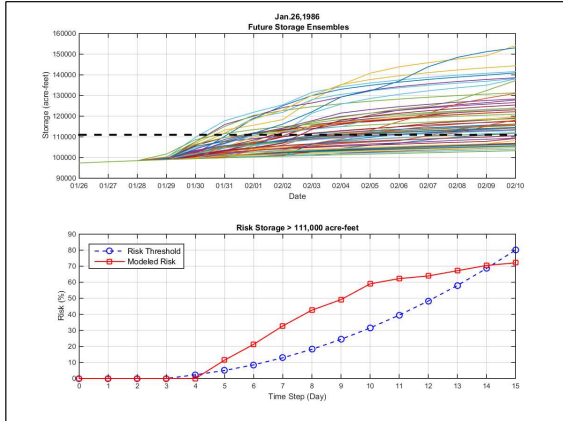
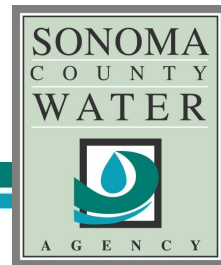


Lake Mendocino Forecast Informed Reservoir Operations Risk Based Approach



Chris Delaney
Water Agency Engineer
Sonoma County Water Agency












www.sonomacountywater.org


Basic Concept

This Afternoon	Tonight	Thursday	Thursday Night	Friday	Friday Night	Saturday	Saturday Night	Sunday
Sunny	Patchy Fog	Patchy Fog then Sunny	Clear	Sunny	Mostly Clear	Sunny	Partly Cloudy	Chance Rain
High: 71 °F	Low: 49 °F	High: 78 °F	Low: 51 °F	High: 84 °F	Low: 52 °F	High: 81 °F	Low: 52 °F	High: 68 °F












Basic Concept


Tonight  Clear Low: 52 °F	Friday  Sunny High: 84 °F	Friday Night  Mostly Clear Low: 52 °F	Saturday  Sunny High: 80 °F	Saturday Night  Partly Cloudy Low: 53 °F	Sunday  40% Chance Rain High: 68 °F	Sunday Night  40% Chance Showers Low: 51 °F	Monday  Chance Showers High: 66 °F	Monday Night  Slight Chance Showers Low: 47 °F
--	--	--	--	---	---	--	---	---



3

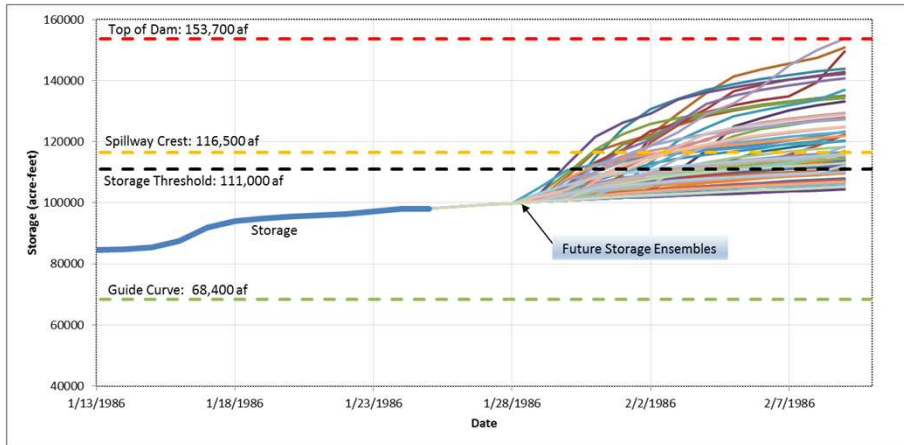
Basic Concept

Today  Sunny High: 80 °F	Tonight  Mostly Cloudy Low: 52 °F	Sunday  60% Heavy Rain High: 70 °F	Sunday Night  80% Showers Low: 50 °F	Monday  40% Chance Showers High: 65 °F	Monday Night  20% Slight Chance Showers then Partly Cloudy Low: 46 °F	Tuesday  Sunny High: 66 °F	Tuesday Night  Mostly Clear Low: 44 °F	Wednesday  Sunny High: 68 °F
---	--	--	--	--	---	--	---	---



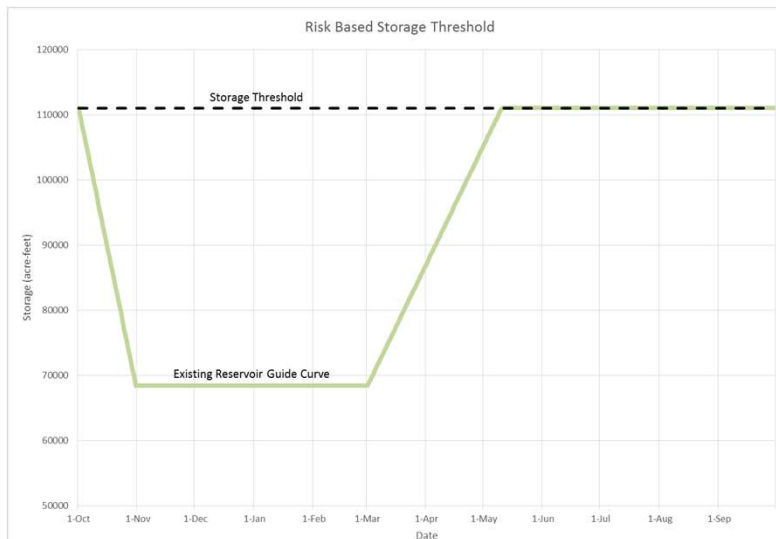
4

Reservoir Stage Forecast from CNRFC Flow Forecast



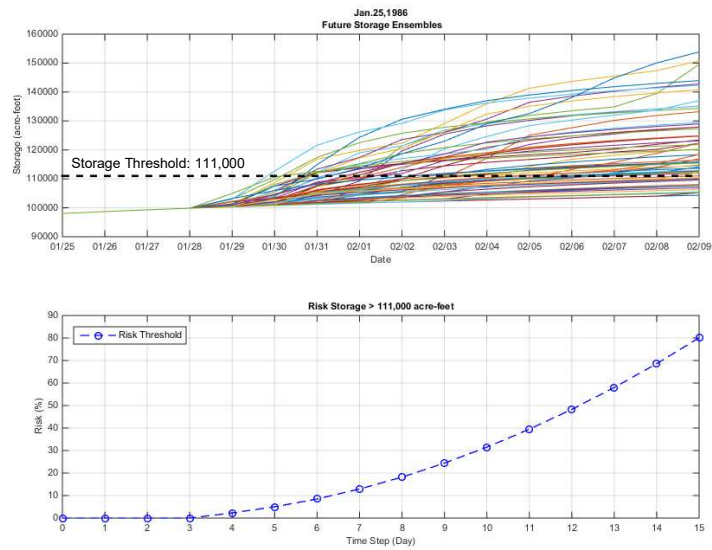
5

Storage Threshold 111,000 acre-feet Top of Conservation Pool



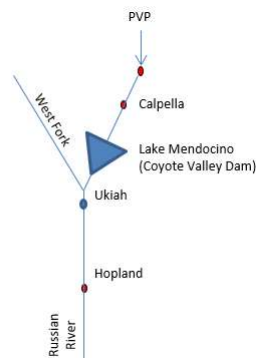
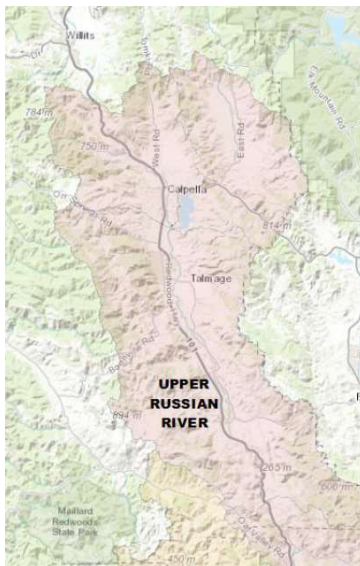
6

