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Forecast Informed Reservoir Operations in the Folsom and Klamath Basins

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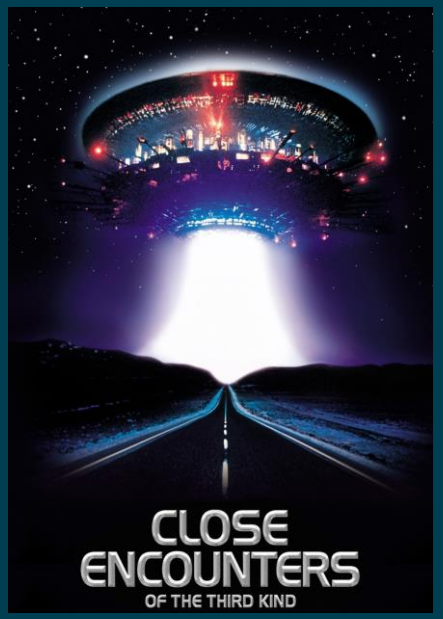
Overview

- FIRO versus Water Supply
- Types of FIRO
- Statistical Forecast Evaluation
- Basins
  - Folsom
  - Klamath
- Uncertainty Space

https://www.cnrfc.noaa.gov/images/storm_summaries/feb1986/cofferdam_slides.php

FIRO versus Water Supply

Types of FIRO



- First Kind – Informal
  - Forecasts are used to inform operator expert judgement
- Second Kind – Reanalysis
  - Hindcasts are used to evaluate operation guidelines for changes
- Third Kind – Real-time Operations
  - Forecasts are coupled with hydrologic/hydraulic/decision models to calculate real time optimal solutions

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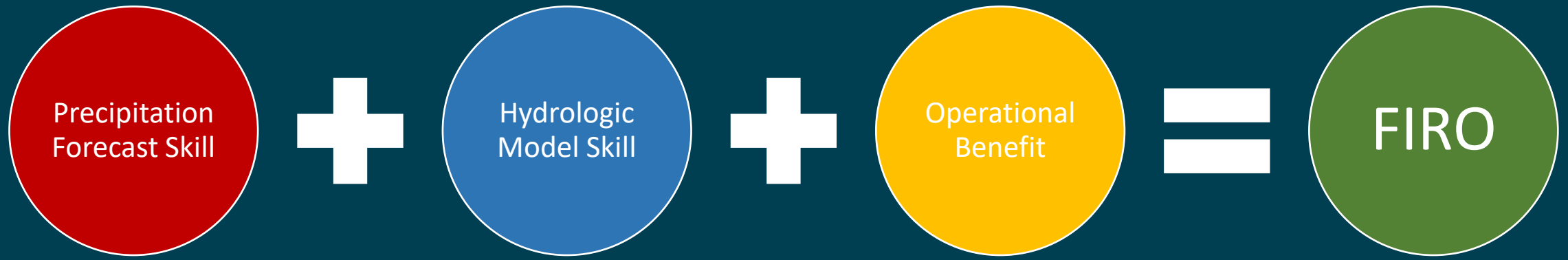
- Extension – Climate Adaption
  - Climate projections are used to evaluate operations guidelines

