# Forecast-Informed Reservoir Operations (FIRO) feasibility assessment for Lake Mendocino, California: Planning and Overview Document

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**Project Vision, Mission and Strategy:**

*Vision:* Assessment of the potential feasibility of Forecast-Informed Reservoir Operations (FIRO) to increase flexibility in reservoir operations for Lake Mendocino to the benefit of flood control and water supply and to enhance ecosystem services. Serve as an example for possible application to other reservoirs and as a climate change adaptation strategy.

*Mission:* Carry out a proof-of-concept project for Lake Mendocino that incorporates expertise and input from water resources engineering to hydrology, meteorology and ecosystems science.

*Overarching strategy:* Form an interagency and interdisciplinary team of experts to develop and carry out a demonstration of FIRO for Lake Mendocino, including a feasibility assessment and benefits analysis. "Demonstrate" is meant as a parallel test during which changes to actual water releases are not made as part of the project. Planning and execution will be organized by a team representing key organizations and expertise ("Lake Mendocino FIRO Planning Team").

**FIRO definition**

FIRO is a system that uses quantitative information, including precipitation, soil moisture and stream flow observations and forecasts, to help water managers selectively retain or release water from single or dual-purpose reservoirs. For regions that experience variable weather conditions such as California and the western United States, FIRO can provide real-time management tools to respond to actual "on the ground" conditions. In addition, impacts from climate change are expected to increase seasonality and variability of weather. FIRO can be an important strategy for water managers to improve resiliency of reservoir facilities to provide important water supply, flood control and ecosystem functions for increasingly variable conditions likely to occur in a changing climate. The goal of FIRO is to enable modest deviations from standard flood control guidelines when the risk of adverse impacts of such deviations become vanishingly small, while meaningful benefits to water supply, flood control and/or ecosystems are expected. Examples where FIRO can have tangible benefits include:

1) "drought mitigation scenario" would occur when recent storms have caused encroachment into the flood pool, but no major precipitation is predicted for several days. In this case additional water is retained for future water supply and ecosystems benefits, unless a new storm appears before spring refill, and

2) "flood mitigation scenario" would occur when a storm is predicted to be potentially intense enough to risk flooding and there is high confidence of significant reservoir inflow. In this case water releases could encroach into the conservation pool, with confidence that the storm will refill at least that amount of encroachment.

**Project concept**

Through better monitoring and prediction of extreme precipitation and stream flow impacting the Russian River (largely from landfalling atmospheric river storms), FIRO would allow additional water to be retained after a storm during the wet season in case no later storm is predicted before spring refill. This would increase water availability/reliability from Lake Mendocino in the dry summer season while maintaining flood control capabilities in the flood-prone winter season. FIRO represents an innovative use of emerging science and technology to relieve impacts of future droughts, without building expensive new reservoir infrastructure.

**Strategies**

Potential strategies include:

- Evaluate current forecast skill for atmospheric rivers in the region of Lake Mendocino.
- Identify causes of gaps in current predictive skill, including factors that cause an atmospheric river to stall over the area, the impacts of pre-storm soil moisture, and limitations in numerical weather predictions of atmospheric rivers and their precipitation.
- Evaluate the impacts of these forecast uncertainties on hydrologic predictions of inflow into Lake Mendocino and in regions downstream of the reservoir.
- Develop prototype operations alternatives using forecasts with varying degrees of forecast skill and uncertainty.
- Conduct hypothetical scenarios in which actual past events are used to simulate the outcomes if forecast-informed-operations had been in place.
- Plan and carry out a demonstration on the Russian River during which hypothetical forecast-informed operations were taking place and evaluate the impacts on water supply, flood risk, fisheries and associated benefits.
- Perform economic impact analyses using the various alternatives.

This effort will leverage existing and planned future facilities and projects by NOAA, California's Department of Water Resources (DWR) and Scripps Institution of Oceanography, including a unique observing network to monitor atmospheric rivers and associated precipitation and soil moisture.

**Requirements, scope and execution**

This interdisciplinary project requires innovations in meteorology, hydrology, civil engineering, water resources management, fisheries management and decision support systems. The goal of increasing water availability and reliability through this approach, without increasing flood risk, represents a major technical challenge requiring robust analyses and demonstrations involving interactions across technical fields. Successful project execution requires experts in atmospheric river science and predictions, stream flow forecasting, reservoir operations, water supply, flood control and impacts analysis, as well as coordination across these efforts. The project will involve the Center for Western Weather & Water Extremes (CW3E) at Univ. of California San Diego/Scripps Institution of Oceanography, USACE (Pacific Div., San Francisco District, HEC), NOAA (OAR, NMFS, NWS), Sonoma County Water Agency, USGS and California Dept of Water Resources. A planning workshop is being held at Scripps/CW3E in August 2014.

**Lake Mendocino FIRO Planning Team**

This team was formed in response to an action from the Russian River IWRSS Pilot Study workshop in April 2014 at Sonoma County Water Agency.

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