

Using Ensemble Forecasts in Practice

HEPEX 10th Annual Workshop
College Park, Md
June 25, 2014



Forecasts Should Not Exist Solely for their Own Sake!

- The utility of forecasts can be measured by how much they improve performance
- To measure utility you **MUST** have performance metrics for the resource
- The best metrics are often **NOT** economic metrics

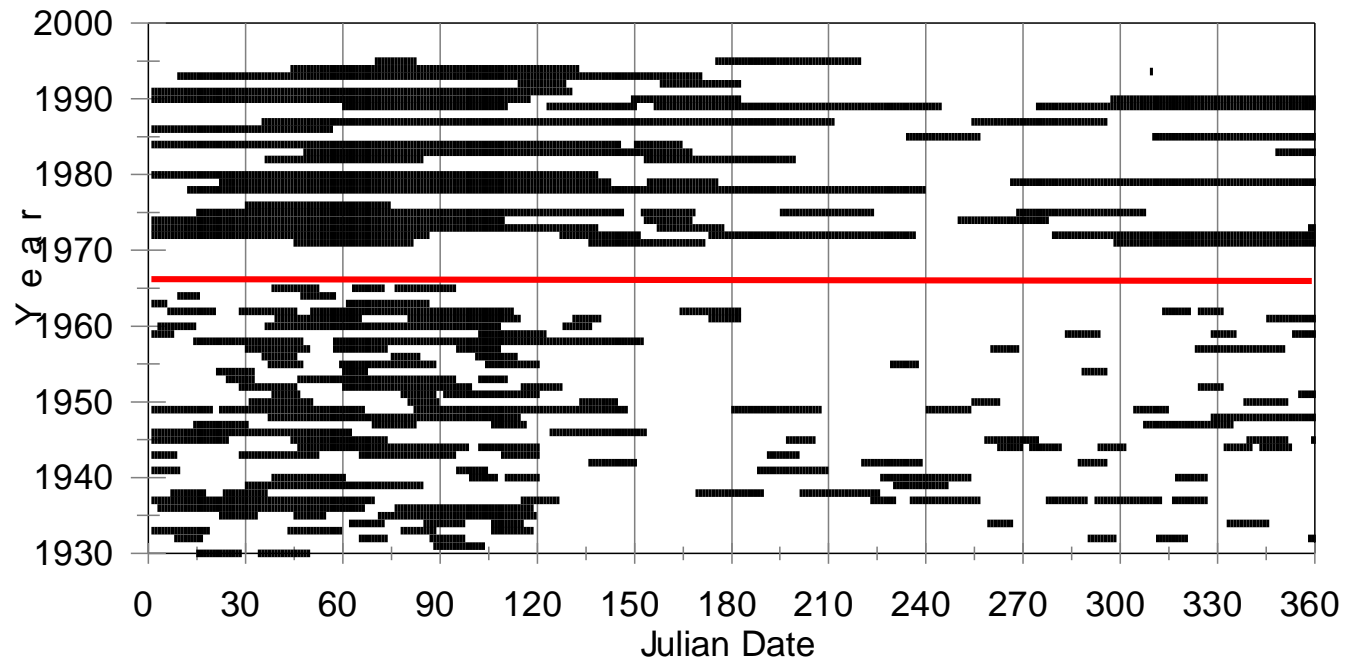
Water Supply Measure

Scenario	Number of Days in Water Restriction	Number of Years with Water Restrictions	Volume of Water Not Delivered (million gallons)
1	10	1	25
2	16	3	30
3	5	5	5
4	25	3	140
5	30	6	130
6	18	2	65

