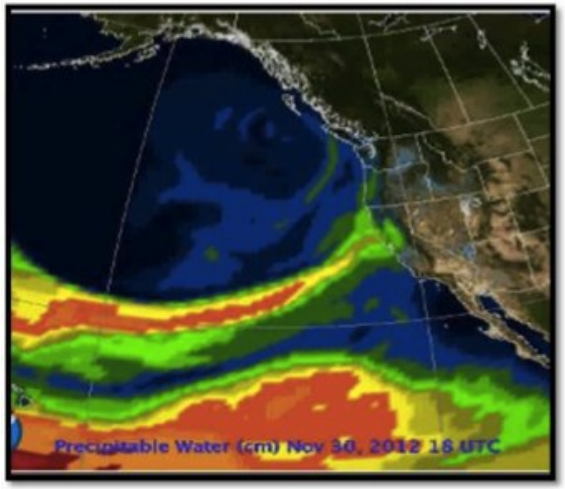
Forecast Informed Reservoir Operations – *An Opportunity to Improve the Resiliency of our Water Supply*



Western States Water Council
May 29, 2015

Jay Jasperse, Chief Engineer
Sonoma County Water Agency

SONOMA COUNTY WATER AGENCY

Russian River System

Dual Purpose Facilities

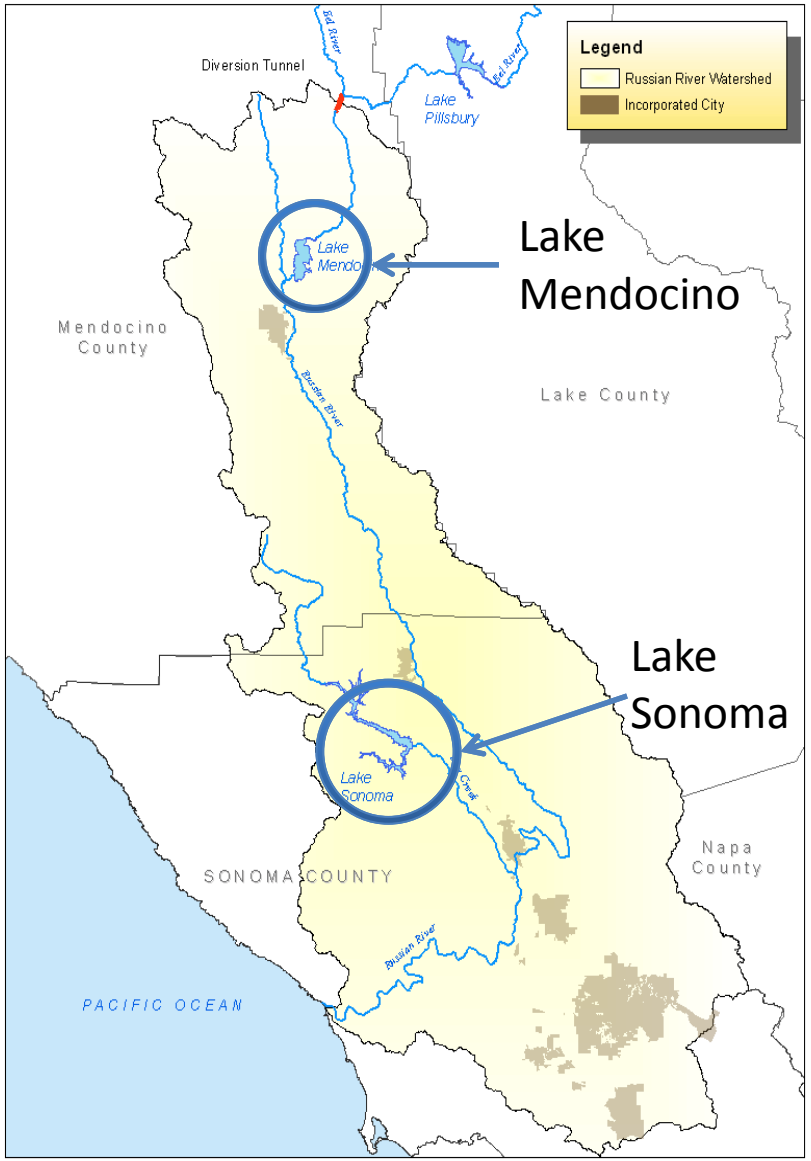
- Flood Protection (ACOE)
- Water Supply (SCWA)
- Rainfall dominated watershed
- Eel River Diversions
- Highly regulated river system

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 (Min)



Lake Mendocino Does Not Function As A Reliable Water Supply Facility

Some Reasons For Inadequate 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

Who Relies On Water Supply From Lake Mendocino?

Municipal Uses:

- Direct river diversions & groundwater recharged by Russian River
- Sonoma County Water Agency (regional system)

Agriculture Uses:

- Vineyards, orchards, row crops

Environmental & Ecosystem Uses:

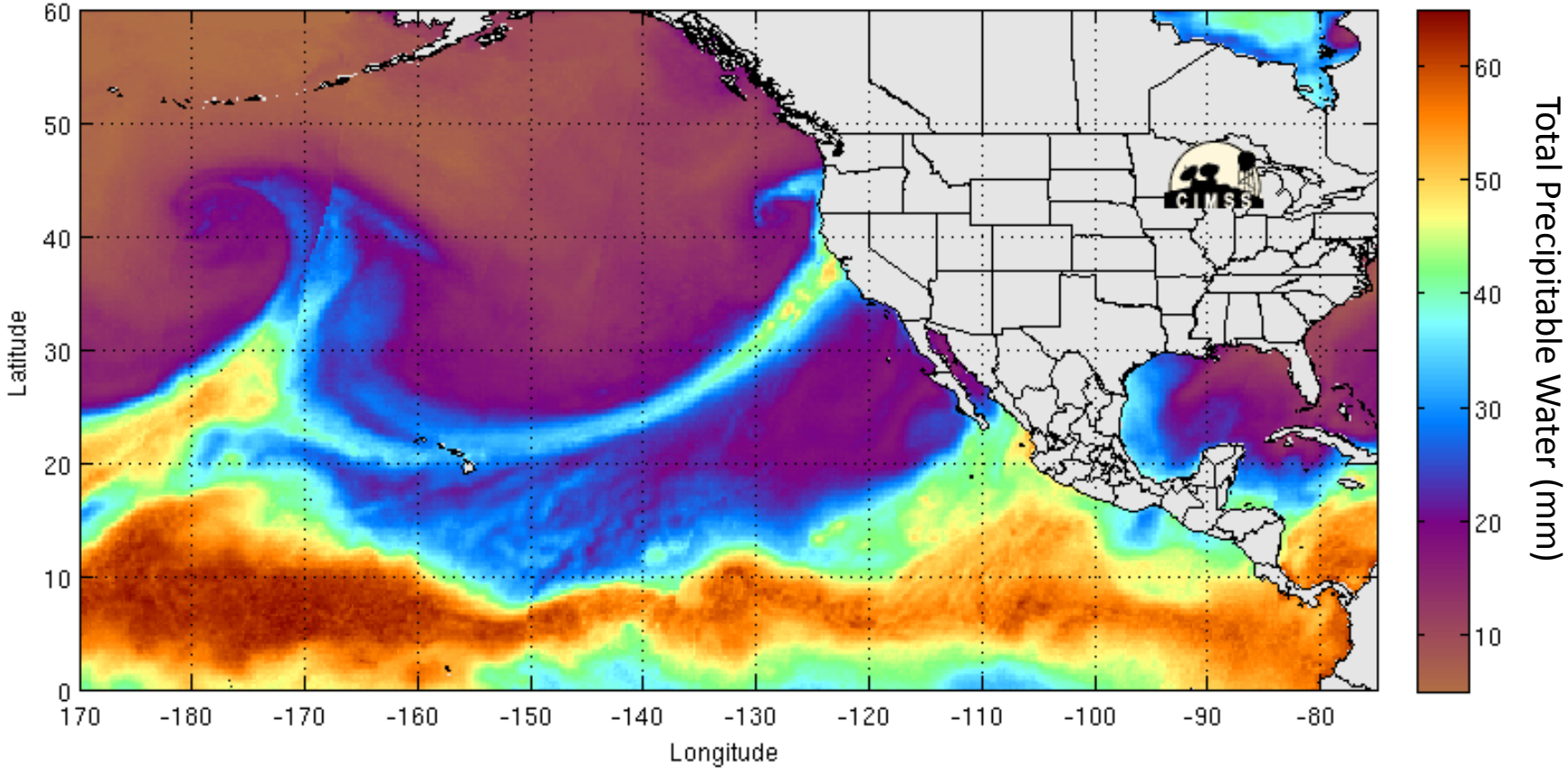
- Three ESA-listed salmonid species

Recreation & Tourism Uses:

- Lake Mendocino high use recreation facility
- Tourism associated with Russian River significant to regional economy

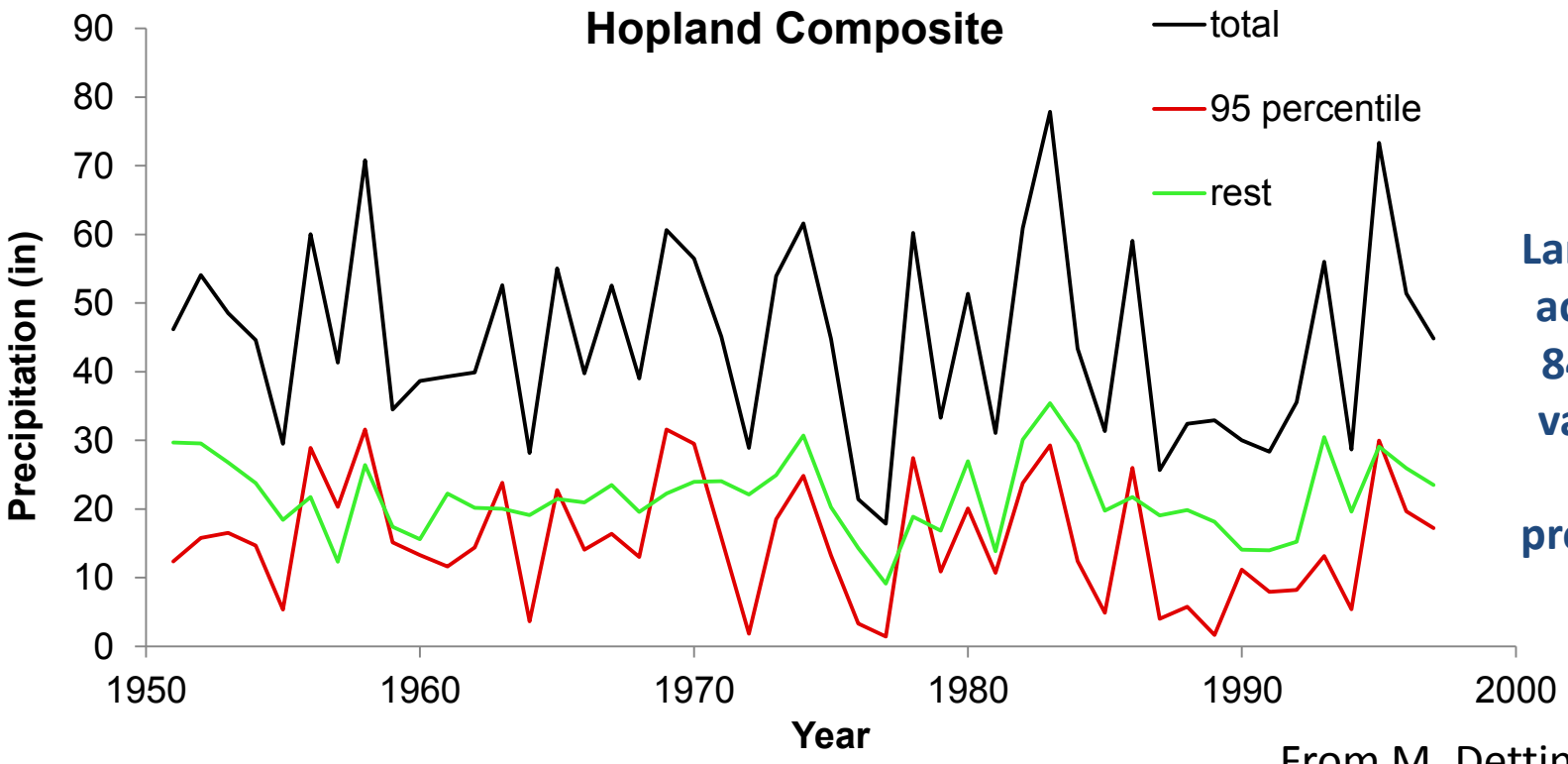
Atmospheric Rivers: Our Extreme Weather Events

