

Pitfalls of Forecasting Water- Year Type Classification in New Hydropower Licenses

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Water Management
Pacific Gas & Electric Co.
71st Western Snow Conference

Hydro Project Relicensing

- License is for 30 years, from FERC
- PG&E has 26 licenses
- 3 years to renew, millions of \$\$
- Studies include aquatic & terrestrial habitat, geomorphology, water quality & temp, TES, historic/cultural, socioeconomic,
- 1000's of hours of meetings with



**MOKELUMNE
HYDROELECTRIC PROJECT**
OWNED AND OPERATED BY
PACIFIC GAS AND ELECTRIC CO.

UNDER FEDERAL ENERGY REGULATORY
COMMISSION LICENSE NO. 137 CALIF.

ADDITIONAL PROJECT INFORMATION
AT PG&E OFFICE 650 "O" STREET
FRESNO, CALIFORNIA 93760

PUBLIC LANDS ADMINISTERED BY
FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE



P·G·E·



RECREATION FACILITIES ARE OPEN TO
THE PUBLIC WITHOUT DISCRIMINATION













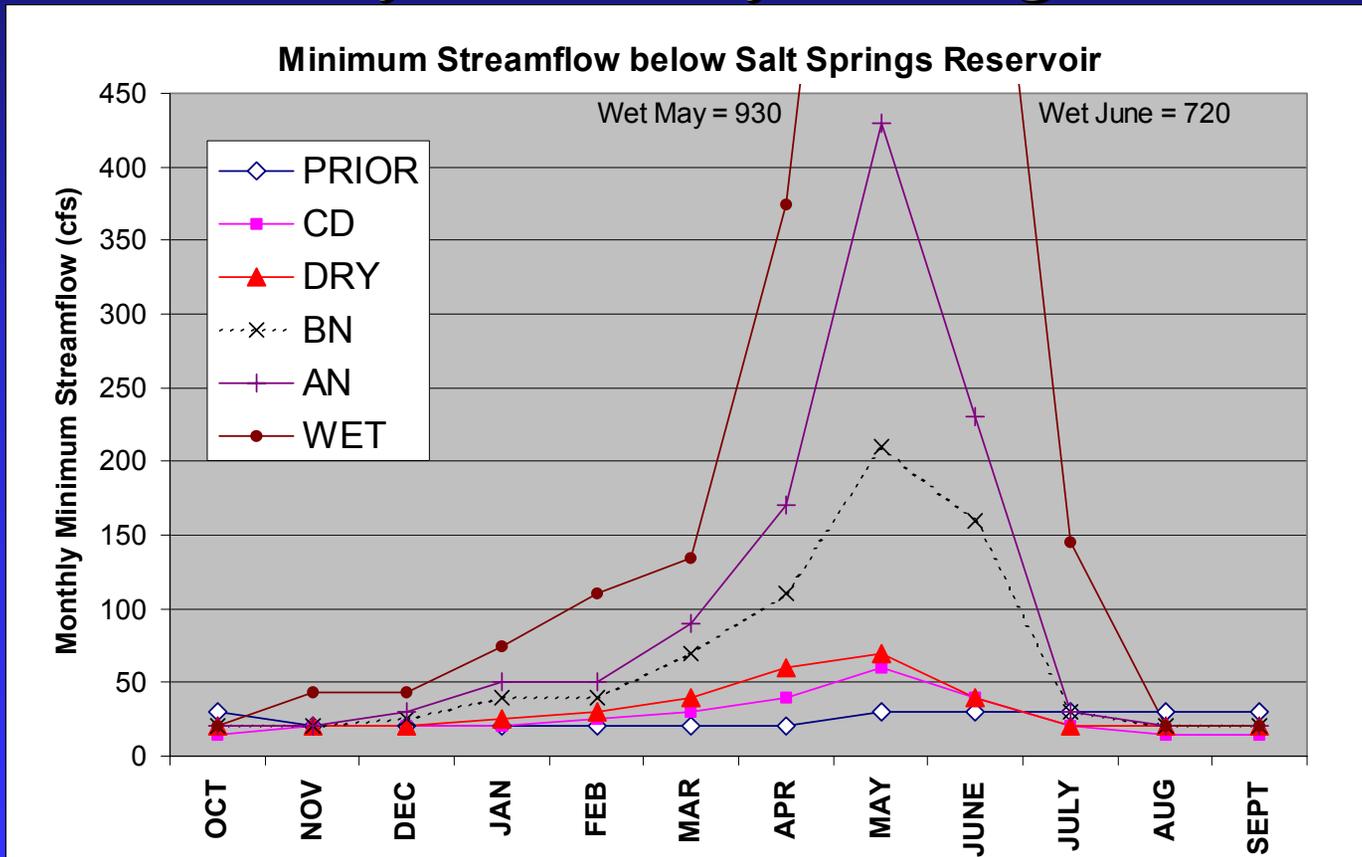
INDIAN HILL ELECTRIC COMPANY

INDIAN HILL POWER HOUSE



Relicensing Products

- Key outcome is streamflow regime
- Mimic shape of natural hydrograph
- Variability in water-year magnitudes



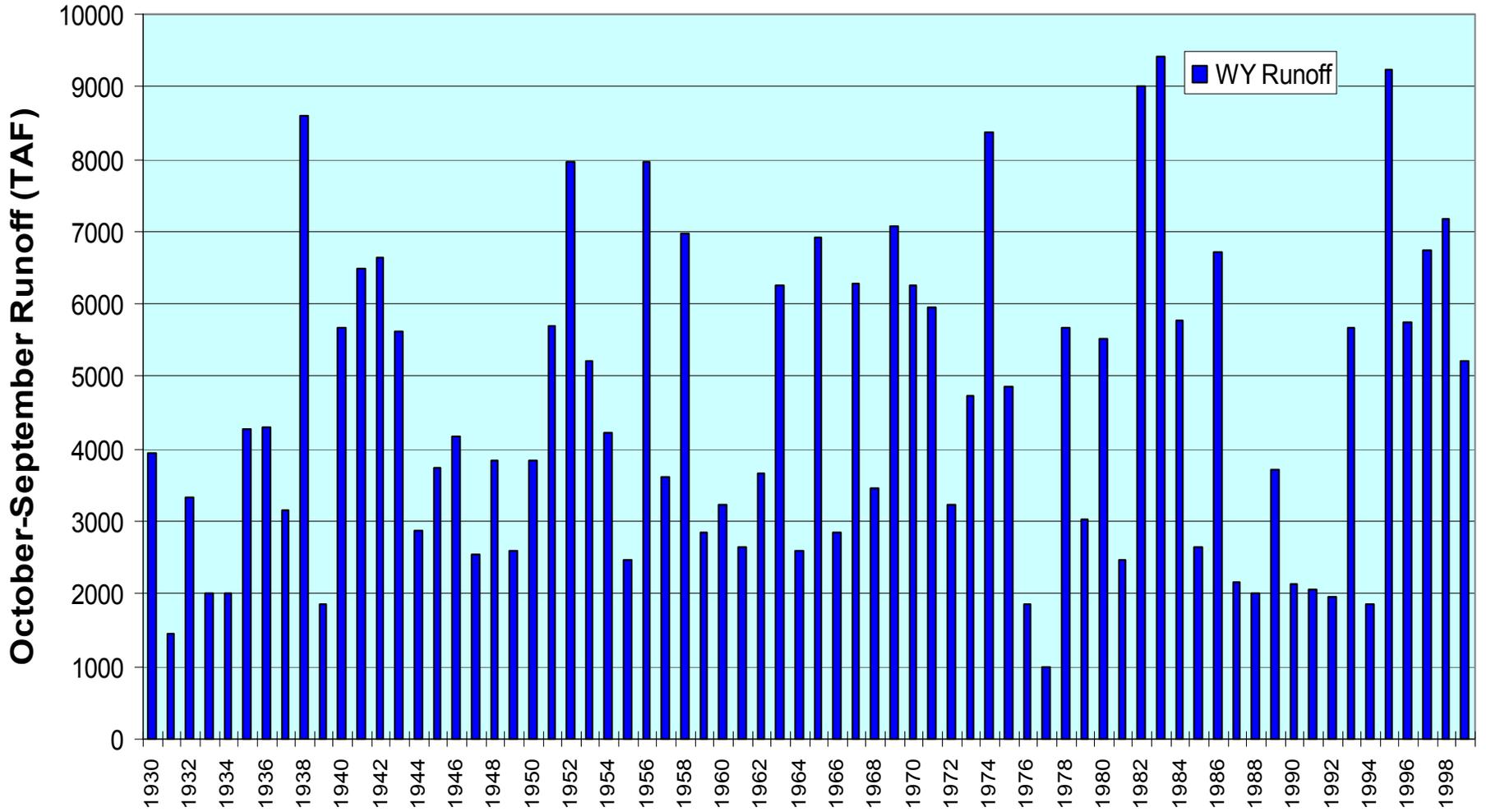
Water-Year Types – Variability!

