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Risk Informed Climate Planning Scenarios and Adaptation Planning September 2024

California Water and
Environmental Modeling Forum

Andrew Schwarz, P.E
SWP Climate Action Manager

Unique Challenges

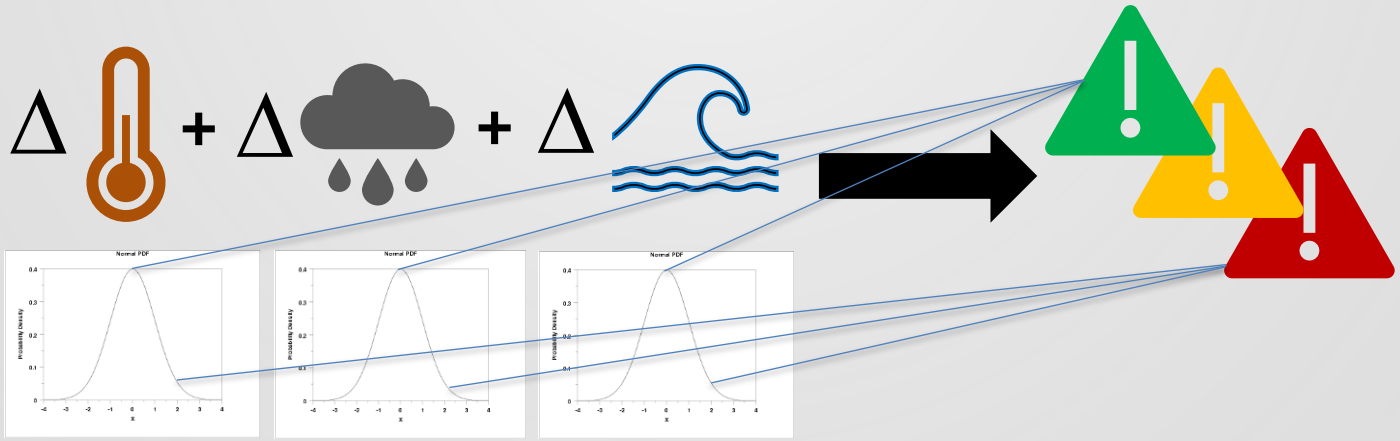
- Data are used as inputs to downstream models
- Existing tools/data structure is deeply embedded
- A wide range of technical sophistication
- Varying degree of reliance/importance across contractors
- Large spatial extent and variability

Enhancement Objectives

- Acknowledge different levels of risk tolerance/risk aversion from different users
- Maintain the utility of the information/work within the tools and processes that our stakeholders have

New Risk Informed Future Climate Scenarios

- Future conditions scenarios evaluate combinations of climate changes (temperature, precipitation, and sea level rise) that represent different levels of risk
  - The "Level of Concern" percent number describes the percent of model informed climate outcomes that would result in better system performance.



These are NOT based on any single projection from a GCM but rather on the ensemble of over 100 LOCA2 Downscaled GCM projections.

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New Risk Informed Future Climate Scenarios

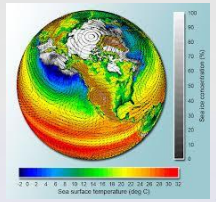
- Newest Science
  - Global climate models, downscaling, sea level rise projections
- New Tools
  - Better representation of intensification of precipitation through use of **Weather Generator**
- New Approach
  - Based on stress-test of SWP/CVP system to provide risk information, not just sensitivity
  - Historical data, operations, and most data processing steps consistent with LTO
- Independent Peer Review

Final Report:
https://data.cnra.ca.gov/dataset/finaldcr2023/resource/e41f531d-dace-4d37-b52e-35a6ddd2224e

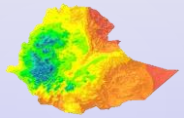
A new hybrid scenario development approach

new DCR scenarios draw on the strengths of both approaches, combining new tools, datasets, and technical advances

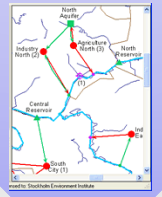
Top-Down Scenario Analysis



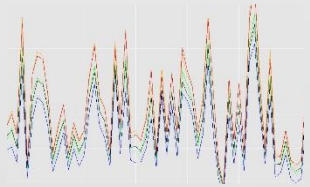
Select a couple of GCM Projections



Downscaling, Hydrologic Modeling

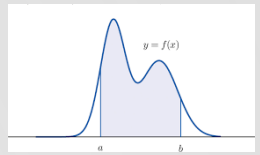


Operations and Planning Models

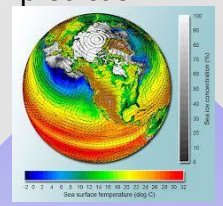


Conditional System Performance Projections

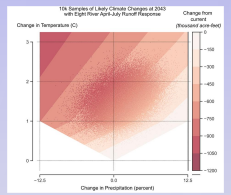
Bottom-Up System Analysis



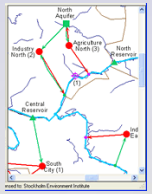
System performance prediction



Climate Model Ensemble



System response surface

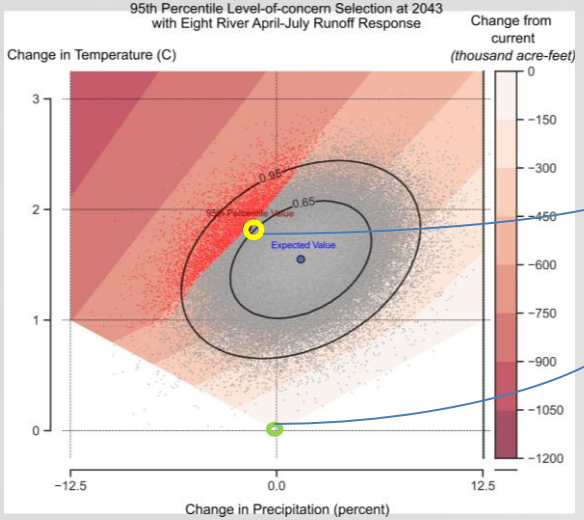


Operations and Planning Models

Process Steps

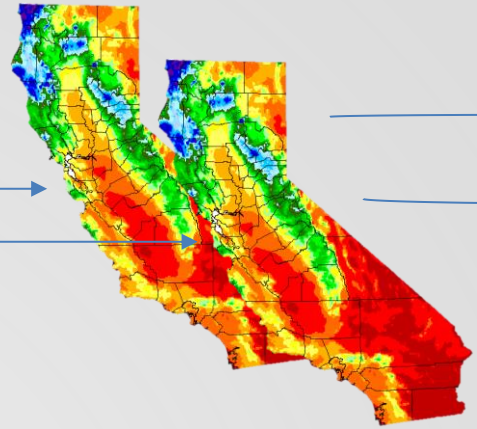
- Evaluate system sensitivity through stress testing
- Identify key performance metric(s)
- Define future climate uncertainty/plausibility space
- Assess risk to system by linking stress test and climate uncertainty space
- Identify climate shifts at defined risk thresholds
- Generate scenarios at identified climate shifts
- Run system model (CalSim3) with generated scenarios

New Process Steps



Weather Generator (Najibi and Steinschneider, 2023)

Provide the selected ΔT, ΔP_{ave} for input to the weather generator.



Use the weather generator to create a complete, statewide 100-year daily gridded T and P dataset (Historical and Climate Scenario)

Adjust inputs to CalSim3

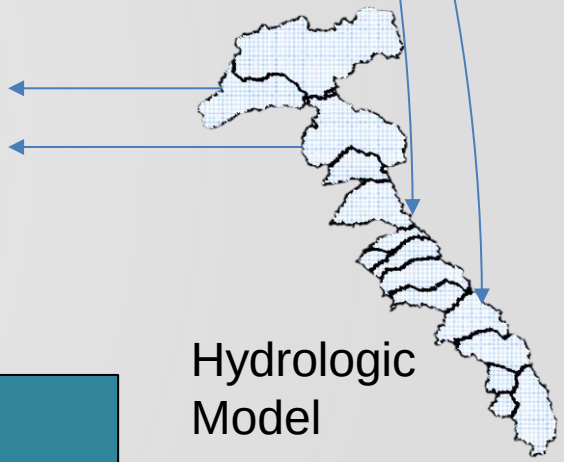
Use the method developed by Jacobs for adjusting the historical streamflow, precipitation, temperature, and ET input datasets for climate changed future scenarios to generate all necessary Calsim3 inputs for each climate change scenarios.

CalSim3 Climate Scenario Runs/Operational Adjustments and Refinements

Apply NASA/OPR SLR guidance to inform levels of SLR to pair with each scenario

DCR 2023 *(December 2023)*

- 1 Historical CalSim3 Run
- 1 Historical Adjusted Current Climate Conditions Run
- 3 Risk informed climate scenarios (50th, 75th, 95th exceedance level of concern)
- Full t/p statewide grids consistent with scenarios
- Guidance for using the scenarios
- Documentation of Scenario Development (Peer Reviewed)



Hydrologic Model

Run the climate changed and baseline T and P datasets through the VIC hydrologic model to generate streamflow at 201 streamflow points needed for CalSim3.

