

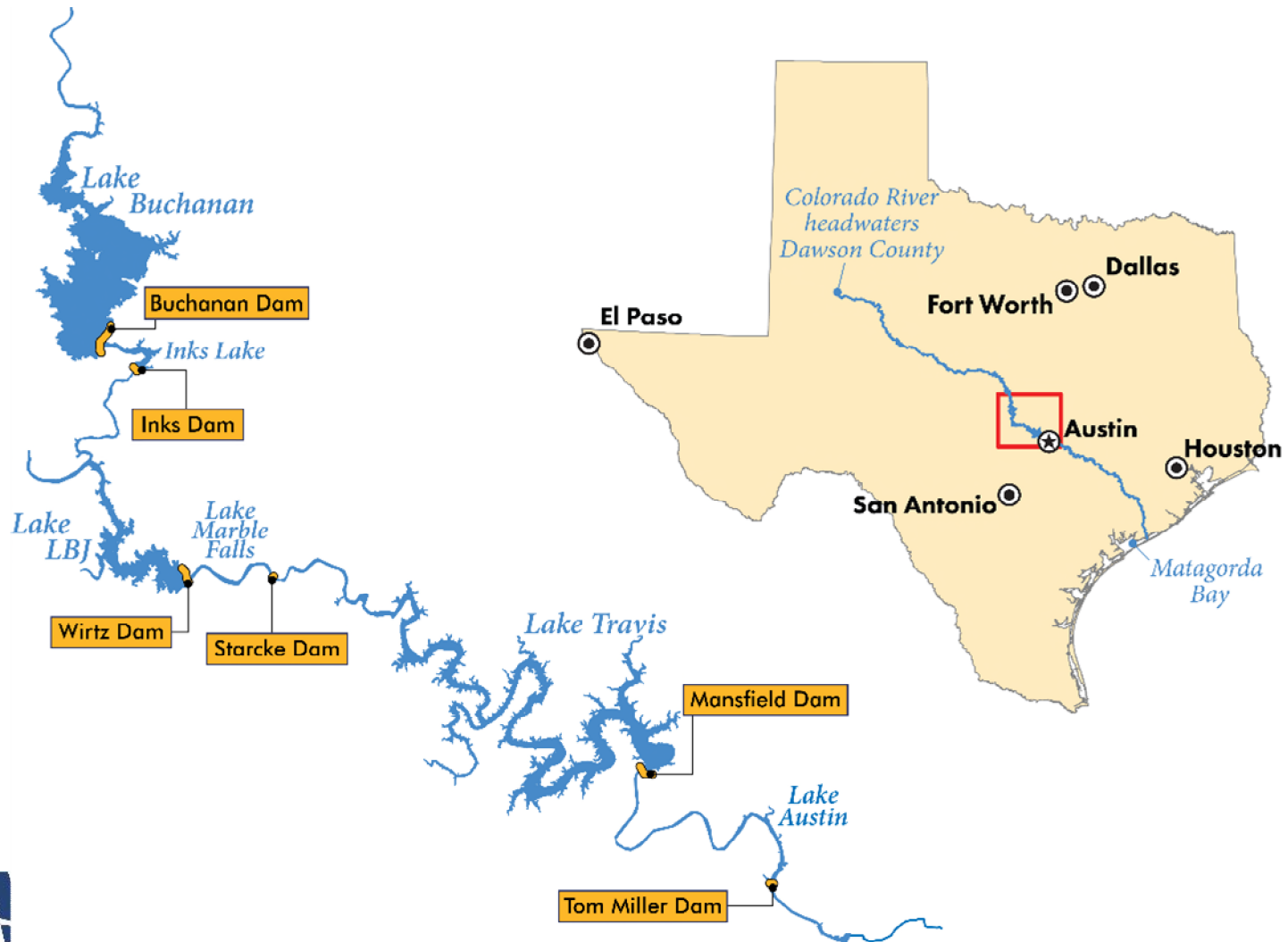
FORECAST-INFORMED RESERVOIR OPERATION AND WATER RESOURCES MANAGEMENT

Ron Anderson and Dan Yates

Sept. 12, 2019



The Highland Lakes Portion of the Colorado River



Managing the Region's Water Supply

LCRA provides water supply for:

- More than 1.4 million people
- Seven power plants capable of providing power to more than 3 million homes
- Irrigation of up to 91,500 acres in four service areas
- Environmental health of the Colorado River and Matagorda Bay

Lower Colorado River Basin

- Arid watershed interrupted by flash floods
- Multi-year droughts
 - 1947 to 1957
 - 2010 to 2015
- Recent Drought of Record
- Water supply managed according to state-approved water management plan

Water Management Plan

- Approved by TCEQ in 2015
- Evaluation dates: March 1 and July 1
- Evaluation criteria:
 - Normal, Less Severe Drought or Extraordinary Drought
 - Combined storage in lakes Travis and Buchanan
 - Look ahead – 12 months and to end of season

Water Supply Forecasts

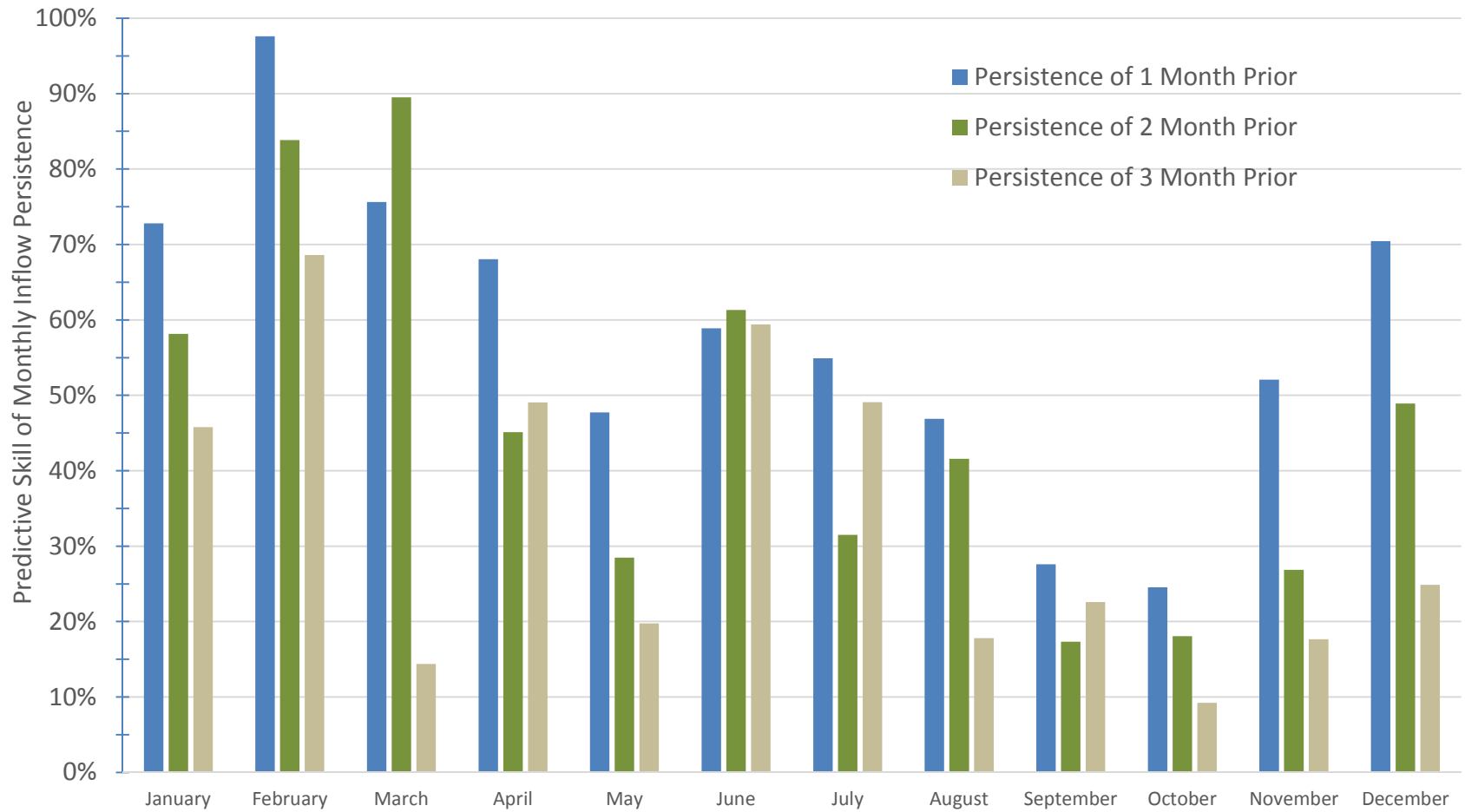
- Model completed in 2006
- MS Excel™ based
- 60-month forward look
- Non-parametric statistics
- Monte Carlo Markov Chain transitional monthly probabilities for inflow persistence to capture skill
- Weather-varied agriculture and evaporation demands
- Water Management Plans (1999 and 2015)

