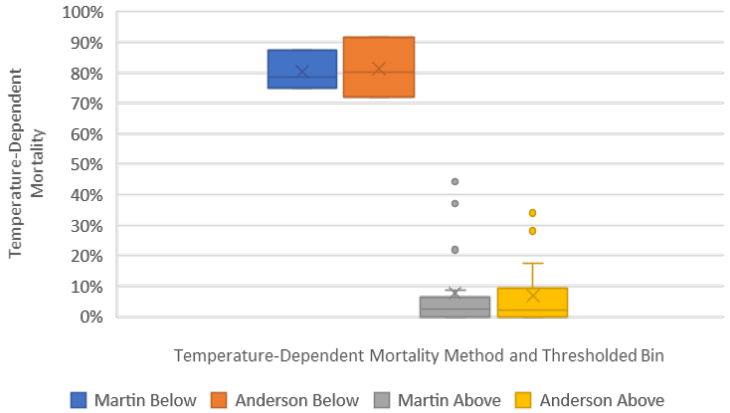
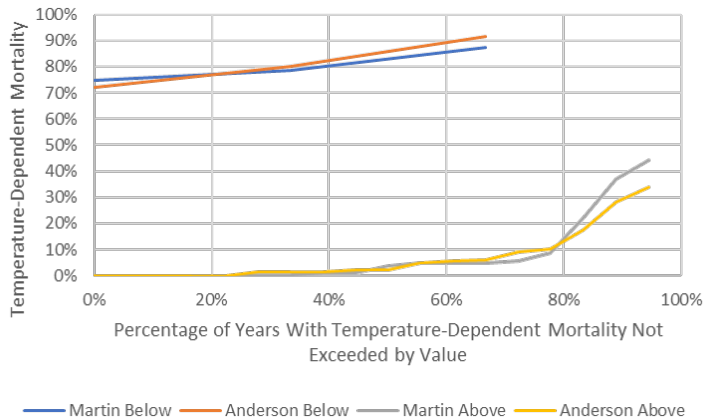
Can we identify what conditions lead to ability to meet acceptable TDM goals?

Based on observed data

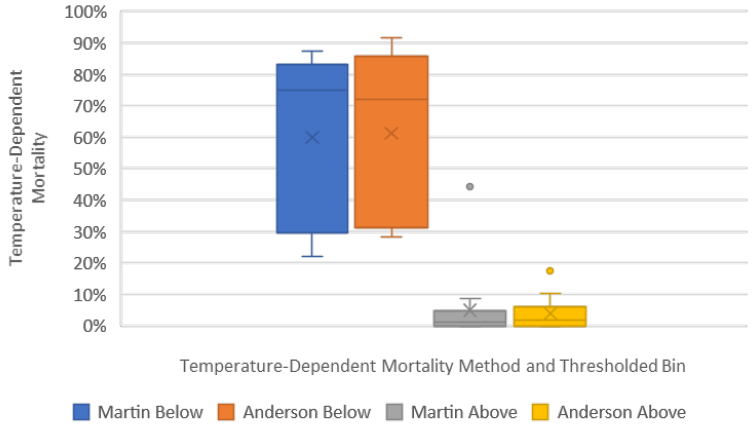
- The SacPAS website tool was used to calculate TDM by applying historical Sacramento river temperatures to a spatiotemporal redd distribution defined by historical aerial redd survey data from that year for 2001-2021.
- The results were compared to End of April Shasta storage for each of these years. The findings were that high-storage years were consistently low in TDM, while low-storage years were consistently high in TDM.

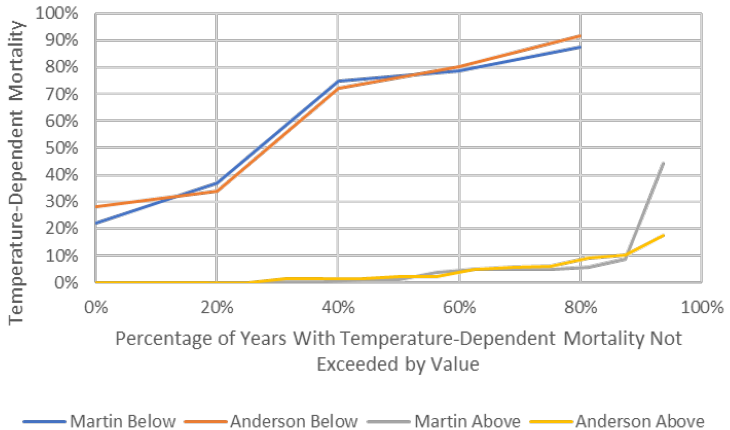
A 2800 TAF cutoff separates years with TDM above and below 50%.





