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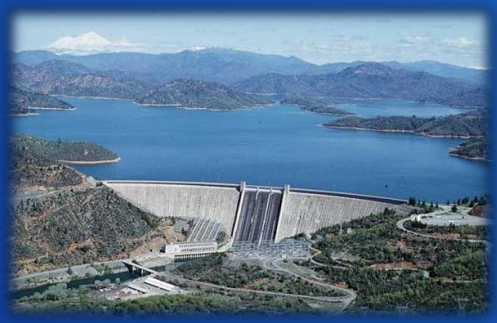
Managing Water in the West

DRAFT: NMFS – Reclamation Stakeholder Workshop #4

Shasta RPA Draft Proposed Amendment

January 26, 2017



U.S. Department of the Interior
Bureau of Reclamation

Introductions

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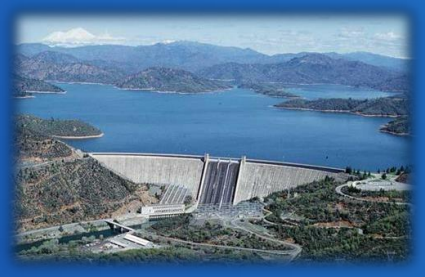
Workshop Agenda



- Introductions
- Workshop Objectives
- Shasta RPA Amendment vs. Current RPA
- 2017 Real-Time Temperature Management
- Updated Sensitivity Analyses
- Draft Science Work Plan
- Next Steps:
  - Temperature Model Development Effort
  - 2018 Operational Concepts
- Discussion Q&A

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Proposed Ground Rules

- Participate!
- Be respectful
- Help us stay on track
- Speak into microphone
- Take comments in batches – in room then on phone
- Cell phones off/silent in room – Mute if on phone

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Workshop Objectives

Provide status updates, discuss, and receive input on:

1. Model Results: Sensitivity Analyses
2. 2018 Temperature Management Proposal
3. Draft Science Work Plan

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Overview of the Shasta RPA Amendment vs. Current RPA

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Insert Overview Here

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2017 Real-Time Temperature Management

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2017 Pilot Test Study

- **Temperature Target:**
  - **53°F DAT at Sacramento River above Clear Creek confluence**
    - **Acts a surrogate to 55°F 7DADM at same location**
- **Compliance:**
  - **56°F DAT at Balls Ferry**

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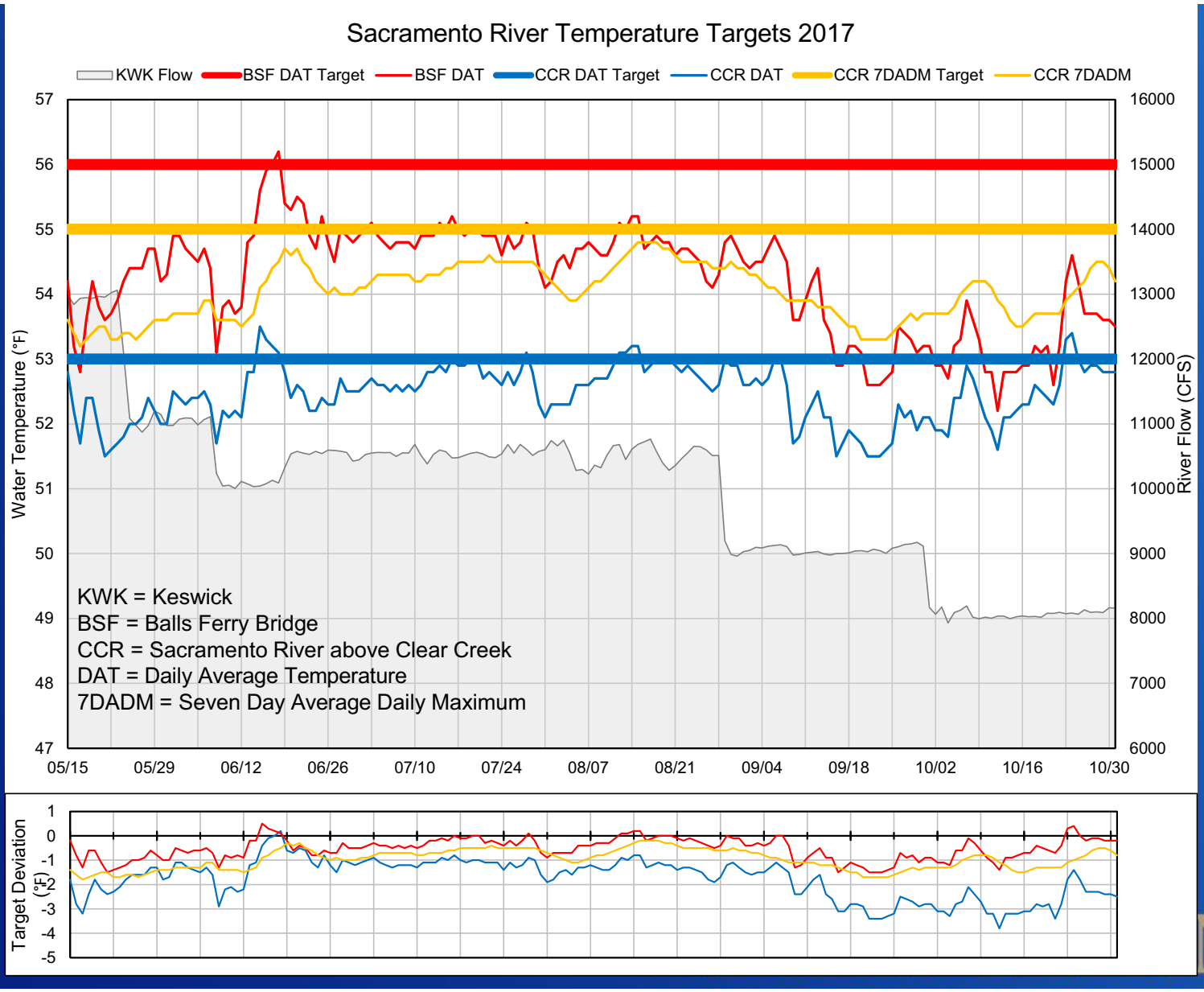
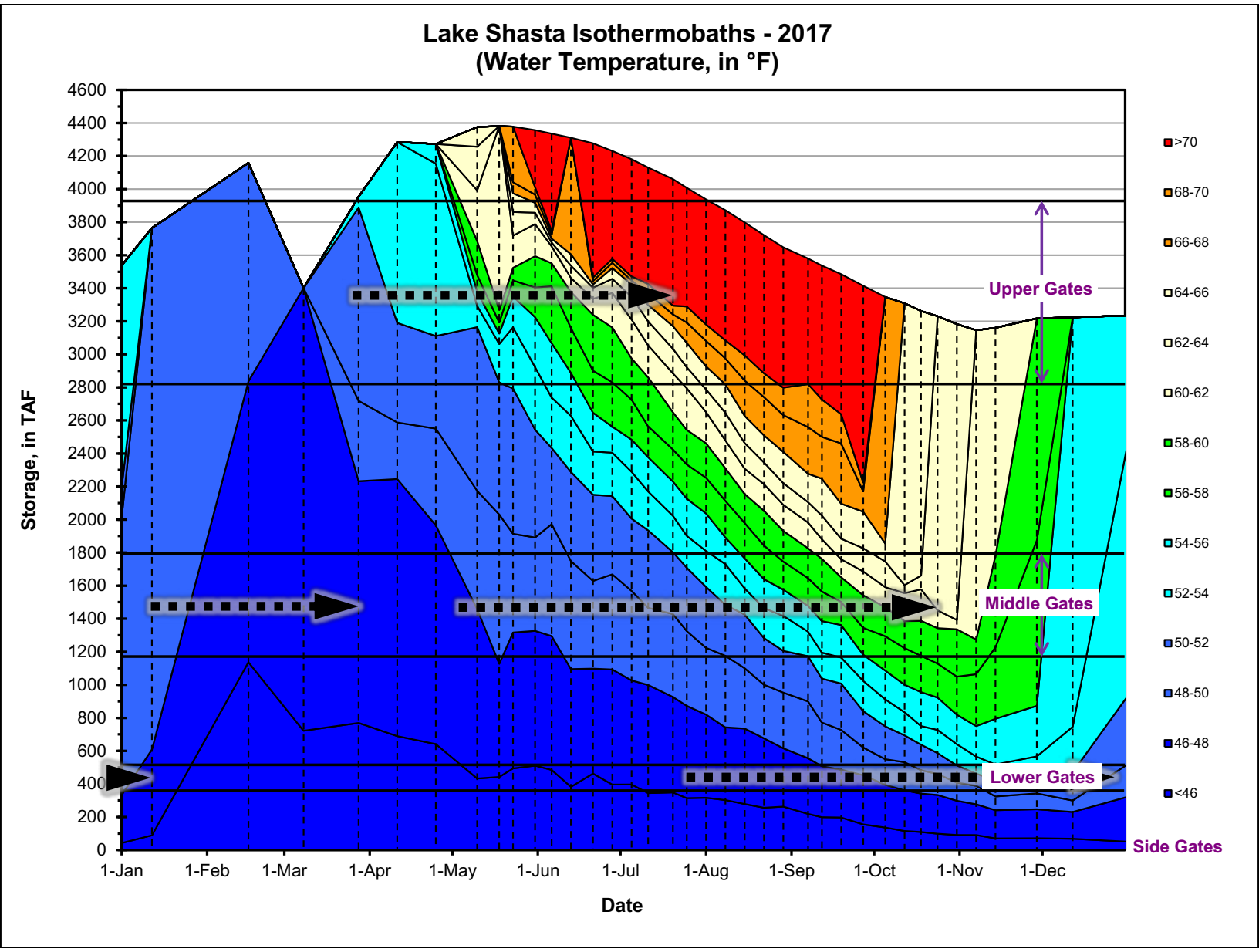

Sacramento River Temperature Targets 2017
KWK Flow
BSF DAT Target
BSF DAT
CCR DAT Target
CCR DAT
CCR 7DADM Target
CCR 7DADM
Water Temperature (°F)
River Flow (CFS)
57
56
55
54
53
52
51
50
49
48
47
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
05/15
05/29
06/12
06/26
07/10
07/24
08/07
08/21
09/04
09/18
10/02
10/16
10/30
KWK = Keswick
BSF = Balls Ferry Bridge
CCR = Sacramento River above Clear Creek
DAT = Daily Average Temperature
7DADM = Seven Day Average Daily Maximum
Target Deviation (°F)
1
0
-1
-2
-3
-4
-5


Lake Shasta Isothermobaths - 2017
(Water Temperature, in °F)
Storage, in TAF
4600
4400
4200
4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec
Date
>70
68-70
66-68
64-66
62-64
60-62
58-60
56-58
54-56
52-54
50-52
48-50
46-48
<46
Upper Gates
Middle Gates
Lower Gates
Side Gates

2017 Hydrologic Conditions

- Wet Water Year type
- Plentiful Shasta Cold Water Pool
- High Keswick releases in spring

- 2017 conditions mask operational impacts

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Update: System-Wide Sensitivity Evaluations

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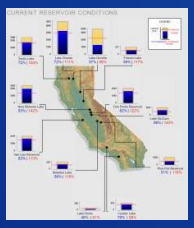
Statements on Modeling

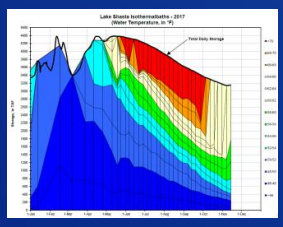
- **Models have limitations ≠ Reality**
- **Formulation as sensitivity analysis**

Modeling Process



System Operation: CalSim-II

Simulate water delivery from reservoirs to meet assumed downstream demands/constraints



Temperature: HEC-5Q

Given system conditions (CalSim), simulate changes the Shasta TCD to meet downstream temperatures

Salmon Mortality: Martin Model

Given flow (CalSim) and temperature (HEC-5Q), project upper reach mortality of redd lifecycle

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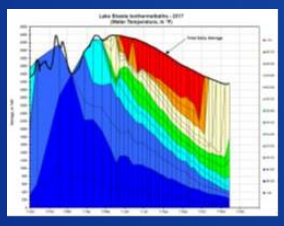
Comparative Sensitivity Analysis 1: Water Operations

System Operation: CalSim-II

Temperature: HEC-5Q



Salmon Mortality: Martin Model

Current Operations*	Proposed NMFS Amendment
Represents recent operational practice	**Shasta Storage and Keswick Release Constraints**
Temperature Target 53°F DAT at CCR*	Same
Base	Same

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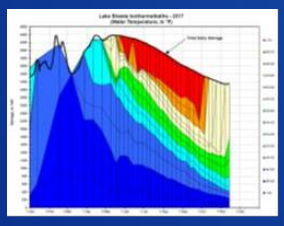
TENTATIVE: Comparative Sensitivity Analysis 2: Temperature Management

System Operation: CalSim-II

Temperature: HEC-5Q



Salmon Mortality: Martin Model

Current Operations	Operational Temperature Study
Represents recent operational practice	Same
Temperature Target 56°F DAT at adjusted downstream locations	**Temperature Target 53°F DAT at CCR**
Base	Same

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Comparative Sensitivity Analysis 1: Water Operations

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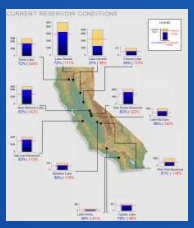
Define the Operational Base Model

CalSim-II
"Existing Model Framework"

CalSim-II
New Base: "Current Operations"



Existing Model Framework	Current Operations (CO)
2008/9 BiOp RPAs	2008/9 BiOp RPAs
Early Long-Term Climate (Q5)	Early Long-Term Climate (Q5)
	Mimic 2013-2015 Drought Relaxations & Curtailments

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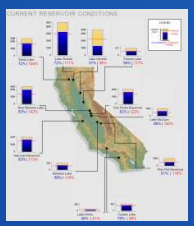
System Operation Assumptions

CalSim-II
"Current Operations"

CalSim-II
"NMFS"