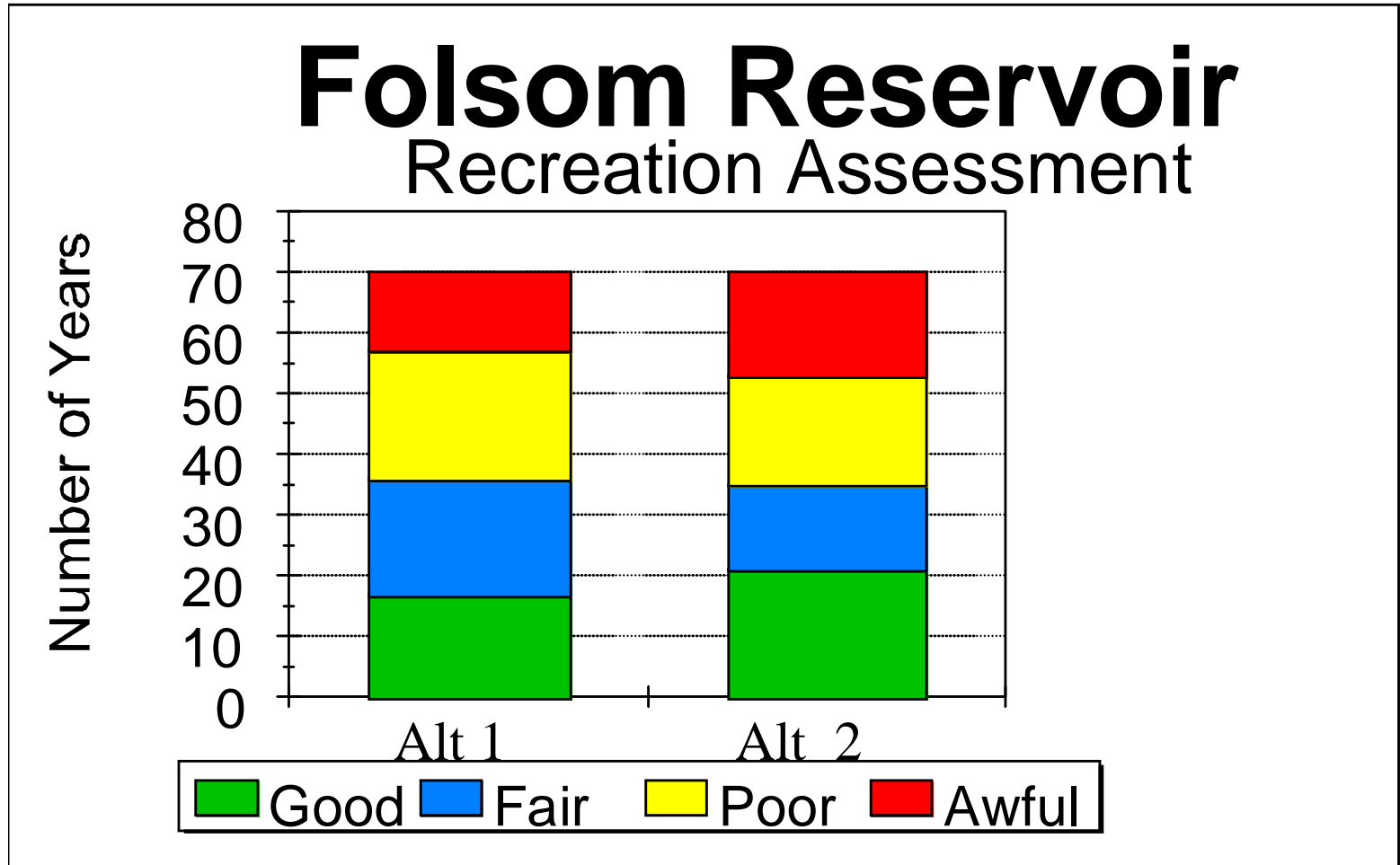
Riparian Habitat Measure

Flood Events - Before and After Dams

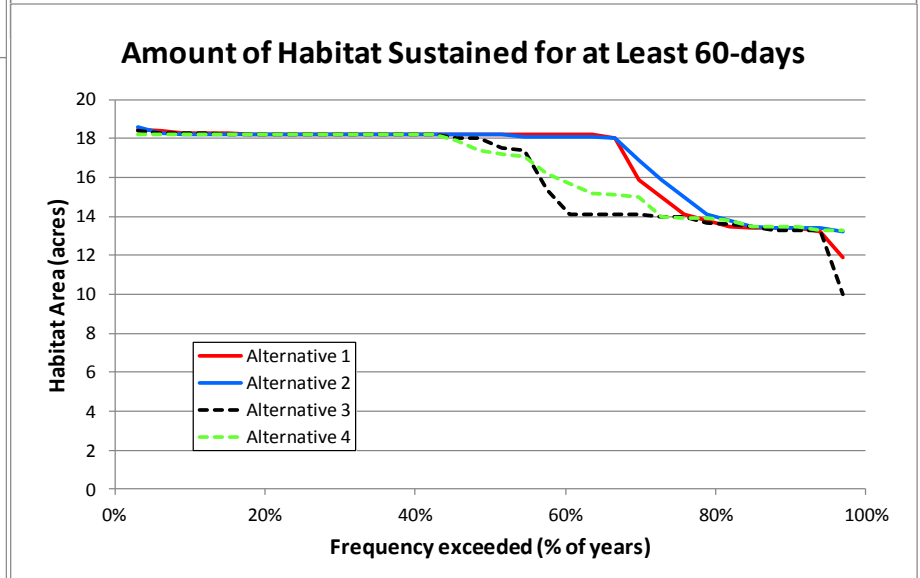
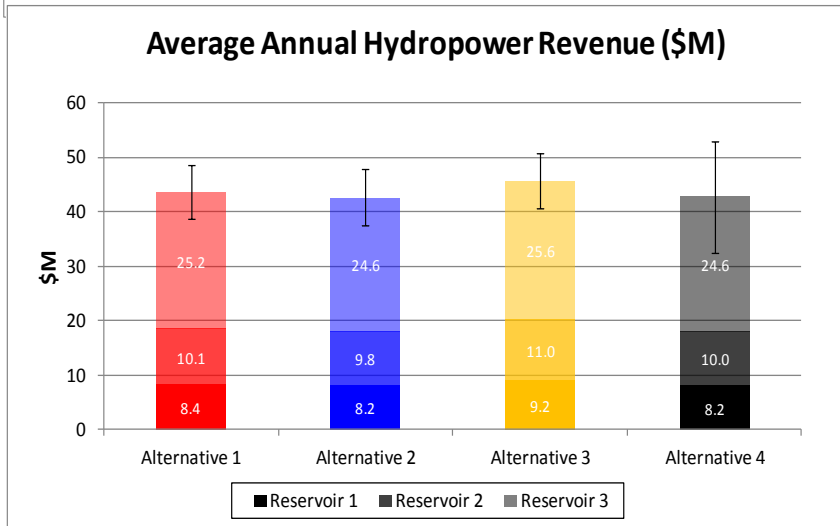
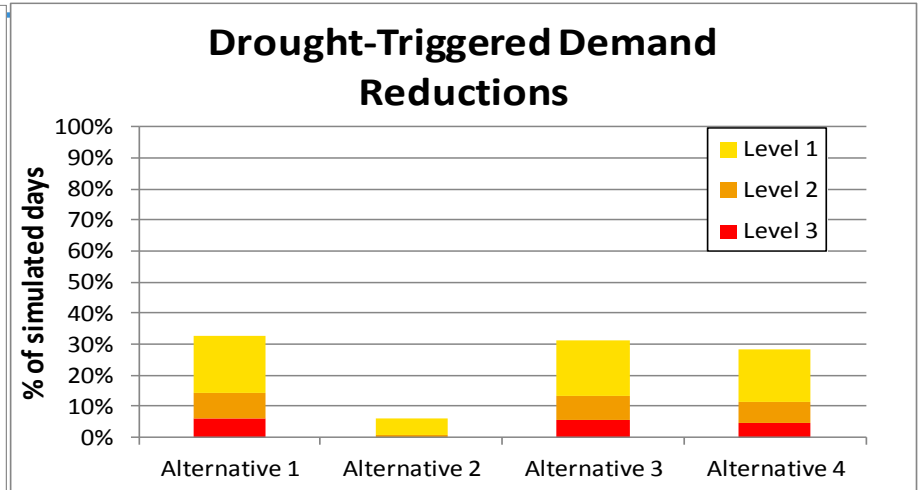
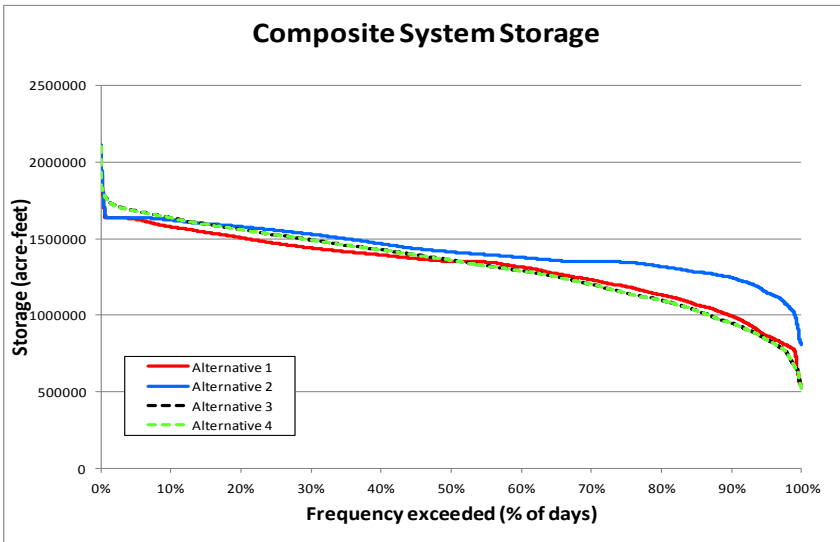
5 days > 11,500; 5 day avg < 8,500 cfs



