Using ensembles to make objective releases decisions on Lake Tahoe

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PRECISION
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TROA
Truckee River Operating Agreement

Outline

- Ensemble Streamflow Prediction (ESP) Forecasts
- ESP Uses
- Lake Tahoe Characteristics and Requirements
- ESP Operational Alternatives
- WY2019 Forecast Review

Ensemble Steamflow Prediction (ESP)

- California-Nevada River Forecast Center (CNRFC)

Driven with Historical Climate (Temp and Precip)

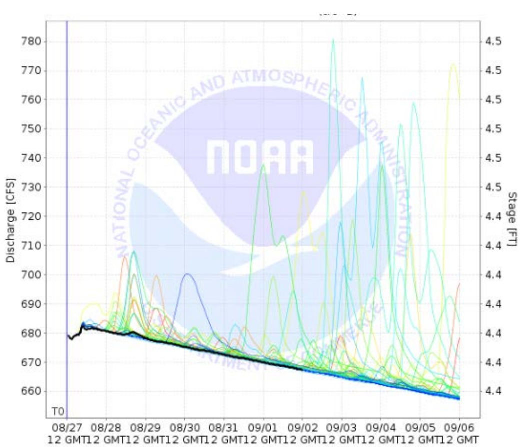
NWSRFS Hydrologic Model

Observed Soil Moisture and SWE

CNRFC Hydrologic Model

Daily Timestep ESP

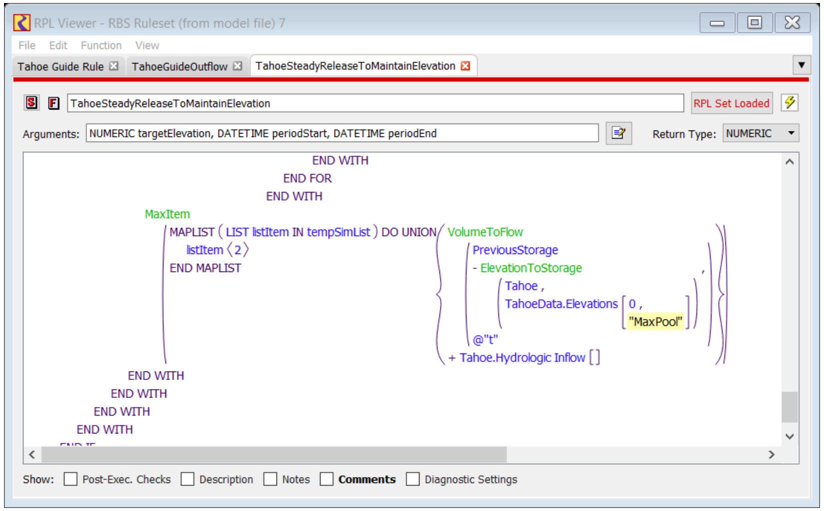
Represents uncertainty in runoff from uncertainty in **future precipitation** and **temperature**



ESP – What is it good for?

- Common Uses:
  - Uncertainty propagation
  - Outreach and communication
  - Temporal disaggregation
  - What-if analysis
  - Alternative to statistical runoff volume forecasts

- Question:
  - Are they a “Novelty?”
  - Can they be used for objective operational decisions?



Tahoe Characteristics and Requirements

- Large natural lake
- 6.1’ tall dam
- Storage behind dam: 744,000 acre-feet
- Drainage Area: 505 mi^2
- 37% of basin is Lake Surface
- Release capacity: 2600 cfs
- 1” of runoff requires 6.5 days to release
- Policy requires that elevation 6229.1’ be maintain **“in-so-far as practicable”**
- Tahoe is also the primary water supply reservoir on the Truckee River, so conservation is important.

*Map from NRCS

Lake Tahoe Operational Requirements

- Water years 2017-2019 each had sufficient inflow to fill the Lake
  - The Lake last filled in 2006, which was before ESP forecasts were made available by CNRFC
- Because of limited release capacity, releases need to be made well in advance of peak runoff
- Forecast uncertainty makes determination of releases difficult
- **We needed to develop a method that utilizes ESP forecasts**
  - This was done collaboratively over the past three years

Practical considerations

- In real life, releases can only be set to one thing at a time.
  - We can't simultaneously operate to **ALL** of the ESP traces
  - We must choose **one** release for right now
- There is some finite amount of time that must pass before there is enough **new** information to warrant a release change
  - This is subjective and not well defined
  - For this analysis we generally used the First of the month NRCS-RFC coordinated forecast.
  - In practice, mid-month forecasts were used as well.