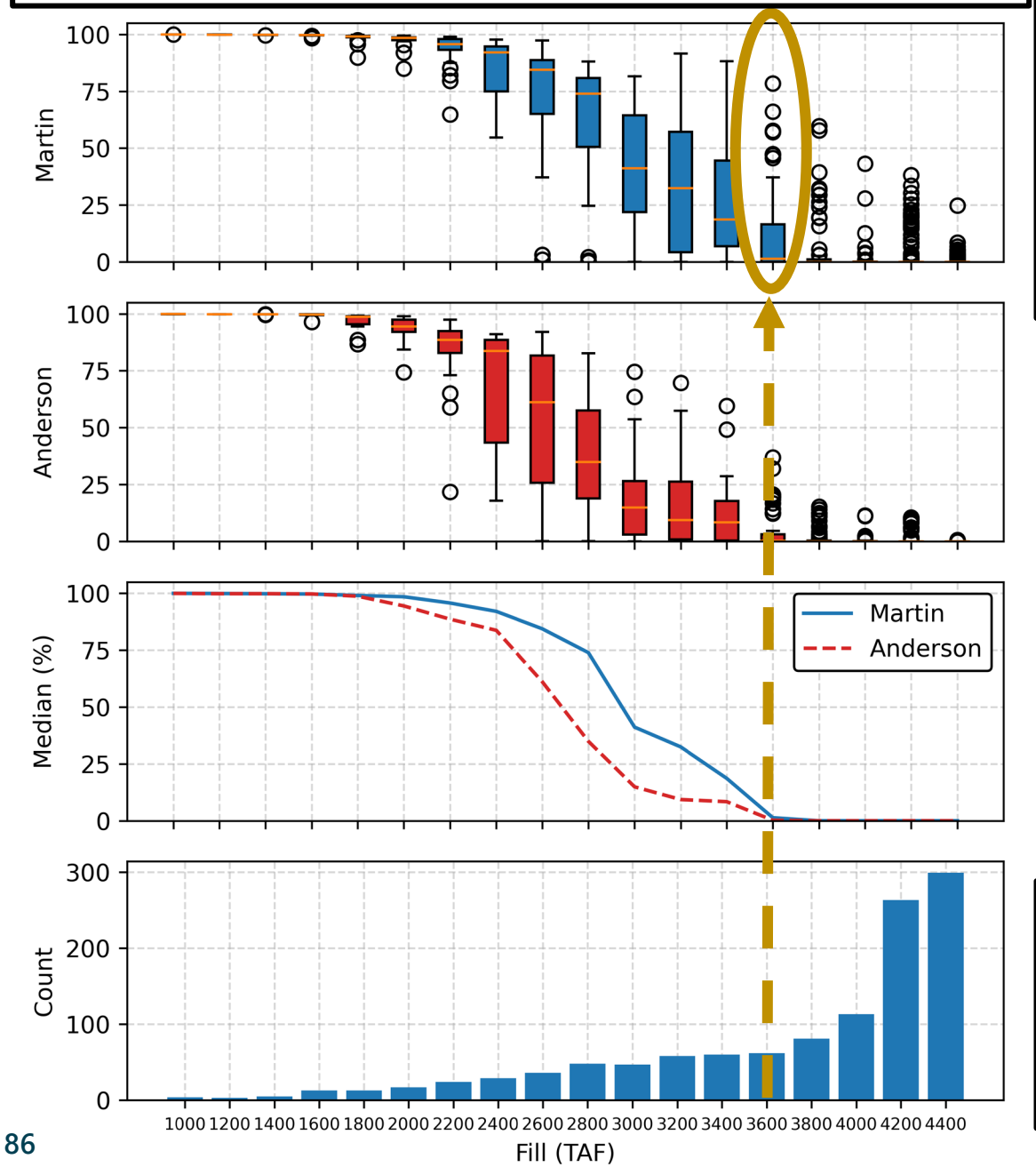
A 3200 cutoff above and below TDM of 20%. (No years were between 3200 and 3600 in the 2001-2021 time period)



