

FORECAST INFORMED RESERVOIR OPERATIONS: NATIONAL SCREENING UPDATE

Cary Talbot, PhD, PE

FIRO Program National Lead
Engineer Research & Development Center
US Army Corps of Engineers

Elissa Yeates

FIRO Screening Process Lead Investigator
Engineer Research & Development Center
US Army Corps of Engineers

WSWC Webinar – July 22, 2026



U.S. ARMY



US Army Corps
of Engineers®

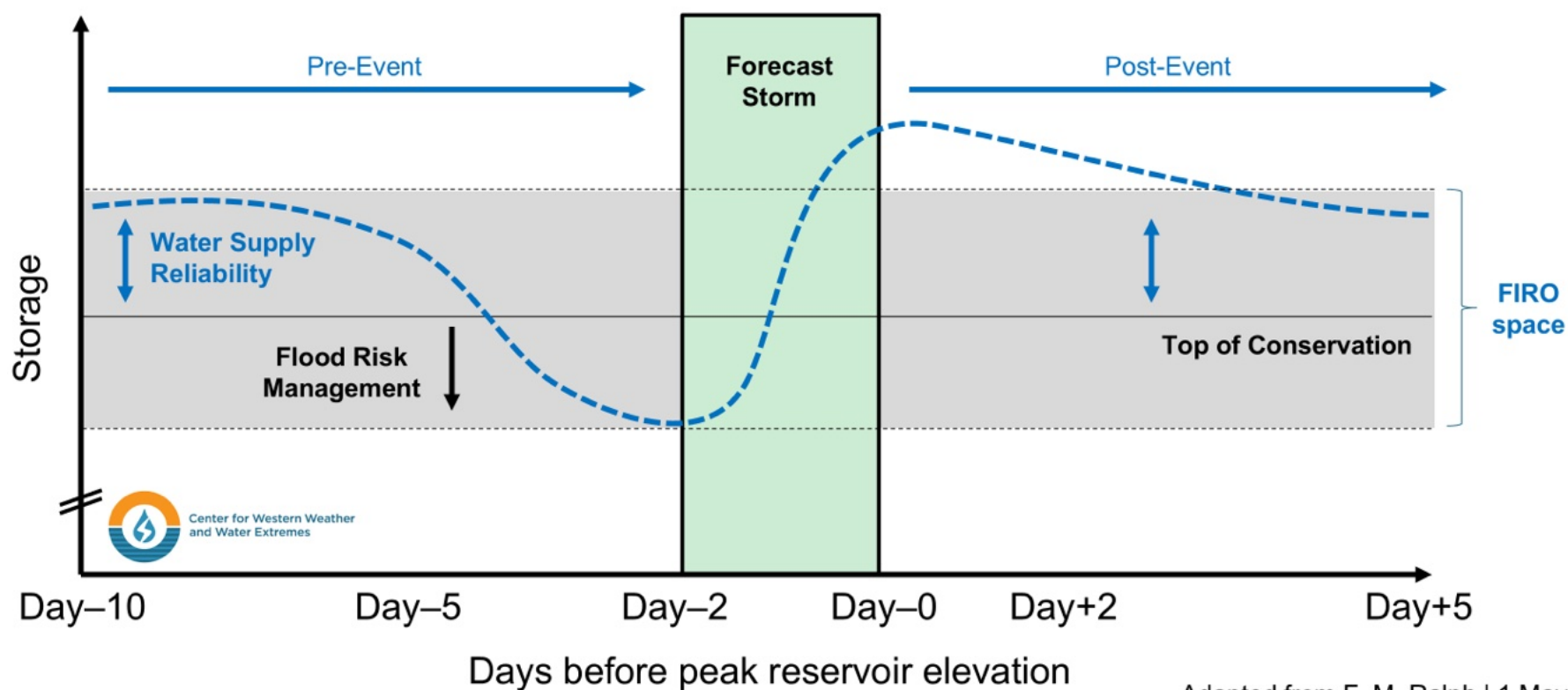


ERDC





FIRO Enables Flexibility in Operations



Adapted from F. M. Ralph | 1 May 2024



Why FIRO in USACE?



- May 2016 update to Water Control Management regulation (ER 1110-2-240) adds this sentence:
 - “**Forecasted conditions** may be used for planning future operations, but releases should follow the water control operations plan based on observed conditions within the watershed to the extent practicable.” (*emphasis added*)
- Policy change to *allow* Corps use of forecasts in water operations is in place, but doesn't define how the change is to be implemented
- Since 2015, FIRO is R&D effort to define how forecast information can be safely and effectively implemented officially in water control manual updates and practice



USACE FIRO Requirements & Direction



- **WRDA 2024, Sec. 1162 *Forecast-Informed Reservoir Operations***

“In updating a water control manual for any reservoir constructed, owned, or operated by the Secretary, including [Section 7 dams], the Secretary shall, to the maximum extent practicable, incorporate the use of forecast-informed reservoir operations”

- **House Water & Environment Subcommittee Hearing – 10 Sep 2025**

ASA(CW) Mr. Telle: *“We can make the pie bigger, in terms of water supply [...], if we’re willing to do what it takes to optimize the use of the reservoirs [...] in the form of WCMs using FIRO.”*