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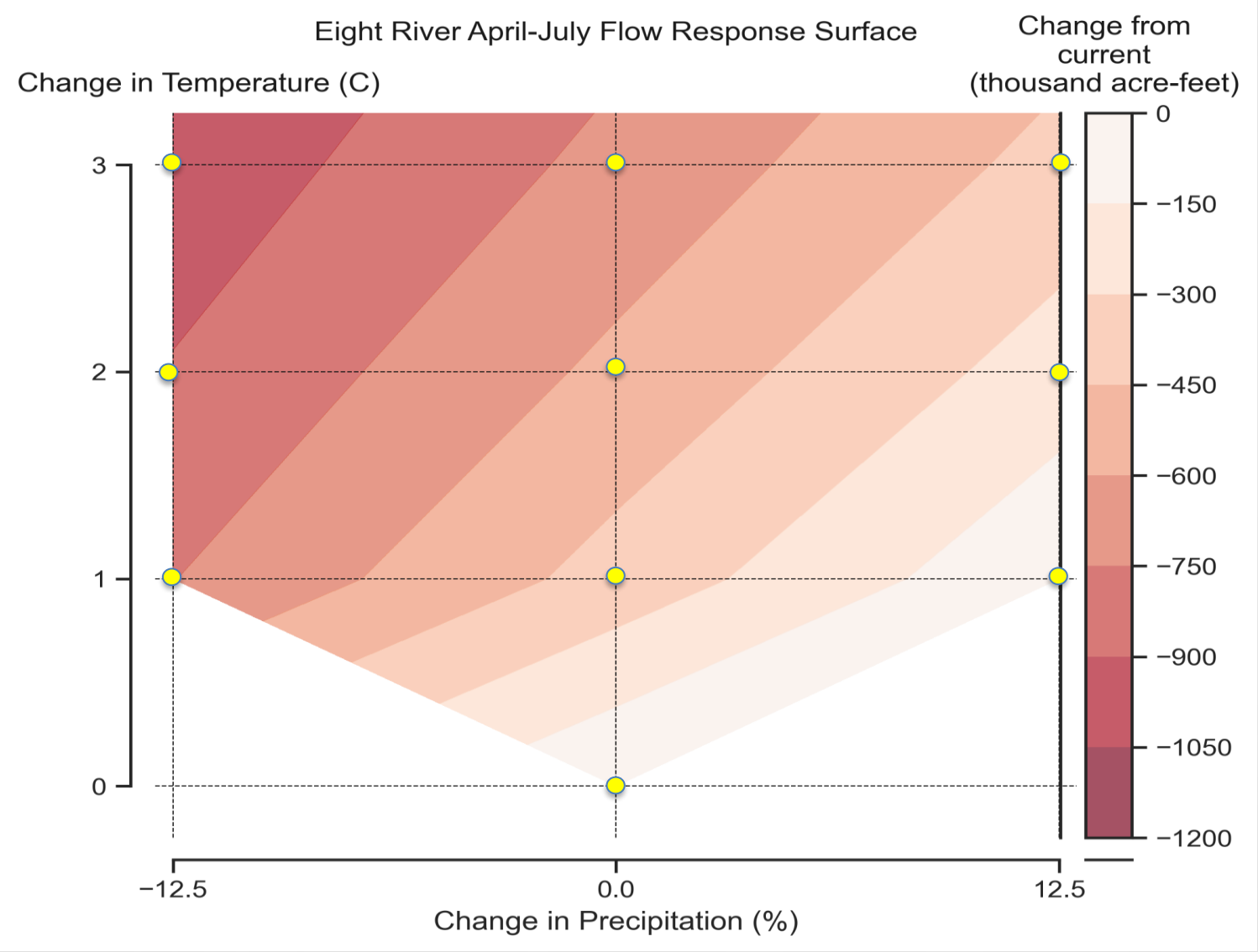
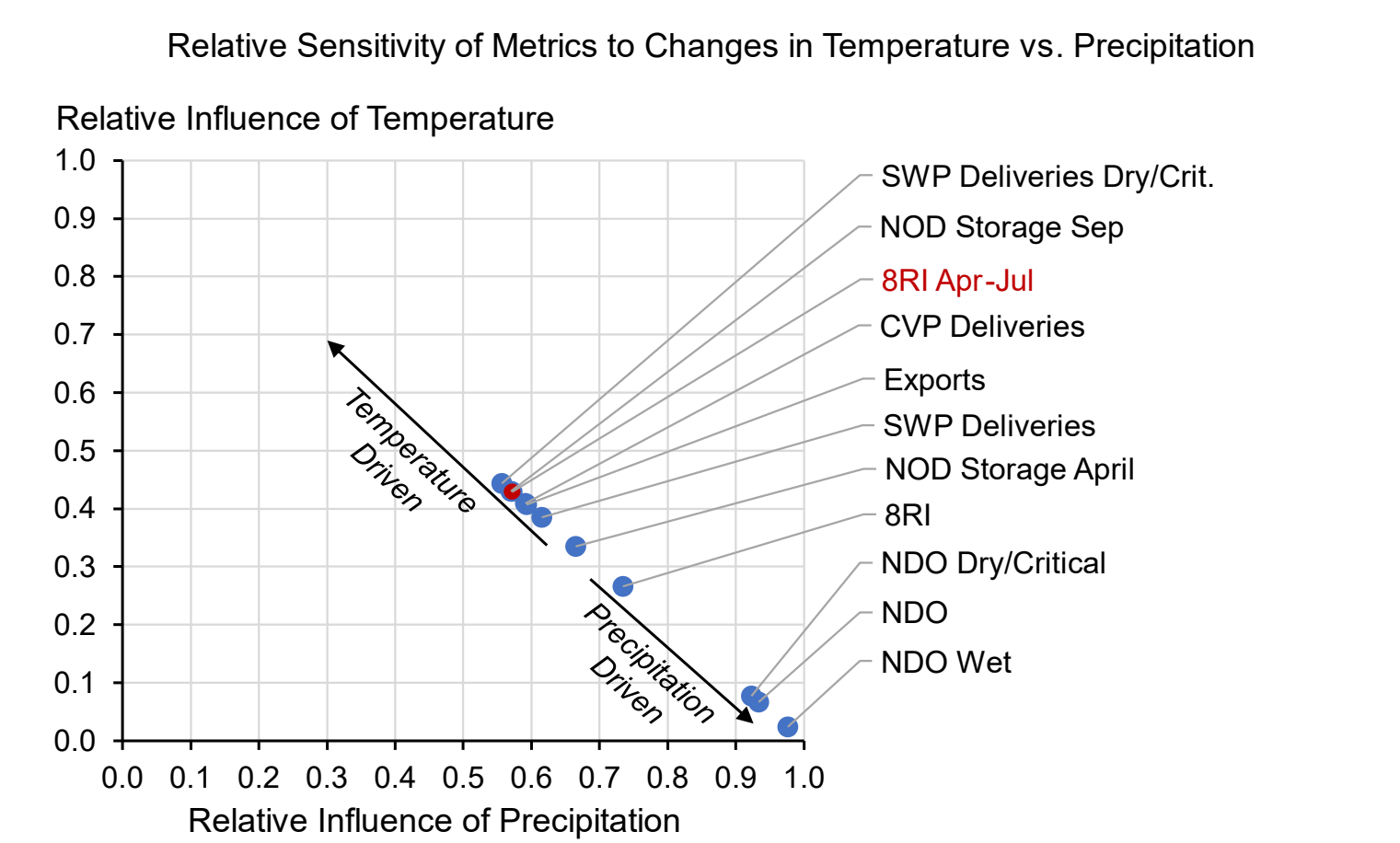
System Stress Testing