Risk Based Approach



7

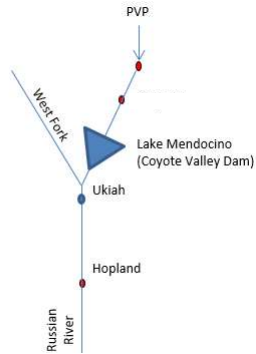
Model Setup



- ❖ **Simple water balance model**
 - Potter Valley Project to the USGS Gage at Hopland
 - Daily time step

8

Model Setup



❖ Model Gains

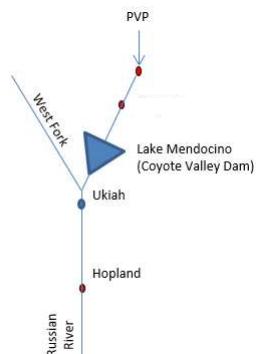
- PVP flows:
 - Eel River Model 1985-2010
 - Simulate current operations
- Unimpaired Flows:
 - CNRFC observed daily flows 1985-2010
 - Lake Mendocino
 - West Fork of Russian River
 - Hopland

❖ Model Losses

- Compliance Releases:
 - Decision 1610 Hydrologic Index
 - Biological Opinion TUC Minimum Flows
- Reach Losses:
 - 2 Year Types
 1. Wet Year
 2. Dry Year

9

Model Setup



❖ Flood Operations

- Max release constraints of Water Control Manual
- No flood releases when:
 - Flows at West Fork RR > 2,500 cfs or
 - Flows at RR at Hopland > 8,000 cfs

❖ Flow Forecast

- CNRFC Hindcast
 - 61 member ensemble
 - Based on GEFS and CFSv2 reforecasts
 - 1985 to 2010
 - Daily average flows out to 15 days
 - Lake Mendocino
 - West Fork
 - Hopland

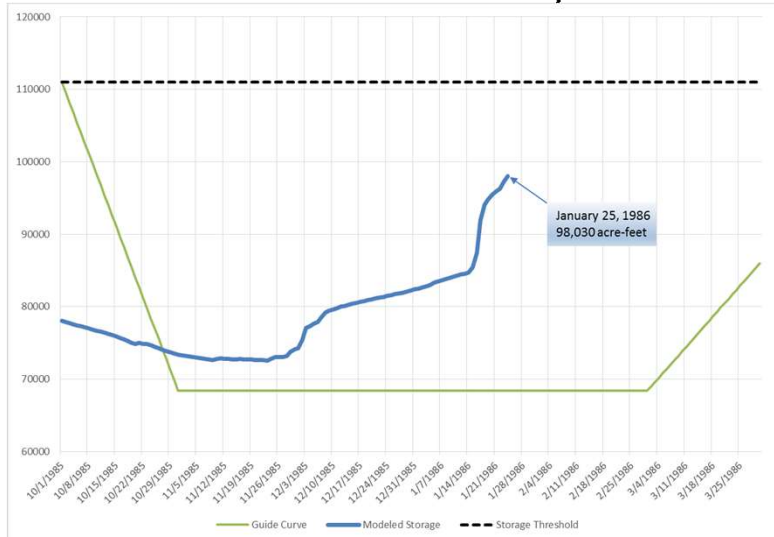
❖ Scenarios

1. **Baseline: Current Guide Curve Operations**
2. **Risk Based Approach**

10

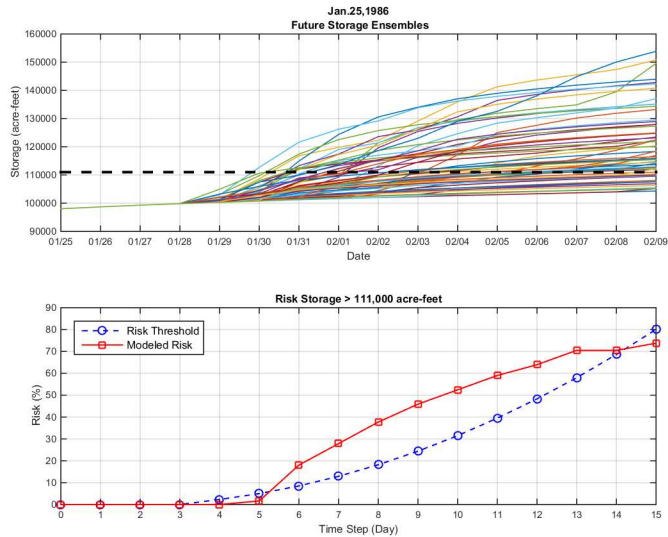
Here's How It Works

Winter 1986 Example



11

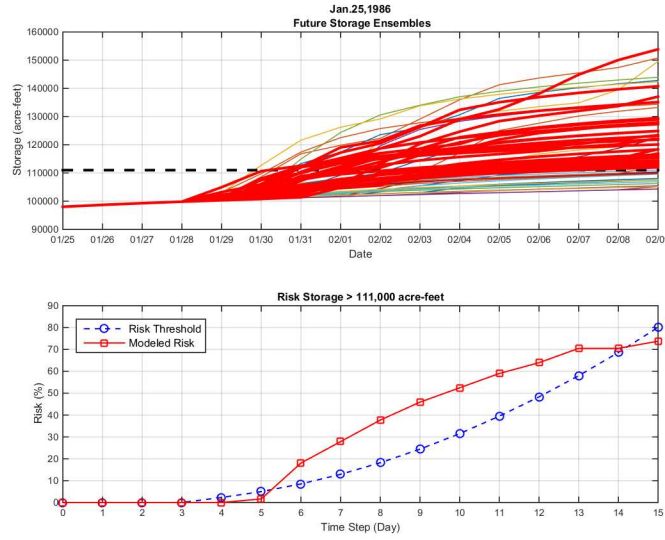
January 25, 1986



12

January 25, 1986

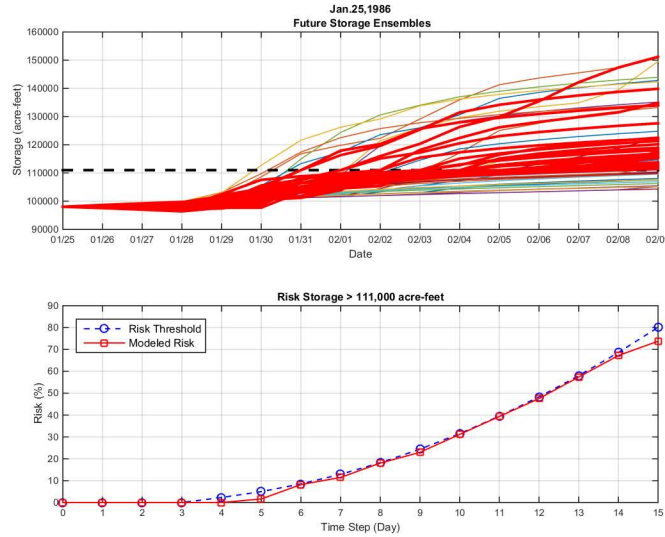
CD1



13

January 25, 1986

CD2



14

Slide 13

CD1 Highlight these only as far as the timestep they affect. This could be tricky because some members are used for multiple time steps.

