BUREAU OF RECLAMATION

# Shasta Temperature Tier Optimization

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Drew Allan Loney, PhD PE

Modeling Division, Bay-Delta Office

DRAFT – SUBJECT TO REVISION

# Overview

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- Impacts of Tiers
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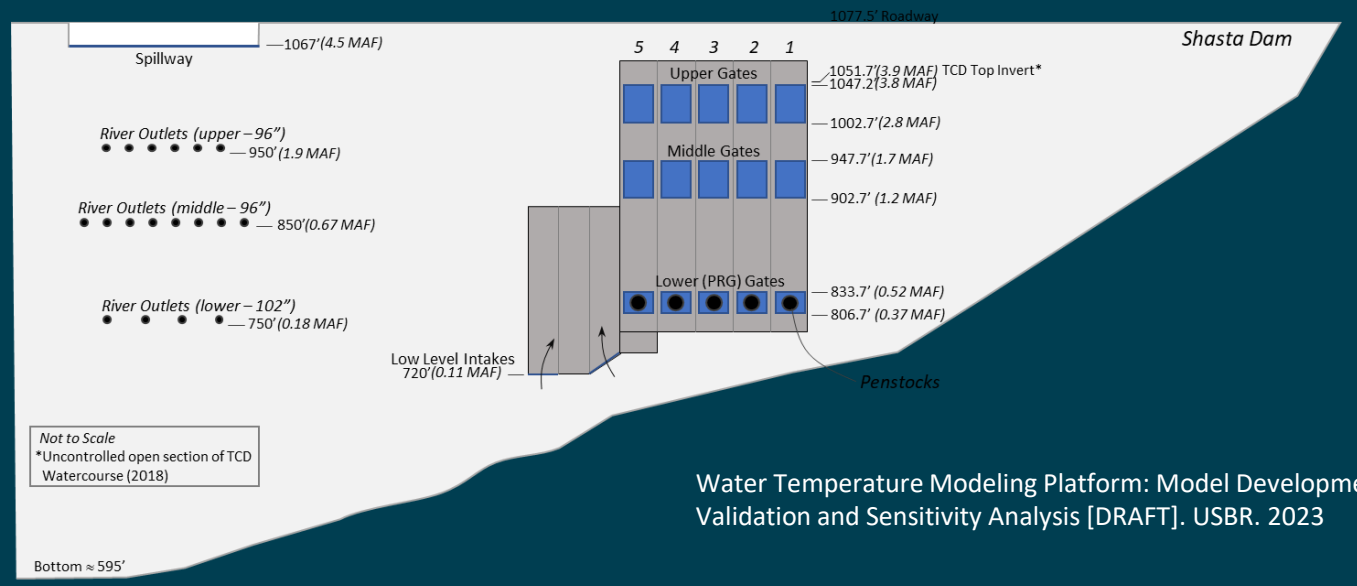
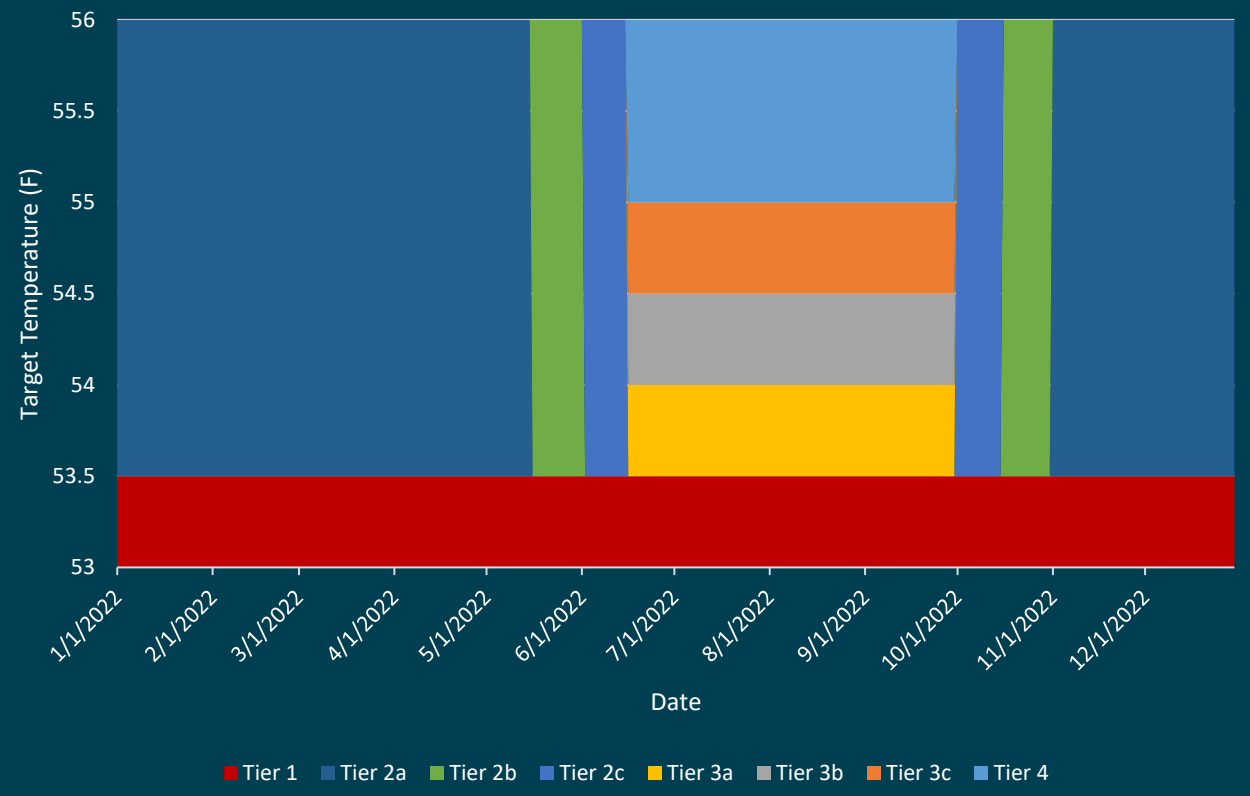
- Greedy Gradient Optimization
- Results
- Next steps