LTG Graham: *“We want to deploy [FIRO] throughout the country [...] wringing every ounce of value we can from these facilities. If this different way of looking at managing water is applicable, we absolutely want to apply it.”*



Recent USACE FIRO Direction



- **Senate Environment and Public Works Subcommittee hearing on WRDA 2026 – 25 Feb 2026**

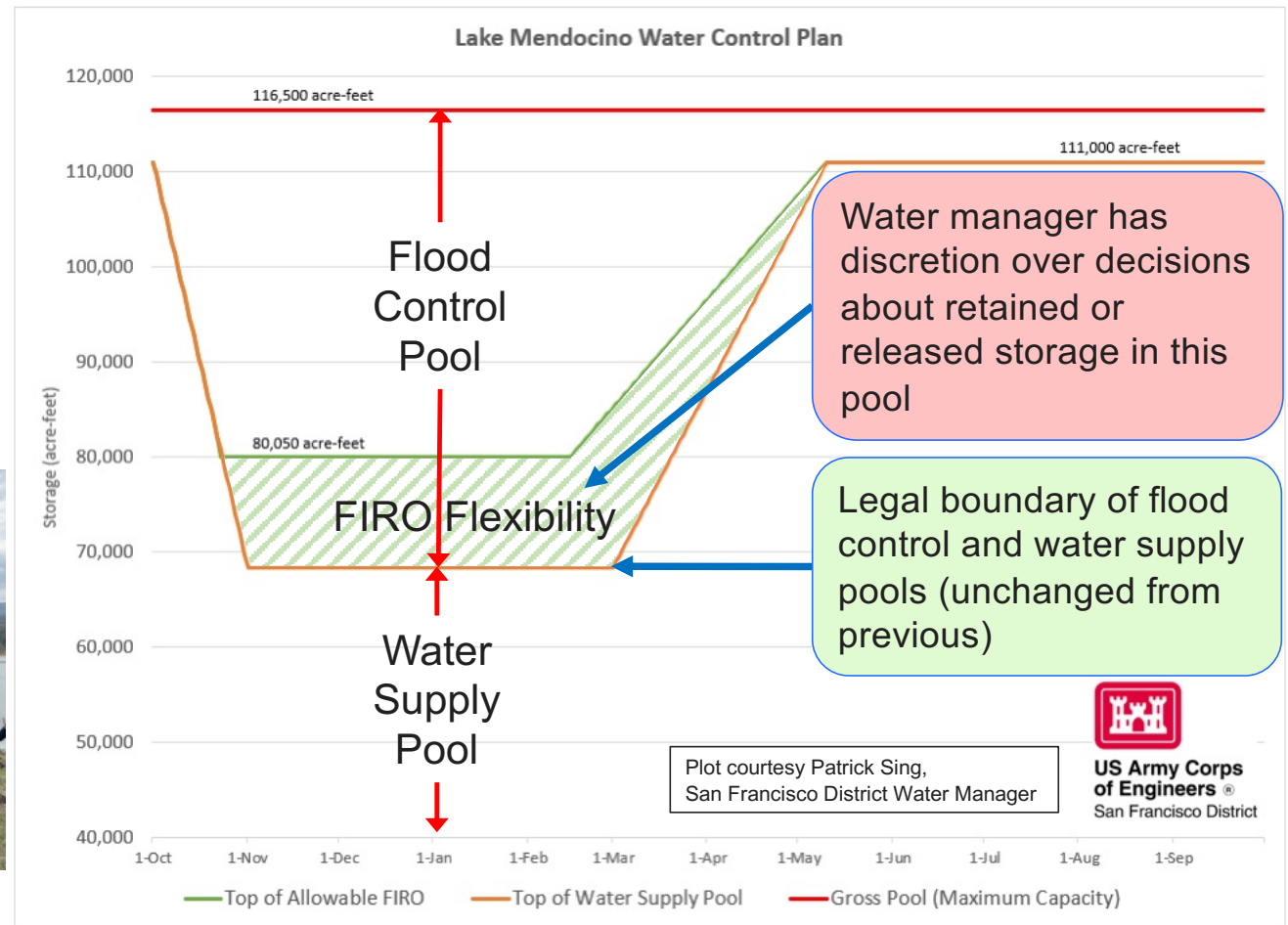
ASA(CW) Mr. Telle: *"Our infrastructure operators need as much information as they can possibly have, especially when water supply is low or floods are imminent to make decisions that don't waste water when we need it or that [do] release water when there is too much of it. And this is a place where we have a lot of work to do in terms of the R&D. We're working on it right now at [ERDC]. This is a place where we can do a lot more of this to make better use of the infrastructure that we have."*



Lake Mendocino Updated Water Control Plan



- FIRO Water Control Plan in updated Water Control Manual (WCM)
- Approved: 8 Oct 2025
- First WCM to formally incorporate FIRO flexibility





Forecast Lead Time in FIRO



- Reservoir release capacity and

Bottom Line Forecast Requirement for Lake Mendocino

- Two days to release the extra water, plus
- 1-3 days to flow past flood-prone area (Guerneville) downstream

→ Predictive skill is needed at 3-5 days lead-time for the storms that produce heavy rain and possible flooding

Mendocino

flow 74 miles*

Guerneville

Ocean

- The key to achieving a better balance between flood risk management, water supply and any other reservoir purposes:
It's all about better forecasts!

