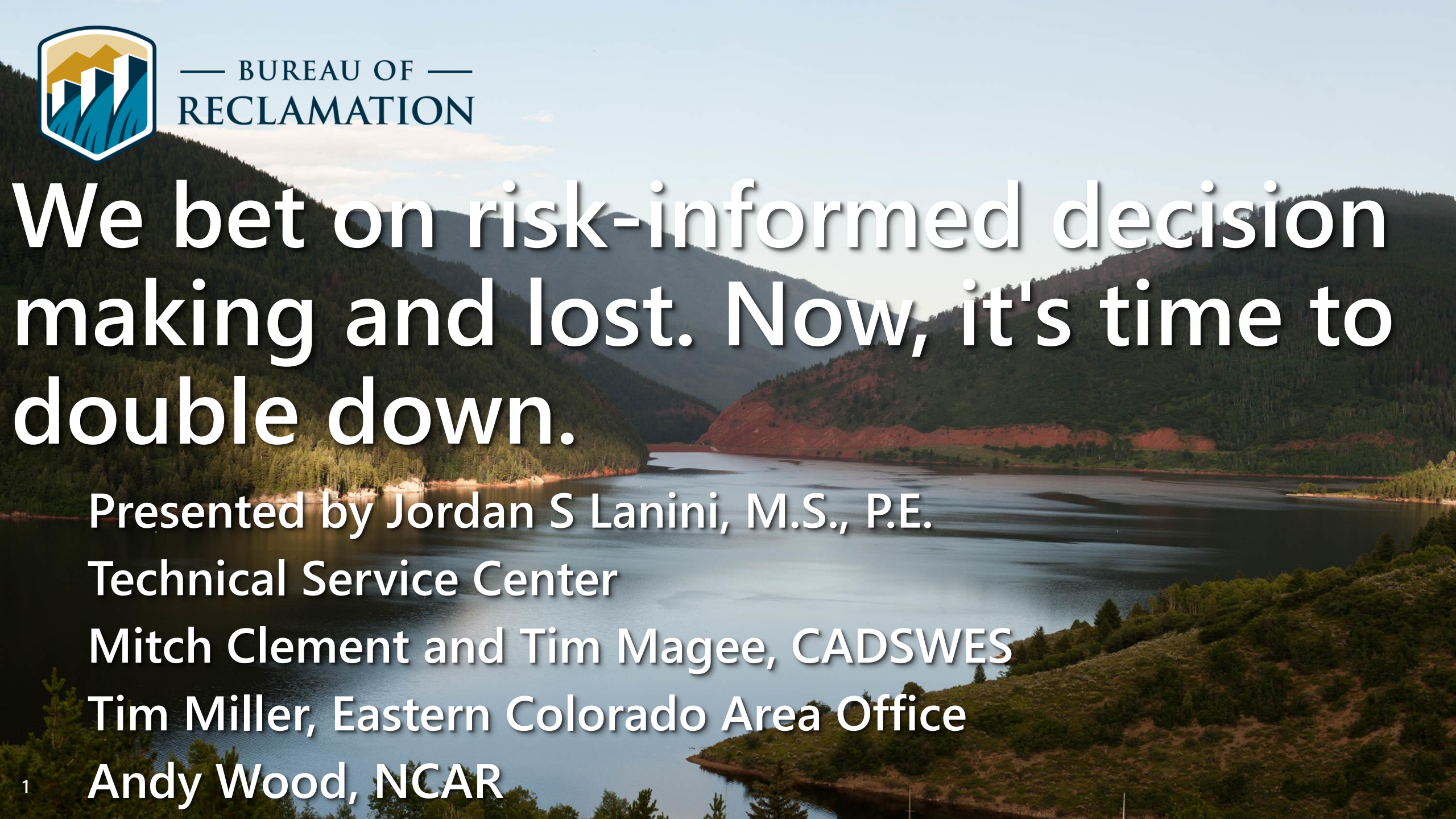


BUREAU OF RECLAMATION

We bet on risk-informed decision making and lost. Now, it's time to double down.

Presented by Jordan S Lanini, M.S., P.E.