Known Conditions

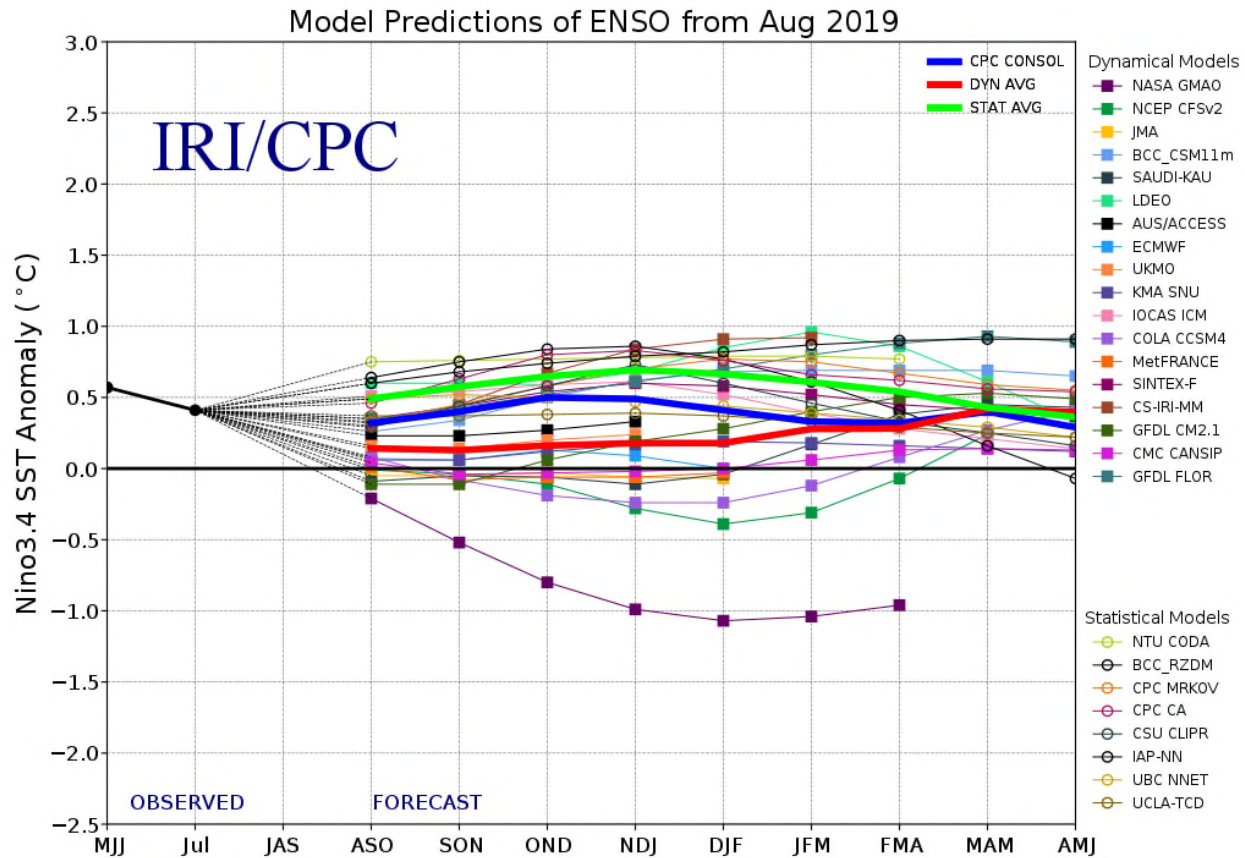
- Antecedent conditions
 - Prior two-month inflows
 - Dry, moderate or wet classification
- ENSO forecasts
 - El Niño, Neutral, La Niña or no forecast
- Historical persistence patterns
 - Seasonal patterns (inflows and evaporation)
 - ENSO and persistence interactions
 - 74 years of data