Current Operations (CO)	NMFS Alternative (NMFS)
2008/9 BiOp RPAs	Same
Mimic 2013-2015 Drought Relaxations & Curtailments	Same
Early Long-Term Climate (Q5)	Same
No Storage carryover or release targets	**Proposed Amendments: Shasta Storage and Keswick Release Constraints**

Analyses – Two Scenarios

1. “Current Ops”
   - Attempts to replicate shortage allocation approaches taken during recent drought sequence
- Delta X2 Relaxations
- Reduction of Rio Vista Flow requirement
- Reduction of Emmaton and Jersey Point Water Quality requirements

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Analyses – Two Scenarios

2. "NMFS Amendment"
   - No specific logic that guarantees Shasta storage levels
   - Allows for Project and Non-Project shortage allocation necessary in attempt to meet proposed operational objectives
- Not a policy or realistic strategy, but used to test ability to reach targets under essentially any supply condition

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Comparative Sensitivity Analysis

- **Answers:**
  - **What are the incremental benefits/impacts by attempting to apply the Proposed Shasta Storage Carryover and Keswick Release constraints on the CVP/SWP system?**
- **CalSim Analysis:**
  - **Feasibility of targets/restrictions**
  - **Impacts/changes to other parts of the CVP/SWP system required to meet targets/restrictions**

Analyses – Fall Storage Targets

- **Draft Proposed September Storage Targets**
  - **Critically dry: 1.9 MAF**
  - **Dry: 2.2 MAF**
  - **Below Normal: 2.8 MAF**
  - **Above Normal: 3.2 MAF**
  - **Wet: 3.2 MAF**

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Analyses – Fall Storage Targets

- **Evaluate:**
  - **Compliance under "Current Ops"**
  - **Compliance with modified CVP delivery allocation**
    - **Allocations consider fall storage target in computing CVP delivery capability**

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Simulation Results: Shasta September Carryover

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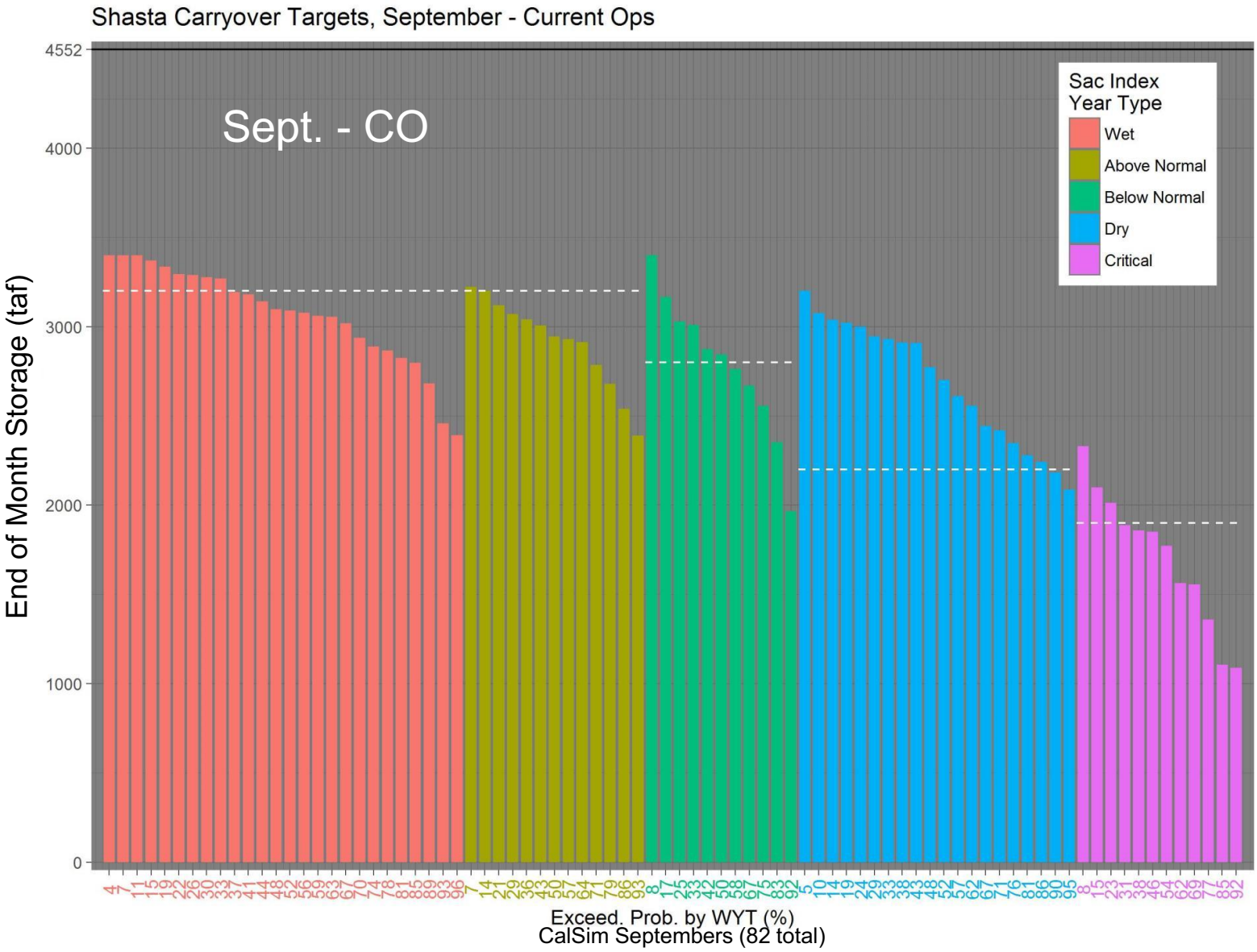
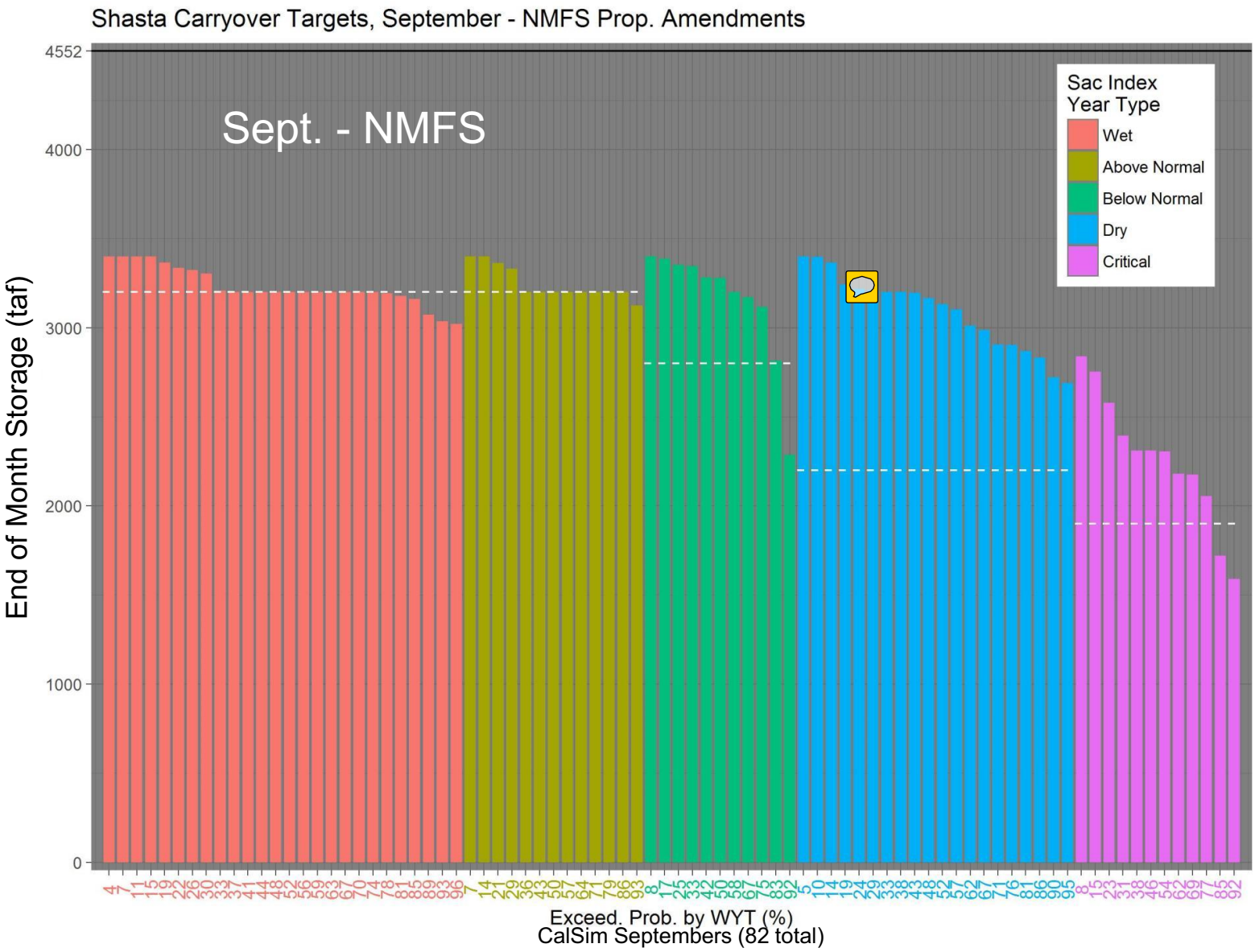

Shasta Carryover Targets, September - Current Ops
Sept. - CO
Sac Index Year Type
Wet
Above Normal
Below Normal
Dry
Critical
End of Month Storage (taf)
4552
4000
3000
2000
1000
0
Exceed. Prob. by WYT (%)
CalSim Septembers (82 total)


Shasta Carryover Targets, September - NMFS Prop. Amendments
Sept. - NMFS
Sac Index Year Type
Wet
Above Normal
Below Normal
Dry
Critical
End of Month Storage (taf)
4552
4000
3000
2000
1000
0
Exceed. Prob. by WYT (%)
CalSim Septembers (82 total)

Analyses – Spring Storage Targets

- **Draft Proposed Spring Storage Targets**
  - **Critically dry: 3.5 MAF**
  - **Dry: 3.9 MAF**
  - **Below Normal: 4.2 MAF**
  - **Above Normal: 4.2 MAF**
  - **Wet: 4.2 MAF**

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Analyses – Spring Storage Targets

- **Evaluate:**
  - **Compliance under "Current Ops"**
  - **Compliance with modified CVP delivery allocation**
    - **No specific effort to modify October-March operations**
    - **Demonstrates ability to fill given September target**