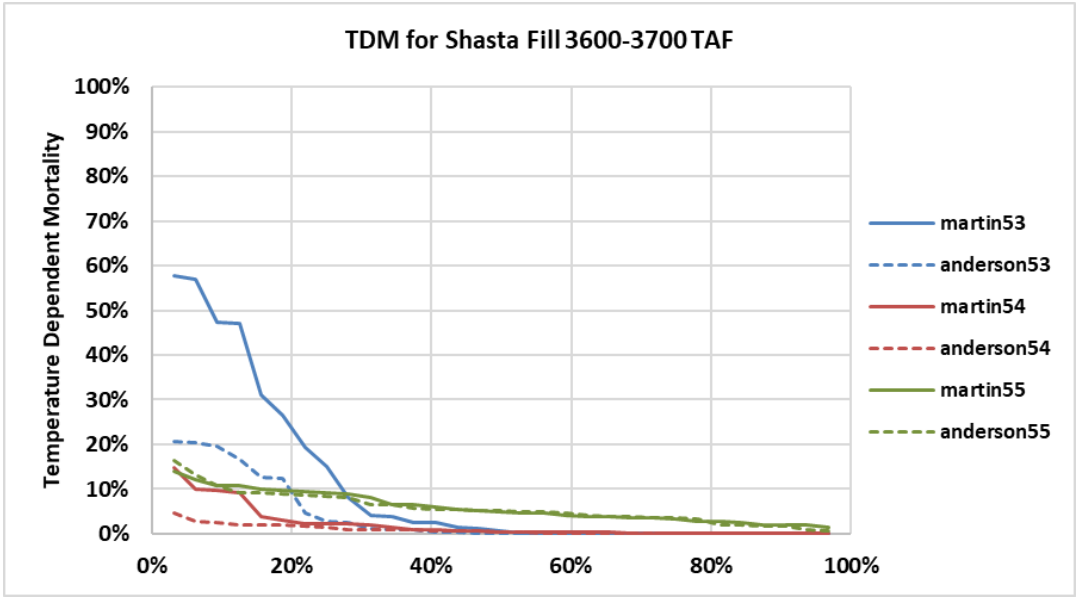


End of Apr Storage (taf)	# of Years Above	# of Years Below
2800	18	3
3200	16	5

% TDM Results for Fixed 53 Degree Clear Creek Target

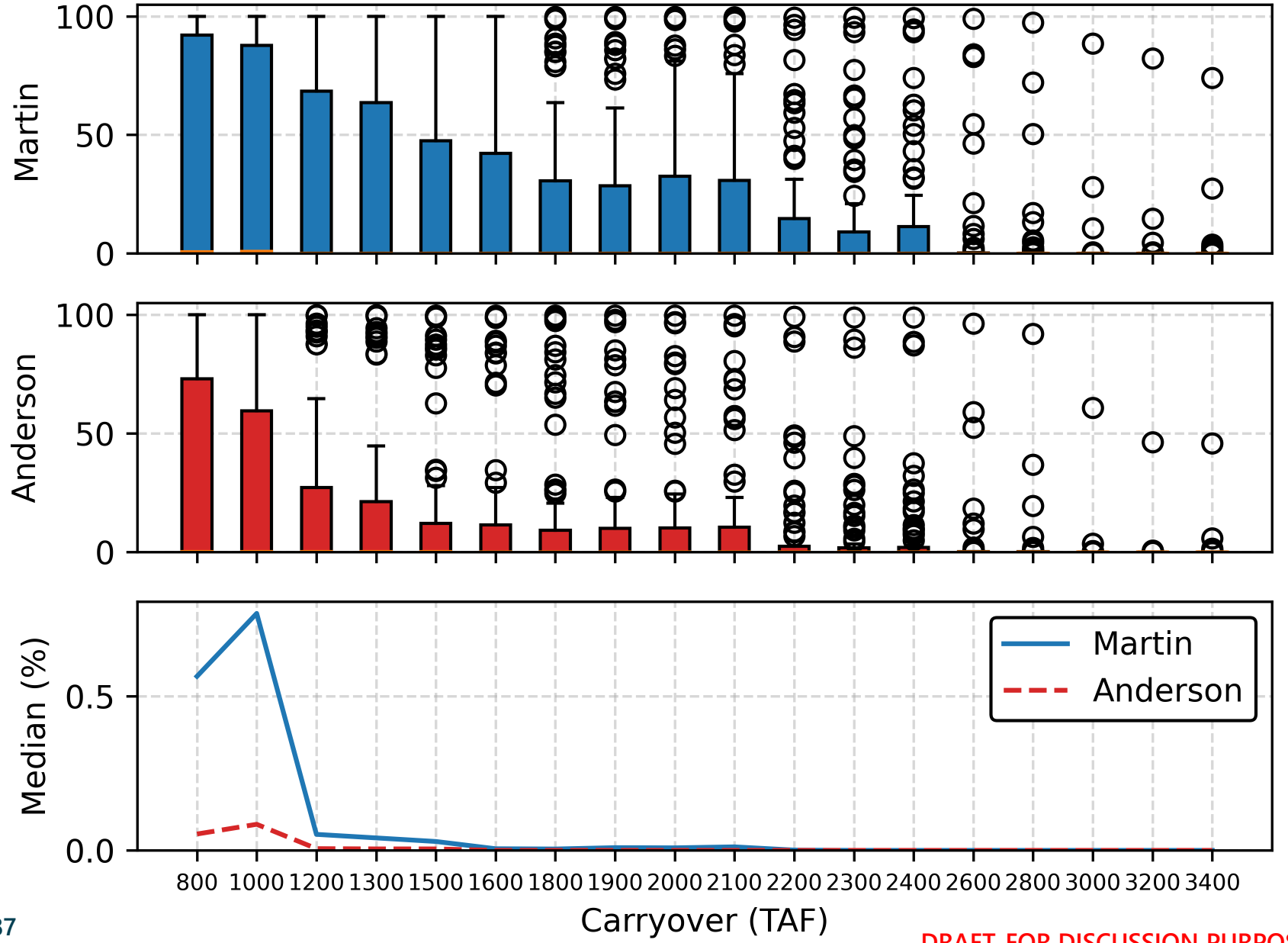


- Temperature and associated TDM, are a strong function of fill
- Even within a similar range of fill, achievable temperature management can vary greatly due to meteorology
- 3600 TAF fill produces a third quartile TDM result for **Martin53** of ~15%
- The median TDM for both Martin and Anderson is < 1%



- **54-degree** operations with Shasta fill of 3600-3700 achieve:
  - Highest TDM is ~ 15%
  - TDM < 5% ~ 85% of the time
- Fill of 3600 TAF or above can achieve significant temperature performance under the vast majority of conditions