Hydrological Persistence

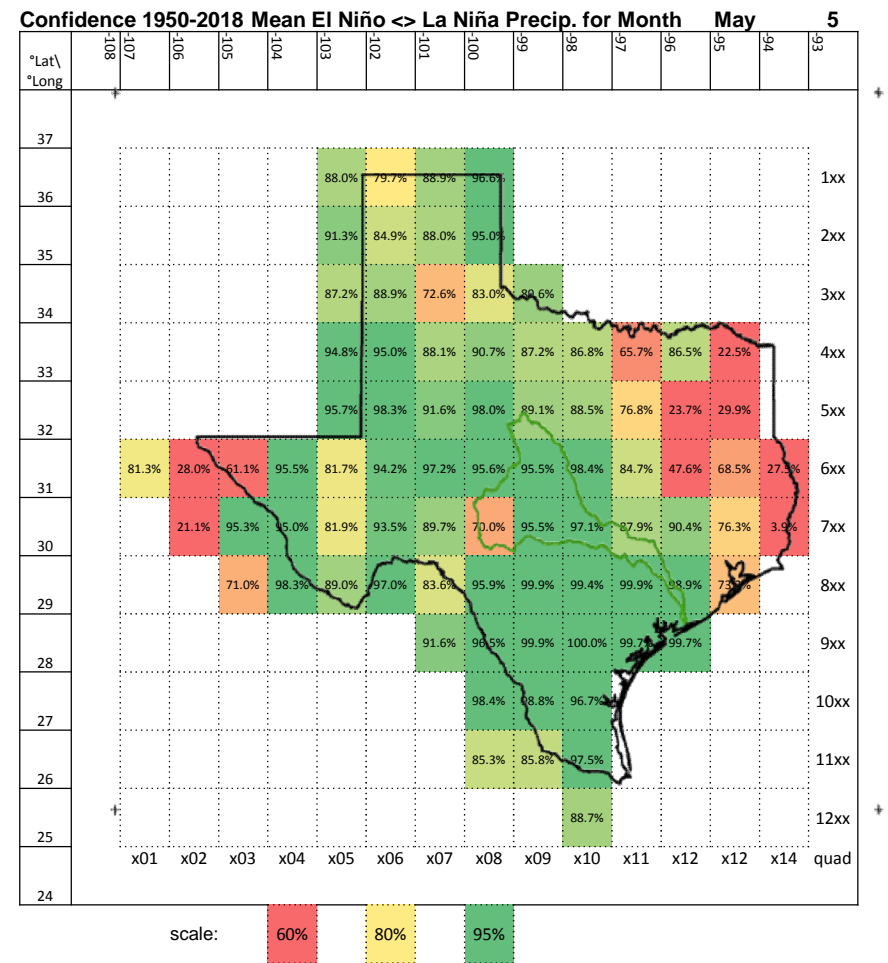
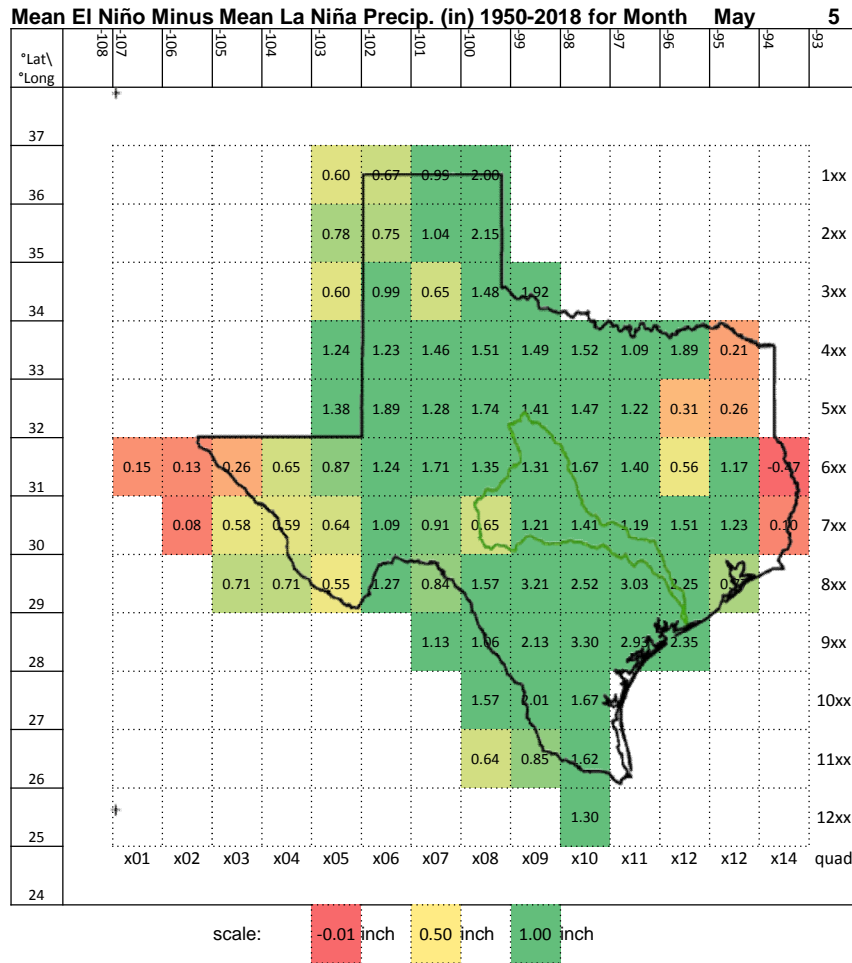
Persistence of Highland Lakes Monthly Inflow
1940-2017