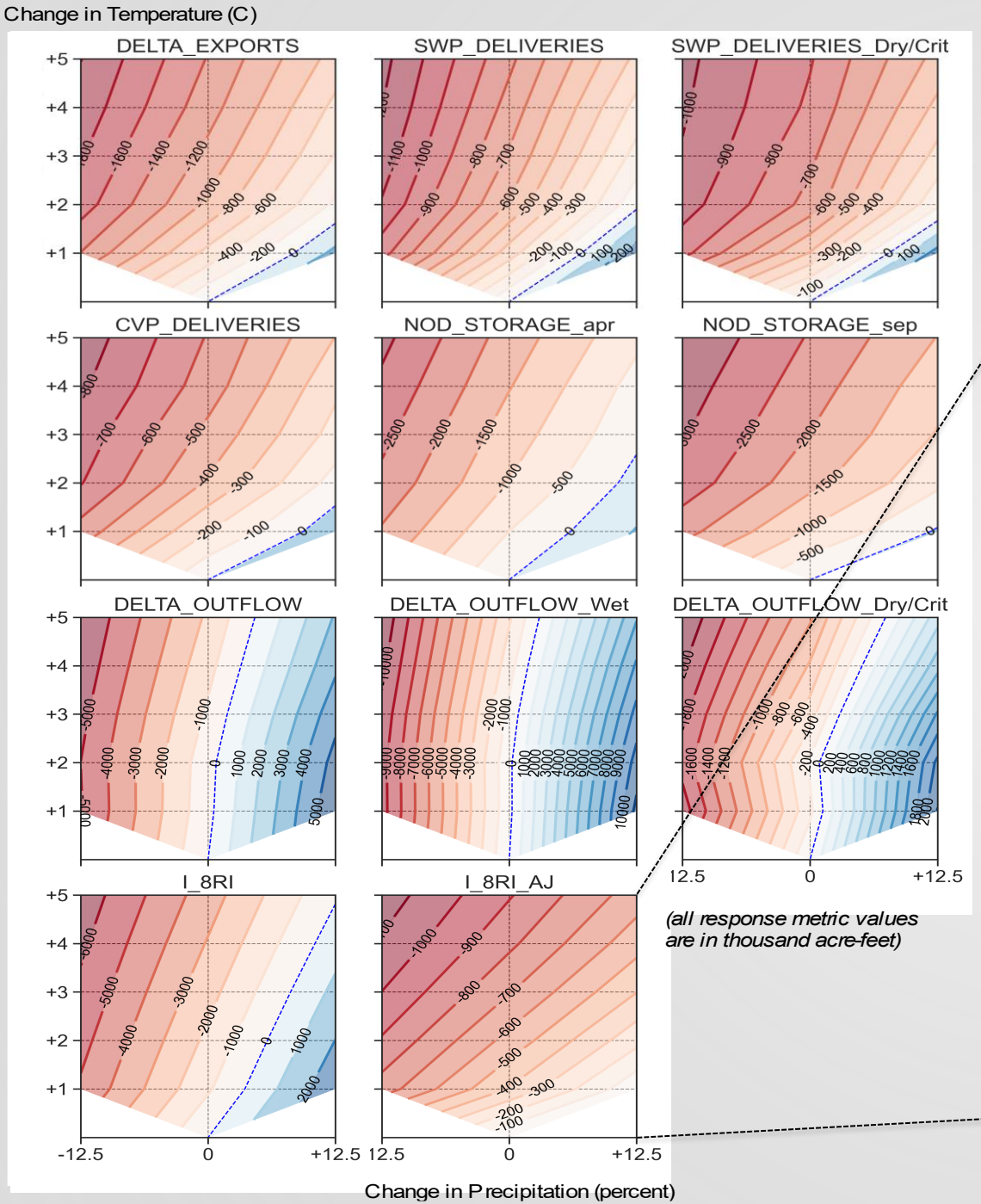


Weather Generator data run at systematic change levels to explore system sensitivity and create response surfaces

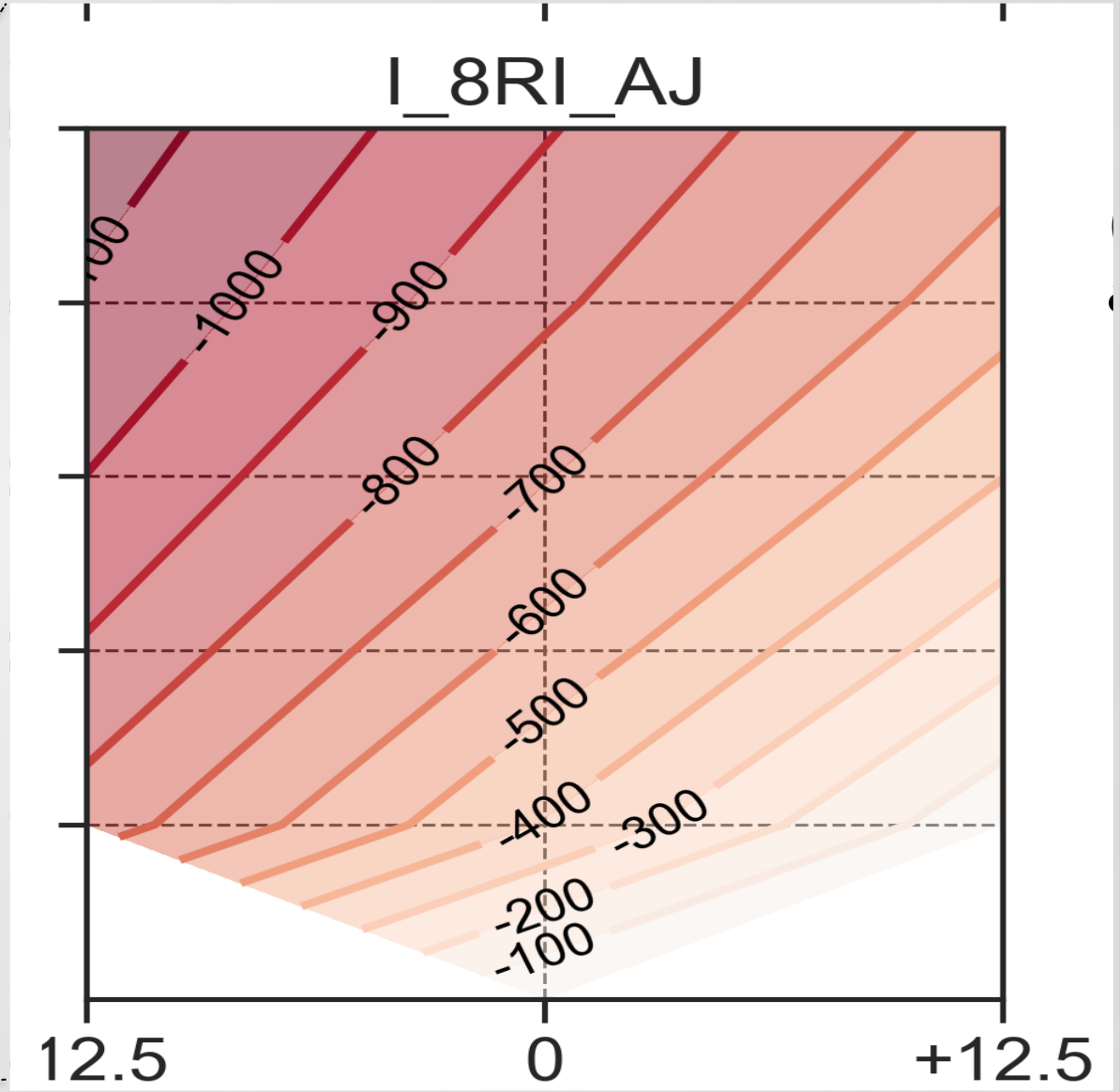
Measuring System Performance



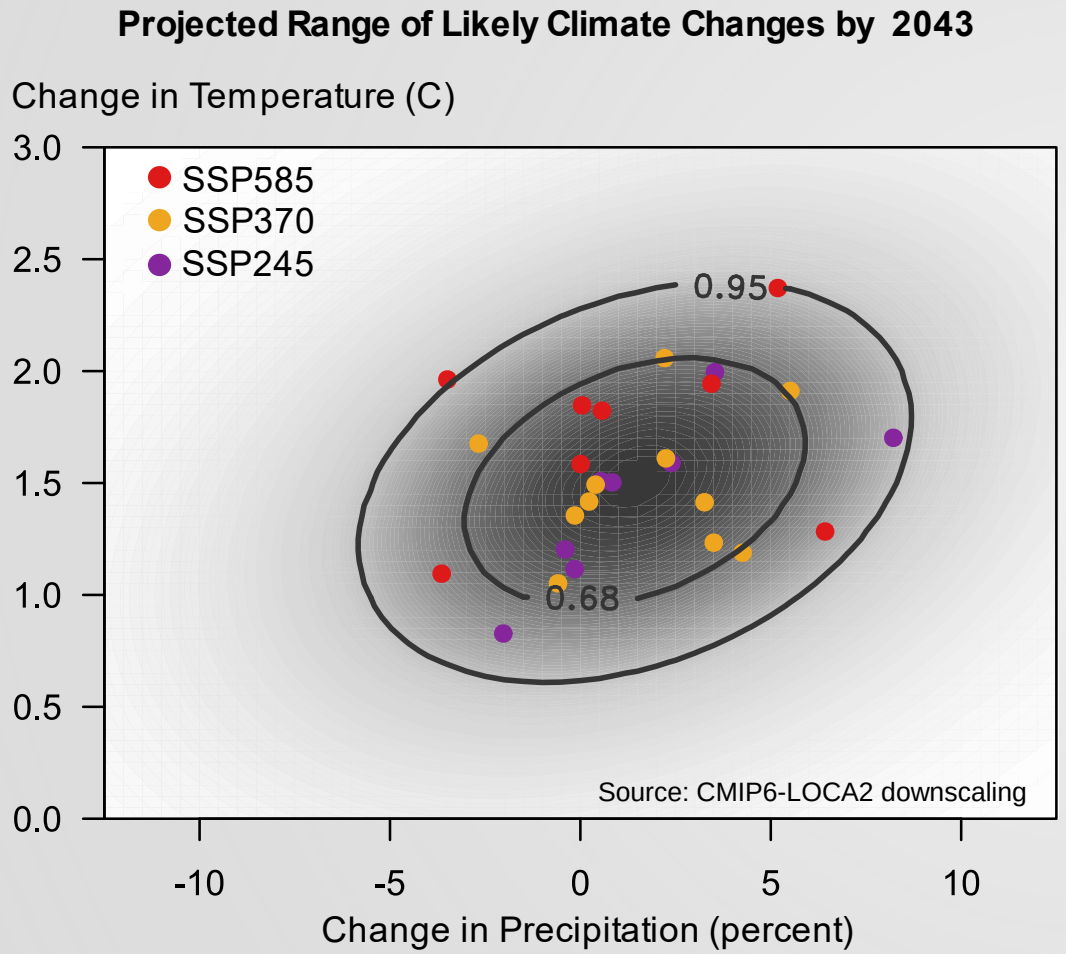
- Good proxy for generalized system consequences
- Higher temperature sensitivity helps pick up important environmental objectives
- Captures both amount and timing of runoff
- Easily understandable and not SWP/CVP specific
- Makes scenarios more broadly applicable to other purposes and consistent statewide/local modeling
- Unimpaired flow metric is not sensitive to potential changes in regulation or operations
- Not sensitive to sea level rise, so sea level rise can be incorporated independently into the scenario inputs to CalSim 3.

