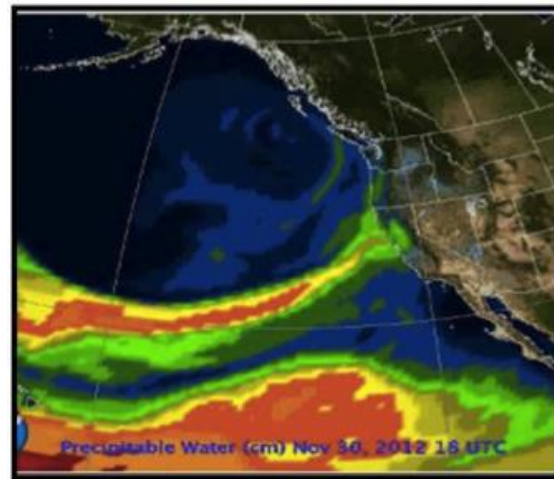


Forecast Informed Reservoir Operations

- An Opportunity to Improve the Resiliency of our Water Supply



**2016 International Atmospheric
Rivers Conference
August 8 2016**

**Jay Jasperse, Chief Engineer
Sonoma County Water Agency**

**SONOMA
C O U N T Y
W A T E R**



A G E N C Y

Russian River Reservoirs

Dual Purpose Facilities

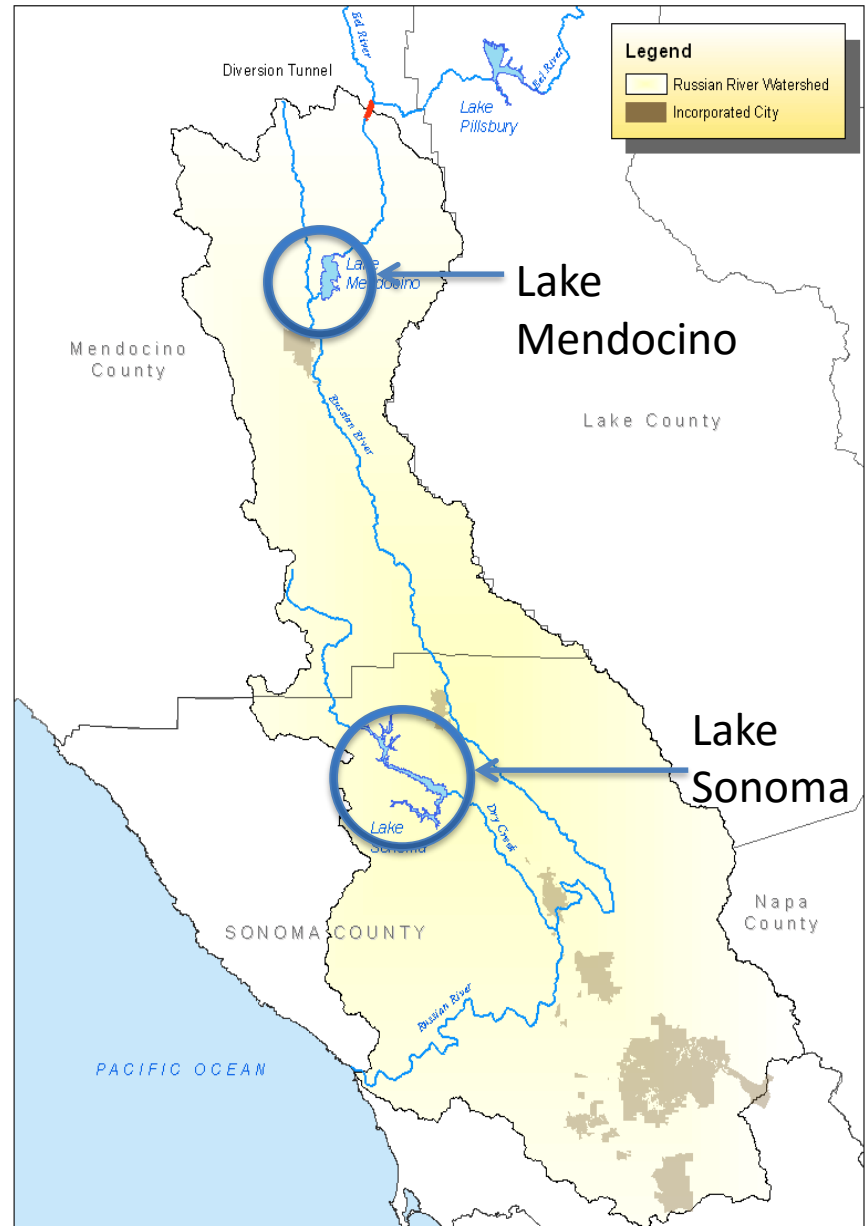
- Flood Protection (ACOE)
- Water Supply (SCWA)
- Operations Dictated by Storage Levels Relative to “Rule Curve”

Lake Sonoma (Warm Springs Dam)

Flood Control Pool: 136,000 AF
Water Supply Pool: 245,000 AF

Lake Mendocino (Coyote Valley Dam)

Flood Control Pool: 48,100 AF
Water Supply Pool: 68,400 AF
(Nov. 1 - March 1)



