

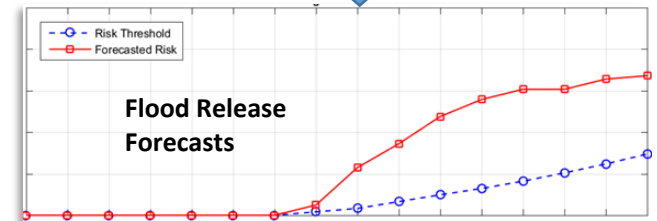
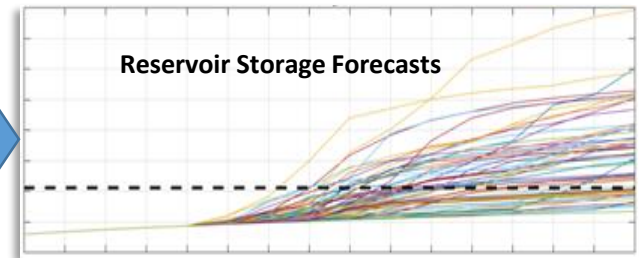
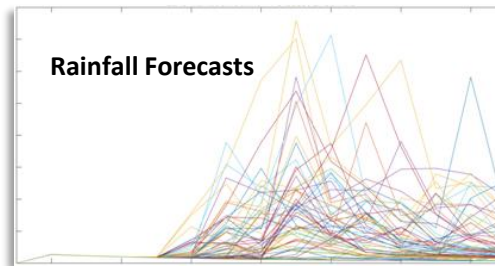
# Forecast Informed Reservoir Operations: Lake Mendocino Demonstration Project



Lake Mendocino 2014

Sixth Annual FIRO Workshop  
Scripps Institute of Oceanography  
August 6, 2019

Jay Jasperse, P.E.  
Chief Engineer/Director Groundwater Management  
Sonoma Water



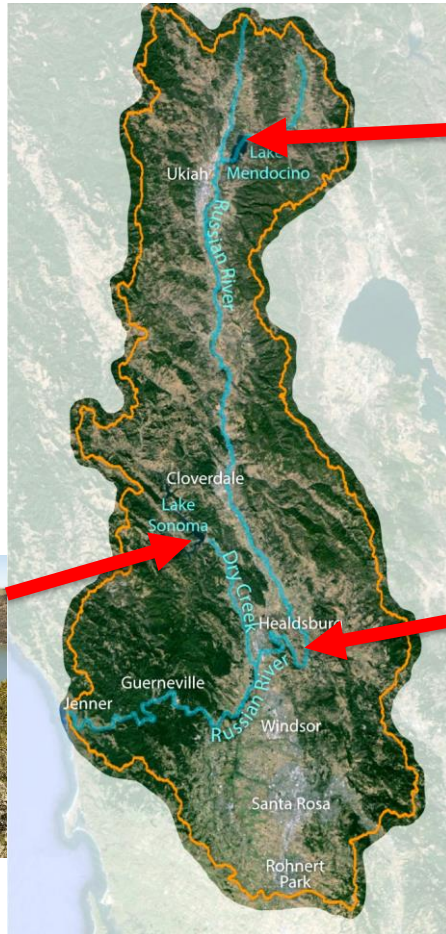
Sonoma  
Water

# Background

## Russian River Watershed



Lake Sonoma



Lake Mendocino



Russian River

## Sonoma Water

- Manage river flows & water supply for 2 reservoirs in partnership with USACE (Flood)
- Regional wholesale drinking water supplier to over 600,000 people
- Flood management services
- Wastewater services



# Motivation For Project

- Reduced inflows into Lake Mendocino
- 2013 Drought experience
- Endangered Species Act: Biological Opinion requirements