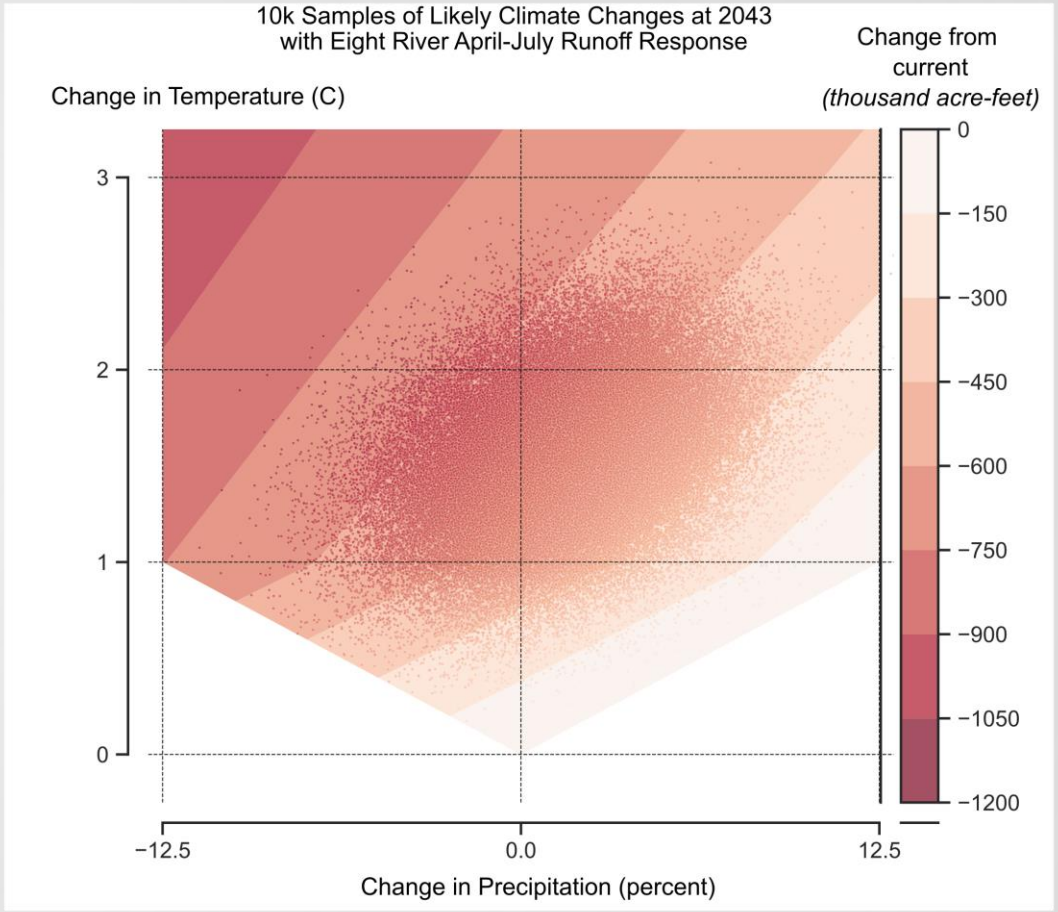


(all response metric values are in thousand acre-feet)



Define future climate uncertainty/plausibility space





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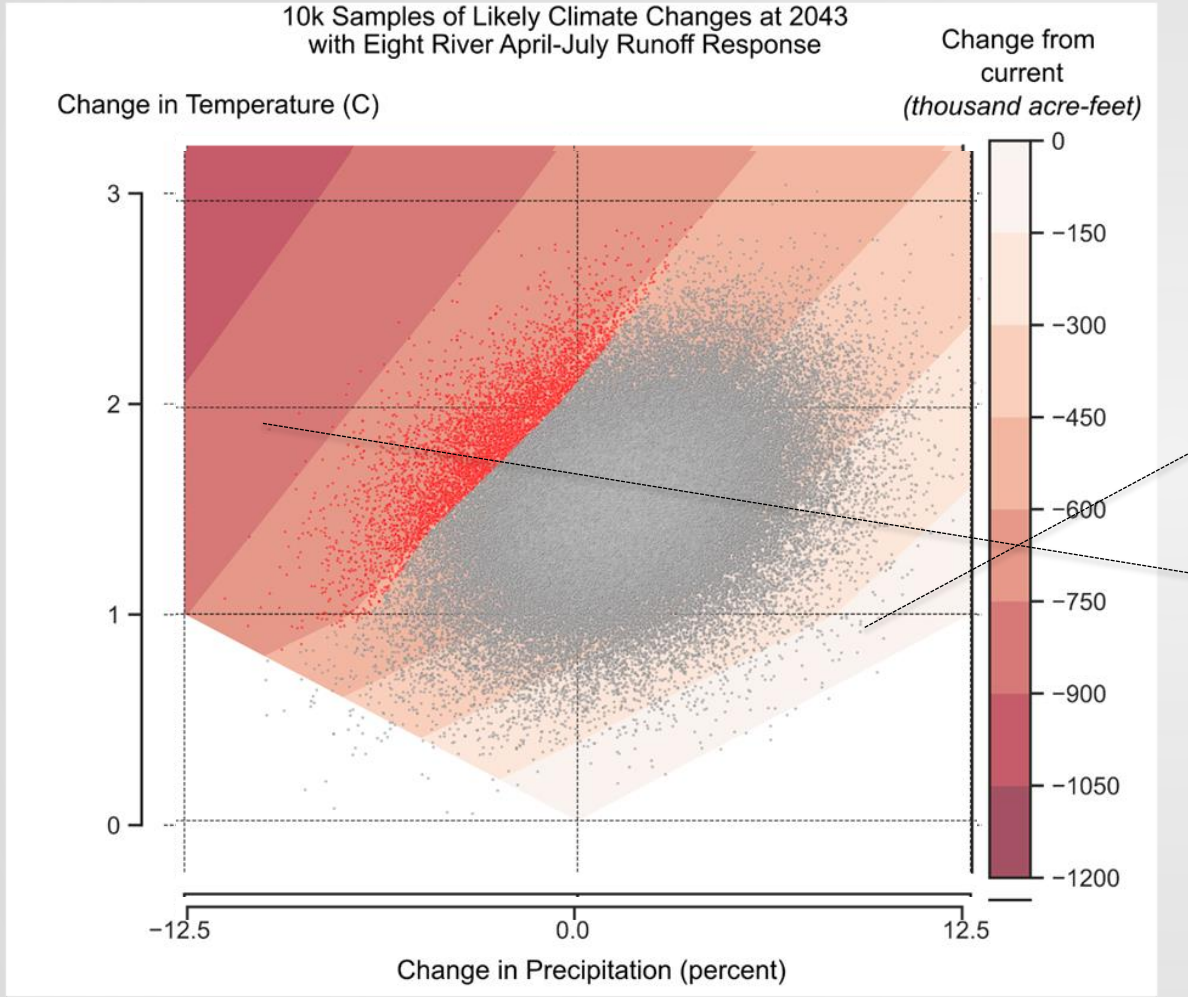
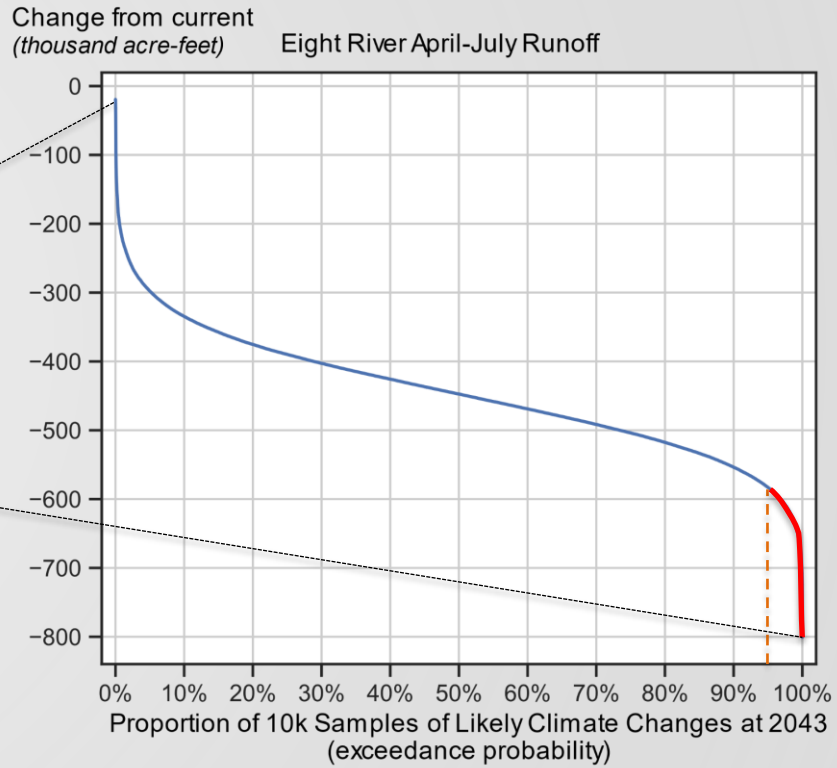
Link stress test and climate space and assess risk