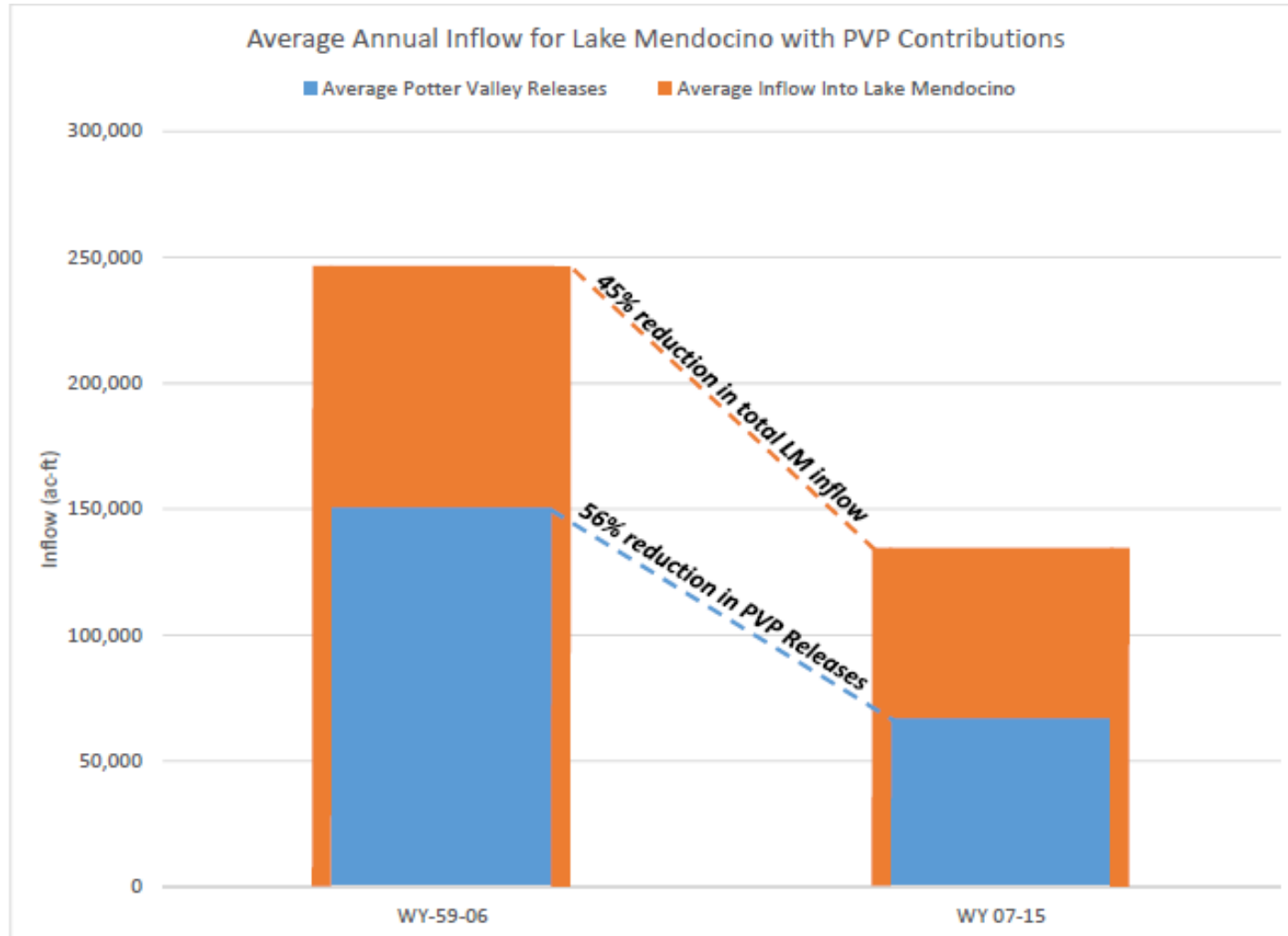
The Issue: Lake Mendocino's Water Supply Is Not Reliable

Some Reasons For Low Water Supply Reliability:

- Relatively small storage capacity
- Relatively unproductive watershed
- Reduced inflow from Potter Valley Project (Eel River)
- Highly variable precipitation patterns
 - Almost 50% rainfall from atmospheric rivers
- Future growth & climate change will likely further reduce reliability