- Mediterranean climate variability is **large!**
 - ◆ RO for Mokelumne, 1977 = 129 TAF, for 1983 = 1,800 TAF :: 14-fold difference
 - ◆ Precipitation, same years: 15.7” to 81.1”
 - ◆ An annual max. at a streamflow site, same yrs: 40 cfs to 6,000 cfs

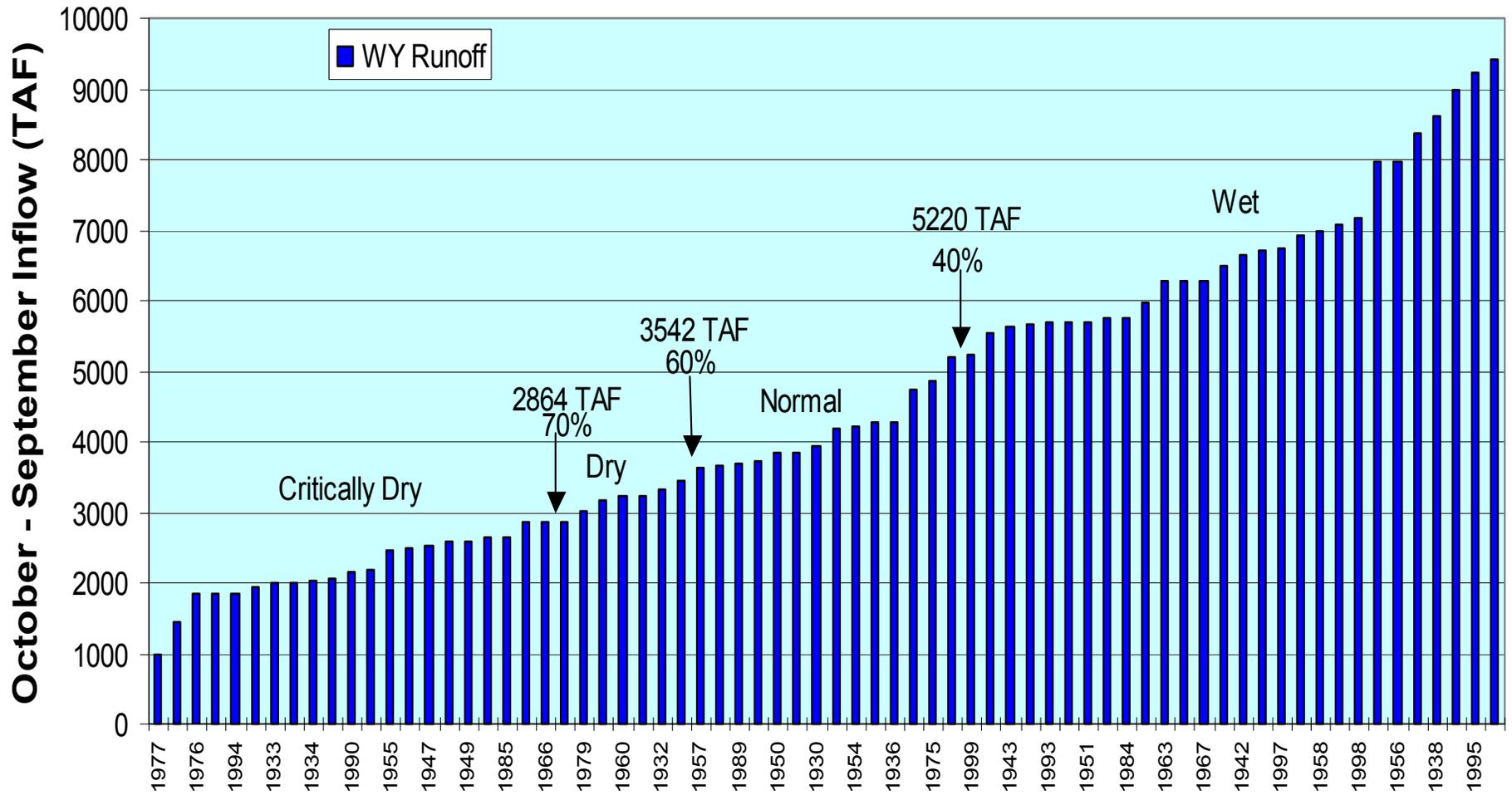
Typical WY Type Definition

- Select relevant downstream forecast point
- Rank historic inflow magnitudes – annual or AJRO
- Subdivide into WY Types
- Use forecasts as spring proceeds to set type, works in snow-dominated systems
- Adjusts flow regime to precipitation & RO, mimics shape of natural hydrograph

Feather River Inflows to Oroville, 1930-1999



Ranked Annual Inflows to Oroville, 1930-99



How Many WY Types?