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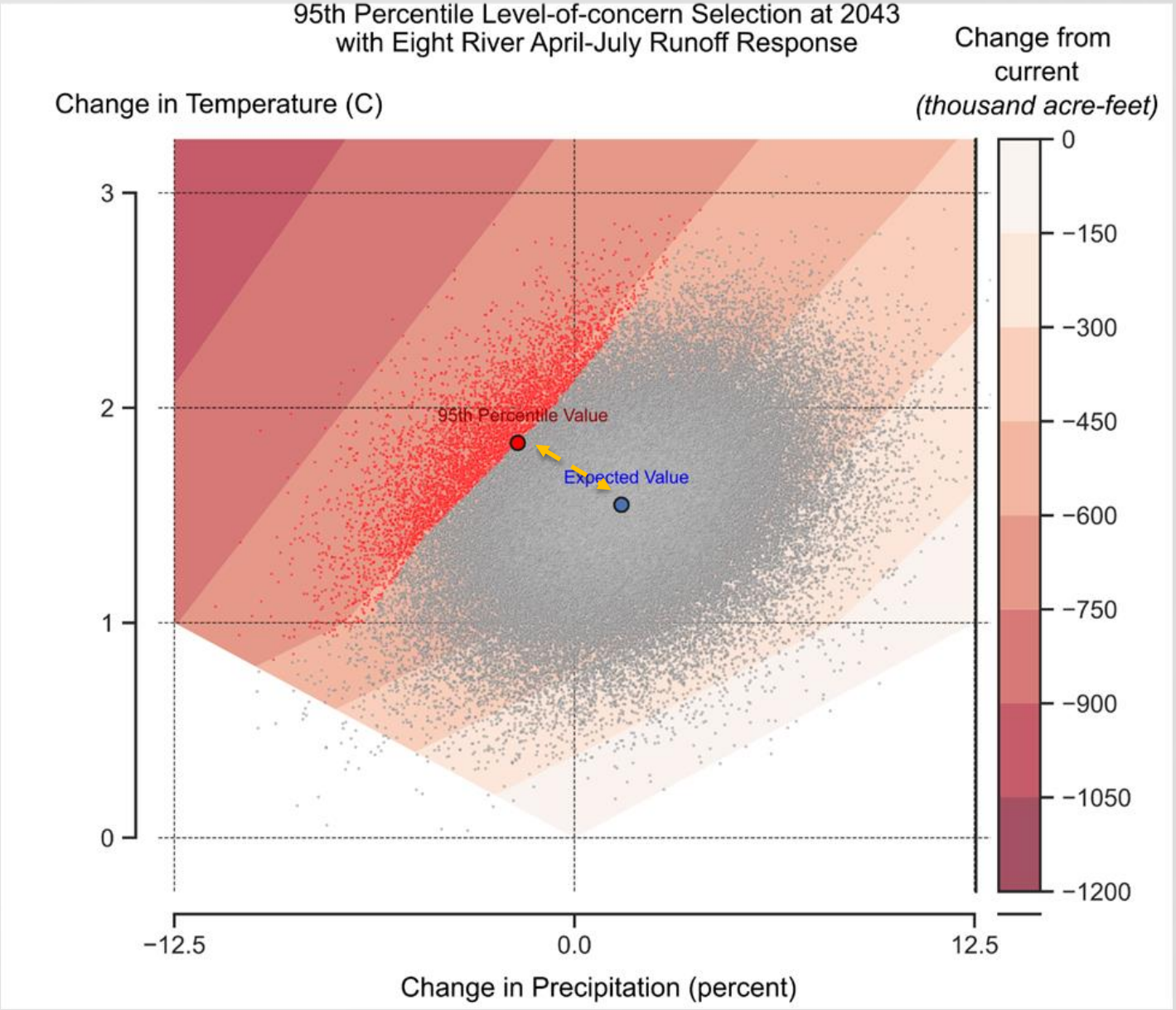
Identify climate shifts at defined risk thresholds

2043 Conditions

Expected Value/
Central Tendency: **+1.5˚C, 1.5% wetter**

95th Percentile
Level-of-Concern: **+1.8˚C, 1.8% drier**



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Generate scenarios at identified climate shifts and Run system model (CalSim3) with generated scenarios

*2nd Use of Weather Generator

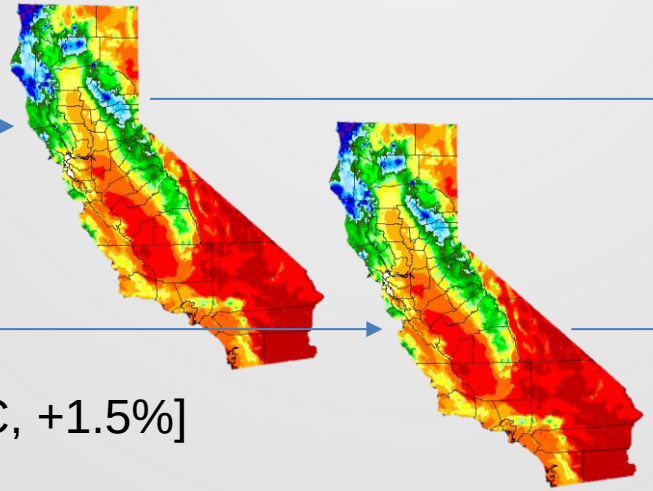
Specific climate forcings fed into Weather Generator to create future scenarios at specific defined climate change levels

Weather Generator (Najibi and Steinschneider, 2023)

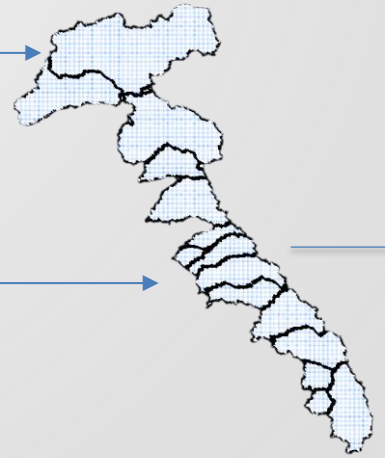
baseline

climate scenarios [e.g., +1.5 C, +1.5%]

100-year daily gridded temperature and precipitation



100-year daily gridded runoff data



Adjusted CalSim3 and CalSimHydro Inputs

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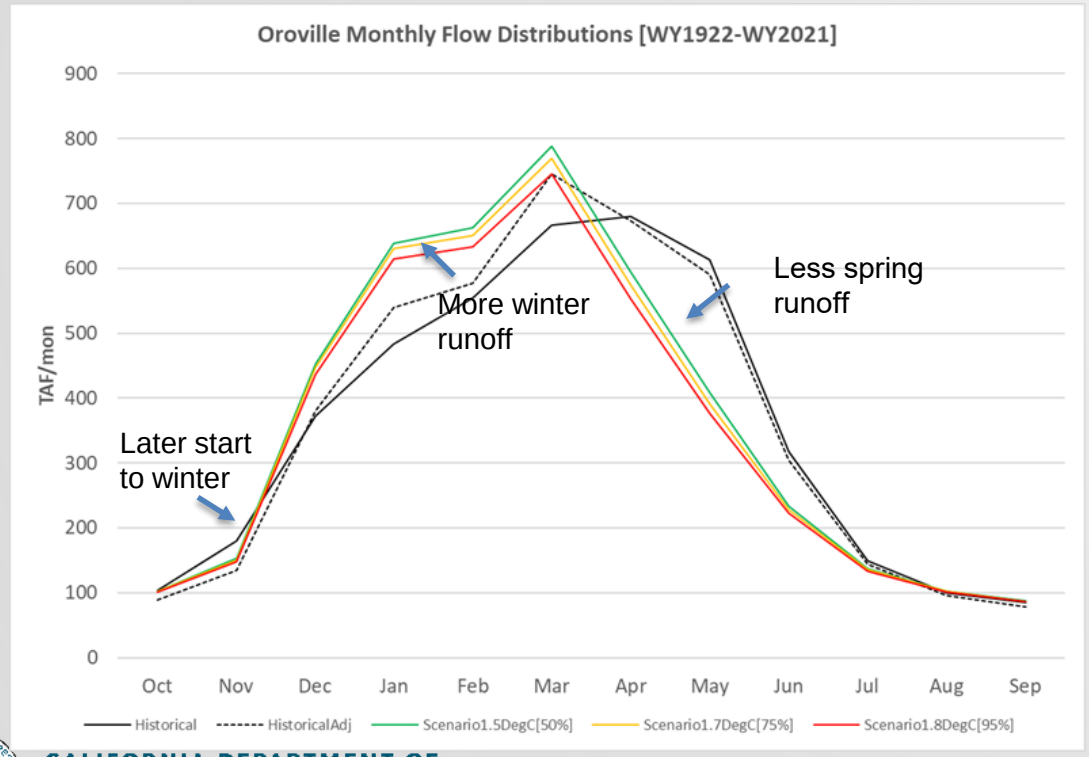
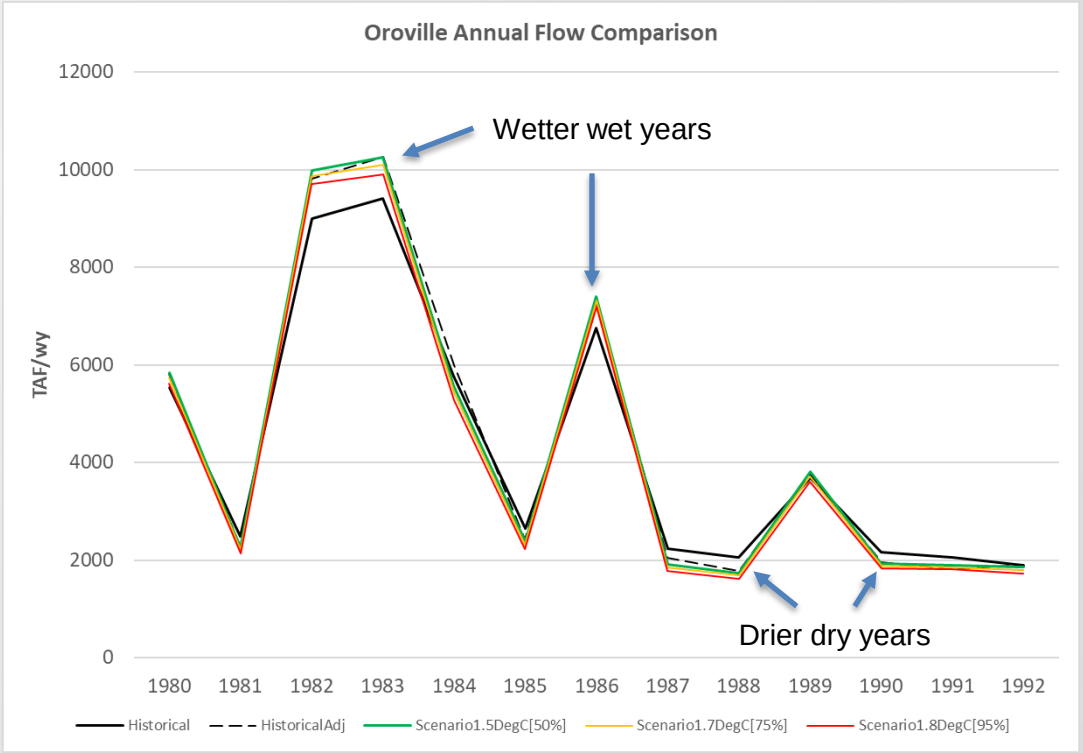
Future Climate Scenario Impacts