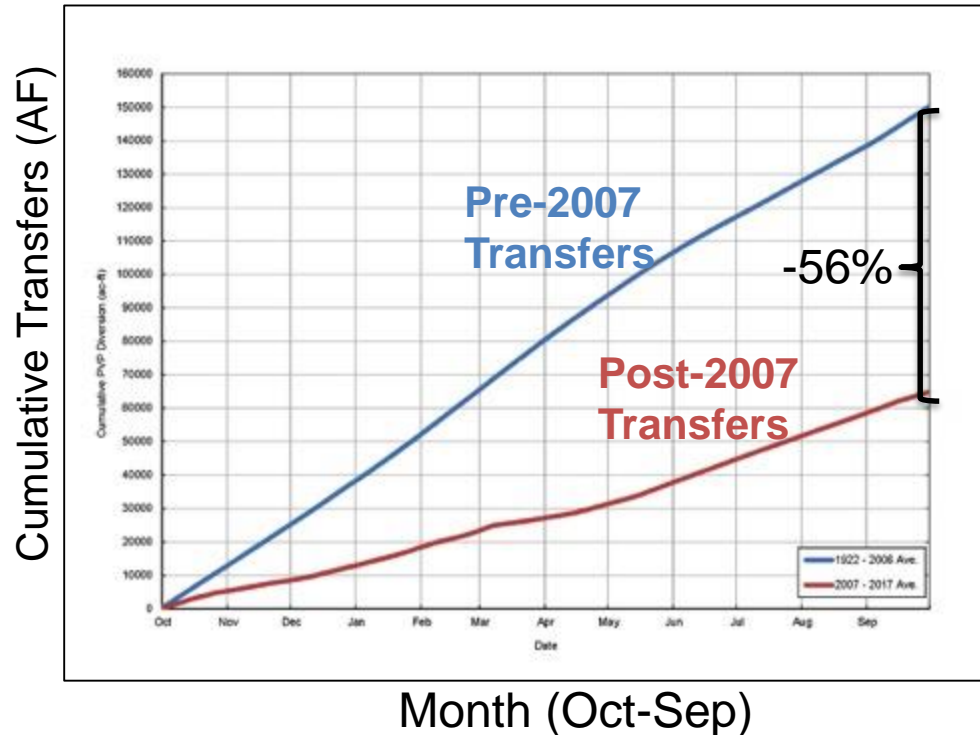


# Reduced Inflows

**Post-2007 reductions (56%) in transfers from the Eel River**

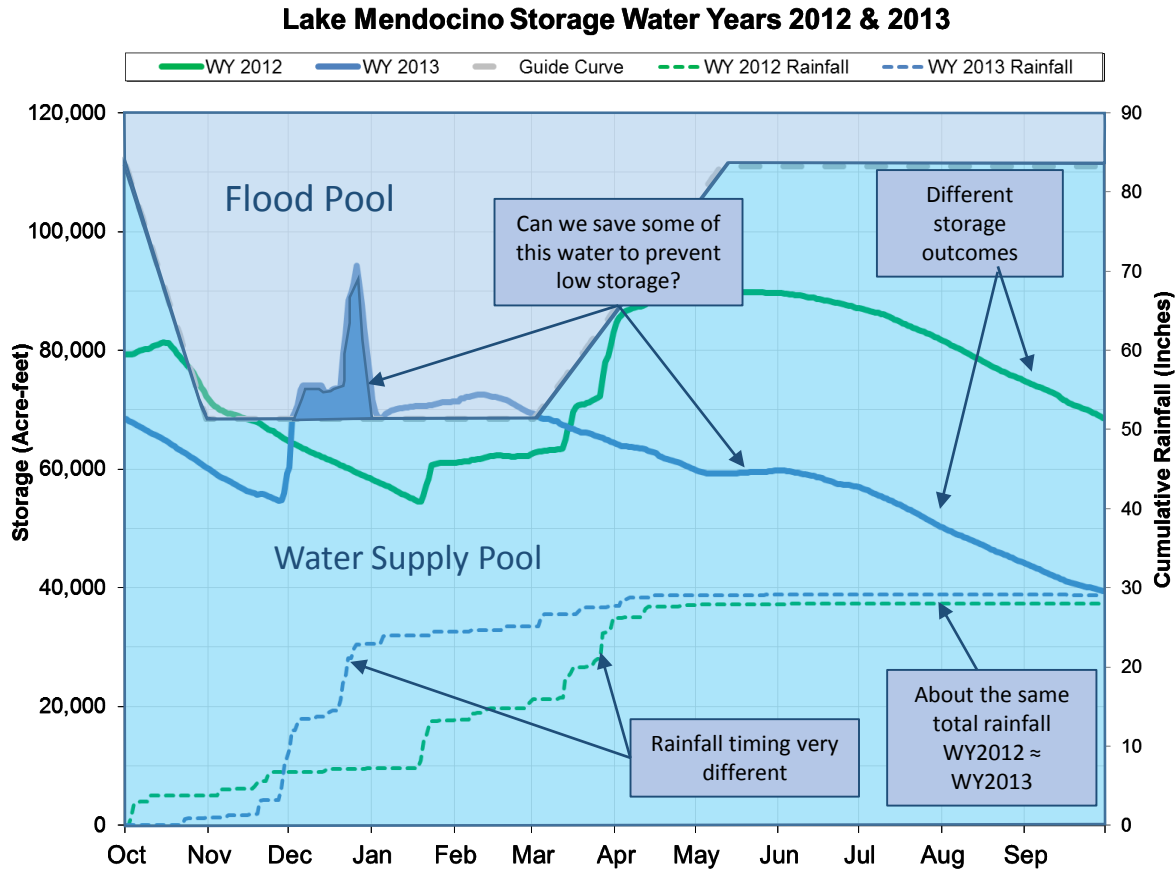
**Dramatically reduced ability of reservoir to provide reliable water supply for municipal, agricultural, and ecosystems needs.**

**Overall average reduction of 45% total inflows into reservoir.**



# Water Years 2012 & 2013: Two Very Different Years

## Motivation for the Demonstration Project



# Endangered Species Act

- Russian River has 3 ESA-listed salmonid species: chinook, steelhead & coho
- 2009 Biological Opinion for Russian River
  - USACE, Sonoma Water, Russian River Flood Control District, NMFS & CA DFW
- Lack of reliable water supply storage results in higher risk of undesirable downstream flows to support fishery habitat



# Goals

## *Lake Mendocino FIRO*

FIRO seeks to explore improvements in multi-purpose reservoir management outcomes through leveraging state-of-the-science technology in monitoring, modeling, and forecasting and through targeted research and development investments.

- Improved water supply reliability
- Undiminished or improved flood control capacity
- Improved environmental outcomes – 3 endangered salmonid species

All without pouring a single yard of concrete...