Two alternative methods:

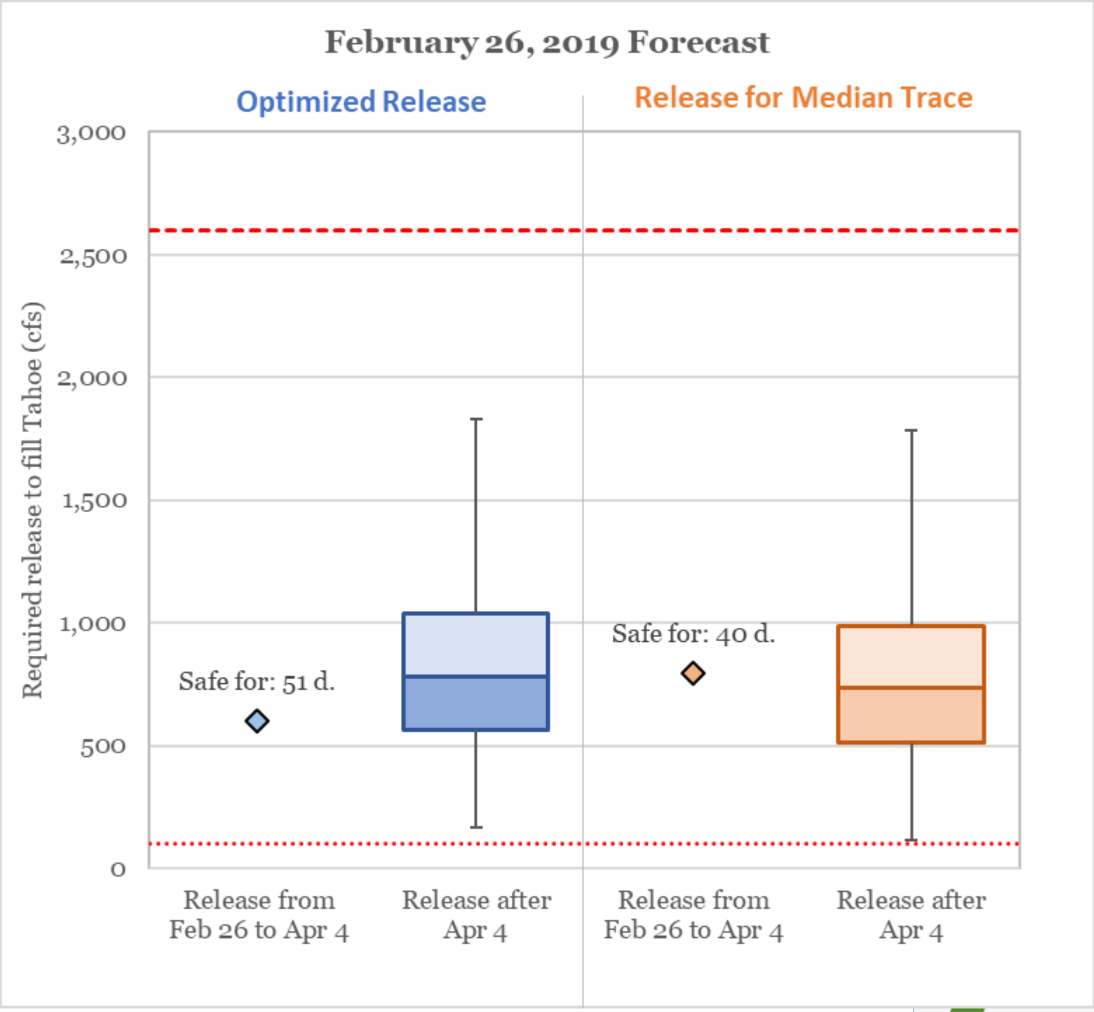
- “Release for Median”
  - Run each ESP trace through the model to determine the required release
  - Set the release to the median of the required releases
  - “Consider” the other traces to analyze and be aware of risks
  - Choose the “most likely” or “normal” trace
- “Optimized Release”
  - Determine the release that **could be held the longest** before you need it needs to be changed to either the maximum or minimum release in **any ESP trace**
  - Requires trial and error or iterative runs of the ESP traces