Technical Service Center

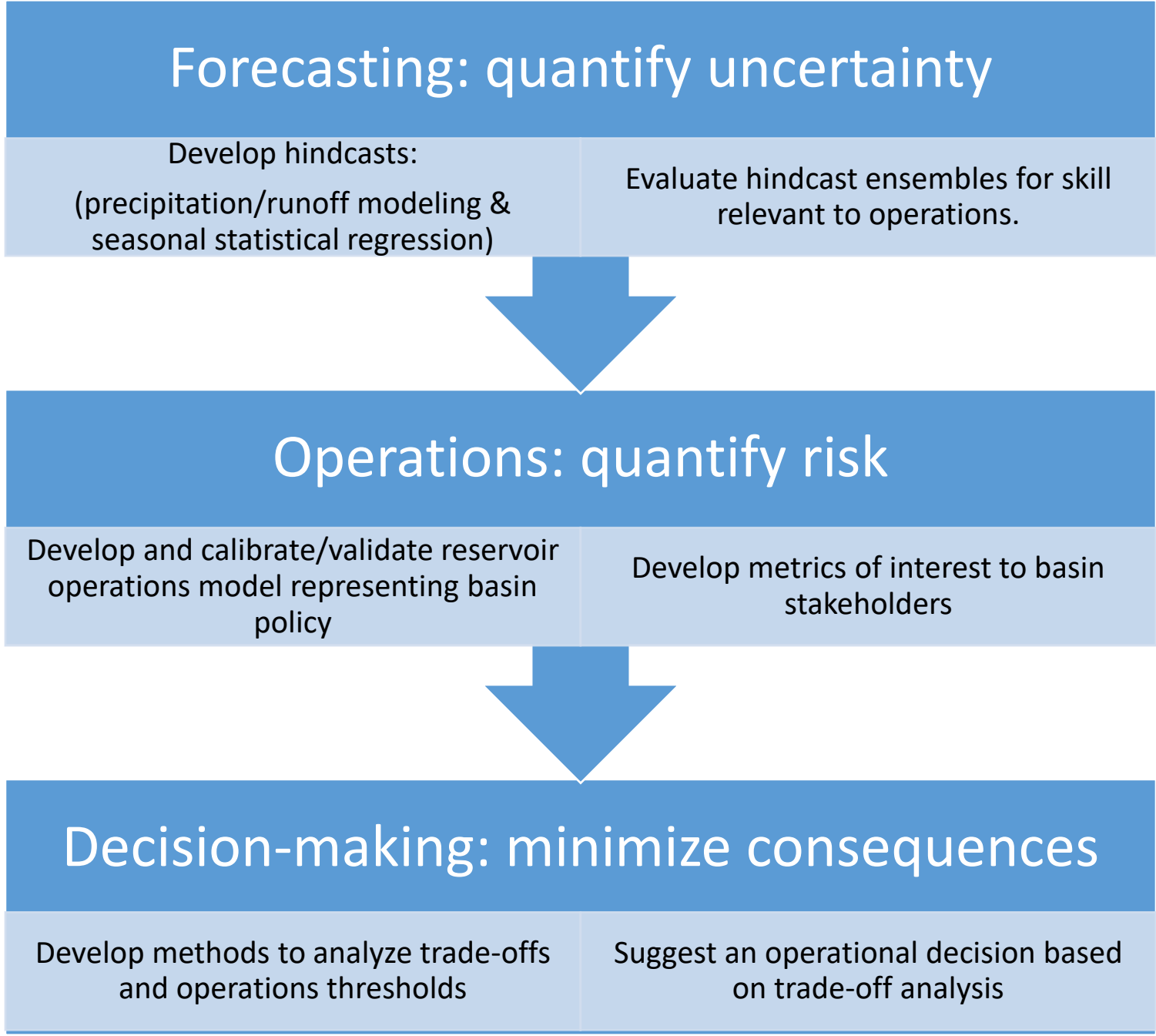
Mitch Clement and Tim Magee, CADSWES

Tim Miller, Eastern Colorado Area Office

Andy Wood, NCAR

Risk-informed decision-making

- Goals: improve operations flexibility and outcomes through risk-informed operations decisions over deterministic ones
- Evaluate outcomes across the range of potential future inflows
- Trade-off analysis between reservoir uses to suggest release decision



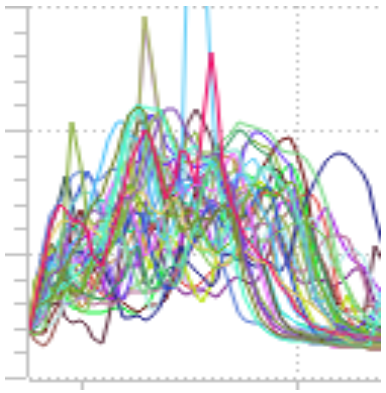
Version 1.0: Buffalo Bill Dam

- Reservoir uses:
  - Irrigation: ~93,000 ac
  - Municipal Use: 6 municipalities, incl. Cody
  - Power Generation:
    - Shoshone Powerplant, 3 MW
    - Buffalo Bill Powerplant, 18 MW
    - Spirit Mountain Powerplant, 4.5 MW
    - Heart Mountain Powerplant, 6 MW
  - Fish and Wildlife
  - Recreation
  - Incidental Flood Control (No allocated storage)

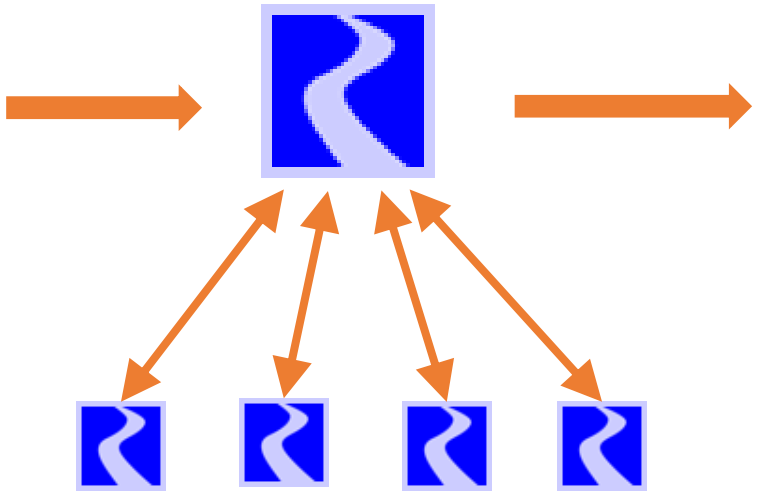
Recommending a Decision: Two-stage stochastic programming with recourse

Step 1 – Determine Week 1 Release options

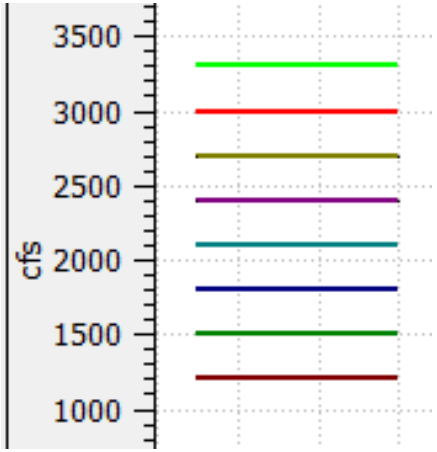
- Method developed by CADSWES, University of Colorado Boulder
- Recommends a decision for a shorter (stage 1) period based on results from stage 1 and longer second stage