Recreation Measures



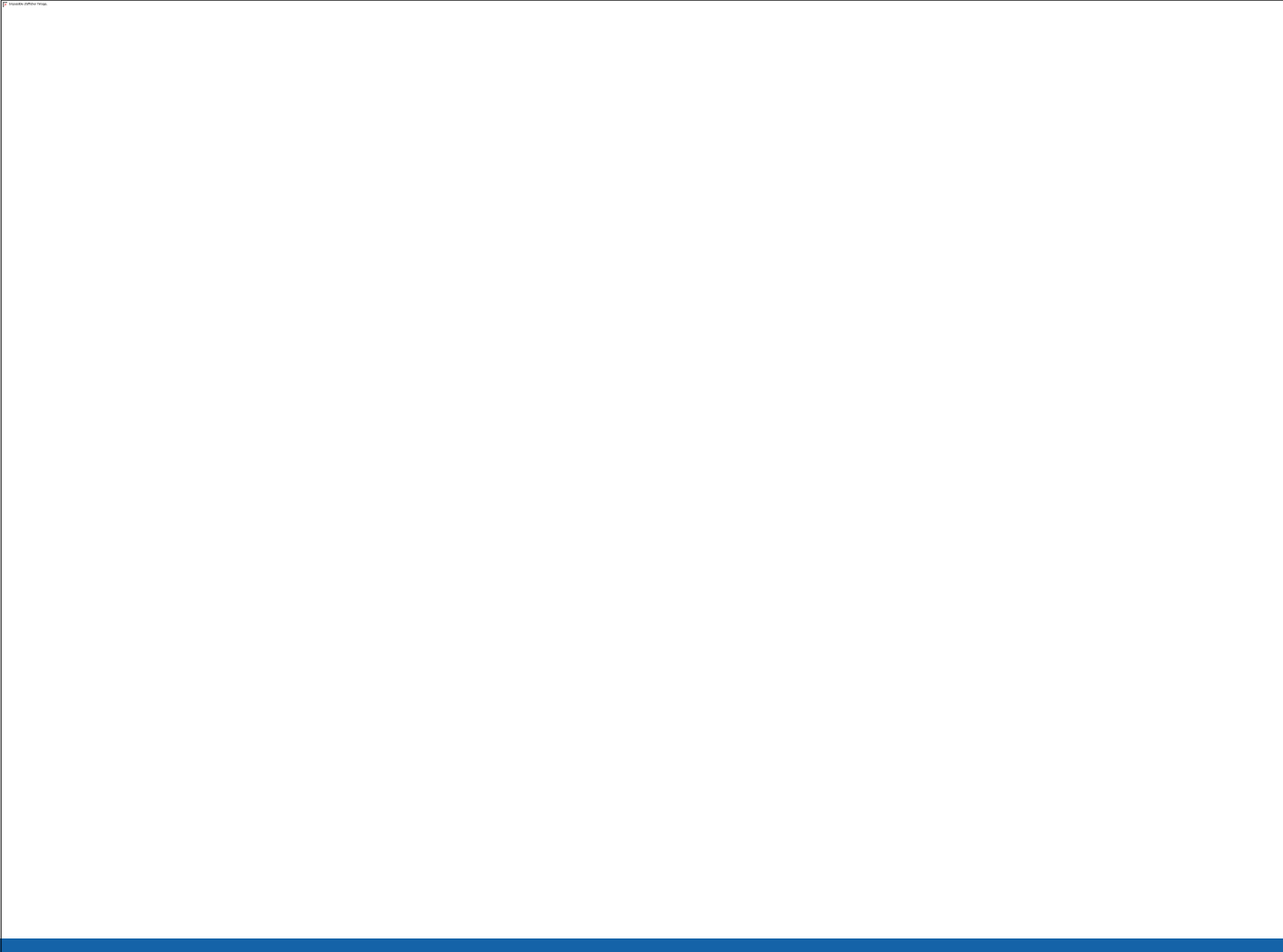
Other Measures



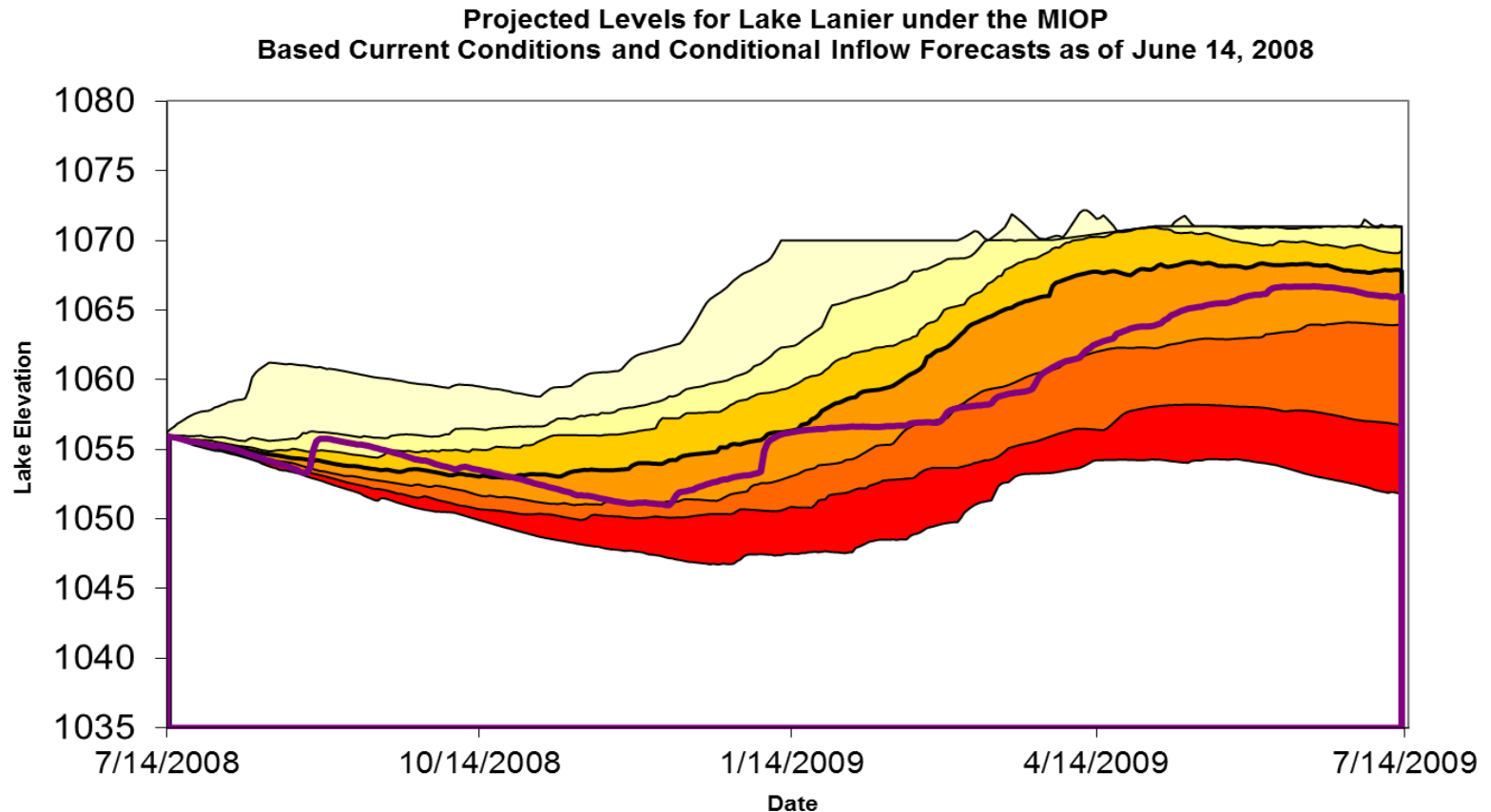
Forecasts + Operations = Improved Performance