Simulation Results:
Shasta April Carryover

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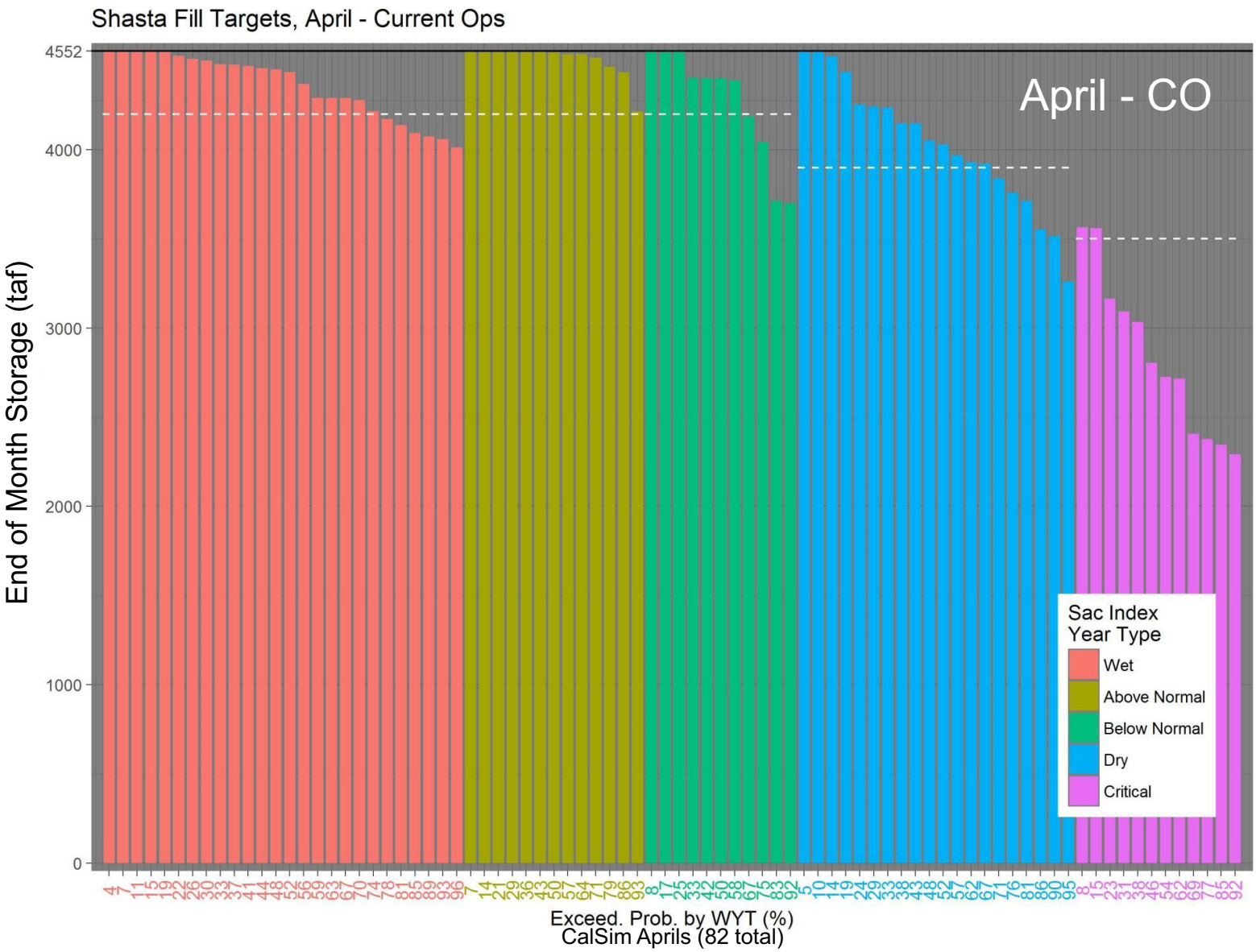
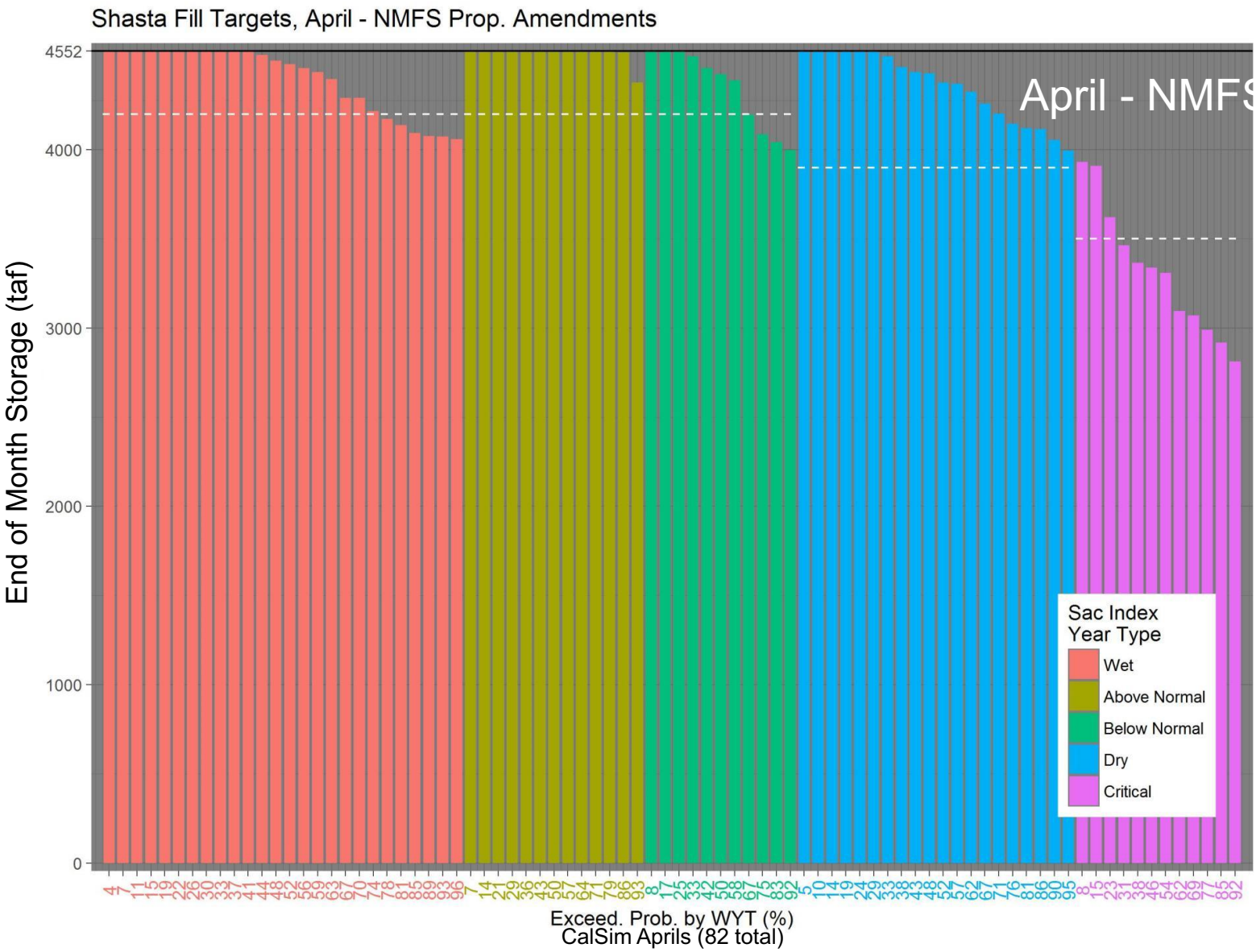

Shasta Fill Targets, April - Current Ops
April - CO
End of Month Storage (taf)
4552
4000
3000
2000
1000
0
Sac Index
Year Type
Wet
Above Normal
Below Normal
Dry
Critical
Exceed. Prob. by WYT (%)
CalSim Aprils (82 total)


Shasta Fill Targets, April - NMFS Prop. Amendments
April - NMFS
End of Month Storage (taf)
4552
4000
3000
2000
1000
0
Sac Index Year Type
Wet
Above Normal
Below Normal
Dry
Critical
Exceed. Prob. by WYT (%)
CalSim Aprils (82 total)

Simulation Results: Shasta May Carryover

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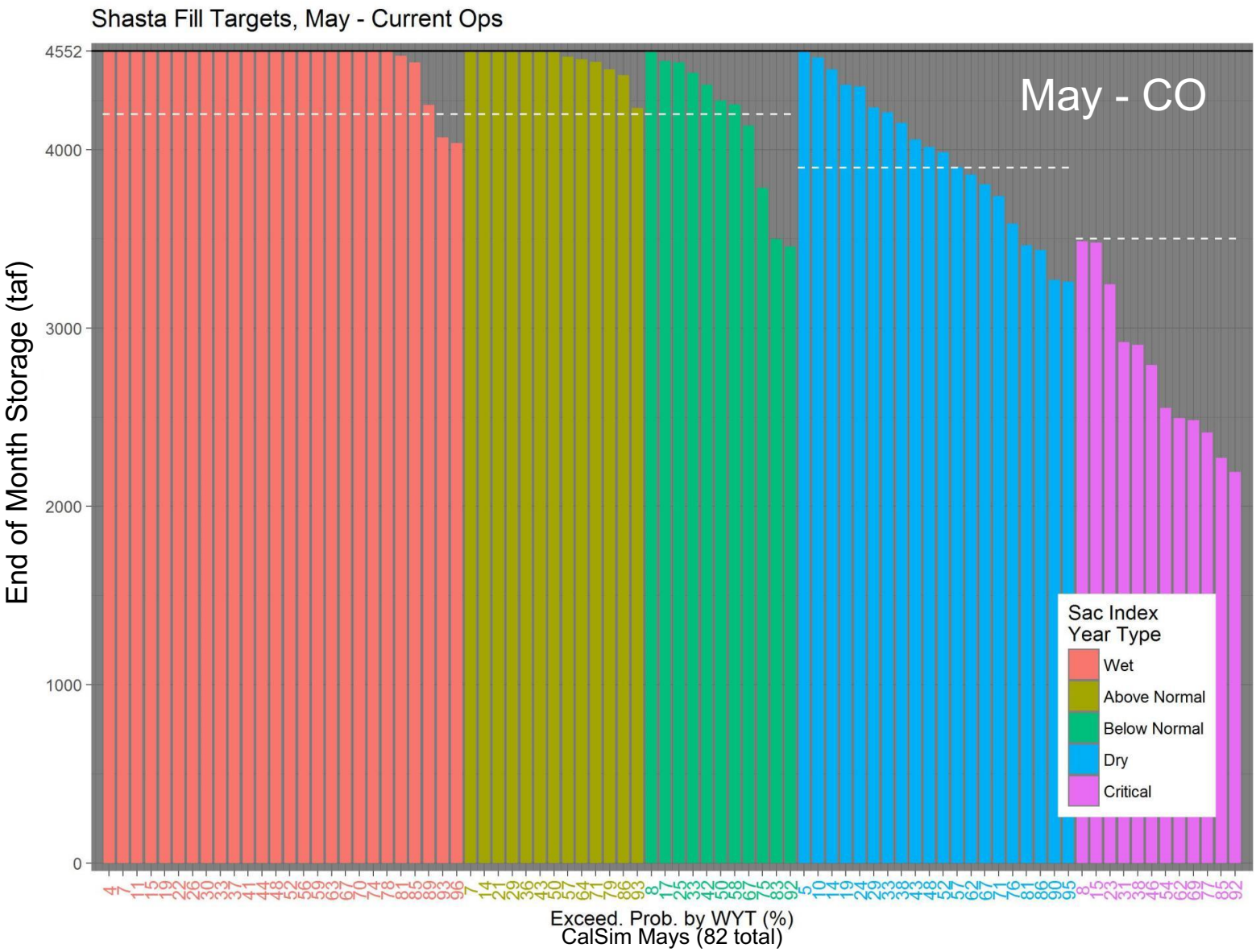
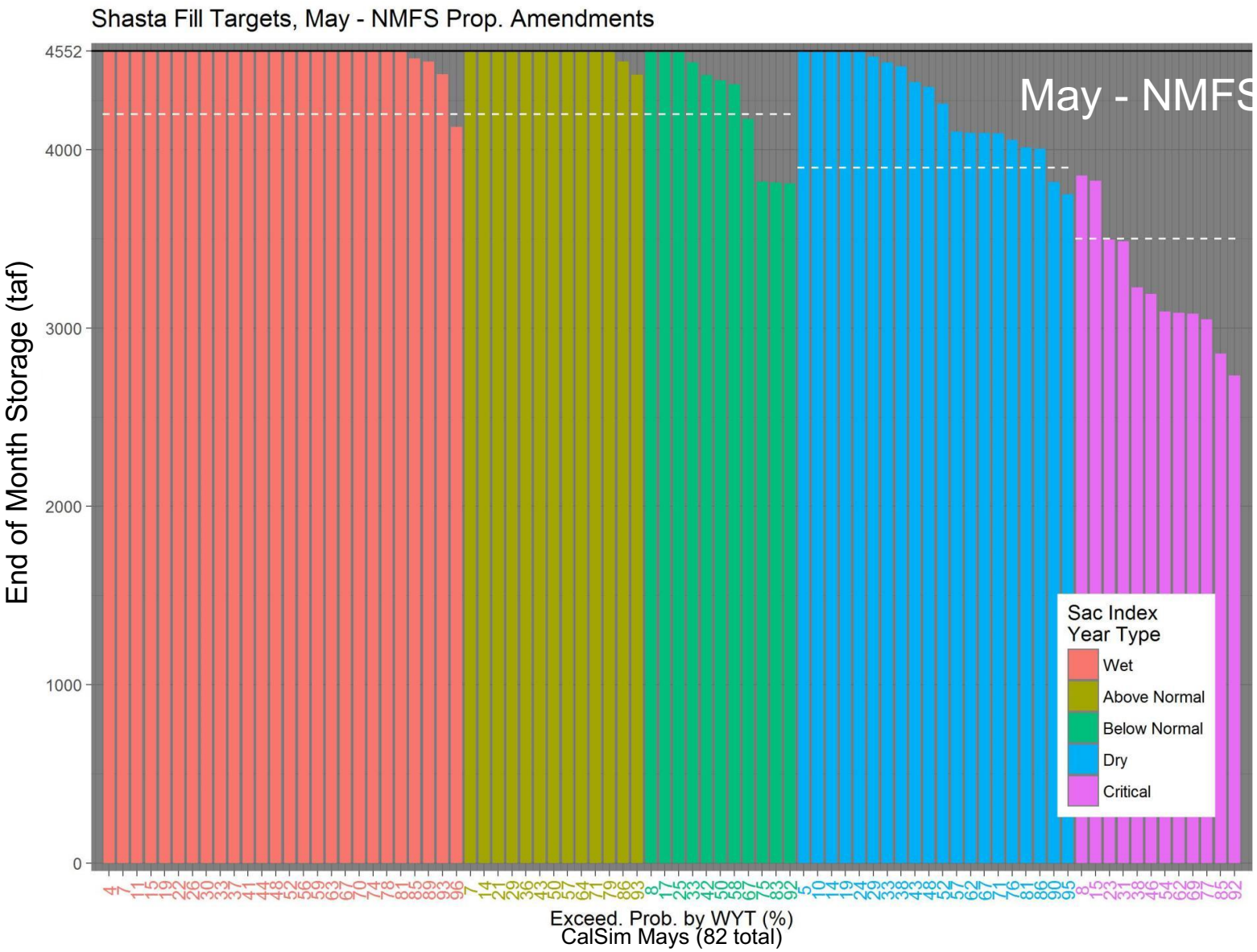

Shasta Fill Targets, May - Current Ops
May - CO
End of Month Storage (taf)
4552
4000
3000
2000
1000
0
Sac Index
Year Type
Wet
Above Normal
Below Normal
Dry
Critical
Exceed. Prob. by WYT (%)
CalSim Mays (82 total)


Shasta Fill Targets, May - NMFS Prop. Amendments
May - NMFS
End of Month Storage (taf)
4552
4000
3000
2000
1000
0
Sac Index Year Type
Wet
Above Normal
Below Normal
Dry
Critical
Exceed. Prob. by WYT (%)
CalSim Mays (82 total)

Why aren't proposed Storage objectives met?