Composite Dec 11, 2014



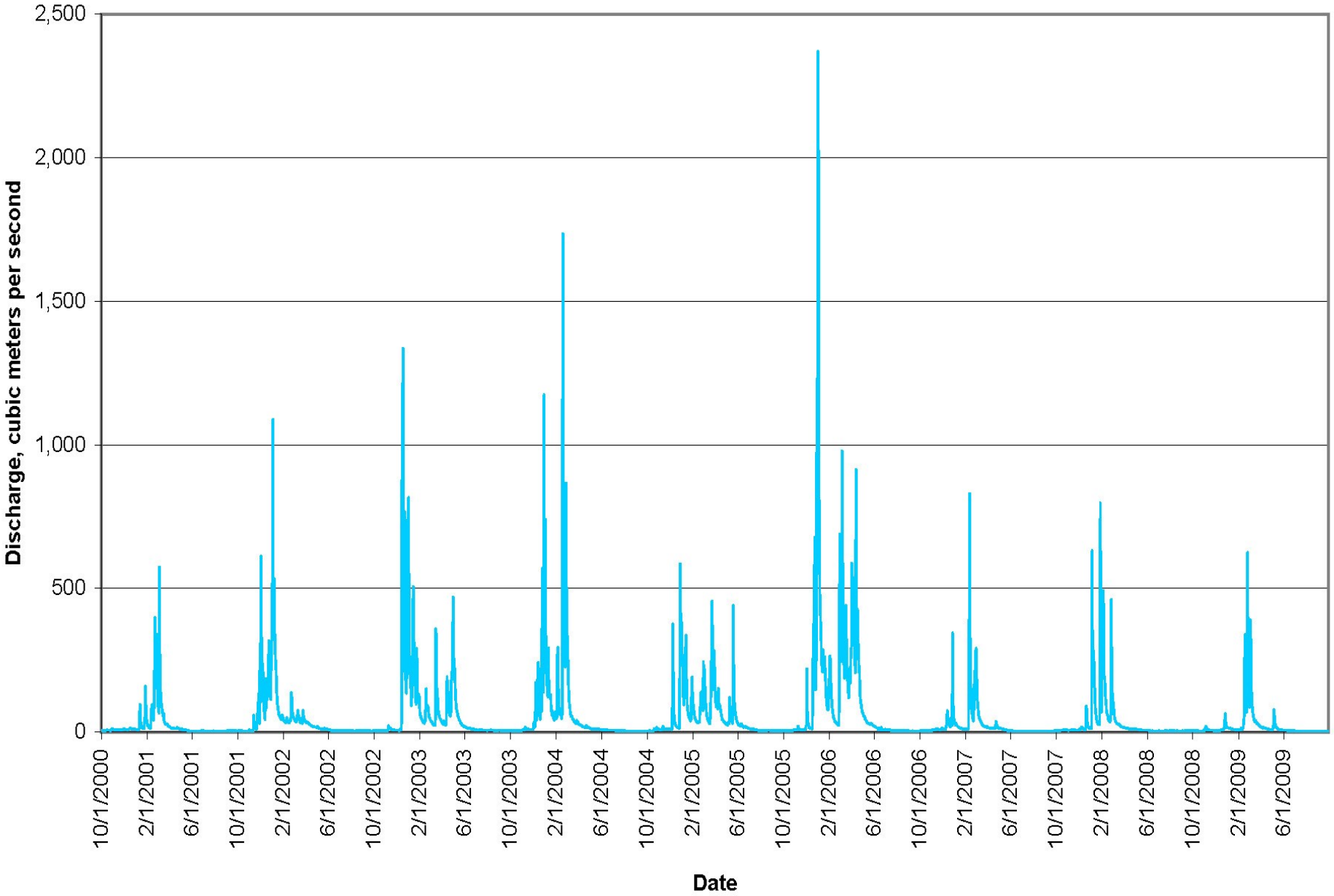
Source: CIMSS

Atmospheric Rivers Drive Droughts & Floods



Large storms account for 84% of the variance of total precipitation

From M. Dettinger


Hydrograph - Russian River at Hacienda Bridge, Guerneville California
Discharge, cubic meters per second
2,500
2,000
1,500
1,000
500
0
10/1/2000
2/1/2001
6/1/2001
10/1/2001
2/1/2002
6/1/2002
10/1/2002
2/1/2003
6/1/2003
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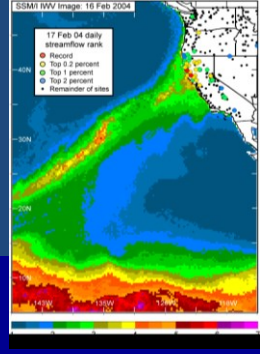
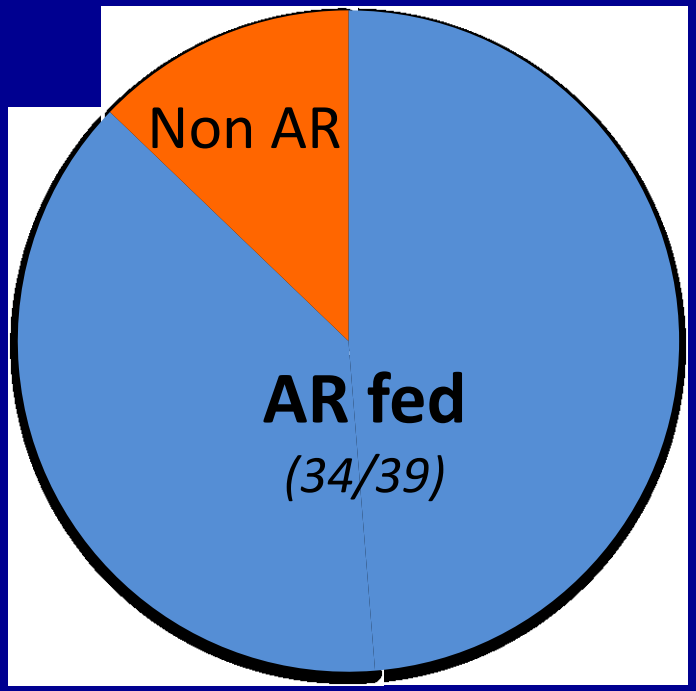
6/1/2009
Date

