

# Lake Mendocino FORECAST INFORMED RESERVOIR OPERATIONS FINAL VIABILITY ASSESSMENT

Optimizing water management at Lake Mendocino, in California's Russian River basin.

## FIRO: A Flexible and Adaptive Water Management Approach

FIRO is a flexible water management approach that uses data from watershed monitoring and improved weather forecasting to help water managers selectively retain or release water from reservoirs for increased resilience to droughts and floods.

Reservoirs like Lake Mendocino are operated according to a Water Control Manual (WCM), which provides a "guide curve" that dictates a storage and release schedule based on past weather patterns. FIRO provides flexibility to help reservoir managers make more informed decisions about how much water to keep during dry periods or release before a storm.

### Why FIRO?

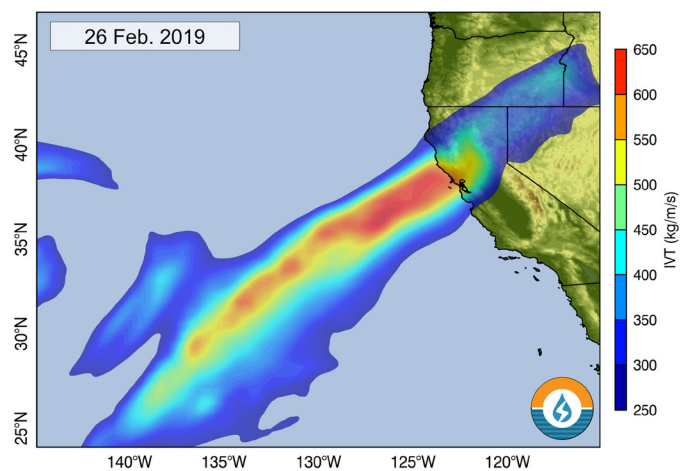
- **WCMs need updating.** The Lake Mendocino WCM dates back to 1959, with minor revisions in 1986. Since then, precipitation and streamflow forecasts have improved as a result of investments in monitoring, modeling, and applications of atmospheric and hydrologic research.
- **We need to adapt to a changing climate.** WCM guide curves are based on historical weather patterns. California has wider fluctuations between wet and dry years than any other state, and these extremes have become more pronounced in recent decades. Climate scientists expect this trend to continue. FIRO helps make our infrastructure resilient in the face of these changing conditions.
- **FIRO is a "win-win" that benefits a wide range of users.** FIRO uses science and technology to optimize water resources for agriculture, water supply, and fisheries without costly new infrastructure. Economic analyses for Lake Mendocino showed that FIRO will result in significant benefits for water supply reliability, flood risk management, dam operations, recreation, and fish habitat.



## Atmospheric Rivers (ARs): The Major Driver of Precipitation, Water Supply, and Flooding in California—and the Key to FIRO

ARs are storms that start in the Pacific Ocean and can make landfall along the California coast. ARs are responsible for much of California's precipitation.

Predicting the timing and intensity of ARs is essential to give water managers and dam operators the information they need with enough lead time to prepare for floods and drought. Over the past decade, AR research has led to important breakthroughs in understanding and forecasting ARs. These breakthroughs make FIRO possible.



*An AR making landfall in the Russian River area in 2019. Shading shows the strength of the AR. An AR is like a river in the sky—a river of water vapor pushed by the wind.*

## A Flagship Project: Lake Mendocino FIRO

A multi-agency Steering Committee came together in 2014 to explore the potential for FIRO at Lake Mendocino. Co-chaired by Sonoma Water and the Scripps Institution of Oceanography's Center for Western Weather and Water Extremes (CW3E), this research and operations partnership created space for innovation, discovery, and common ground. The team conducted research, collected observations, modeled FIRO alternatives, and tested FIRO operations through planned major deviations in 2019 and 2020.