Stages of FIRO



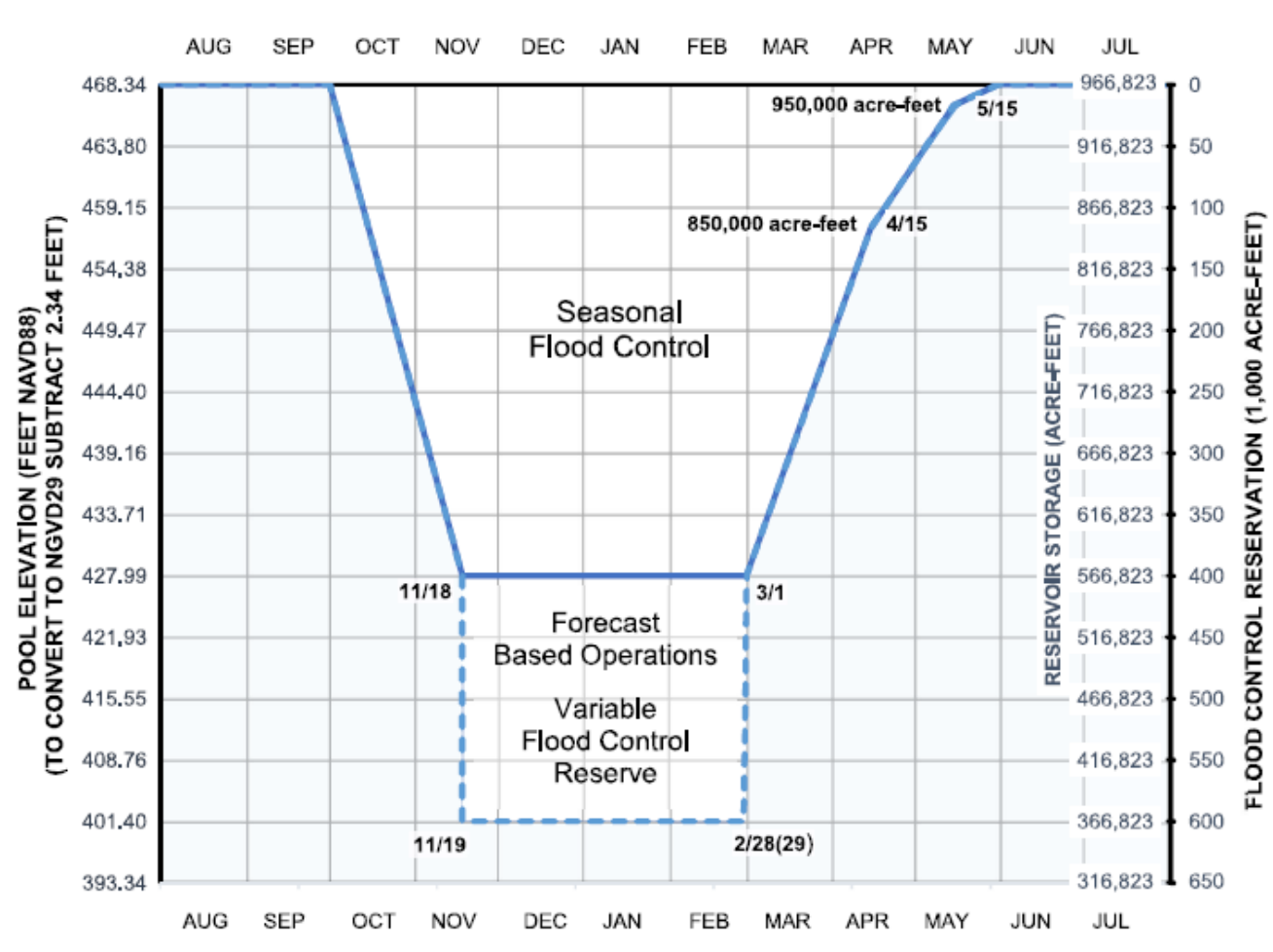
Statistical Forecast Evaluation

Correlation	Pearson Correlation
	Spearman Correlation
	p Value
Distance	MAE
	ME
	MSE
	RMSE
Probabilistic	Brier Score
	CRPS
	CRPSS
	Discrimination
	Rank Histogram
Contingent	Hit Rate
	Miss Rate
	False Alarm Rate
	Success Ratio
	Relative Operation Characteristic

- Converts forecasts to water management skill
- Must capture the variability/uncertainty of the ensemble
- No single metric is sufficient to describe all forecast features

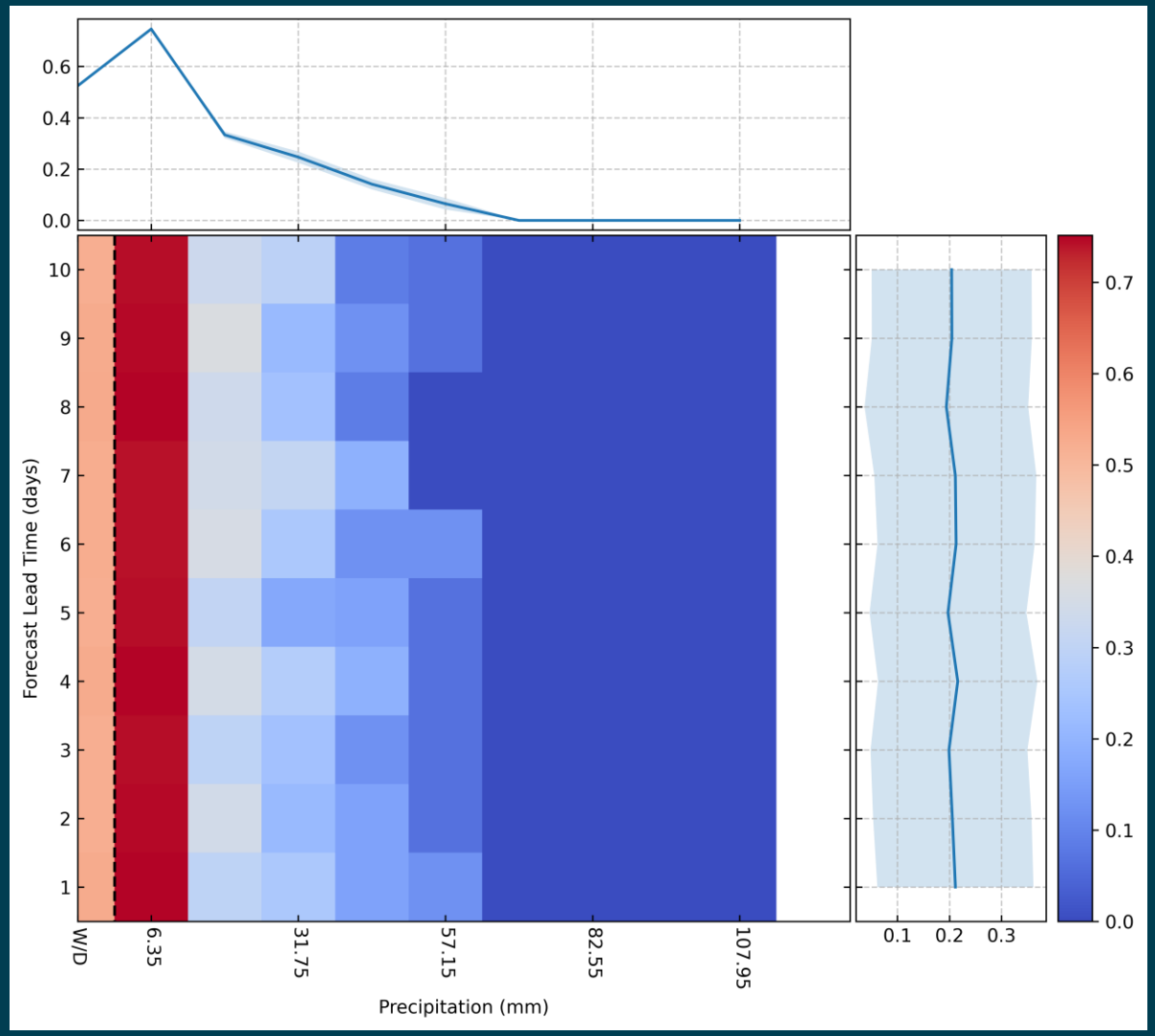
Need to critique forecast skill across metrics and use in formulating risk-based rule curve