ENSO Model Predictions

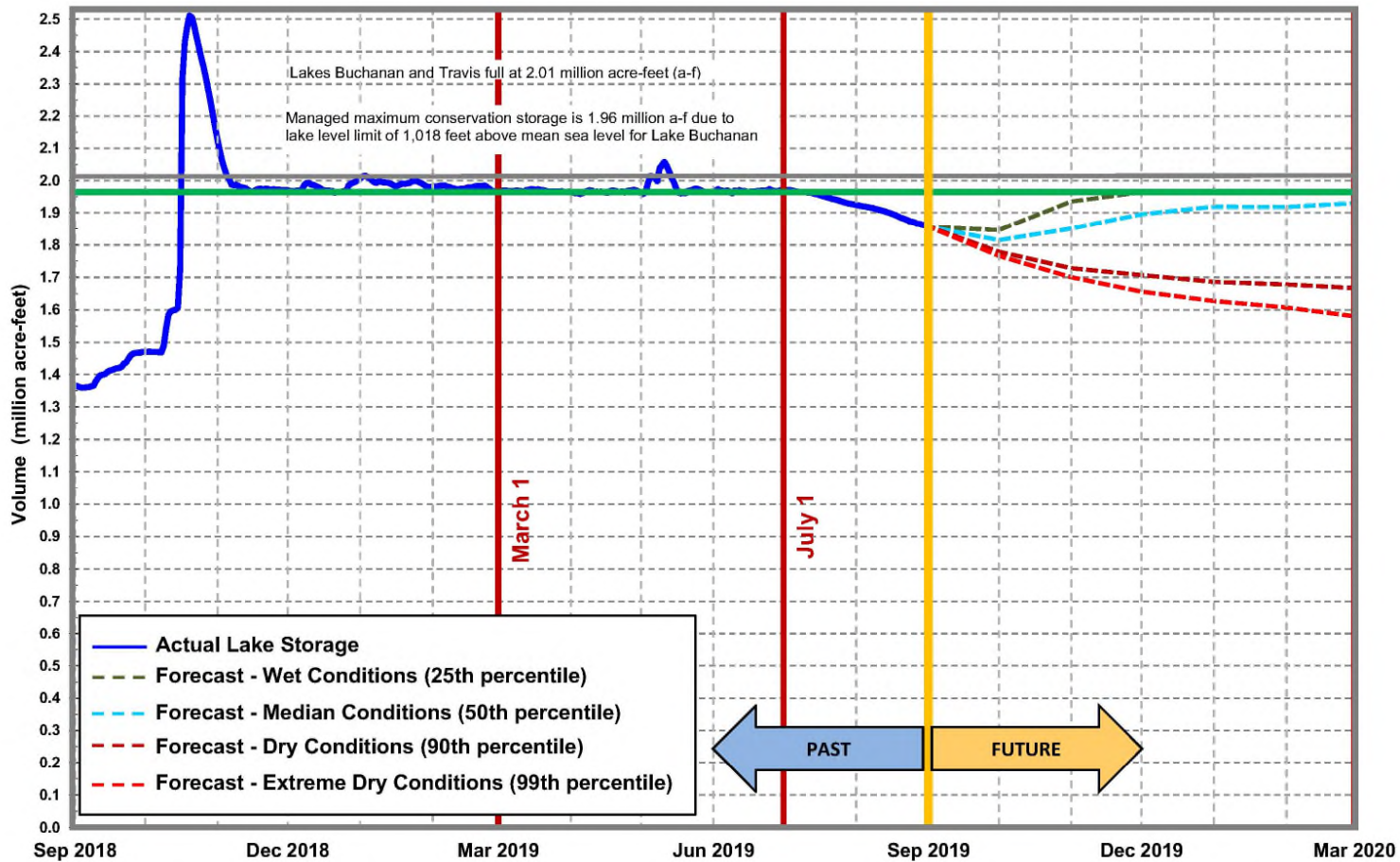


El Niño Precipitation increase over La Niña May (1950-2018)



