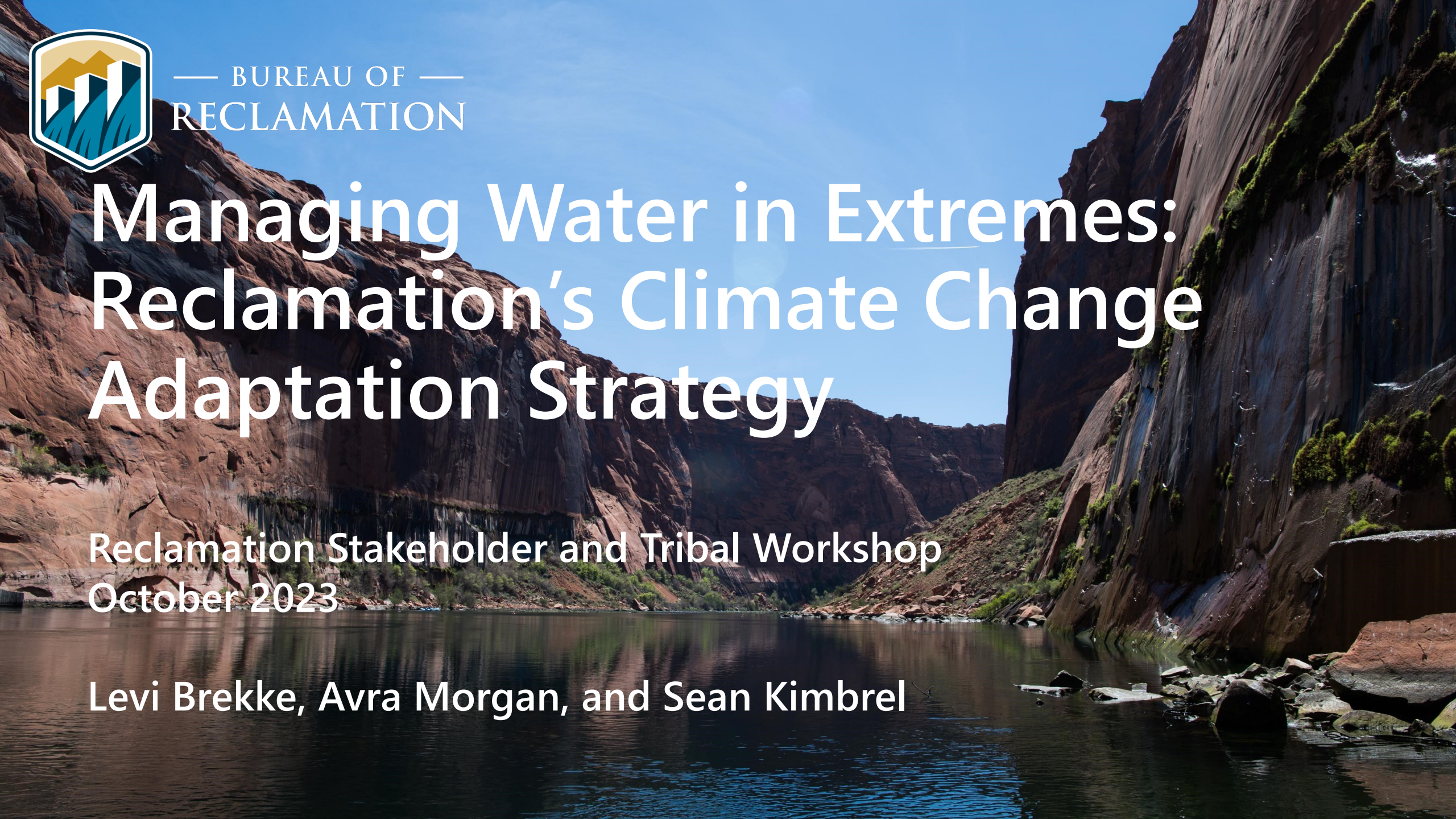


BUREAU OF RECLAMATION

Managing Water in Extremes: Reclamation's Climate Change Adaptation Strategy

Reclamation Stakeholder and Tribal Workshop
October 2023

Levi Brekke, Avra Morgan, and Sean Kimbrel

Managing Water in Extremes: Agenda

- How is climate change impacting water managers?
- What is Reclamation doing about it?
- What resources can Reclamation provide to our partners and stakeholders?
- Q&A

Photo: Lone Rock, Lake Powell, Utah

About the Bureau of Reclamation

Managing Water and Power in the Western United States

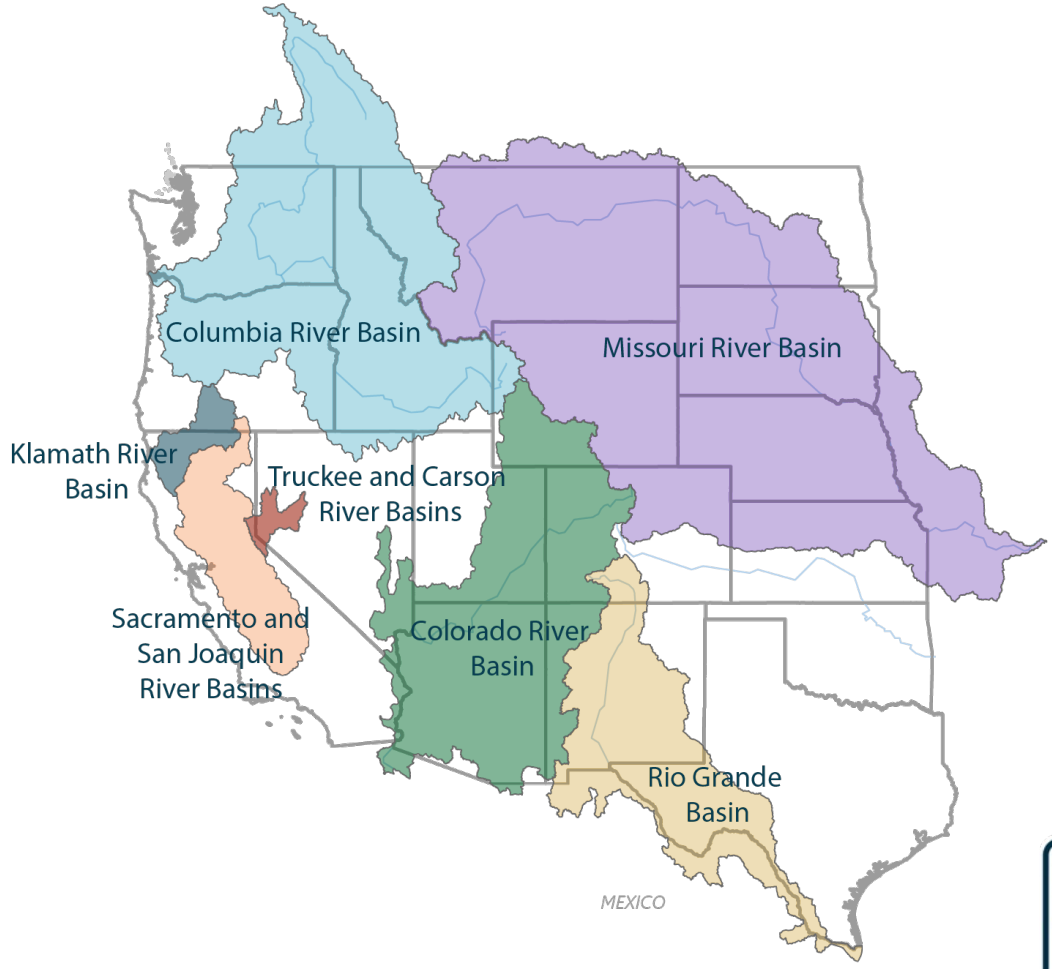
RECLAMATION PROVIDES water to **140,000** Western farmers

10 Million
acres of farmland irrigated by Reclamation water

60% **25%**
The percent of the Nation's vegetables, fruits, and nuts produced by Reclamation water

2nd
largest producer of hydroelectric power in the United States

53
powerplants owned and operated by Reclamation, generating over 40 billion kilowatt-hours each year, on average



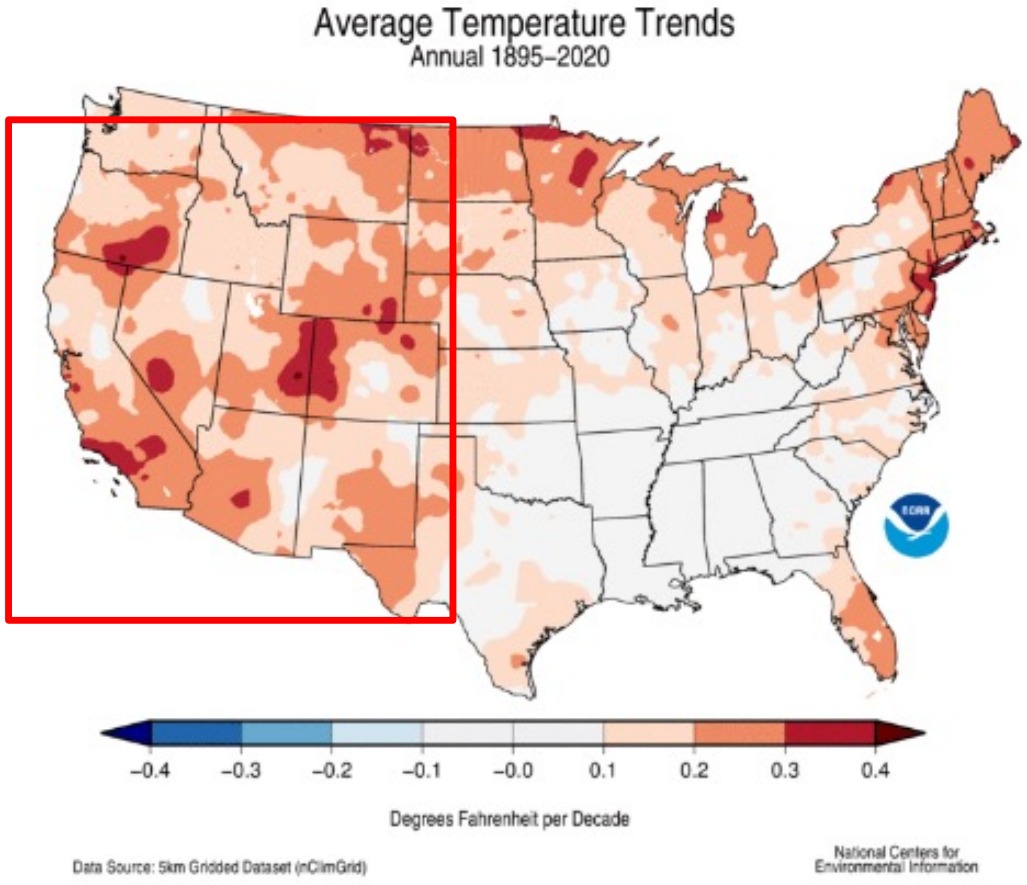
Managing Water in Extremes: How is climate change impacting water managers?

- Historical trends
- Projected changes
- Recent extremes
- Implications for water management