18 initial conditions (end of September carryover from previous year), 82 1-year traces for each initial condition, 2035 CT hydrology



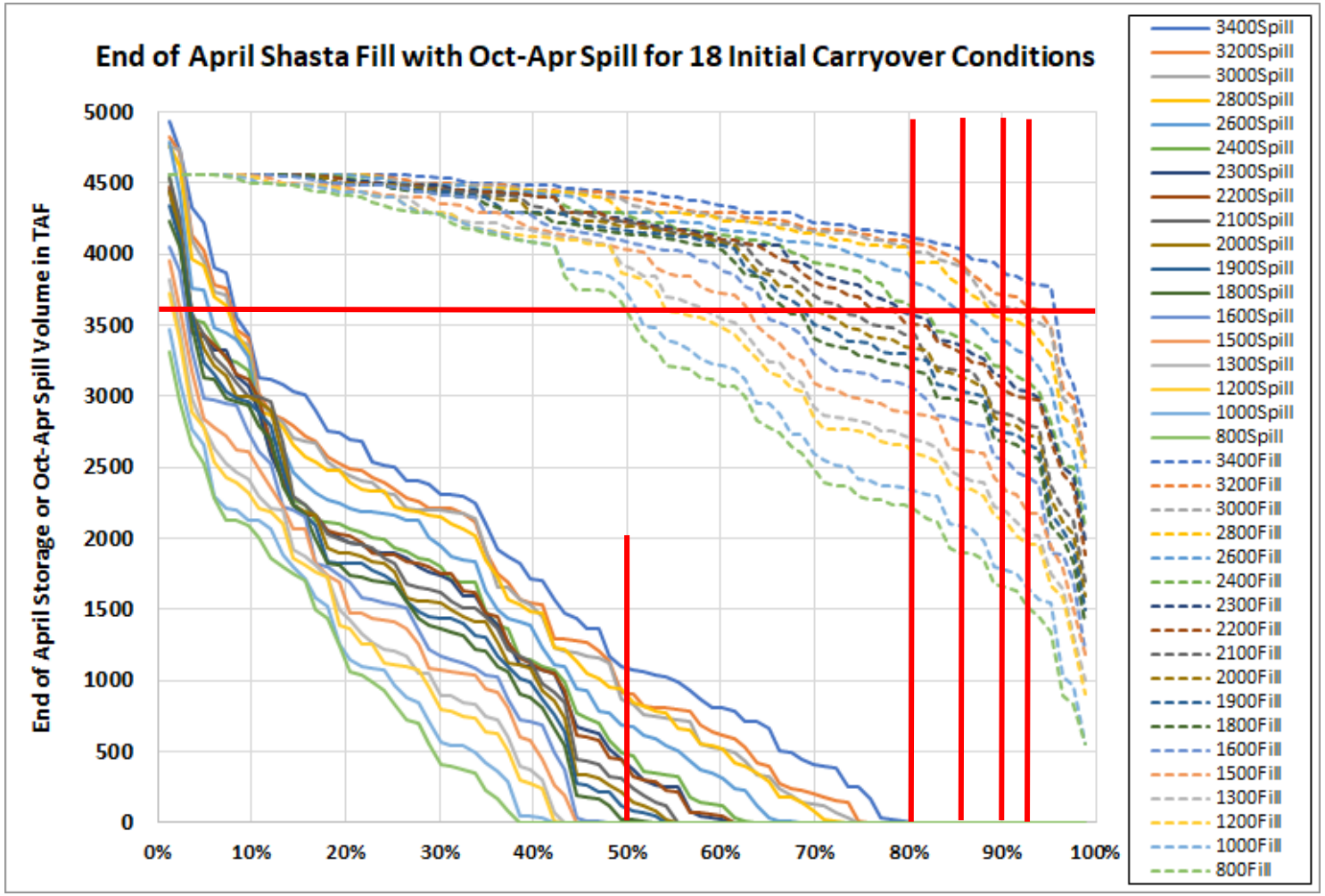
- Same data as previous, regrouped by initial carryover rather than EOA storage
- Median condition is nearly always functionally zero
- Variability decreases with higher carryover because higher fill is achieved

More challenging to predict temperature performance from carryover alone

Carryover target of 2200 TAF is sufficient to drop 75% percentile to functionally 0%

What carryover (from previous year) is needed to meet 3600 taf fill?