Projections with Persistence and ENSO

Lakes Buchanan and Travis
Total Combined Storage Projections

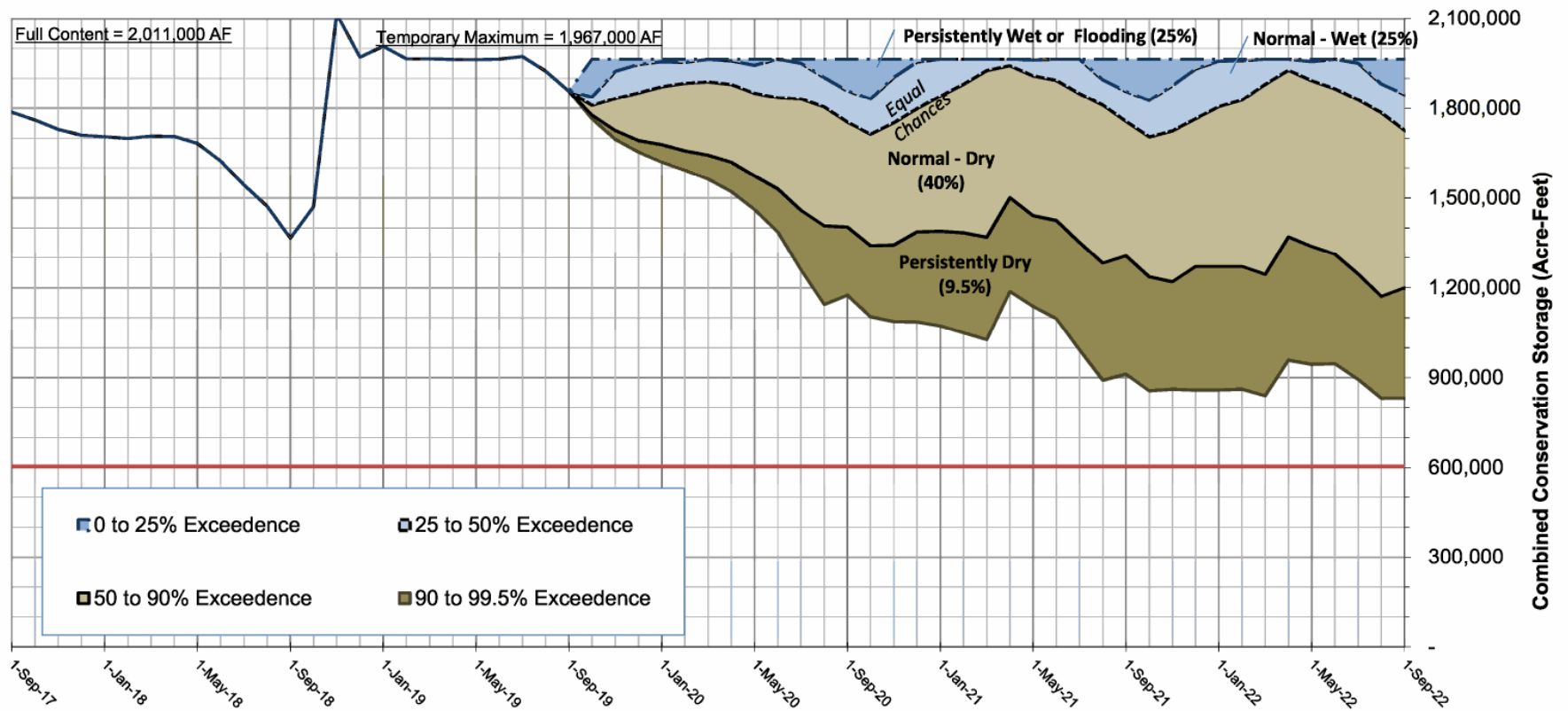


Note: One acre-foot equals 325,851 gallons.