Level of Concern (Percentile)	2043 Change in Temperature	2043 Change in Precipitation	2043 Precipitation Intensification	2043 Sea Level Rise	Change in Average April 1 Snow Water Equivalent (TAF)	Change in Average Annual 8 River Index Flow (TAF)	Change in Average April to July 8 River Index Flow (TAF)
50th	1.5°C	+1.5%	11%	15 cm	-2,633	-156	-1,852
75th	1.7°C	+0.1%	12%	30 cm			
95th	1.8°C	-1.8%	13%	30 cm	-3,158	-1,261	-2,474





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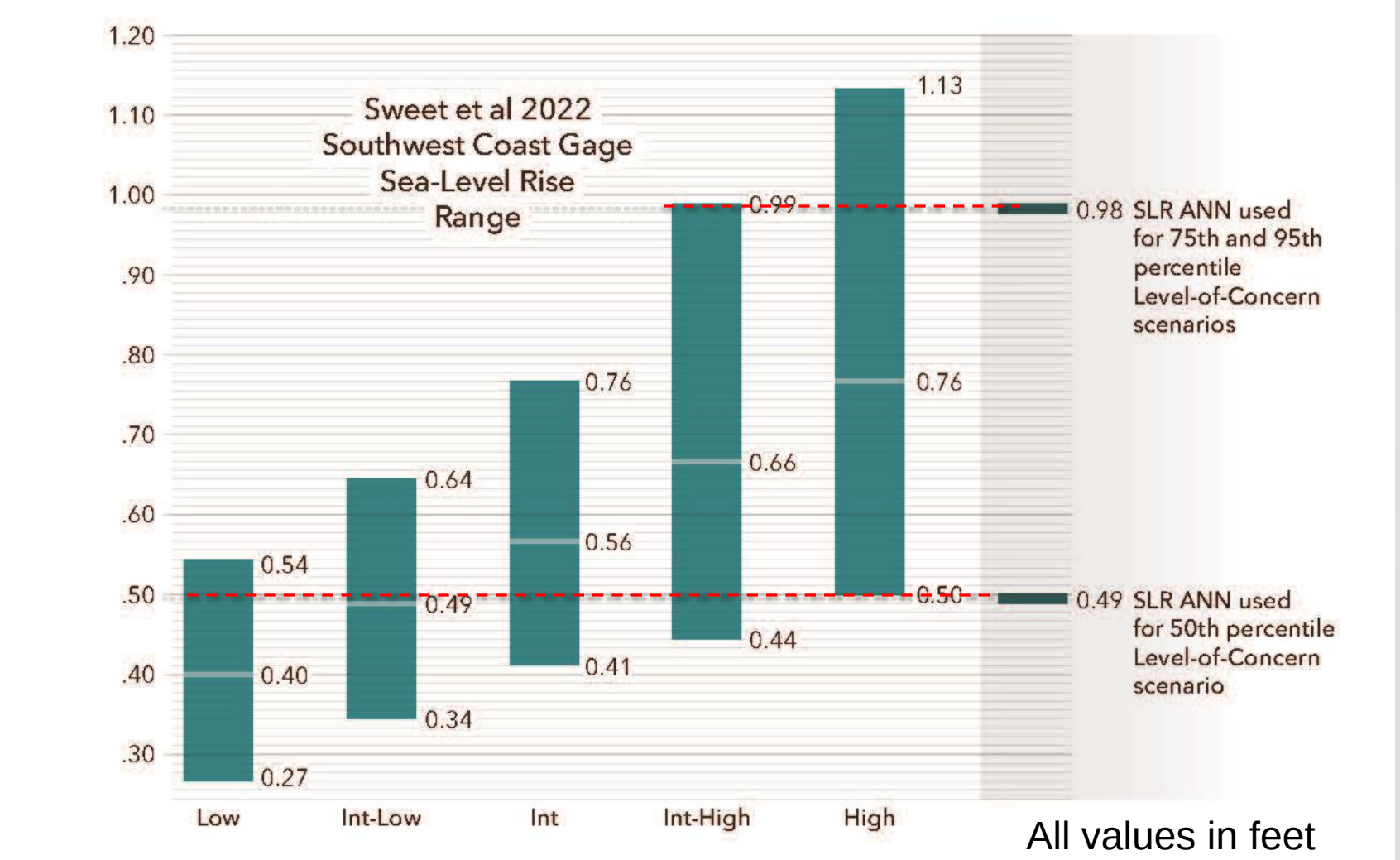
Draft figures subject to change

Sea Level Rise Increments



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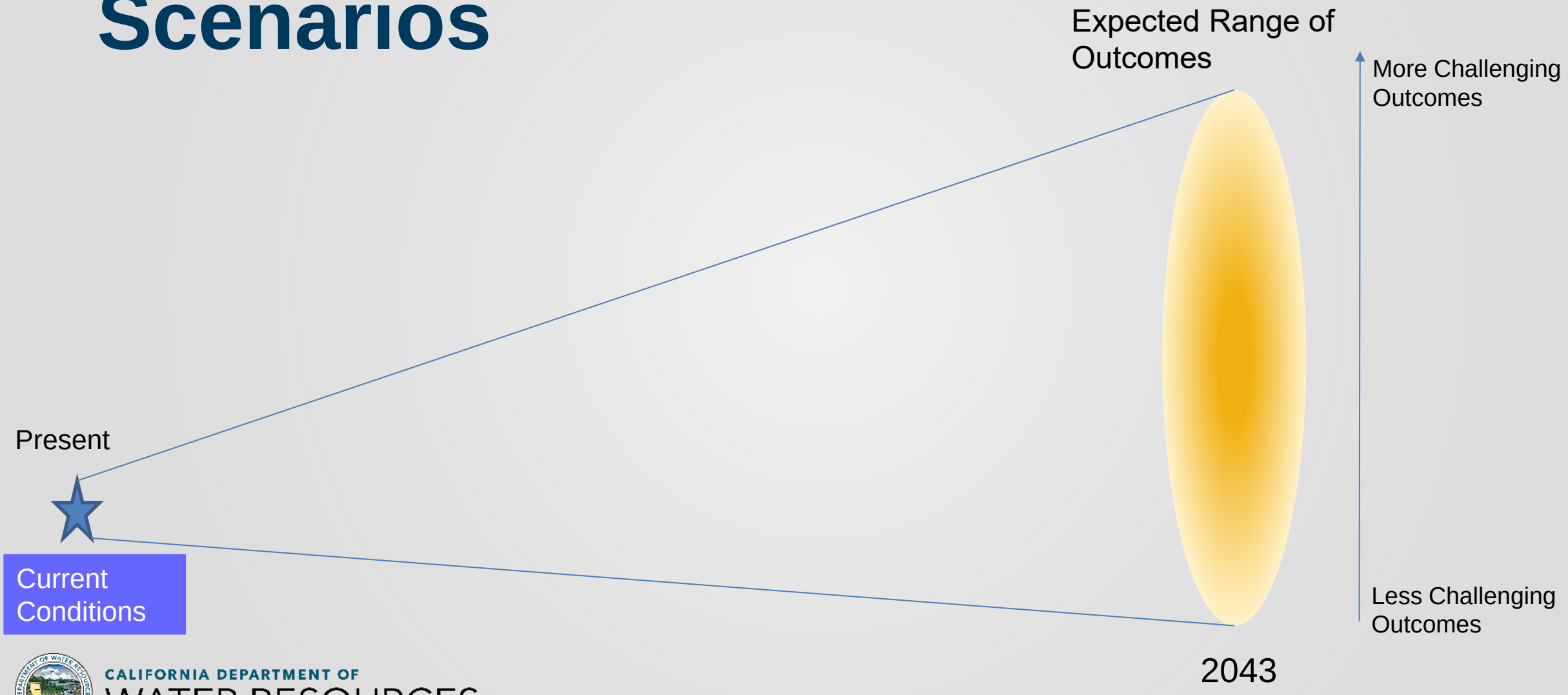
New Risk Informed Future Climate Scenarios