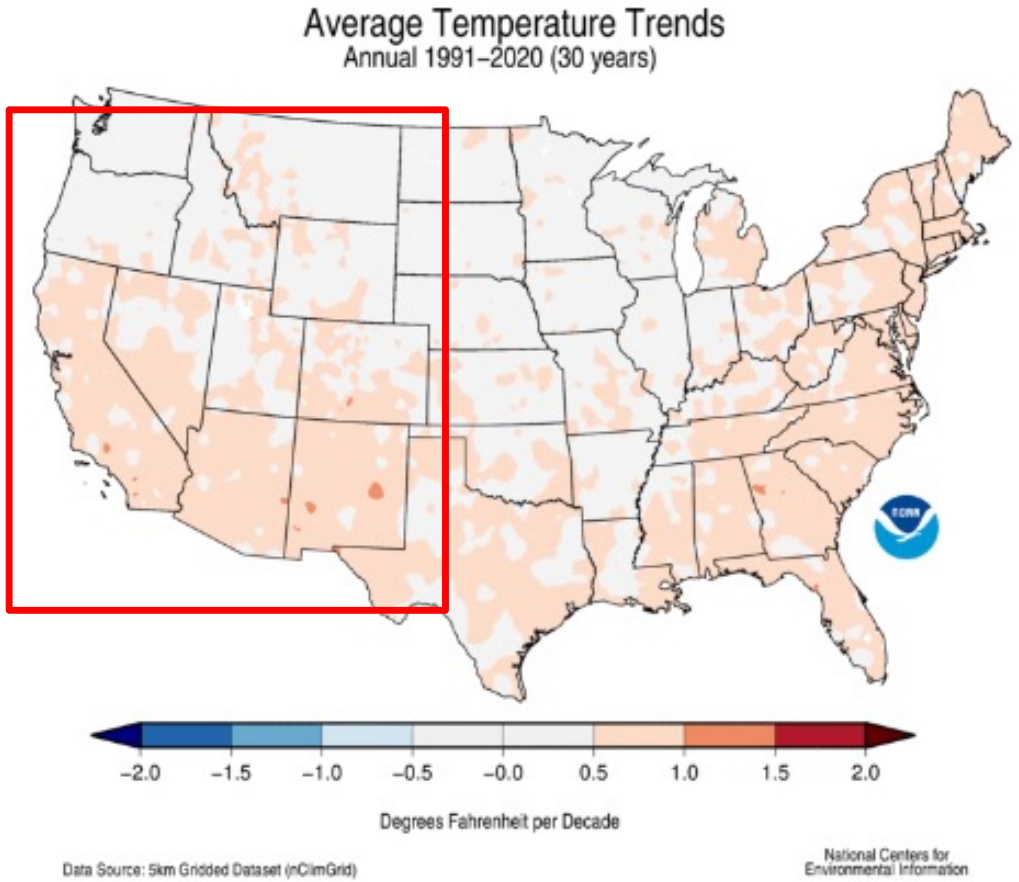
Photo: Shasta Dam, California

Historical trends: temperature

Long-term



Last 30 years

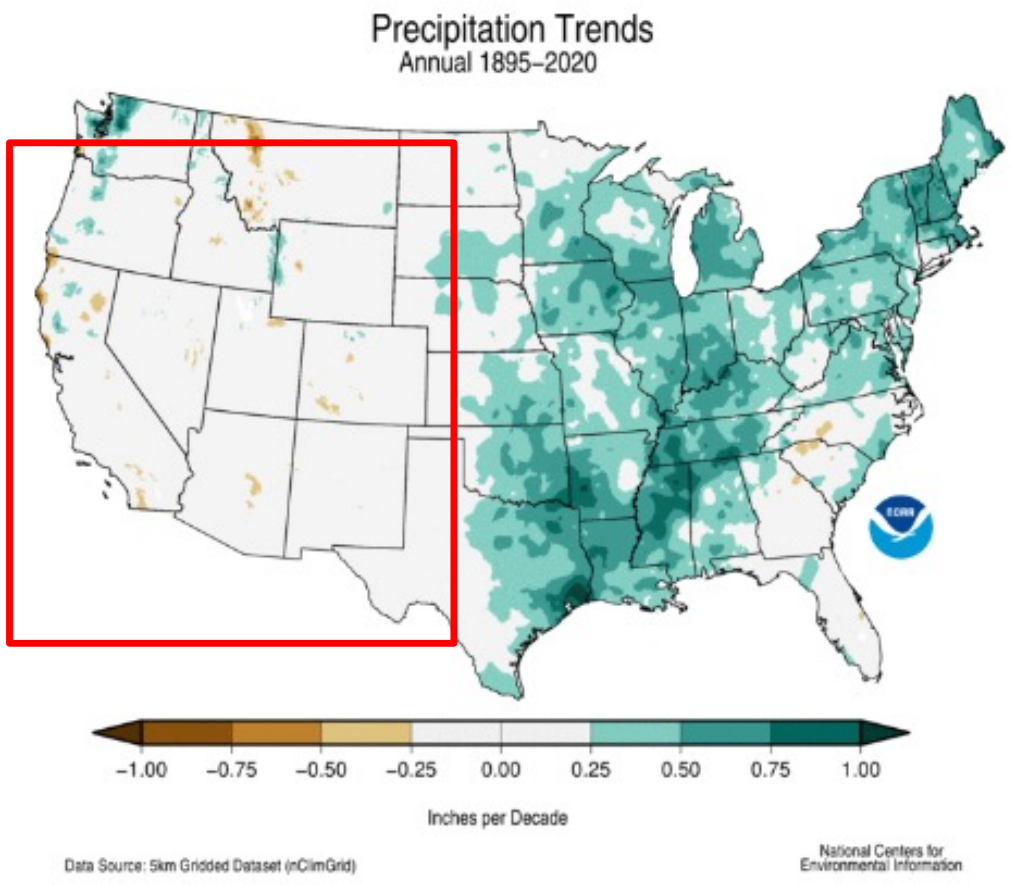


Strong warming trends are observed at the century scale ***and*** over recent decades

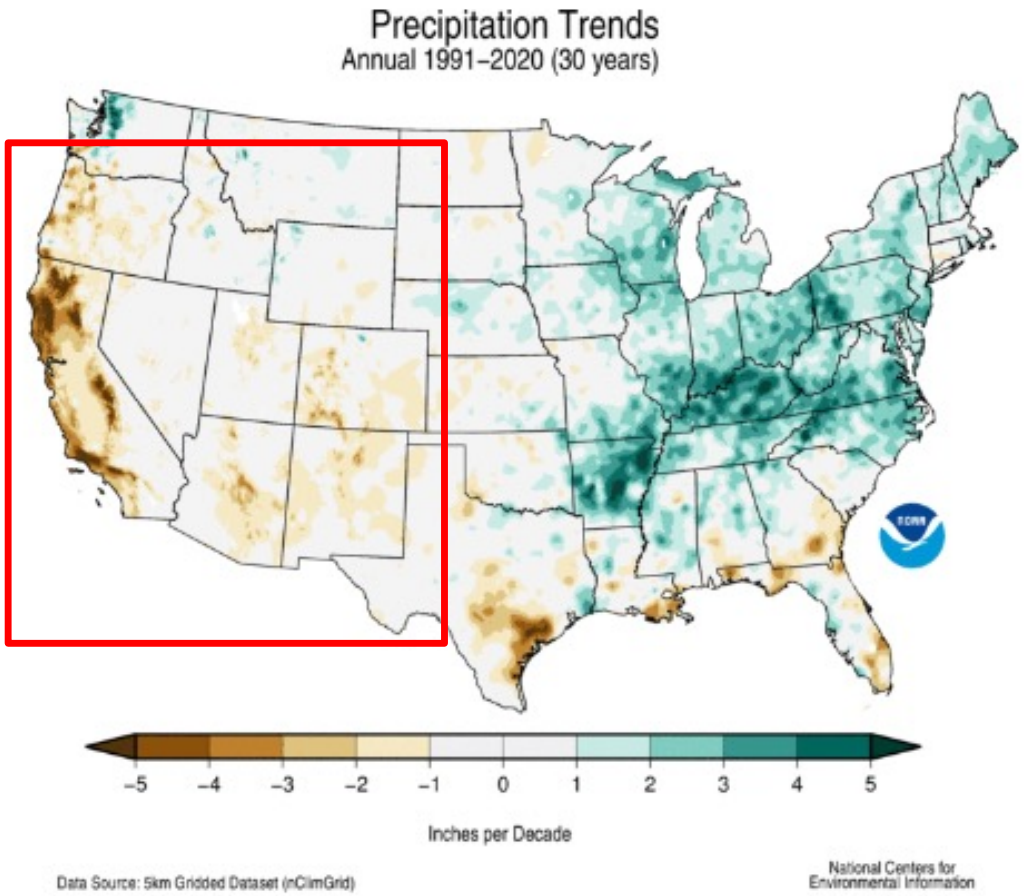
Note: color bar ranges are different, recent trends are stronger

Historical trends: precipitation

Long-term



Last 30 years

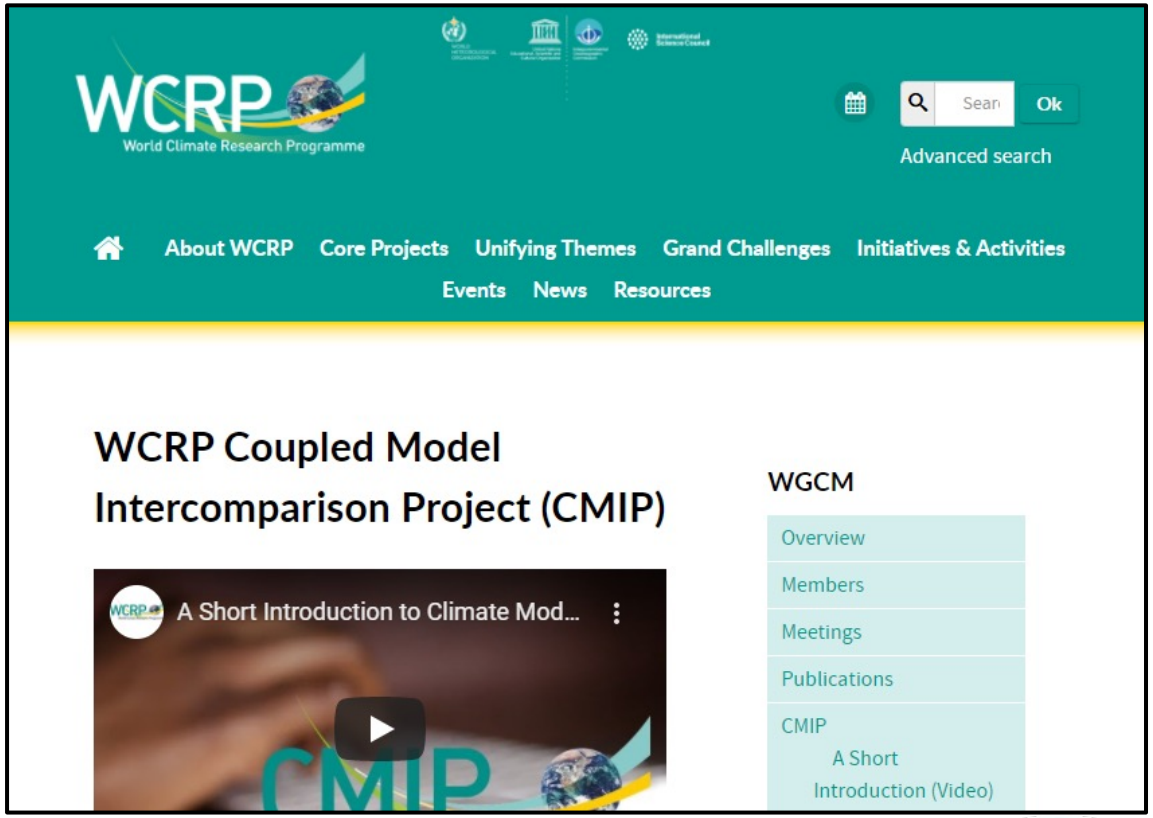


Strong drying trends are observed in recent decades

Note: color bar ranges are different, recent trends are stronger

Coupled Model Intercomparison Project (CMIP)

- Coupled refers to climate models that couple atmosphere, ocean, land and other earth processes
- Project is organized through World Climate Research Program, over multiple generations of models intercomparison that inform global climate assessments
  - CMIP 3 -> IPCC AR4[1] (2007)
  - CMIP 5 -> IPCC AR5 (2014)
  - CMIP 6 -> IPCC AR6 (2023)



[1]Intergovernmental Panel on Climate Change (IPCC) Assessment Report (AR)

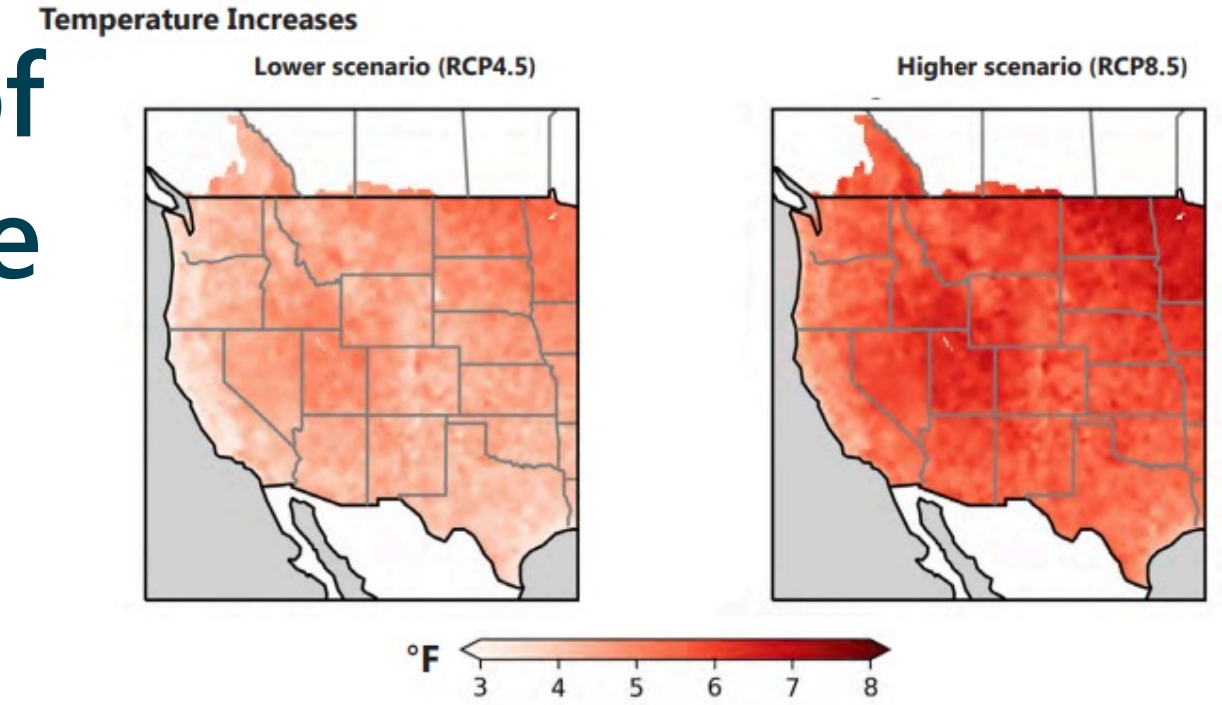
CMIP5 Projections of Western U.S. Climate