- If you don't know what to do with a forecast it is unlikely to help very much
- Operations must be “tuned” to best utilize forecast skill
- There are many ways to use forecasts
- Ensemble forecasts plus simulations allows for investigating a very wide range of possible futures

Ensemble Display – Future Water Supply Storage



Storage Ensemble and Actual Performance ACF Drought of 2008



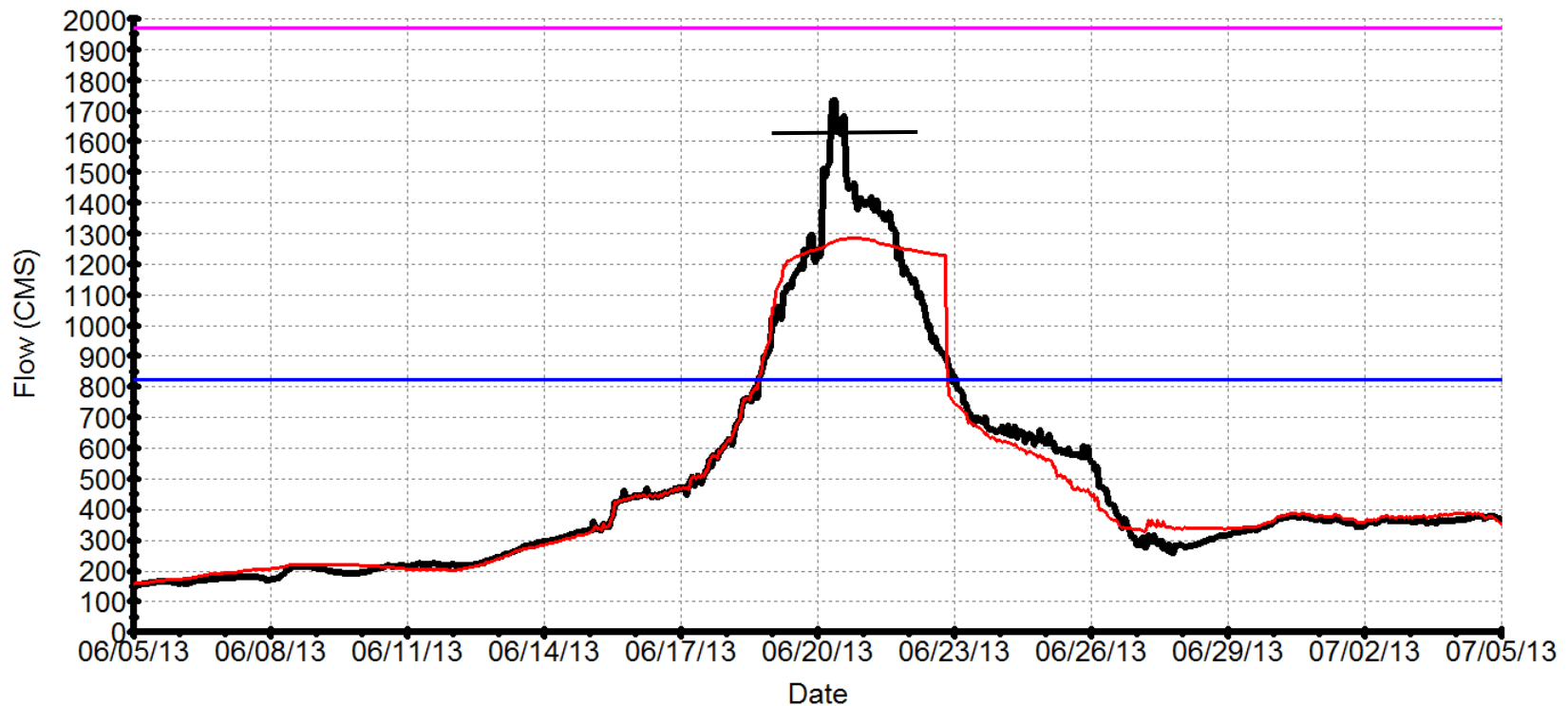
Colored bands correspond to exceedance probabilities (the probability that lake levels will fall within or above a given band on a given date) as shown below. The bold line is the median

□ 02-10% □ 10-25% □ 25-50% □ 50-75% □ 75-90% □ 90-98% □ 98-100% ■ Historical

Potential Flood Reduction – Calgary 2013 Flood

Bow River at Calgary (Upstream of Elbow)