- **Wet Years:**
  - Flood Control requirements evacuates additional water from storage

- **Below Normal, Dry, and Critical years:**
  - Demonstrates improved storage with relaxed requirements and delivery curtailments
  - Not feasible in all years. Poor hydrology in consecutive dry years can not recover storage deficit

Analyses – Spring Release Limits

- **Draft Proposed Spring Release Limits**
  - **April:**
    - **Critically Dry: 4,000 cfs**
    - **Dry: 6,000 cfs**
    - **Below Normal: 6,000 cfs**
    - **Above Normal: 6,500 cfs**
    - **Wet: 8,000 cfs**
  - **May:**
    - **Critically Dry: 7,500 cfs**
    - **Dry: 8,000 cfs**
    - **Below Normal: 9,000 cfs**
    - **Above Normal: 11,000 cfs**
    - **Wet: 12,000 cfs**

Analyses – Spring Release Limits

- **Evaluate:**
  - **Compliance under "Current Ops"**
  - **Compliance with modified CVP delivery allocation**
    - **No specific limits set on releases**
    - **Operation affected solely by allocation and storage conditions**

Simulation Results: Keswick April Release

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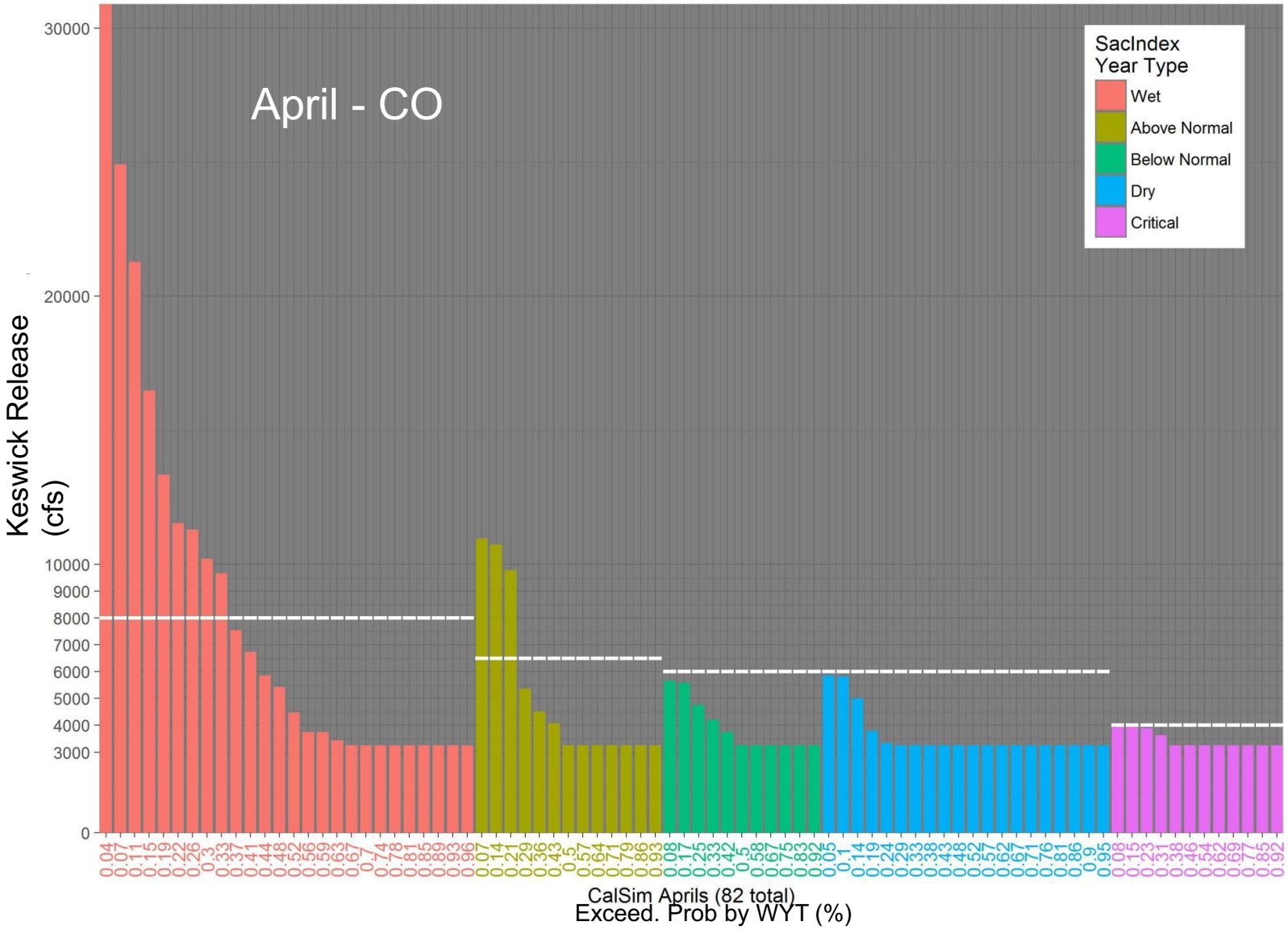
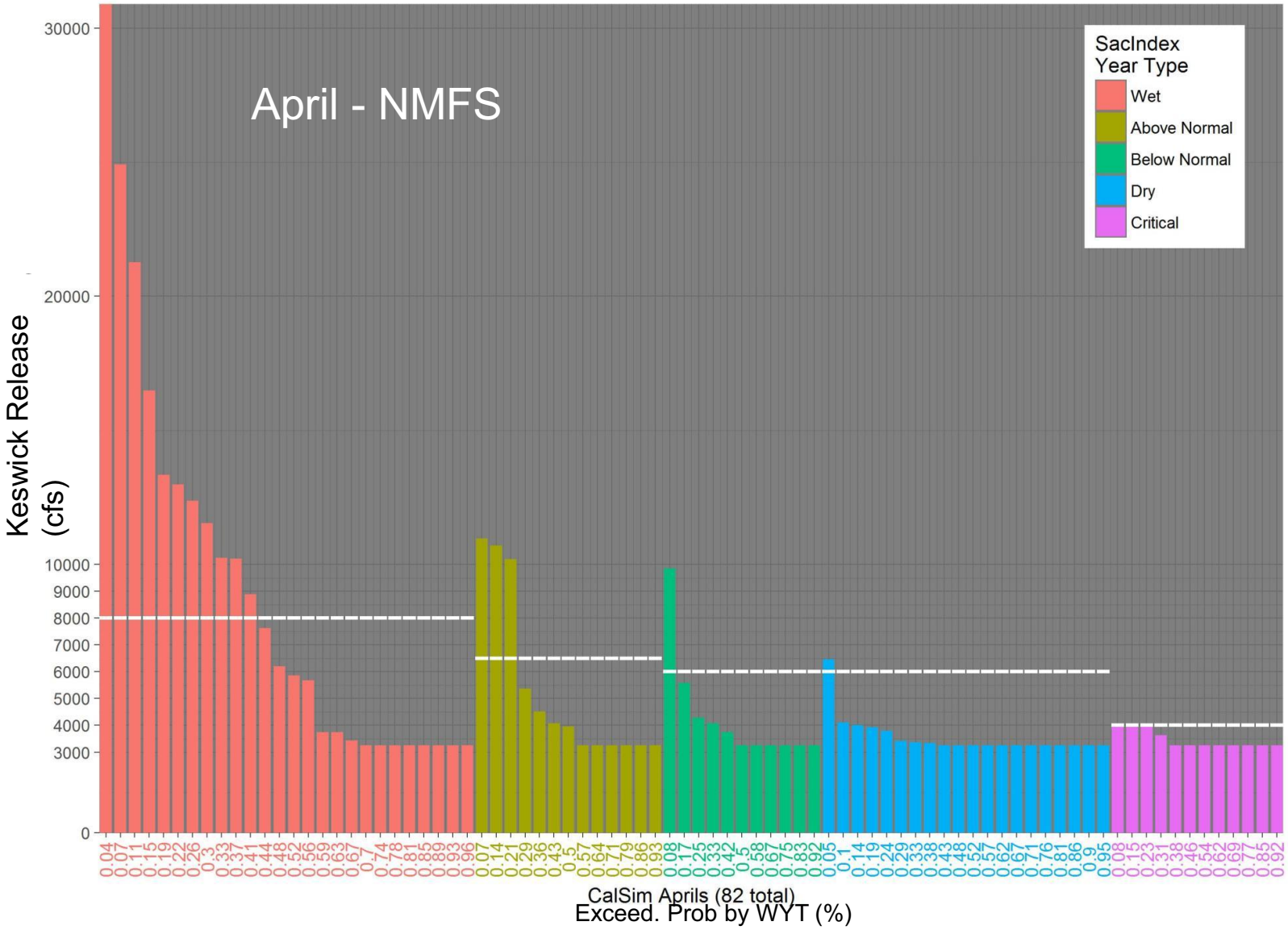
Keswick Release and NMFS proposed release limits, April – Current Ops



Keswick Release and NMFS proposed release limits, April - NMFS



Simulation Results: Keswick May Release

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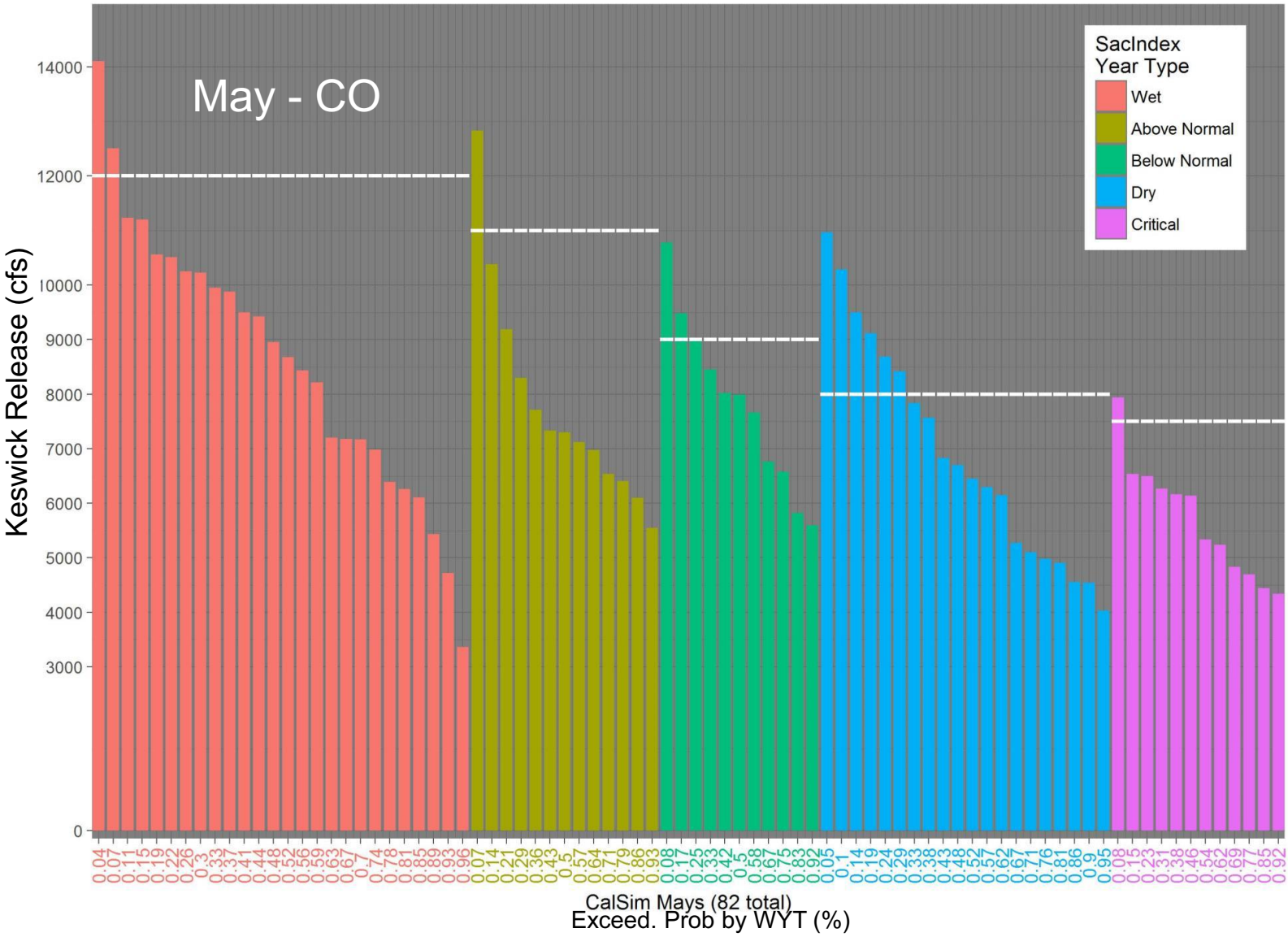
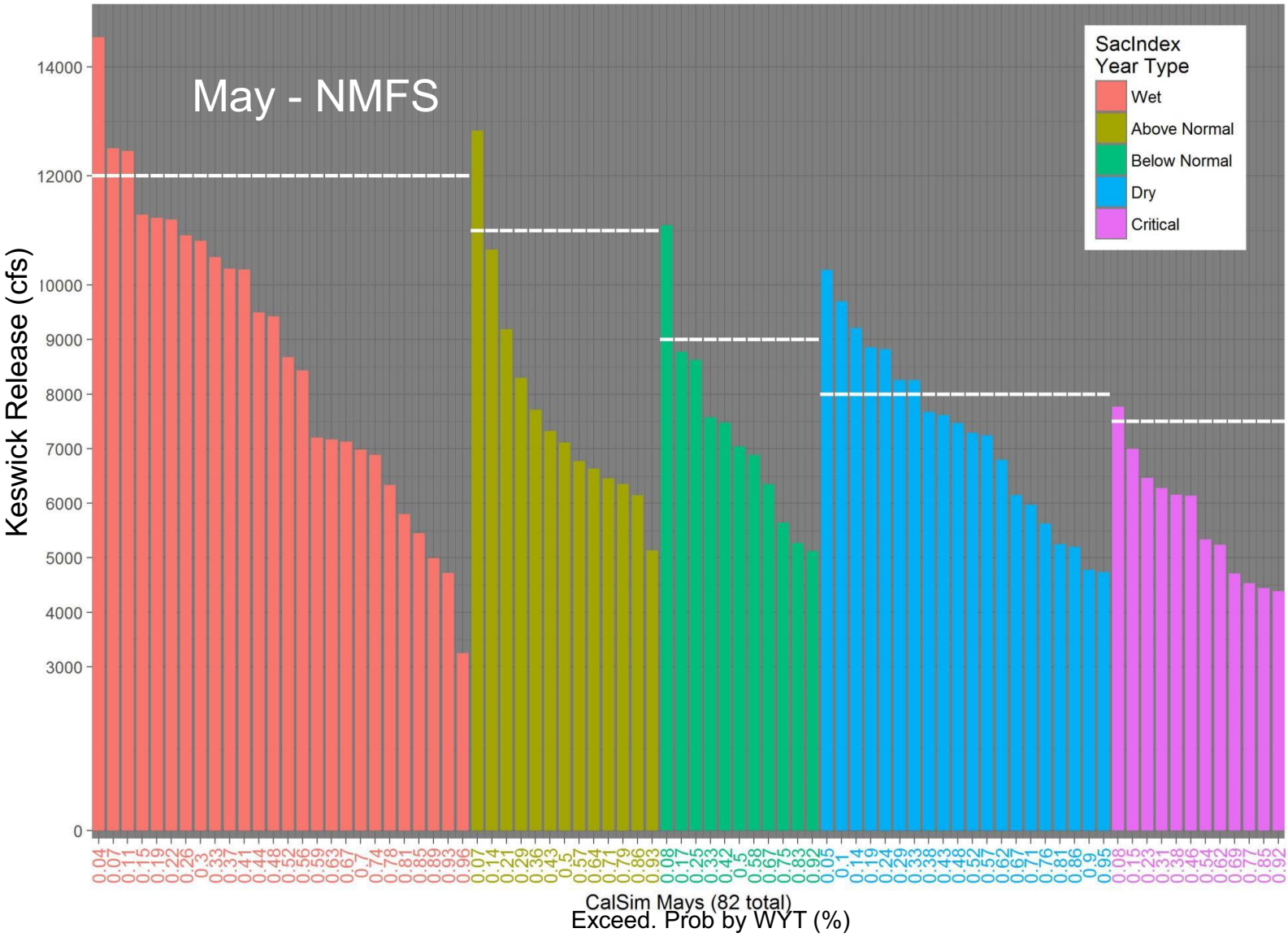
Keswick Release and NMFS proposed release limits, May – Current Ops



Keswick Release and NMFS proposed release limits, May - NMFS



Why aren’t proposed Releases objectives met?