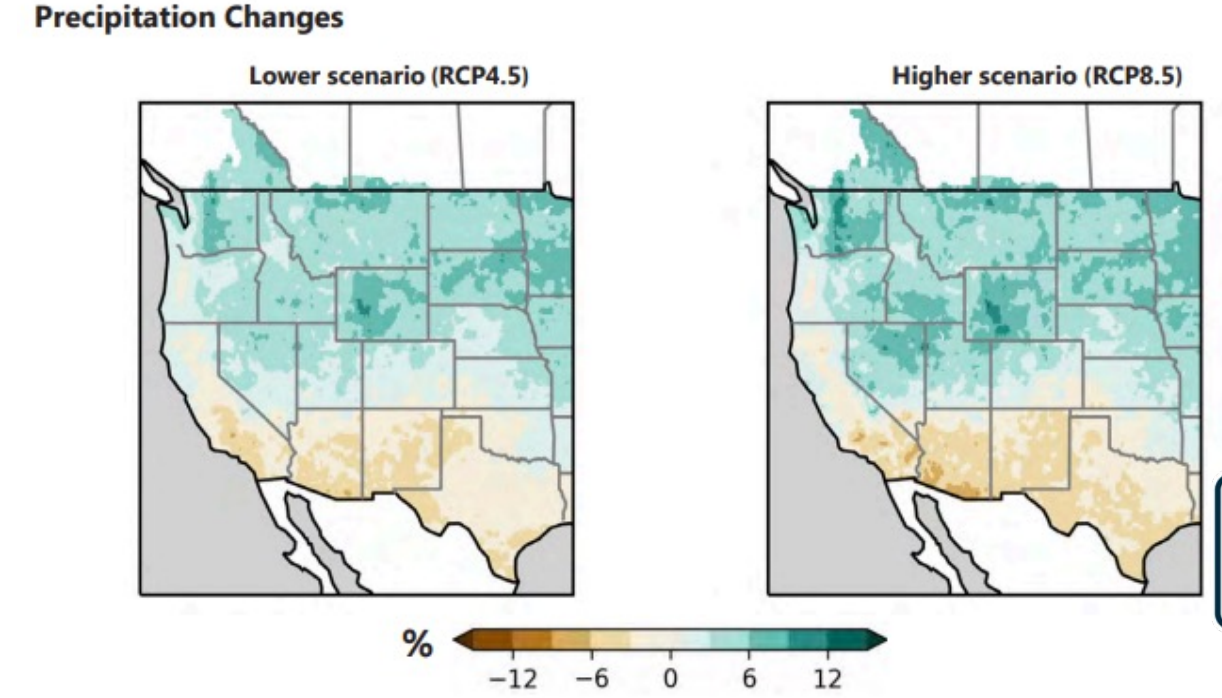
RCP = Representative Concentration Pathway = climate forcing scenario

RCP8.5 is more intense forcing

Models suggest:

- "bet warmer" throughout West
- "bet wetter" to the north
- "bet drier" to the south

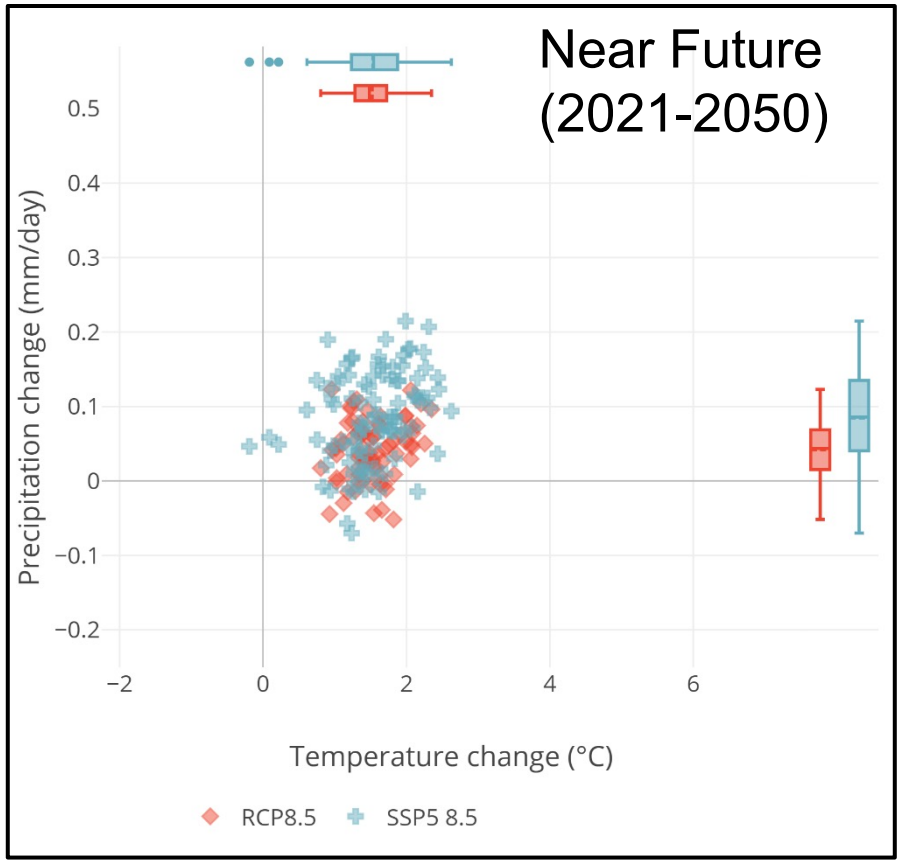


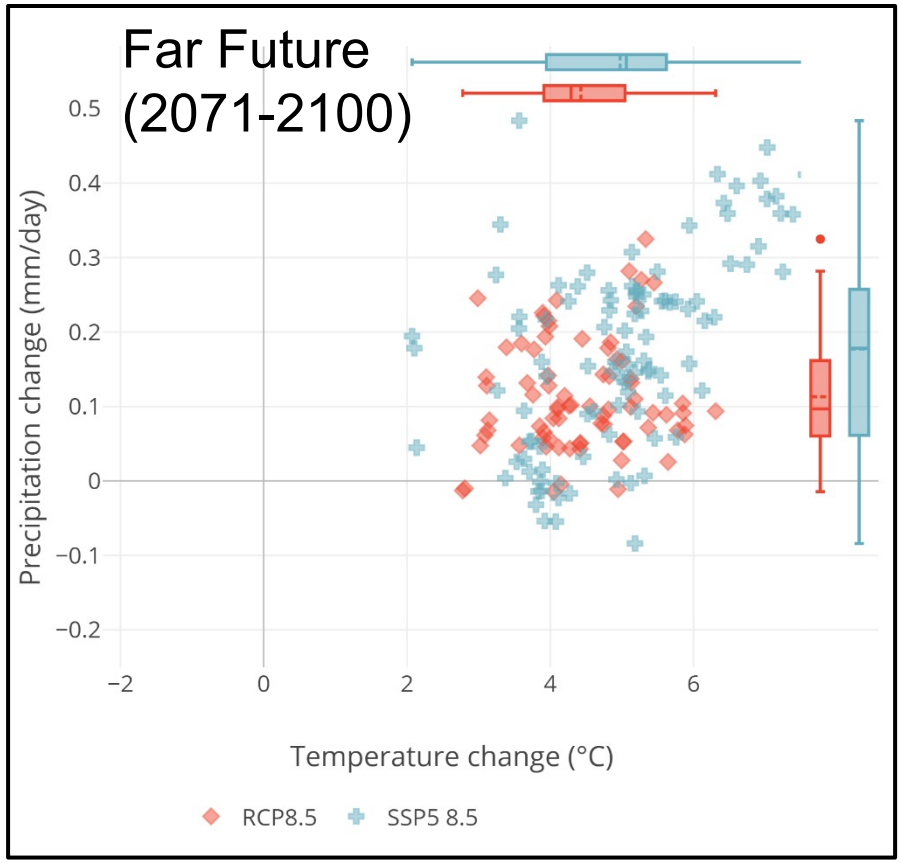


CMIP6 projections are arriving. Comparison to CMIP5…

CMIP5 (RCP8.5 red)

CMIP6 (SSP5.8.5 blue)





Change in Annual Temperature and Preciptiation, Western North America:

CMIP5 and CMIP6 climate models show similar possible changes

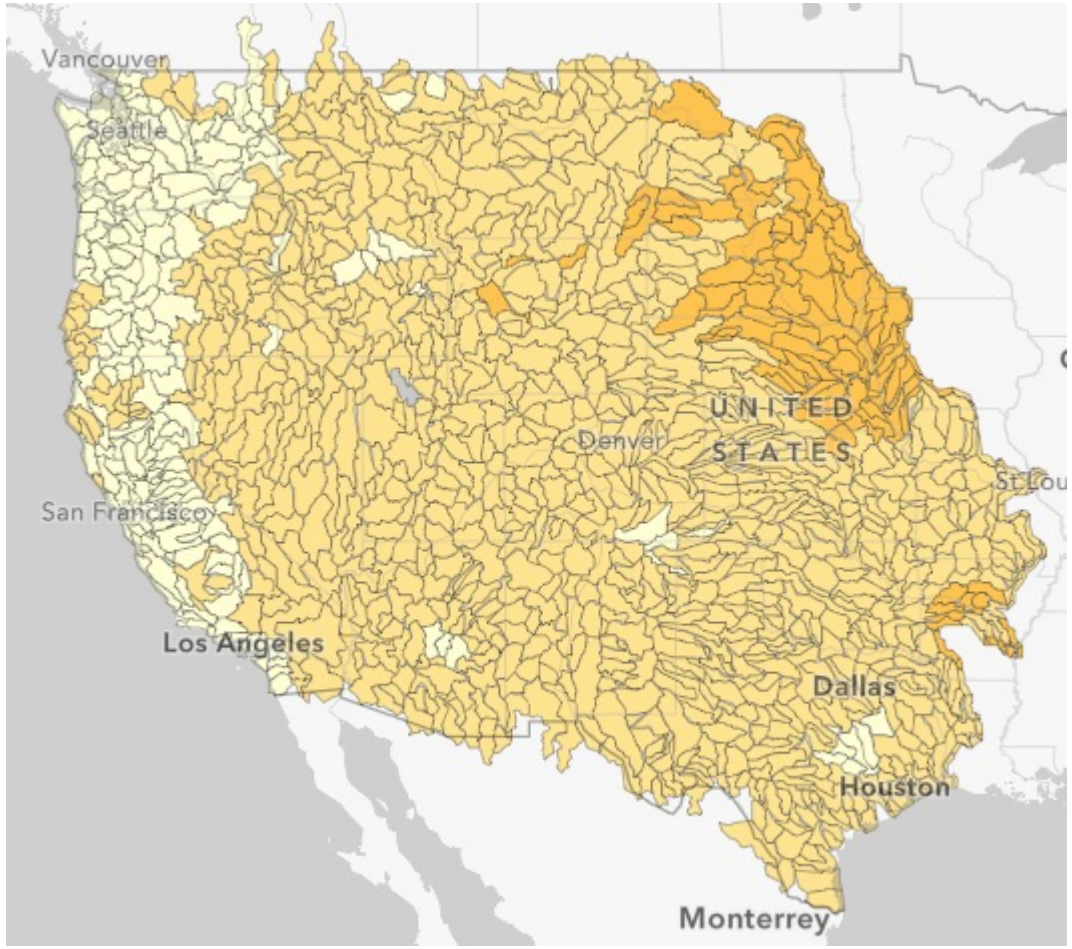
All models project warming

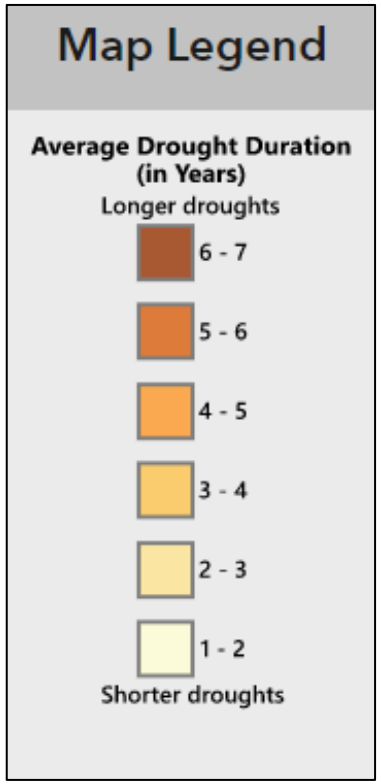
Most models project wetter conditions, but uncertainty spans drier to wetter conditions

