New Hydrologic Forecasts for CalSim 3

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Focus for Today

- Background
  - CalSim 3 Streamflow Forecast Needs
  - DWR B120 Forecast
  - Existing Flow Forecast for CalSim 2&3
  - New Flow Forecast for CalSim 3
- Forecast Development Example
  - Seasonal Flow Forecast
  - Monthly Flow Forecast
- Comparison with B120 Forecast
  - Monthly Flow Comparison

CalSim 3 Streamflow Forecast Needs

- Forecasted monthly inflows at major river locations required by forecast-based allocations and operations in CalSim 3
- DWR Bulletin 120 (B120) or statistically equivalent forecasts
- Forecast for the entire model simulation period of WY 1922-2021
- Monthly forecasts made on the fly for sequential model run and position analysis

DWR B120 Forecast

- Median monthly flow forecasts available from WY 1969
- Other exceedance flow forecast available from WY 1999
- Hybrid forecast method
  - Statistical + Engineering judgement and manual adjustment
  - Forecast methods have been evolving over time
- Data used in the forecast
  - Precipitation, snowpack, historical unimpaired flow records, and other basin information

Existing Flow Forecast for CalSim 2&3

- Monthly flow forecasts were developed at all 11 major locations in 2003 using the historical data up to WY 2001.
- Only historical unimpaired flows and precipitation were used for the forecast development. The unimpaired flows and precipitation were the only data went back to WY 1922 at the time.
- Statistical method only
- Forecast DLL to automate the forecasts on the fly
- Forecasts were extended to WY 2015 without updating forecast equations.

New Flow Forecast for CalSim 3

- Monthly flow forecast at all 11 major locations for WY 1922-2021.
- Forecasts were developed based on the unimpaired flows, precipitation, vapor pressure deficit (VPD), and temperature for WY 1922-2021. The VPD and temperature recently became available from PRISM
- Statistical method only
- Forecasts statistically equivalent to B120
- Forecast DLL to automate the forecasts on the fly

Forecast Development Example

Seasonal Flow Forecast

Oroville February-September Seasonal Forecast

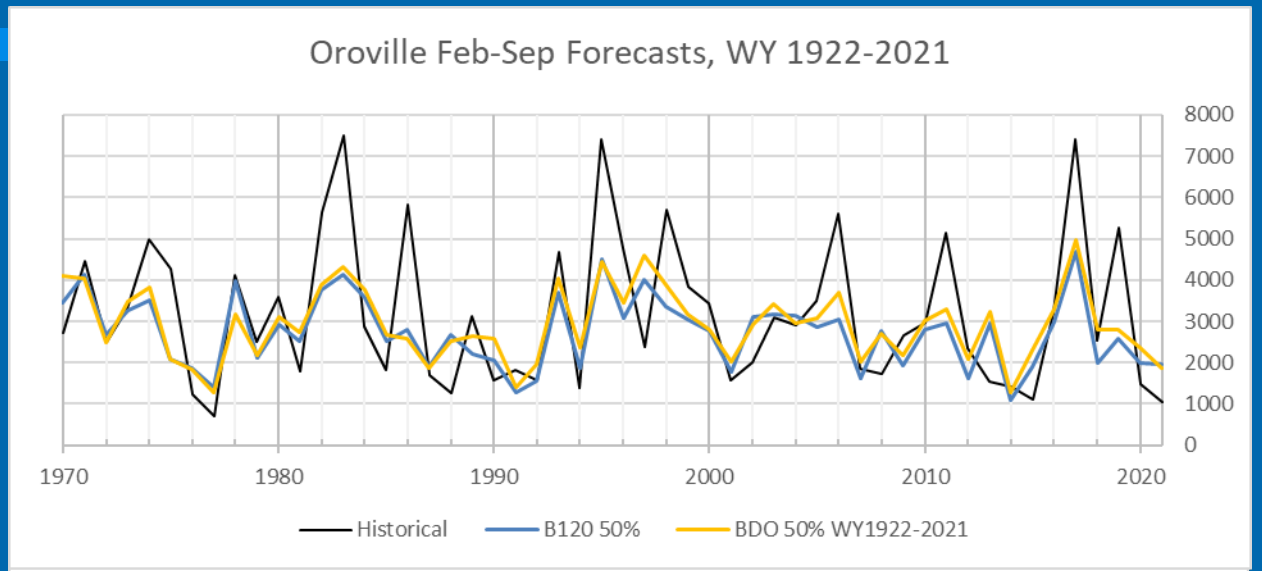
Source	SS	df	MS		
Model	4.7611328	3	1.58704427	Number of obs	= 97
Residual	.137315051	93	.001476506	F(3, 93)	= 1074.86
				Prob > F	= 0.0000
Total	4.89844785	96	.051025498	R-squared	= 0.9720
				Adj R-squared	= 0.9711
				Root MSE	= .03843