Folsom Basin



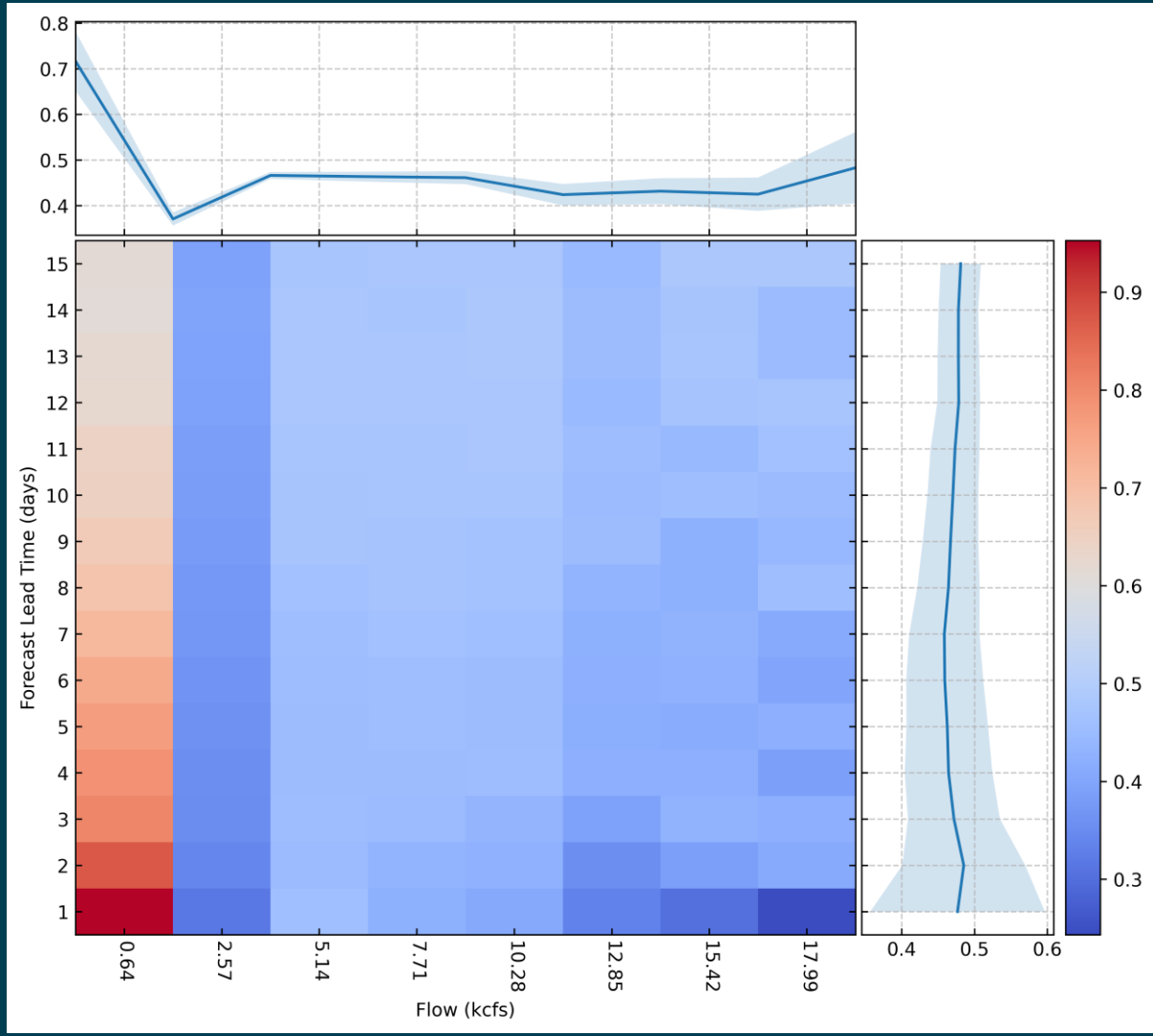
- Flood control drawdown
- Climate change
- Decision confidence as a function of forecast skill
- Repeatability and staff experience offsets
- Competing management objectives
- 2022 example

Folsom Precipitation



DRAFT – SUBJECT TO REVISION

Folsom Streamflow



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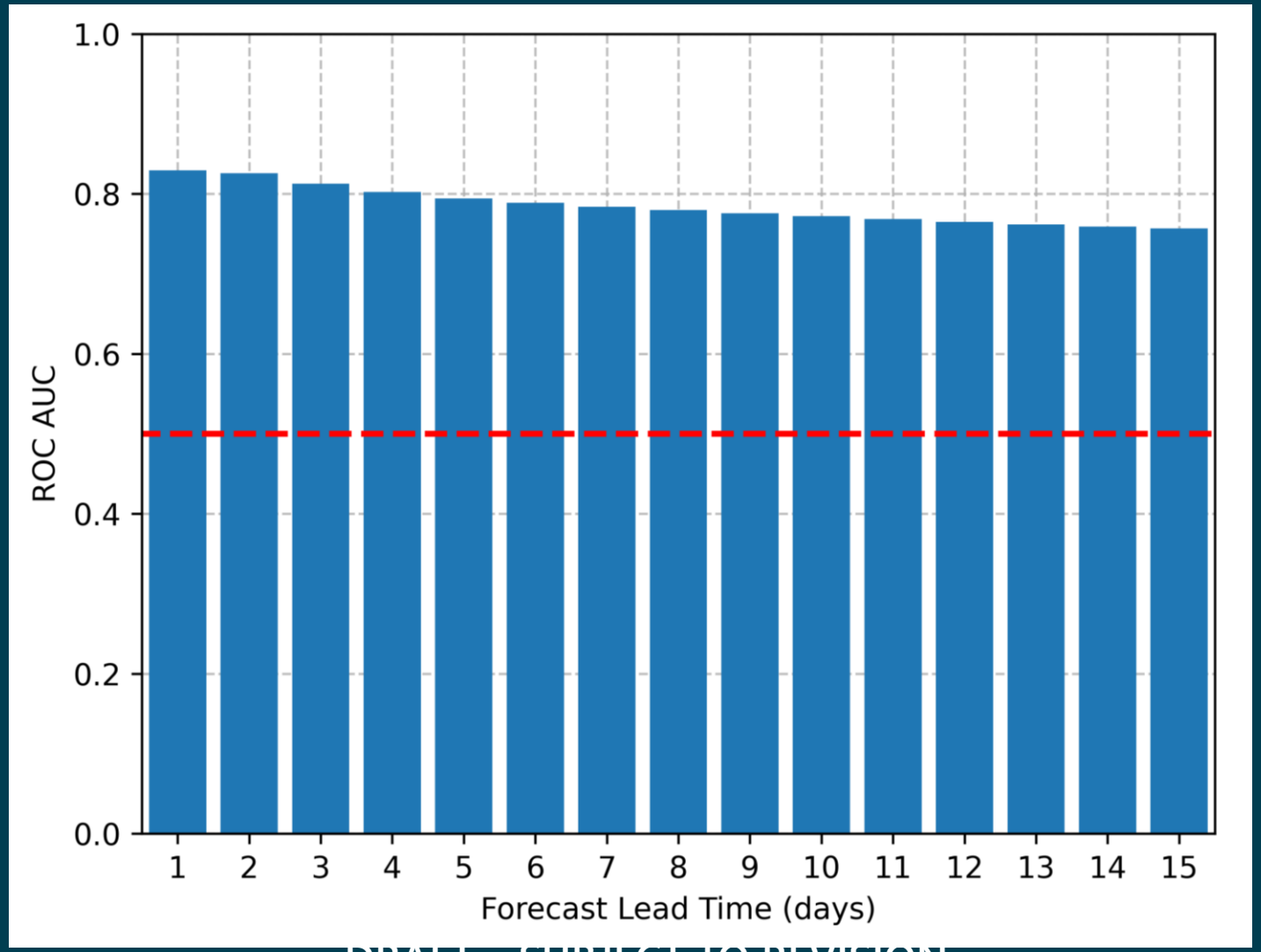
Folsom Streamflow