Water Temperature Modeling Platform: Model Development, Calibration, Validation and Sensitivity Analysis [DRAFT]. USBR. 2023

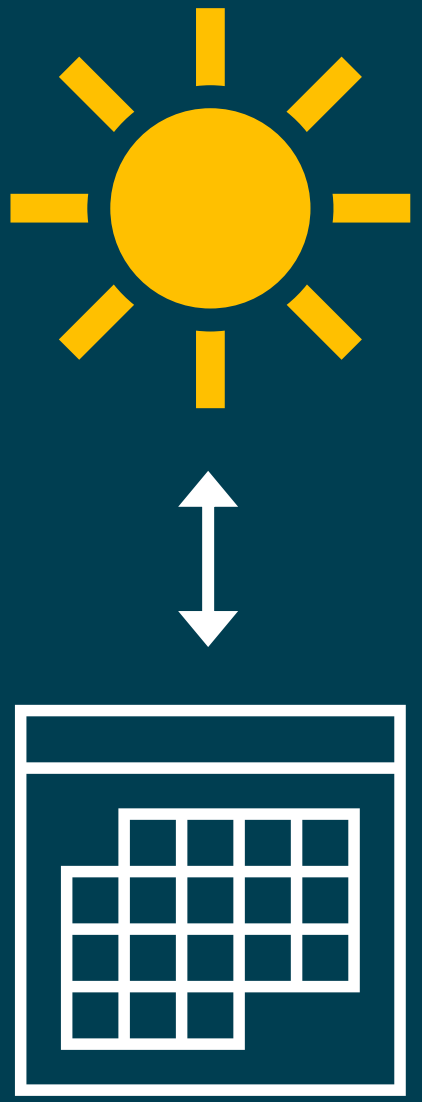
# Shasta Temperature Tiers

- Downstream compliance temperatures defined by cold water pool volume (CWP)
- Adapt temperature management to utilize cold water when it's most impactful
- Tiers resulted from the 2019 BiOp process to protect fisheries
- CWP defines tier (<52 F)
  - > 3800 TAF: Tier 1
  - > 2800 TAF: Tier 2
  - > 2500 TAF: Tier 3
  - Otherwise Tier 4