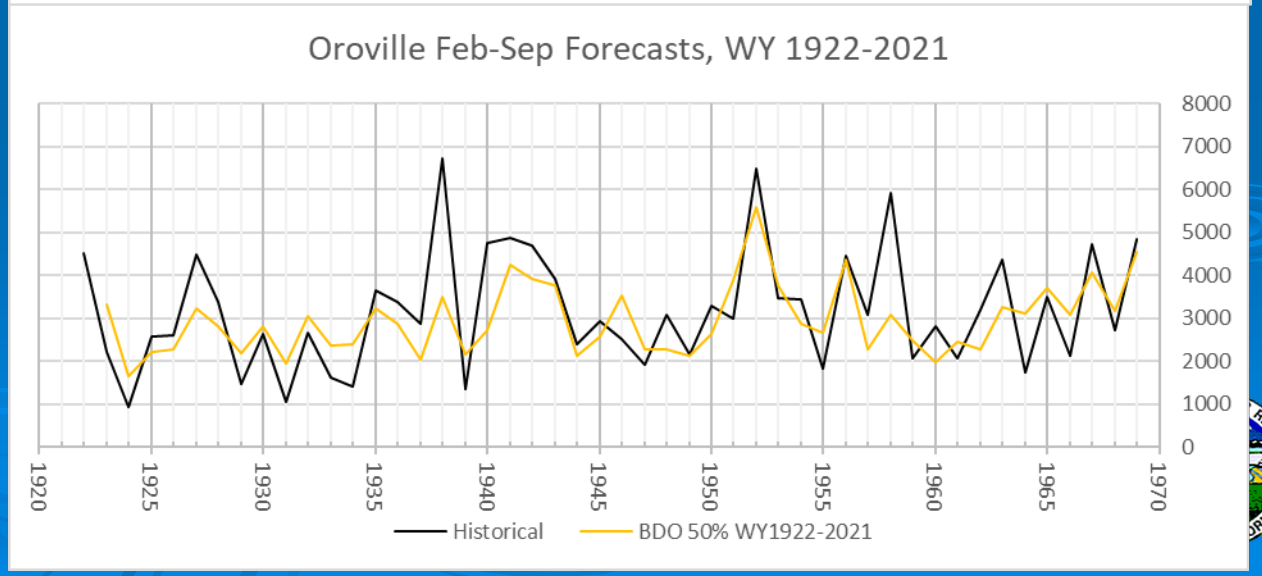
LgQ_ann	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LgQ_oct_jan	.0986253	.0222289	4.44	0.000	.0544831	.1427676
LgP_ann2	.1453565	.027851	5.22	0.000	.09005	.200663
LgP_ann	1.331292	.0431674	30.84	0.000	1.24557	1.417014
_cons	.905618	.0611465	14.81	0.000	.7841933	1.027043

$$P_{Ann} = P_{Oct\text{-}Jan} + P_{50\%,\ Feb\_Sep}$$

$$Q_{Feb\_Sep} = Q_{ann} - Q_{Oct\_Jan}$$

	All WY Types R^2	W R^2	BN&AN R^2	D&C R^2
B120 1970-2021	0.54	0.11	0.69	0.05
MSO 1970-2021	0.52	0.04	0.66	0.12
MSO 1922-1969	0.50	0.07	0.02	0.12
MSO 1922-2021	0.51	0.04	0.10	0.13
B120 1992-2021	0.56	0.18	0.66	0.04
MSO 1992-2021	0.58	0.08	0.70	0.04





Oroville March-September Seasonal Forecast

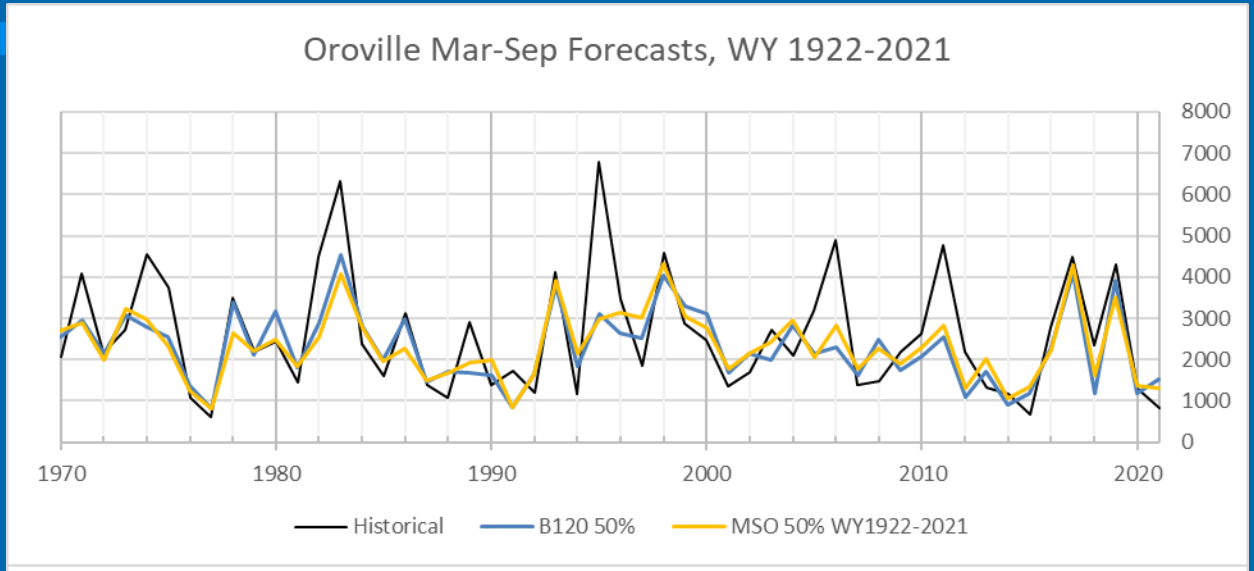
Source	SS	df	MS		
Model	4.79133447	7	.684476353	Number of obs =	97
Residual	.107113382	89	.001203521	F(7, 89) =	568.73
				Prob > F =	0.0000
				R-squared =	0.9781
				Adj R-squared =	0.9764
Total	4.89844785	96	.051025498	Root MSE =	.03469