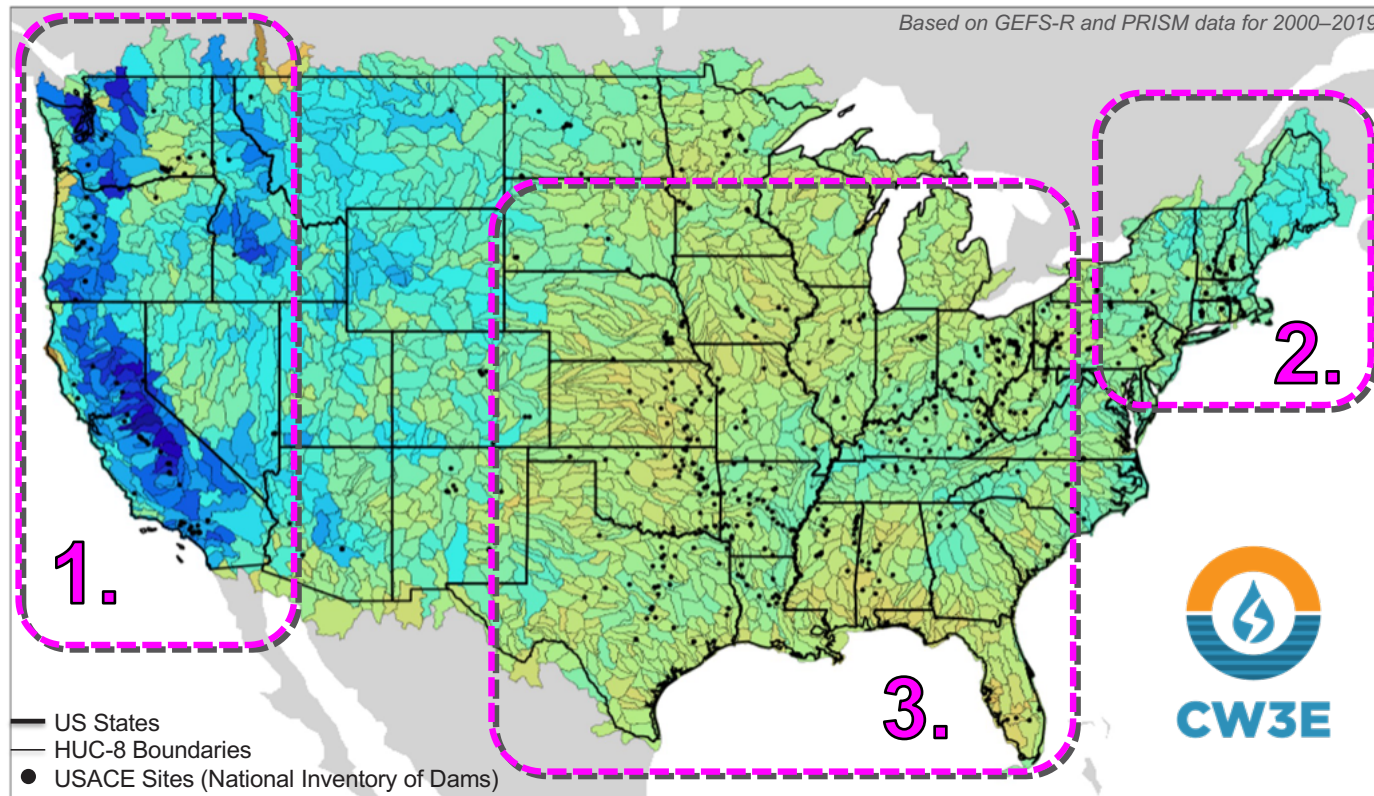




Nationwide Forecast Skill Varies Greatly



National Precipitation Forecast Skill | Top-5% | Days 1–3



Precipitation Skill based on the “Critical Success Index” for an example lead time of Days 1–3 [F12–F84]



Precipitation forecast skill varies across the US:

1. Highest skill over West anchored by terrain and atmospheric rivers (ARs).
2. Higher skill also over New England and Mid-Atlantic influenced by ARs and Nor'easters.
3. Lower skill over Central and Southeast influenced by convection and tropical processes (with some exceptions; e.g., along the Appalachians).