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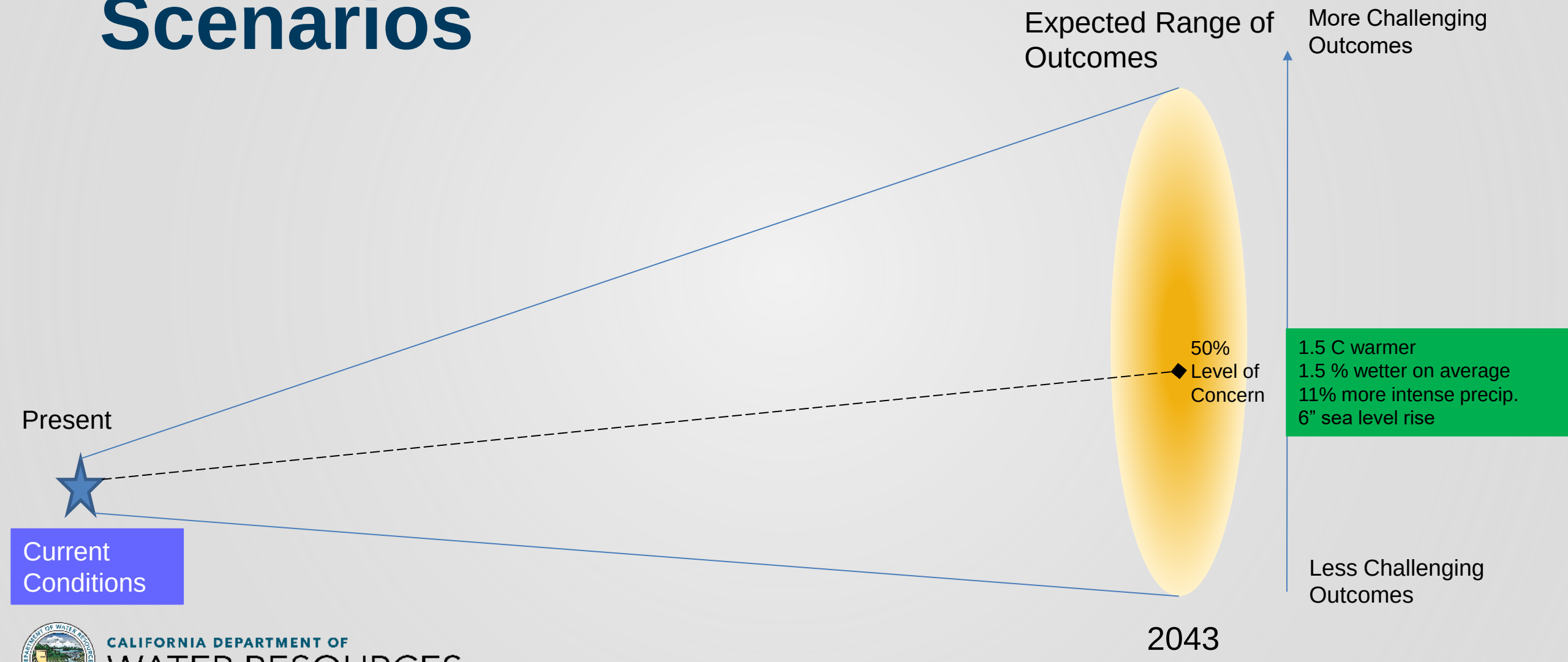

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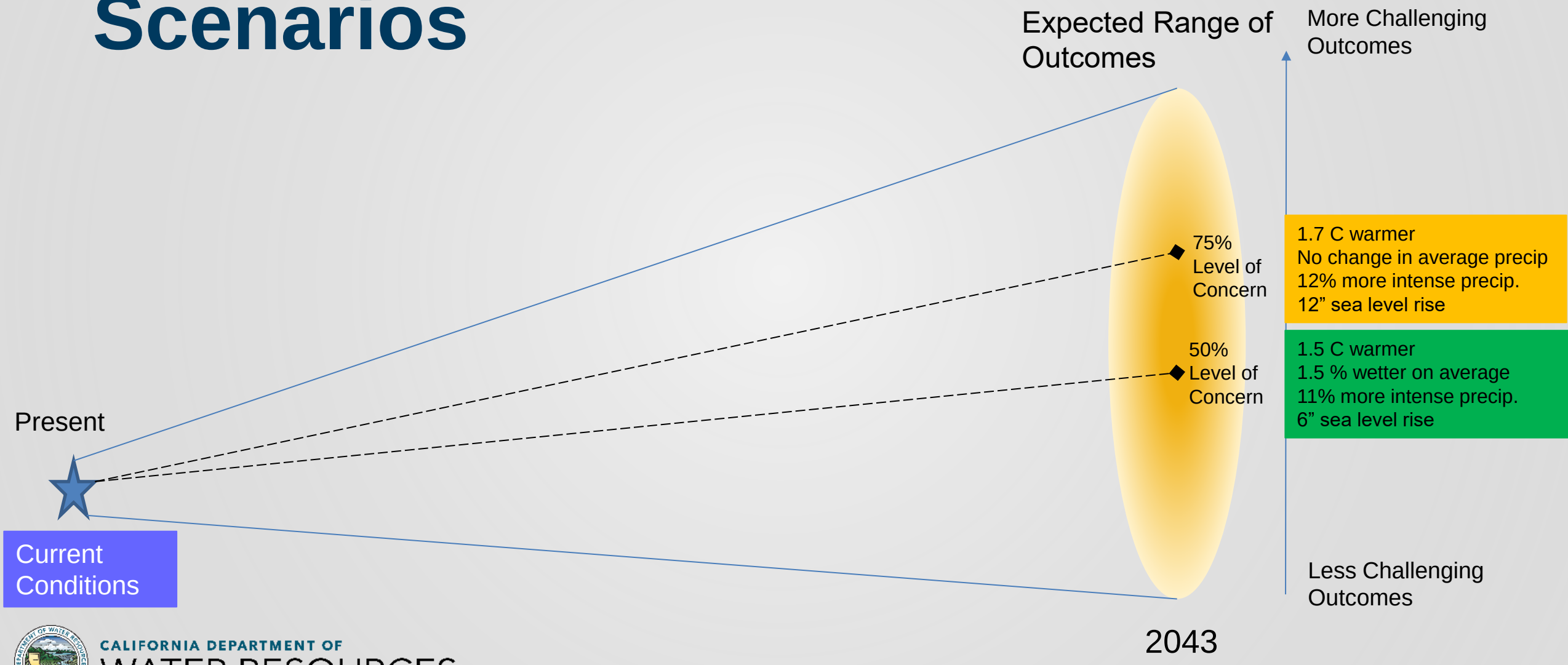

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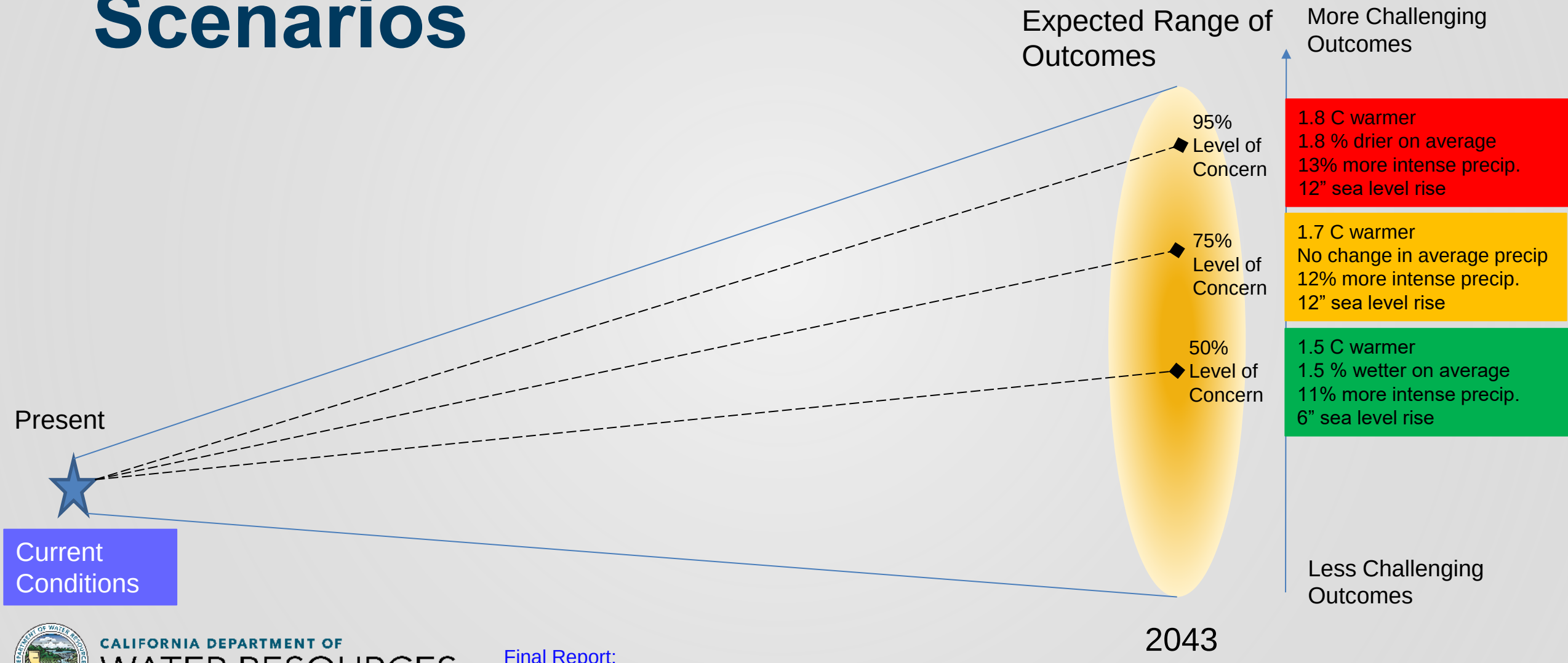