- In systems with reservoirs that spill in most years, simple SPILL/NO SPILL might work
- In systems with complex fish habitat or recreation needs, maybe three -five types
- Monthly flow regime magnitude changes based on WY Type
- Increased compliance complexity with more types: # types X # of reaches X # months









Monthly Analysis - February

Mokelumne River at Pardee WY2003

DWR Unimpaired Flow (TAF)						DWR Forecasted Flow (TAF)							
OCT	NOV	DEC	JAN		FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total
1.2	17.6	25.3	37.0		45	80	140	180	70	10	4	1	610
DWR April-July Forecast, as of Feb. 1, 2003 = 400 TAF (85% of mean)													
PG&E April-July Forecast, as of Feb. 1, 2003 = 474 TAF (105% of mean)													
bjmcgurk 030212													

Water-Year Breakpoints

Mokelumne River Water Year Cutoffs, as per the Settlement Agreement

Category	DWR@Moke Hill (TAF)	Exceedence	
Crit. Dry	<376	<80%	
Dry	376.1-518	81-65%	Forecast
Below Normal	518.1-724.3	66-50%	610 TAF
Above Normal	724.4-958.6	51-30%	
Wet	>958.7	<30%	
Conclusion: BELOW NORMAL Water Year, as of February 2003			
bjmcgurk 030212			

Monthly Analysis - March

Mokelumne River at Pardee WY2003

Unimpaired Flow (TAF)						Forecasted Flow (TAF)								
OCT	NOV	DEC	JAN	FEB		MAR	APR	MAY	JUN	JUL	AUG	SEP	Total	
1	18	25	37	35		60	120	150	50	10	3	2	510	DWR
1	18	25	38	34		64	86	124	55	8	4	3	460	PG&E

DWR April-July Forecast, as of Mar. 1, 2003 = 330 TAF (71% of mean)

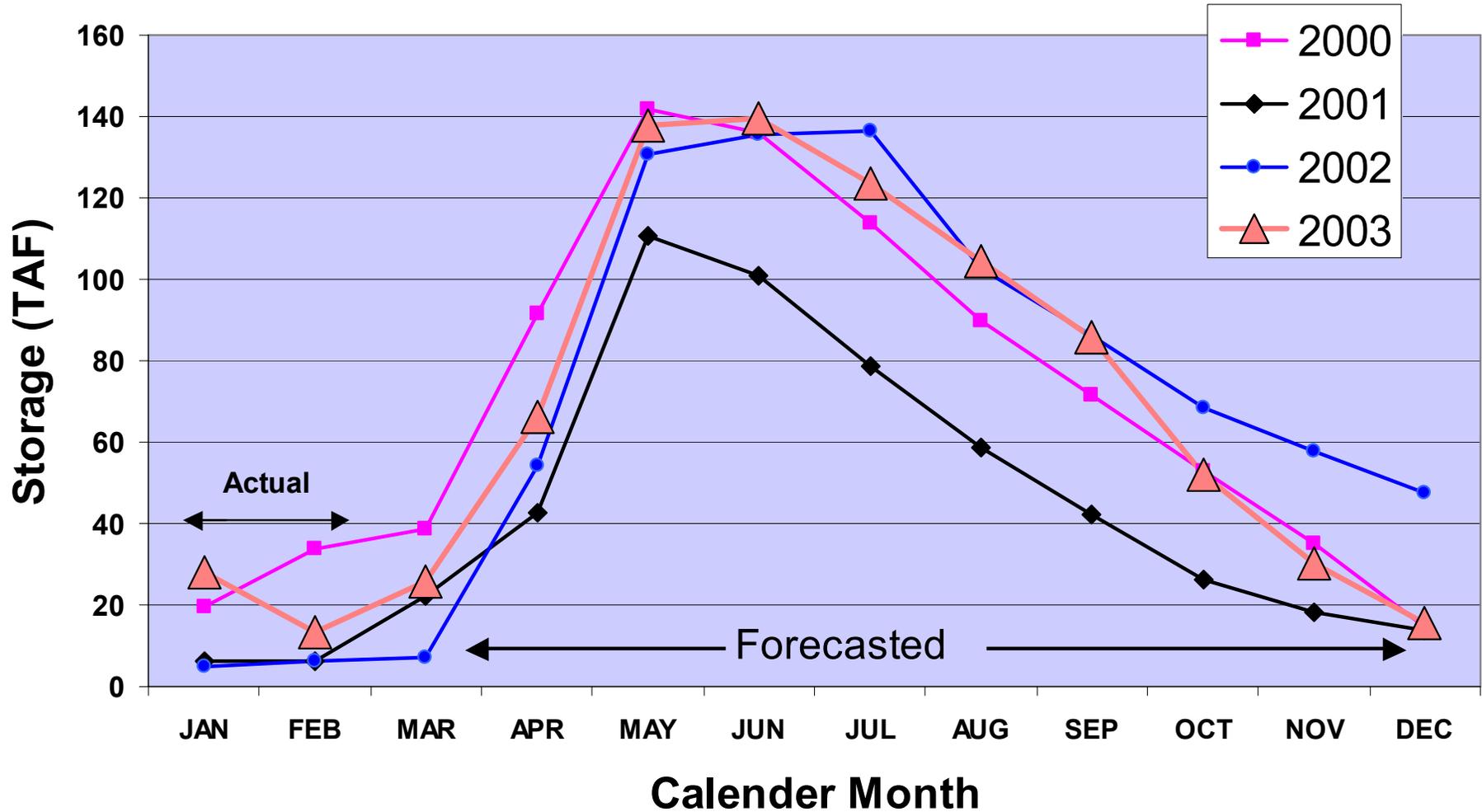
PG&E April-July Forecast, as of Mar. 1, 2003 = 273 TAF (61% of mean)