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

USGS science for a changing world

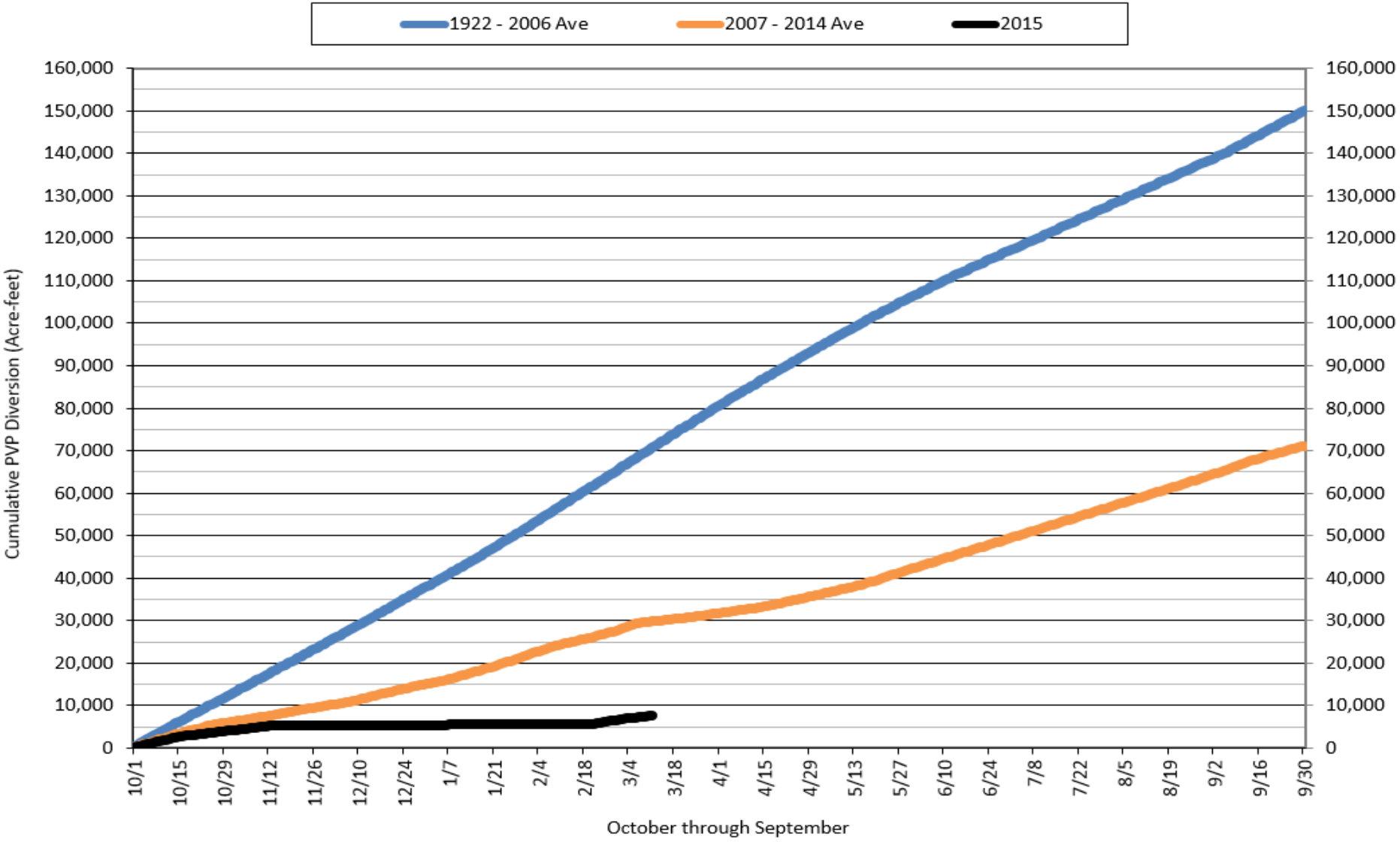
Southwest Climate Science Center

CNAP California-Nevada Climate Applications Program

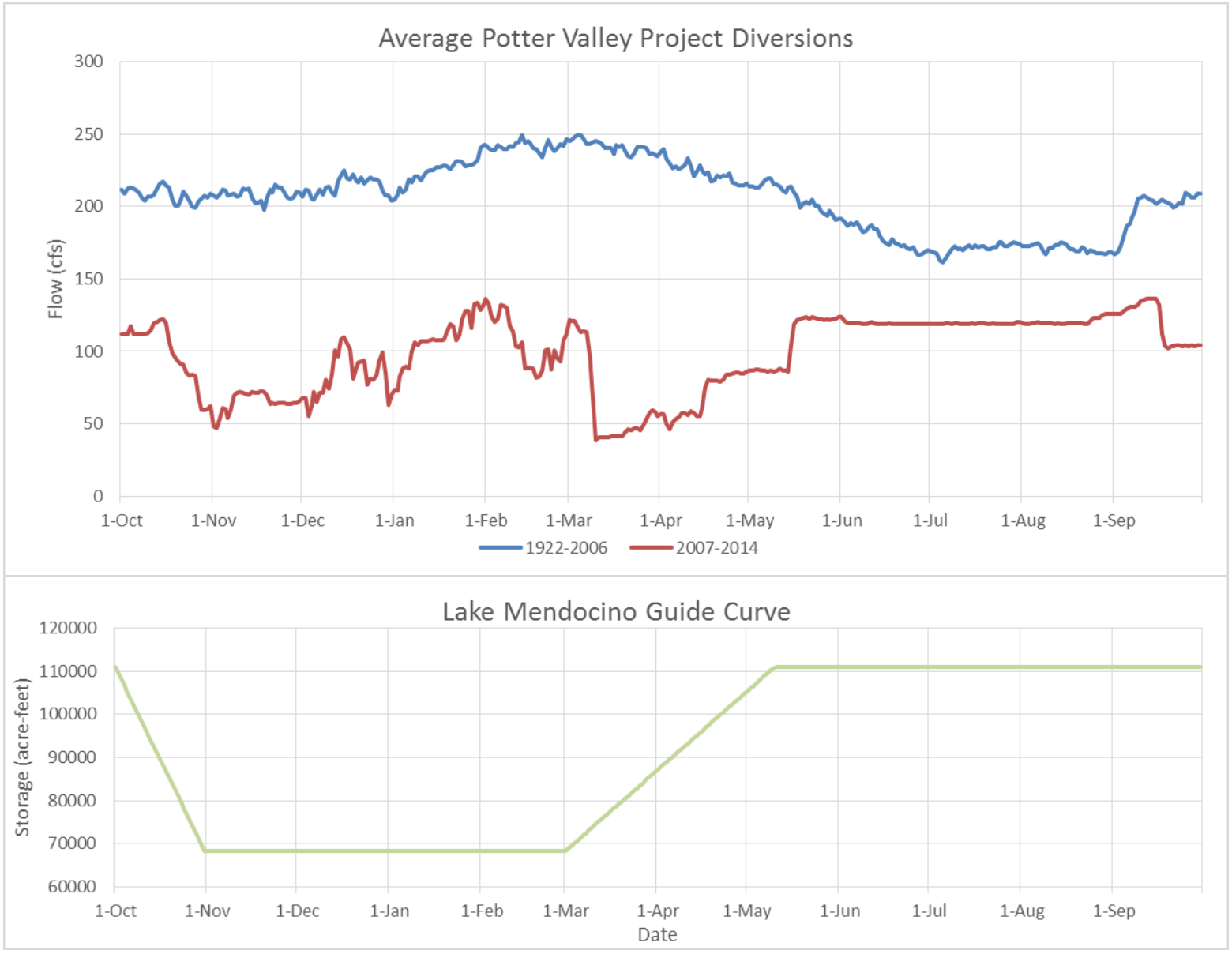
Ralph et al., GRL, 2006

Cumulative Potter Valley Project Diversions

A Declining Trend