Date: Sept. 1, 2019

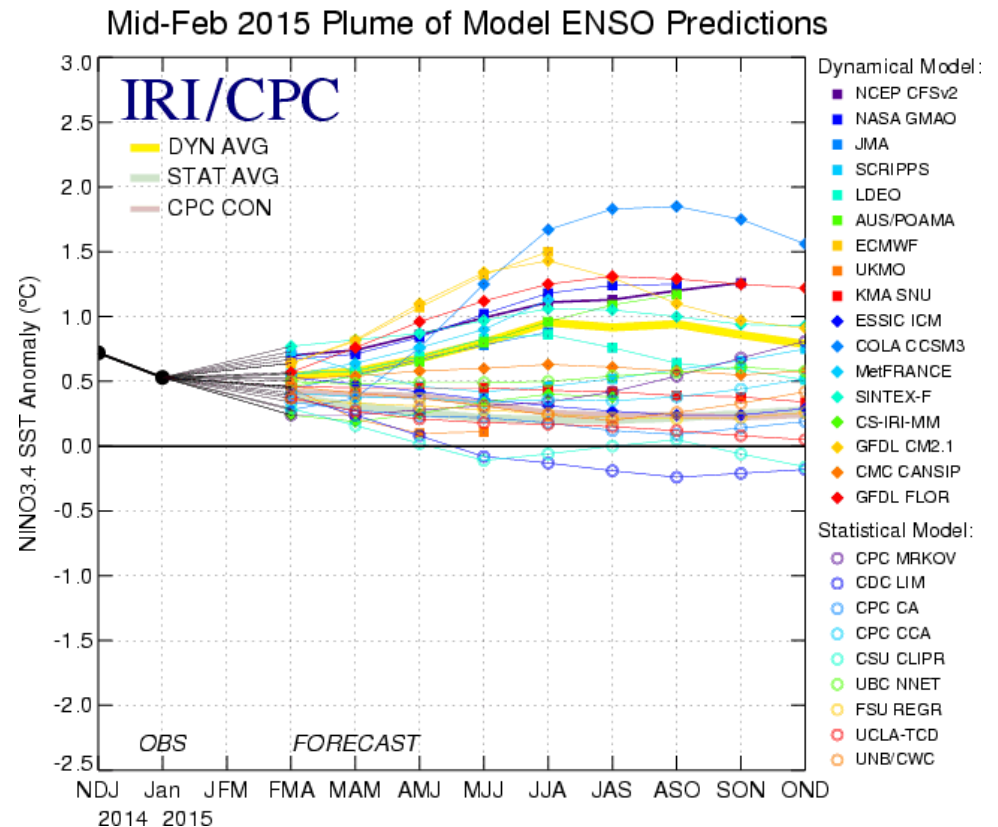
60-Month Storage Outlook

Stochastic Outlook for Lakes Buchanan and Travis Combined Conservation Storage



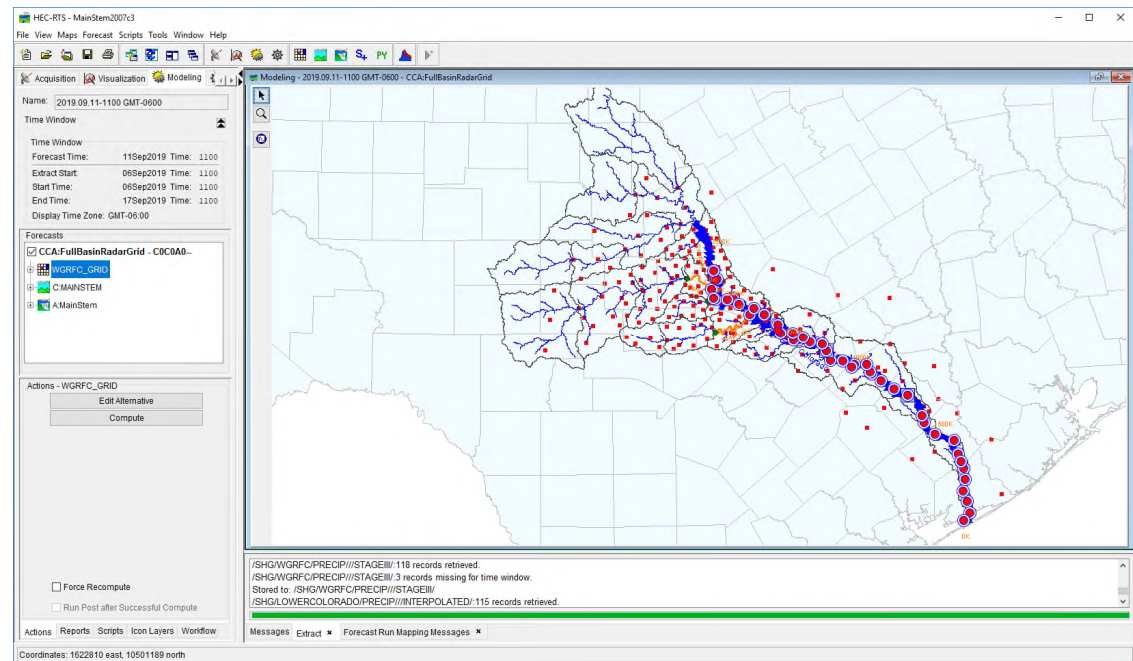
Experiences

In spring 2015, use of ENSO ensembles provided more optimistic outlook of drought improvement because of projected Neutral or El Niño conditions.



Flood Forecasting

- HEC-RTS (Real Time System)
- Inputs
 - NWS Gridded Precipitation
 - LCRA Hydromet
- Models
 - Rainfall runoff
 - Flow routing
 - Reservoir simulation



- Dam operation decisions are based on “water on the ground”

Opportunities for Improved Forecast

- Soil moisture monitoring
- Evapotranspiration
- Surface water evaporation