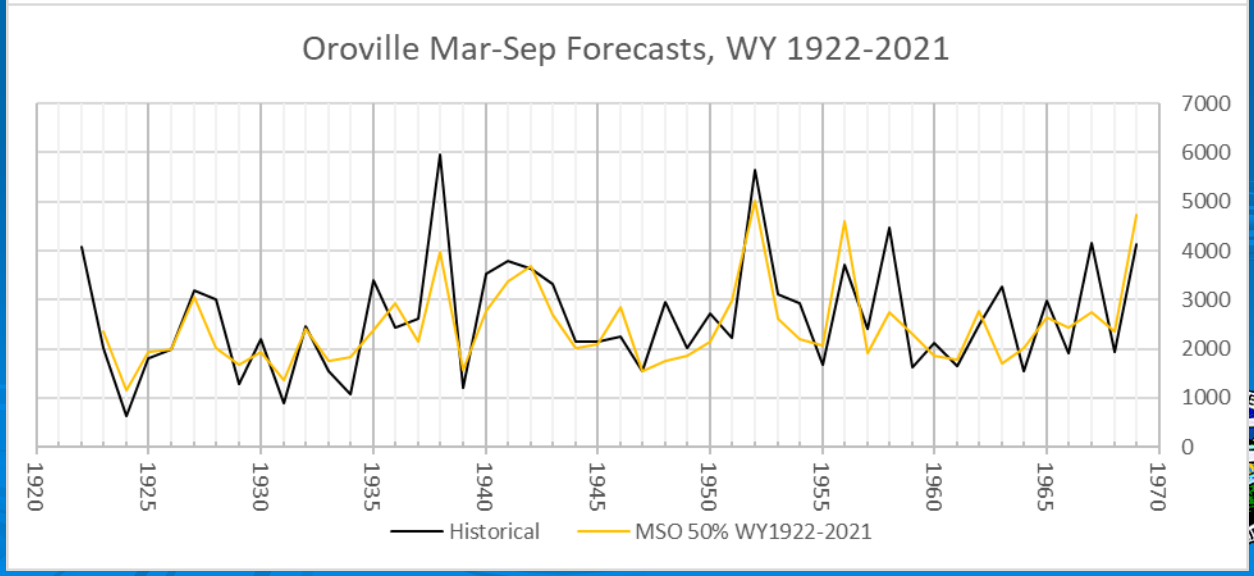
LgQ_ann	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LgP_ann2	.1139394	.0274536	4.15	0.000	.0593896	.1684892
LgP_oct_feb	-.2045681	.0735161	-2.78	0.007	-.350643	-.0584932
LgQ_oct_feb	.2173415	.0418629	5.19	0.000	.1341609	.3005221
LgP_jan	.0312784	.0113212	2.76	0.007	.0087833	.0537734
LgP_ann	1.28809	.0570352	22.58	0.000	1.174762	1.401417
LgVPD_dec	-.0967291	.0300174	-3.22	0.002	-.156373	-.0370852
LgT_feb	-.370126	.1246917	-2.97	0.004	-.6178858	-.1223662
_cons	1.524595	.196824	7.75	0.000	1.13351	1.91568

$P_{Ann} = P_{Oct\text{-}Feb} + P_{50\%,\ Mar\_Sep}$

$Q_{Mar\_Sep} = Q_{ann} - Q_{Oct\_Feb}$

	All WY Types R^2	W R^2	BN&AN R^2	D&C R^2
B120 1970-2021	0.57	0.20	0.32	0.12
MSO 1970-2021	0.58	0.14	0.35	0.19
MSO 1922-1969	0.62	0.34	0.01	0.69
MSO 1922-2021	0.58	0.18	0.10	0.35
B120 1992-2021	0.50	0.03	0.35	0.24
MSO 1992-2021	0.54	0.00	0.41	0.31