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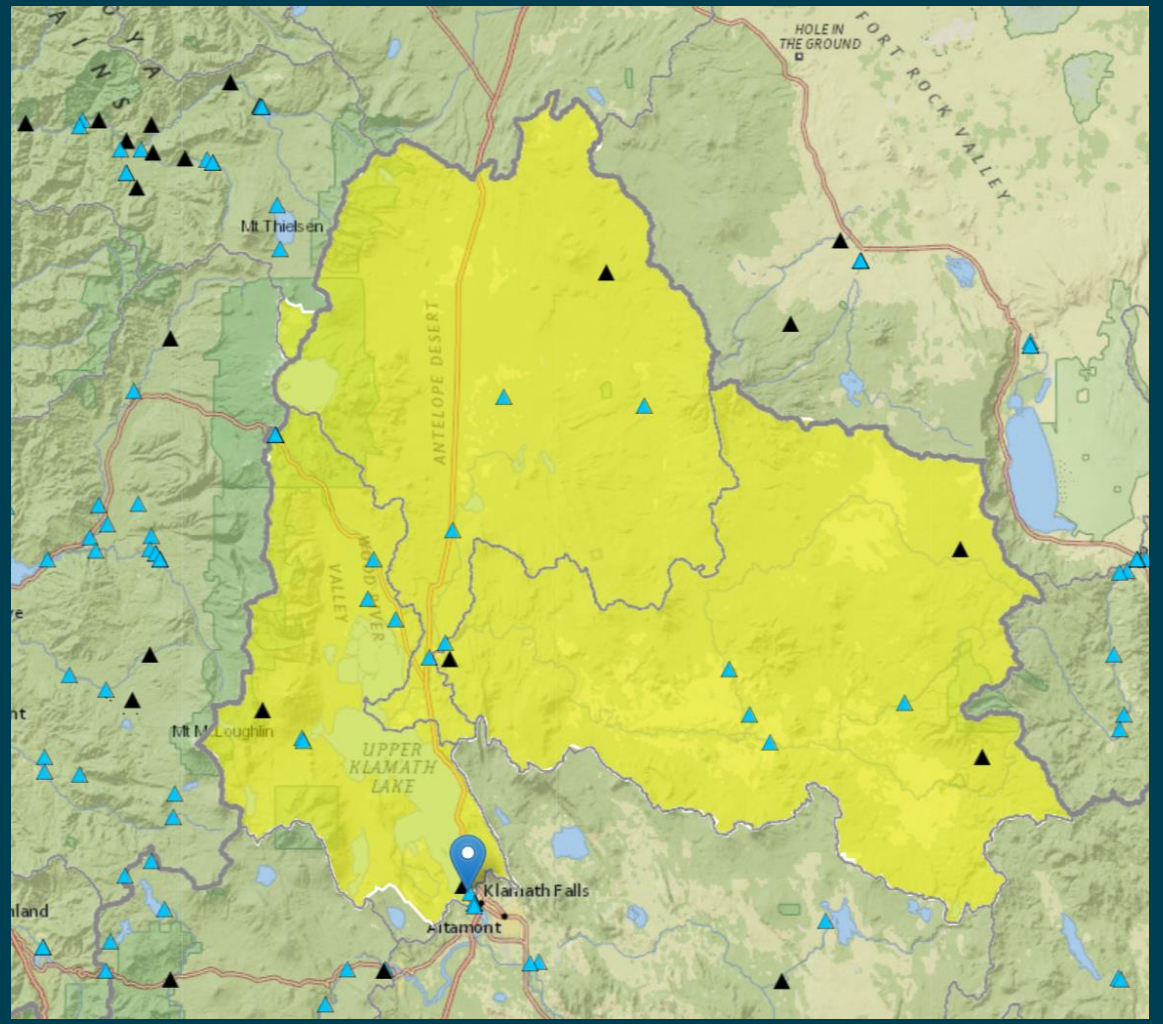
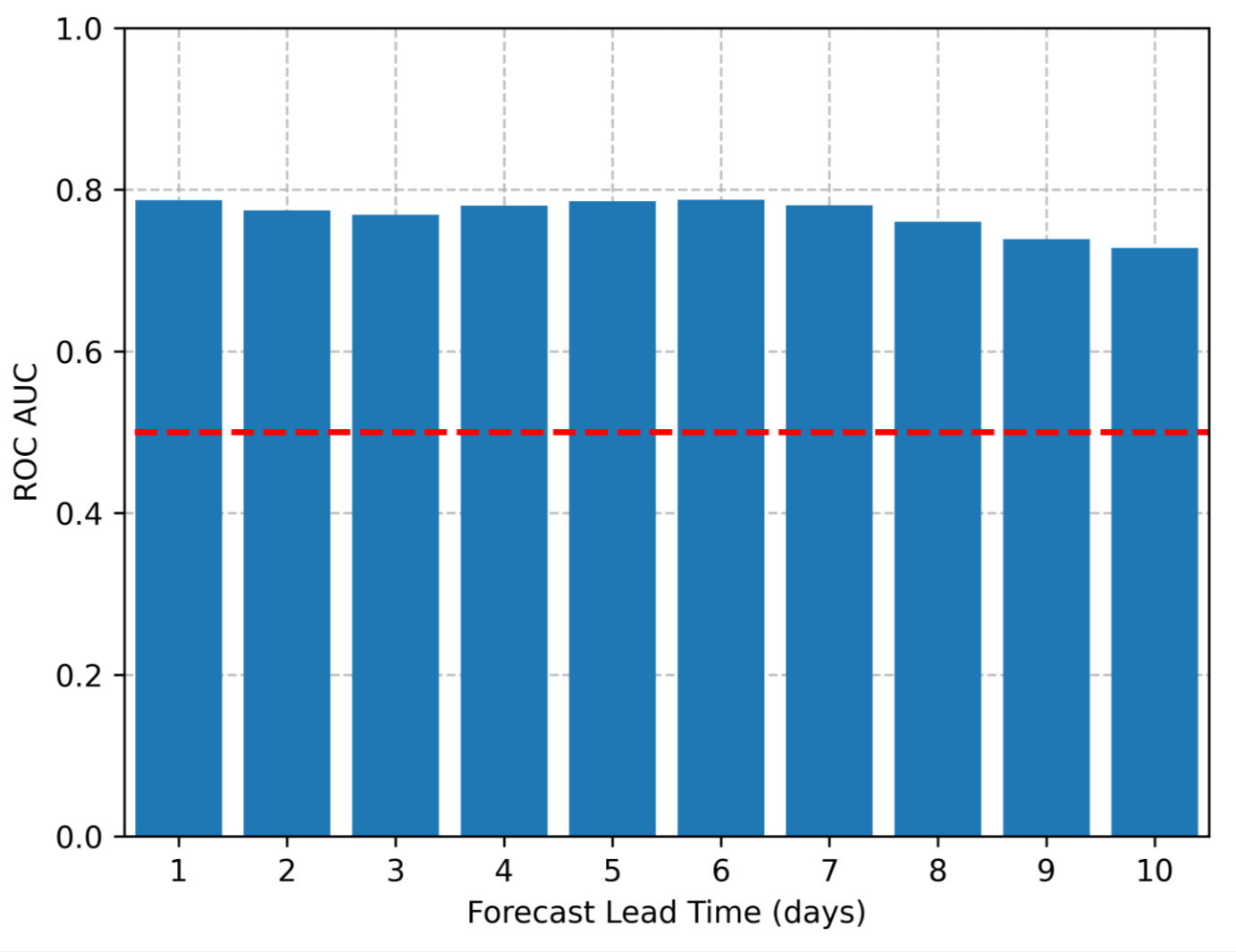
Klamath Basin