Method Evaluation

1. Number of days release could be held
   - A release that can be held longer increases the time before you are forced to make a change
   - **This should be maximized**
2. Probability of being within Constraints
   - Percentage of ESP traces where the release that you must change to with the next forecast is within the constraints (maximum and minimum releases)
   - If the reaction release > maximum release -> risk exceeding 6229.1’
   - If the reaction release < minimum release -> risk of not filling
3. Range of required releases
   - It is better for downstream users to limit major changes in release

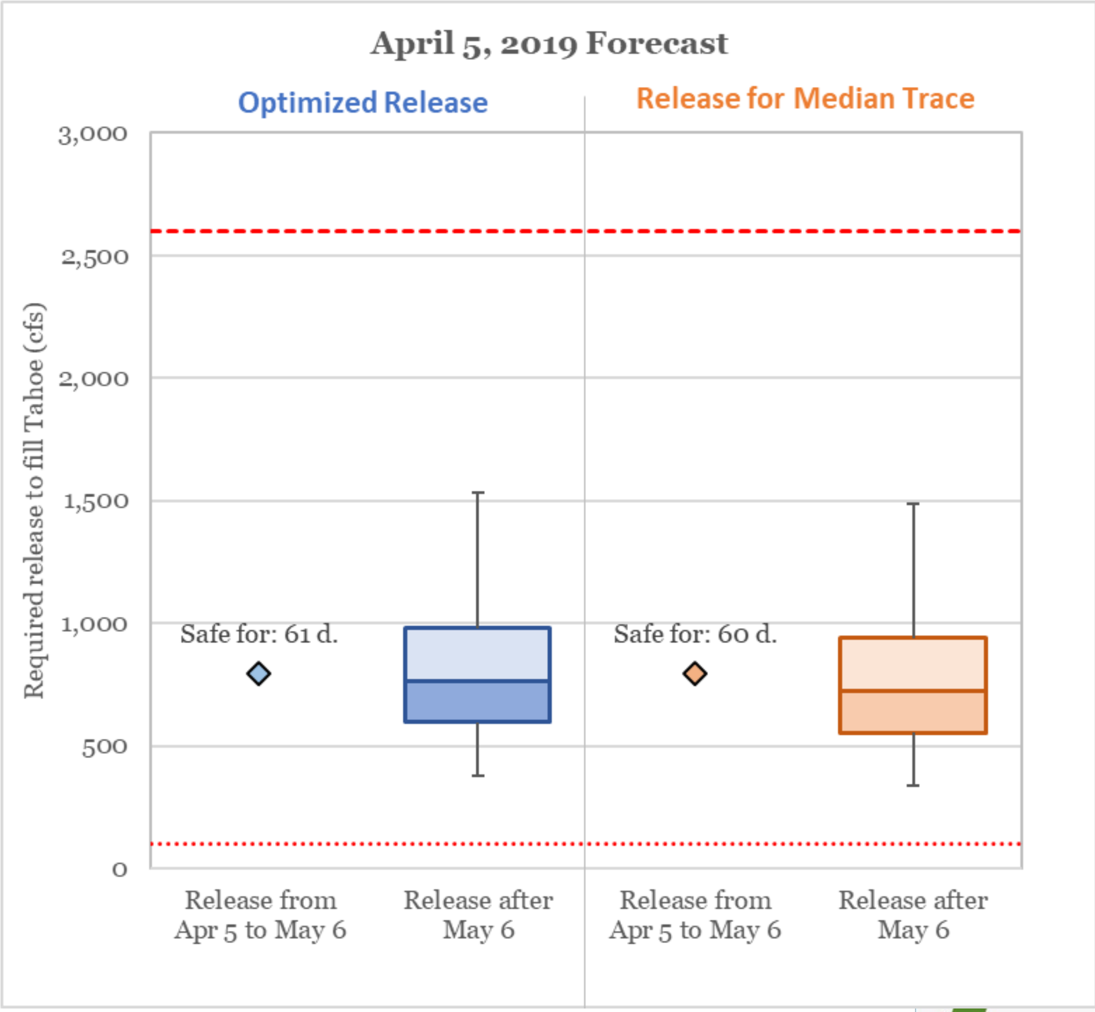
February 26 Forecast

Metric	Optimized Release	Release for Median
Number of days it could be held	51 days	40 days
Probability of being within Constraints	100%	100%
Range of required releases	1,661 cfs	1,666 cfs