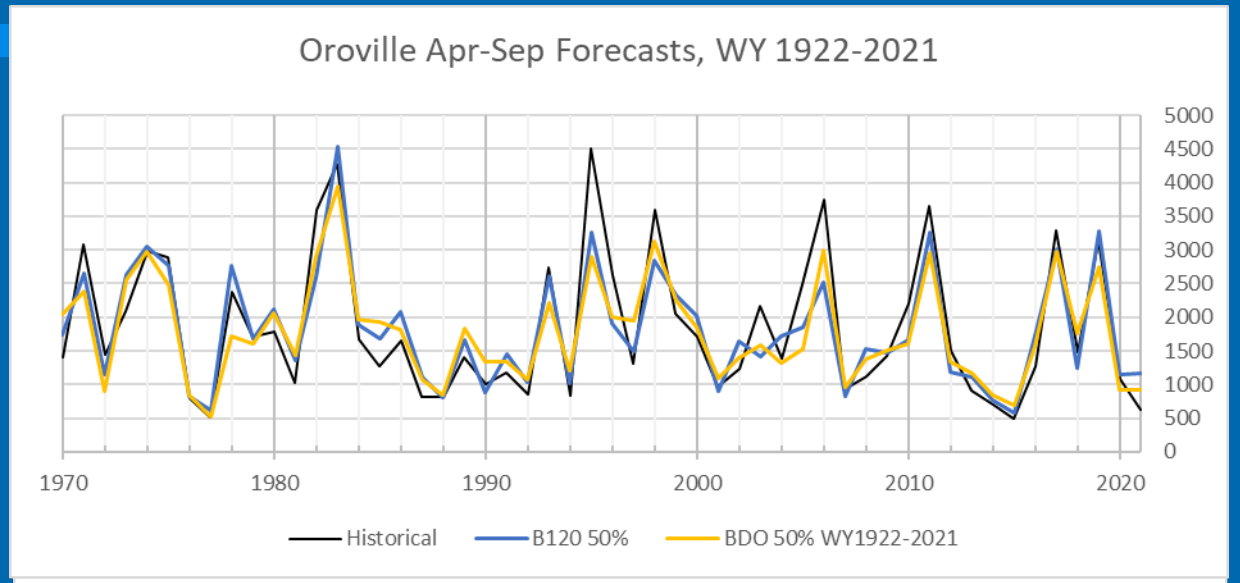


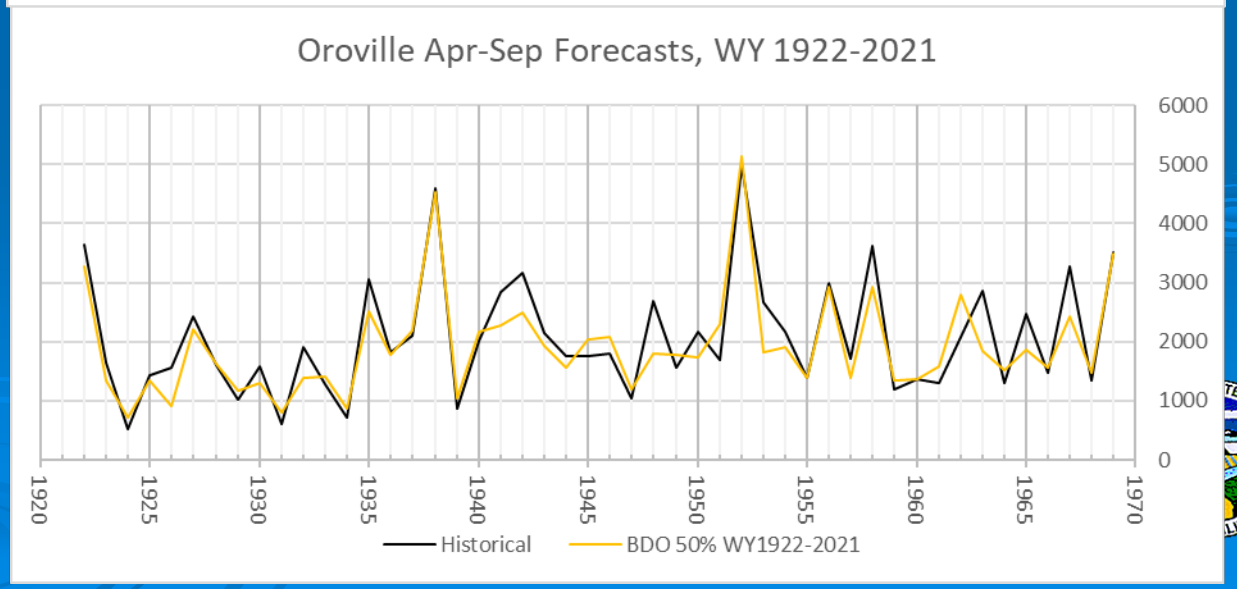


Oroville April-September Seasonal Forecast

Source	SS	df	MS		
Model	4.81342364	5	.962684728	Number of obs =	97
Residual	.423653914	91	.004655538	F(5, 91) =	206.78
Total	5.23707755	96	.054552891	Prob > F =	0.0000
				R-squared =	0.9191
				Adj R-squared =	0.9147
				Root MSE =	.06823