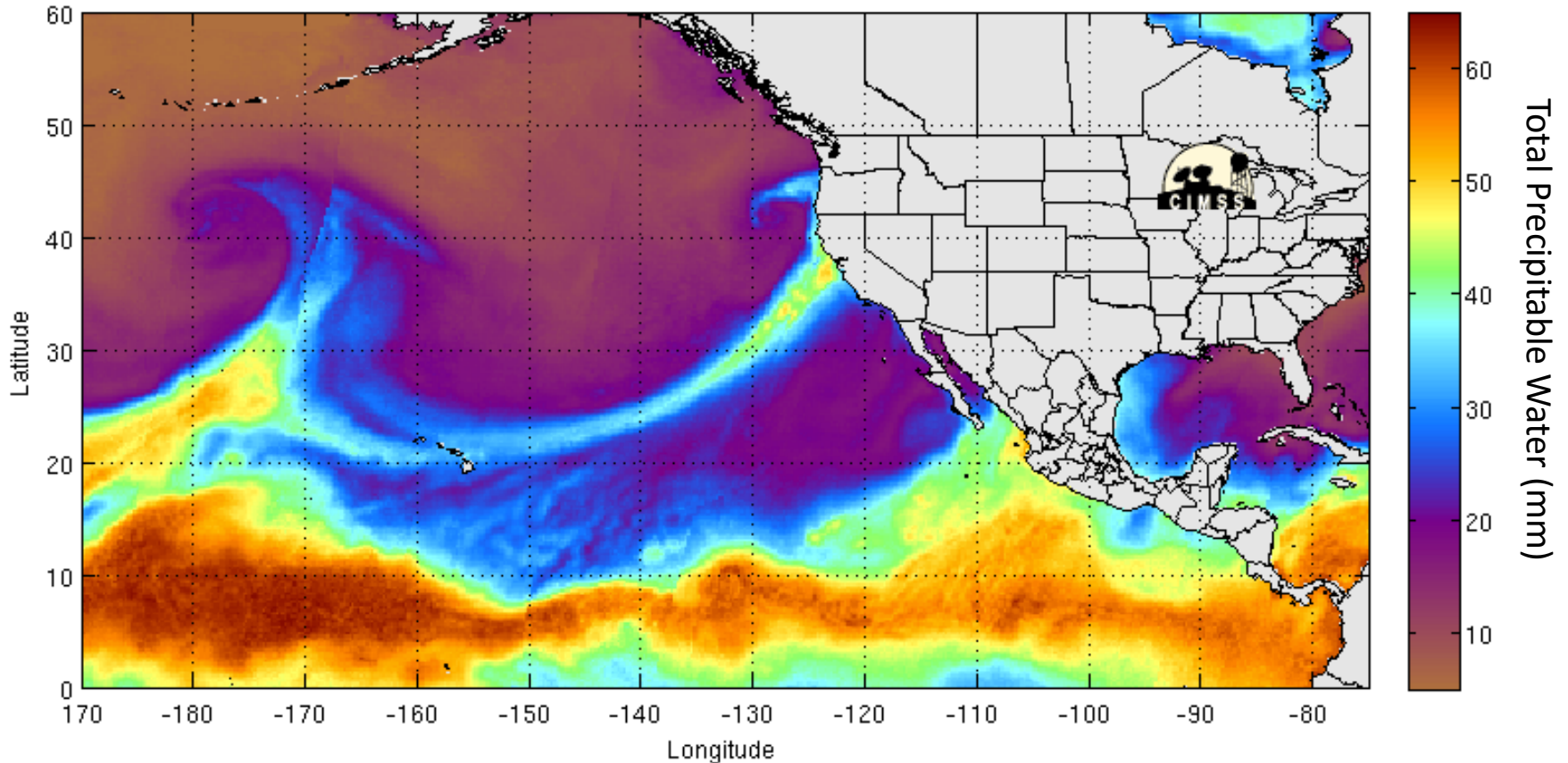


Reduced Inflows From Potter Valley Have Significant Impacts on Lake Mendocino



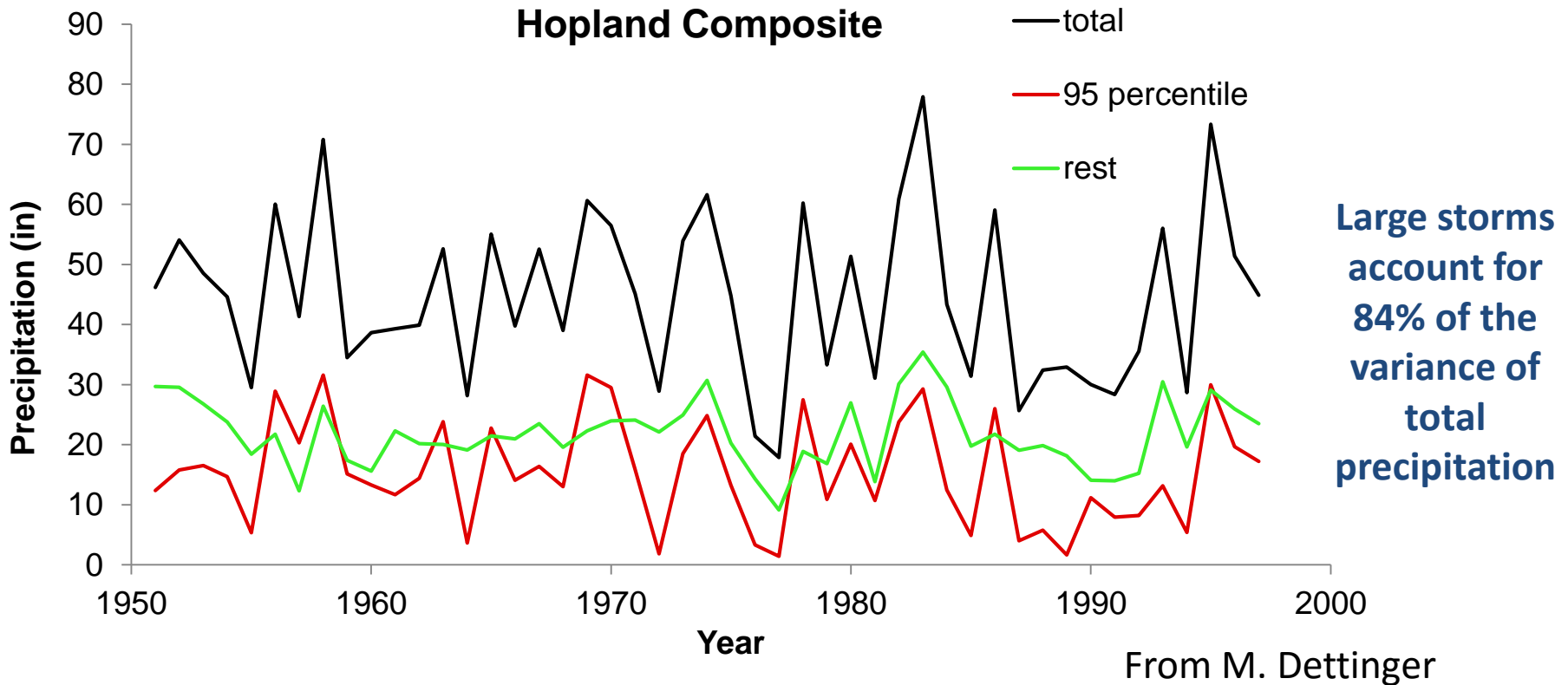
Atmospheric Rivers: Our Extreme Weather Events