# Tier Impacts

- Define when to use cold water pool for fisheries benefit
- Defines tradeoff between holding and using water
  - Accepts warming of water in the reservoir in exchange for later use
  - Accepts hydrodynamic constraints on reservoir releases



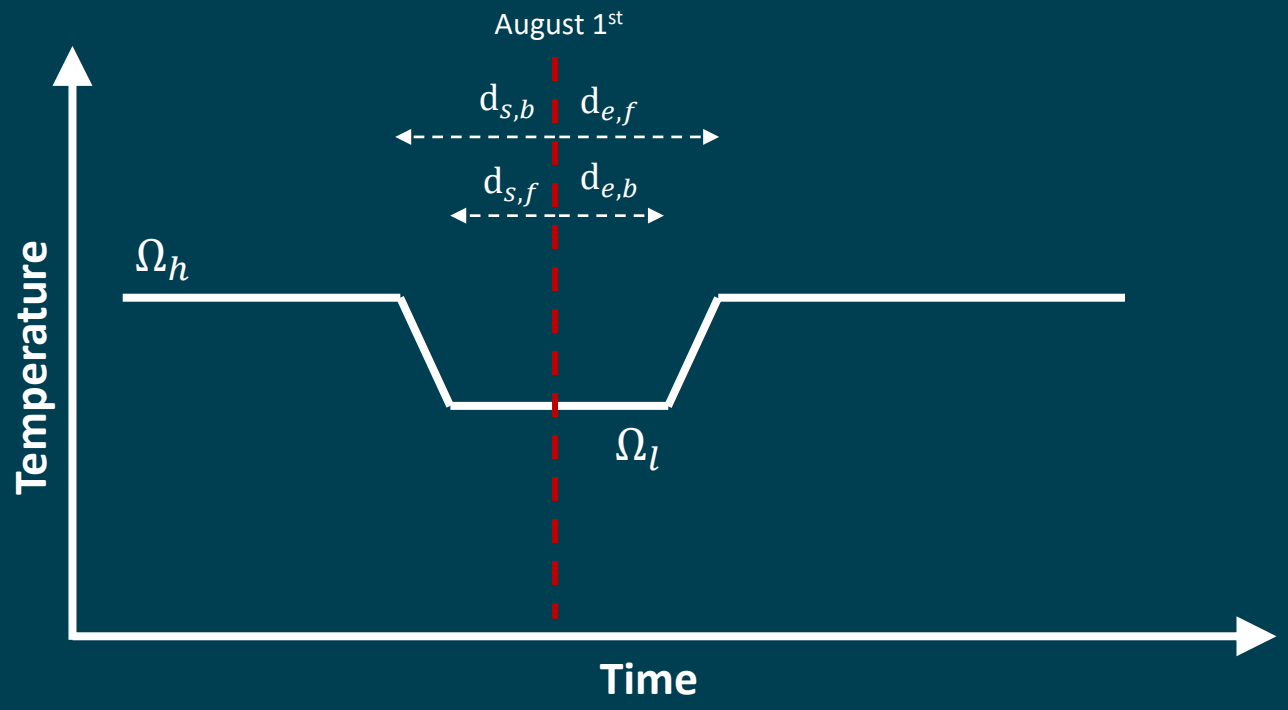
# What do we want from our tiers?