Carryover/Fill/Spill Tradeoffs



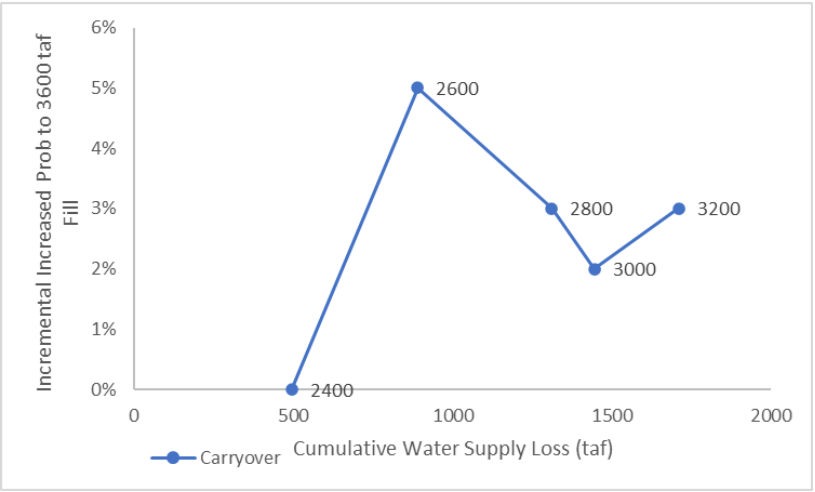
Need carryover of:

- 2400 taf for 3600 taf fill 80% of the time
- 2600 taf for 3600 taf fill 85% of the time
- 3000 taf for 3600 taf fill 90% of the time
- 3200 taf for 3600 taf fill 93% of the time

(given 1921-2003 2035CT input hydrology)

Spill at 50% exceedance:

- 120 taf for 1900 taf carryover
- 440 taf for 2200 taf carryover
- 495 taf for 2400 taf carryover
- 690 taf for 2600 taf carryover
- 845 taf for 3000 taf carryover
- 910 taf for 3200 taf carryover

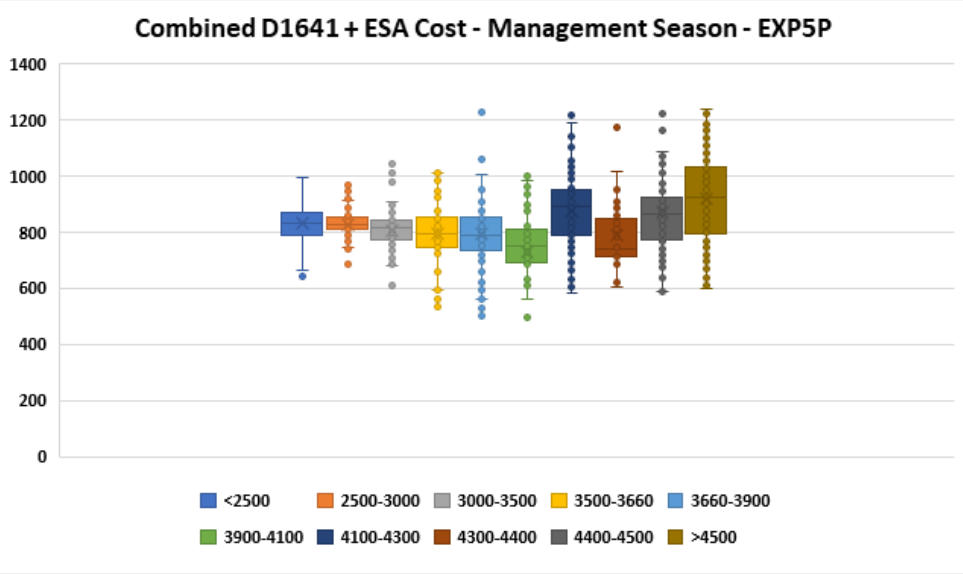


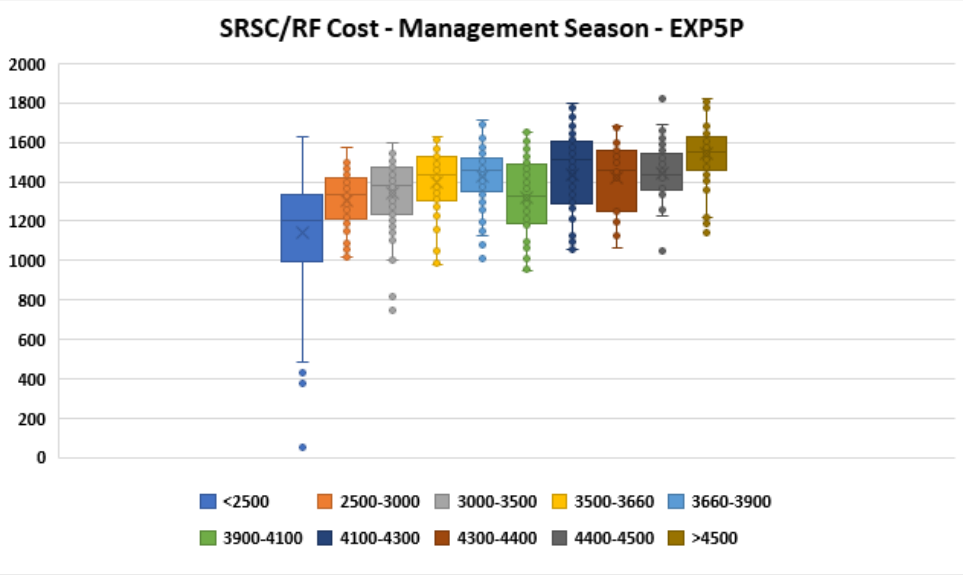
Carrying over 3200 taf instead of 2600 taf means:

- Delivering or releasing 600 taf less in May-Sept to achieve certainty of carryover
- Spilling 910 taf instead of 690 taf in the following year – a difference of 220 taf
- Limited additional benefit to temperature performance for an 8% better chance of fill to 3600

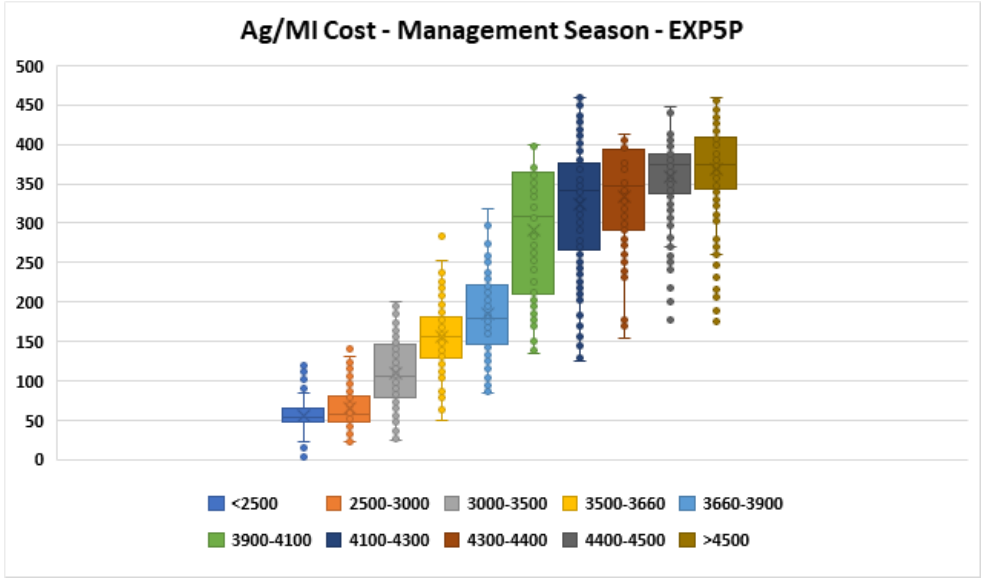
18 initial conditions (end of September carryover from previous year), 82 1-year traces for each initial condition, 2035 CT hydrology

Release cost variability by fill volume





- Regulatory cost can vary by 300-600 taf
- There is less variability in drier years