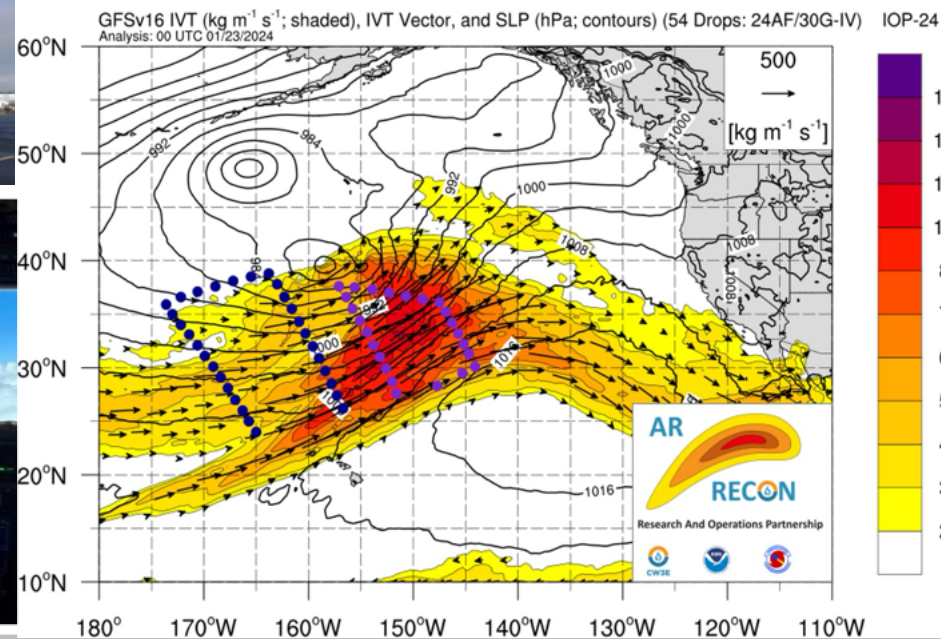




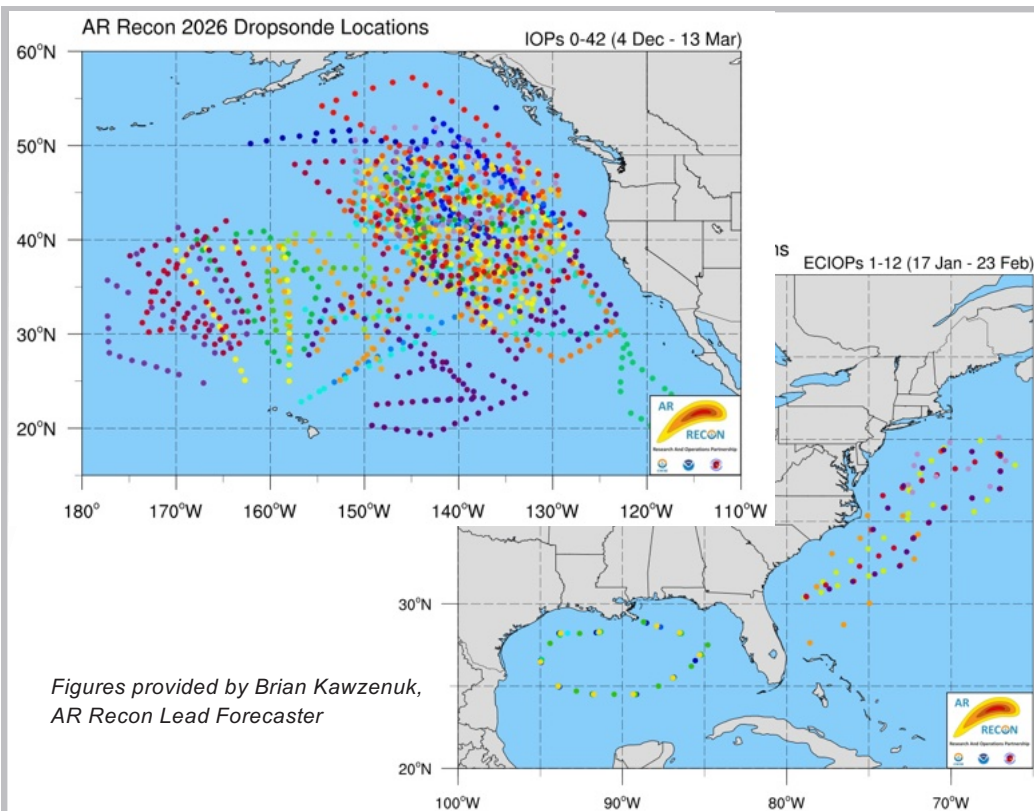
Atmospheric River Reconnaissance Improving Forecast Skill to Support FIRO

F. Martin Ralph, Ph.D., AR Recon PI
Director, Center for Western Weather and Water Extremes

Vijay Tallapragada, Ph.D., AR Recon Co-PI
Senior Scientist, NOAA/National Weather Service