LgQ_apr_sep	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LgP_ann	2.017243	.1442639	13.98	0.000	1.73068	2.303805
LgT_mar	-1.26712	.2042117	-6.20	0.000	-1.672761	-.8614784
LgT_feb	-.6785365	.2074544	-3.27	0.002	-1.090619	-.2664538
LgQ_oct_mar	-.4522716	.0849062	-5.33	0.000	-.6209273	-.2836159
LgQ_ann_1	.1388111	.0352378	3.94	0.000	.0688156	.2088066
_cons	4.033981	.4920631	8.20	0.000	3.056558	5.011404





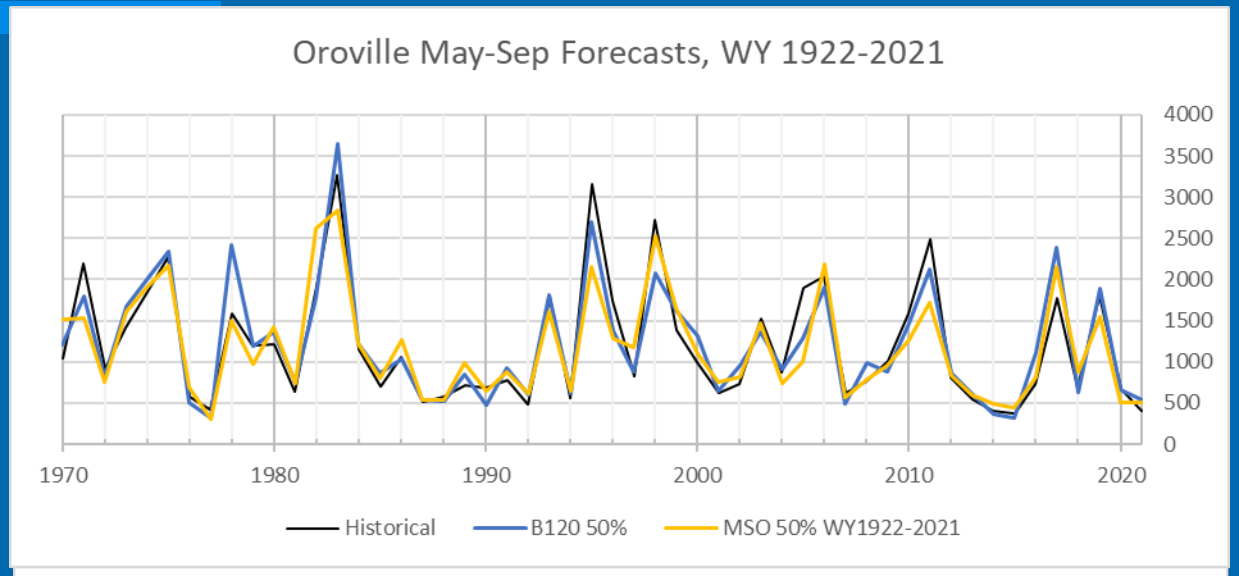
	All WY Types R^2	W R^2	BN&AN R^2	D&C R^2
B120 1970-2021	0.83	0.68	0.40	0.73
MSO 1970-2021	0.83	0.75	0.23	0.76
MSO 1922-1969	0.84	0.90	0.57	0.53
MSO 1922-2021	0.83	0.71	0.44	0.56
B120 1992-2021	0.84	0.66	0.35	0.64
MSO 1992-2021	0.87	0.72	0.29	0.72

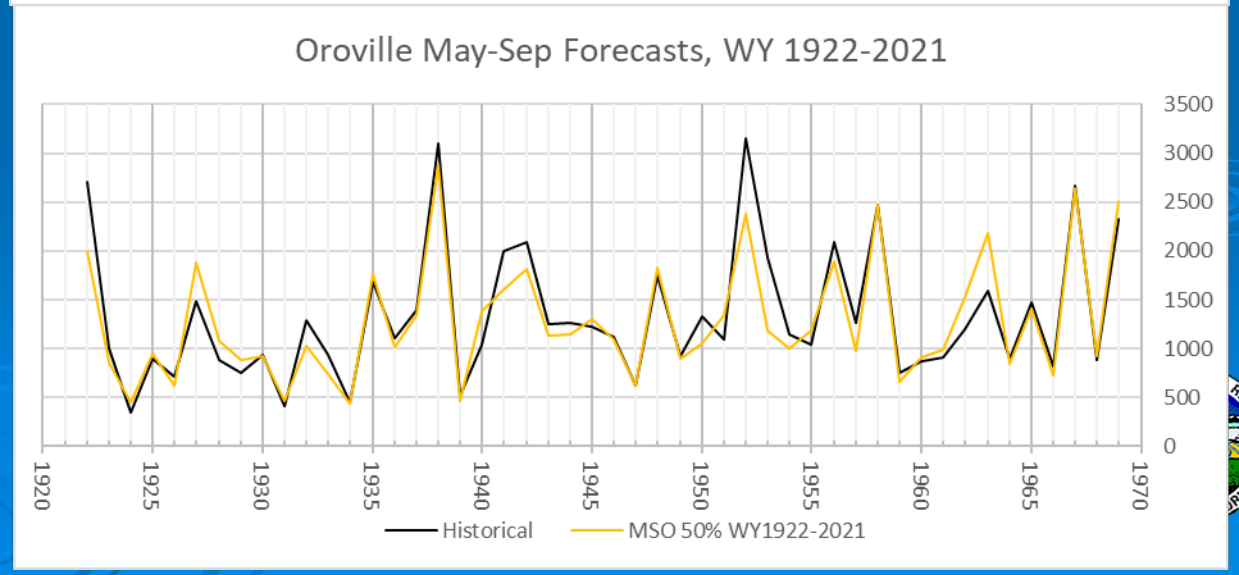
Oroville May-September Seasonal Forecast