Composite Dec 11, 2014

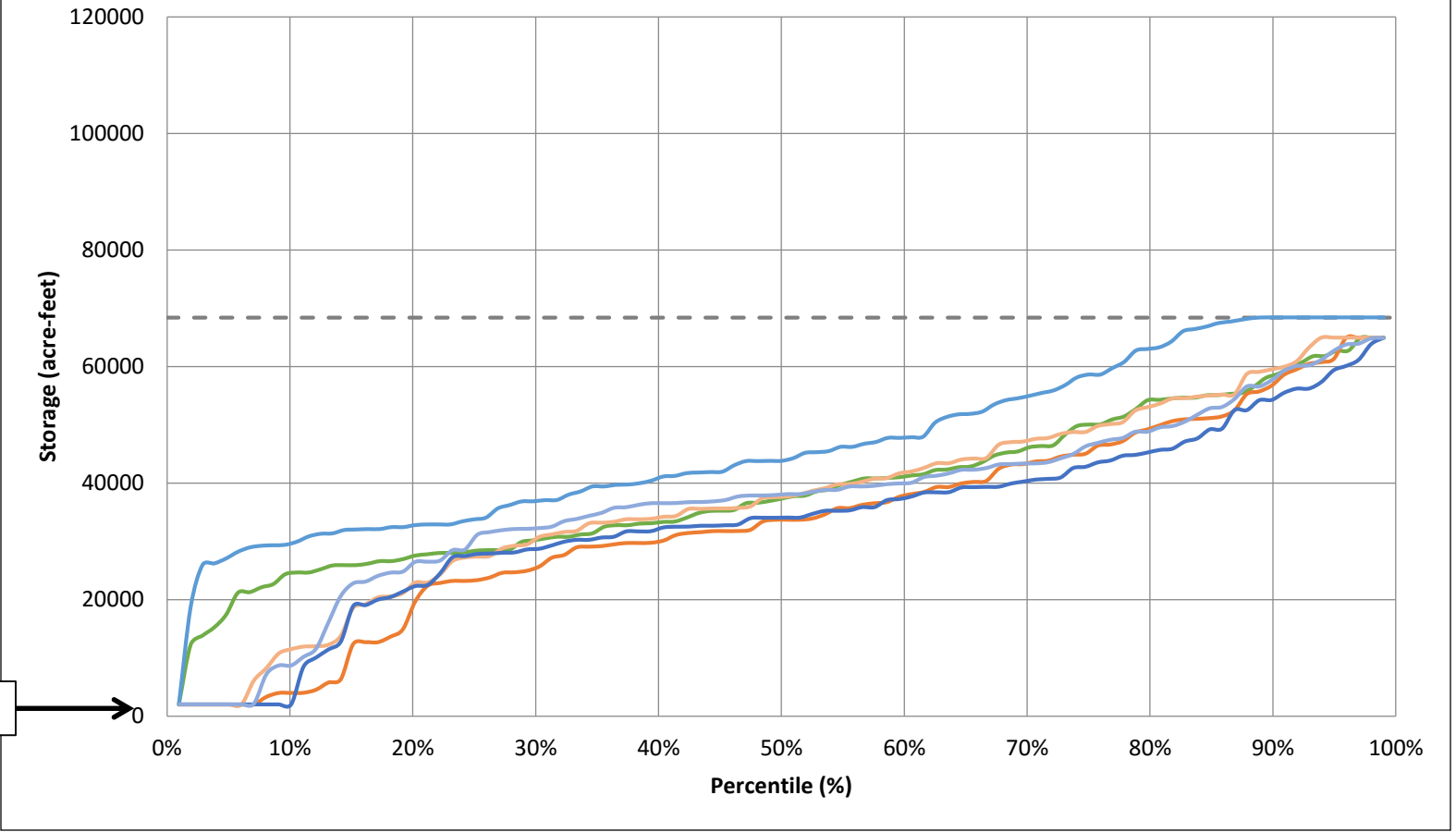


Source: CIMSS

Atmospheric Rivers Drive Droughts & Floods



Lake Mendocino Minimum Annual Storage Distribution



Reservoir is Dry

- Scenario #1: Modeled Data (1910 - 2013) with Current Operations of PVP, 2015 Projected Demands, and Modeled Historical Climate
- Scenario #4: Modeled Data (1910 - 2013) with Current Operations of PVP, 2045 Projected High Demands, and Modeled Historical Climate
- Scenario #5: Modeled Data (2001 - 2099) with Current Operations of PVP, 2045 Projected Low Demands, and Modeled Dry Climate
- Scenario #6: Modeled Data (2001 - 2099) with Current Operations of PVP, 2045 Projected High Demands, and Modeled Dry Climate
- Scenario #7: Modeled Data (2001 - 2099) with Current Operations of PVP, 2045 Projected Low Demands, and Modeled Wet Climate
- Scenario #8: Modeled Data (2001 - 2099) with Current Operations of PVP, 2045 Projected High Demands, and Modeled Wet Climate

Lake Mendocino FIRO Demonstration Project - A Collaborative Effort

Broad coalition of federal, state, & regional agencies comprised of scientists & water managers

Steering Committee:

Federal: NOAA (OAR, NWS, NMFS), USGS, Army Corps of Engineers, & Bureau of Reclamation

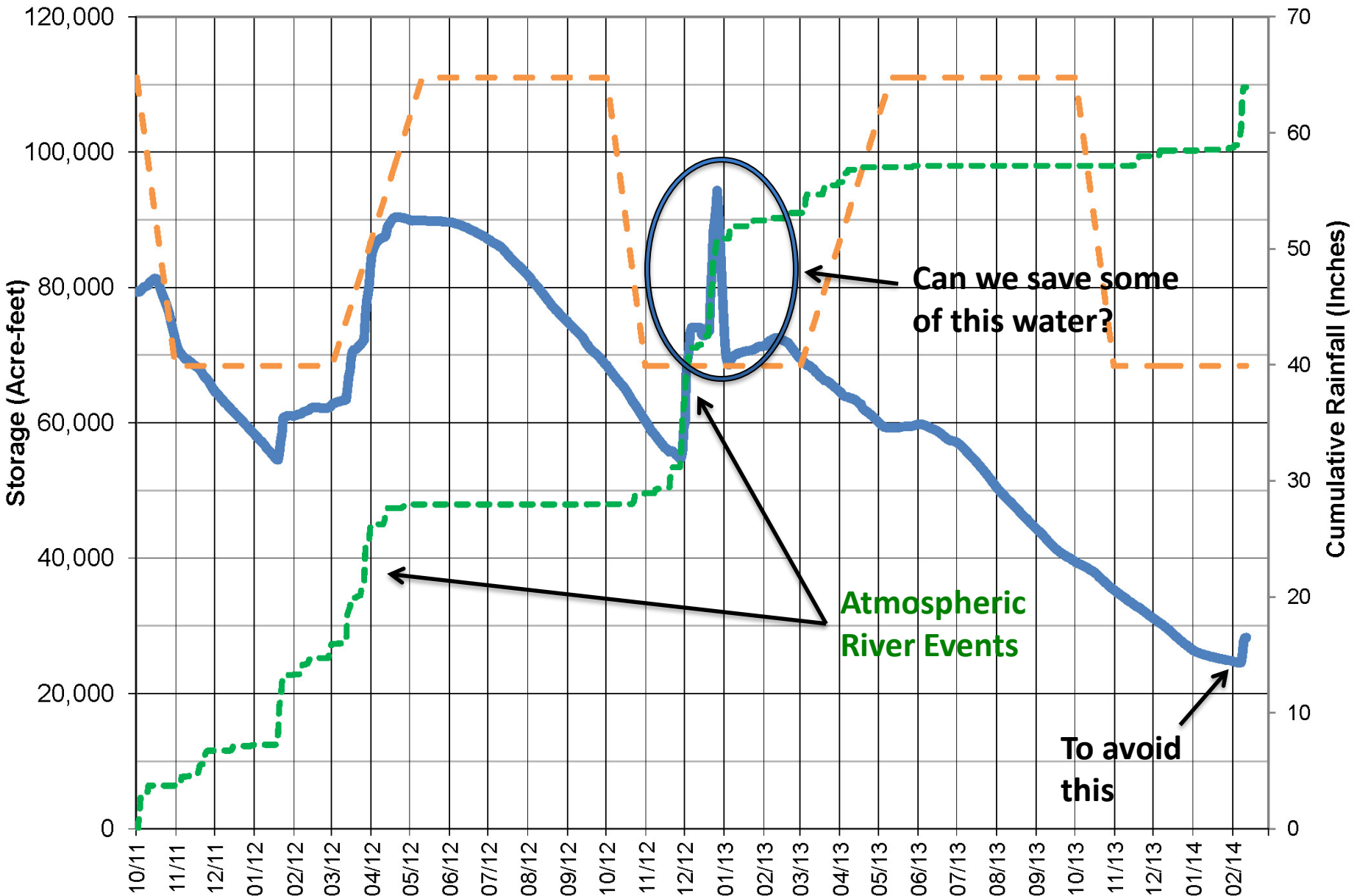
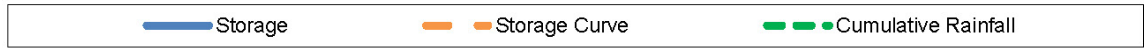
State: California Department of Water Resources & Scripps Center for Western Weather & Water Extremes