# LK. Mendocino FIRO Steering Committee

- **Co-Chairs**

Jay Jasperse – Sonoma County Water Agency

F. Martin Ralph – UCSD / SIO / CW3E

- **Members**

Michael Anderson – California DWR

Levi Brekke – USBR

Nick Malasavage – USACE / SPN

Michael Dettinger – USGS

Joe Forbis – USACE / SPK

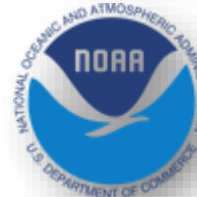
Alan Haynes – NOAA / NWS

Natalie Manning – NOAA / NMFS

Cary Talbot – USACE / ERDC

Robert Webb – NOAA / OAR

## Project Partners



Mendocino County  
**RUSSIAN RIVER FLOOD CONTROL**  
& Water Conservation Improvement District



# Lake Mendocino FIRO Timeline 2014-2020



**First FIRO  
workshop  
August 2014**

**2nd FIRO  
workshop  
July 2015**

**3rd FIRO workshop  
June 2016**

**4th FIRO  
workshop  
August 2017**

**5th FIRO  
workshop  
August 2018**

**6th FIRO  
workshop  
August 2019**

**Steering  
Committee  
formed  
June 2014**

**Work Plan  
Completed  
September  
2015**

**Draft PVA  
December  
2016**

**Final PVA  
July  
2017**

**Major  
Deviation  
Fall 2018**

**2nd Major  
Deviation  
Fall 2019**

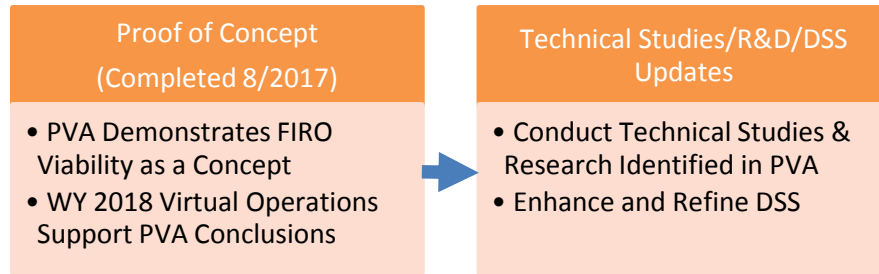
**Final Viability  
Assessment  
Completed  
(2021)**