- Maximize the fisheries benefit of cold water releases
- Use cold water before it becomes warm water
- Use cold water before while it’s possible to release it

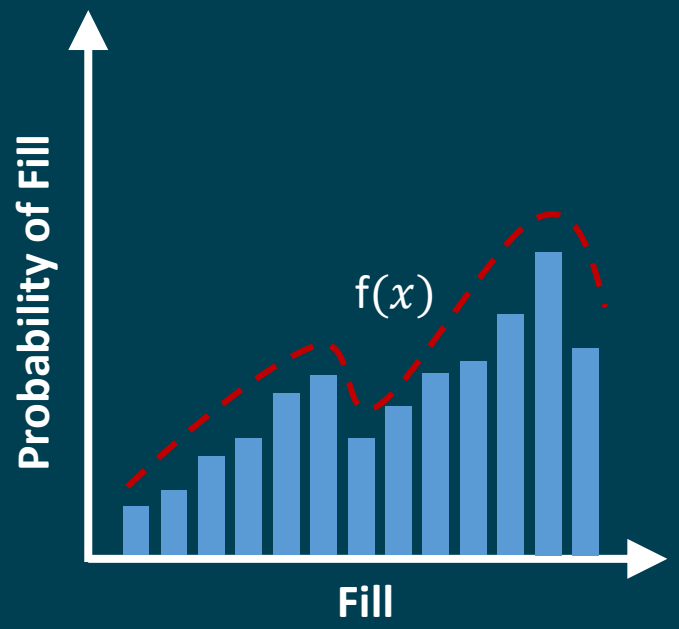
- Possible to optimize tiers against a quantitative objective
  - Use TDM despite not describing full life cycle
  - Life cycle models too computationally intensive
- Keep operations logic fixed across analysis

# Tier Formulation

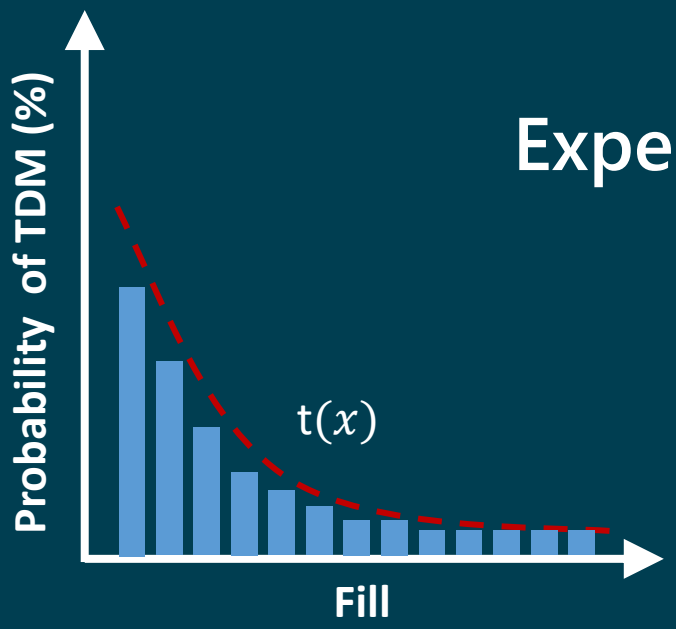
- Tiers defined by:
  - Minimum Temperature
  - Maximum Temperature
  - Four ramp offsets
- Offsets defined to August 1st
- Cold water pool (<52F) volume defines transition between tiers