Source	SS	df	MS		
Model	4.89160349	4	1.22290087	Number of obs =	97
Residual	.558209625	92	.006067496	F(4, 92) =	201.55
				Prob > F =	0.0000
				R-squared =	0.8976
				Adj R-squared =	0.8931
Total	5.44981312	96	.056768887	Root MSE =	.07789

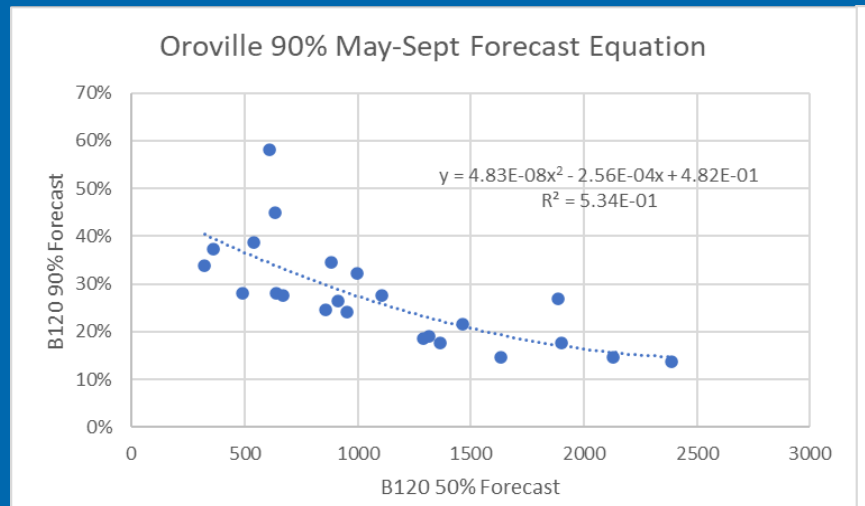
LgQ_may_sep	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LgT_apr	-1.774594	.2506619	-7.08	0.000	-2.27243	-1.276758
LgP_ann	1.031163	.0618047	16.68	0.000	.9084138	1.153913
LgT_mar	-1.598979	.2185879	-7.32	0.000	-2.033114	-1.164845
LgVPD_feb	-.3039585	.0611304	-4.97	0.000	-.4253688	-.1825482
_cons	6.977278	.5190114	13.44	0.000	5.946476	8.008079

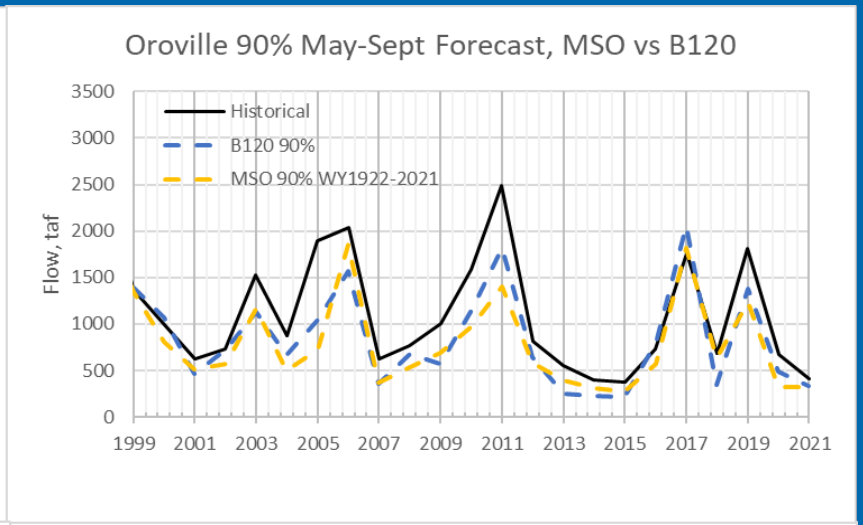
	All WY Types R^2	W R^2	BN&AN R^2	D&C R^2
B120 1970-2021	0.87	0.79	0.52	0.67
MSO 1970-2021	0.81	0.55	0.50	0.70
MSO 1922-1969	0.86	0.61	0.70	0.84
MSO 1922-2021	0.83	0.58	0.62	0.80
B120 1992-2021	0.87	0.69	0.66	0.69
MSO 1992-2021	0.81	0.50	0.55	0.76