Source: https://gcmeval.met.no/

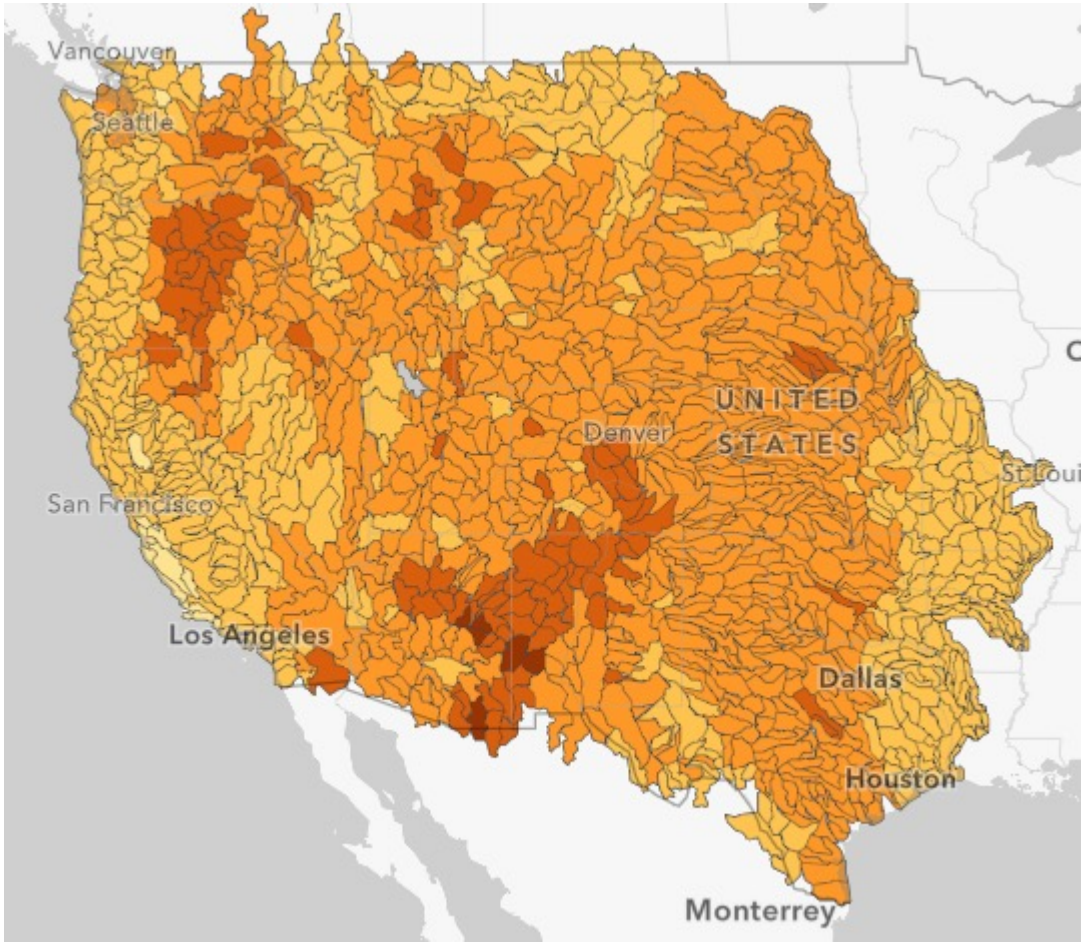
CMIP5 Projections of drought duration

Historical (1473-2005)





21st Century (2006-2099)



Droughts under the historical period last an average of 1 to 4 years.

Droughts are projected to last longer in the future.

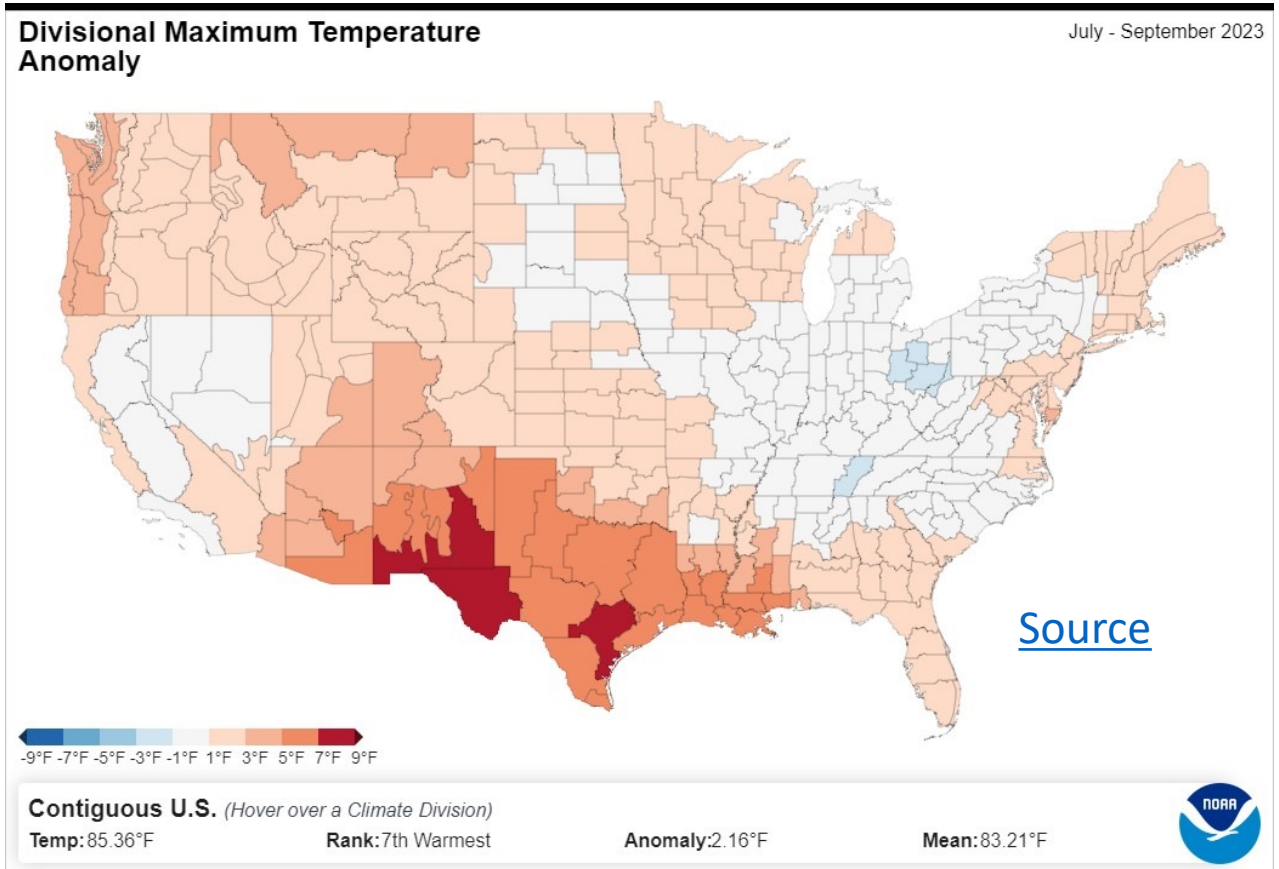
Source: usbr.gov/climate

Recent Extremes – Temperature (T)

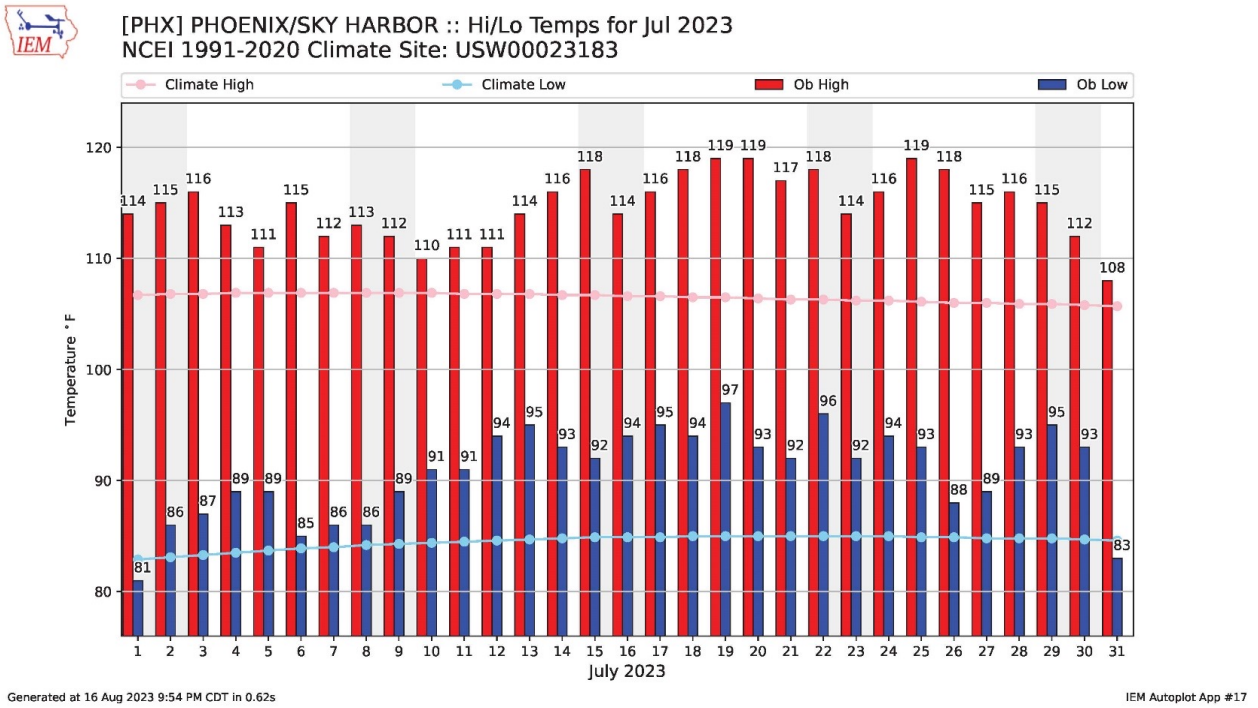
July-September 2023

U.S.: 7th warmest "daily max T"