# Roadmap to FIRO Implementation

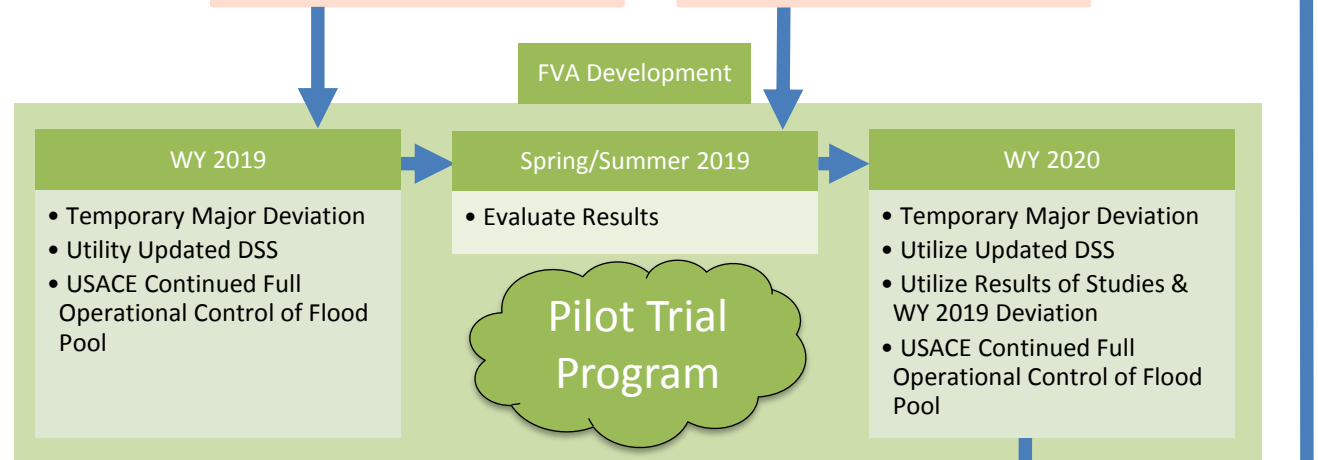
## Phase I

Proof of Concept +  
Tech Studies



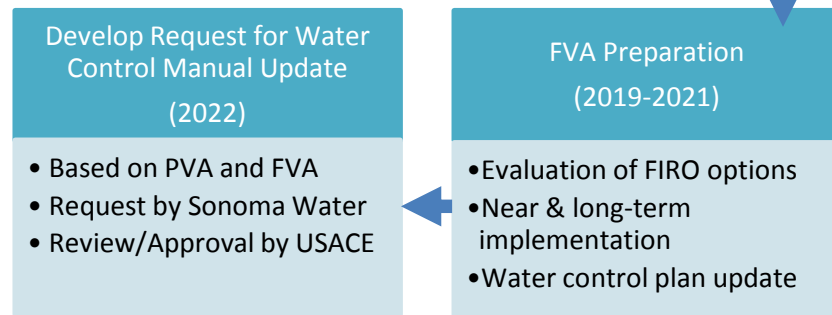
## Phase II

Demonstration of  
Concept



## Phase III

FVA Prep + Water  
Control Manual Update



**PVA** = Preliminary Viability Assessment

**FVA** = Final Viability Assessment

**DSS** = Decision Support System

# Phase I: 2017 Preliminary Viability Assessment

**SCWA** – Development and evaluation of a reservoir model that leverages streamflow forecast skill

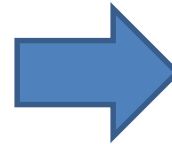
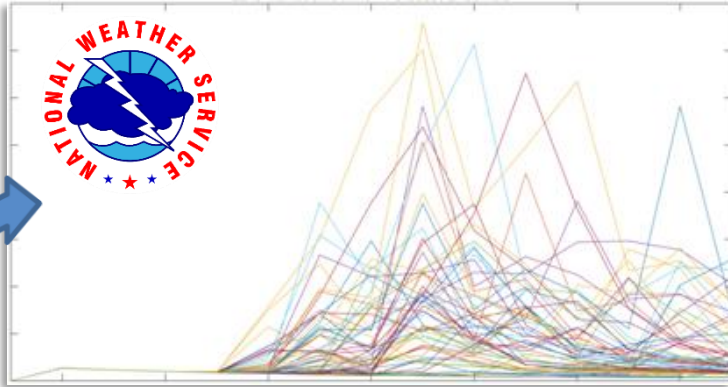
**USACE/HEC** – Evaluation of multiple reservoir management rule-sets/schemes in the HEC-WAT framework

**CW3E** – AR analysis, monitoring enhancements, and quantified forecast skill requirements

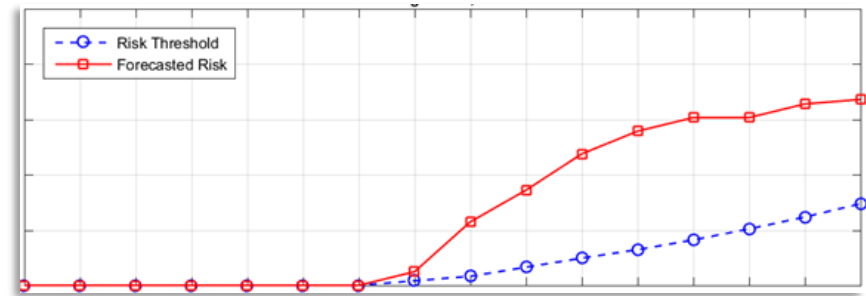
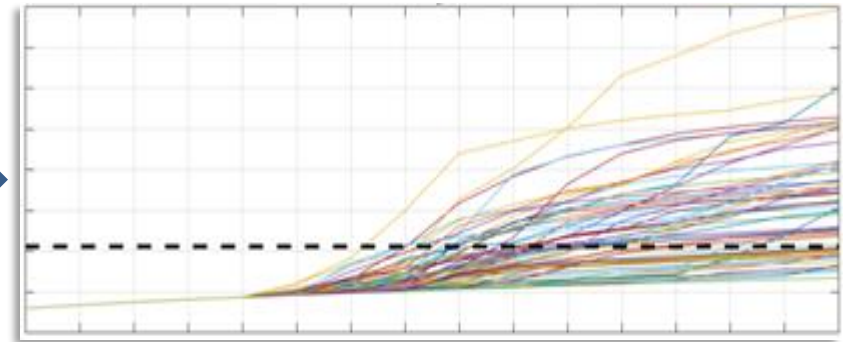


# Ensemble Forecast Operations (EFO) Model

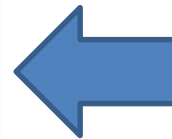
CA-NV River Forecast Center  
Ensemble Flow Forecast