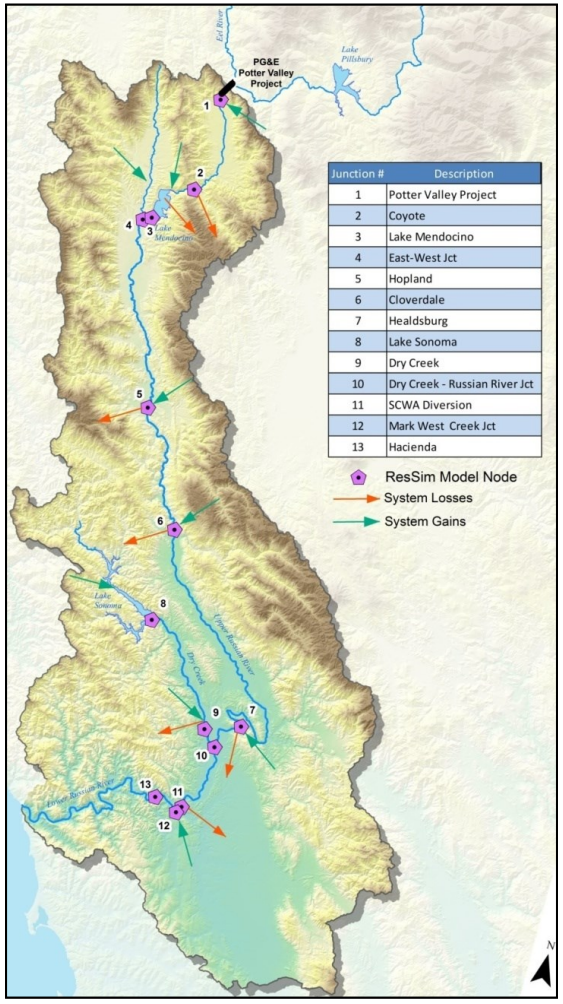
Reduced Potter Valley Project Diversions



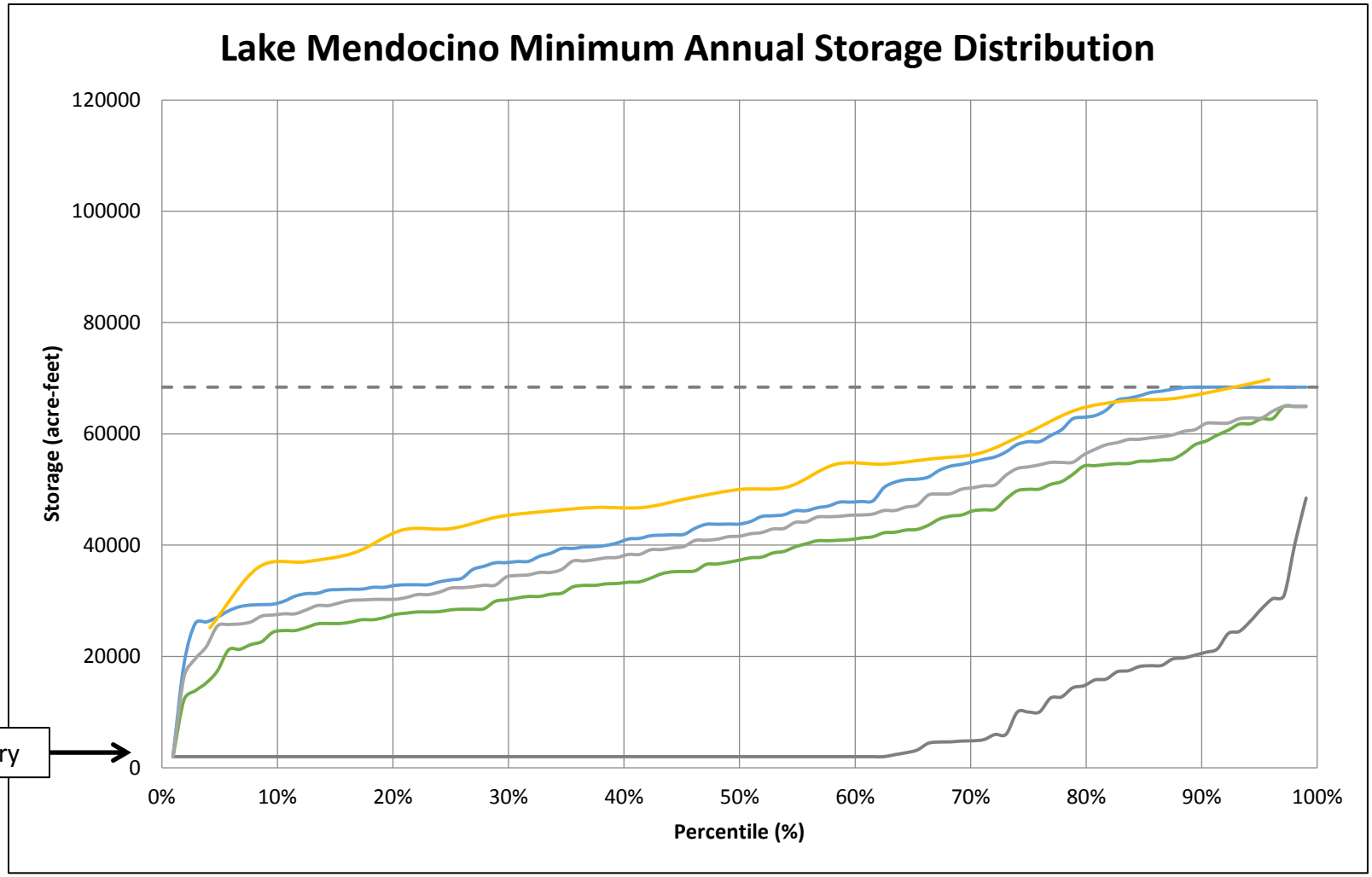
Lake Mendocino Reliability Study

Modeling Study: 8 Scenarios Evaluated

- Current Water Supply Reliability
  - Current Eel River Diversions
  - No Eel River Diversions
- Projected 2045 Water Demand: High & Low
- Potential Climate Change Impacts: Dry & Wet