TX/NM: warmest, AZ 2nd warmest



Source

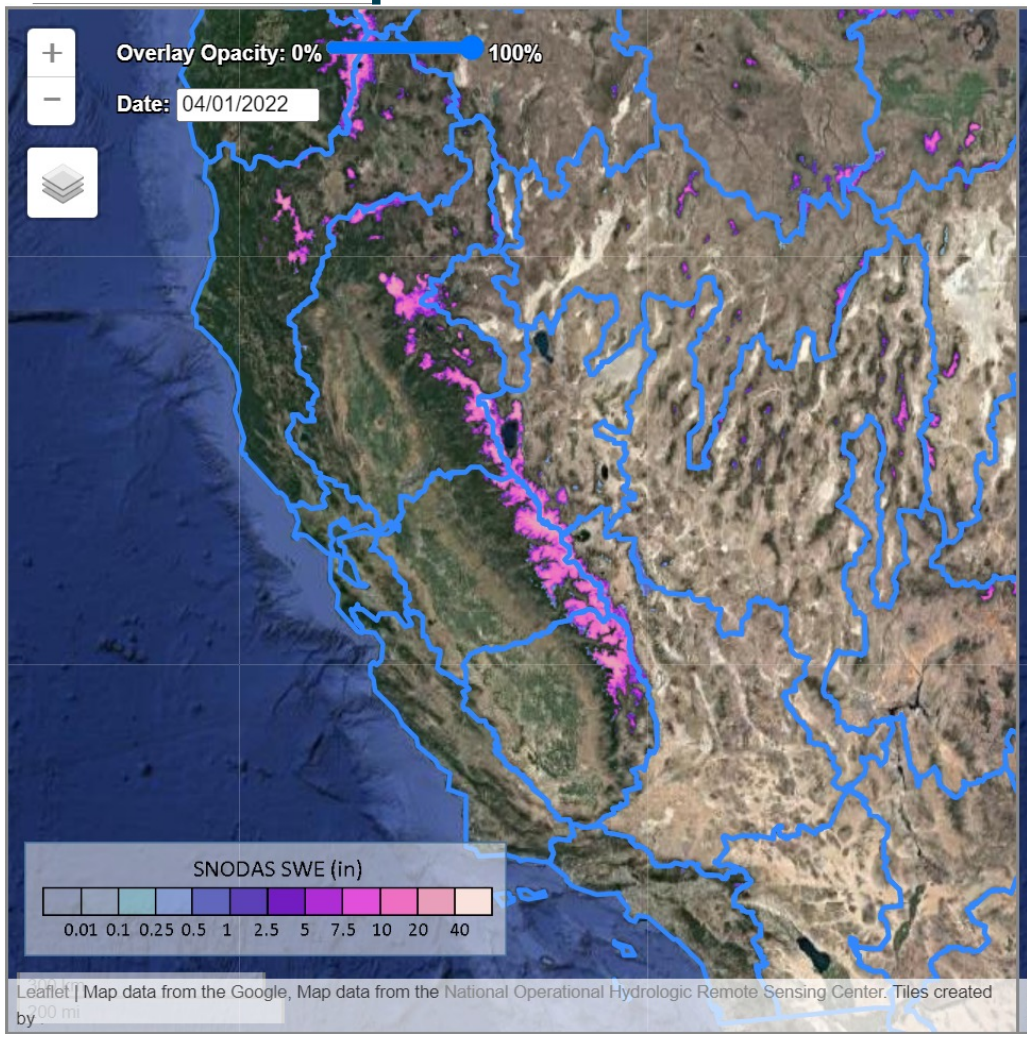


July 2023

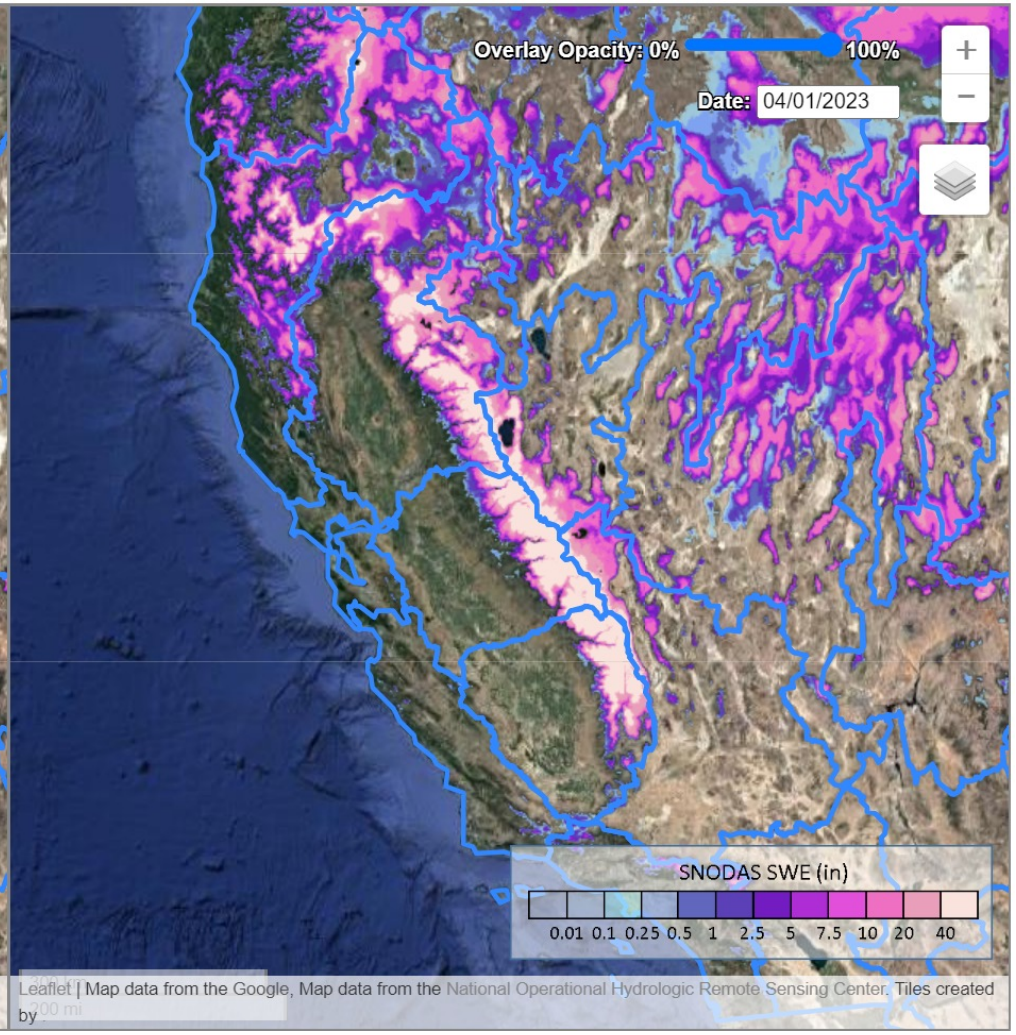
Phoenix sets record for consecutive days of "daily max T" > 110F

Recent Extremes - Snow

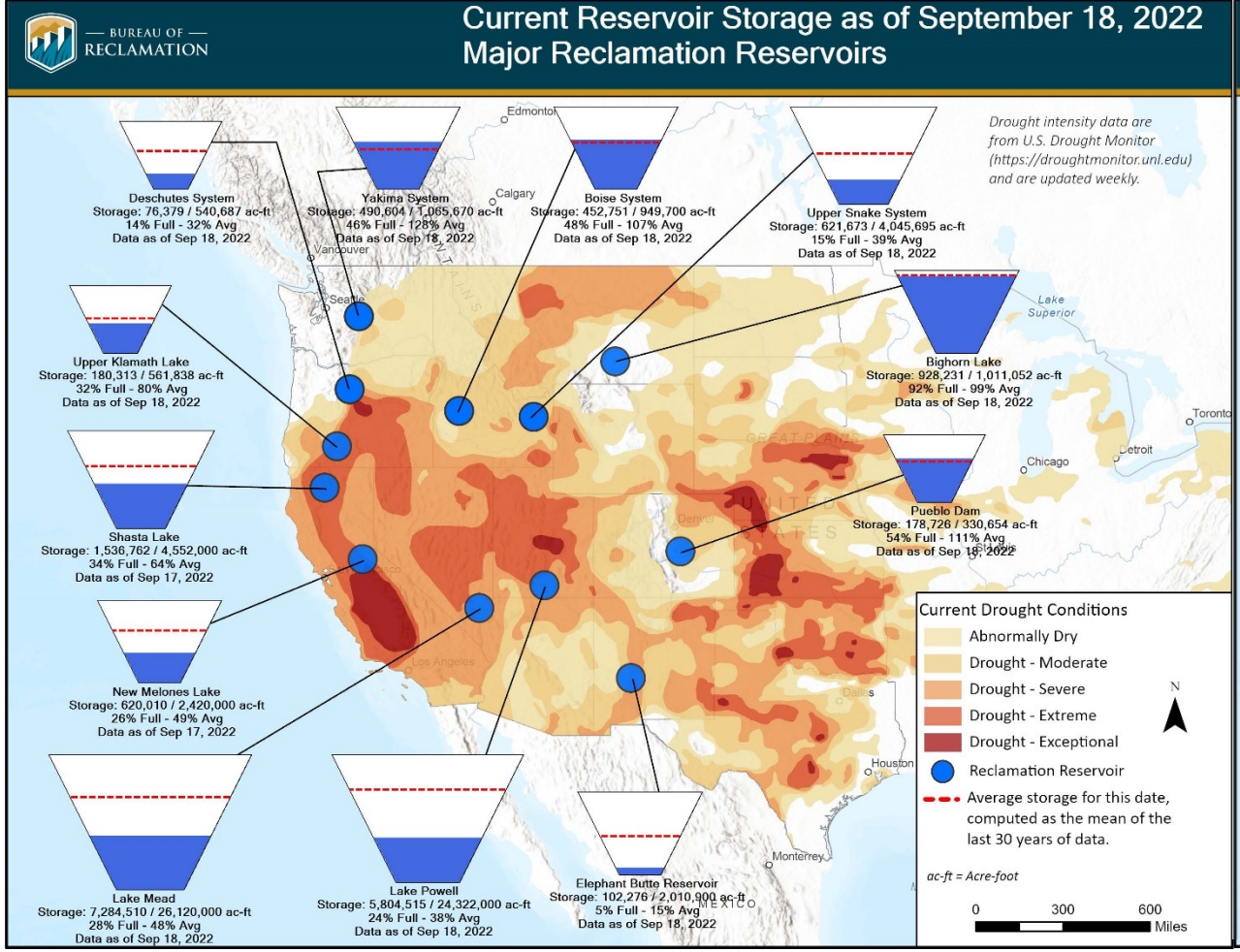
April 1, 2022

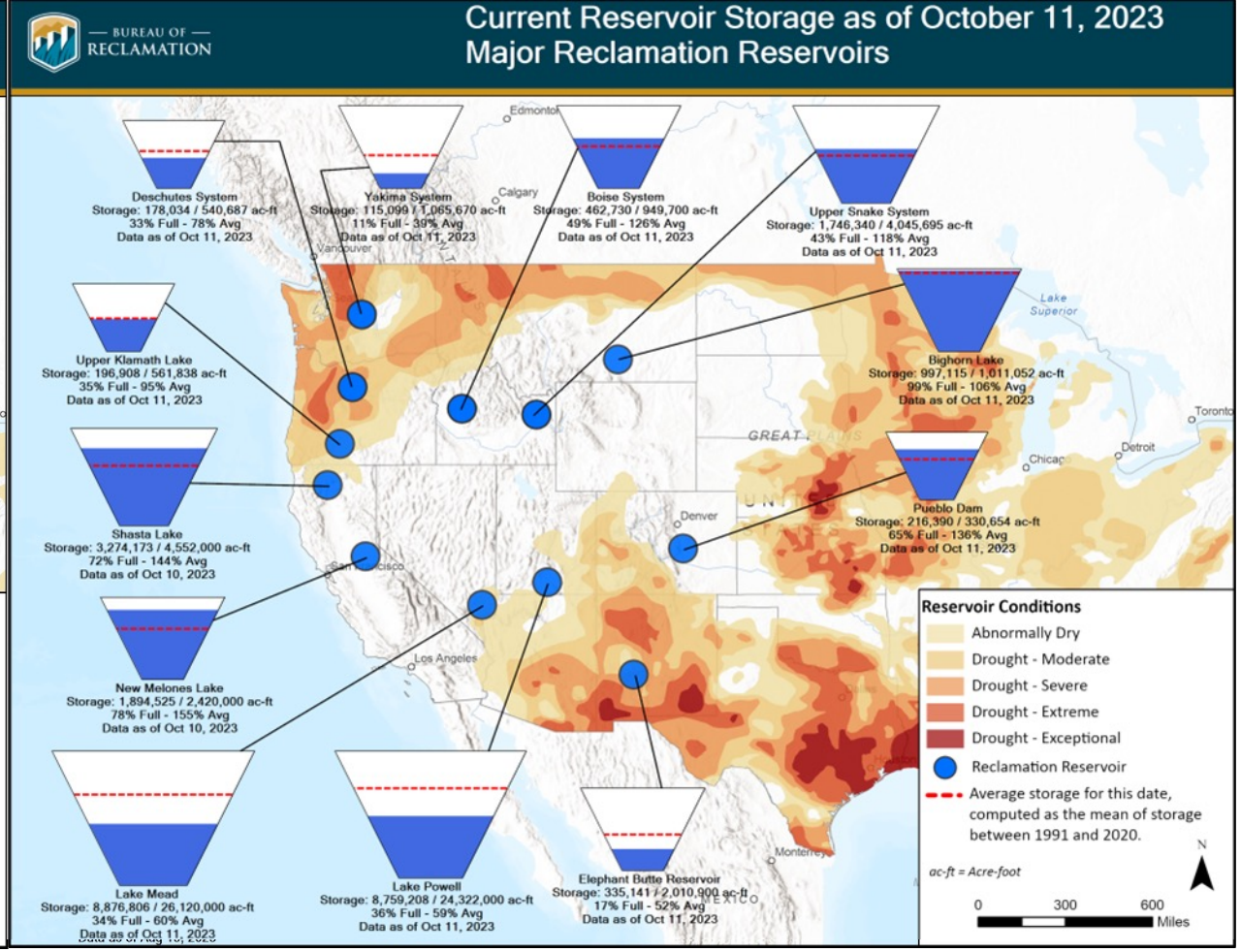


April 1, 2023



Source: https://climate.arizona.edu/snowview/





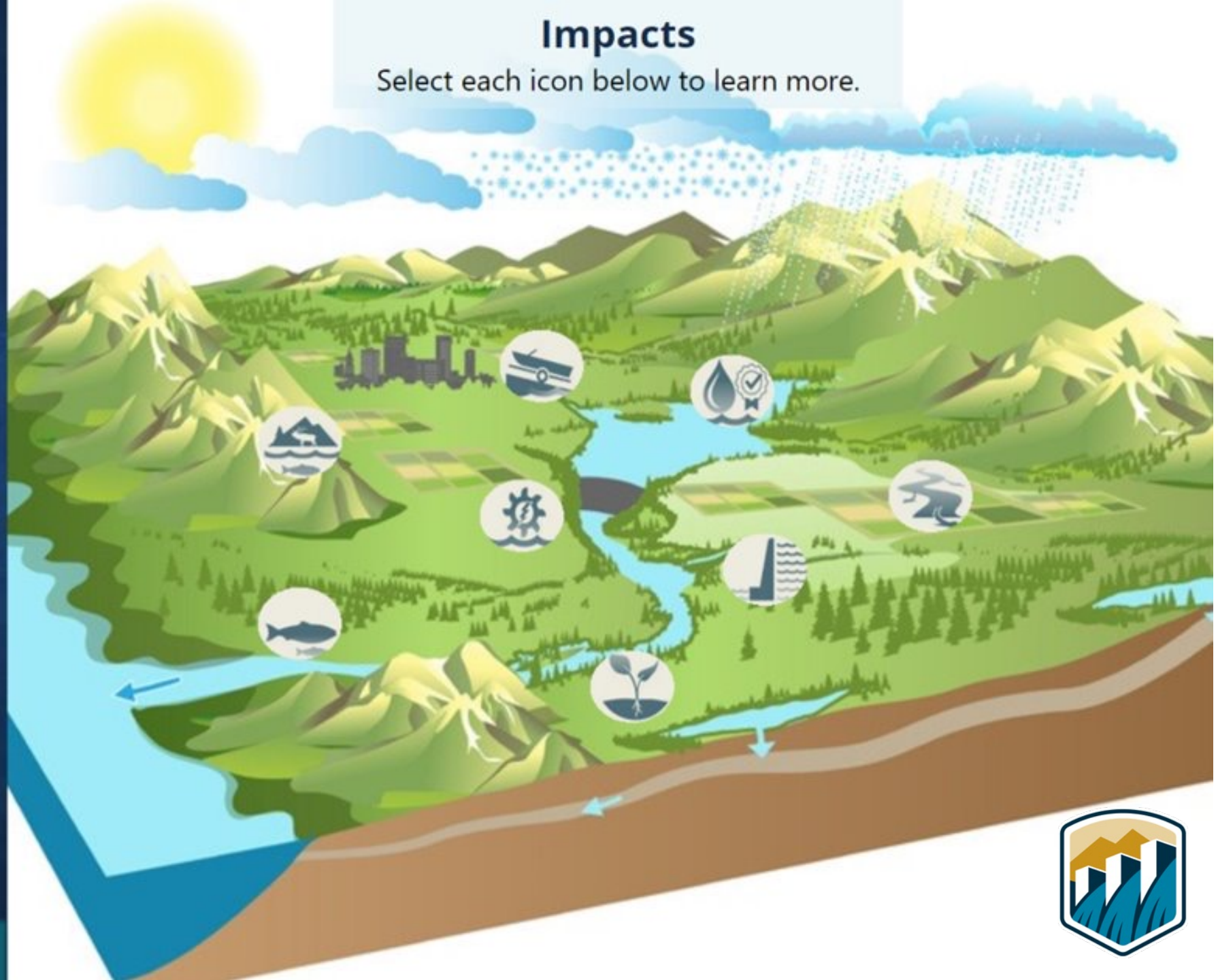
- **Drought conditions have subsided in the West, but continue to persist in areas**
- **Reservoir storage remains far below average in the Southwestern U.S.**

Impacts

Select each icon below to learn more.