Inflow forecast ensemble



Distributed ensemble runs
1 week
Standard rules

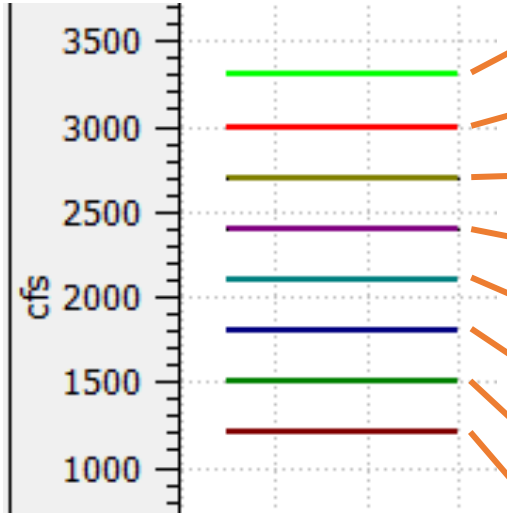


Discrete stage 1 release options

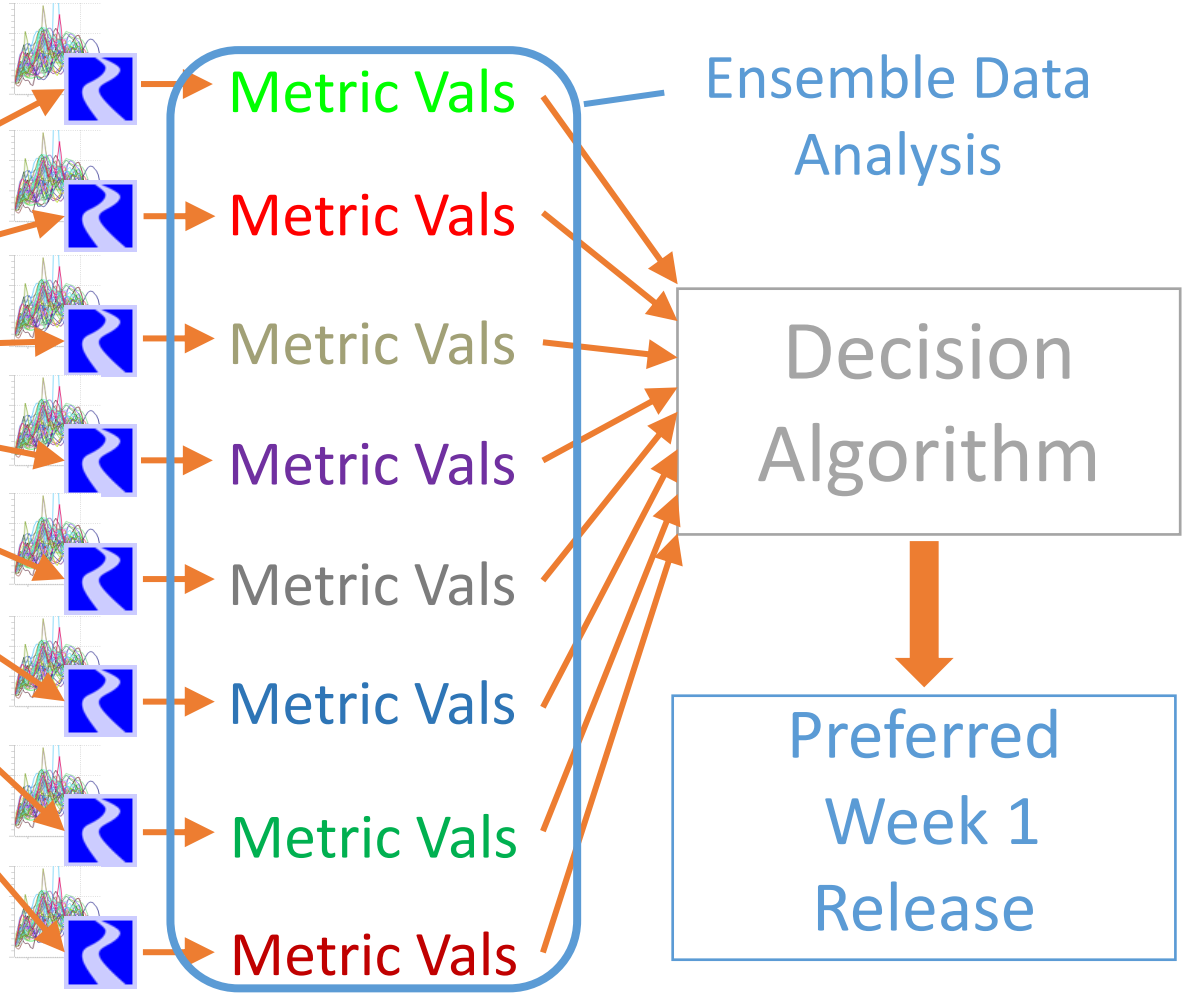
Risk-informed Operations

Step 2 – Apply Week 1 Release options

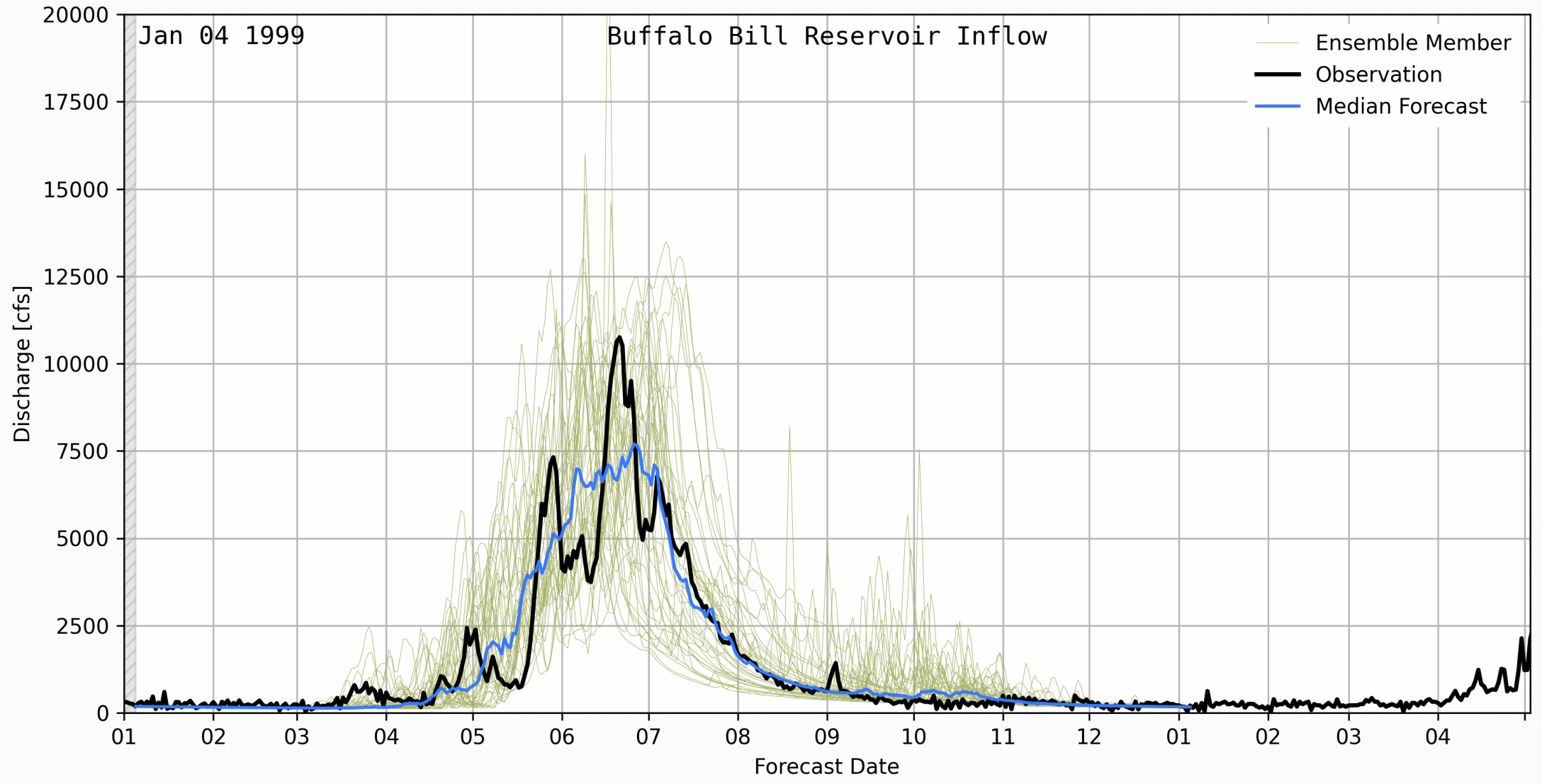
- For each Week 1 Release – simulate forecast ensemble
- Week 1 – use specified release; rest of year – standard rules
- Evaluate metrics