Chris Delaney, 11/12/2015

Slide 14

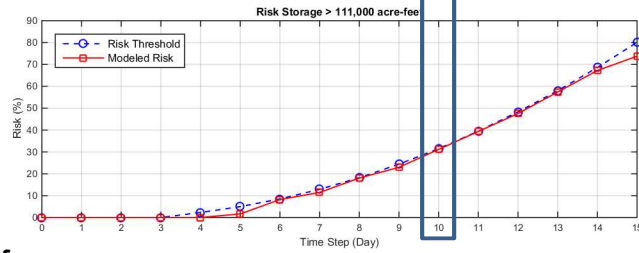
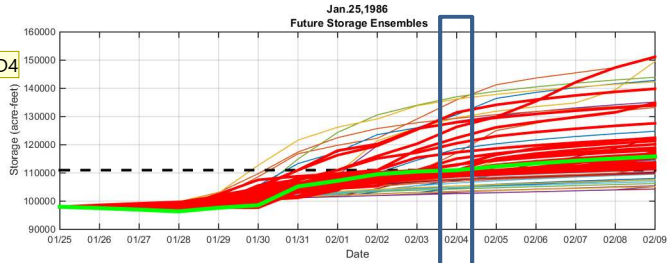
CD2 Highlight these only as far as the timestep they affect.

Chris Delaney, 11/12/2015

January 25, 1986

Possible Releases

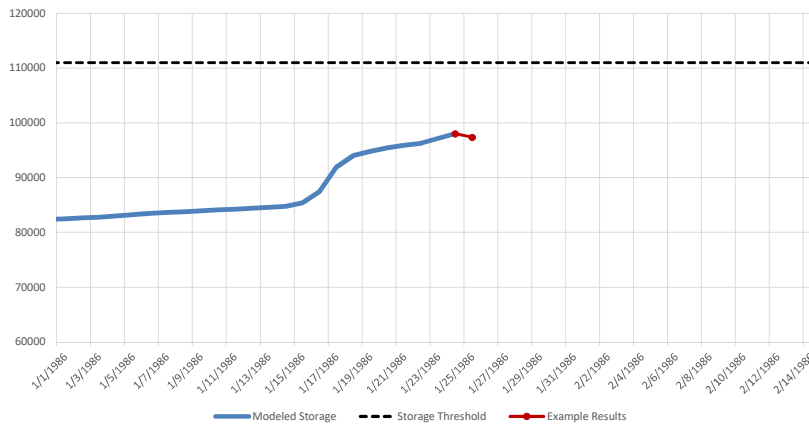
Time Step	Release (cfs)
1	0
2	0
3	0
4	0
5	0
6	182
7	356
8	534
9	599
10	625
11	375
12	339
13	312
14	42
15	0



Release = 625 cfs

15

January 25, 1986



$$\text{EOD Storage} = \text{BOD Storage} + \text{Inflow} - \text{Total Release} - \text{Evaporation}$$

98,030 af
+ 295 cfs
- 625 cfs

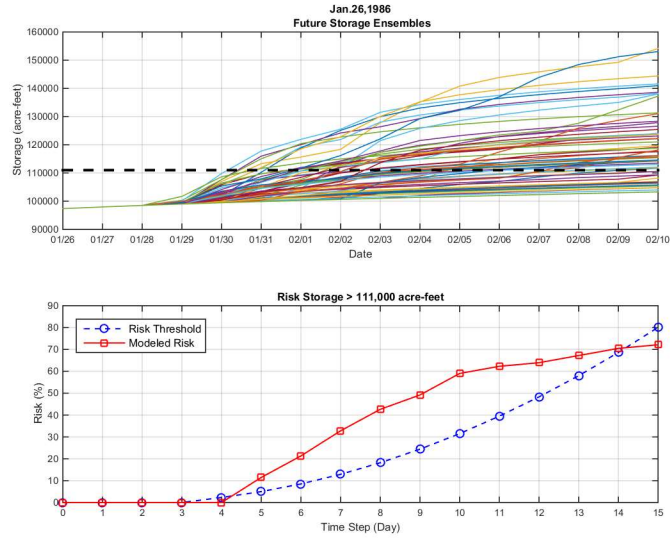
EOD Storage = 97,365 acre-feet

16

Slide 15

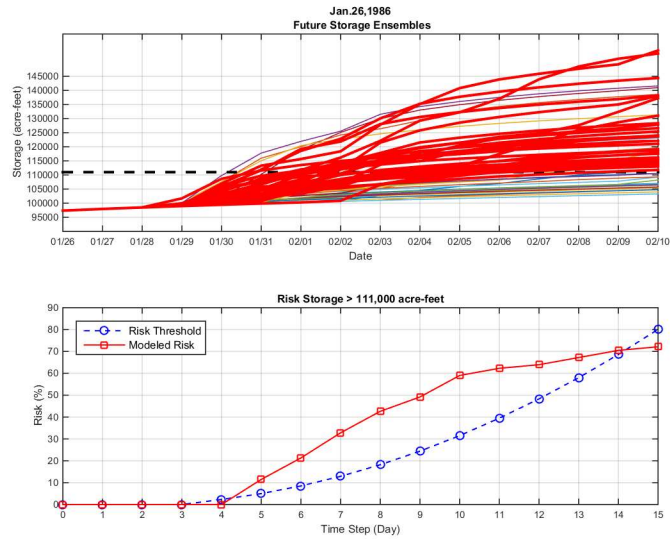
D4 Recalculate so these are all total releases.
Delaney, 11/7/2015