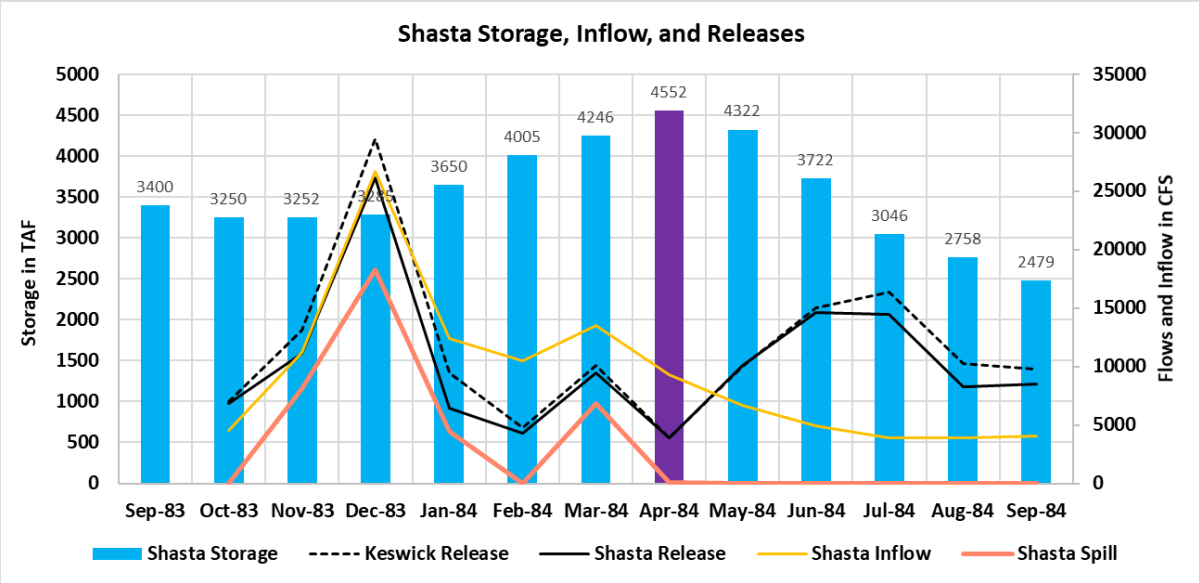


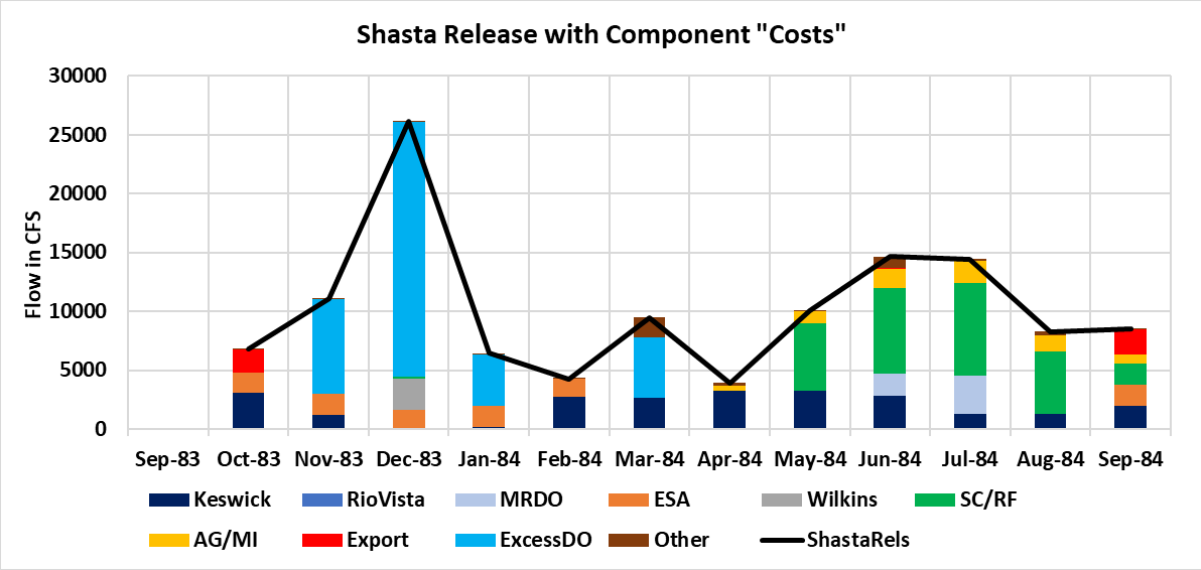
- Delivery water cost to Shasta:
  - Tops at around 450 taf with the whiskers
  - Low in dry years
  - Increases when fill is above 3900 taf

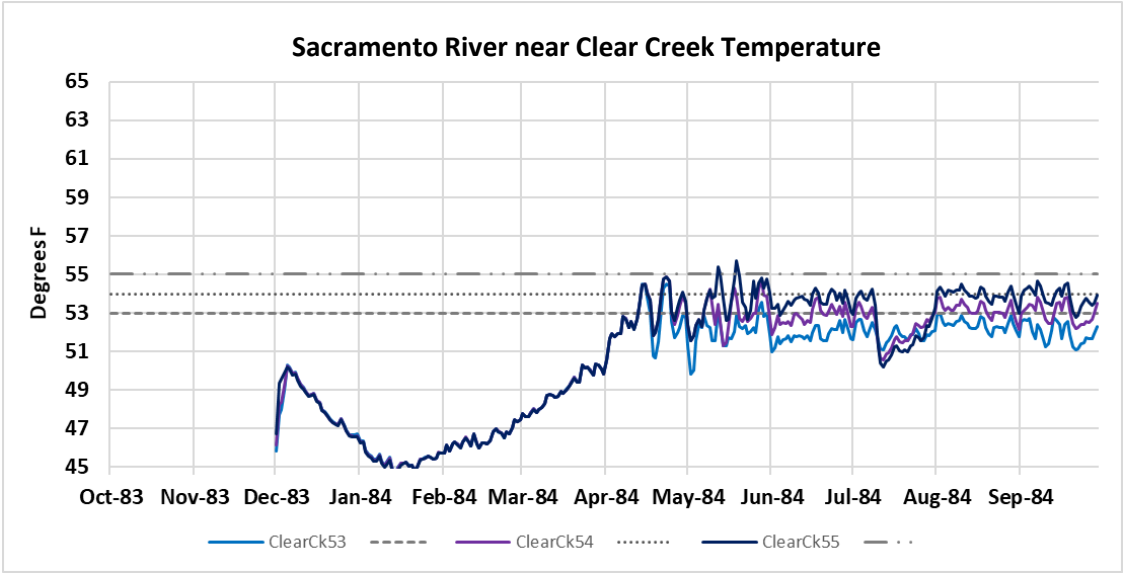
18 initial conditions (end of September carryover from previous year), 82 1-year traces for each initial condition, 2035 CT hydrology

1984 Case Study

- Shasta fills to the brim
- Temperature met for any target
- End of September carryover 2479 taf
- If a wet year CO target was 3200 taf, that would mean about 700 taf cuts to other releases
  - 700 taf is beyond proj delivery cost to Shasta
  - And 2400 taf CO has 80% of chance to fill up to 3600 taf next year (See slide 17)







- Seasonal Totals:
  - Reg. Cost: 1066 taf
  - Ag/MI Cost: 406 taf
  - SC/RF Cost: 1701 taf