Regional: Sonoma County Water Agency

Partnerships: NOAA Habitat Blueprint
Integrated Water Resource Sciences & Services



Lake Mendocino Water Years 2012 - 2014



Possible Operational Improvements: Forecast Informed Operations

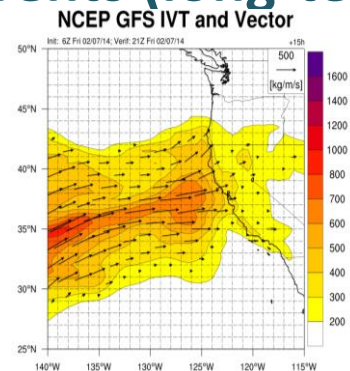
Incorporate current forecast skill into operations for periods when no storm events are predicted (near-term)

Reservoir operations consider watershed conditions (near-term)

- SCWA/NOAA/USGS install soil moisture & rain gages above reservoirs
- Develop correlations between rainfall-soil moisture-reservoir inflow

Forecast skill for atmospheric river events (long-term)

- Predict landfall & intensity of storms
- CalWater-2 and other research



Preliminary Viability Evaluation

Is FIRO currently viable strategy to improve water supply and environmental conditions without impairing flood protection?

YES –
FIRO
is a viable
strategy

(Note: some FIRO strategies may be currently viable while others are not)

NO-
FIRO is
NOT currently
a viable
strategy to
improve
reservoir
operations

How can FIRO
become
incorporated
into reservoir
operations?
• Process
• Decision
support
tools/model

What Improvements in
scientific knowledge &
decision tools need to occur
so that FIRO is viable and can
meet the needs of water
managers?

Science & Technical Programs

- Data collection & monitoring (watershed, hydrometric)
- Weather Forecasting
 - QPI
 - QPE
 - ARs
- Decision support model
- Data interoperability

Demonstration Project Status

Steering Committee

- Monthly calls
- Quarterly meetings


Annual Workshops

- Three workshops to date

Completed Work Plan Summer 2015

Three Workgroups

- **Preliminary Viability Assessment (end of year)**
- Procedural Matters & Implementation
- Science & Research



**FACT SHEET: LAKE MENDOCINO FORECAST INFORMED RESERVOIR OPERATIONS
PRELIMINARY VIABILITY ASSESSMENT WORK PLAN**

PURPOSE: The Lake Mendocino Forecast Informed Reservoir Operations (FIRO) Preliminary Viability Assessment Work Plan (Work Plan) describes an approach for using modeling, forecasting tools and improved information to determine whether the Lake Mendocino Water Control Manual can be adjusted to improve flood-control and water supply operations. This proof-of-concept FIRO viability assessment uses Lake Mendocino as a model that could have applicability to other reservoirs.

BACKGROUND: The 1959 Lake Mendocino Water Control Manual (with minor updates in 1986), specifies reservoir elevations to control flooding and establishes the volume of storage that may be used for water supply. The Manual was developed using the best information available at the time, but it has not been adjusted to reflect changing climate conditions and reduced inflows over the past 30 years.

FIRO WORK PLAN: The FIRO Steering Committee* has developed a work plan for assessing the viability of FIRO that takes advantage of current science and technology. FIRO envisions modern observation and prediction technology that could provide water managers more lead time to selectively retain or release water from reservoirs based on longer-term forecasts. Optimizing reservoir operations potentially benefits water supply and environmental flows without diminishing flood control or dam safety.

This Work Plan presents an approach for conducting a proof-of-concept FIRO viability assessment using Lake Mendocino as a model. Specifically, it outlines a process for evaluating whether FIRO can support adjustments to the Manual. The work plan describes current technical and scientific capabilities, and outlines technical/scientific analyses and future efforts to demonstrate the potential of FIRO to improve reservoir management.

The assessment will present a suite of actions ranging from practical, short-term steps to longer-term research needs. If deemed viable, FIRO will likely be implemented incrementally, as science evolves and implementation criteria are met. FIRO follows adaptive management principles for continual improvement of reservoir operations. In the case of Lake Mendocino, and much of the west coast, this hinges on opportunistically applying advances in monitoring and predicting atmospheric rivers, their associated precipitation and runoff.