- In either scenario, few instances exceed the release objective
- Higher storage conditions increase Flood Control potential which increase releases

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Simulation Results: Delta Outflow

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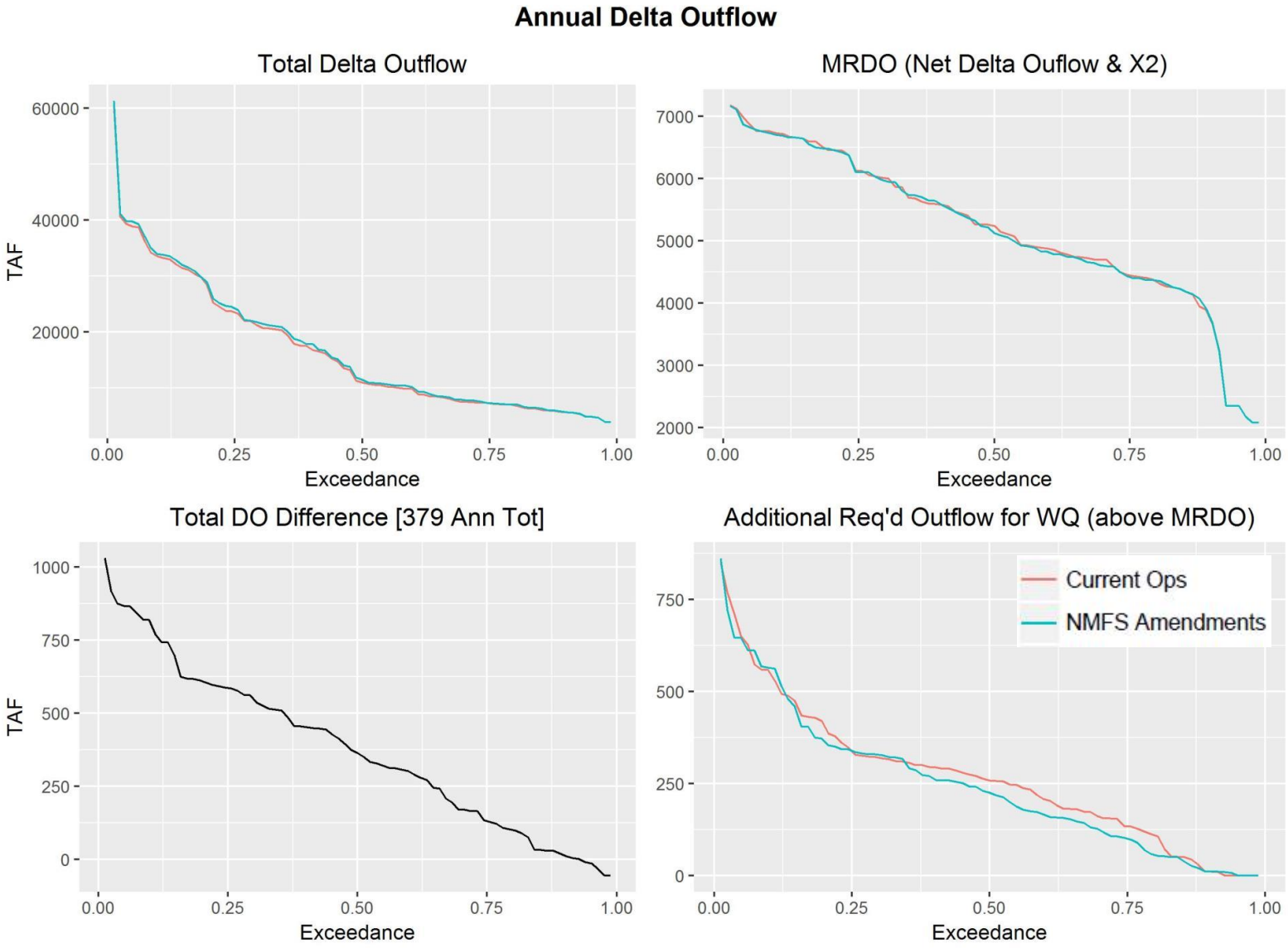
Annual Delta Outflow
Total Delta Outflow
TAF
60000
40000
20000
0.00
0.25
0.50
0.75
1.00
Exceedance
MRDO (Net Delta Ouflow & X2)
7000
6000
5000
4000
3000
2000
0.00
0.25
0.50
0.75
1.00
Exceedance
Total DO Difference [379 Ann Tot]
TAF
1000
750
500
250
0
0.00
0.25
0.50
0.75
1.00
Exceedance
Additional Req'd Outflow for WQ (above MRDO)
Current Ops
NMFS Amendments
750
500
250
0
0.00
0.25
0.50
0.75
1.00
Exceedance

Simulation Results: Deliveries

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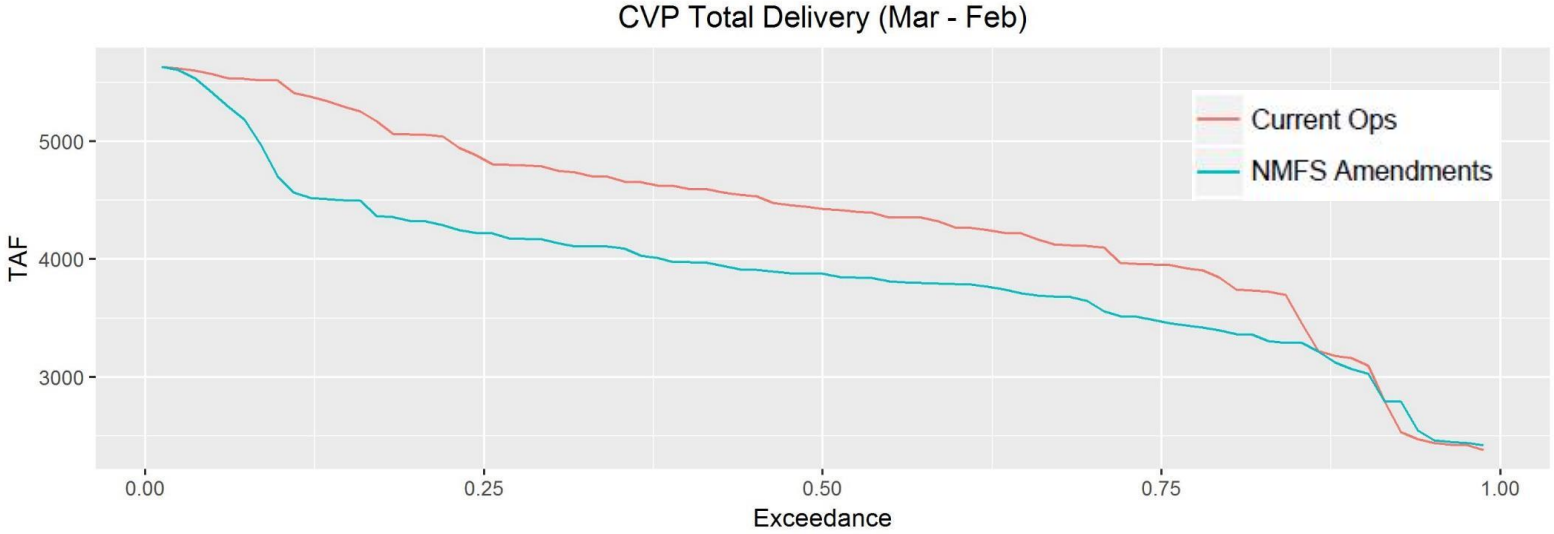
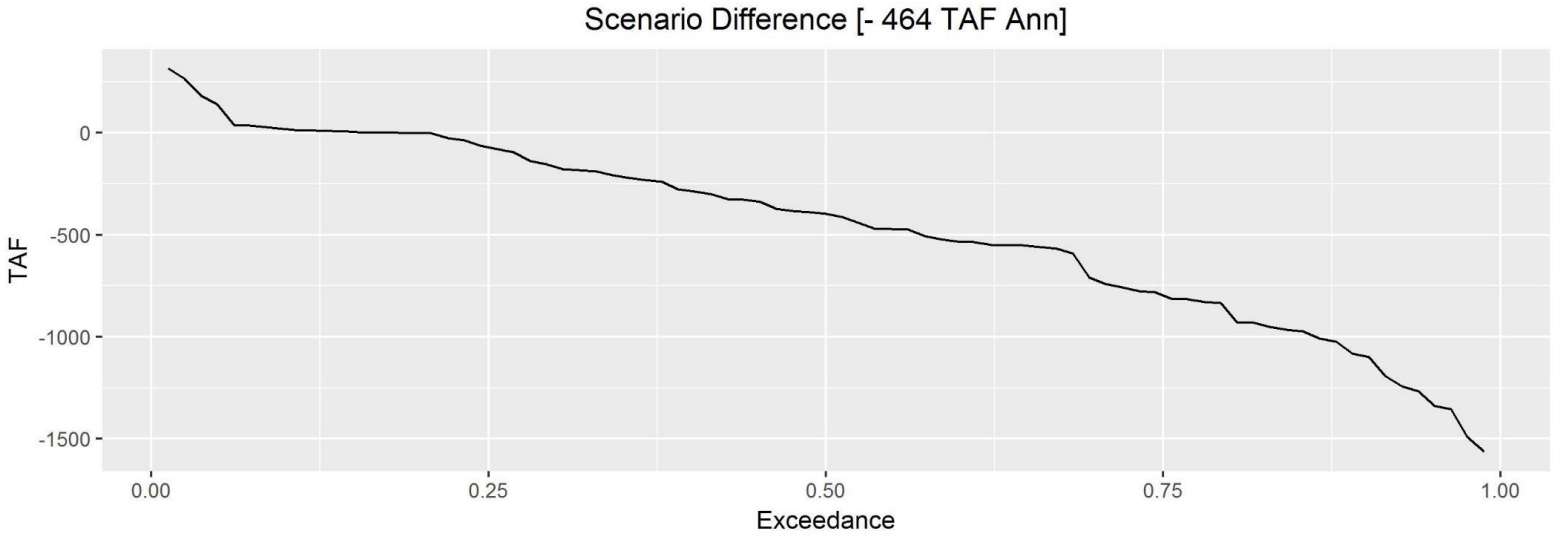
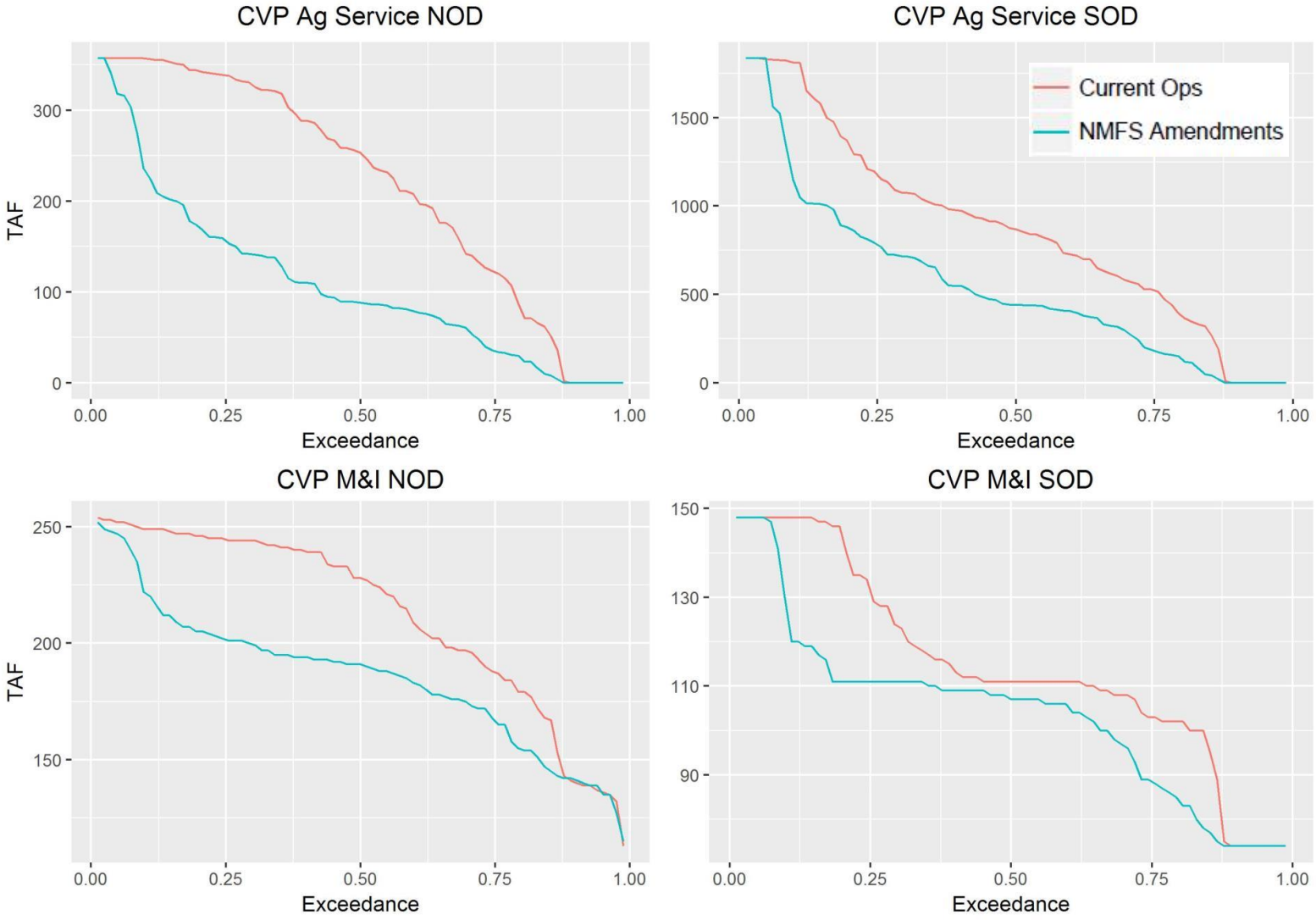
Overall change in CVP Delivery