- Upper Klamath Lake is storage limited
- Removing downstream storage facilities
- Not Section 7
- Ongoing tradeoffs between environmental and water supply



Klamath Streamflow



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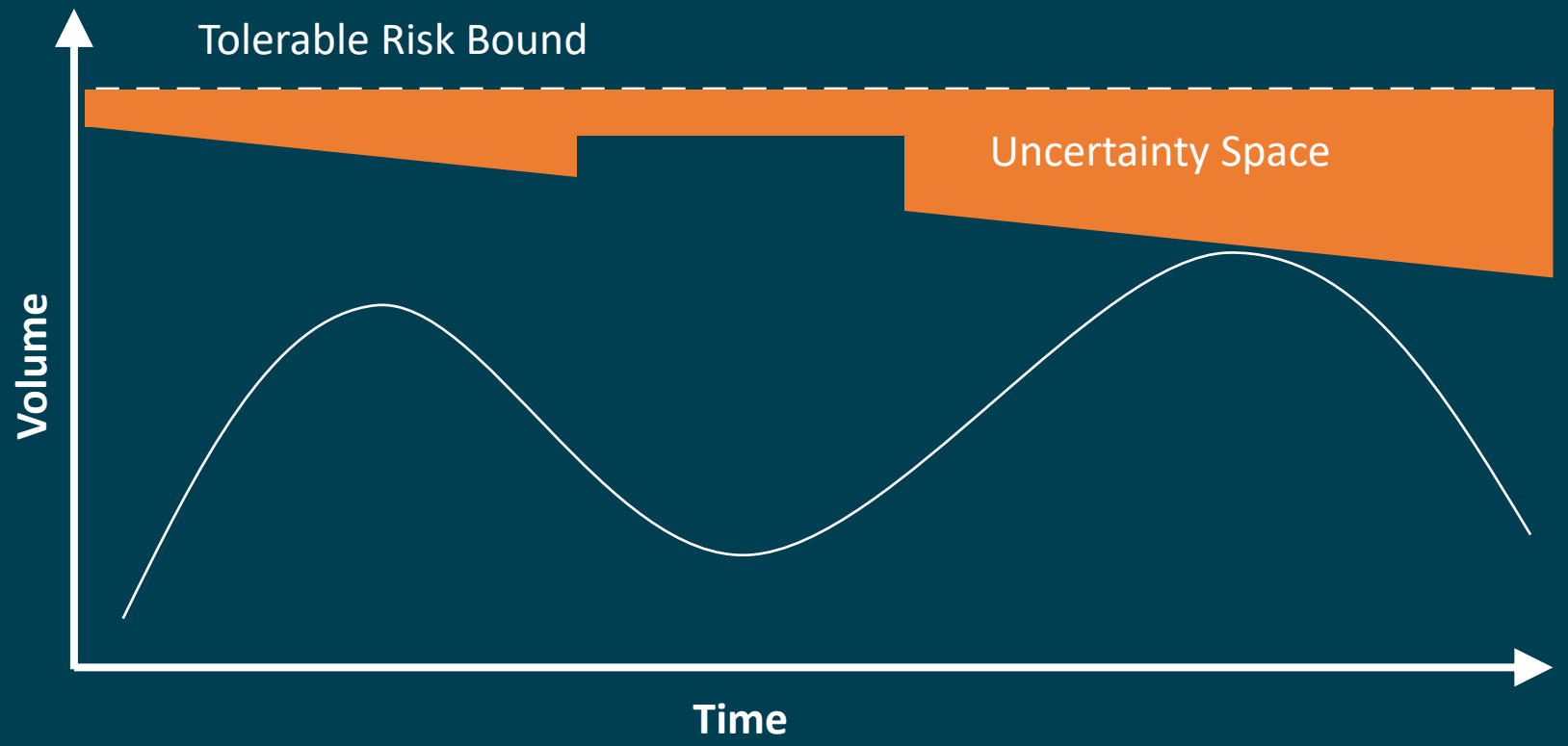
Rule Curve Creation