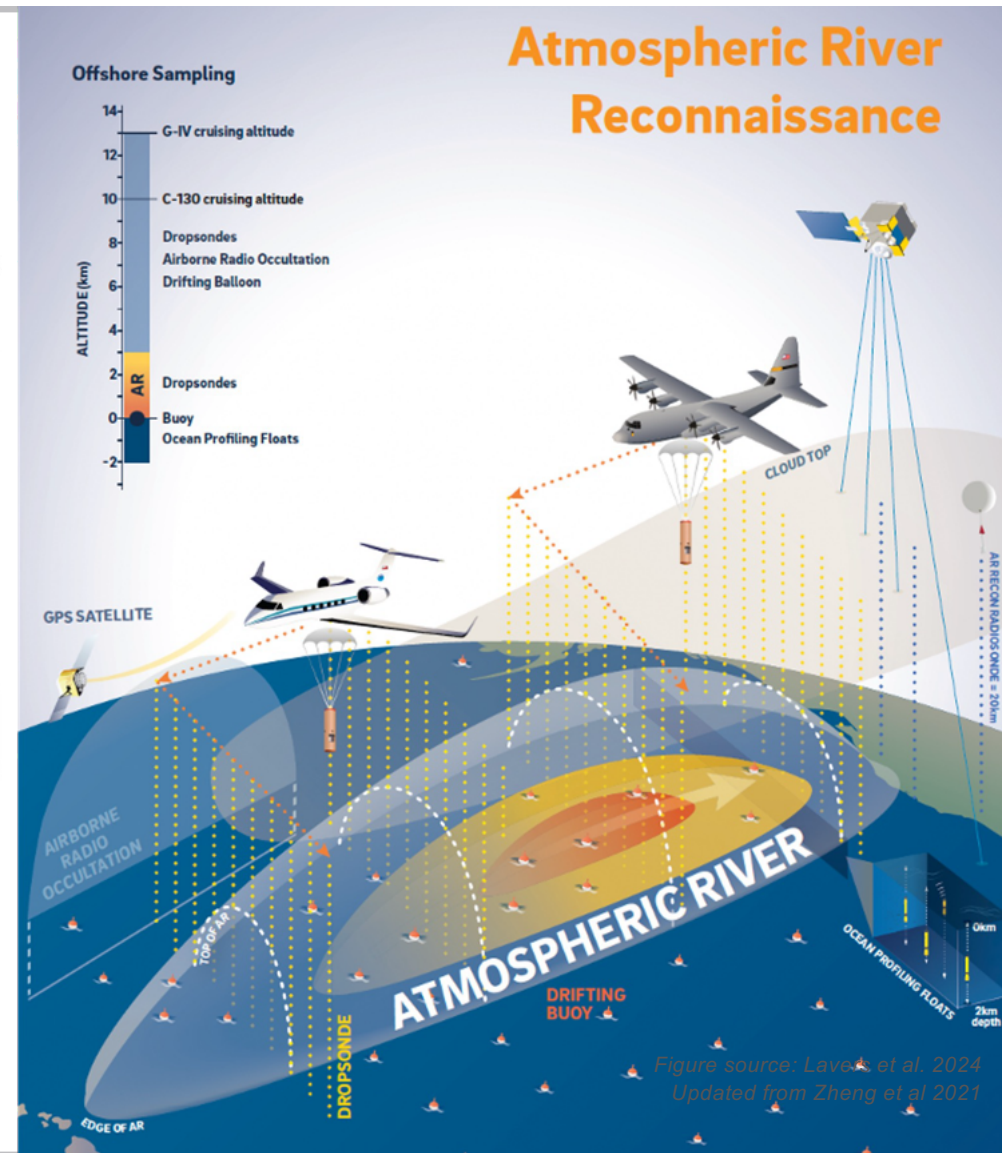


Ralph et al. 2020, BAMS⁹



AR Recon's Major achievements in water year 2026:

- 54 Observation Periods/68 flights/472 flight hours
- 1566 dropsondes deployed along with drifting buoys
- ARO on all Air Force aircraft
- Multiple publications covering data impact, scientific advances enabled by the data, and model diagnostics