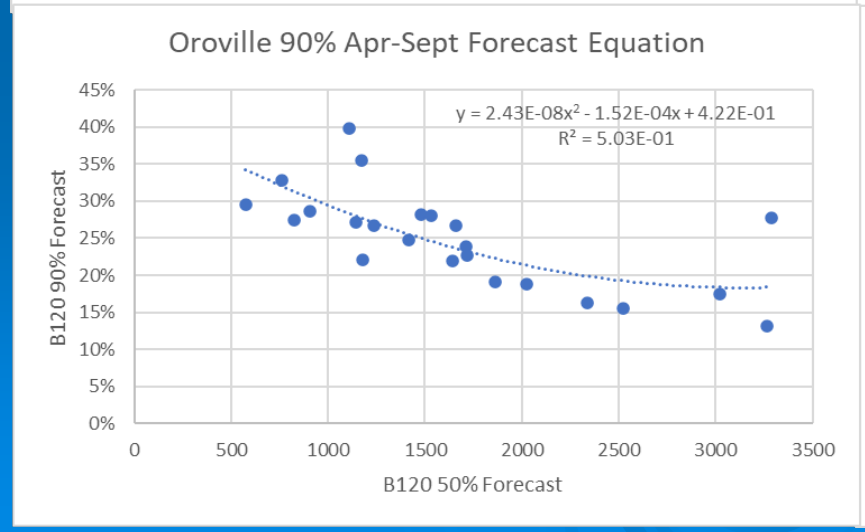


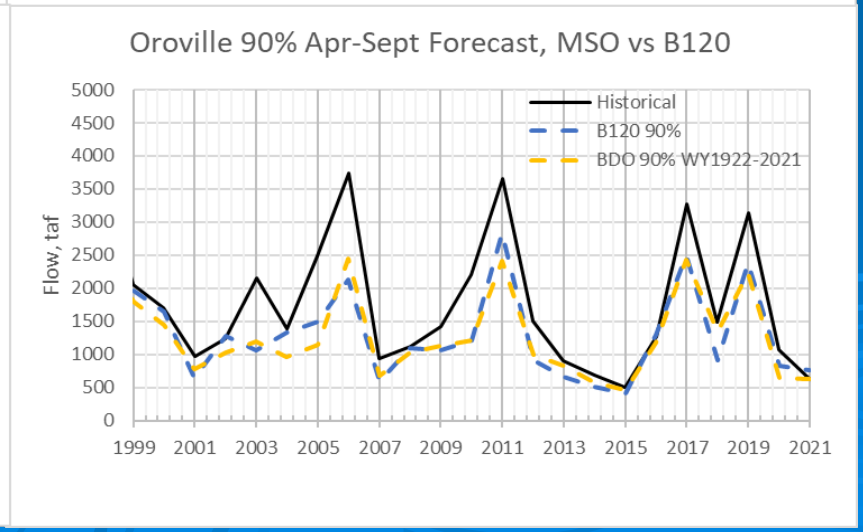


Seasonal Flow Forecast at Other Exceedance Levels









Seasonal Flow Forecast at Other Exceedance Levels

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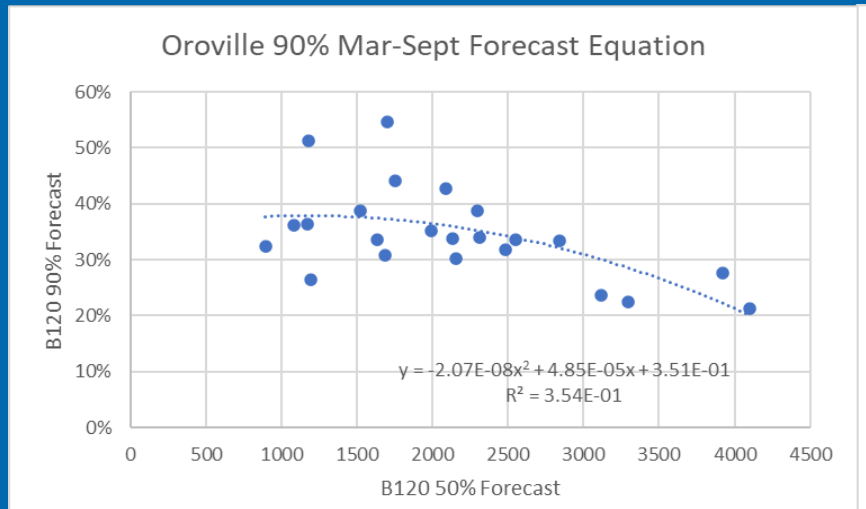