- Ties back into the statistical properties of the forecast
- Dynamic based on forecasted event magnitude, facility

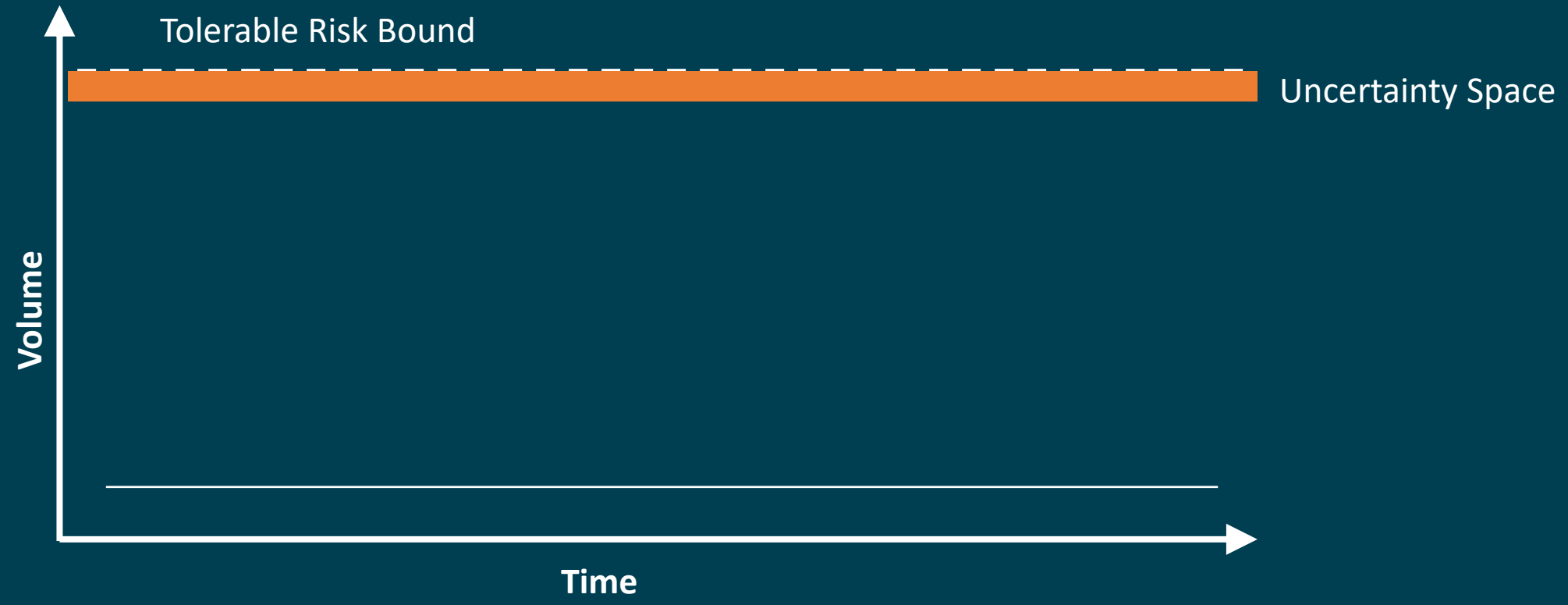


Uncertainty space can be a function of:

- Hit Rate
- Miss Rate
- False Negative Rate
- False Positive Rate
- Errors included

