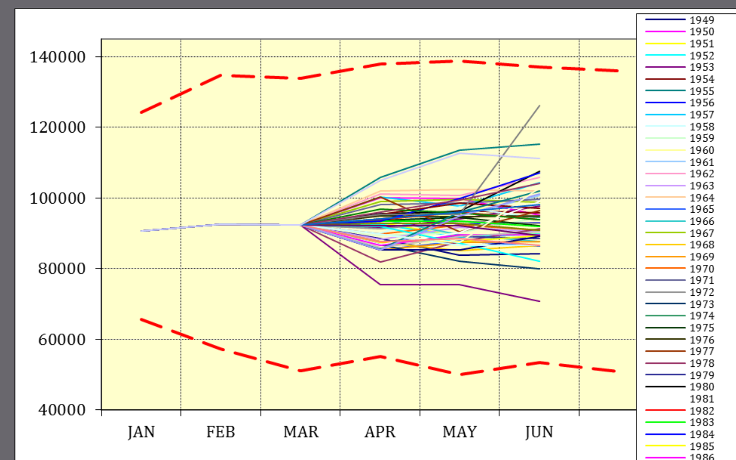




Historical Water Supply Forecasts

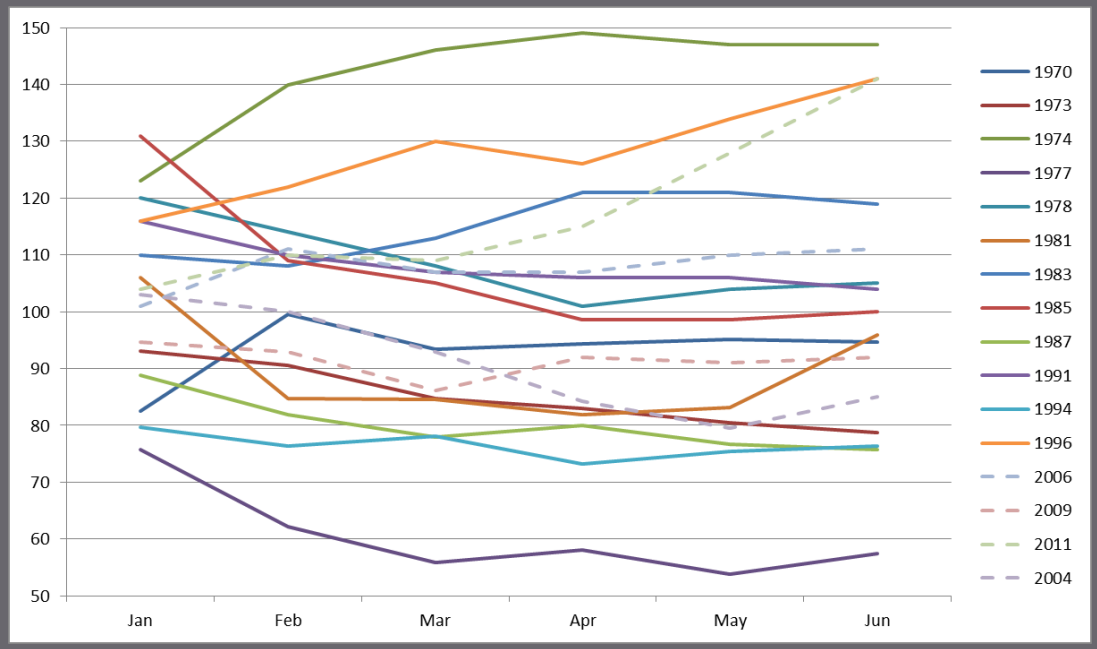






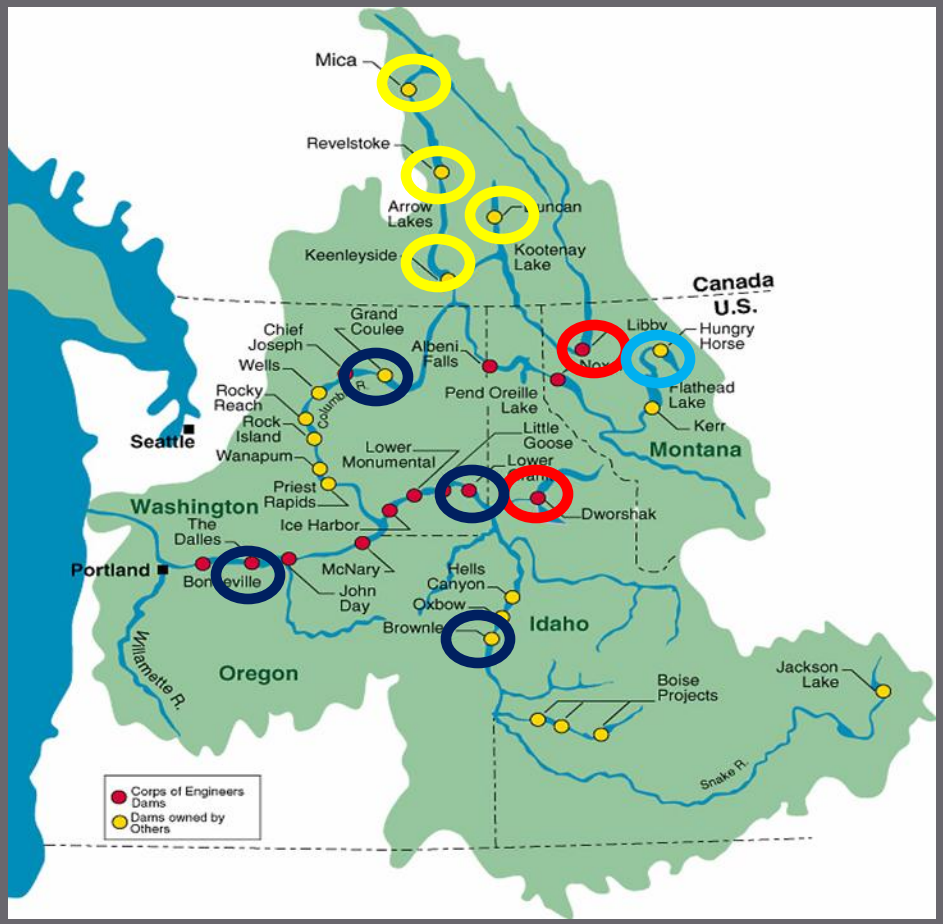
Water Supply Forecasts

- Analysis of historical record shows that over time, variability of forecast post 2001 is reduced
- Mimicked this reduction in variability by placing limits on month to month changes of historical forecasts
- Agency needs uncertainty in future forecasts similar to current variability but in the correct direction for each historical weather trace



Forecasts of Forecasts

- Water supply forecasts will be different by some amount from our internal ESP traces summed for that season
- Some forecasts done with regression and that forecast procedure has often changed over time
- Start with the historical water supply forecasts for same years as historical record (‘49-’03)
- Recently, NWS has begun generating forecasts using ESP.
- Can these be blended? (spatially and temporally)
- Is there a way to still use the historical record?



Forecasts of Forecasts

- If you don't start with the historical water supply forecasts, then what do you start with?
- How do you add variability to the forecasts for successive months? How do you ensure the perturbation is in the right direction? And of the right magnitude?

Questions?