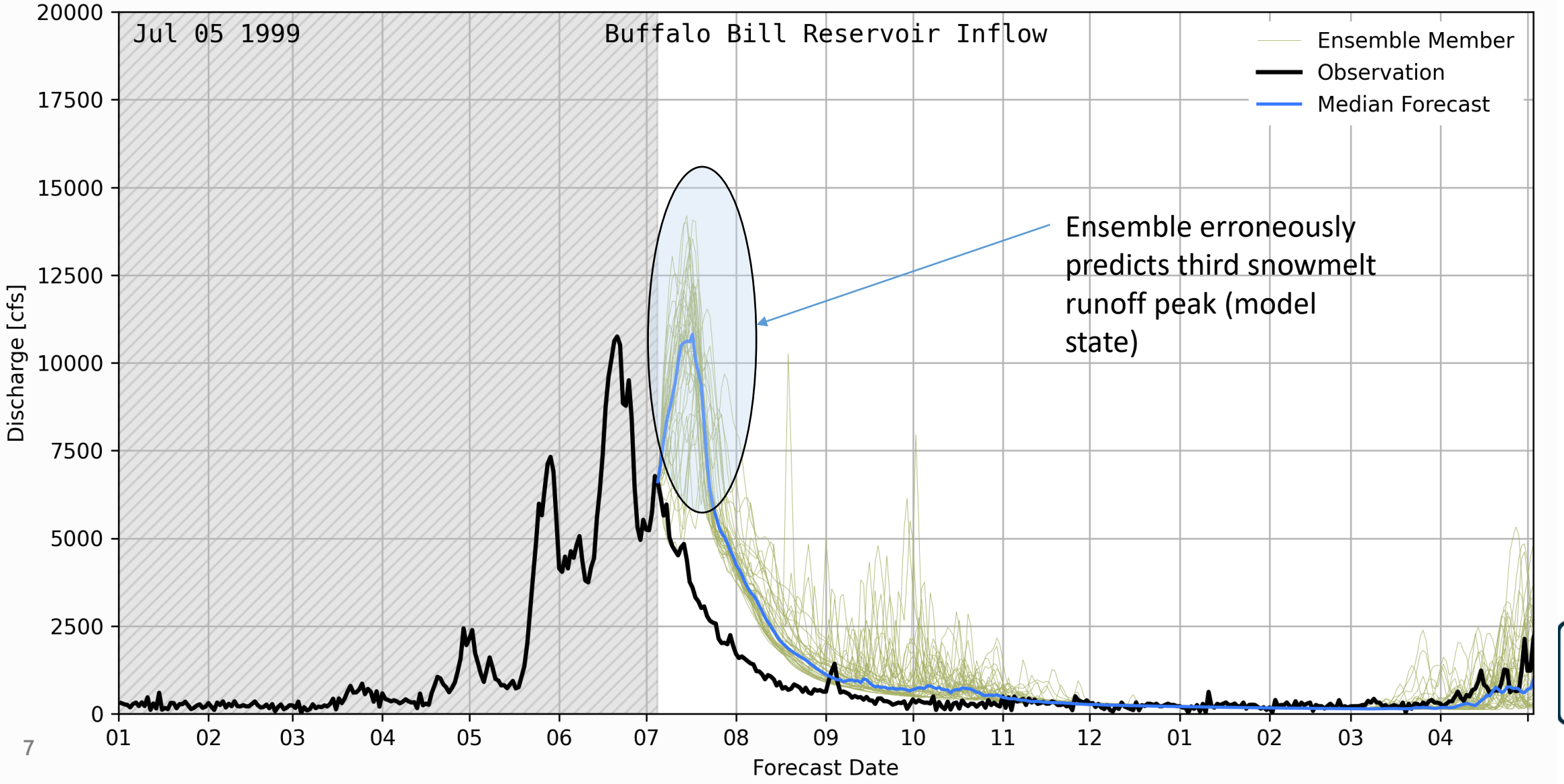
MRM for each Week 1 Release



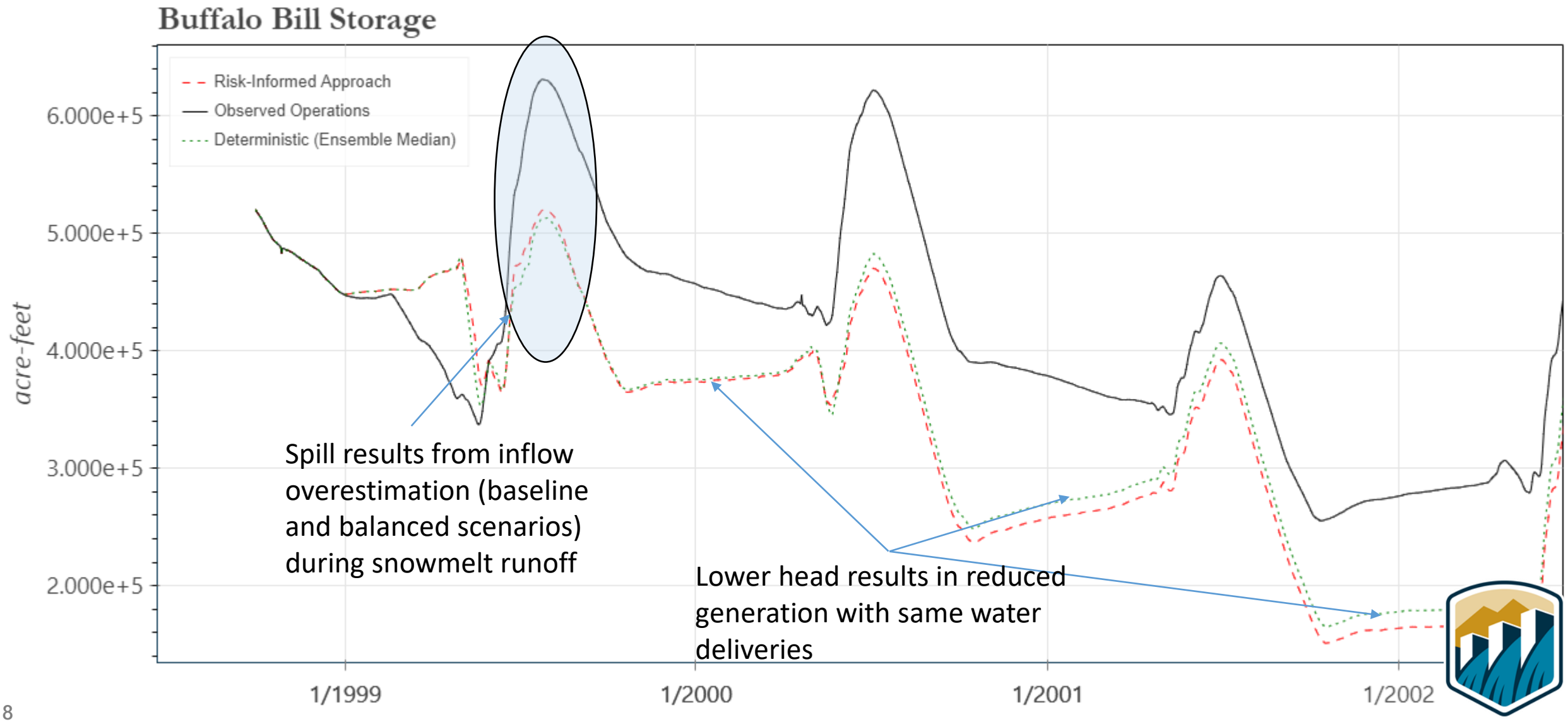
1999 Forecast Evolution: Preceding a drought



July 5, 1999 Ensemble Forecast



Experiment Results

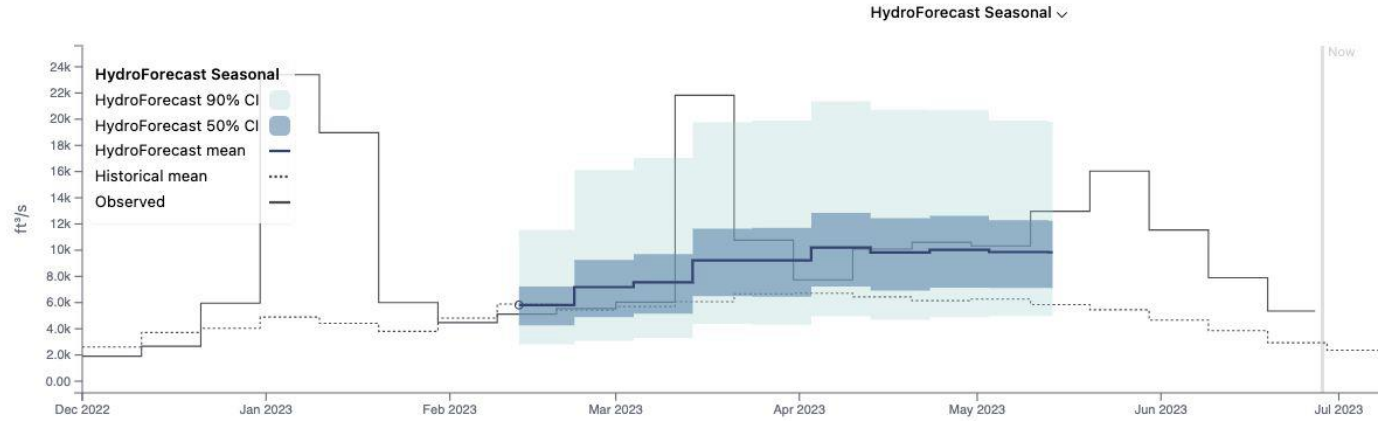


Conclusions and Recommendations

- Risk-informed decision-making approach
  - Approach provides a robust framework for evaluating release decisions
  - Ensemble spread errors (reliability) limited our ability to explore its value
  - Would ensemble post-processing/combine forecast sources improve performance?