UpperBow_TA_GoA_agr_2013



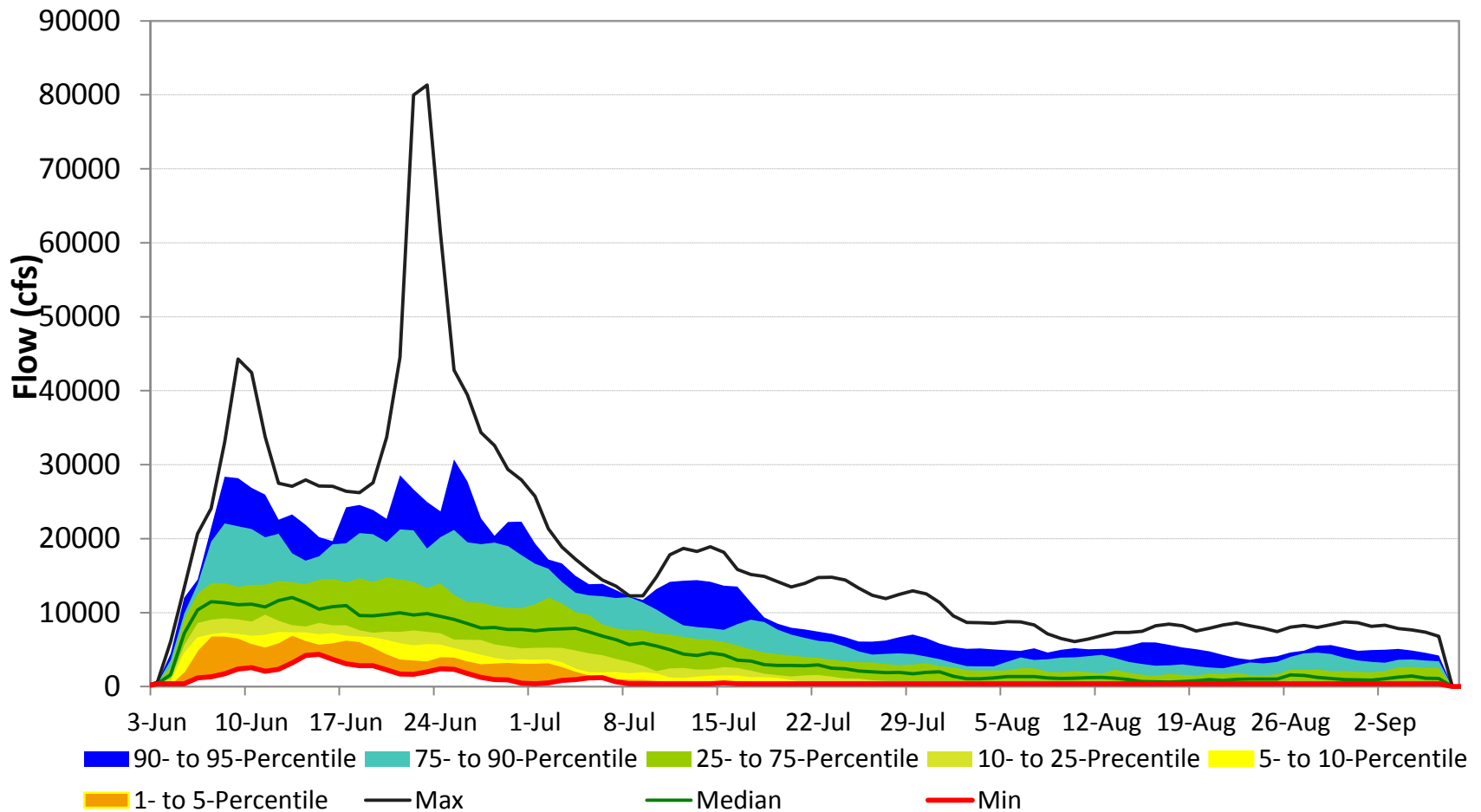
— Basecase Flow
— 1:100 Flood

— Sim. Flow w/ Perfect Knowledge
— TA's Estimated Reduced Flow

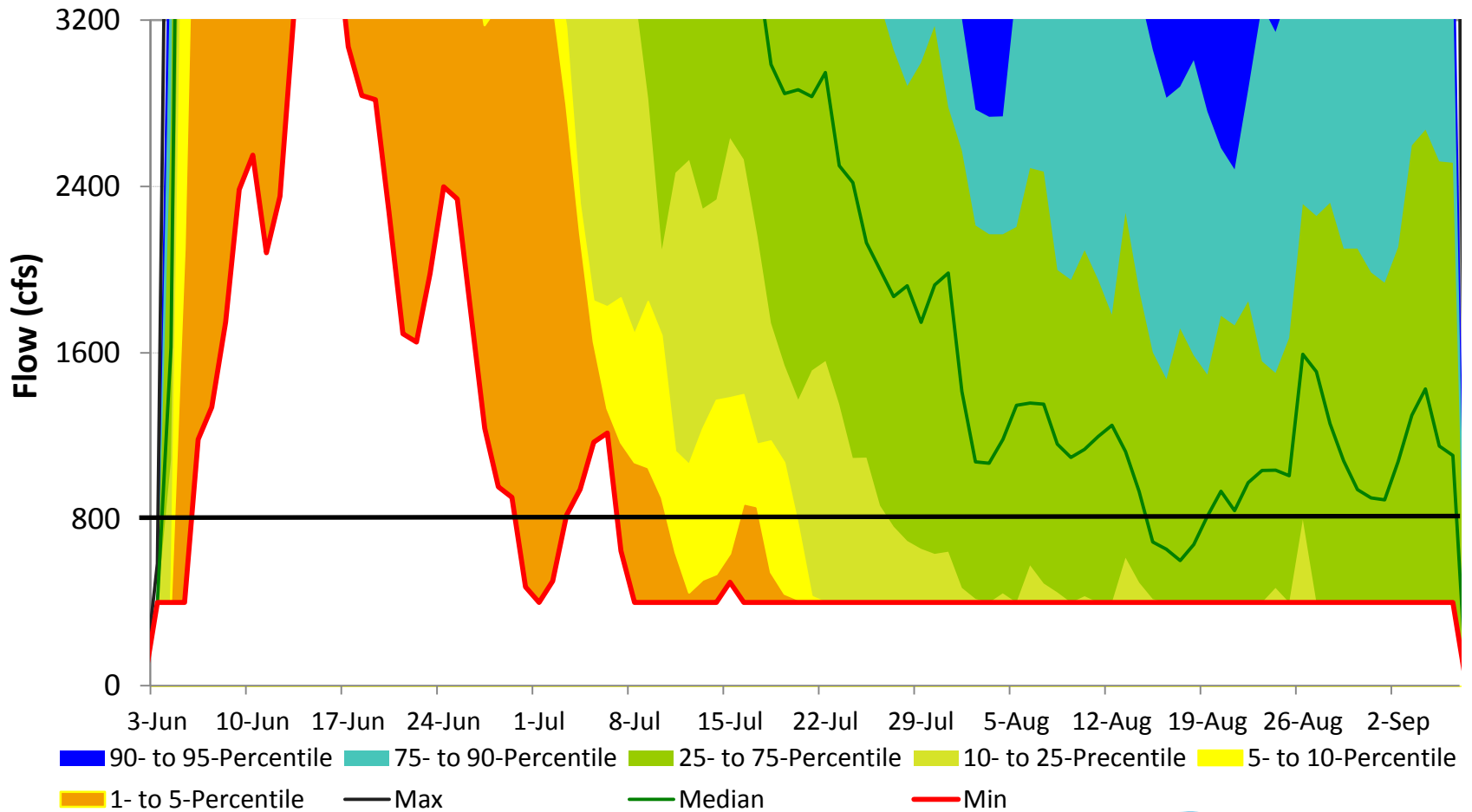
— Mitigation Target



Bassano Flow Forecast



Bassano Low Flow Forecast

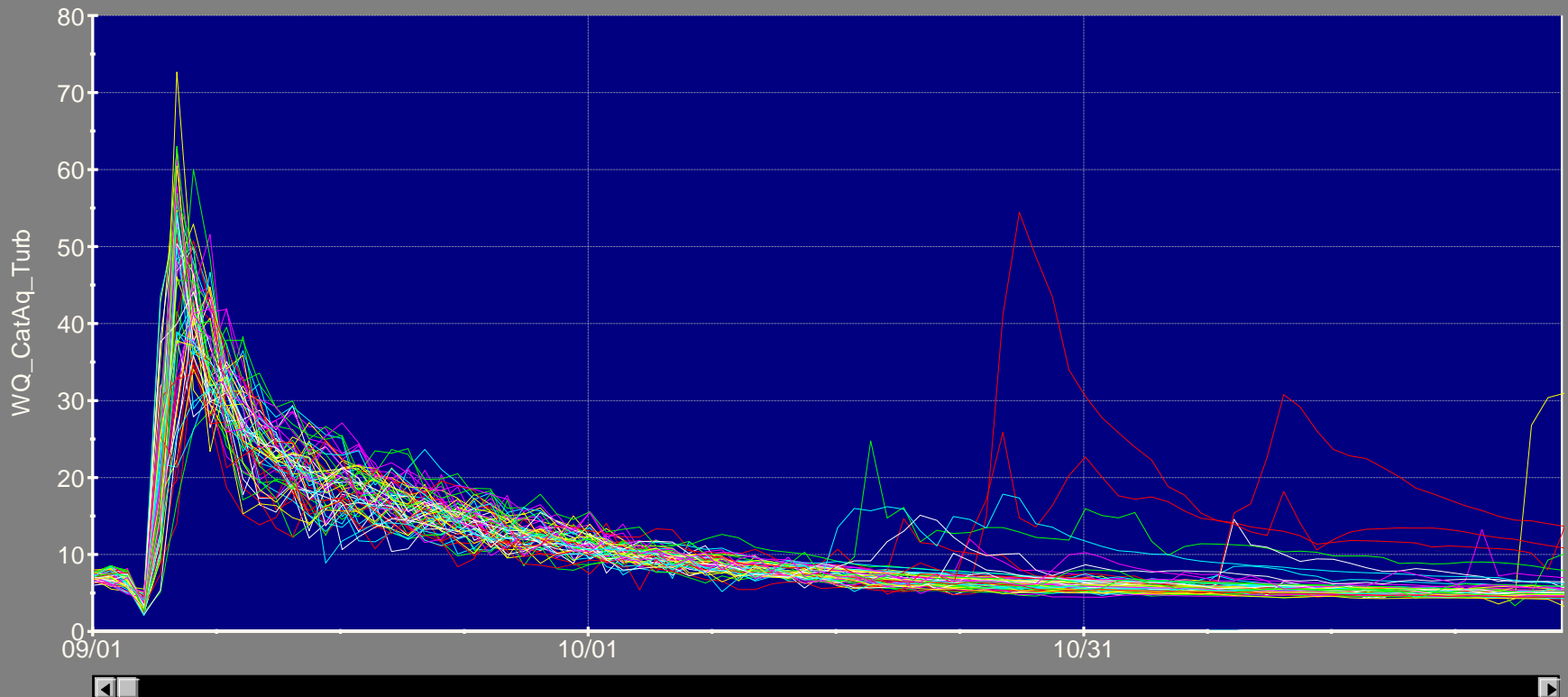