Water-Year Breakpoints

Mokelumne River Water Year Cutoffs, as per the Settlement Agreement

Category	DWR@Moke Hill (TAF)	Exceedence		
Crit. Dry	<376	<80%		
Dry	376.1-518	81-65%		Forecast
Below Normal	518.1-724.3	66-50%		510 TAF
Above Normal	724.4-958.6	51-30%		
Wet	>958.7	<30%		
Conclusion: DRY Water Year, as of March 2003				
bjmcgurk 030319				

Salt Springs EOM Storage



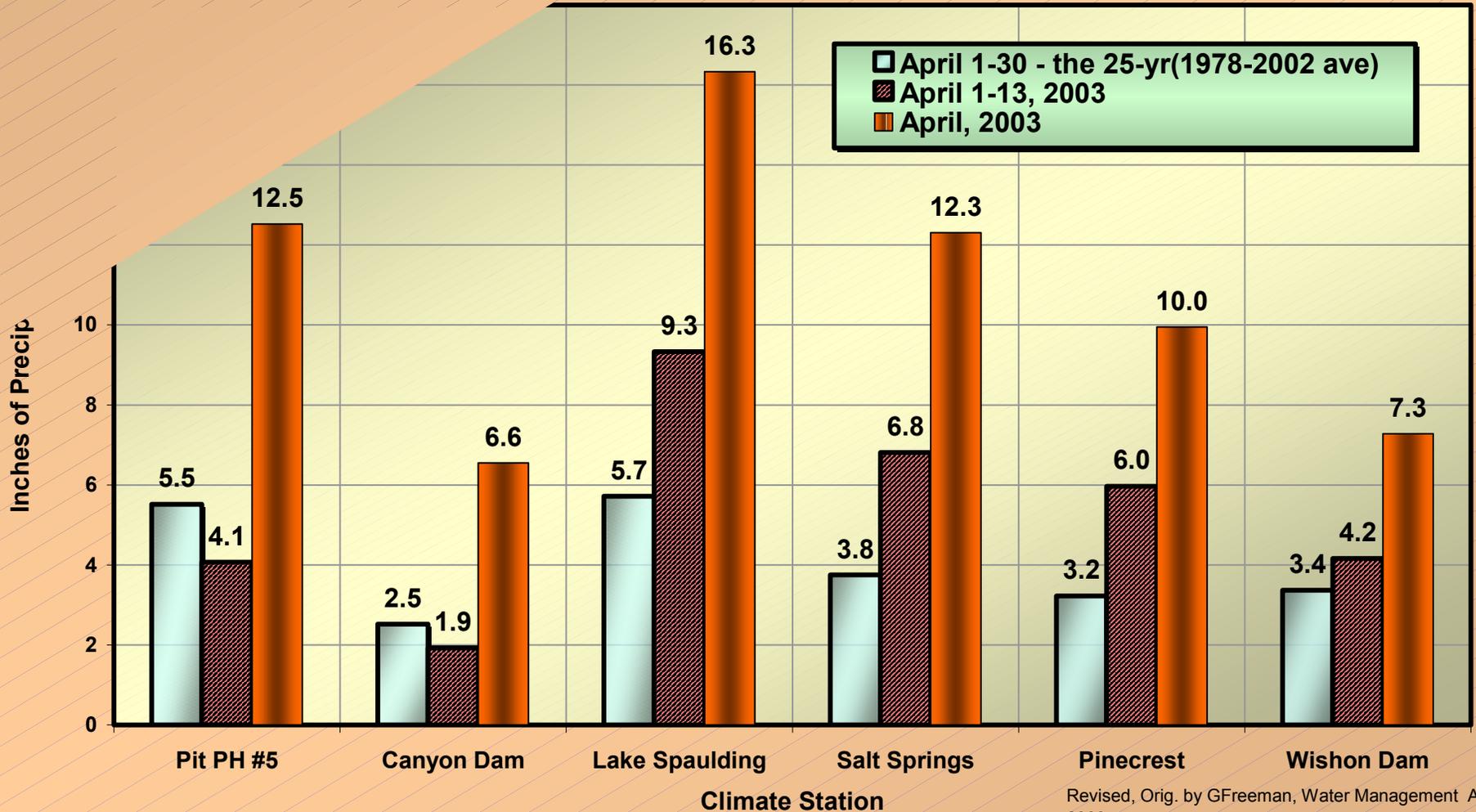
Forecasts Produce Plans

- Boating flows got canceled – web posting
- Biological surveys were deferred
- Construction got planned



April 2003 Rains!

(1978-2002) for full month of April compared with
and the full month of precipitation, April 2003



Monthly Analysis - May

Mokelumne River at Pardee WY2003

DWR Unimpaired Flow (TAF)							DWR Forecasted Flow (TAF)					
OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total
1	18	25	37	35	50	100	180	140	20	4	1	625
											81% of normal	

DWR April-July Forecast, as of May. 1, 2003 = 450 TAF (96% of mean)

PG&E April-July Forecast, as of May. 1, 2003 = 450 TAF (101% of mean)

Water-Year Breakpoints

Category	DWR@Moke Hill (TAF)	Exceedence	
Crit. Dry	<376	<80%	
Dry	376.1-518	81-65%	Forecast
Below Normal	518.1-724.3	66-50%	625 TAF
Above Normal	724.4-958.6	51-30%	
Wet	>958.7	<30%	

Conclusion: BELOW NORMAL Water Year, as of MAY 2003

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Forecasts Revise Plans