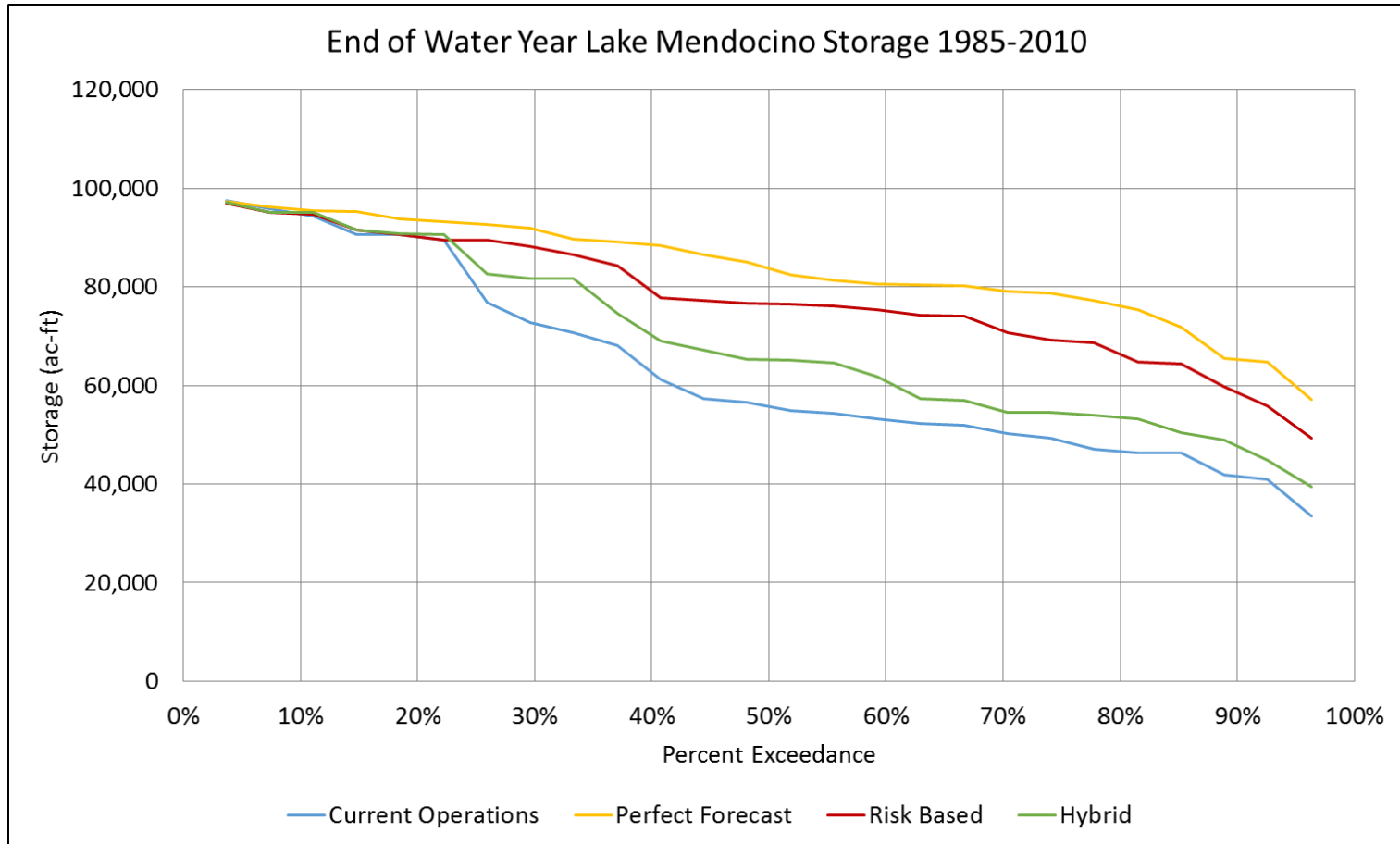
While aimed at benefitting Lake Mendocino, the project has transferability potential, thus the Work Plan will document a process that can be replicated in other watersheds. It consists of the following steps:

- Develop evaluation criteria and methodology
- Develop evaluation scenarios
- Identify science needs and carry out necessary research projects
- Evaluate model results
- Evaluate FIRO viability (preliminary) and assess benefits
- Develop implementation strategies