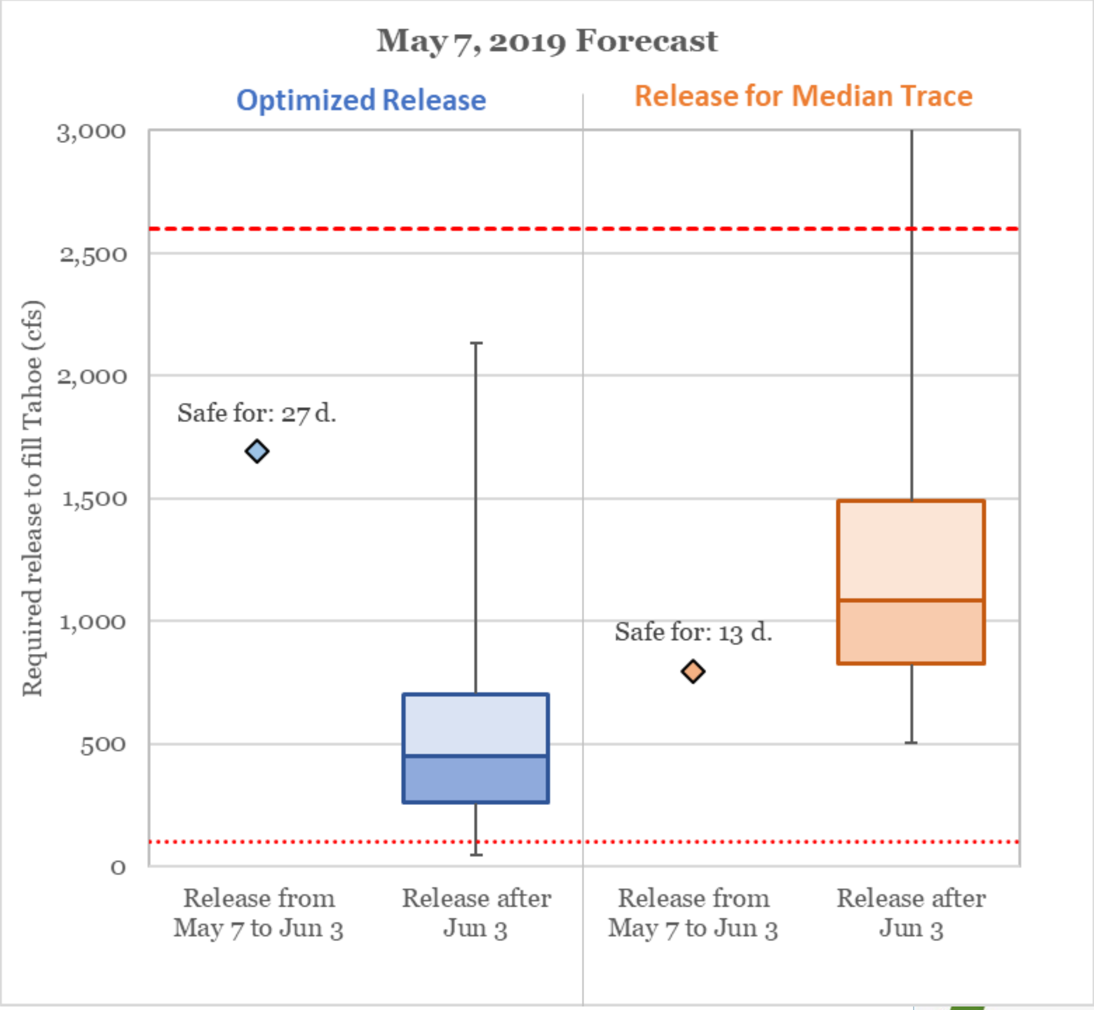
April 5 Forecast

	Optimized Release	Release for Median
Number of days it could be held	61 days	60 days
Probability of being within Constraints	100%	100%
Range of required releases	1,155 cfs	1,147 cfs