# Expected Value




x




Expected Value of TDM

$= E(x)$

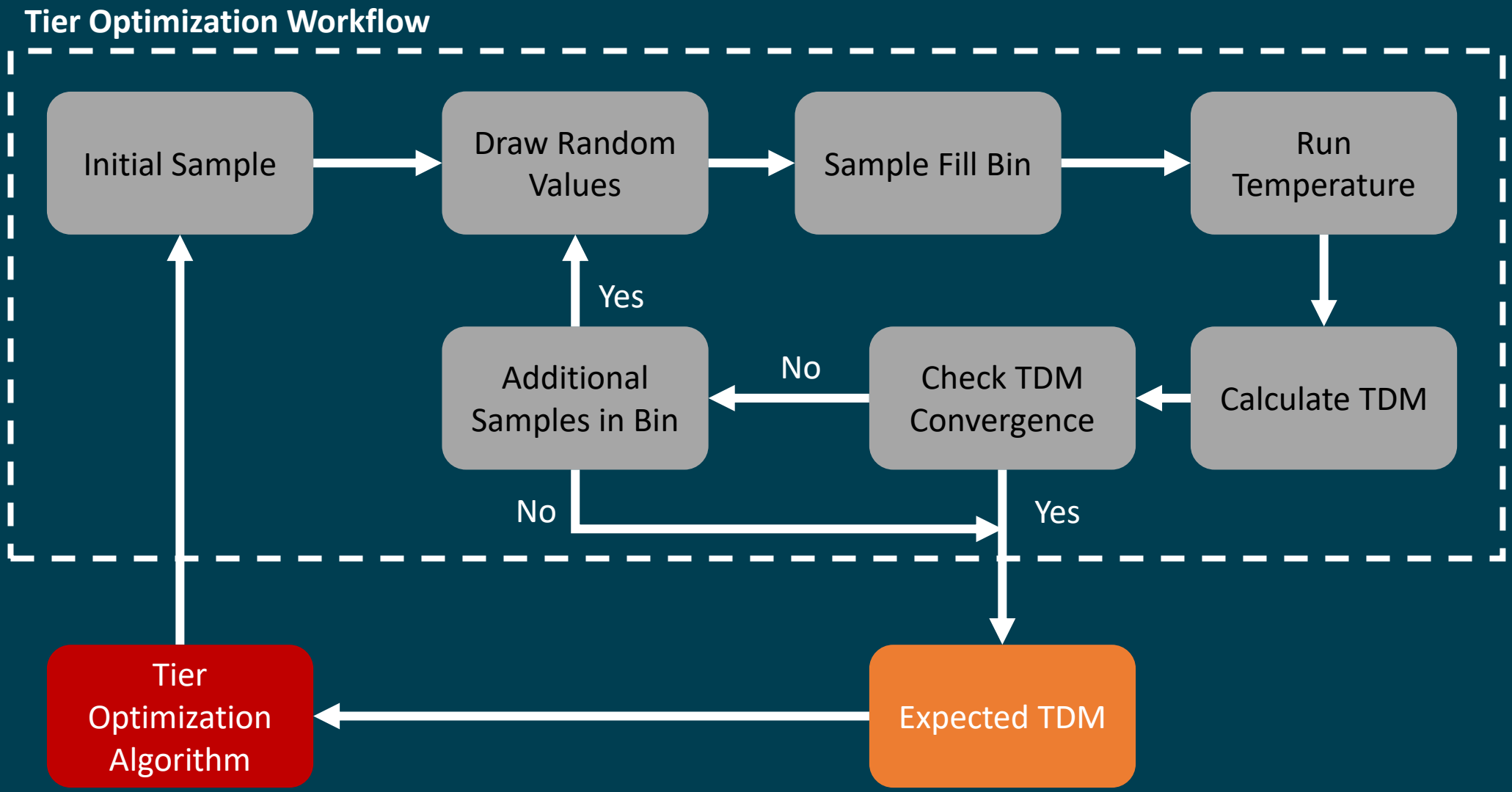
- Carryover analysis population is taken to be statistically representative of fills
- Fill bins are drawn from until convergence (<0.1% change) or until all years computed in bin

# Greedy Gradient Optimization

- Uses a gradient solver to determine which tier and parameter has greatest impact on TDM magnitude
- Continues to change that variable along the gradient direction until improvement stops
- Recalculates gradient and continues with next variable
- Stops when no variables can improve the solution