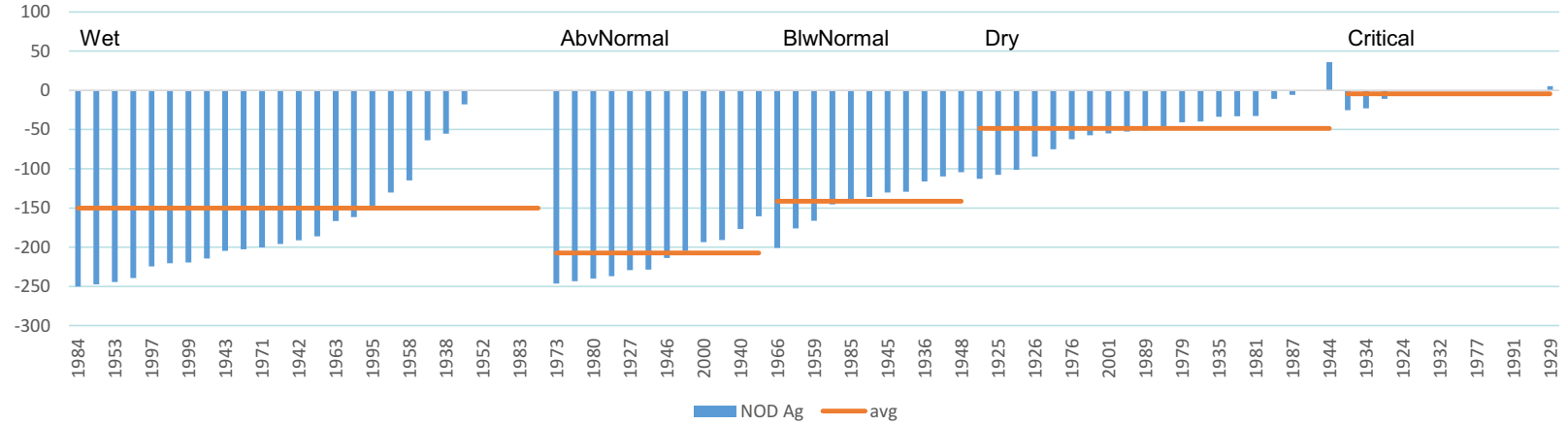




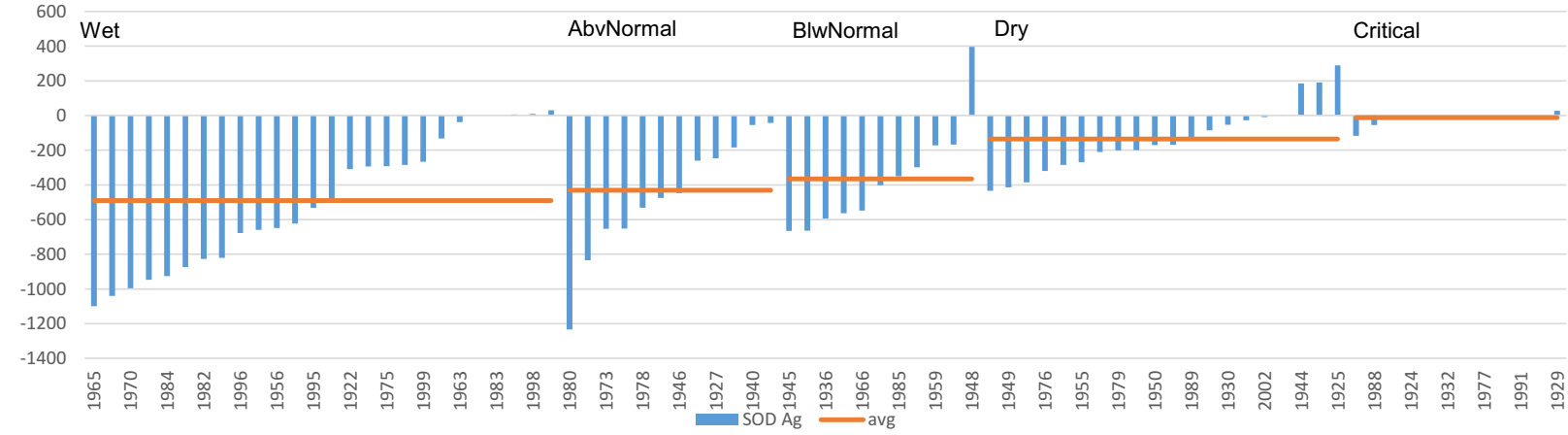
Annual Delivery Exceedance (Mar - Feb) - Ag and M&I



Annual North of Delta Ag Delivery Differences (NMFS - Current Ops)



Annual South of Delta Ag Delivery Differences (NMFS - Current Ops)



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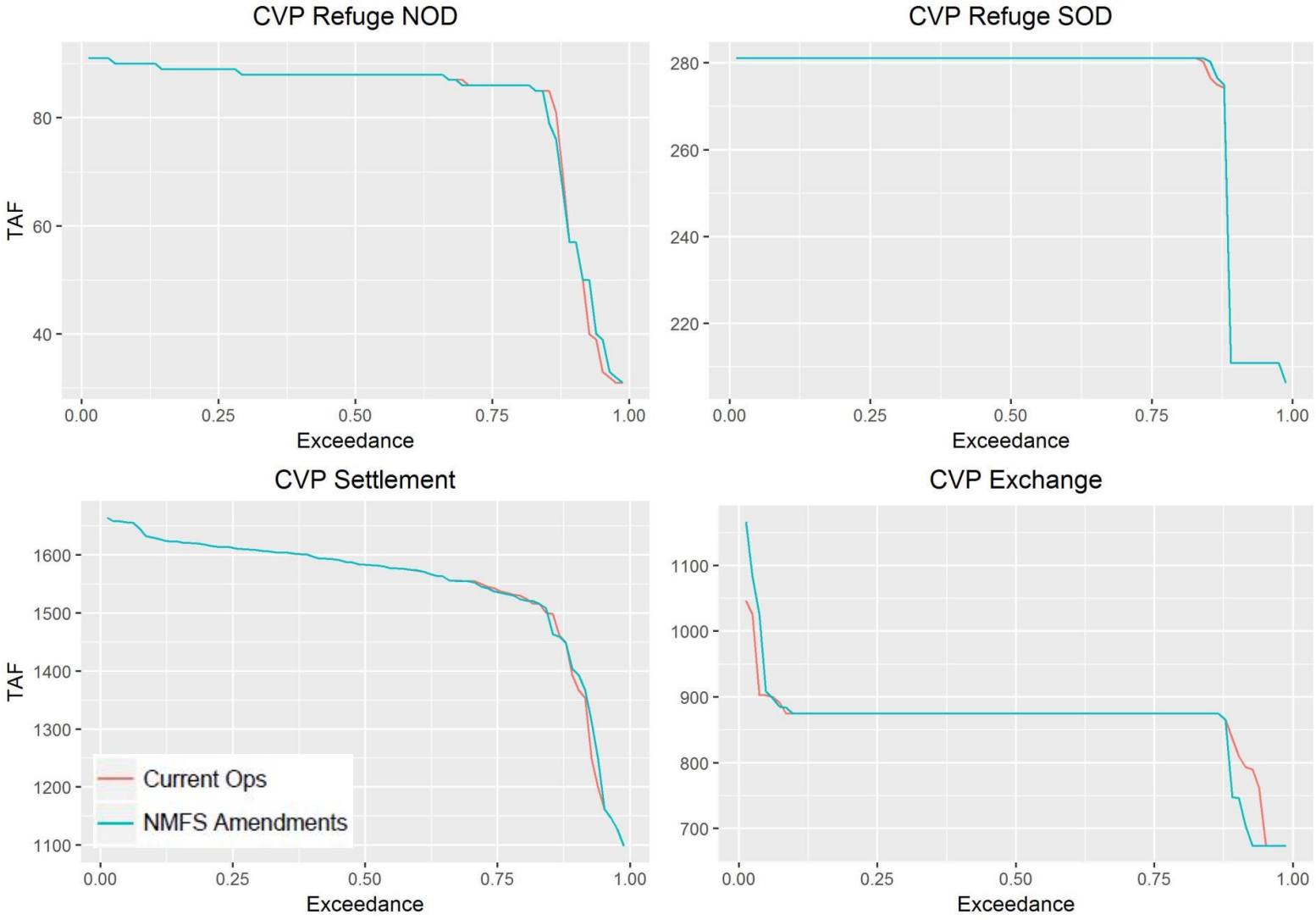
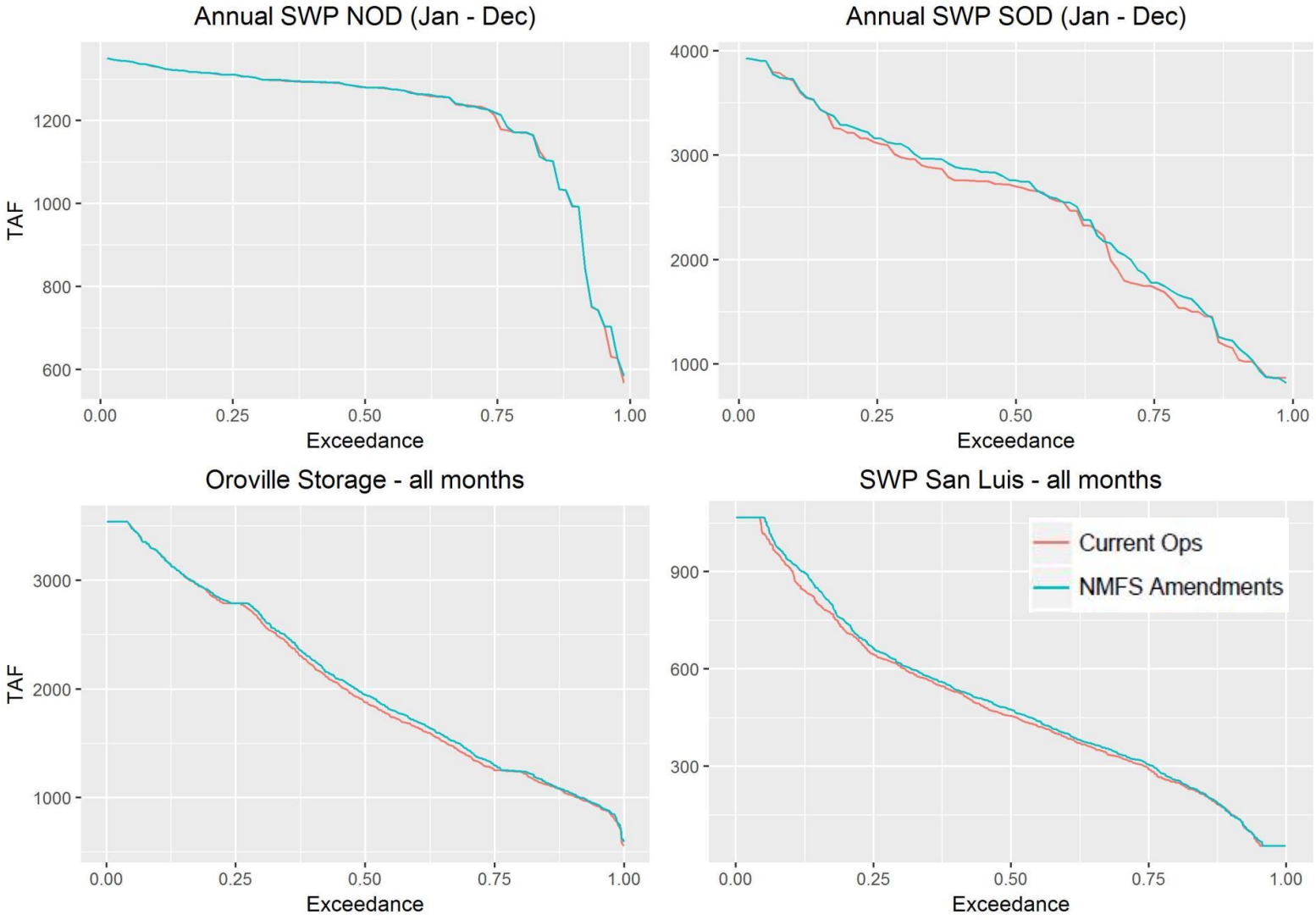
Annual Delivery Exceedance (Mar - Feb) - Refuges, Exchnge, Sttlmnt