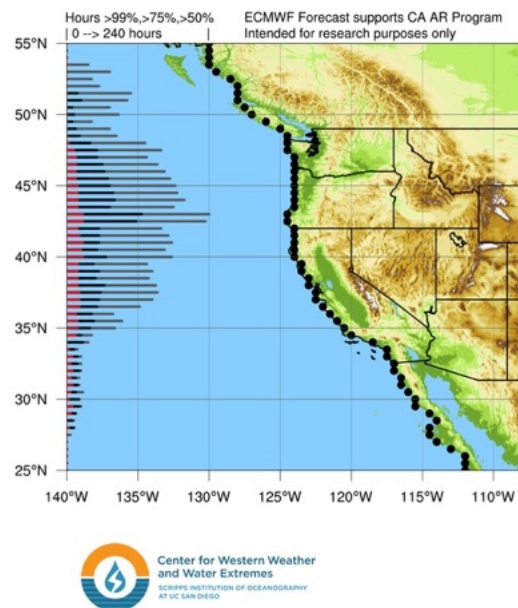
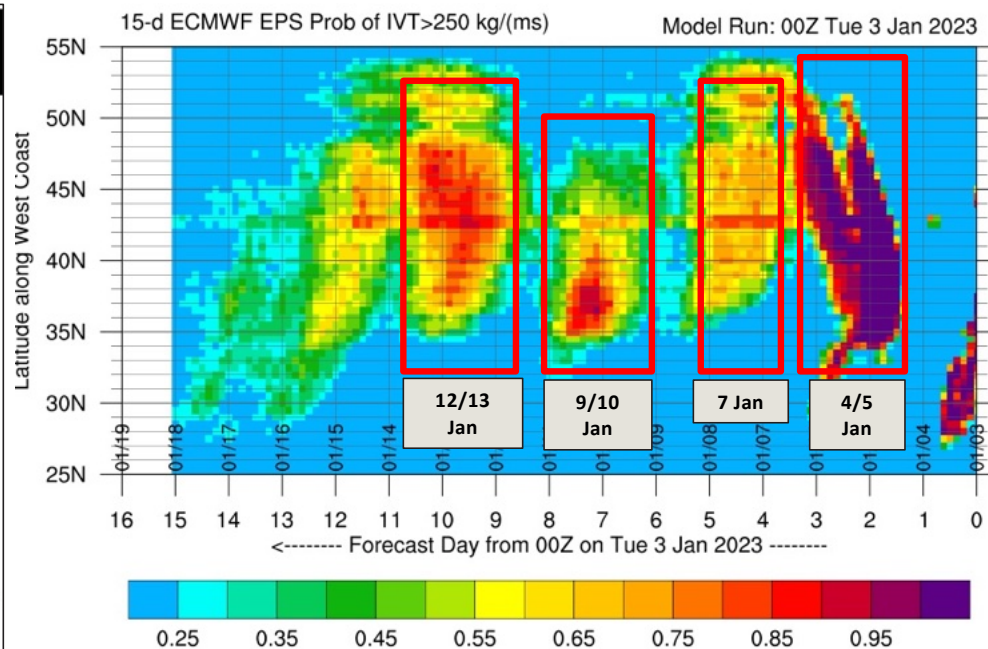
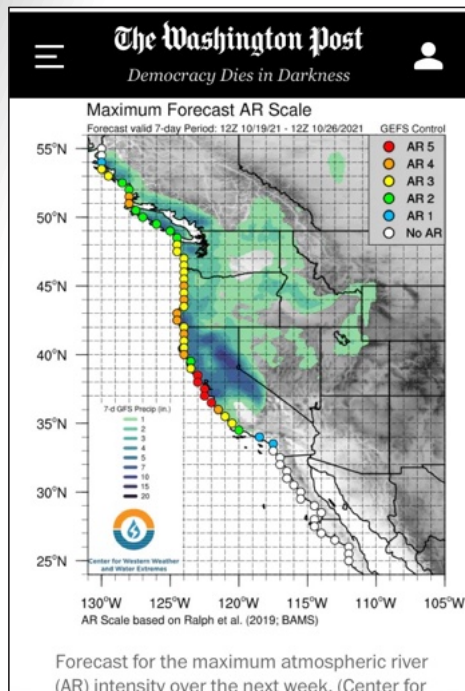




Advanced Forecast Products

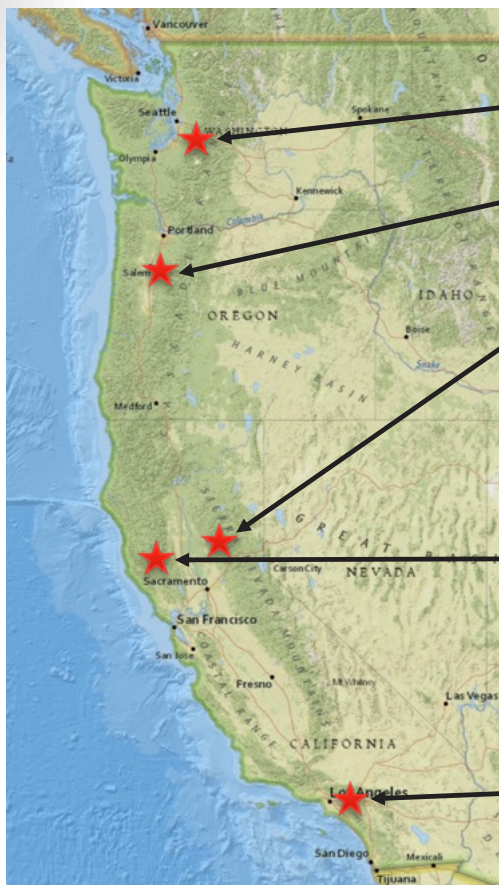


Forecast Products





FIRO Pilot Site Status



Howard Hanson Dam

Green River, Seattle District USACE

Willamette Valley (13 Dams)

Willamette River, Portland District USACE



New Bullards Bar Dam

Yuba River, Yuba Water Agency

FVA Complete

Oroville Dam

Feather River, CA Dept. of Water Resources
Sacramento District, USACE

FVA Complete

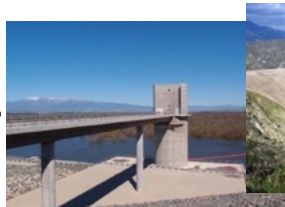


Lake Mendocino

WCM Update Complete

Lake Sonoma

Russian River, San Francisco District USACE



Prado Dam

FVA Complete

Seven Oaks Dam

Santa Ana River, Los Angeles District USACE,
San Bernardino County Flood Control District



Collaboration is Key to FIRO Success



- FIRO viability assessments are led by interagency Steering Committees carefully formed with senior representatives from stakeholder agencies and academic partners
 - Blend of engineers and scientists from research, operations and regulatory perspectives (a Research and Operations Partnership)
 - Primary focus: What does the science support?