Storage Forecast



Flood Risk Analysis



Flood Release

Process repeated each time step

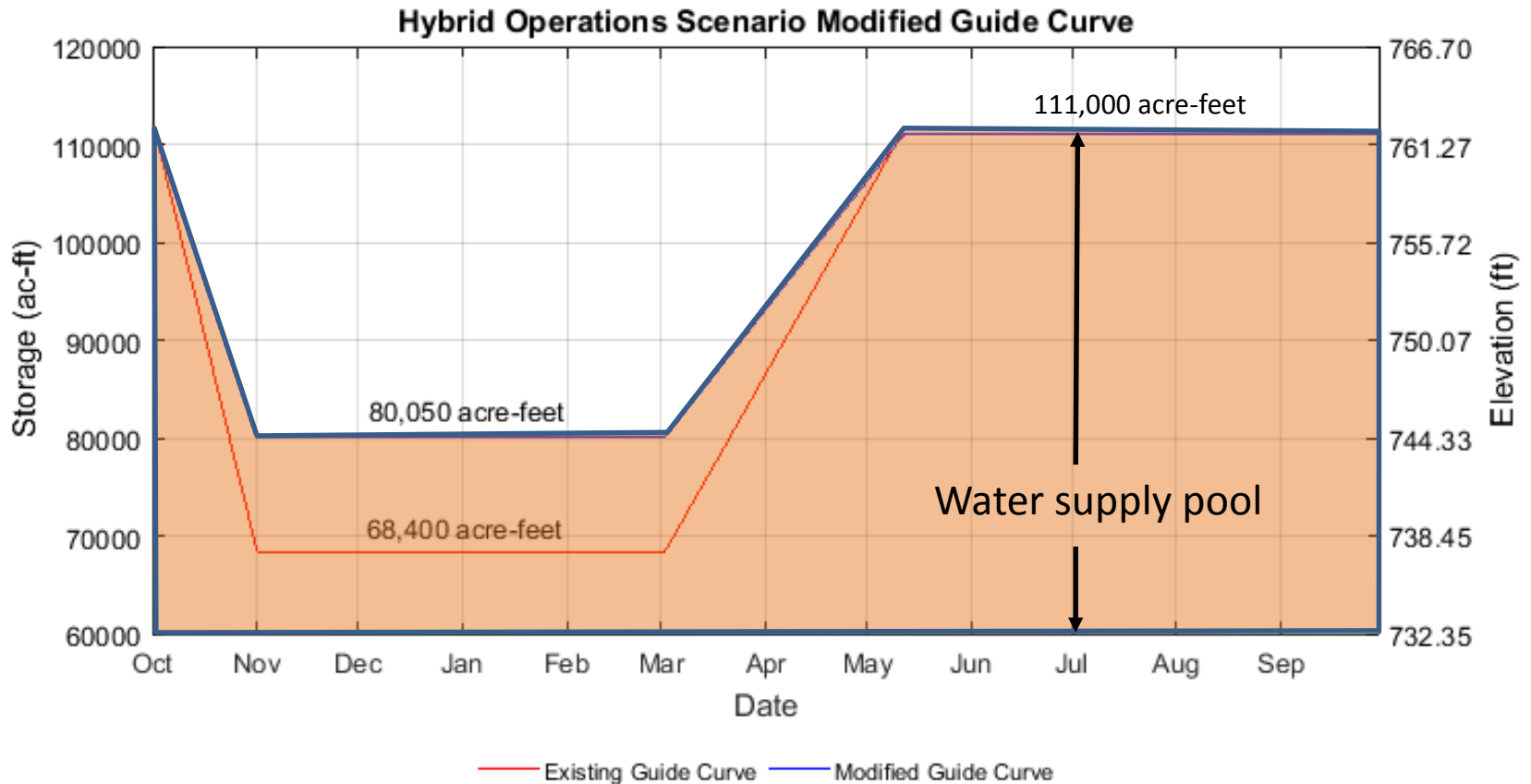


# PVA Simulated Operational Scenarios

- **Existing Water Control Manual Operations**
  - Variable conservation storage 68,400 AF (winter) to 111,000 AF (summer) with fall/spring transition of guide curve
- **“Perfect” Forecasts – Theoretical (Cannot be achieved)**
  - Manages “risk” of exceeding 111,000 AF over next 15 days (inflows known)
- **Ensemble Forecast Operations (EFO)**
  - Non-rule curve approach
  - Utilizes CNRFC ensemble streamflow forecasts
  - Manages “risk” of exceeding 111,000 AF over next 15 days
  - Established “book end” for maximum benefits
- **Hybrid Operations (Modified guide curve with “FIRO pool”)**
  - Variable conservation pool between 68,400 AF and 80,050 AF with fall/spring transition of guide curve
  - Utilizes CNRFC ensemble streamflow forecasts
  - Two Criteria: Guide curve operations kick in above 80,050 AF & evaluates risk of exceeding 111,000 AF over next 15 days except for fall/spring transition of guide curve
  - Operate to more conservative criteria

***All options constrained by the same release limits and release rate of change limits and downstream objectives***

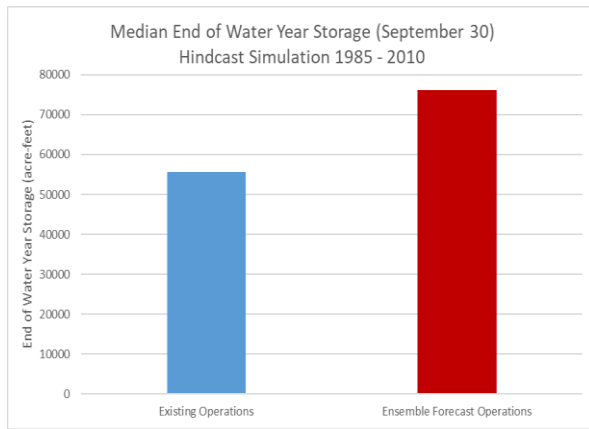
# Modified Guide Curve: “Hybrid” Scenario