Turbidity Event Example – NYC Drinking Water Quality

- ...elevated diversion turbidity...

Ashokan Diversion Turbidity (WQ_CatAq_Turb)

2010-09-10_Turb_1

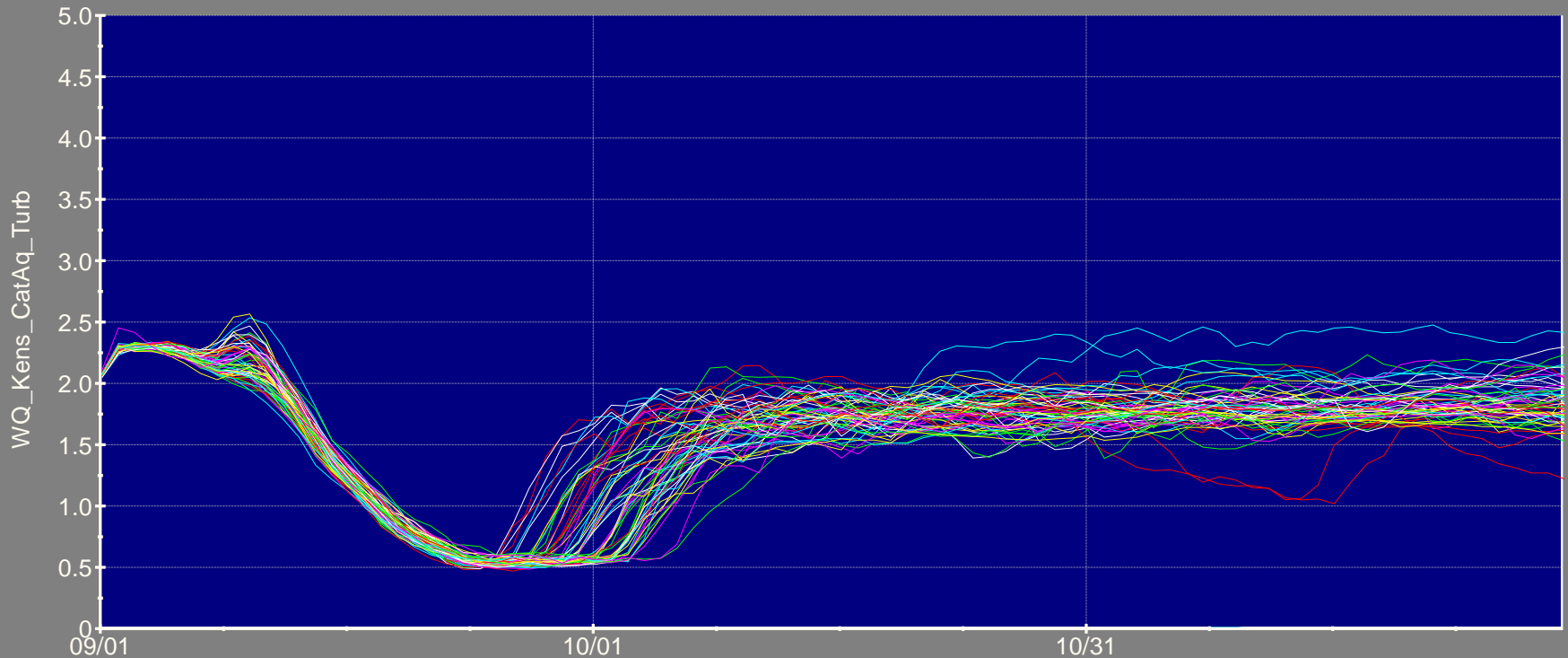


Turbidity Event Example – NYC Drinking Water Quality

- ...low Kensico diversion turbidity

Kensico Diversion Turbidity (WQ_Kens_CatAq_Turb)