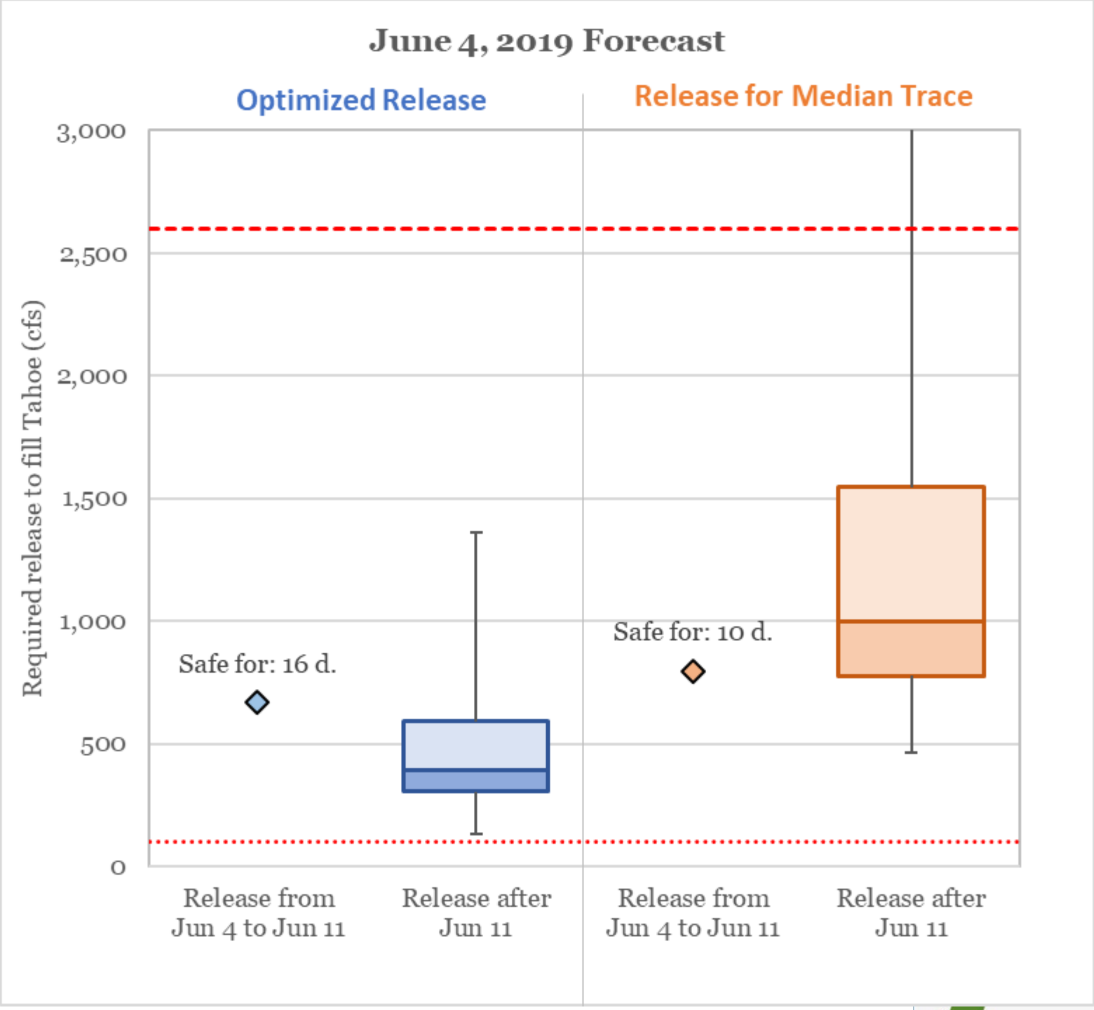
May 7 Forecast

	Optimized Release	Release for Median
Number of days it could be held	27 days	13 days
Probability of being within Constraints	95%	90%
Range of required releases	2,085 cfs	16,034 cfs