January 26, 1986



17

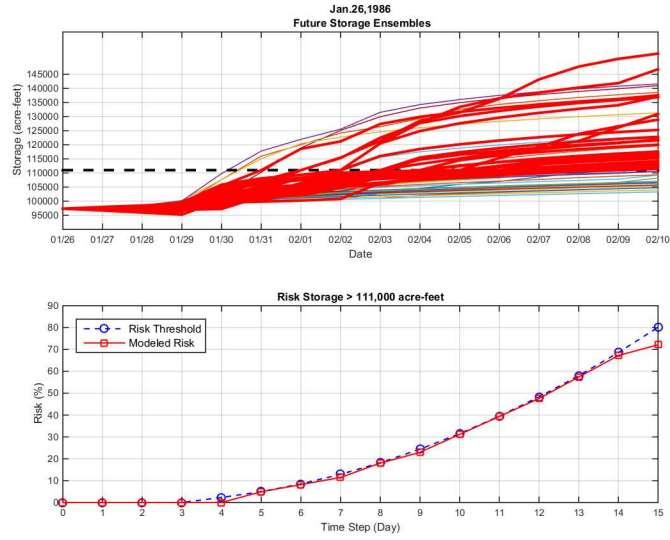
January 26, 1986



18

January 26, 1986

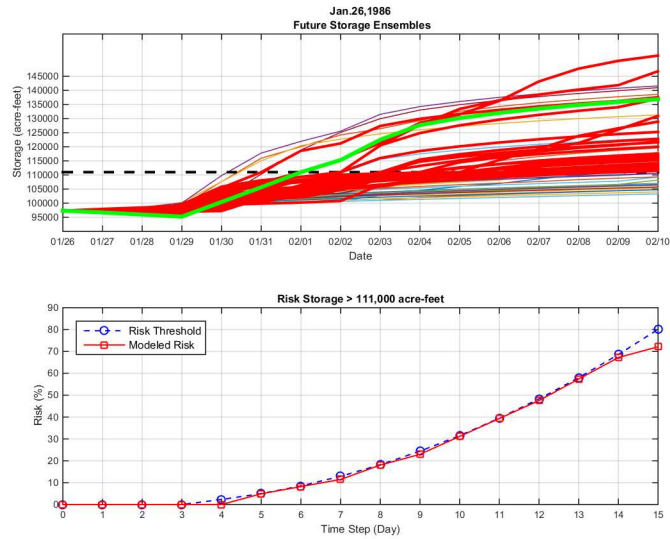
D8



19

January 26, 1986

D7



Release = 682 cfs

20

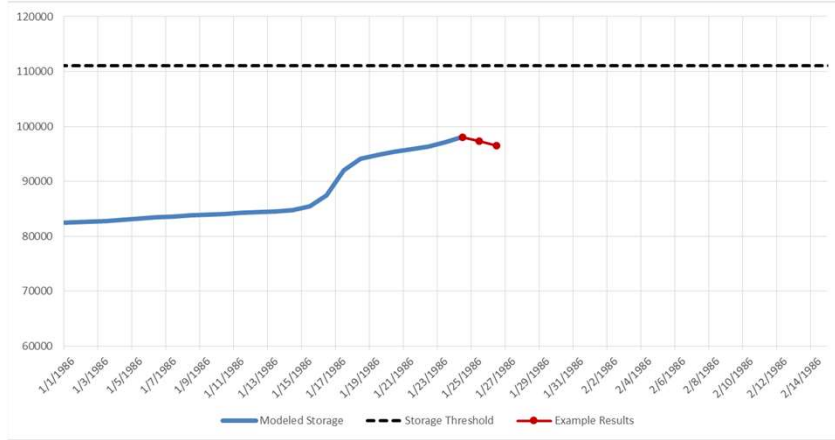
Slide 19

- D8** Maybe highlight these just until they fall below the storage threshold and not past this.
Delaney, 11/7/2015

Slide 20

- D7** Also include the table with this plot to show the max releases at the future timesteps. And the controlling timestep on the table and the plot.
Delaney, 11/7/2015

January 26, 1986



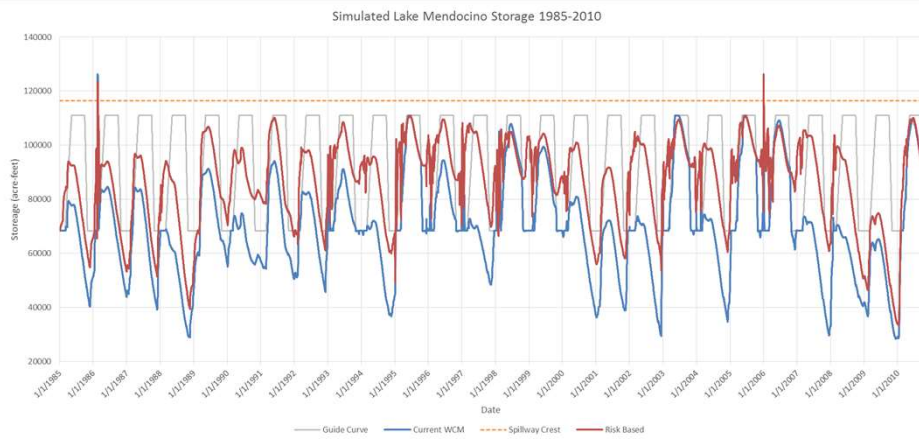
$$\text{EOD Storage} = \text{BOD Storage} + \text{Inflow} - \text{Total Release} - \text{Evaporation}$$