(over) →

FIRO Improves Water Storage

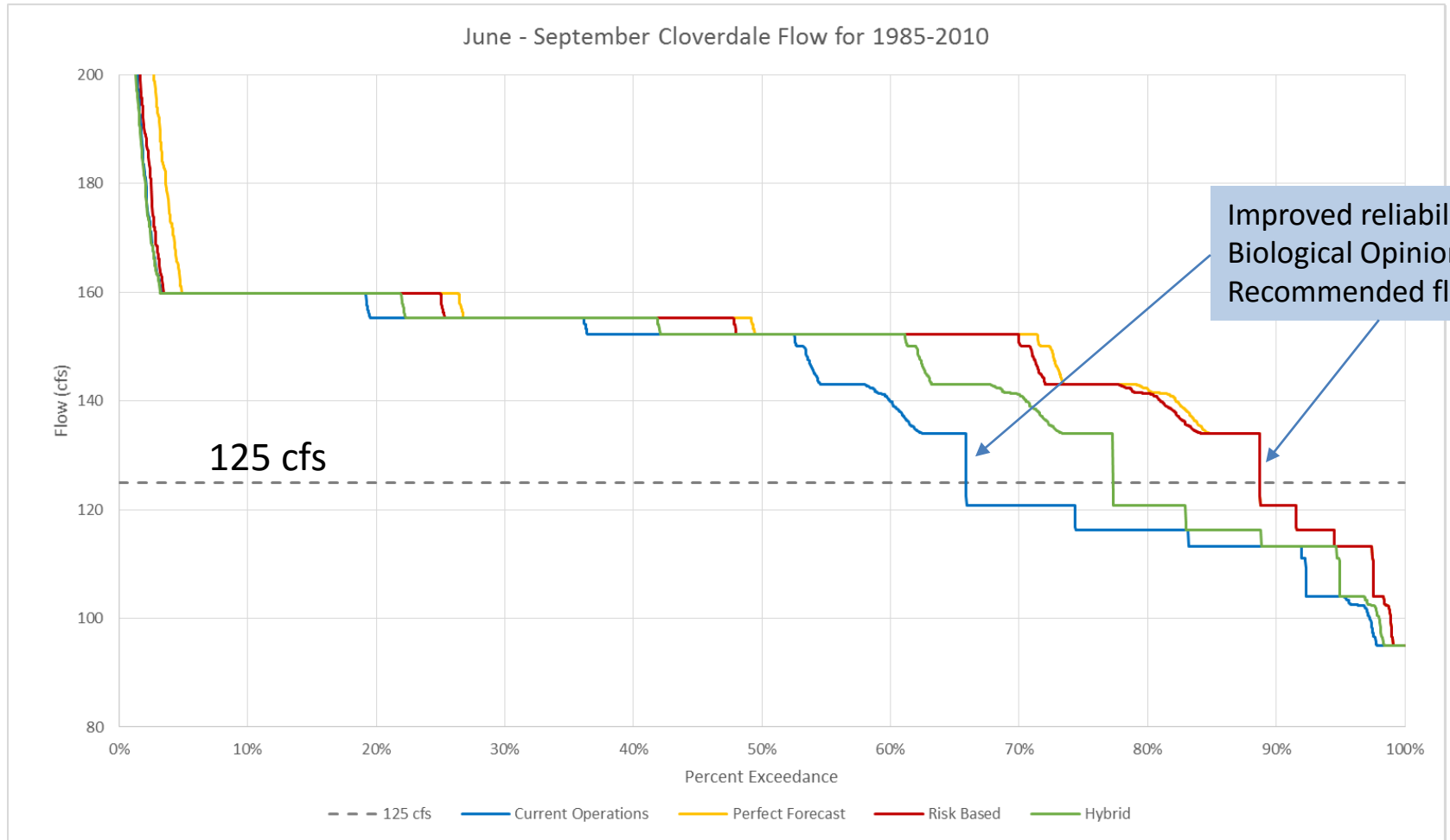
Preliminary Modeling Results



FIRO Improves In-Stream Flows

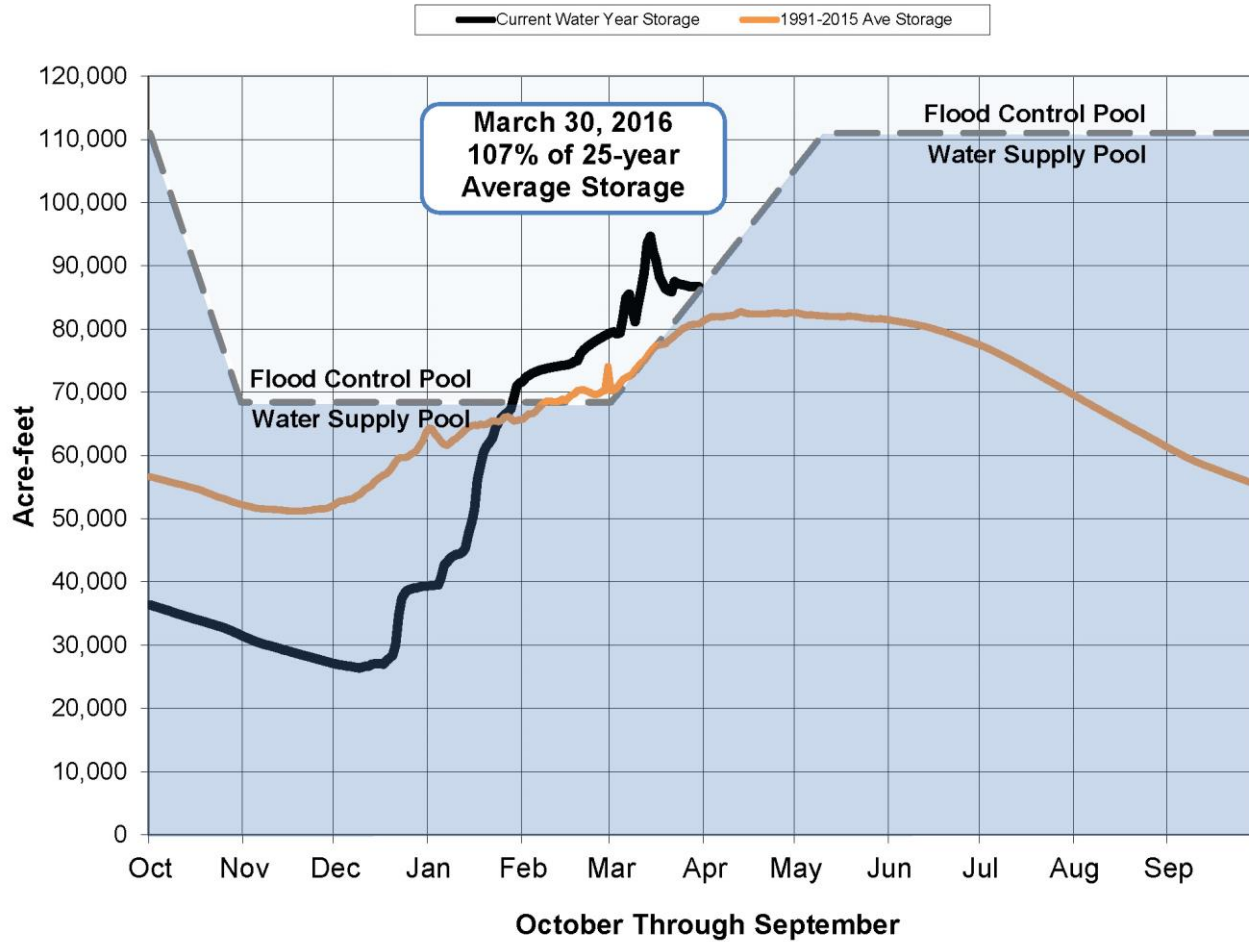
June to September Cloverdale Flows

Preliminary Modeling Results



Water Year 2015-16 Lake Mendocino Operations

Lake Mendocino Storage



Summary

- Water management operations must respond to highly variable weather conditions - eg., Atmospheric Rivers
- FIRO shows promise for improved reservoir water supply & in-stream flows
- Must ensure that flood protection won't be compromised
- Build resiliency & defer/avoid expensive capital projects
- Demonstration project employs technical/scientific innovation utilizing a collaborative multi-agency partnership
- Implementation will be incremental (FIRO version 1, version 2, etc.)

Lake Mendocino Forecast Informed Reservoir Operations Highlighted in White House Report

- **Piloting promising solutions.** Testing and demonstration of new approaches to water sustainability is an essential precursor to large-scale implementation. Today, the Administration is announcing pilots of several such approaches:
 - Improving weather forecasts for water-management operations. This year, **NOAA**, **USGS**, and the **U.S. Army Corps of Engineers (Army Corps)**, along with the **Sonoma County Water Agency** and other local and state partners, will launch the Lake Mendocino Forecast Informed Reservoir Operations pilot project in California's Russian River. This pilot will demonstrate ways in which improved weather forecasts can aid the decisions made by Army Corps and other water-resource managers as they balance flood and drought risks, maximize reservoir-storage potential, and minimize conflict among competing water users.