Lake Mendocino Minimum Annual Storage Distribution



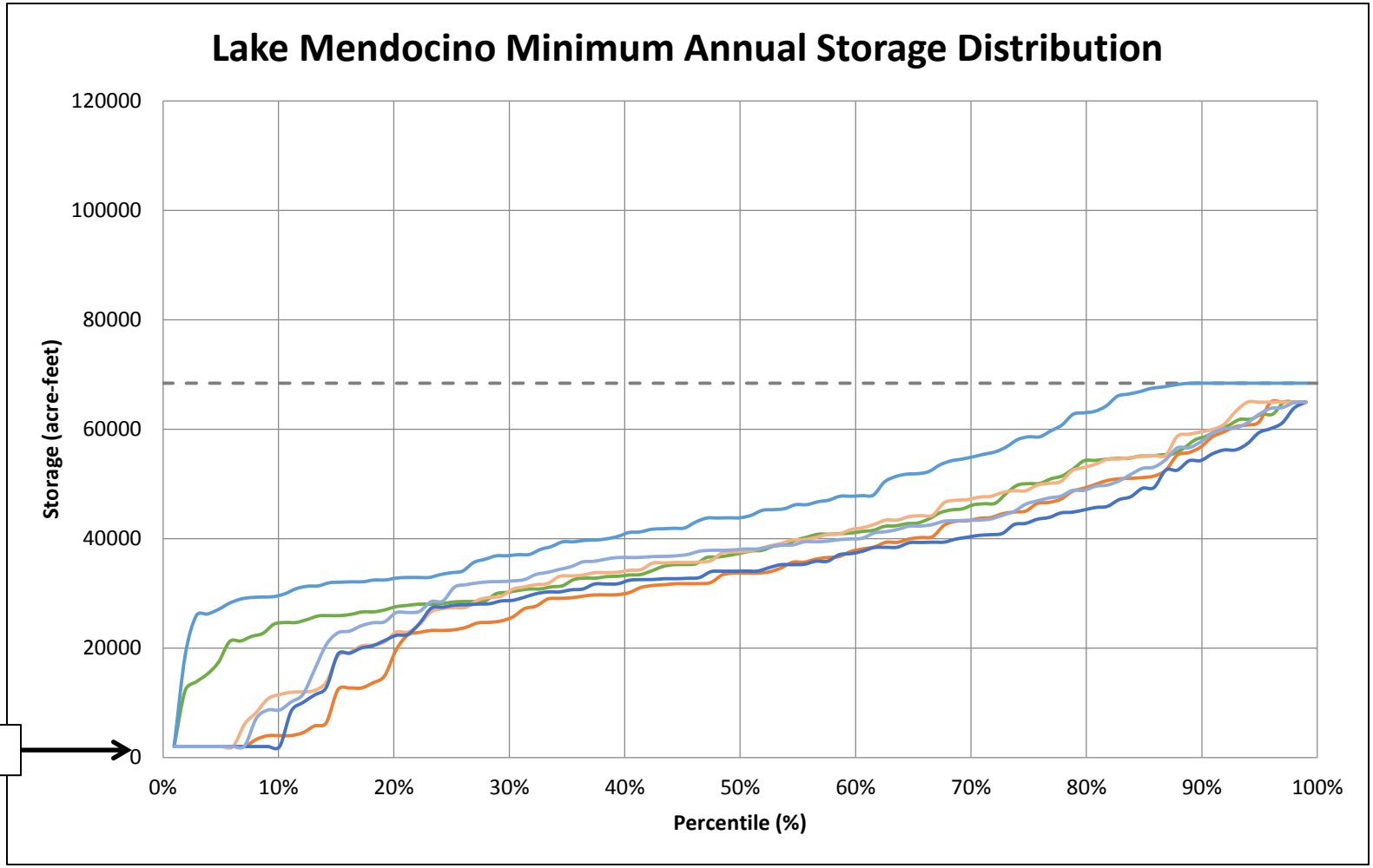
Scenario #1: Modeled Data (1910 - 2013) with Current Operations of PVP, 2015 Projected Demands, and Modeled Historical Climate

Scenario #2: Modeled Data (1910 - 2013) with No Operations of PVP, 2015 Projected Demands, and Modeled Historical Climate

Scenario #3: Modeled Data (1910 - 2013) with Current Operations of PVP, 2045 Projected Low Demands, and Modeled Historical Climate

Scenario #4: Modeled Data (1910 - 2013) with Current Operations of PVP, 2045 Projected High Demands, and Modeled Historical Climate

Observed Historical Data (1984 - 2006)



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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

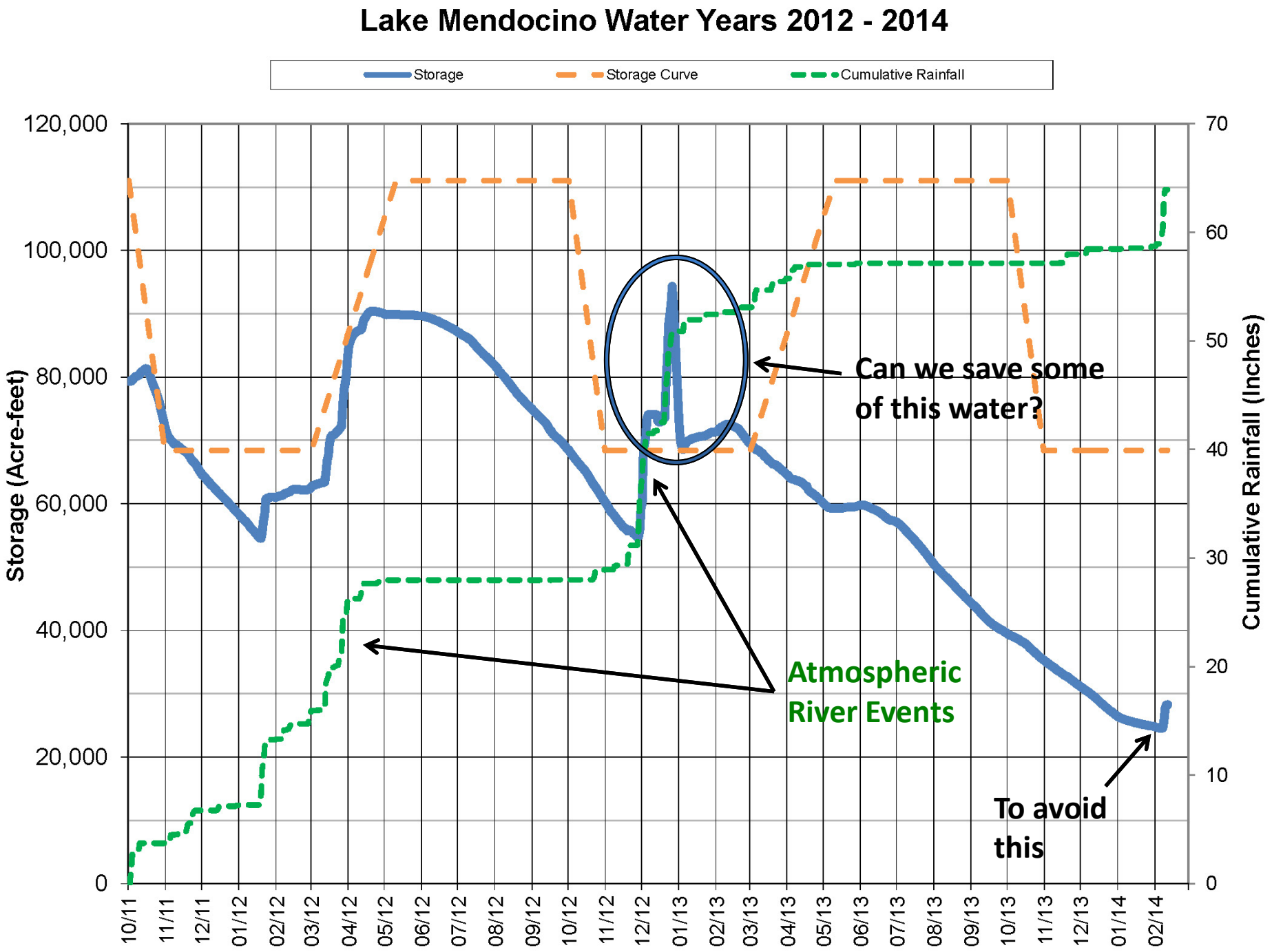
Scenario #6: Modeled Data (2001 - 2099) with Current Operations of PVP, 2045 Projected High Demands, and Modeled Dry Climate