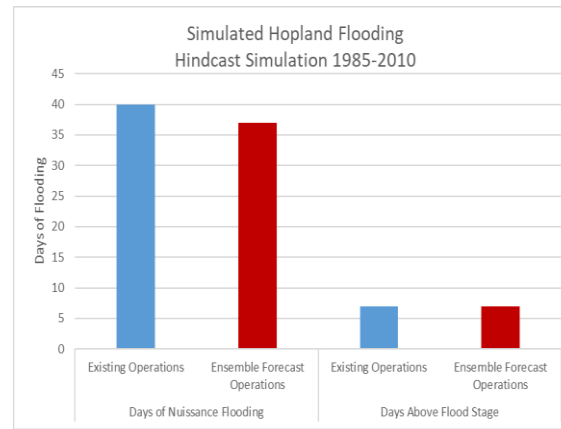
# Improved Reservoir Performance

## Hindcast Simulation 1985-2010

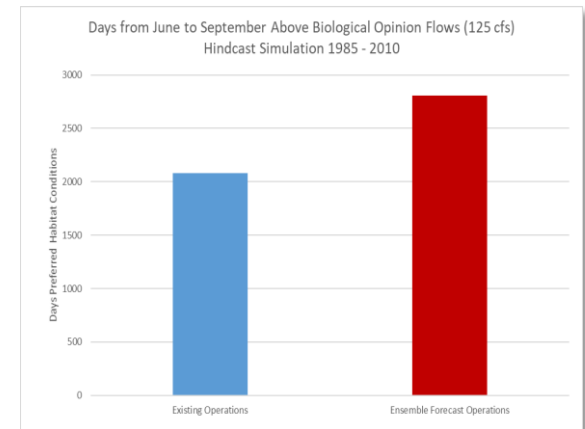
### Average Year End Water Storage



### Number Days Flooding



### Number Days Ecologically Beneficial Summer River Flows



**Blue** = Existing Operations **Red** = Forecast Informed Operations – “Hybrid” Operations



# Phase II: Demonstration of FIRO Concept

## WY 2019 Major Deviation

- “Hybrid” Scenario from PVA
- Steering Committee request – November 2017
- USACE approval – November 2018

## Review of 2019 Results & Development of New Major Deviation

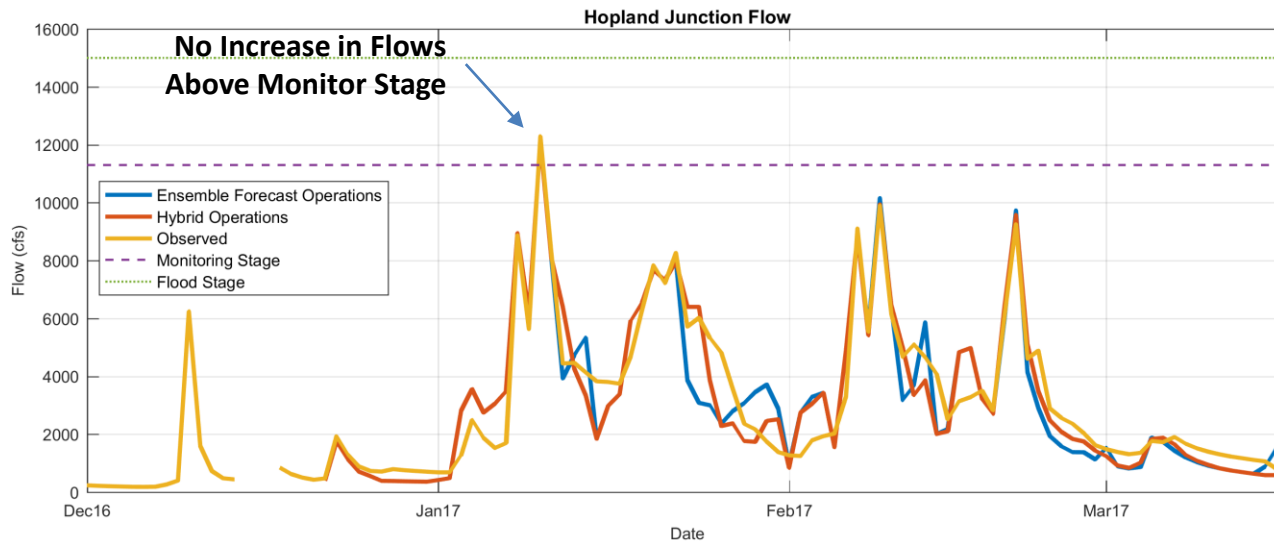
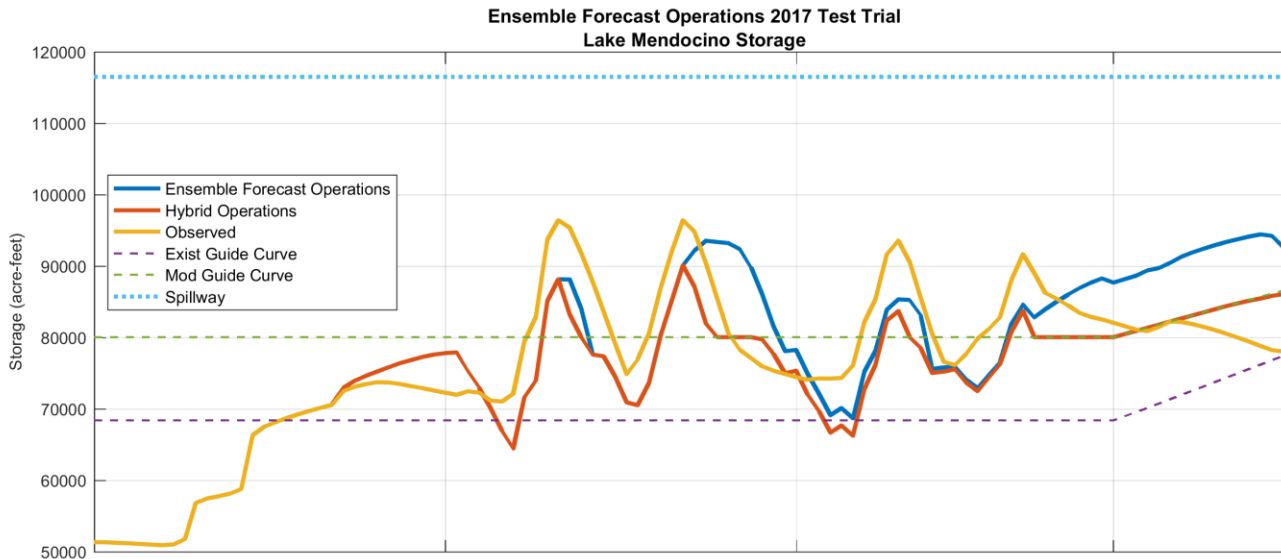
- Review & modeling of several options