- Boating flows rescheduled
- Biologists scrambled to schedule field work
- Operations shifted to accommodate monitoring
- Spill planning/public safety issues





May 1 Forecast is Final

- In 2002, forecasts dropped Jan. – May
- May forecast, Feather R. = Below Normal

Rock Creek/Cresta Water Year Cutoffs, as per the License					
Category	DWR@Lake Oroville		Exceedence		
		(TAF)			
Crit. Dry		<2505		<80%	
Dry		2505-3228		81-65%	Forecast
Normal		3228-5679		64-35%	3300 TAF
Wet		>5679		<35%	
Conclusion: BELOW NORMAL Water Year, as of May, 2002					
bjmcgurk 020510					

May 14 Update and Cost

- May 14 forecast update dropped 75 TAF
- Water Year shifted to DRY
- Minimum streamflow remained 30-50 cfs higher than was appropriate for next 9 months
- 19.6 TAF extra allocated to streamflow
- Foregone generation.... \$\$\$\$\$\$

CCSS Forecasts & Hydro

- Water-Year Typing is being included in most new 30-year licenses
- WY Types now integral in Rock-Creek Cresta, Mokelumne, Big Creek
- WY Types will be integral in Poe, Upper N. Fork Feather, Stanislaus/Tri-Dam, and Upper American River

Conclusions

- WY Type forecasting a key part of hydro
- If possible, improvements needed in field equipment, technology, and in analysis
- Changes in WY type have costs
- Hydro operations have joined irrigation planning and water supply
- Forecasts and forecast accuracy becoming increasingly important