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

Several Initiatives To Improve Water Supply Reliability

- Raise Coyote Valley Dam
- Integrated water management & conservation
- Modification of the hydrologic index
- ***Forecast Improved Reservoir Operations (FIRO)***


Lake Mendocino Water Years 2012 - 2014
Storage
Storage Curve
Cumulative Rainfall
Storage (Acre-feet)
Cumulative Rainfall (Inches)
120,000
100,000
80,000
60,000
40,000
20,000
0
70
60
50
40
30
20
10
0
10/11
11/11
12/11
01/12
02/12
03/12
04/12
05/12
06/12
07/12
08/12
09/12
10/12
11/12
12/12
01/13
02/13
03/13
04/13
05/13
06/13
07/13
08/13
09/13
10/13
11/13
12/13
01/14
02/14
Can we save some of this water?
Atmospheric River Events
To avoid this

Lake Mendocino FIRO Demonstration Project – A Collaborative Effort

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

<u>Steering Committee:</u>

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

Possible Operational Improvements: Forecast Informed Operations

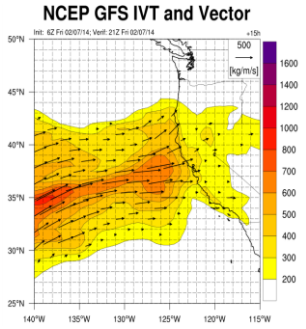
Incorporate current forecast skill into operations for periods when no storm events are predicted (near-term)

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

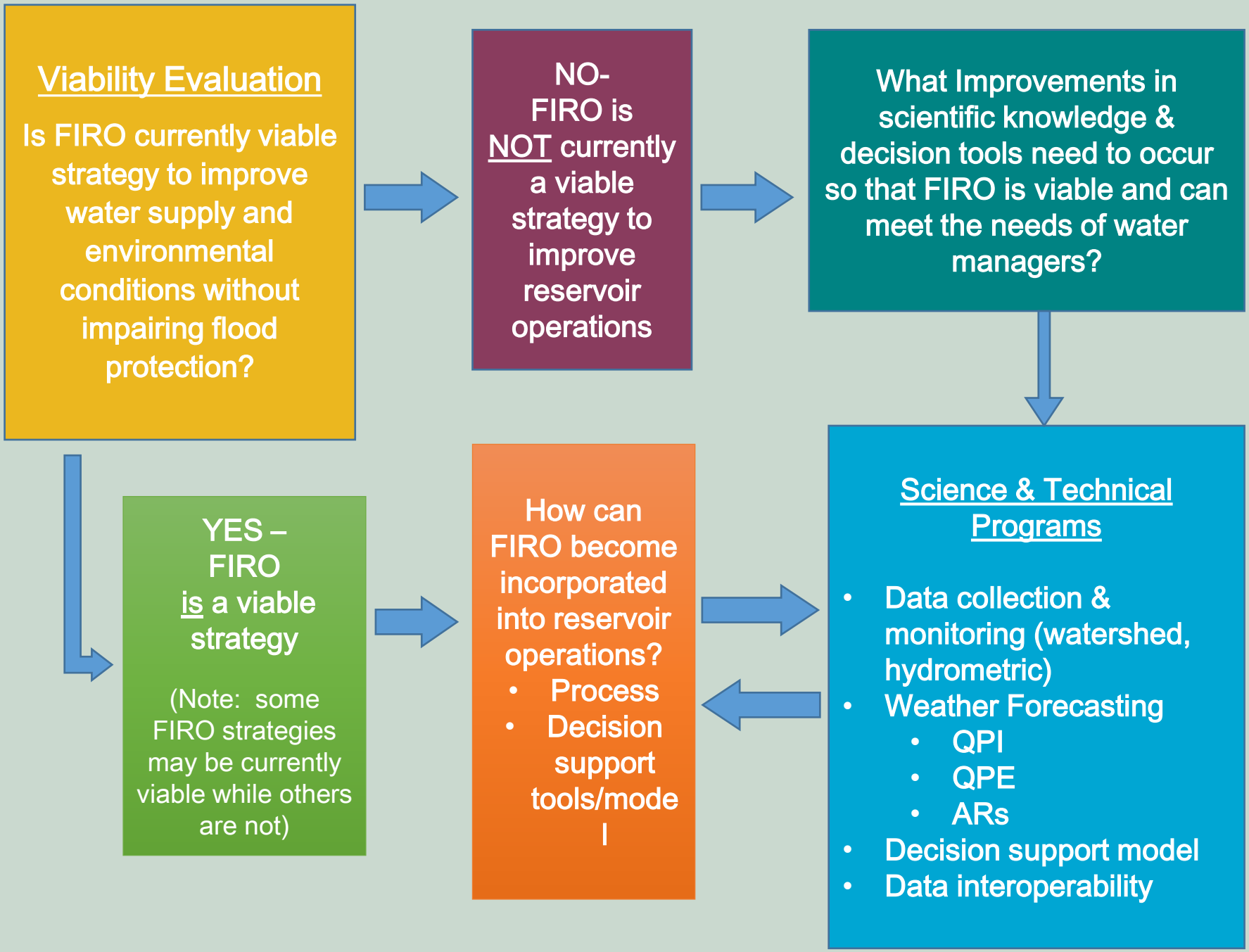


Lake Mendocino
FIRO Demonstration Project

Goal of initial phase is to answer the following question:
Is FIRO currently viable as an operational strategy to improve water supply and environmental conditions without impairing flood protection?

If answer is yes, then next step is to answer the following:
What decision support system & tools need to be employed to operationalize FIRO?

If answer is no, then next step is to address the following:
What research needs to be conducted to improve science & technology to meet the needs of water managers?