Sonoma
Water



— BUREAU OF —
RECLAMATION



KING COUNTY
FLOOD CONTROL
DISTRICT



FY26 Scripps-CW3E/ERDC Joint Efforts: Screening Process – Where Might FIRO Work?



← National Inventory of Dams

ADVANCED SEARCH ABOUT THE NID ▾ DAMS BASICS ▾ MEDIA ▾



DAMS

DAM DETAILS

Start a new search



DOWNLOAD I

Dwor

Emerg

Owner

Prima

Coug

Emerg

Owner

Prima

Carte

Emerg

Owner

Prima

Detro

Emerg

Owner

Prima

Pine

Emerg

Owner

Prima

Mud

Emerg

Owner

Prima

Mud

Emerg

Owner

Prima

Mud

Emerg

Owner

Prima

Mud

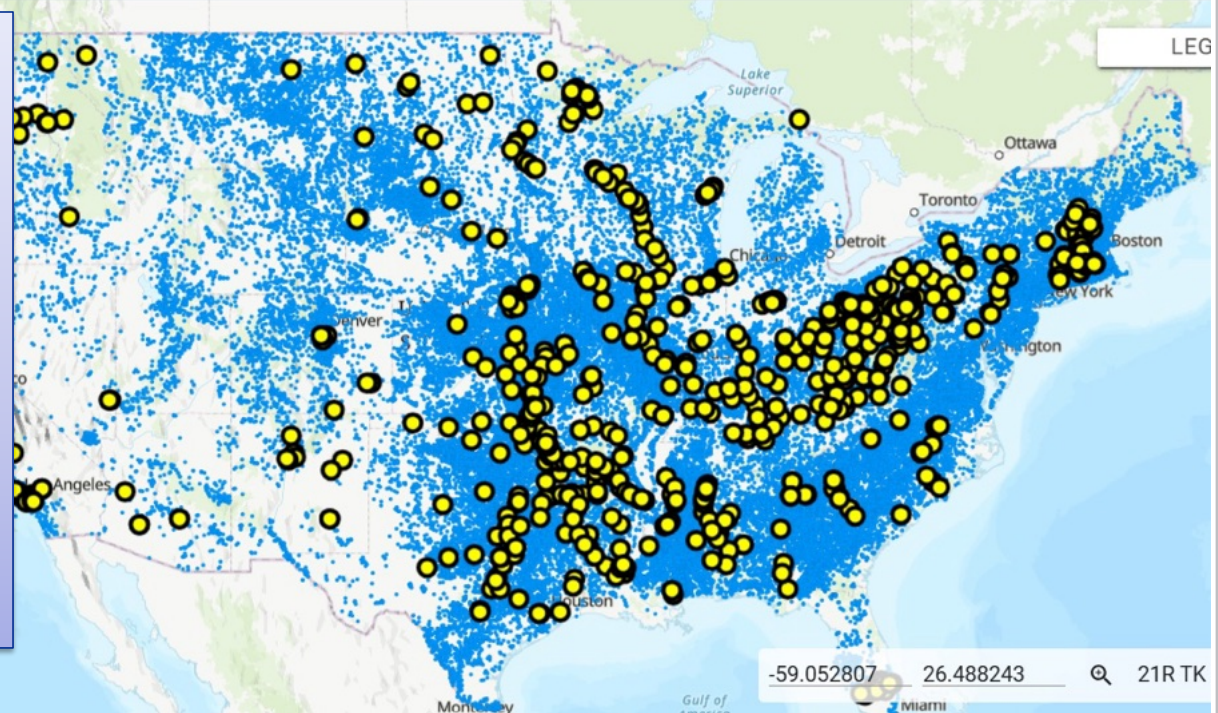
Emerg

Owner

Prima

- Good forecast skill
- Shorter operational lead times
- A need – some water management objectives in tension
- Flexibility can solve a problem
- Stakeholders are willing to work together

Owner Name: USACE - Seattle District
Primary Purpose: Flood Risk Reduction





USACE-USBR Collaboration



- US Bureau of Reclamation (USBR) has on-going efforts tied to specific projects that are under investigation for potential implementation of FIRO
- USACE and USBR hold quarterly FIRO coordination meetings where on-going efforts are discussed and opportunities for collaboration are identified
- USBR has participated in the Russian River FIRO Viability Assessments (Lake Mendocino and Lake Sonoma) and also participates in the Screening Process Steering Committee
- Like USACE, USBR is developing FIRO guidance document that will be shared by each agency for comment and coordination



NOAA-NWS Structural Changes to Support FIRO



- USACE and USBR have communicated need for increased level of support from NOAA NWS River Forecast Centers (RFCs) to support FIRO going forward, based on FIRO pilot site implementation
- NWS has been responsive to this need and as of June 1, NWS restructured RFCs under the Office of Water Prediction (OWP), headquartered at the National Water Center (NWC)
- RFCs remain in their current locations but organizationally report to NWC, better enabling sharing of best management practices in support of FIRO across the country