97,365 af
 264 cfs
 682 cfs

EOD Storage = 96,531 acre-feet

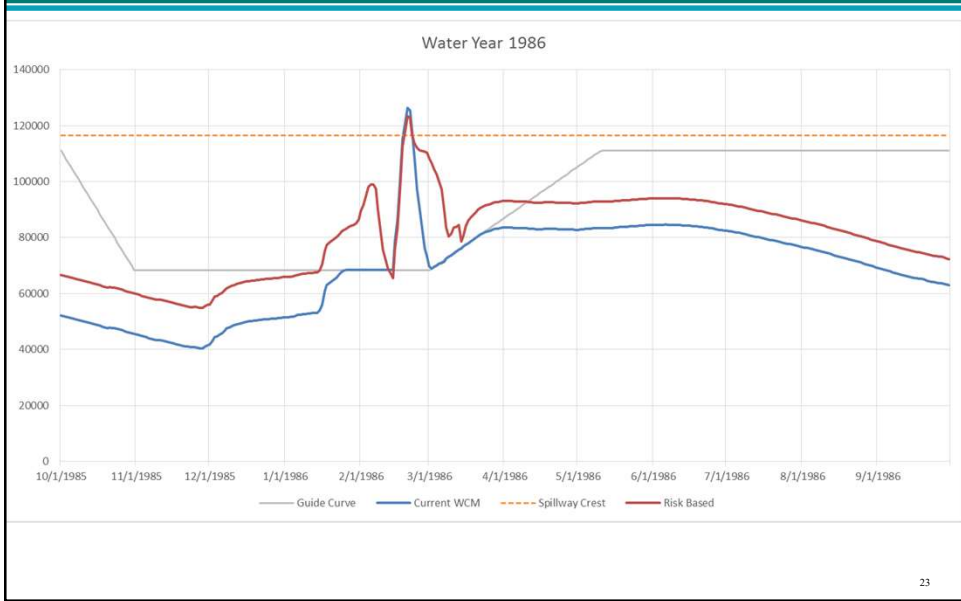
21

Results 1985 - 2010

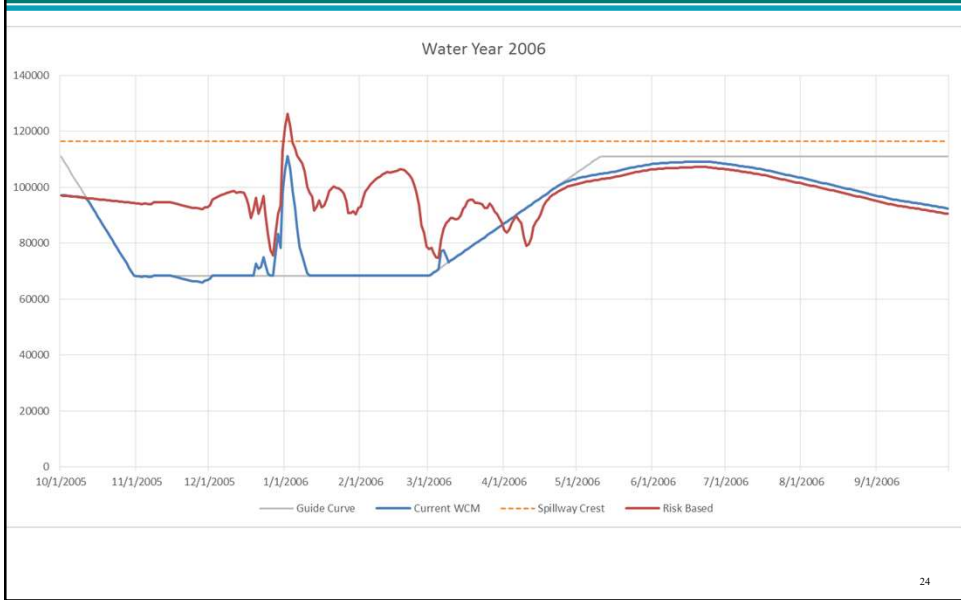


22

Results 1986



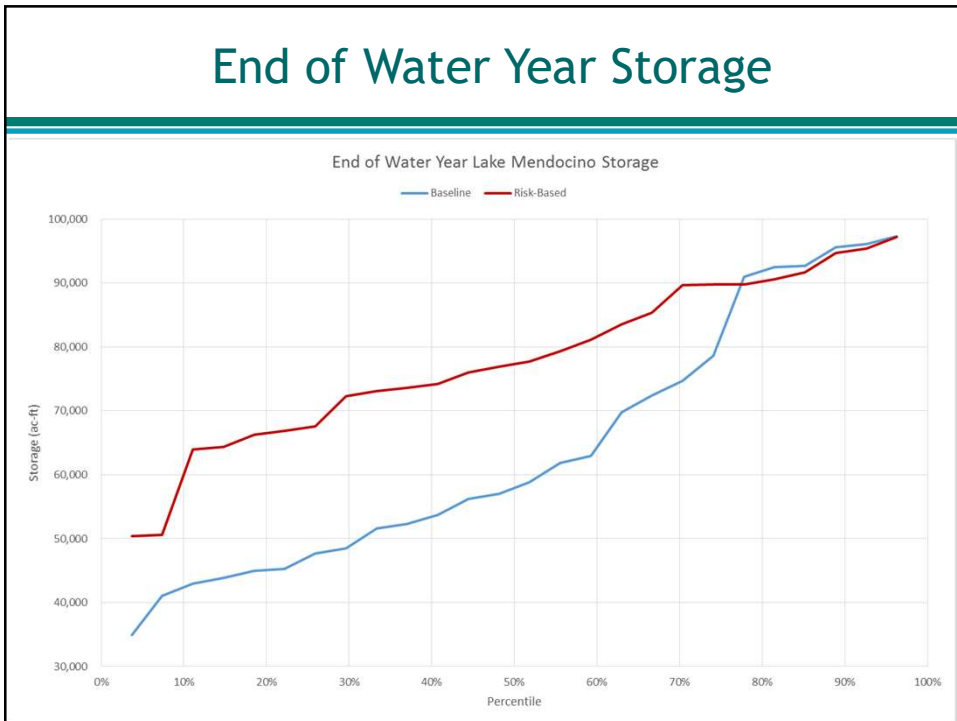
Results 2006



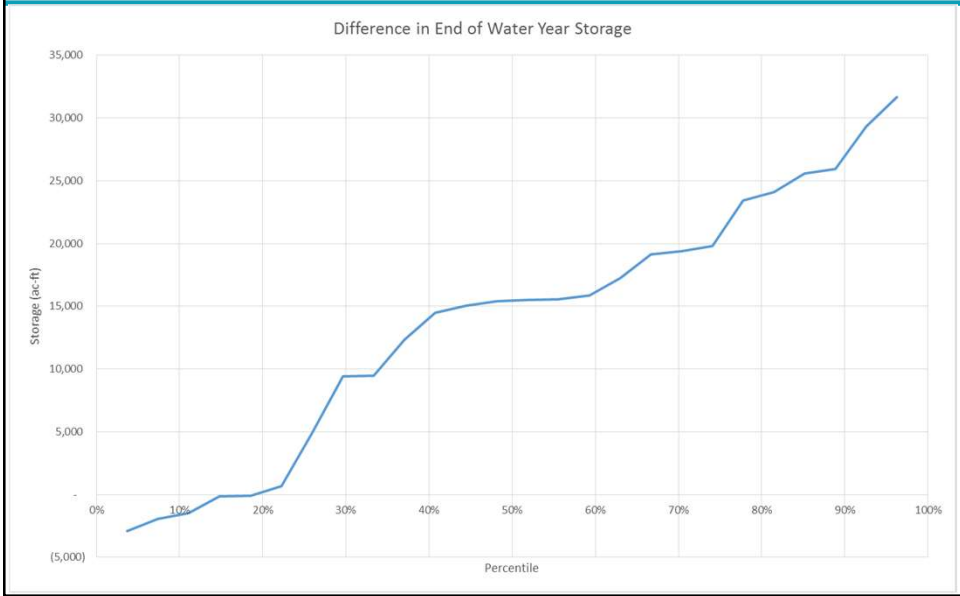
Results 1988



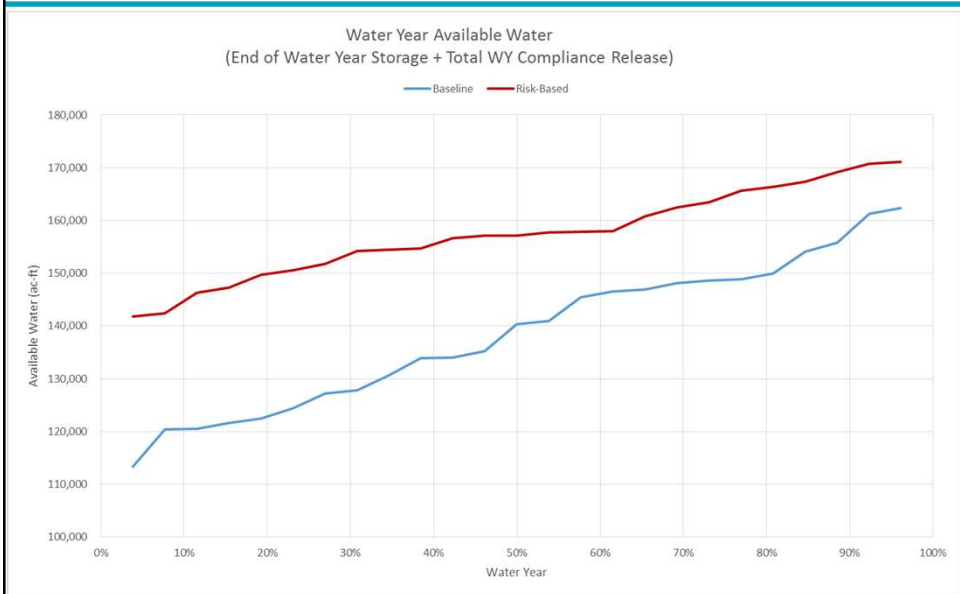
End of Water Year Storage



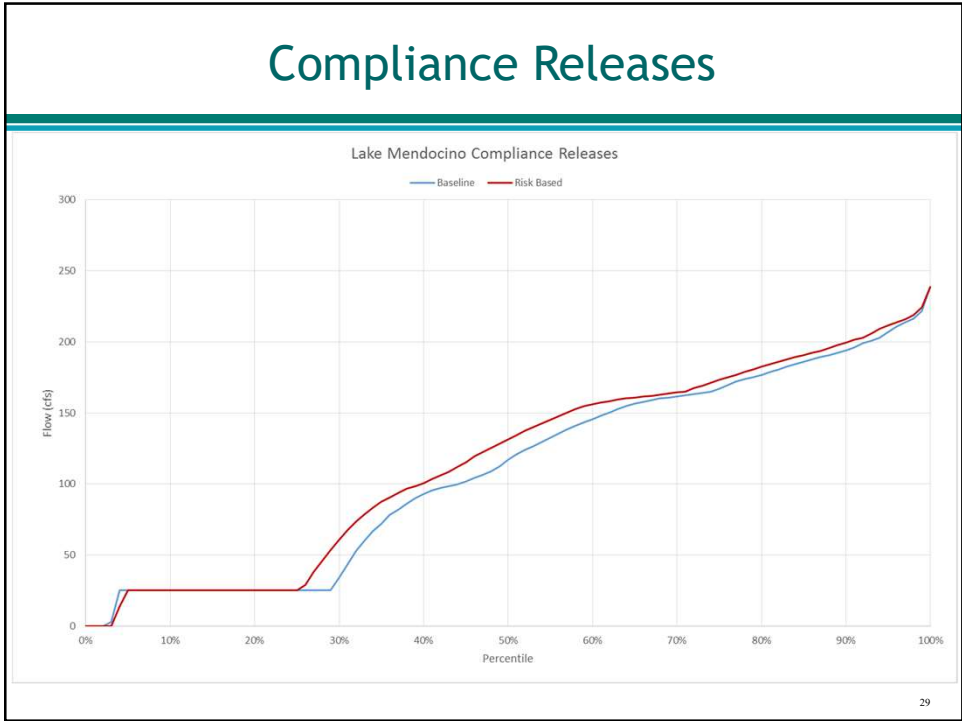
Difference in End of Water Year Storage



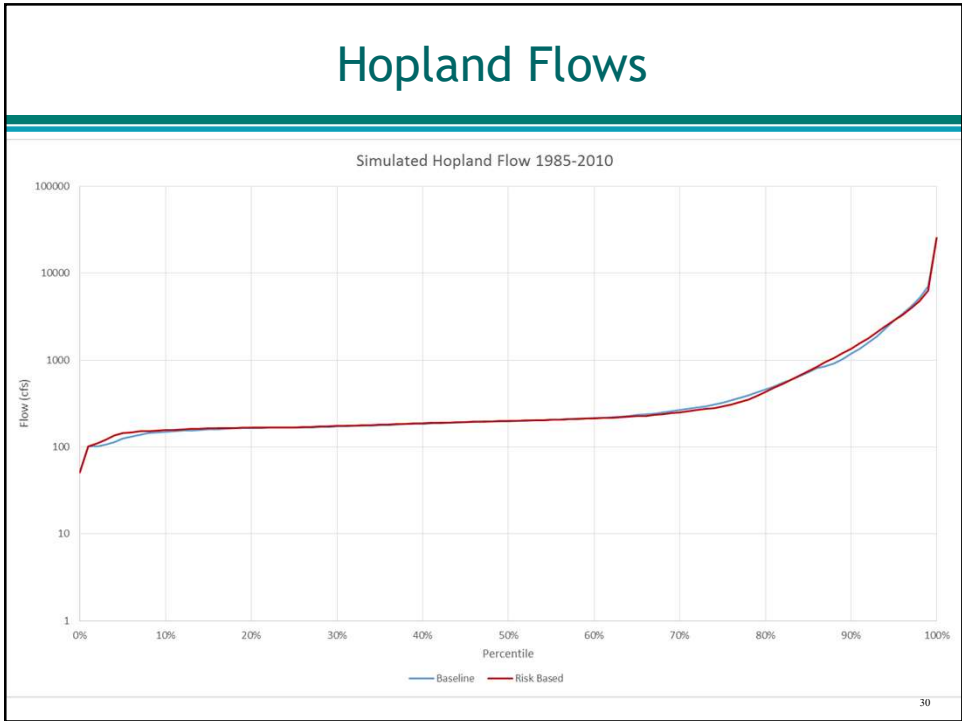
Water Year Available Water



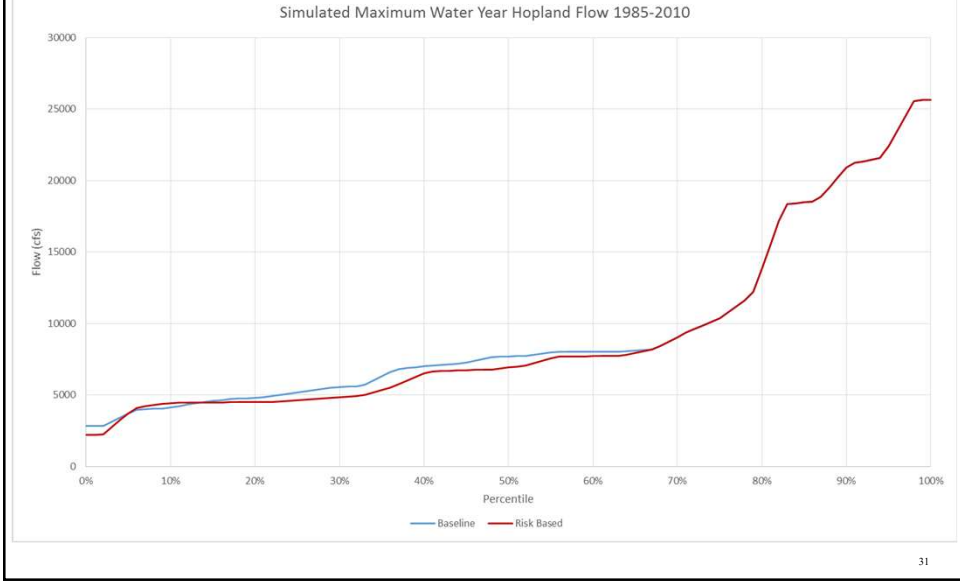
Compliance Releases



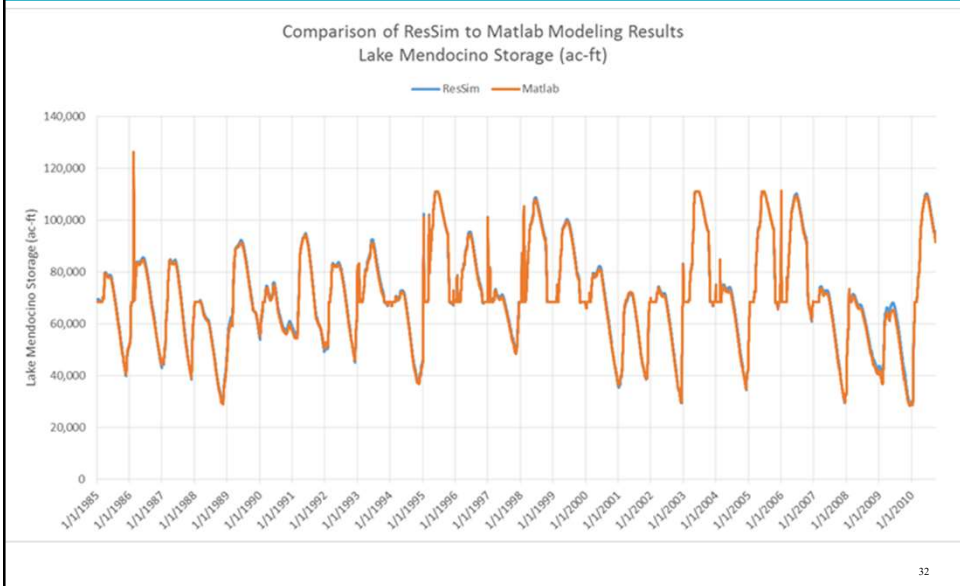