## WY 2020 Major Deviation (Proposed)

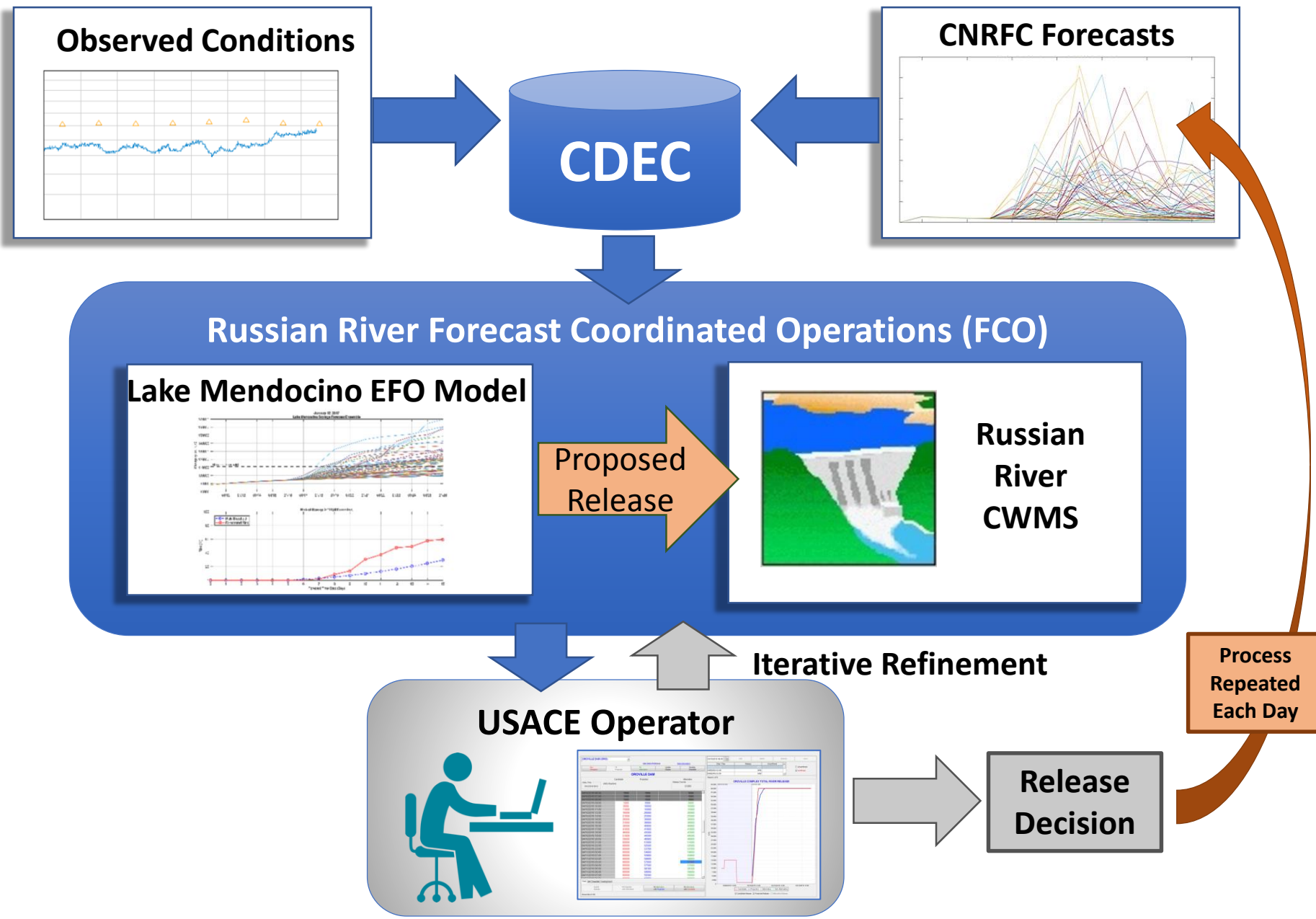
- Same scenario as WY2019 except allow pre-release into water conservation pool if:
  - FIRO support tools indicate needed for flood management, and
  - Approved by Sonoma Water (in coordination with NMFS)