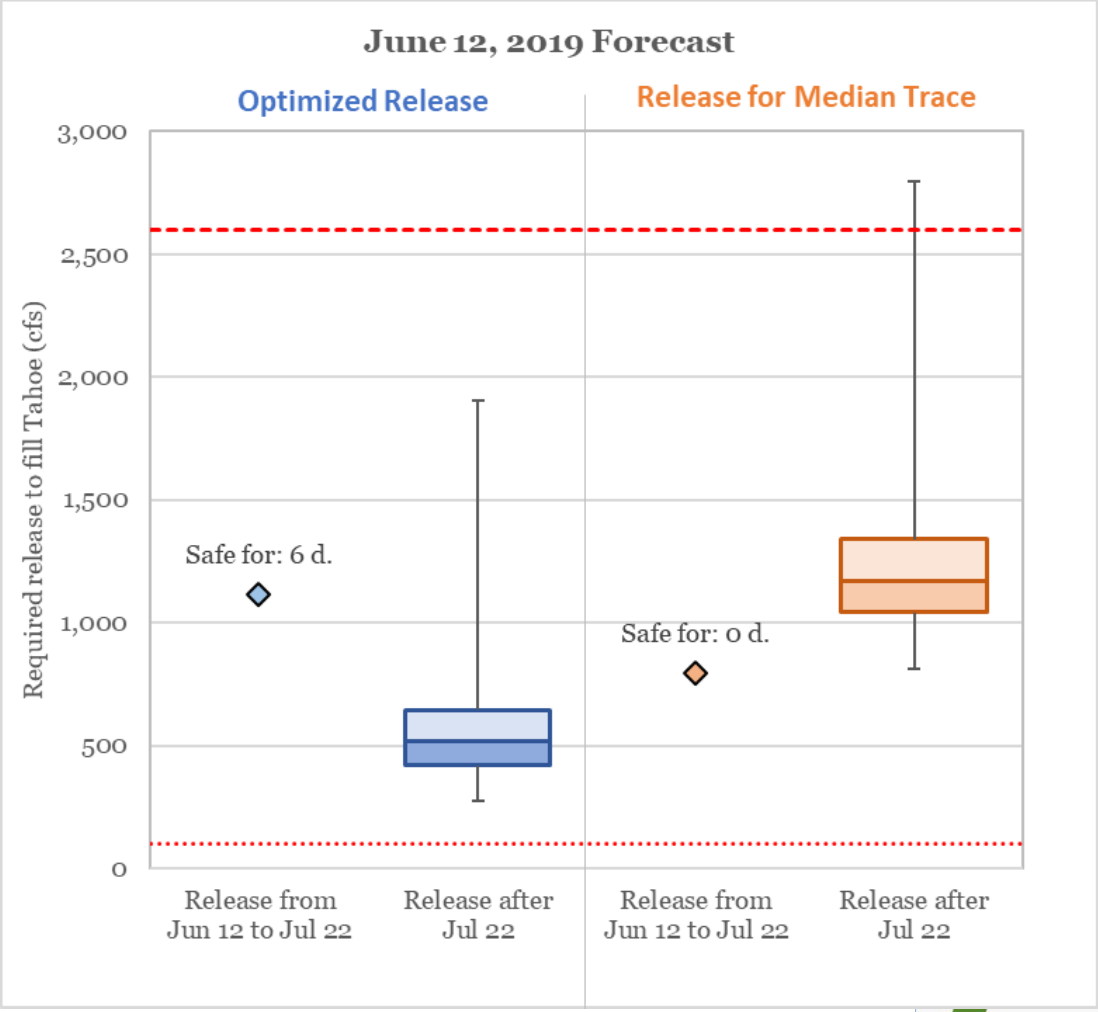
June 4 Forecast

	Optimized Release	Release for Median
Number of days it could be held	16 days	10 days
Probability of being within Constraints	100%	83%
Range of required releases	1,228 cfs	10,851 cfs