Hopland Flows



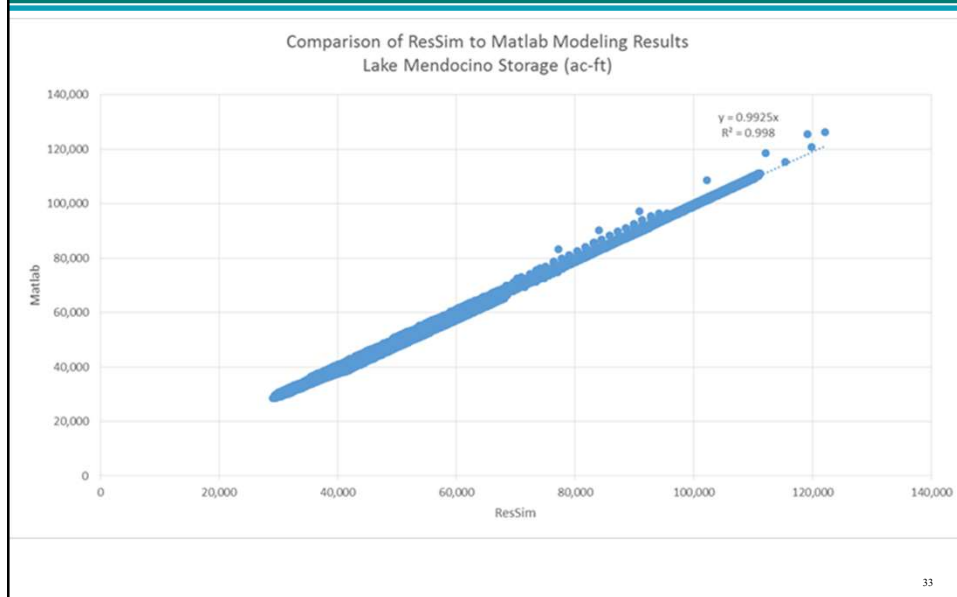
Max Water Year Flows at Hopland



Comparison to Russian River ResSim



Comparison to Russian River ResSim



Model Limitations

- ❖ **Limited historical period of evaluation 1985-2010**
 - Does not include the event of record: 1964
 - Does not include any significant droughts: 1976-1977 or 2013-2015
- ❖ **Limited spatial scope**
 - Only evaluates conditions to the Hopland gage
- ❖ **Daily time step**
 - Flow peaks occur at a sub-daily time step
- ❖ **Risk threshold has not been optimized**
- ❖ ~~Simplified dry season hydrology~~
 - ~~Annually repeating compliance releases~~