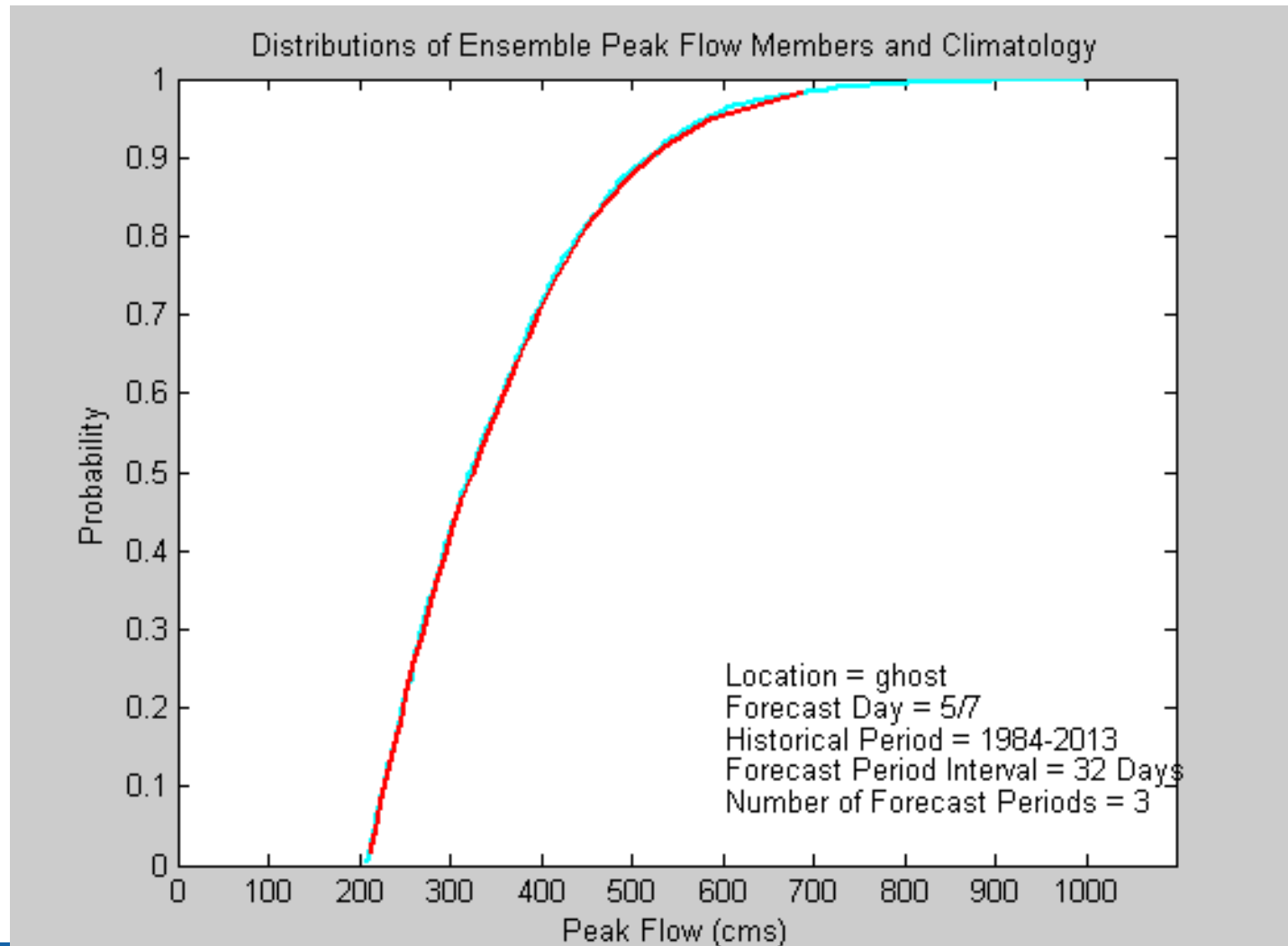
2010-09-10_Turb_1



Forecast Bias and Variance

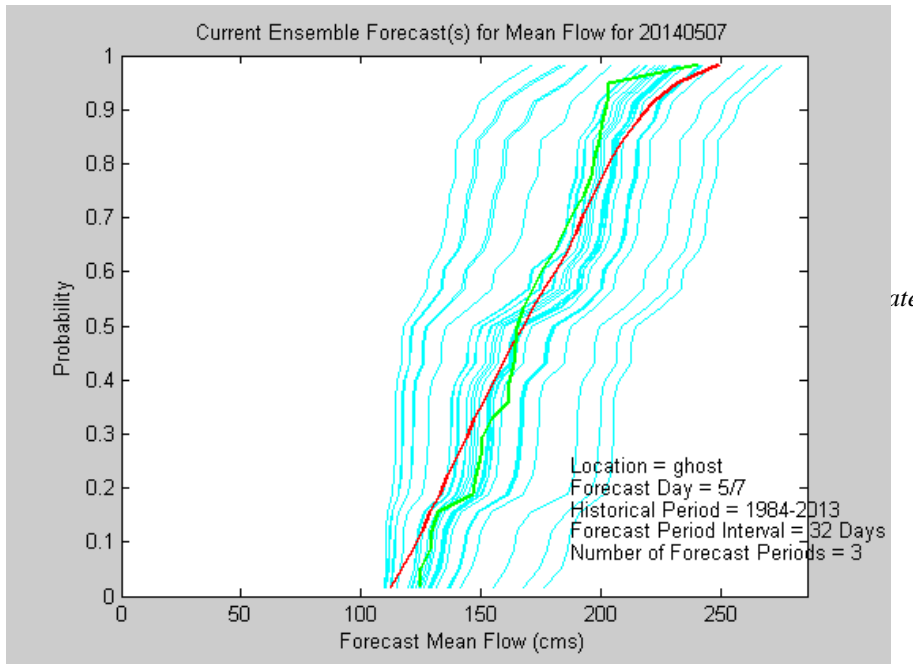
- Operating rules can be “tuned” to account for bias, differential bias, and reduction in variance
- Better to correct for these factors in the forecast itself