Version 2.0: Ruedi Reservoir Operations Pilot Study

- Collaborators: CADSWES, MBART,ECAO, UpstreamTech
- Use UpstreamTech and disaggregated PyForecast seasonal forecasts
- Simplify trade-offs
- Short-term (~10 days) experiment focusing on flood control/filling reservoir using UpstreamTech forecasts



Risk-Informed Operations: Version 2.0

Phase I: Develop Seasonal Fill Plan

- Weekly timestep, seasonal forecast (Today through end of fill season)
- Calculate flood control and water supply guide curves based on risk tolerances
- Hydropower guide curve based on turbine capacity

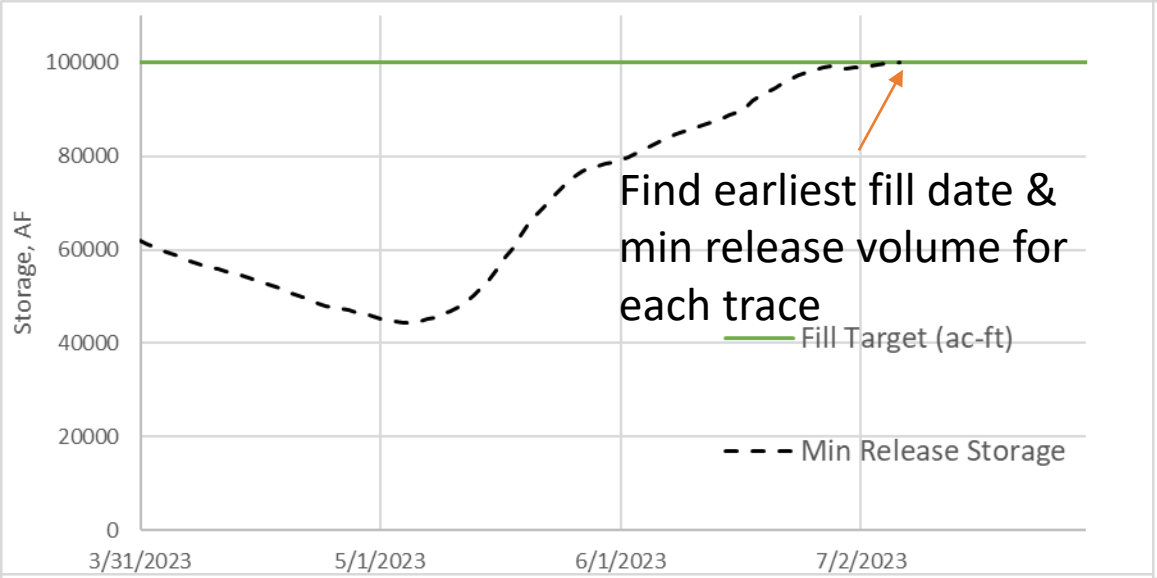
Phase II: Make short-term release decision for seasonal plan

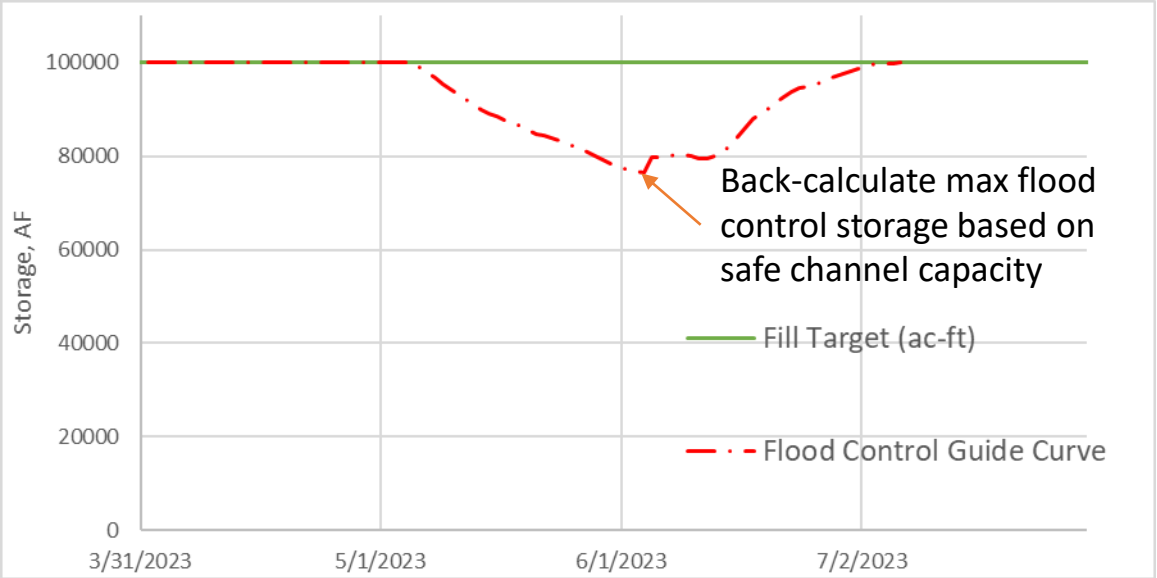
- Trade-off between water supply and flood risk
- Maximize hydropower