34

Next Steps

❖ Viability Assessment

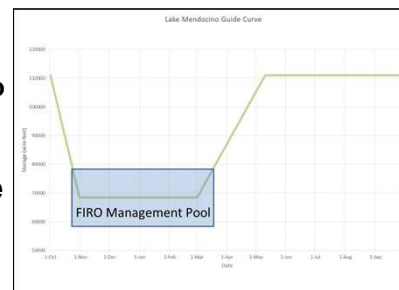
- Collaborate with Steering Committee, HEC and CNRFC to incorporate the Risk Based Approach as alternative.

❖ Model Improvement:

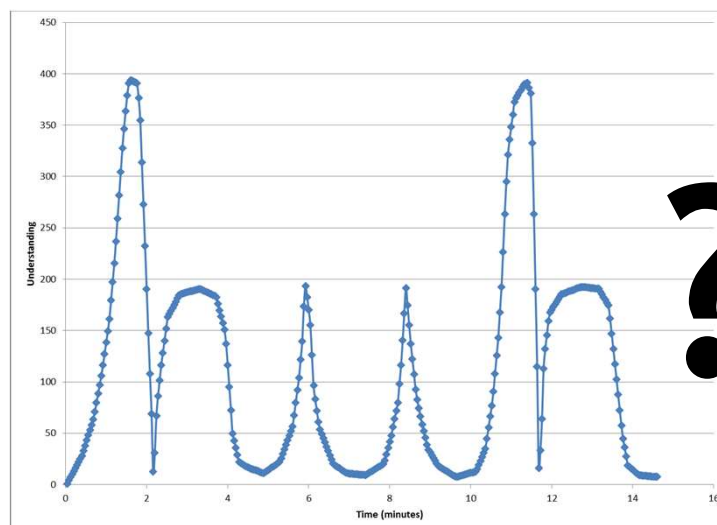
- Optimize risk threshold
- Sub-daily time step
- Improve dry season hydrology
- Extend model further downstream to the Healdsburg gage

❖ Partial implementation alternative

- FIRO management reservoir pool

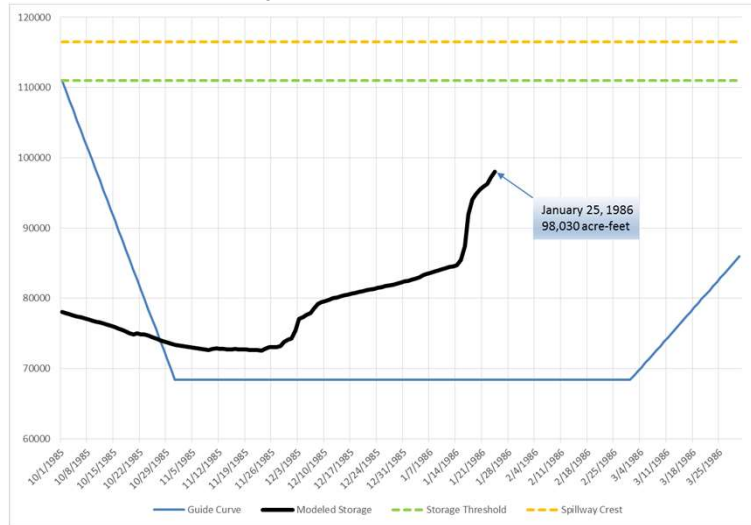


Questions?



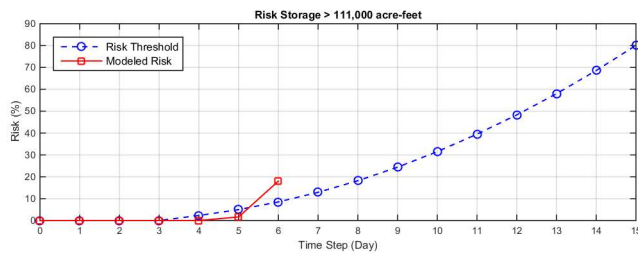
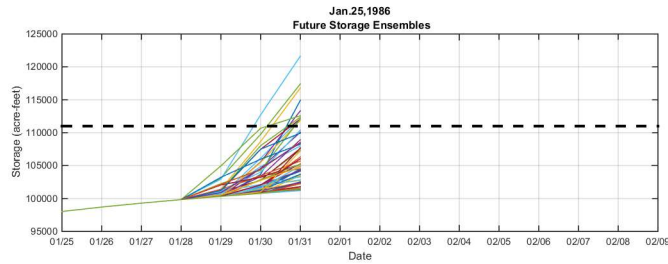
Since You Asked...

January 25, 1986 Example



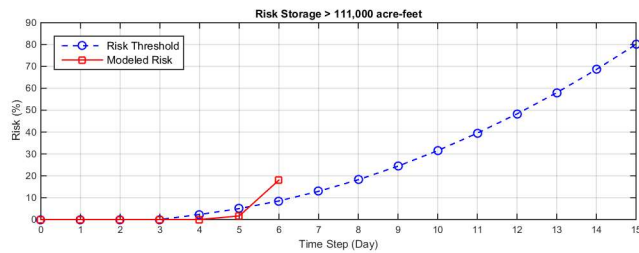
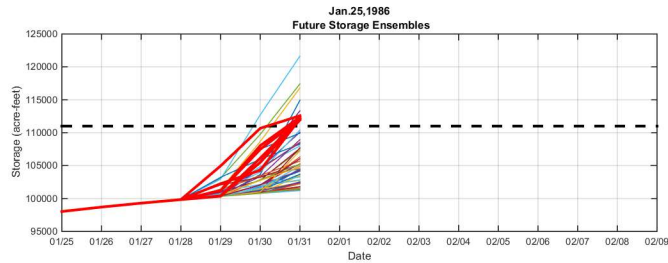
37