COMMITMENTS TO ACTION ON BUILDING A SUSTAINABLE WATER FUTURE

The Executive Office of the President



March 22, 2016

Several Initiatives To Improve Water Supply Reliability

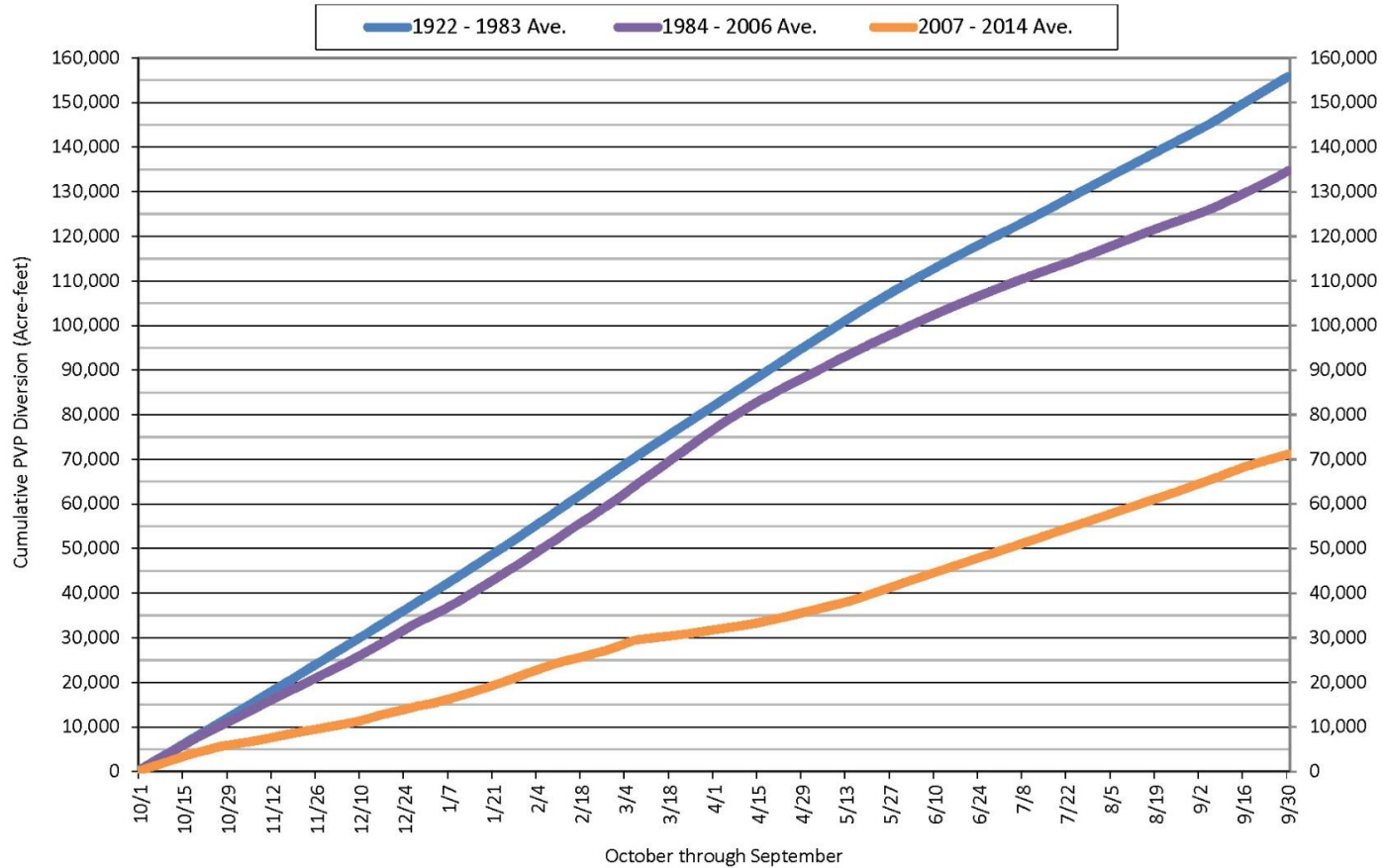
- Reduced summer releases (per Biological Opinion)
- Modification of the hydrologic index
- Raising Coyote Valley Dam
- ***Forecast Informed Reservoir Operations (FIRO)***



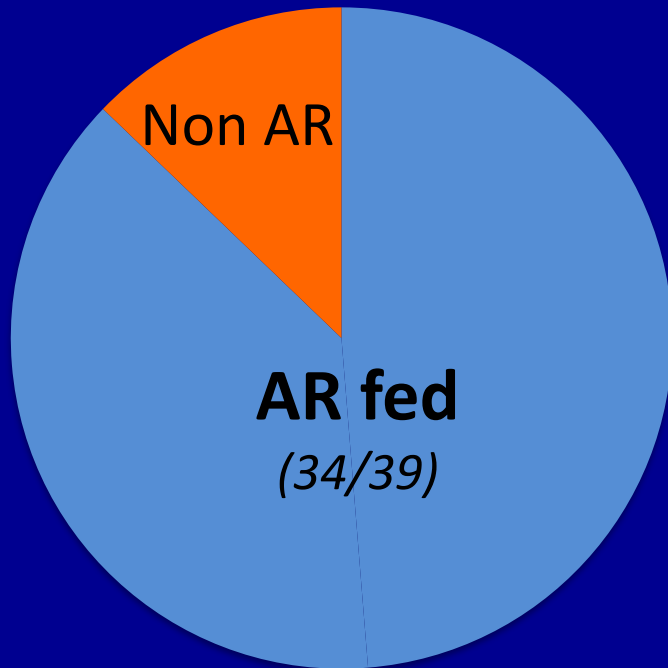
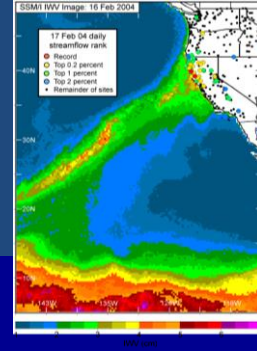
Cumulative Potter Valley Project Diversions

A Declining Trend

Cumulative Diversion To Potter Valley Project By Water Year



ARs & Russian River floods



- ALL 7 major floods of Russian River since 1997 have been atmospheric rivers (Ralph et al, GRL, 2006)

On a longer time scale, among all 39 “declared” floods of the Russian River (39 cases with > 50,000 cfs) from 1948-2011...

87% were caused by ARs