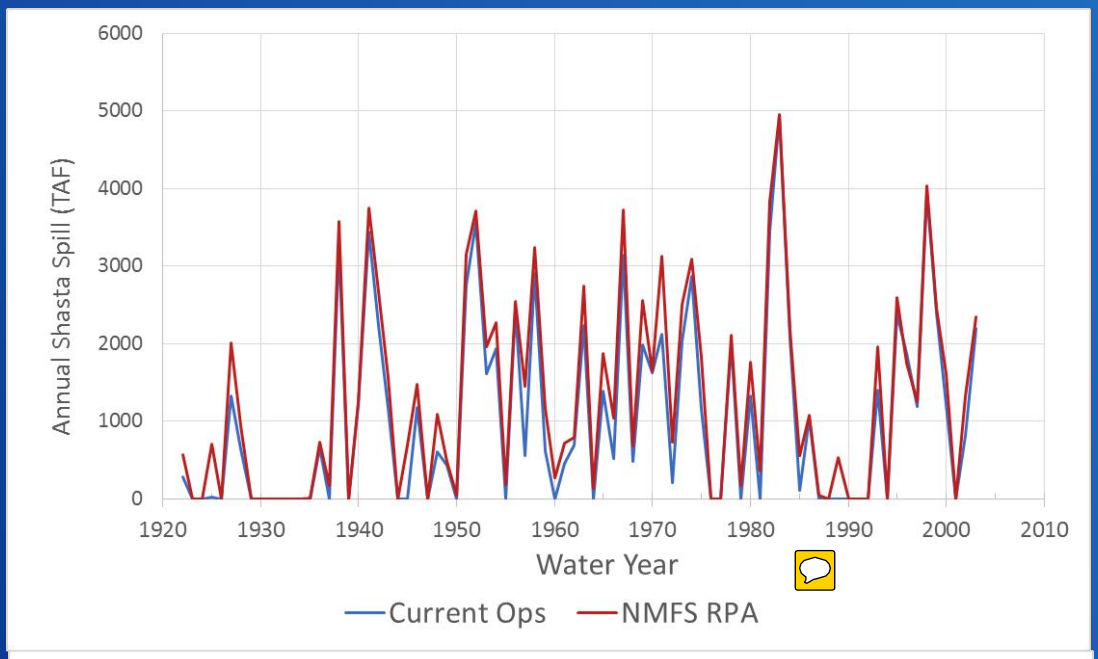


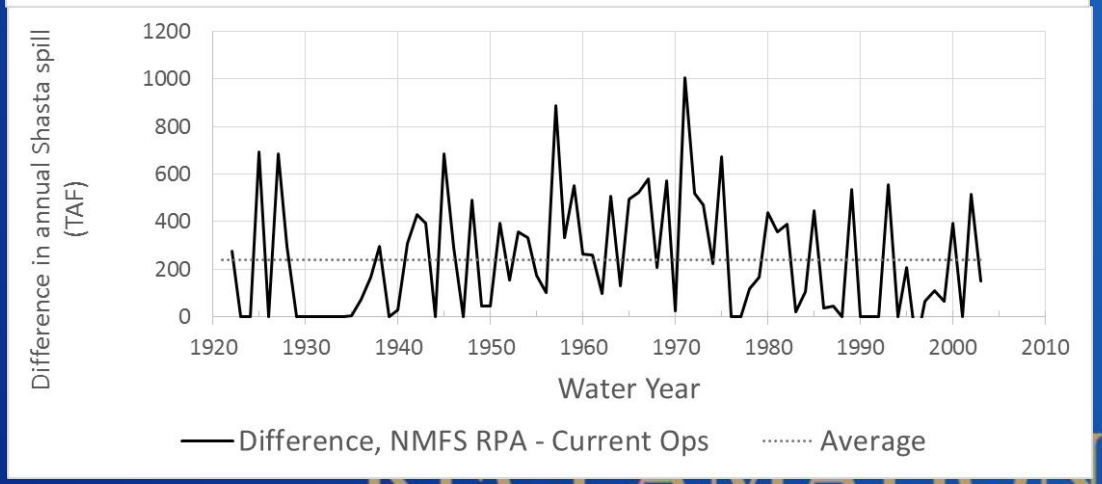
State Water Project Delivery & Storage Effects



Annual Shasta Flood Control Spill:

NMFS Amendment increases average spill by 239 TAF





CalSim-II Summary

- Shasta carryover storage is increased most in Dry and Critical year types
- Not all years can meet Shasta storage targets
- Flood control spills are increased
- Release targets are largely met already
- CVP delivery curtailments indicate estimated volume of water to increase Shasta storage
  - Underestimated for full storage performance
  - Model designed to isolate impacts to CVP delivery, remaining performances are largely the same

Temperature Management Analyses

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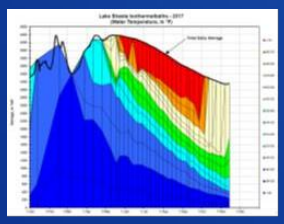
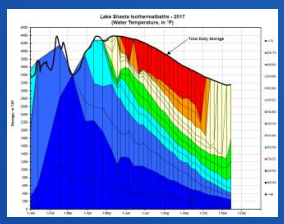
Temperature Assumptions

HEC-5Q
"Current Operations"



HEC-5Q
"NMFS"



Current Operations (CO)	NMFS Alternative (NMFS)
Uses CalSim CO Monthly Results	**Uses CalSim NMFS Monthly Results**
6-hr time-step	Same
May 15- Oct 31	Same
Max 6 gate changes per month	Same
Iterates gate operations to conserve cold water pool	Same
Target 53°F temperature at CCR	Same

Comparative Analysis

- **Answers:**
  - **What are the incremental benefits/impacts of the proposed temperature target by attempting to apply the proposed Shasta storage carryover and release criteria?**

Temperature Results

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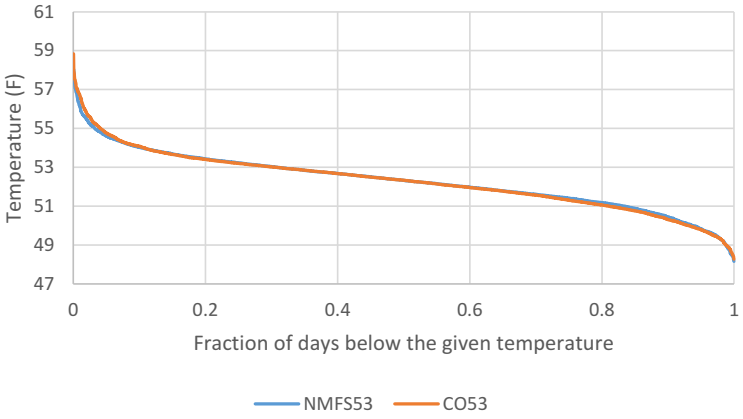
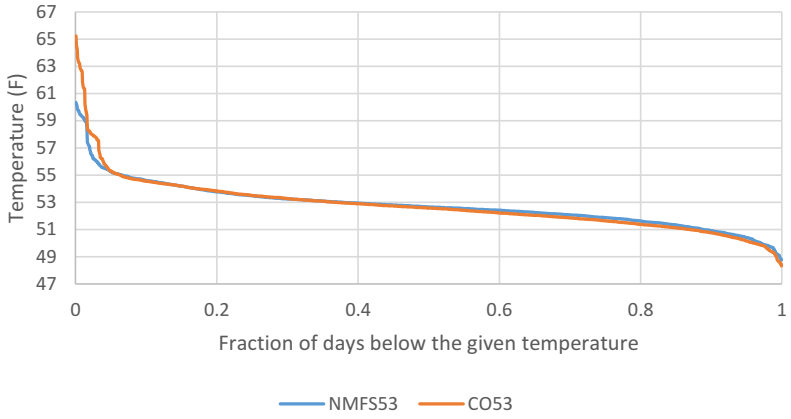
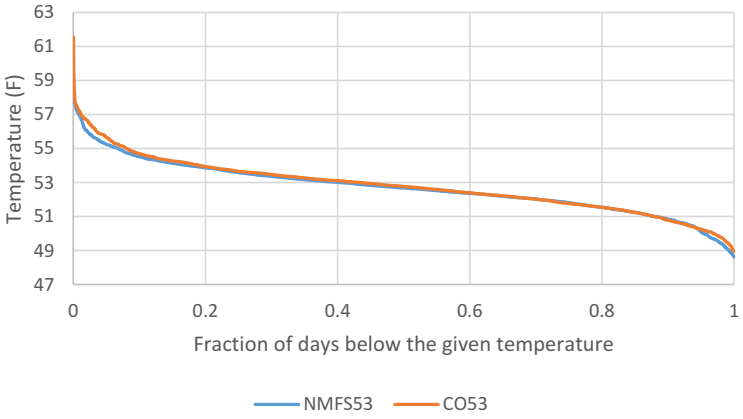
Sac R. Below Clear Creek Temperature: May - Oct, Wet Water Year Type



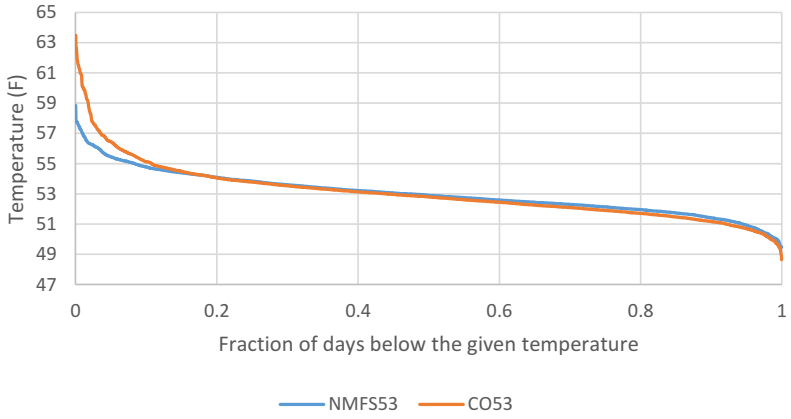
Sac R. Below Clear Creek Temperature: May - Oct, Above Normal Water Year Type

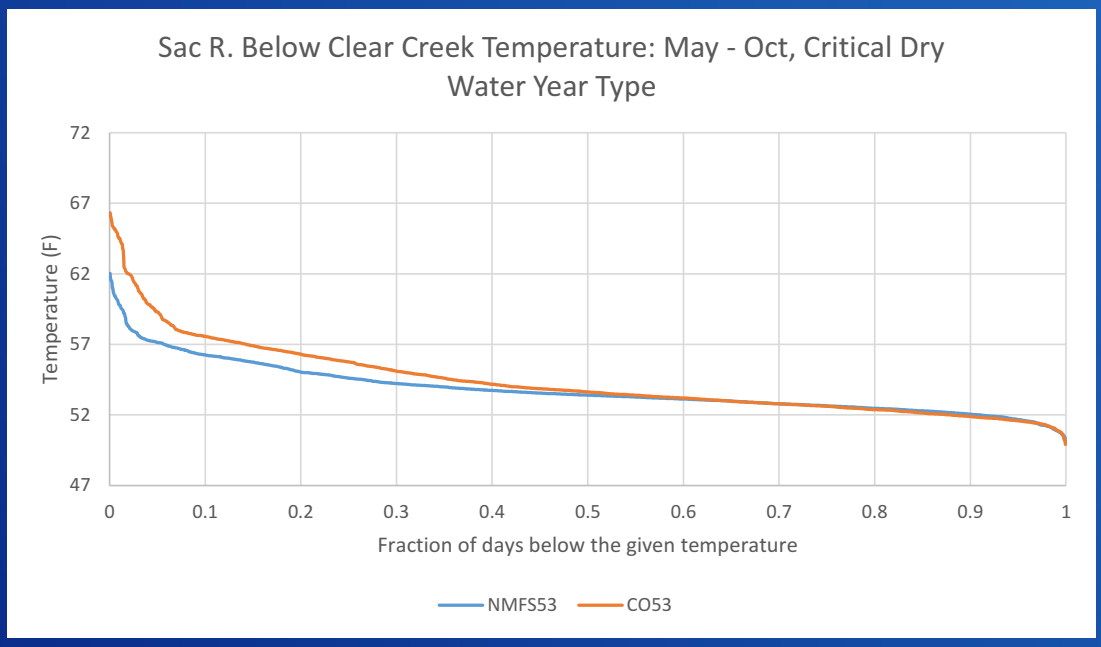


Sac R. Below Clear Creek Temperature: May - Oct, Below Normal Water Year Type



Sac R. Below Clear Creek Temperature: May - Oct, Dry Water Year Type





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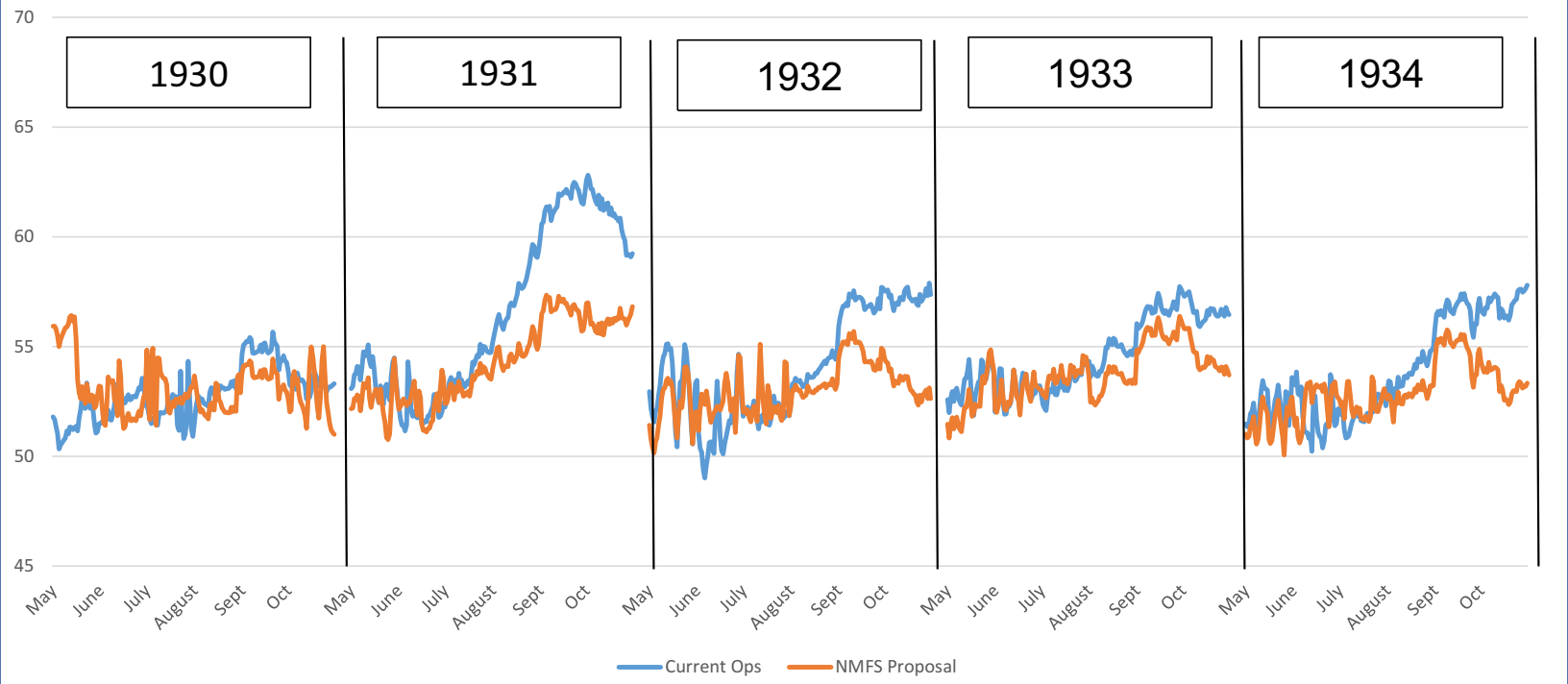