Value of FIRO in Practice in USACE



FIRO implementation sites:

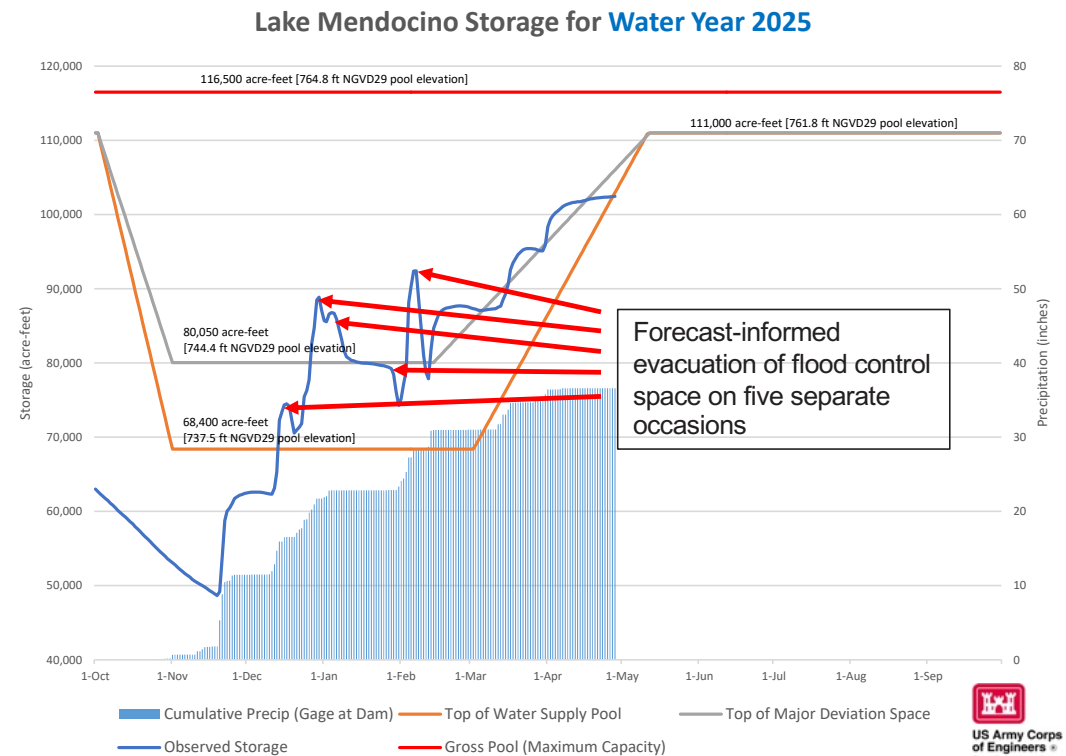
- CA: 6 dams
- WA: 1 dam
- OR: 13 dams

Pilot site annual water availability increases

- Lakes Mendocino & Sonoma (No. CA)
 - 2020: 22,000 homes (~\$11M)
 - 2023: 48,000 homes (~\$24M)
 - 2024: 58,000 homes (~\$29M)
 - 2025: 50,000 homes (~\$25M)
 - 2026: 58,000 homes (~\$29M)
- Prado Dam (So. CA)
 - 2024: 12,200 homes (~\$6.1M)
 - 2026: 1,300 homes (~\$0.7M)

Total: 249,500 homes, \$124.8M

Total FIRO R&D Investment through FY26:
\$93.4M



Plot courtesy Patrick Sing,
San Francisco District Water Manager



FIRO Impacts and Benefits



Water Availability

- Lake Mendocino & Sonoma
- Prado Dam

Forecast Improvements

- AR Recon
- 2-3 days improved lead time
- West-WRF forecasts in NOAA AWIPS
- AR Scale
- CW3E forecast products website

USACE Water Management

- CWMS Improvements
- Water Manager skill and familiarity with CWMS and forecast products

NOAA Impacts

- RFC restructure
- Embedded meteorologist & hydrologist researchers at RFCs

USBR Impacts

- Economic benefit of FIRO analysis at USBR Section 7 dams
- FIRO Best Practices document

Stakeholder Impacts

- State & Local water agencies praise and defend USACE water management decisions in public



What's Next for FIRO



- Next FIRO Phase: “Implementation”
- Use results of Screening Process nationwide application together with USACE Water Control Manual (WCM) update priority list to determine FIRO implementation priorities
- WCM updates to implement FIRO don't require a formal FIRO Viability Assessment but will provide greater benefits if performed
- FIRO Viability Assessment Pathways:
 - Expedited (~2 years)
 - Streamlined (2-3 years)
 - Full (~4 years)
- Engineering & Construction Bulletin (ECB) on FIRO coming out later this year (2026) to detail lessons learned to date and define FIRO pathways to implementation

Thank you!

Cary Talbot
USACE FIRO Program National Lead
Cary.A.Talbot@usace.army.mil

Elissa Yeates
USACE FIRO Screening Process Lead
Elissa.M.Yeates@usace.army.mil