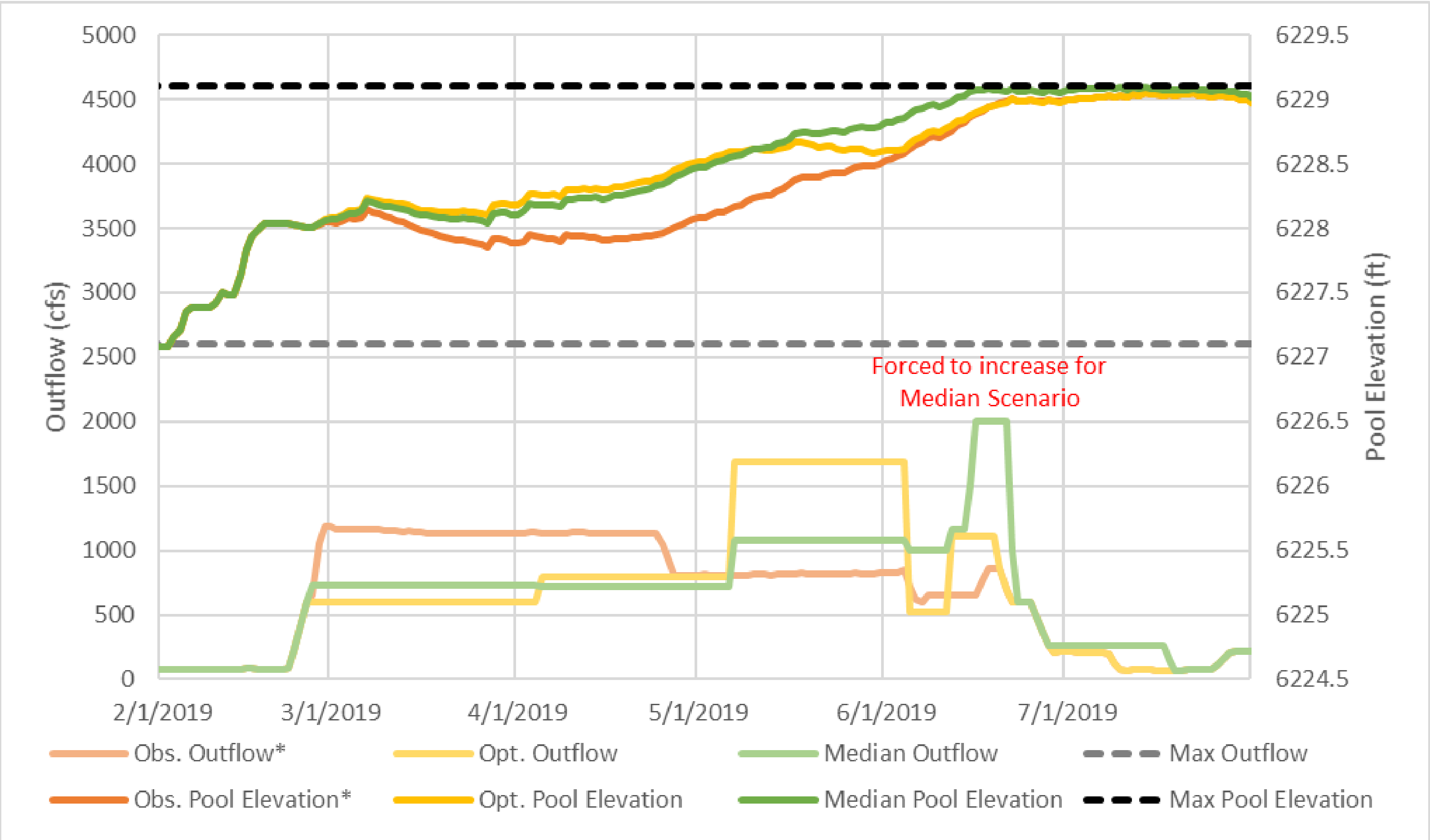


June 12 Forecast

	Optimized Release	Release for Median
Number of days it could be held	6 days	**0 days**
Probability of being within Constraints	100%	98%
Range of required releases	1,630 cfs	1,983 cfs



Review:



*For actual releases, the 14-day precipitation forecasts were referenced to inform which part of the distribution was more likely (wet or dry) and some of the traces were thrown out accordingly.

Conclusion

- Operating to the median trace does not equally protect against the high and low end of the distribution
  - This is partially because of the statistical skew
  - It may not be apparent that there is a problem until it is too late
- Choose the release that can be maintained the longest, before changing for either the largest or smallest trace.
  - Able to increase this period by 6 to 14 days for the May 7, June 4 and June 12 forecasts
- Using ESP forecasts to determine Tahoe releases, allows us to:
  - Reduce risks of over/under filling
  - Have fewer swings in releases
  - Provide better flows downstream
- Similar methods may be applicable to other reservoir operational questions

Questions?

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- Dave Wathen
- Pat Fritchel

References:

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