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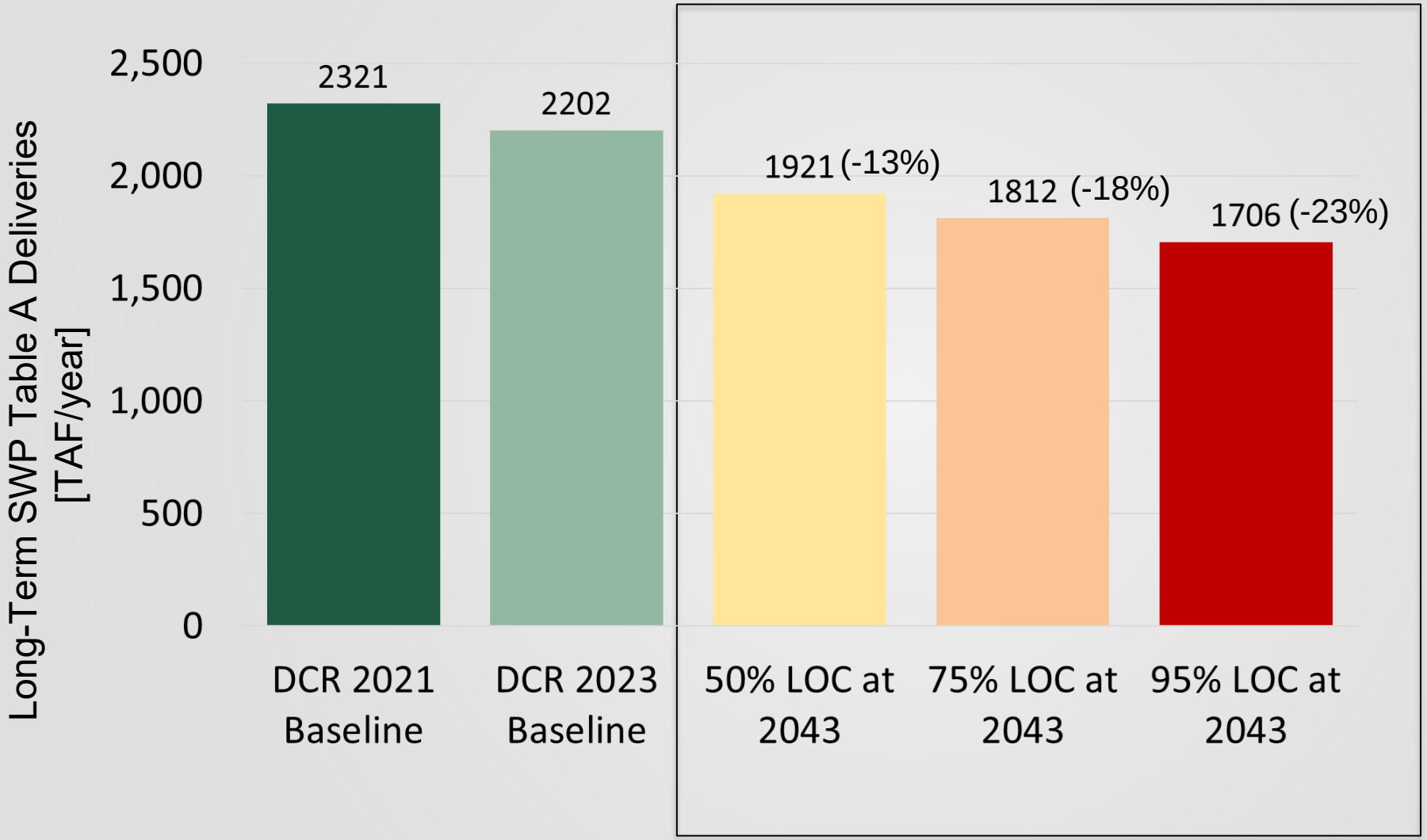
Average Annual SWP Table A Deliveries



Climate change with NO adaptation likely to decrease average long-term deliveries by

13-23%

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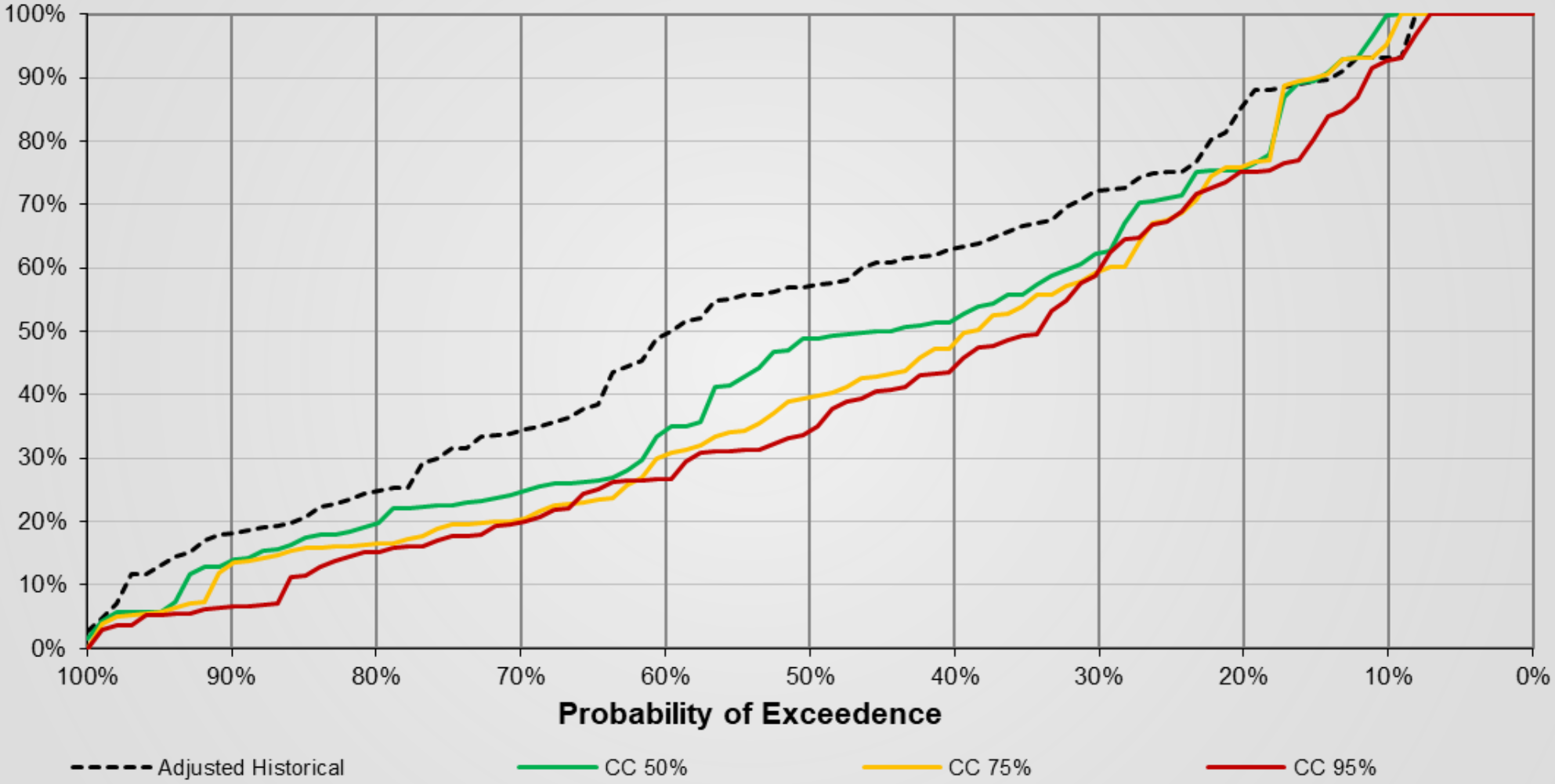
Final Report: https://data.cnra.ca.gov/dataset/finaldcr2023/resource/92356681-957a-48ee-97c4-529d25b9dbb2

State Water Project Table A Allocation (End-of-May)



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SWP Climate Adaptation Plan

We can change to keep up with climate

- **SWP is developing several significant projects that would provide climate adaptation and resilience**
- **Evaluate the current strategies alone and in combination**

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Key Benefits of this Study

- Builds on top of DCR work—alternative futures where we have improvements in place by 2045
- Looks further into the future (2085) to the end of the current water supply contracts with and without adaptation
- Shows how combinations of projects are more than the sum of their parts
- Shows how SWP is preparing for a hotter more extreme future

Key SWP Adaptation Measures

Structural Measures

- **Delta conveyance project**
- **California aqueduct subsidence project**
- **Increased south of Delta storage**
- Delta barriers
- Pumped storage and other energy benefits identified in flexible resource study

Operations and Management Measures

- **Forecast informed reservoir operations/Lake Oroville flood control manual update**
- **SWP enhanced asset management**
- Improved seasonal forecasting
- Revised carryover storage targets
- Shaping SWP power load and generation
- Enhanced financial management and contract extensions
- SWP Delta islands management
- WSIP project integration
- Reservoir temperature management

Nature Based Solutions

- Recreation development
- Feather river watershed management
- Environmental restoration

DCR Key Take Aways

- If we don't act:
  - Changes in snow accumulation, precipitation, temperature, and sea level will reduce deliveries
  - Average SWP deliveries ↓ by >10% by 2043
  - Dry/Critical Year SWP deliveries ↓ by >20% by 2043
  - **That doesn't mean there isn't water, its just that our current infrastructure wasn't designed for these conditions, we can adapt…**

Adaptation Plan Key Take Aways

- SWP Adaptation Plan will show:
  - How adaptation can lead to alternative futures and mitigate climate impacts
  - Which adaptation strategies are most important/impactful
  - How multiple adaptation strategies work together
  - Residual vulnerabilities

Andrew.Schwarz@water.ca.gov

THANK YOU

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