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Temperature Summary

- **Wet and Above Normal water year types indicate weak benefits**
  - **Result of abundance of cold water pool, where both scenarios perform similarly**
- **Below Normal and Dry water year types indicate moderate benefits**
  - **Improved downstream temperature is realized by avoiding early-season cold water pool use and extending temperature control in the late season**
  - **CO late-season performance is poorer as a result of mining early-season cold water pool, however, early-season temperature in NMFS scenario are warmer**

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Temperature Summary

- Critical Water year types yield most significant benefits
  - Higher storage conditions offer enhanced gate use and flexibility
  - Benefits are limited and can not sustain downstream temperature goals during persistent drought periods

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Example: Salmon Mortality Analyses

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Salmon Mortality Assumptions

Martin Model
"Current Operations"

Martin Model
"NMFS"

Current Operations (CO)	NMFS Alternative (NMFS)
Uses Daily HEC-5Q CO data	**Uses Daily HEC-5Q NMFS data**
Keswick to Tehama Bridge	Same
Martin equation applied across redds lifetime	Same
Assumed spatial-temporal representative redd distribution	Same
Each date-river mile combination multiplied by % of total redd population and combined for an estimate of yearly total mortality %	Same

Example: Salmon Mortality Results

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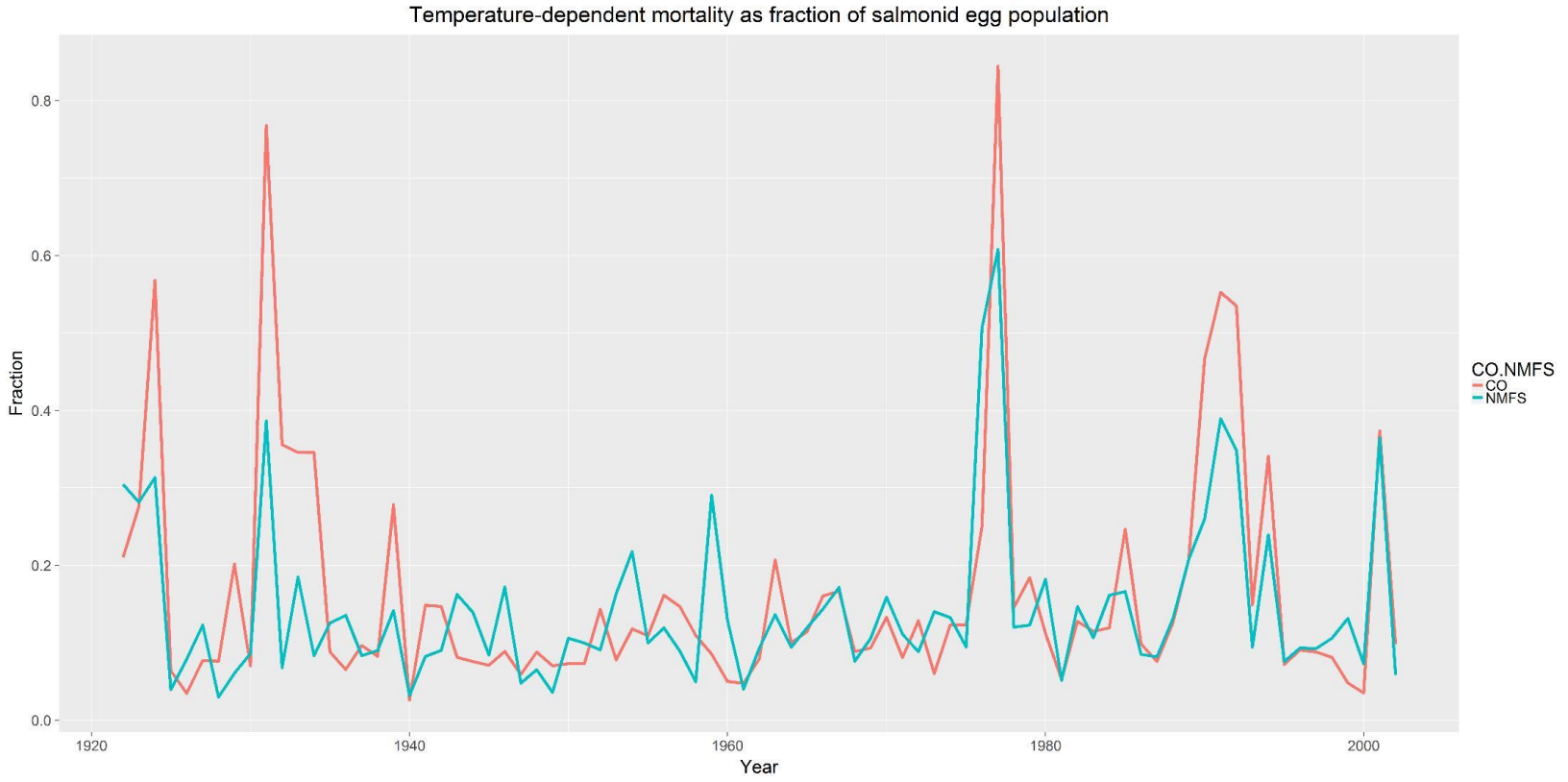
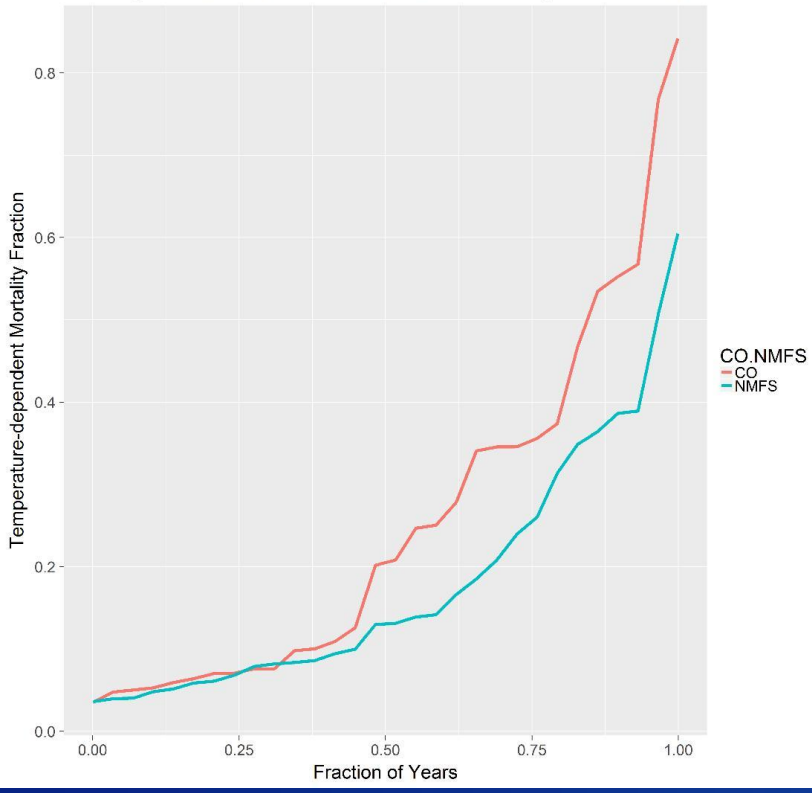
Mortality results: Time series, 1922-2002



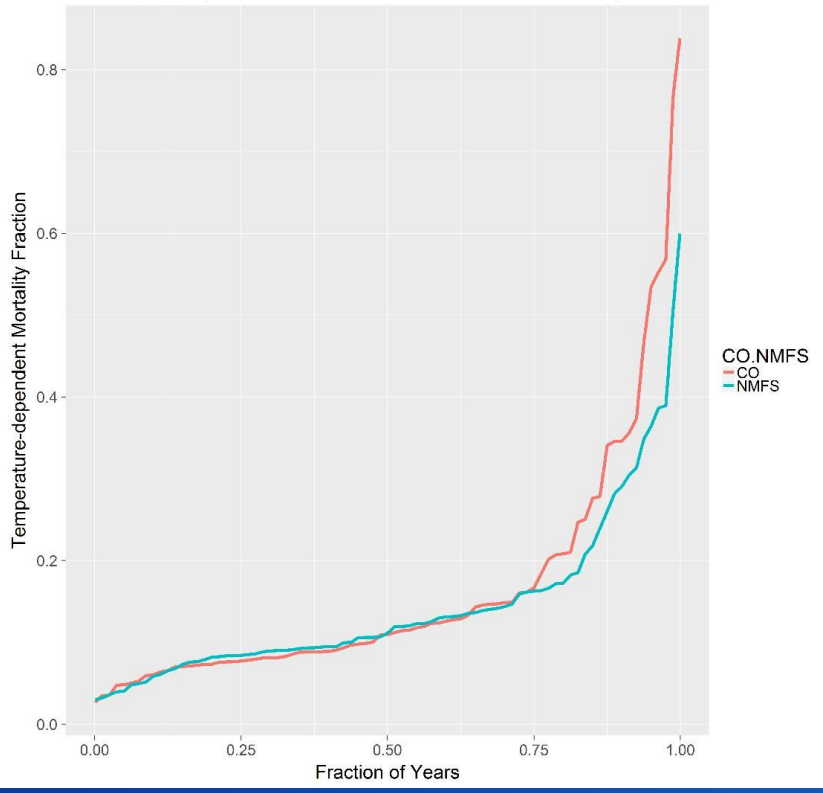
RECLAMATION

Mortality results: Exceedance graphs

Exceedance graph of temperature-dependent mortality fraction - C, D WYTs



Exceedance graph of temperature-dependent mortality fraction



Salmon Mortality Summary

- Demonstrates an example application

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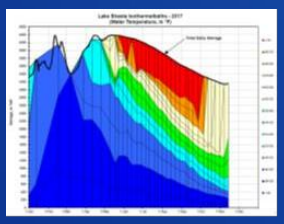
TENTATIVE: Comparative Sensitivity Analysis 2: Temperature Management

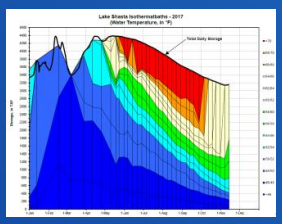
RECLAMATION

Temperature Assumptions

HEC-5Q
"Current Operations"



HEC-5Q
"Ops Study"



Current Operations (CO)	Ops Study
Uses CalSim CO Monthly Results	Same
6-hr time-step	Same
May 15- Oct 31	Same
Max 6 gate changes per month	Same
Iterates gate operations to conserve cold water pool	Same
Target 56°F temperature at adjusted downstream locations	**Target 53°F temperature at CCR**

Comparative Analysis

- **Answers:**
  - **What are the incremental benefits/impacts of the proposed temperature 53°F DAT (surrogate) target at CCR compared to 56°F DAT at adjusted downstream locations?**

Temperature Results

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Temperature Results TBD

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Temperature Summary

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Salmon Mortality Assumptions

Martin Model
"Current Operations"

Martin Model
"Ops Study"

Current Operations (CO)	Ops Study
Uses Daily HEC-5Q CO data	**Uses Daily HEC-5Q Ops Study**
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Martin equation applied across redds lifetime	Same
Assumed spatial-temporal representative redd distribution	Same
Each date-river mile combination multiplied by % of total redd population and combined for an estimate of yearly total mortality %	Same

Salmon Mortality Results

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Mortality results: Time series, 1922-2002

- TBD

RECLAMATION

Mortality results: Exceedance graphs

- TBD

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Draft Science Work Plan

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Next Steps

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Road Map

#1

- Stakeholder Workshop #1
- Science and Modeling Work Plans

#2

- Stakeholder Workshop #2
- Introduction to Analyses
- 2017 Temperature Operation

#3

- Stakeholder Workshop #3
- Preliminary Operations Results
- Science Work Plan Introduction

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Road Map (continued)

#4

- Stakeholder Workshop #4
- Sensitivity Results Update
- Draft Science Work Plan
- 2018 Temperature Operation Proposal

Re-consultation

- Establish Shasta Focus Group under ROC on LTO
- Products and Milestones TBD

On-Going

- Develop Temperature Target Location/Value/Metric Concepts and Studies

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Temperature Model Development Effort

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Insert slides here

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2018 Operational Concepts

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2018 Operational Concepts

- Location
- Value
- Metric

- Contingency

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Discussion Q&A

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