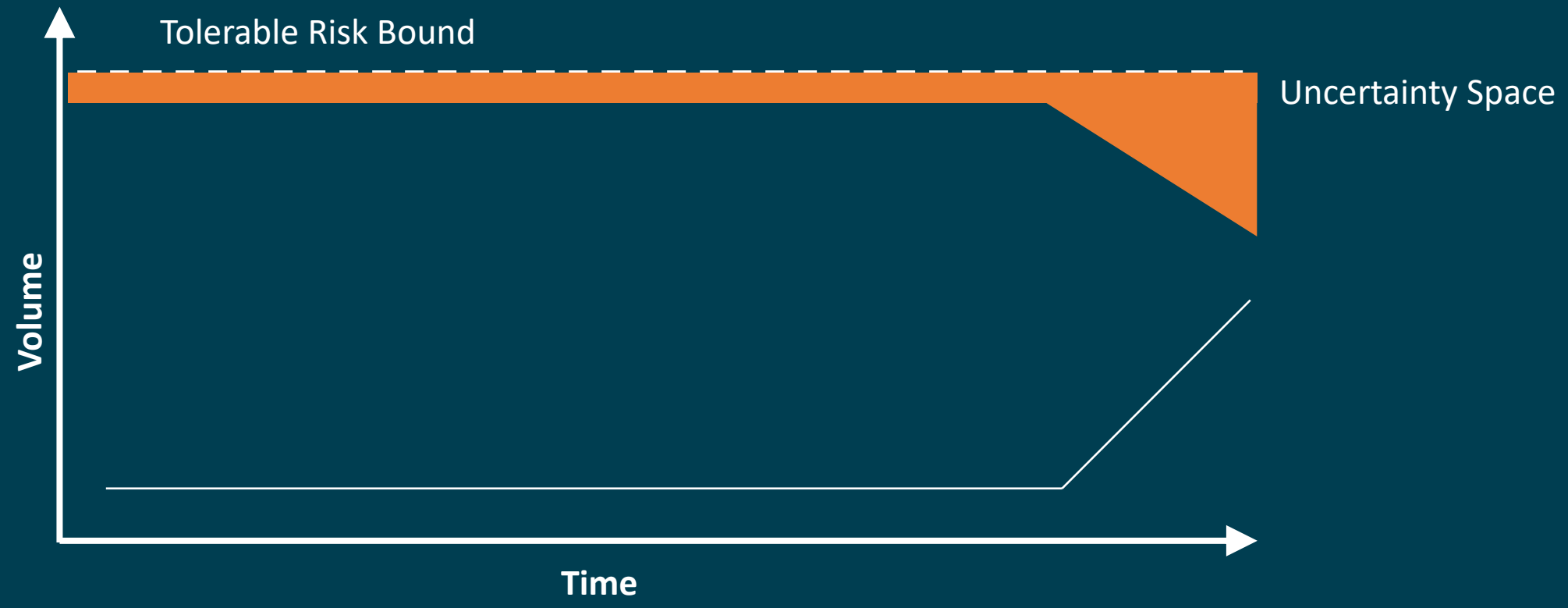
Event sequence

- Governed by wet/dry skill and the expected value of the miss rate, false negative rates



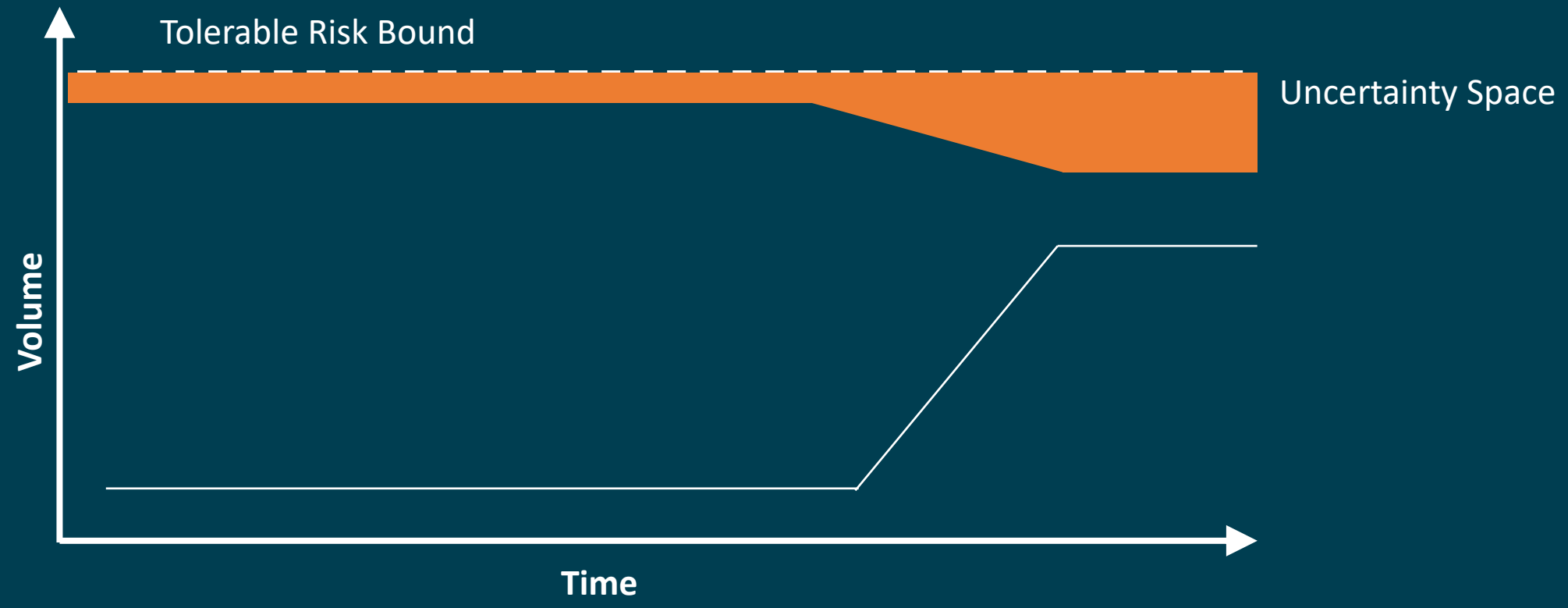
Event sequence

- Event detected. Uncertainty space increases to account for forecast uncertainty