Increasing temperatures, decreasing snowpack, changes to the volume of precipitation, and changes to runoff timing and volume across the west will affect numerous aspects of water management:

- Water Deliveries
- Water Quality
- Recreation
- Fish and Wildlife Habitat
- Hydropower
- Endangered, Threatened, or Candidate Species
- Flood Control
- Ecological Resilience



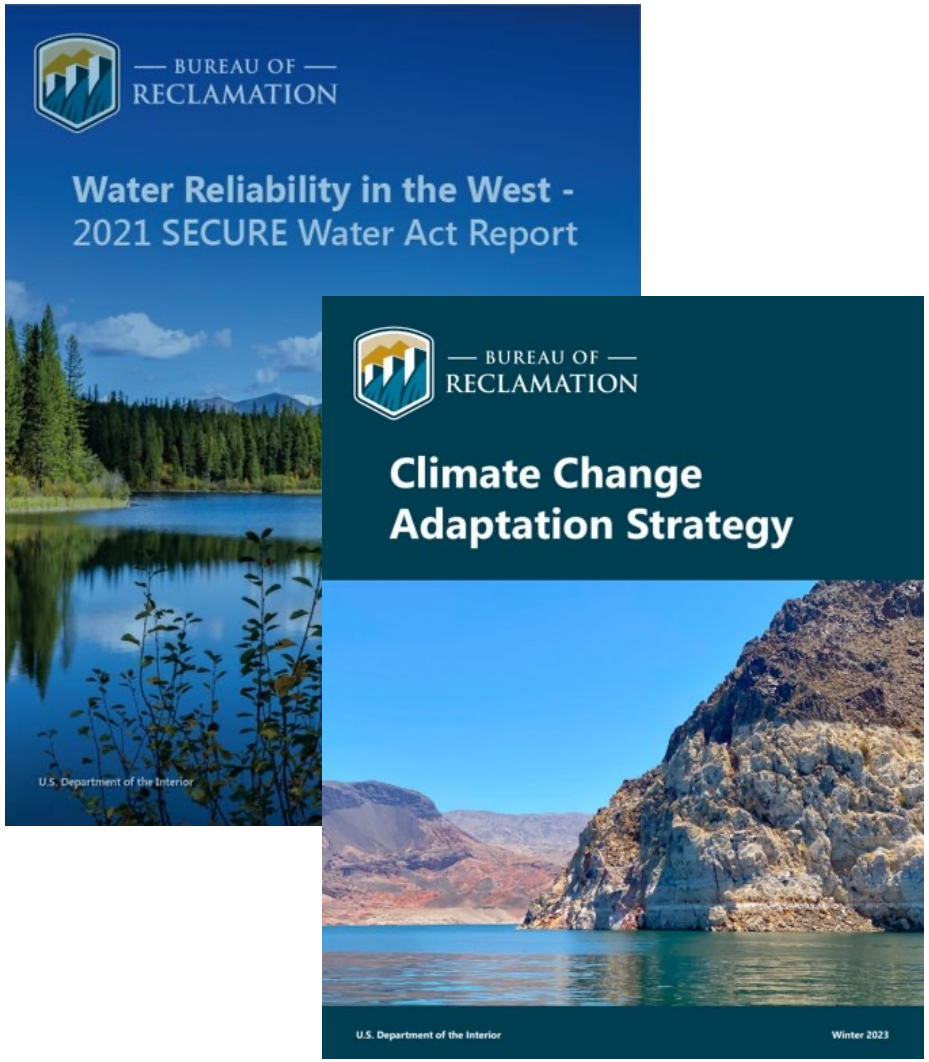
Conditions

Recap of how climate change is impacting water managers

- Historical observations show:
  - warming over past century, with warming rate increasing in recent decades
  - drying trend emerging in recent decades in many western U.S. areas
- Future projections show:
  - warming throughout the west
  - likely wetter towards the north, likely drier towards the south
- We still experience wide range of extremes, but climate change is shifting those extremes (e.g., temperature).
- These changes are impacting numerous aspects of water management.

Managing Water in Extremes: What is Reclamation doing about it?

- Reclamation's Approach to Build Resilience to Climate Change
  - SECURE Water Act
  - Climate Change Adaptation Strategy
  - Climate Change Community of Practice
  - Investments from the Bipartisan Infrastructure Law and Inflation Reduction Act
    - Infrastructure
    - Water reuse and recycling
    - Nature-Based Solutions



Department of the Interior has responded by strengthening climate adaptation policy

- Secretary Haaland Announces New Policies to Strengthen Climate Adaptation and Resilience Efforts | U.S. Department of the Interior
- Themes
  - Early engagement w/ partners, apply climate science to shape and evaluate actions, employ landscape perspectives in seeking solutions, use adaptive management to navigate uncertainty
- Links
  - 526 DM 1 - Applying Climate Change Science
  - 523 DM 1 - Climate Change Policy (Climate Change Adaptation)
  - 604 DM 1 - Implementing Landscape-Level Approaches to Resource Management
  - 522 DM 1 - Adaptive Management Implementation Policy

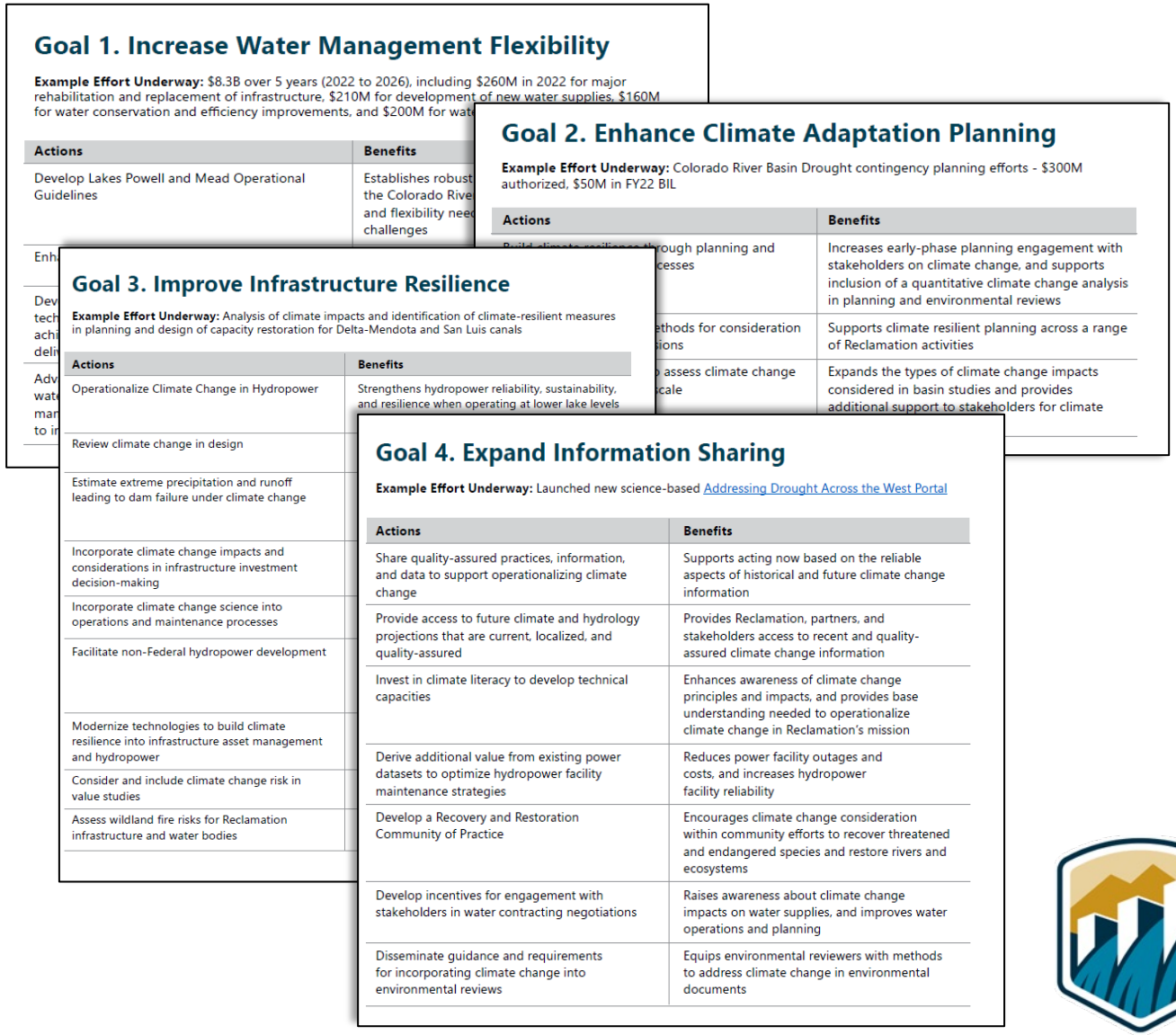
Climate Change Adaptation Strategy

Four Goals:

- Increase Water Management Flexibility
- Enhance Climate Adaptation Planning
- Improve Infrastructure Resiliency
- Expand Information Sharing

Identifies 23 Activities to Implement the Four Goals

- All Activities are currently ongoing



Goal 1. Increase Water Management Flexibility

Example Effort Underway: $8.3B over 5 years (2022 to 2026), including $260M in 2022 for major rehabilitation and replacement of infrastructure, $210M for development of new water supplies, $160M for water conservation and efficiency improvements, and $200M for wat

Actions	Benefits
Develop Lakes Powell and Mead Operational Guidelines	Establishes robust the Colorado Rive and flexibility nee challenges
Enh	
Dev tech achi deli	
Adv wat mar to ir	

Goal 2. Enhance Climate Adaptation Planning

Example Effort Underway: Colorado River Basin Drought contingency planning efforts - $300M authorized, $50M in FY22 BIL

Actions	Benefits
rough planning and cesses	Increases early-phase planning engagement with stakeholders on climate change, and supports inclusion of a quantitative climate change analysis in planning and environmental reviews
ethods for consideration ions	Supports climate resilient planning across a range of Reclamation activities
assess climate change cale	Expands the types of climate change impacts considered in basin studies and provides additional support to stakeholders for climate

Goal 3. Improve Infrastructure Resilience

Example Effort Underway: Analysis of climate impacts and identification of climate-resilient measures in planning and design of capacity restoration for Delta-Mendota and San Luis canals

Actions	Benefits
Operationalize Climate Change in Hydropower	Strengthens hydropower reliability, sustainability, and resilience when operating at lower lake levels
Review climate change in design	
Estimate extreme precipitation and runoff leading to dam failure under climate change	
Incorporate climate change impacts and considerations in infrastructure investment decision-making	
Incorporate climate change science into operations and maintenance processes	
Facilitate non-Federal hydropower development	
Modernize technologies to build climate resilience into infrastructure asset management and hydropower	
Consider and include climate change risk in value studies	
Assess wildland fire risks for Reclamation infrastructure and water bodies	

Goal 4. Expand Information Sharing

Example Effort Underway: Launched new science-based Addressing Drought Across the West Portal

Actions	Benefits
Share quality-assured practices, information, and data to support operationalizing climate change	Supports acting now based on the reliable aspects of historical and future climate change information
Provide access to future climate and hydrology projections that are current, localized, and quality-assured	Provides Reclamation, partners, and stakeholders access to recent and quality-assured climate change information
Invest in climate literacy to develop technical capacities	Enhances awareness of climate change principles and impacts, and provides base understanding needed to operationalize climate change in Reclamation's mission
Derive additional value from existing power datasets to optimize hydropower facility maintenance strategies	Reduces power facility outages and costs, and increases hydropower facility reliability
Develop a Recovery and Restoration Community of Practice	Encourages climate change consideration within community efforts to recover threatened and endangered species and restore rivers and ecosystems
Develop incentives for engagement with stakeholders in water contracting negotiations	Raises awareness about climate change impacts on water supplies, and improves water operations and planning
Disseminate guidance and requirements for incorporating climate change into environmental reviews	Equips environmental reviewers with methods to address climate change in environmental documents