# 2017 FIRO Virtual Test Trial: Value of Pre-Releases

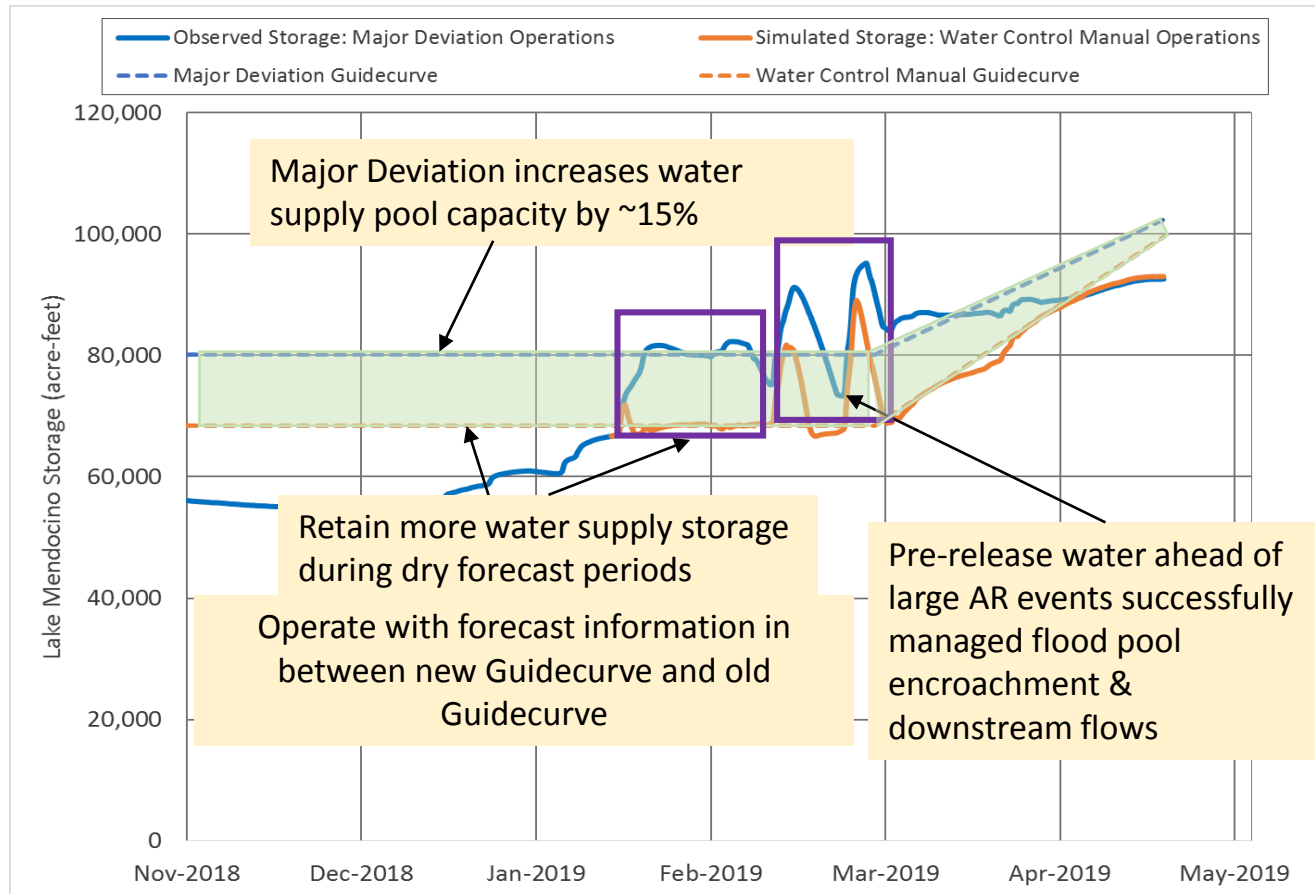


# Phase II: FIRO Decision Support System



# Phase II: Water Year 2019

## Lake Mendocino Major Deviation Operations



# Phase III – Final Viability Assessment

## Final Viability Assessment (FVA)

### HEMP

- Evaluation of FIRO options
- Identification/Recommendation of preferred FIRO option (initial implementation)
- Recommendation for longer-term implementation
- **July 2019 to June 2020**



### Implementation Plan

- Develop draft WCP for preferred FIRO option – initial implementation
- Develop adaptive management protocols to allow continued WCM updates due to increased forecast skill & modeling/technology advances
- **July 2019 to January 2021**



### WCM Update Request

- Proposed WCP from FVA implementation plan
- WCM – Update rest of manual (in addition to WCP)
- NEPA compliance
- **January 2021 to October 2022**

### Notes/Definitions

FIRO – Forecast Informed Reservoir Operations

HEMP – Hydrologic Engineering Management Plan

FVA – Final Viability Assessment

WCP – Water Control Plan (a component of WCM)

WCM – Water Control Manual

NEPA – National Environmental Protection Act

# Next Steps & Key Challenges

## Phase I

- Continue with technical studies

## Phase II

- Submit request for major deviation #2 & implement if approved by USACE

## Phase III

- Initiate HEMP (Final draft of HEMP workplan completed)
- Workgroup formed to identify approaches for adaptive water control manuals
- Support USACE-HEC in developing “FIRO-capable” models