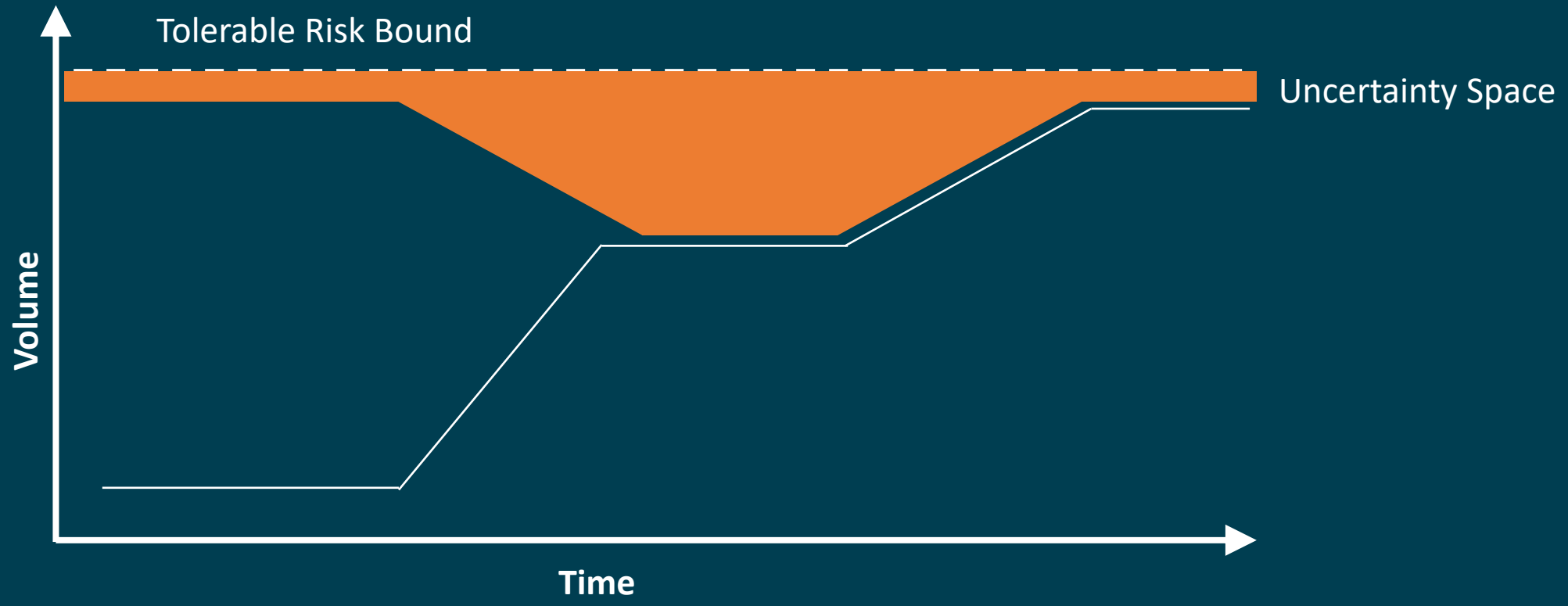
Event sequence

- Uncertainty space increases to account for forecast uncertainty



Event sequence

- Event tapers, reducing the uncertainty space and allowing system to move more aggressively toward the risk bound



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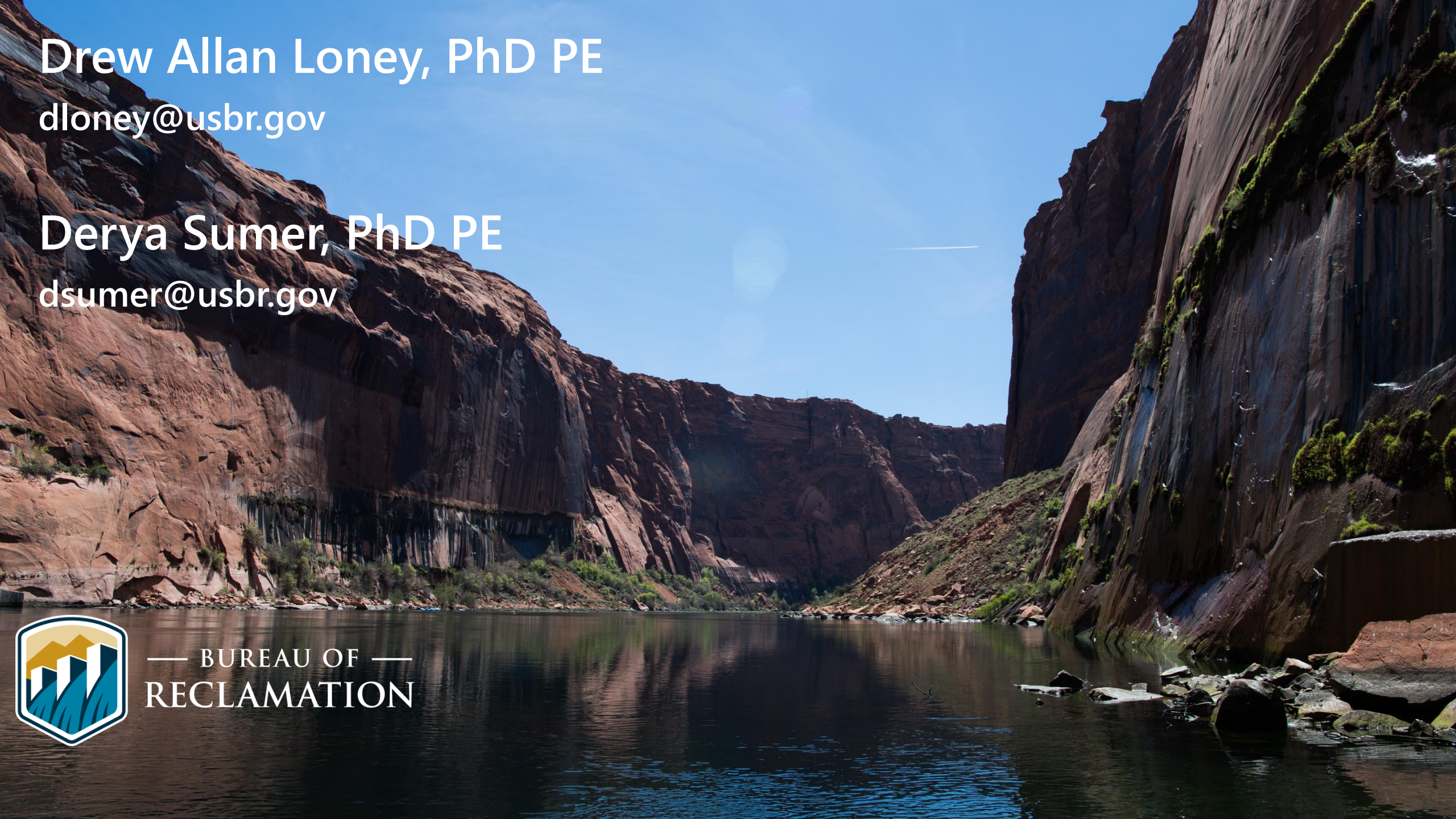

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