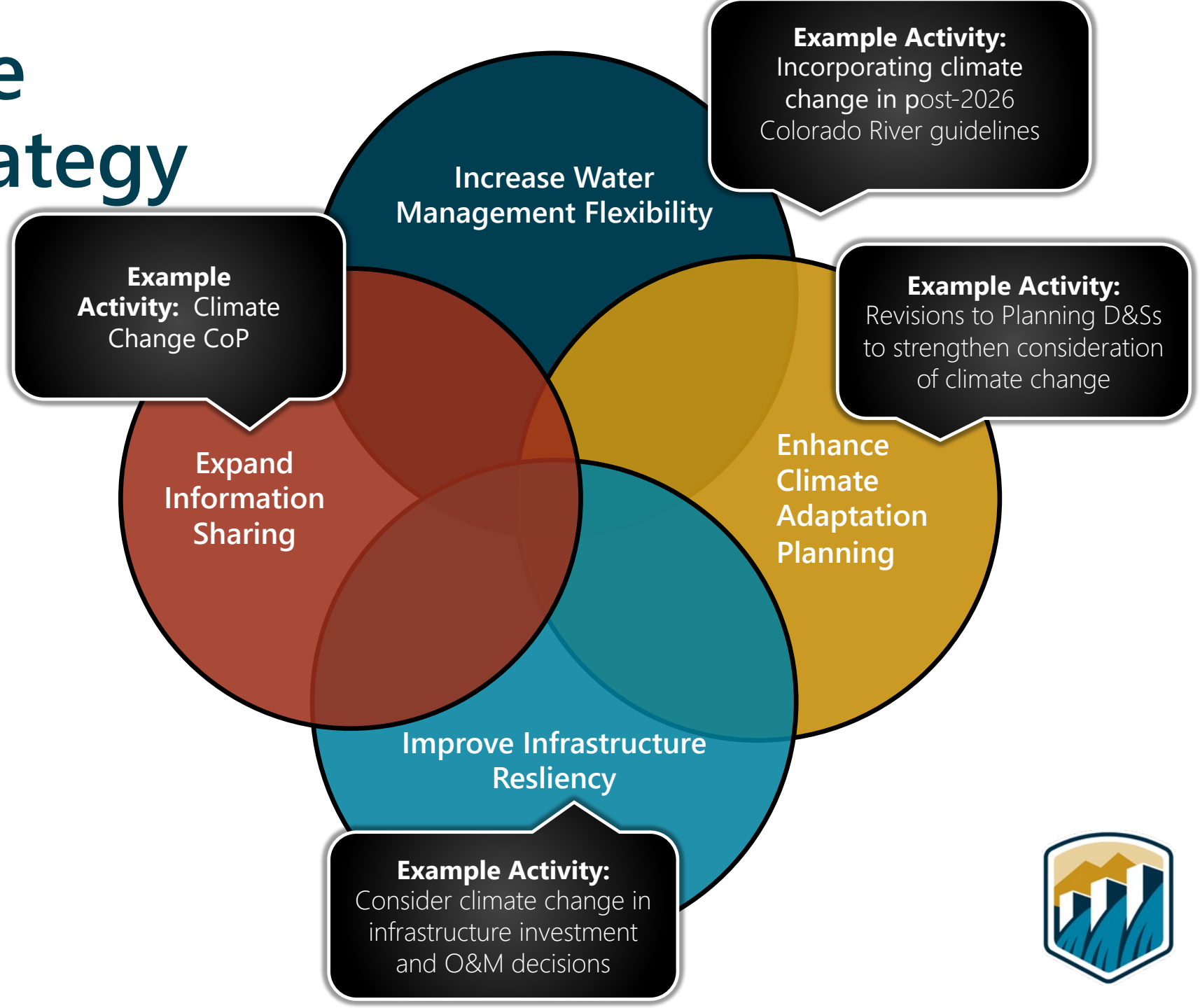
Climate Change Adaptation Strategy

Four Goals:

- Increase Water Management Flexibility
- Enhance Climate Adaptation Planning
- Improve Infrastructure Resiliency
- Expand Information Sharing

Identifies 23 Activities to Implement the Four Goals

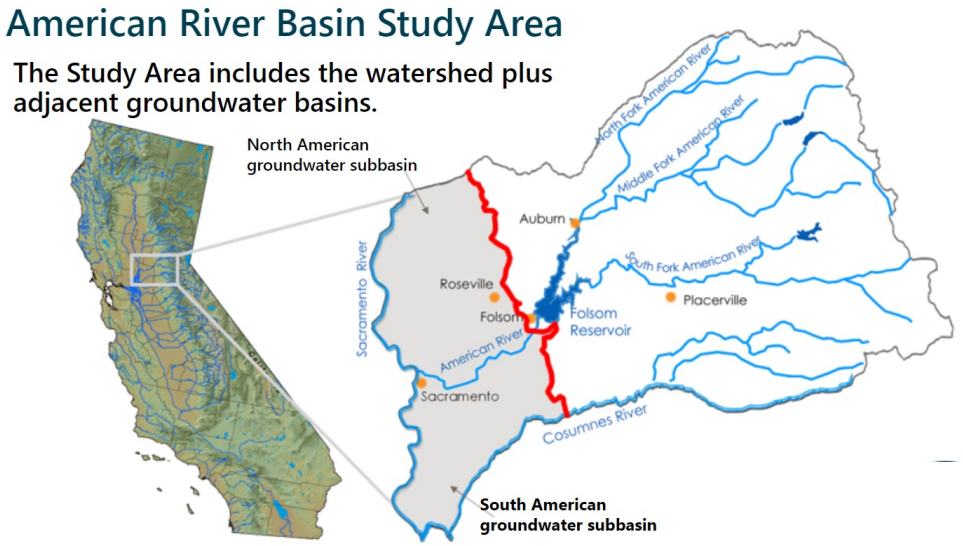
- All Activities are currently ongoing

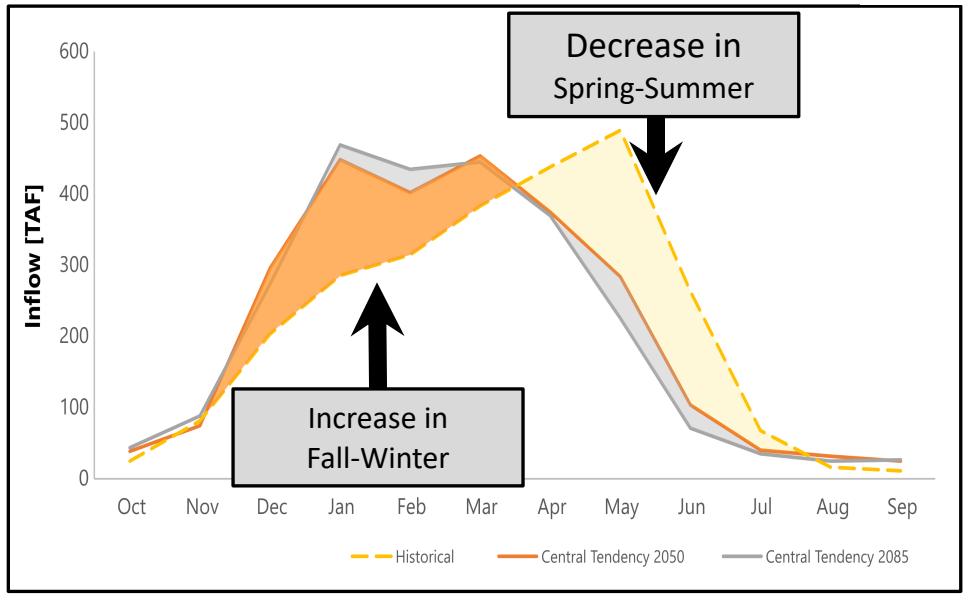


Climate Change Community of Practice

- Build a larger tent
- Reach all staff who carry out a role
- Support community goals:
  - operationalize climate change information across Reclamation's mission areas
  - advance the use of the best available science and tools
  - build a community and break down silos

Collaborative Planning through Basin Studies





- Imbalances in 2070 are projected to be 125,000 to 233,000 AF
- Adaptation strategies
  - Ensure water contract deliveries
  - Infrastructure development
  - Groundwater banking

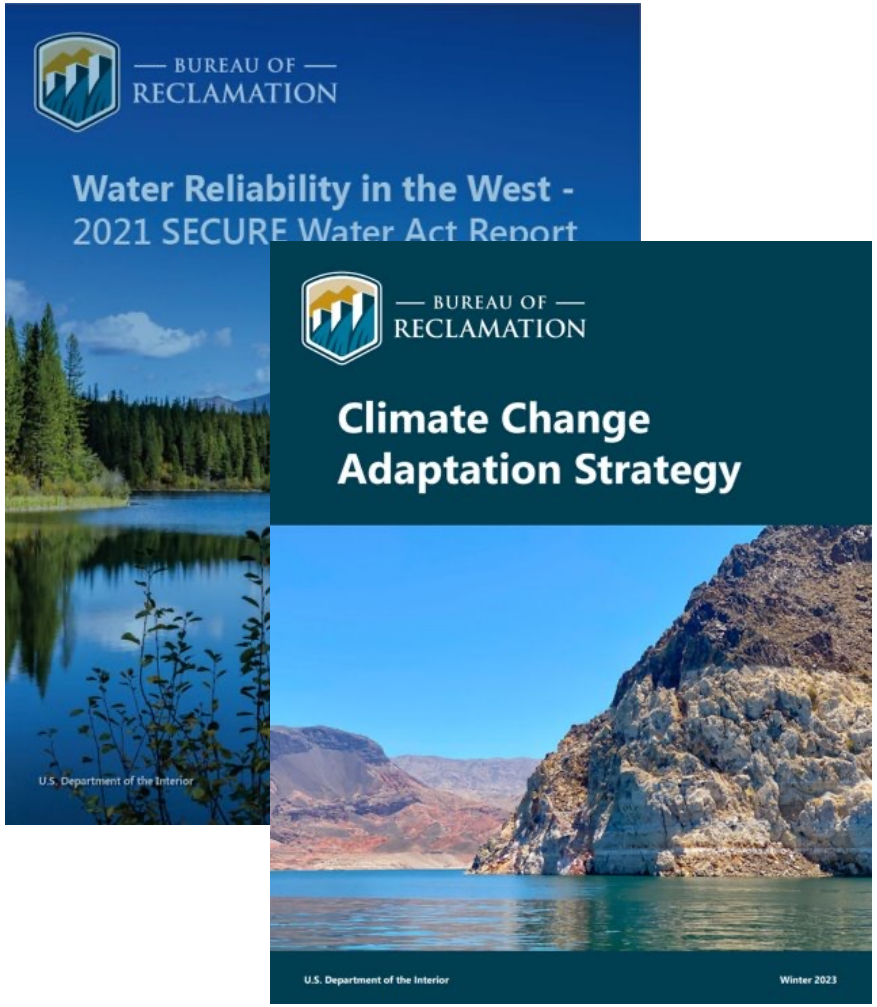
Recap of What We Are Doing

- Reclamation's Approach to Build Resilience to Climate Change
  - SECURE Water Act
  - Climate Change Adaptation Strategy
  - Climate Change Community of Practice
  - Investments from the Bipartisan Infrastructure Law and Inflation Reduction Act

Photo: San Acacia Diversion Dam, NM

Managing Water in Extremes: How can Reclamation support our Partners and Stakeholders?