Viability Evaluation
Is FIRO currently viable strategy to improve water supply and environmental conditions without impairing flood protection?
NO- FIRO is NOT currently a viable strategy to improve reservoir operations
What Improvements in scientific knowledge & decision tools need to occur so that FIRO is viable and can meet the needs of water managers?
YES – FIRO is a viable strategy
(Note: some FIRO strategies may be currently viable while others are not)
How can FIRO become incorporated into reservoir operations?
• Process
• Decision support tools/model
Science & Technical Programs
• Data collection & monitoring (watershed, hydrometric)
• Weather Forecasting
• QPI
• QPE
• ARs
• Decision support model
• Data interoperability

Demonstration Project Status

Complete Work Plan
- Early Summer 2015

In-person Steering Committee Mtg
- July 2015

"Bookend" Model Studies
- Baseline and perfect forecast
- Current condition assessments
- Fall 2015

Preliminary feasibility/viability study
- Winter 2016

IMPROVING RELIABILITY FOR DROUGHTS & FLOODS: FORECAST-INFORMED RESERVOIR OPERATIONS (FIRO)

PROJECT PARTNERS

steering committee members

firo co-chairs

Jay Jasperse
Sonoma County Water Agency

F. Martin Ralph
Center for Western Weather and Water Extremes

Michael Anderson
California State Climate Office, Department of Water Resources

Levi Brekke
Bureau of Reclamation

Mike Dillsbough
US Army Corps of Engineers

Michael Dettinger
United States Geological Survey

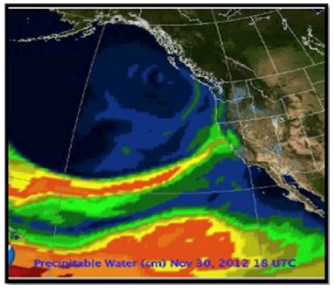
David Ford
Ford Consulting

Rob Hartman
NOAA's National Weather Service

Patrick Rutten
NOAA Restoration Center

Cary Talbot
US Army Corps of Engineers

Robert Webb
NOAA's Earth System Research Laboratory



background Lake Mendocino is located on the East Fork of the Russian River in Mendocino County, California. Created in 1958 by the Coyote Valley Dam, it provides flood control, water supply, recreation and stream flow regulation. The U.S. Army Corps of Engineers (Corps) owns and operates the dam in accordance with the Lake Mendocino Water Control Manual (1959, revised in 1986). Sonoma County Water Agency is the local partner that manages water stored in Lake Mendocino for water supply.

The Manual specifies elevations for an upper volume of reservoir storage that must be kept available for capturing storm runoff and reducing flood risk and a lower volume of storage that may be used for water supply. During a flood event, runoff is captured by the reservoir and released soon after to create storage space for another potential storm. The Manual is based on typical historical weather patterns – wet during the winter, dry otherwise.

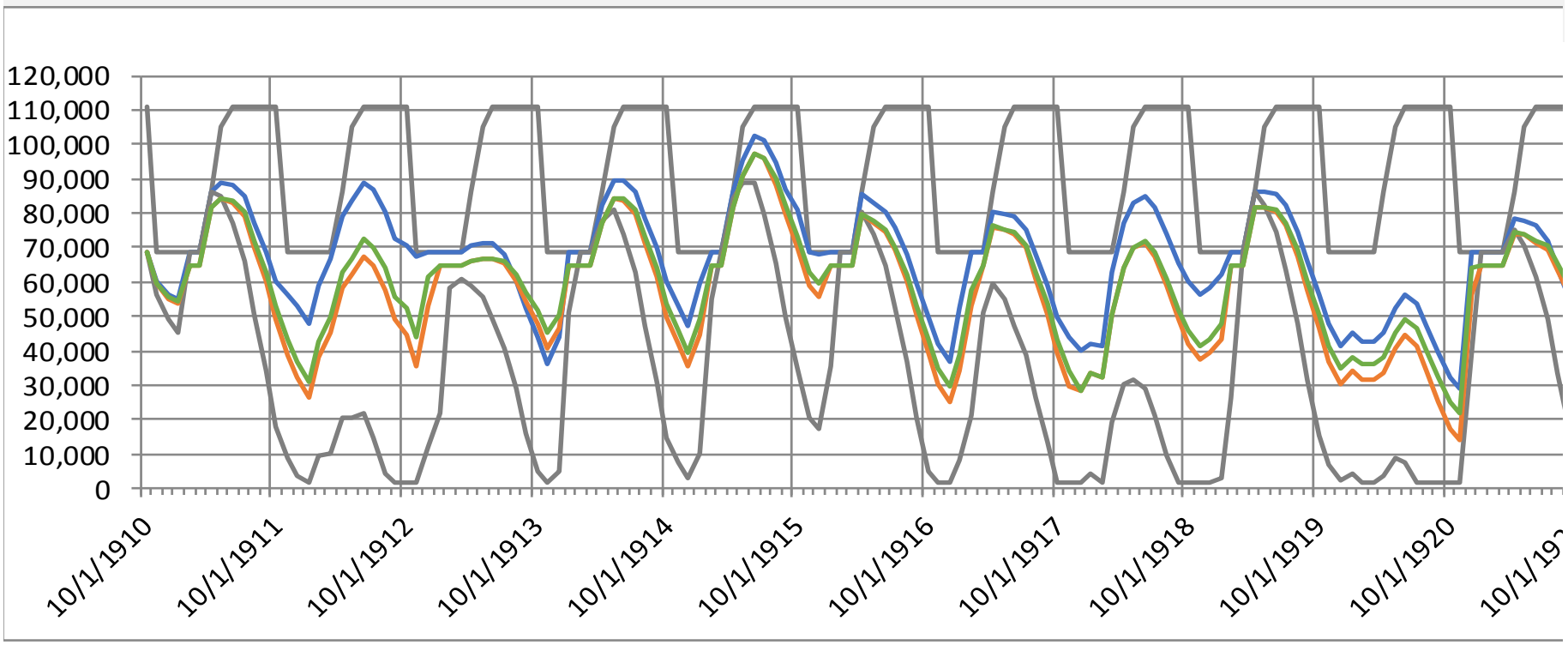
the problem

The Manual utilizes gross estimates of flood potential to establish reservoir storage and release requirements. It does not account for changing conditions in the watershed—for example, increased variation in dry and wet weather patterns and reductions to imported flows into the Lake that have occurred since 1986. Also, the Manual's reservoir operations procedures were developed decades ago, without the benefit of current science that more accurately predicts weather and streamflow.

Given reduced supplies, changed hydrologic conditions, and technological advances, some adjustments to the current reservoir operating procedures may be possible to optimize the goals of maintaining flood control while bolstering water supply reliability for downstream users and the environment (e.g., to support recovery of endangered and threatened fish). Modern observation and prediction technology could be used to reduce flood risk by supporting decisions of greater reservoir level drawdown in advance of storms. Or, such technology might be used to improve supply reliability by permitting more storm runoff to be retained for water supply while still preserving flood risk reduction objectives.

(over)

Modeling Shows FIRO Potential for Water Supply Benefits



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Modeled Data (1910 - 2013) with No Operations of PVP, 2015 Projected Demands, and Modeled Historical Climate

Observed Historical Data (1984 - 2006)

Challenges

Coordination between (and within) multiple agencies

Operationalizing research products & new technology into reservoir management decisions

Who accepts risks? What is tolerable risk?

Take the long-term view but demonstrate short-term improvements

Manage expectations: “No silver bullets”