January 25, 1986: Time Step 6



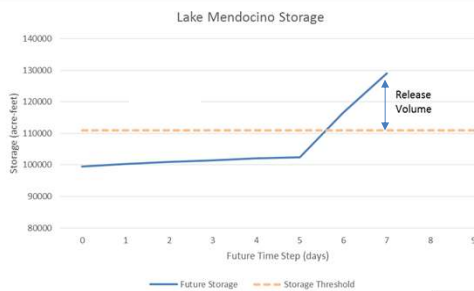
38

January 25, 1986: Time Step 6



39

Future Release Schedules

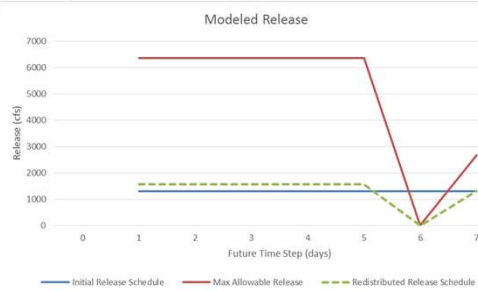


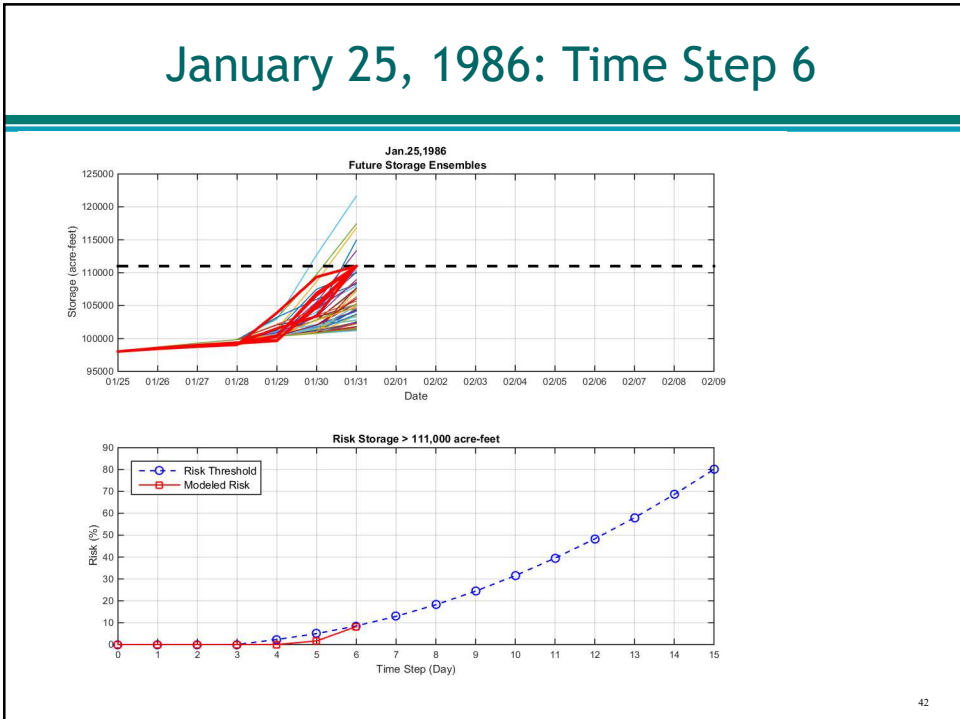
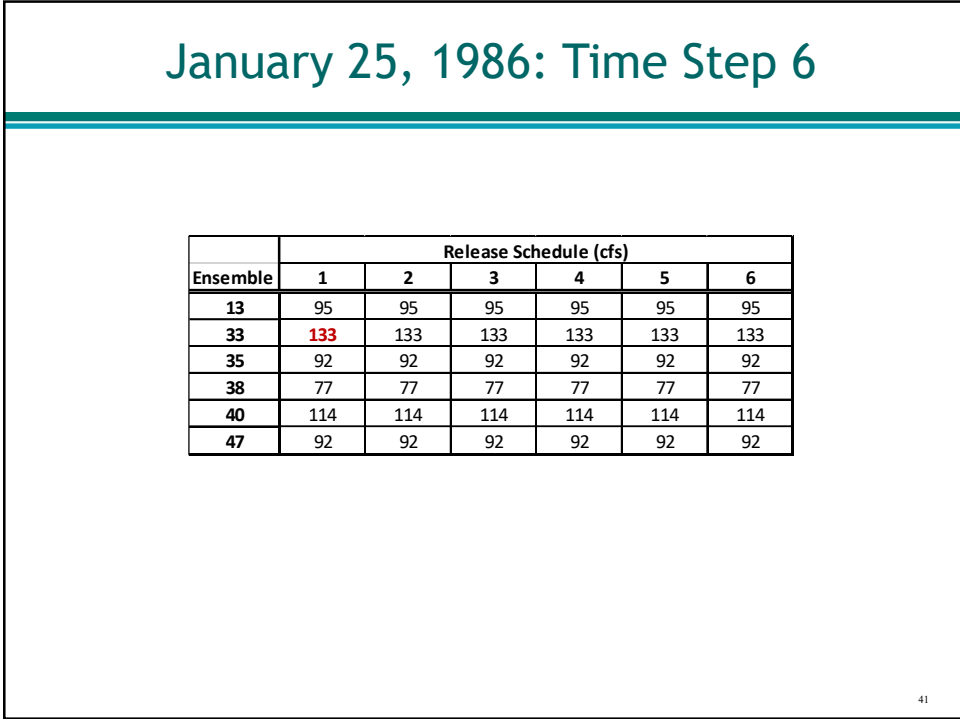
Future Release Schedules calculated for each ensemble member:

- Total release volume = future storage – 111K af
- Initial release:
 - Release per day = Total volume / # days future

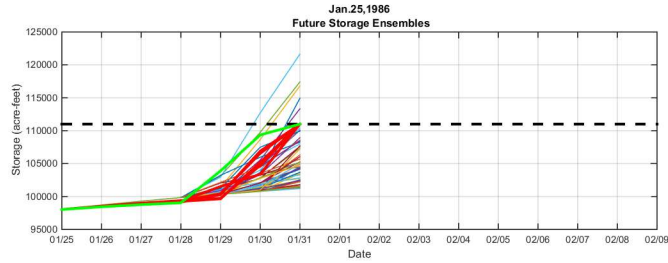
Releases adjusted:

- Max allowable release:
 - No flood release if Hopland flow > 8000 cfs
 - Physical constraints of the controlled outlet
- Redistributed Release:
 - If initial release > max allowable release:
 - Excess released the next earlier day



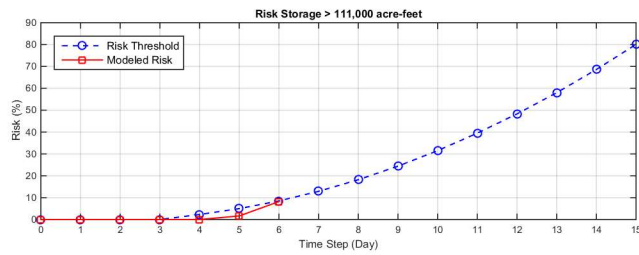


January 25, 1986: Time Step 6



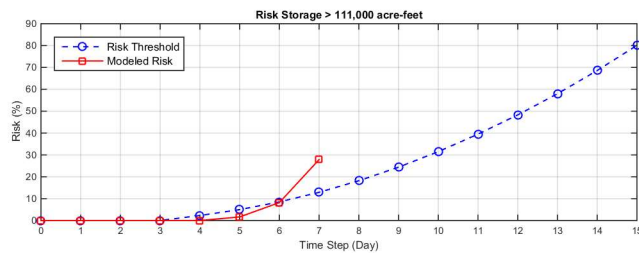
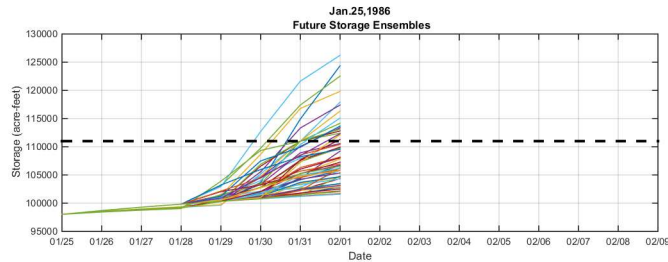
Possible Releases

Time Step	Release (cfs)
1	0
2	0
3	0
4	0
5	0
6	133



43

January 25, 1986: Time Step 7



44