- Provide information and decision-support tools to optimize reservoir operations in changing conditions
- Support for projects that build resilience
  - Increasing Infrastructure Resiliency
  - Addressing Water Scarcity through Reuse and Recycling
  - Addressing Water Scarcity through System Conservation
  - Using Nature Based Solutions

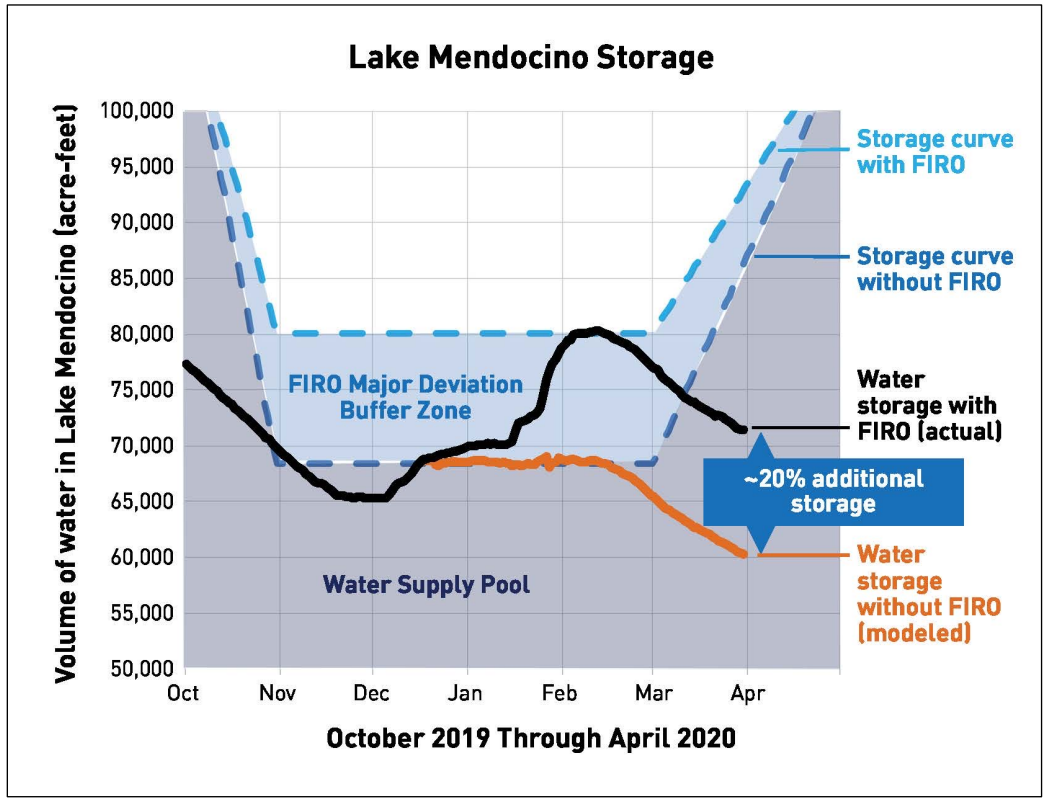


Optimizing Reservoir Operations for Changing Conditions

- **Snow Water Supply Forecast Program:** Enhancing snow monitoring with emerging technologies and in underserved areas in order to improve the skill of water supply forecasts
- **Forecasting Tools:** Working with water management and forecasting partners to enhance forecast skill, including crowdsourcing better short- term streamflow forecasts – the Streamflow Forecast Rodeo
- **Reservoir Operations Pilots:** Evaluates reservoir operating alternatives to increase water availability, improve environmental compliance, adapt to a changing climate
- **Hydropower:** Advanced decision support tools that maximize hydropower generation with less water help address challenges from longer, more severe droughts and floods
- **Applied Science Tools:** Improve hydrologic information, or develop decision support tools to improve water management, including improved modeling and forecasting capabilities to support water operations or water management.

Forecast Informed Reservoir Operations (FIRO)

- FIRO at Lake Mendocino moves away from static rule curves and leverages improved forecasts
  - Rule curves are based on historical norms that may have changed
  - Forecast skill has improved significantly since many rule curves were developed
- Can enable more flexibility to operate based on current conditions
  - Retain water in storage based on forecast information
  - More dynamic water management in response to changing conditions
- Reclamation is pursuing similar concepts at our facilities



FIRO increased water supply benefits and managed flood risks for Lake Mendocino. In 2020, FIRO increased water storage by nearly 20 percent, which is the equivalent water used by 22,000 households.

Support for Projects that Build Resilience

Significant Federal investment from the Bipartisan Infrastructure Law (BIL) and Inflation Reduction Act (IRA) allows Reclamation to fund meaningful projects across the West that increase management flexibility during drought, conserve water, and support ecological benefits. These projects include:

- Infrastructure projects that increase safety and resilience to climate change
- Large-Scale Water Recycling Projects including desalination and water reuse facilities
- Water and Energy Efficiency Projects that result in significant water savings or capture the additional benefit of hydropower generation
- Environmental Water Resources Projects that restore aquatic ecosystems or conserve water for instream environmental uses

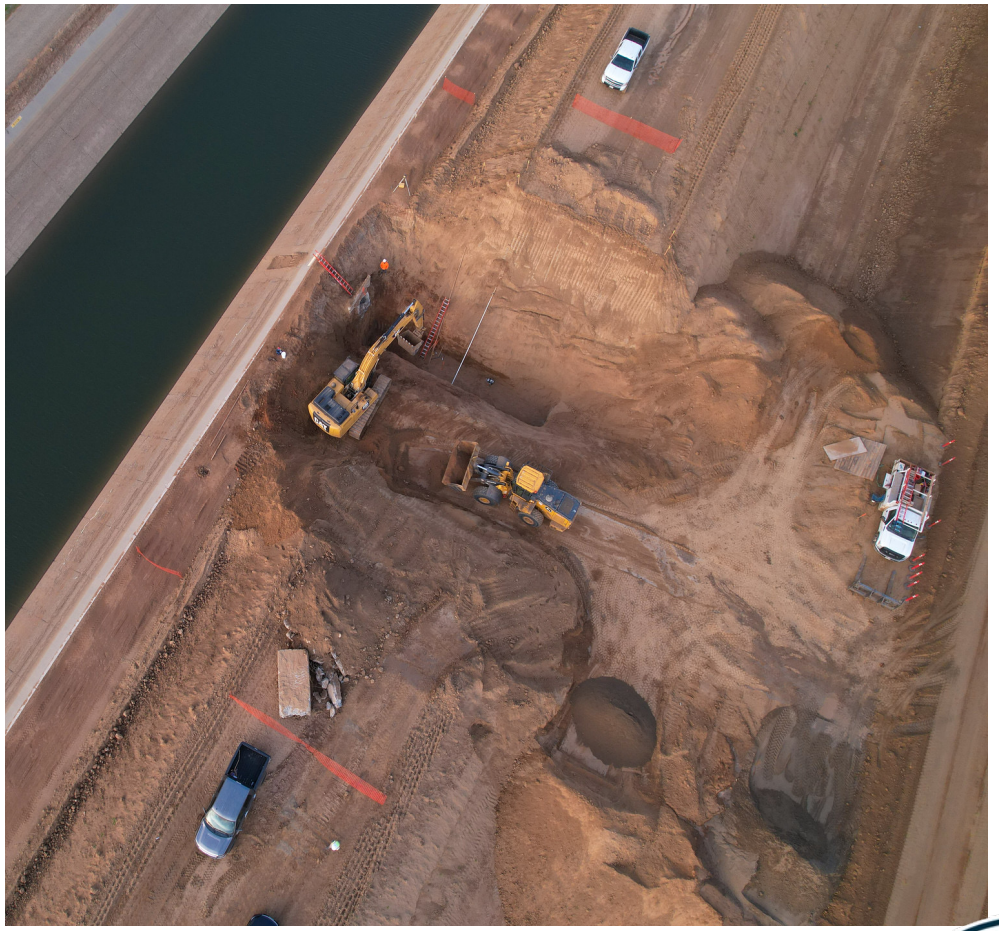


Photo: Construction of the Friant-Kern Canal Middle Capacity Reach Correction, a project to increase water supply reliability and reduce conveyance loss in Central California.

Increasing Infrastructure Resiliency

- Climate-informed projections of future flood hazards can build resilience into the dam safety risk assessment process.
- New Department policies mentioned strengthen consideration of climate change impacts in planning, designing, constructing and repairing water delivery infrastructure
- Wide head turbines enhance hydropower performance across a range of reservoir conditions
- BF Sisk Dam and San Luis Reservoir construction to ensure reliable water deliveries

B.F. Sisk Dam and San Luis Reservoir Safety of Dams Groundbreaking California, June 2022 - $100M in BIL funding in 2022

Addressing Water Scarcity through Water Reuse and Recycling

- Water recycling is used as a part of strategies to prepare for drought and address projected water supply shortages by turning currently unusable water sources into new, local sources of water supply.
- Reclamation cost shares with project sponsors to construct water reuse and recycling projects that can yield up to 50,000 acre-feet per year, per project.
- Reclamation is using BIL funding to support a new Large-Scale Water Recycling program.
  - Whereas a typical water recycling project yields from 1,000 to 50,000 acre-feet per year, these larger projects could yield as much as 150,000 acre-feet per year.

Photo: The Padre Dam Municipal Water District in San Diego County was selected to receive $28.3 million in BIL funding in FY 2022 to complete Phase II of the East County Advanced Water Purification Program, which is expected to result in an additional 8,960 acre-feet per year of local potable water supply.

Addressing Water Scarcity through System Conservation

- Addressing short-term risks to the Colorado River system with direct compensation for conserved water
- Paired with investments to mitigate the negative impacts to of system conservation to communities and the environment
- Stakeholder engagement and coordination is vital component of drought adaptation
- Phase II of the program will focus on system efficiencies that provide long-term water savings to the system

Photo: System Conservation Agreement signing with the Gila River Indian Community

Using Nature-Based Solutions (NBS)

Examples include:

- Restoration or conservation of natural areas
- Reconnection of rivers to their floodplains and expansion of wetlands to reduce flood risks and support ecosystem benefits
- Removal of barriers to fish passage
- Strategic relocation of agricultural or municipal water diversions to benefit habitat while still supporting existing water uses
- Installing rocks, woody debris, and analog beaver dams to restore a better functioning river channel

NBS can increase resilience to threats like flooding and extreme heat and can slow climate change by capturing and storing carbon dioxide. They can provide numerous social, economic, environmental "co-benefits" beyond direct ecological benefits.

Photo: Installation of the Sailor Bar Project, an instream gravel bar complex to create habitat for native Chinook Salmon in the Lower American River in *Sacramento, California*.

Examples of Nature-Based Solutions

The Bureau of Reclamation both provides funding to external entities to implement nature-based solutions *AND* employs NBS in our own projects.

Laguna Division Conservation Area (BOR)

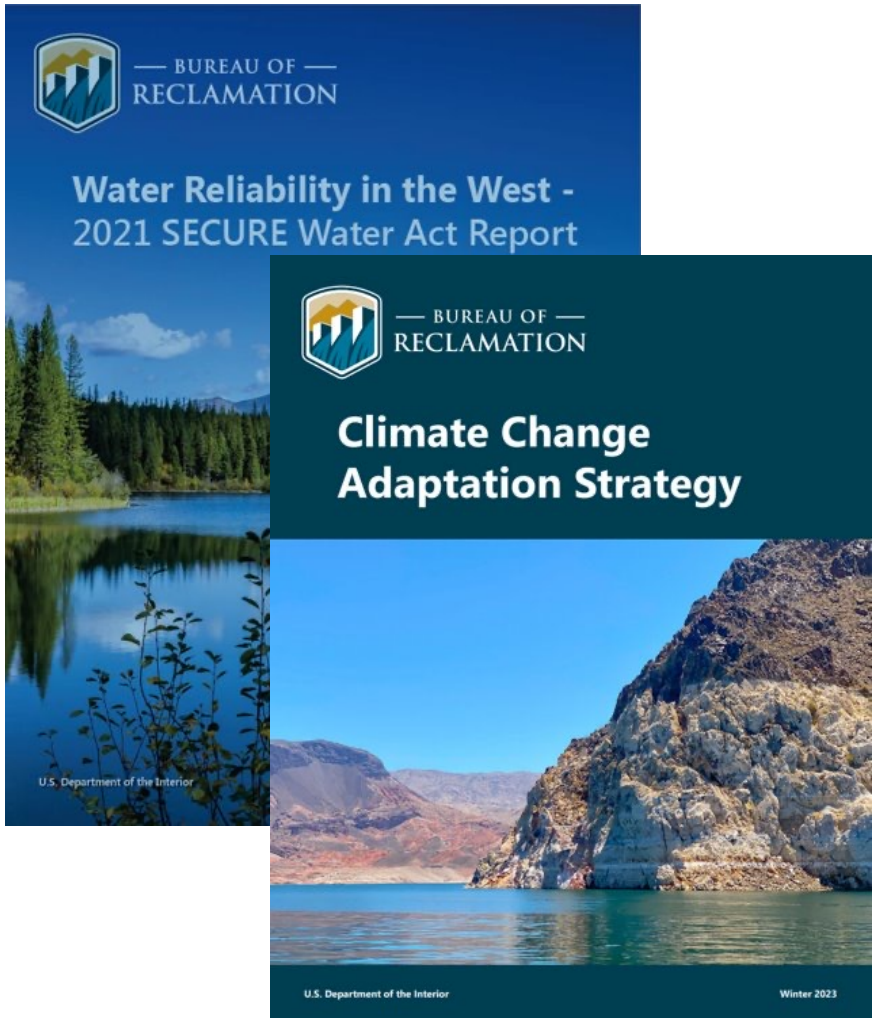
LDCA is a terraced, vegetated flood control structure located on the Colorado River on the Arizona/ California Border. The complex can safely flood periodically when flows need to be released, supporting both flexible water management and a thriving native ecosystem.

Battle Creek Ecological Restoration at Sowo Gahni (Northwestern Band of the Shoshone Nation)

The Battle Creek Restoration Project in southern ID seeks to restore natural river hydrography and ecosystem features to the culturally significant Sowo Gahni site, location of the 1863 Bear River Massacre. The project will both restore river function and provide a place of healing and reflection for the Northwestern Band of the Shoshone Nation.

Recap of How We Can Support

- Providing information and decision-support tools to optimize reservoir operations
- Support for projects that build resilience
  - Increasing Infrastructure Resiliency
  - Addressing Water Scarcity through Reuse and Recycling
  - Addressing Water Scarcity through System Conservation
  - Using Nature Based Solutions




BUREAU OF
RECLAMATION
Questions?