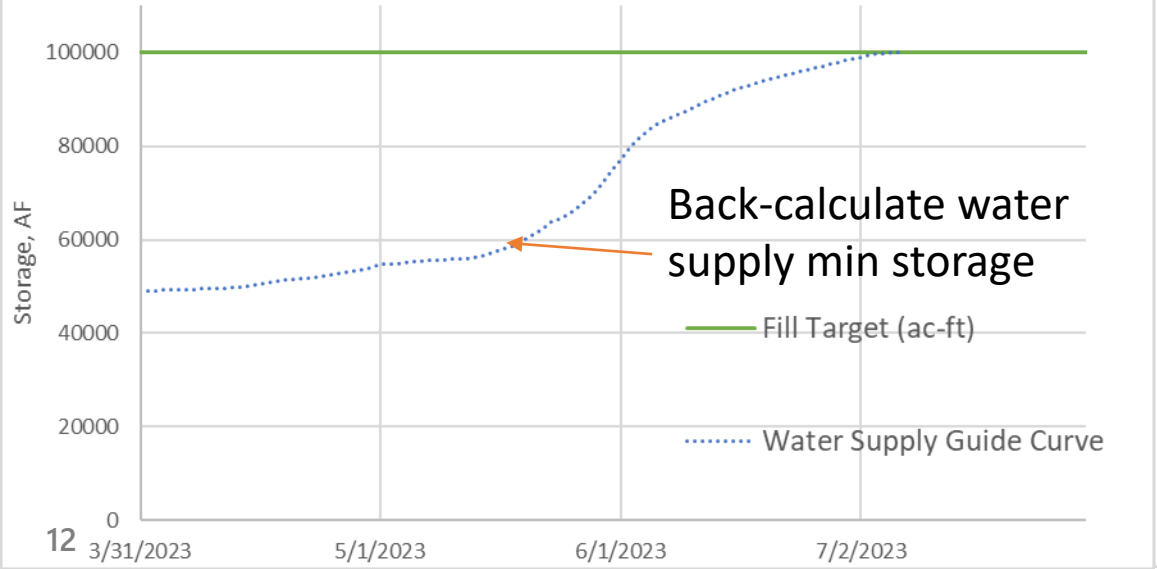
Phase III: Short-term flood control operations (aka, FIRO)

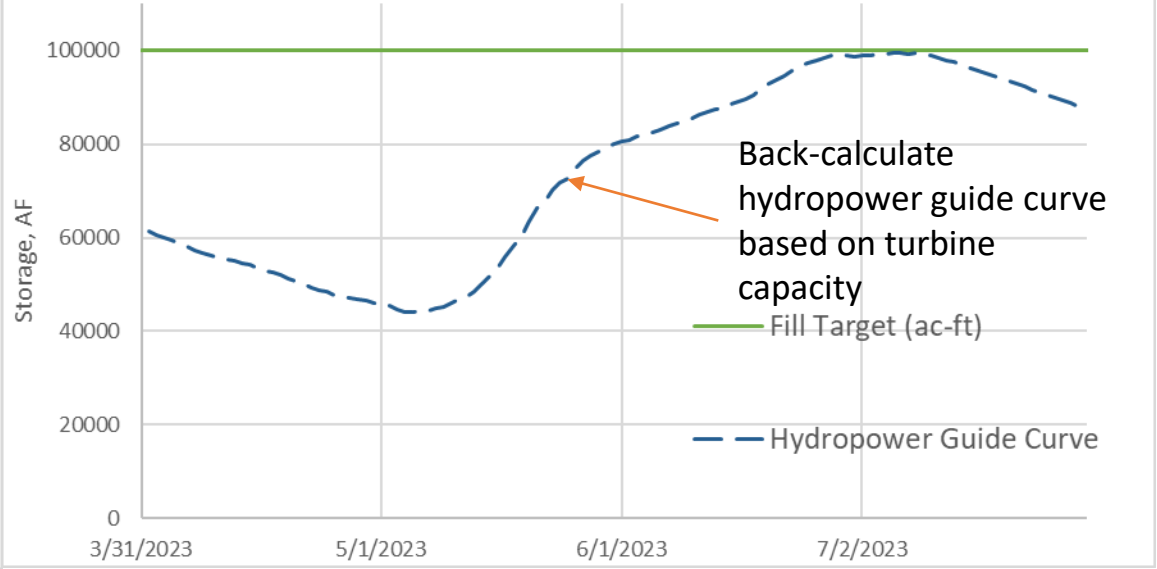
- Daily (or subdaily timestep), 10-day forecast
- Check the current short-term release and the 10-day forecast against flood control and water supply curves
- Change short-term release if necessary