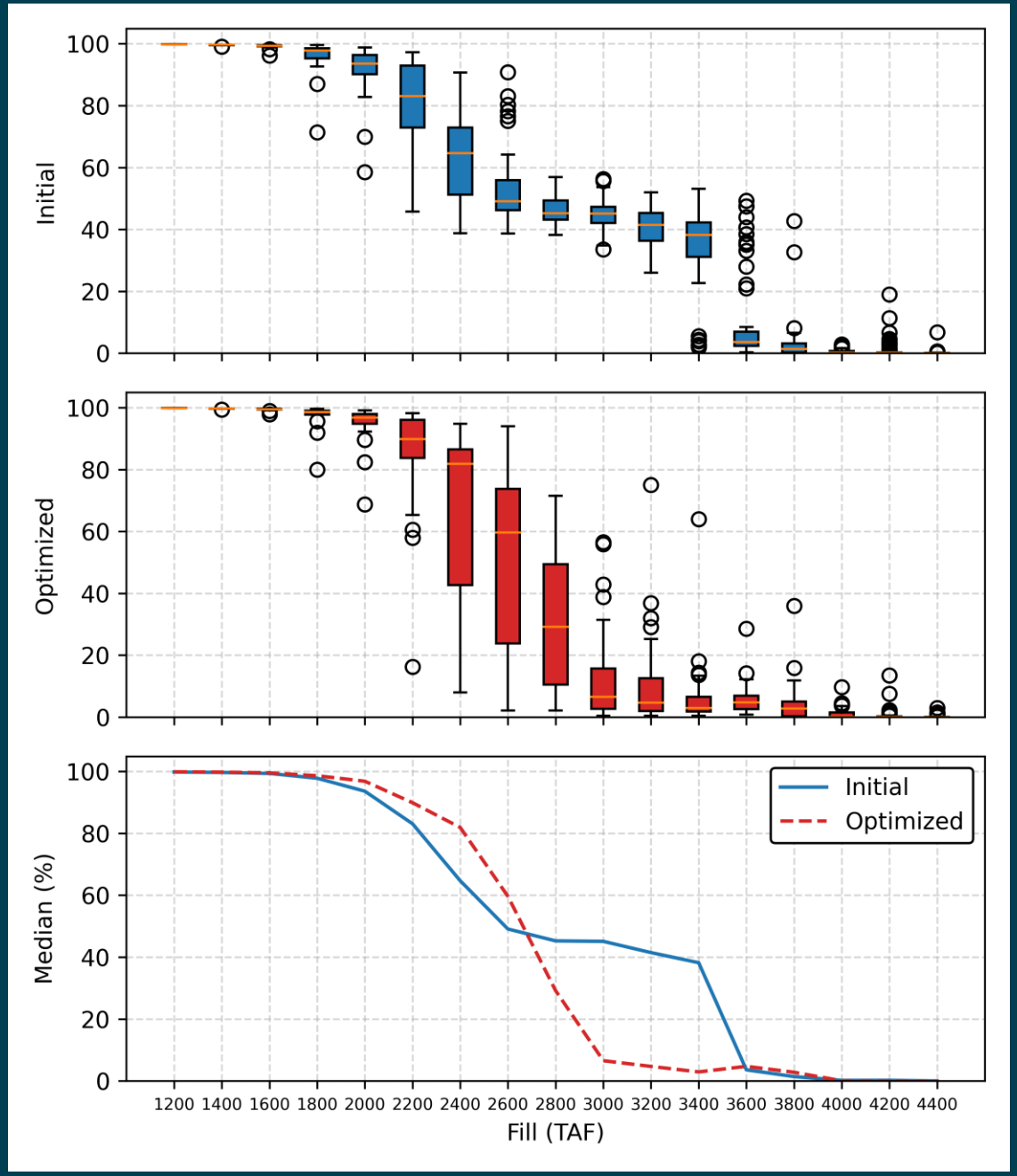
- Maximizes local improvement at the expense of global optimums