### Demonstrated Benefits of FIRO at Lake Mendocino

Operational testing in 2019 (a wet year) demonstrated FIRO's ability to successfully manage flood operations. Testing in 2020 (the third driest of the past 127 years) led to nearly 20 percent more water storage than standard (non-FIRO) operations.

Lake Mendocino storage increased by about 20 percent during FIRO testing in winter 2019–2020.

### What's Next?

Work is now underway to incorporate FIRO into an updated WCM for Lake Mendocino. Further investment in research and improved forecasts of ARs will increase FIRO benefits. This future phase—"FIRO 2.0"—will leverage improvements in forecast skill to further improve water supply reliability and adapt to a changing climate.

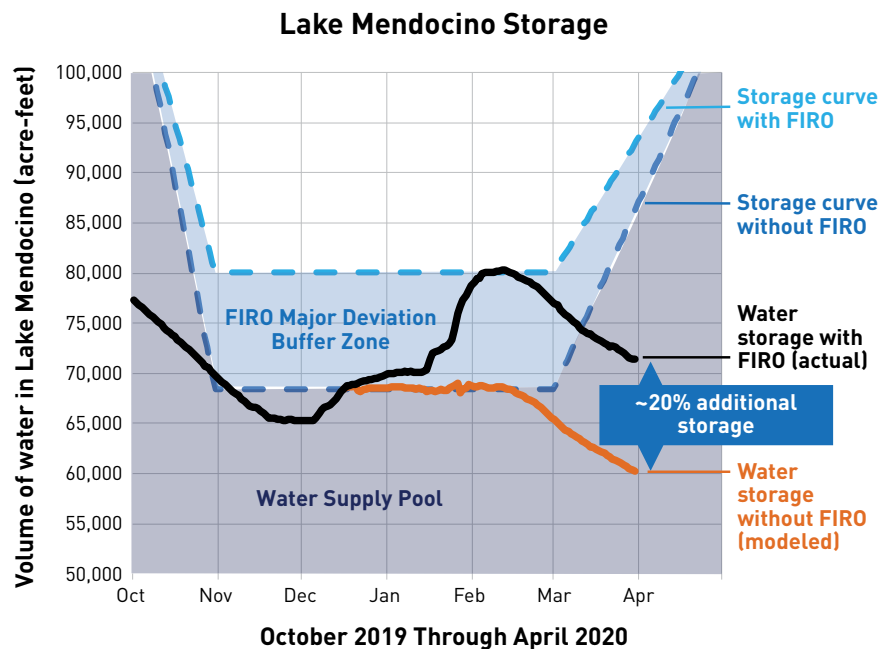
FIRO could optimize water management at other reservoirs, particularly in areas dominated by ARs. CW3E is working with the U.S. Army Corps of Engineers to assess FIRO in California and beyond, and incorporating the results into a FIRO screening tool. The Lake Mendocino project offers a successful research-to-application model that other projects can embrace to meet multiple water management objectives of today and tomorrow.

## FIRO is Viable at Lake Mendocino Now

State, local, and federal funding for advanced AR science and forecasting skill has enabled project team members to:

- Build a reconnaissance program to fill gaps in AR observations over the Pacific Ocean.
- Support a robust monitoring network in the Russian River watershed.
- Create a scale for categorizing AR intensity and impacts.
- Develop decision support tools, such as the AR landfall tool.
- Develop an Ensemble Forecast Operations model to improve forecasting using multiple data sources.
- Build a regional weather model optimized for FIRO prediction needs.

These innovations have enabled prediction of ARs and associated precipitation and runoff that support FIRO at Lake Mendocino. The results show that FIRO is viable now.



Read the full Final Viability Assessment at <https://escholarship.org/uc/item/3b63q04n>.

For more information about FIRO at Lake Mendocino, visit [https://cw3e.ucsd.edu/firo\\_lake\\_mendocino\\_fva](https://cw3e.ucsd.edu/firo_lake_mendocino_fva).

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