Phase I: Guide Curve Development

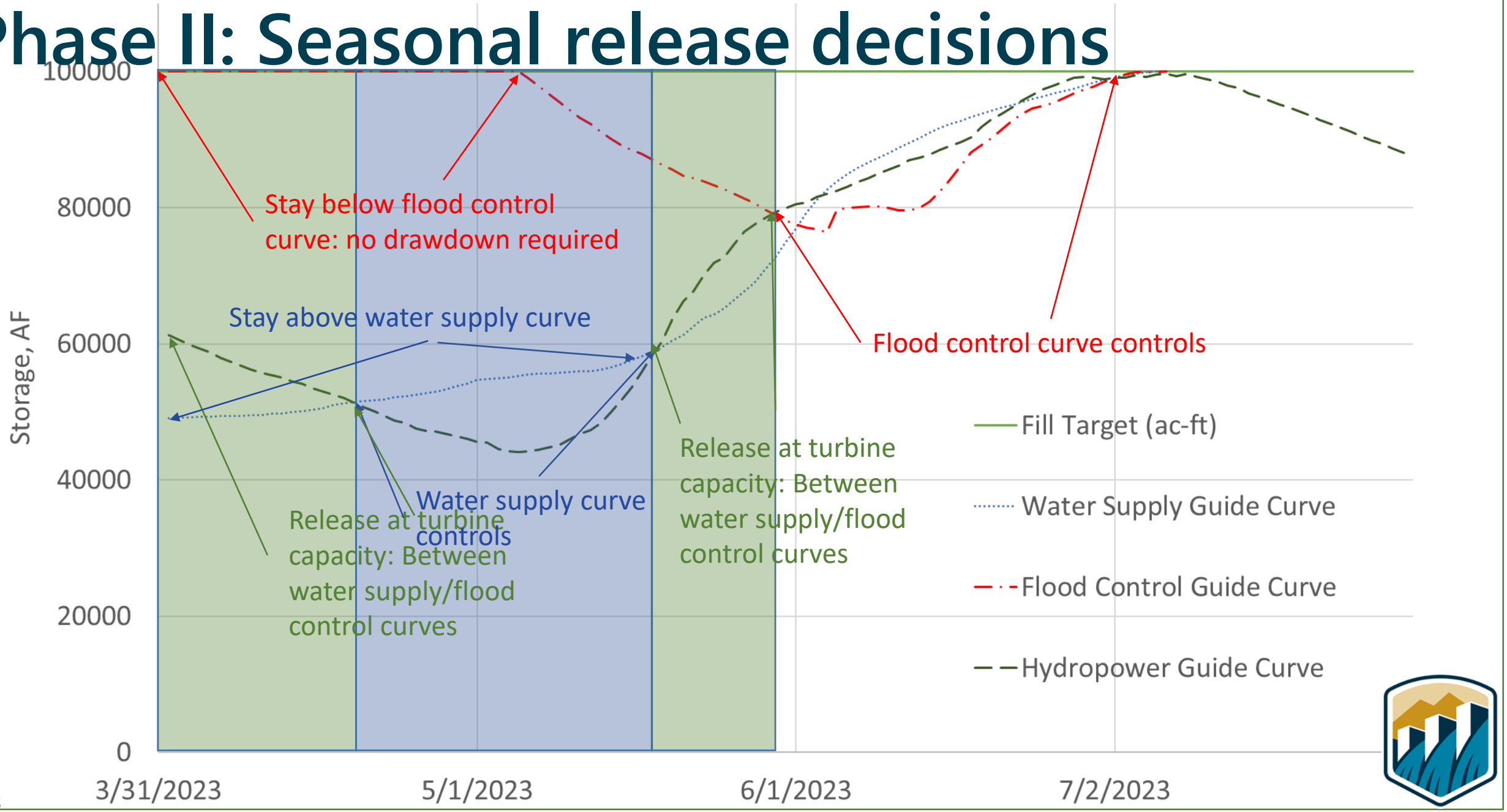




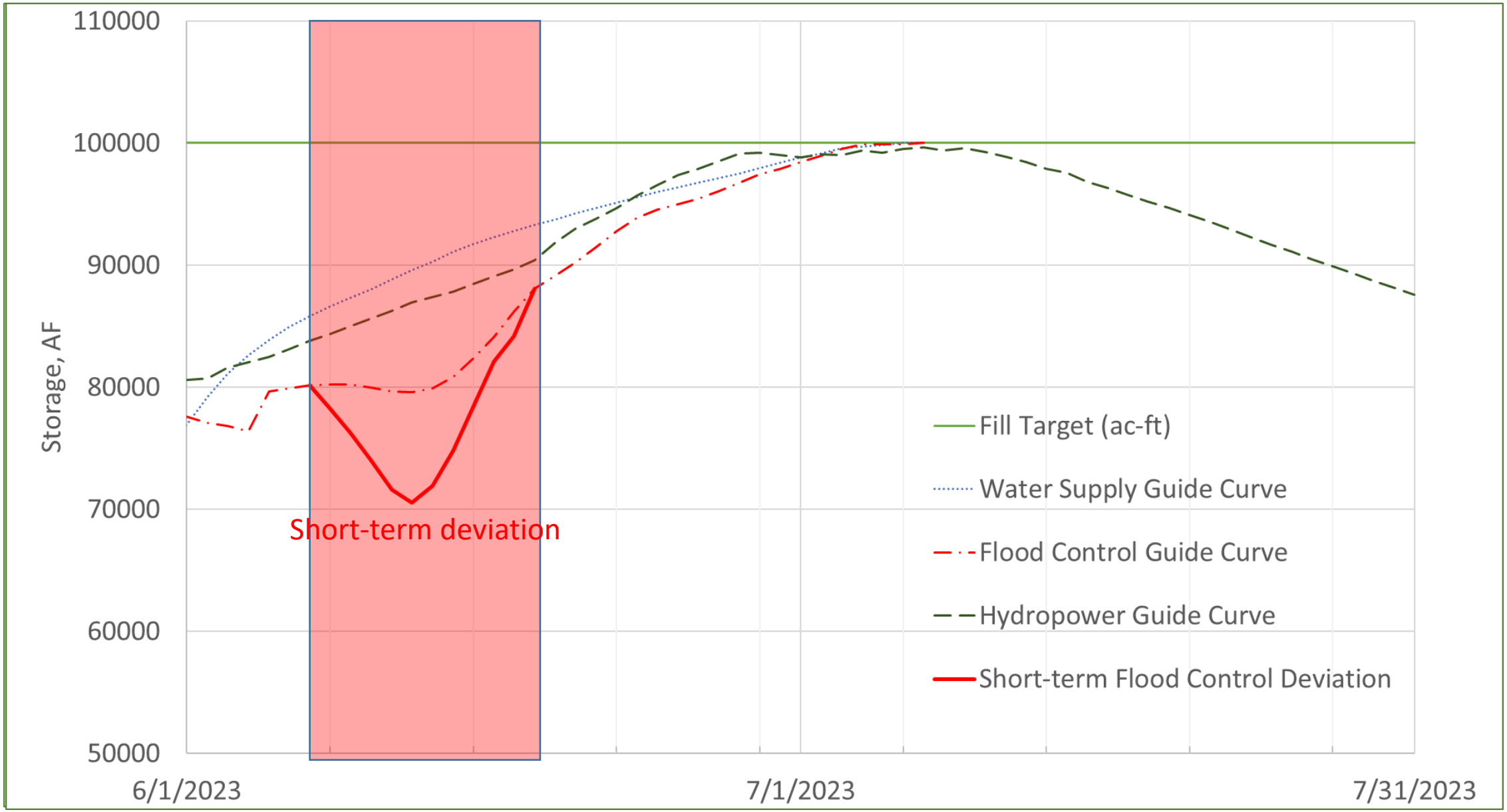




Phase II: Seasonal release decisions



Phase III: Short-term release decisions



Conclusions

- Buffalo Bill effort was limited by forecast reliability/lack of post-processing
- Lessons learned regarding forecasts and trade-offs
- Next steps:
  - Complete Ruedi model
  - Implement updated approach
  - Stakeholder engagement
  - Execute experiments

Ruedi Dam and Reservoir.