# Optimization



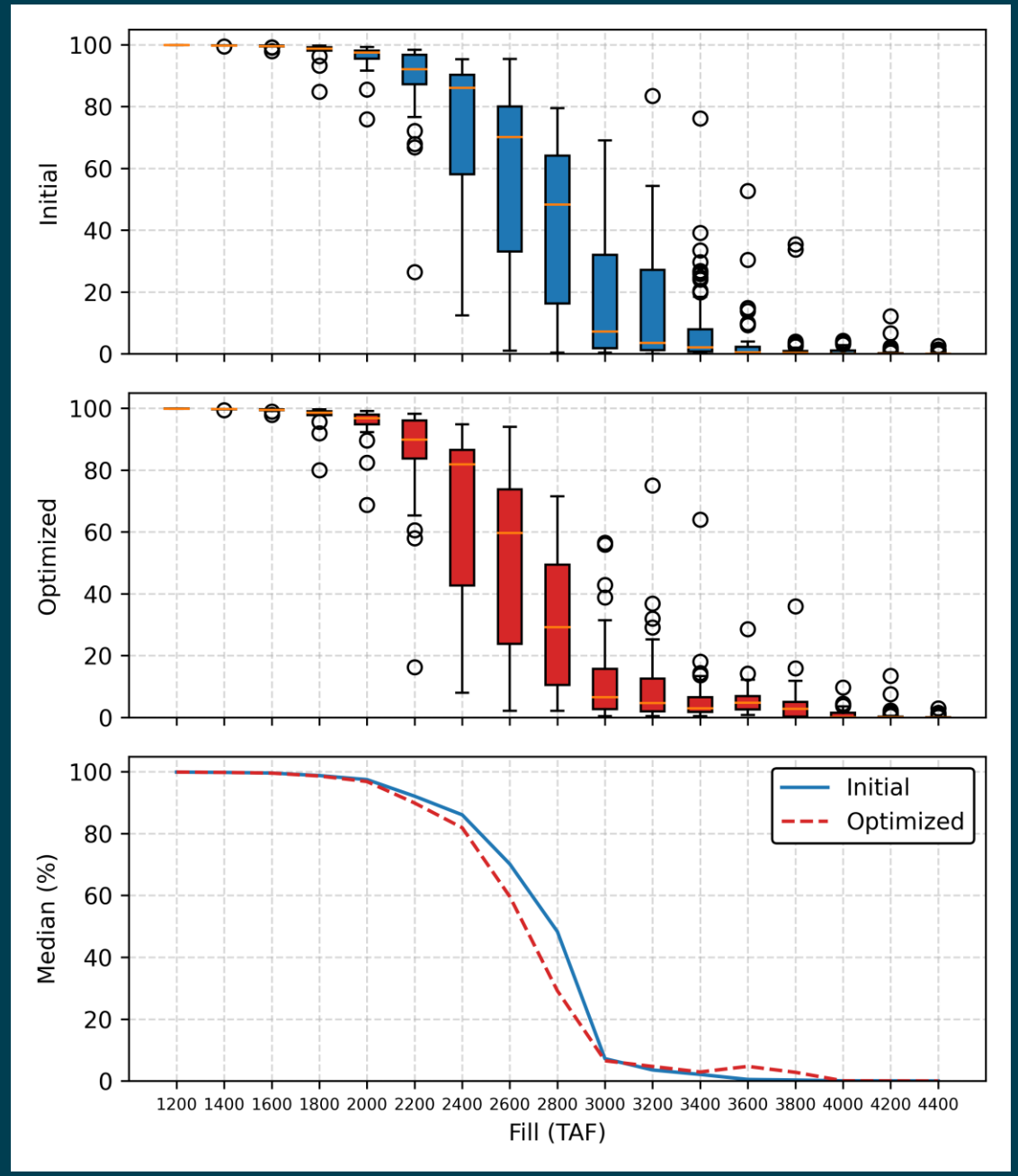
# Results – 2019 BiOp

- Optimization can significantly improve performance in the middle fill range
- Lose performance in lower fills, upper fills
  - Tier 1 & 2 tiers collapse
  - Less resolution through Tier 3



# Results – Constant Tiers

- Optimization improves, but struggles with the tier collapse
- Lower tiers generally improve
- Timing affects not strong enough to overcome temperatures
  - Implies either a larger sample or more strategic initial condition



# Next Steps

- Adjust CWP tier transitions to prevent collapse of tiers
- Continue timing investigation
  - Tier 4 heating
- Increase sampling tolerance for more resolution in the expected TDM
- Weight objective function to prioritize lower fills
  - Prevents more frequent high fills from dominating


# Drew Allan Loney, PhD PE

dloney@usbr.gov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