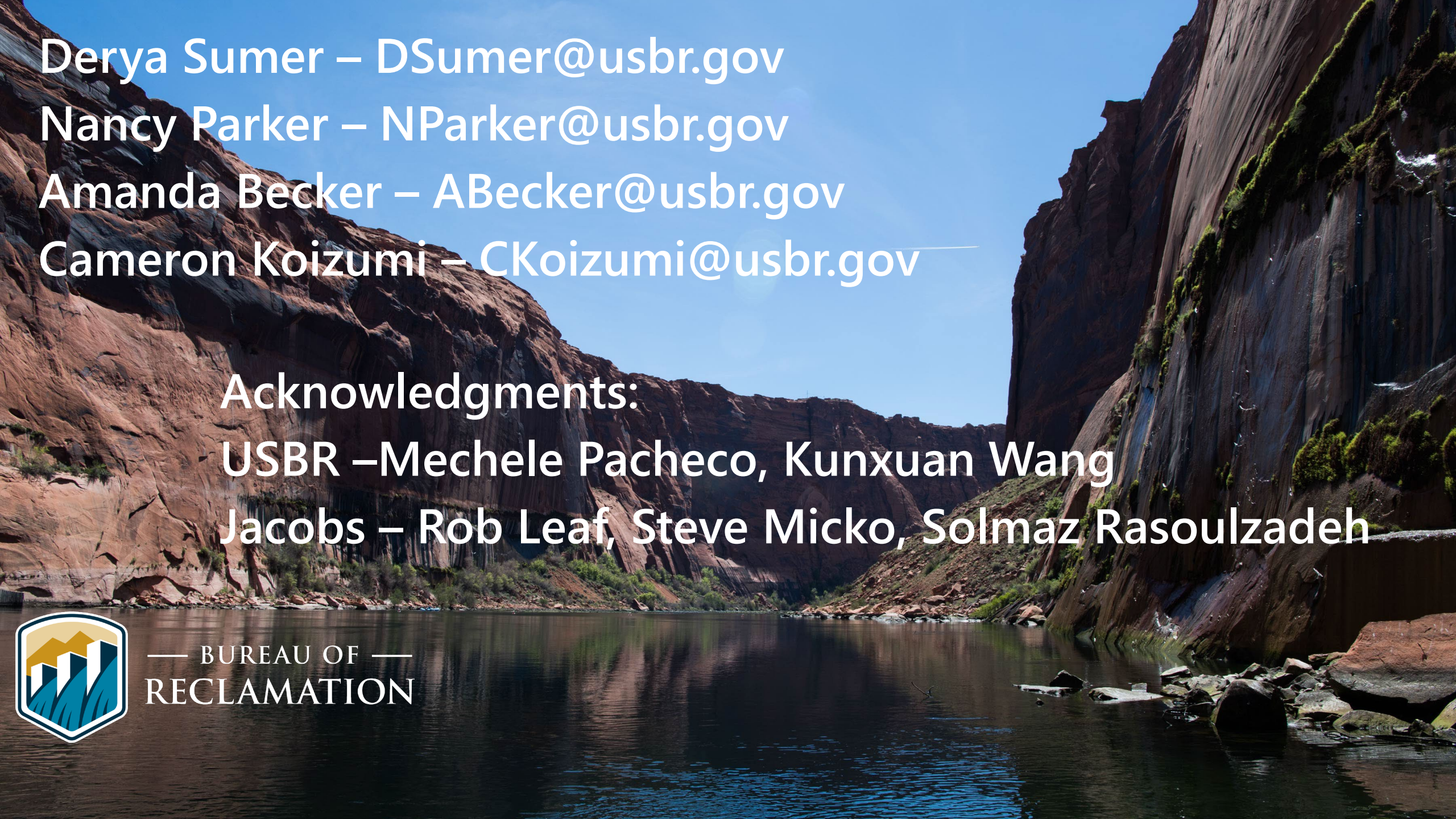
Inflow: 1681 taf
Export Cost: 70 taf

Take Home Messages

- Seasonal planning occurs early in the season
  - Limited, uncertain data
  - Water year type is not known
- Fill Season:
  - Carryover from previous year and historical monthly inflow data (forecast hydrology available later on) are the only available information and reducing regulatory releases is the only knob to meet an end of April target.
  - Water year type is still not known – construct end of April goals that are based on the available information
- Management Season:
  - Reservoir releases needed to meet regulatory criteria still have uncertainty in the management season.
  - The higher end of September target, the higher the fill next year, the less water we have for seasonal management; the more water supply loss including spills in the next winter
  - Water year type is known – but still- construct end of September goals that are based on:
    - Available information: end of April storage
    - Uncertainty: variability in seasonal management reservoir release needs, consider ranges
    - Driving factors: cold water pool storage, meteorological conditions, flow patterns, etc.

LTO GOALS

- Consider and adapt to climate change proactively
- Proactively limit extreme drought effects
- Avoid dramatic changes to water supply
  - Limit spill frequency and magnitude
- Connect fish protections with drought protection
  - Manage Shasta and take actions that will support cold water pool and overall storage volume if the following year is dry.
  - Support drought protection based on hydrology, system conditions, and fish conditions together
- Consider Victorian Objectives – enhance in wet years, protect in dry years
- Integrate VA assets as a mechanism for achieving Shasta management objectives (flows and habitat)
- Enhanced collaboration, especially in the drought years
- Recognize the value of habitat improvements
- Science-based planning
- Multi-agency management evaluation of system-wide risk tradeoffs



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BUREAU OF RECLAMATION