Distributions of Peak Flow Observations and Re-Forecast Ensemble Members

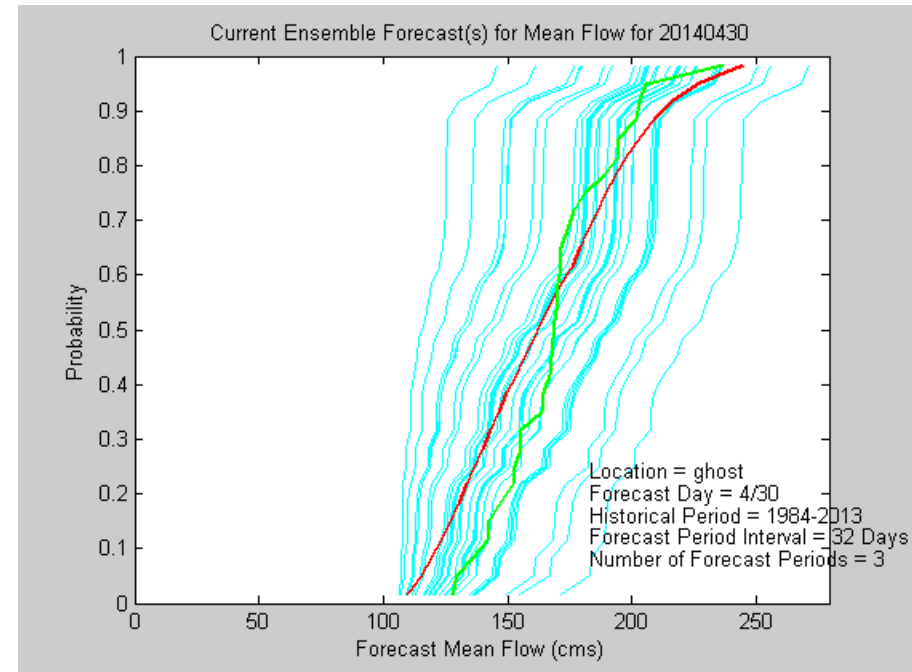


2014 Mean Flow Forecasts

4/30/2014



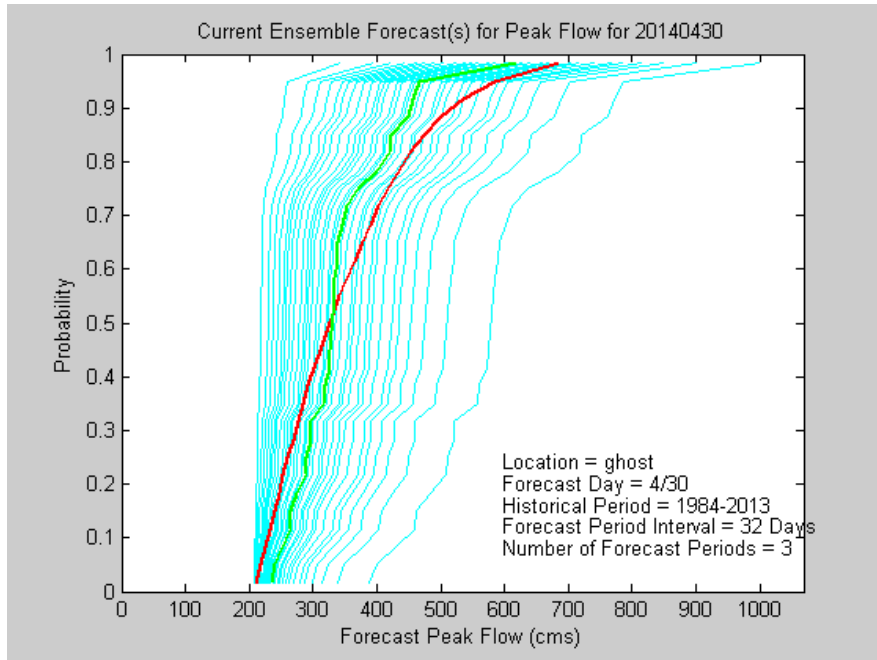
5/9/2014



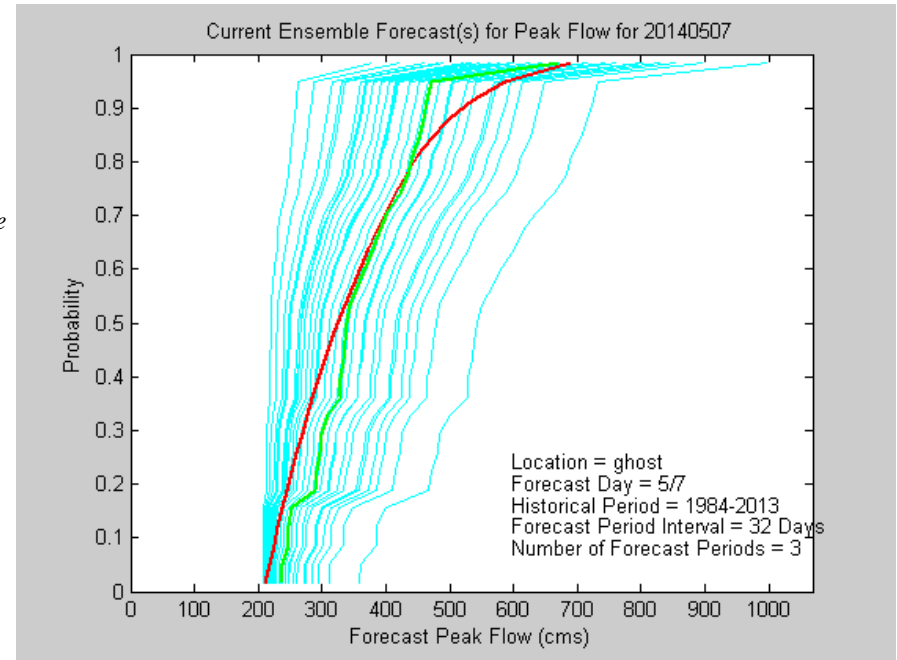
2014 Peak Flow Forecasts

4/30/2014

5/9/2014



late



Forecast Based Rules Must Be Tested Prior to Implementation

- Rules can be simulated on a historical record
- This **REQUIRES** reforecasts using current technology
- Implementing a new rule blind is a very bad idea
- Resistance to forecast based rules can be overcome by testing and gaming

Sample Results from Ensemble Forecast Based Rules

- City of Rocky Mount, NC – new pipelines not needed - ~\$70M
- New York City – Multi-level outlet avoided - ~\$300M
- Bow River – 200% increase in flood peak reduction possible
- Smith Mountain Lake, Va. – Improved fisheries habitat w/ little impact on other uses



Thank You