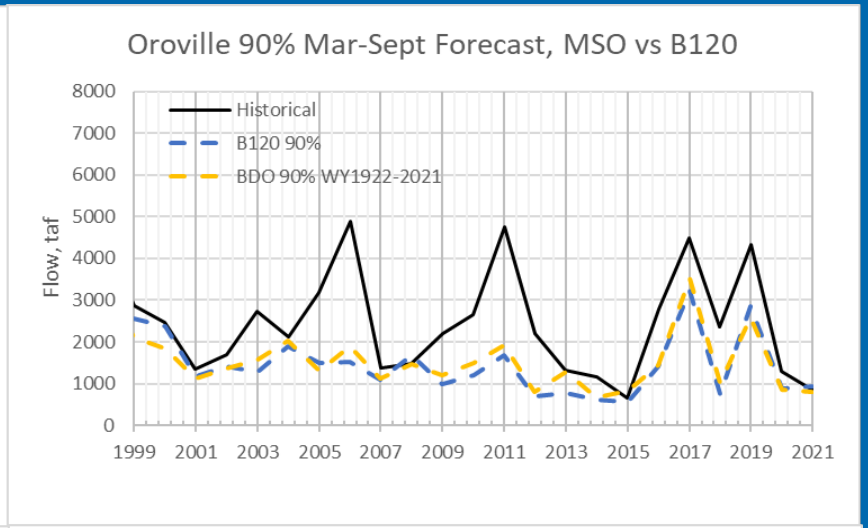

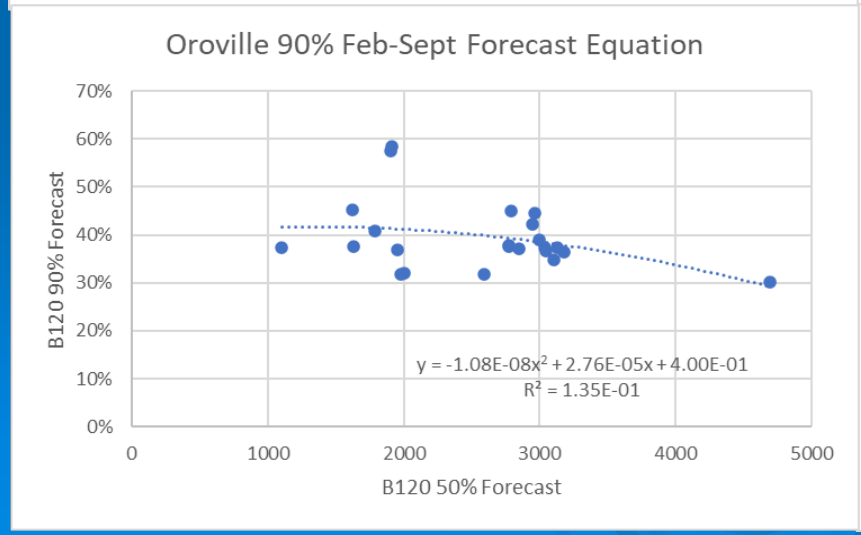

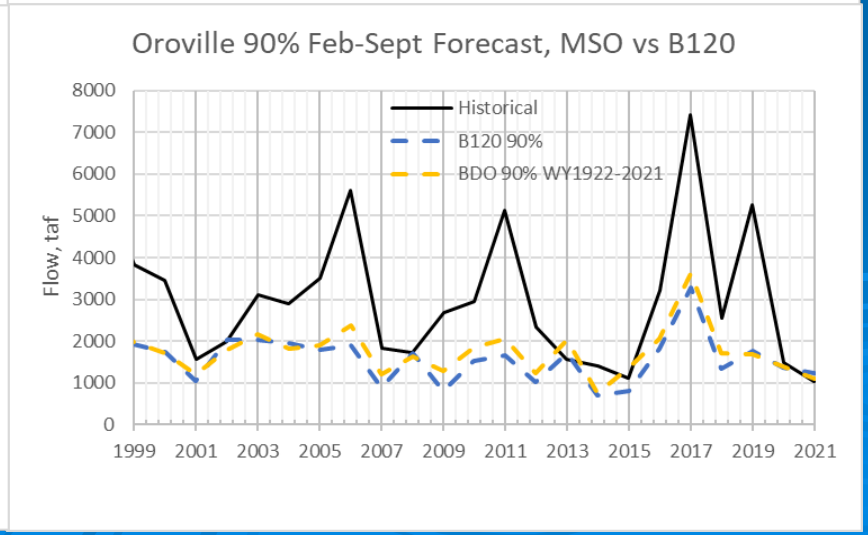

Forecast Development Example

Monthly Flow Forecast

Monthly Flow Disaggregation With Multivariate Regression

The form of multivariate regression is

$$\mathbf{Q}_{monthly} = \mathbf{B}Q_{seasonal} + \mathbf{e}$$

Where

$\mathbf{Q}_{monthly}$ is a *n*x1 matrix of monthly inflows;
$Q_{seasonal}$ is the seasonal total inflow;
B is a *n*x1 coefficient matrix;
e is a *n*x1 error matrix and E(**e**)=0;
n is the number of months in the season ending in September.

Comparison with B120 Forecast

Oroville Monthly Flow Forecast SSE Comparison
B120 vs. MSO

	Forecast Date	Source	February	March	April	May	June	July	August	September
B120: WY 1970-2021 MSO: WY 1970-2021	1-Feb	B120	478	463	309	299	208	64	62	76
		MSO	501	426	296	303	209	63	27	28
	1-Mar	B120		433	296	269	185	62	64	76
		MSO		421	289	278	191	59	27	29
	1-Apr	B120			234	195	137	43	68	76
		MSO			217	221	159	45	24	28
	1-May	B120				163	109	40	68	76
		MSO				188	141	43	28	31
B120: WY 1970-2021 MSO: WY 1922-2021	1-Feb	B120	478	463	309	299	208	64	62	76
		MSO	421	369	291	292	184	56	26	24
	1-Mar	B120		433	296	269	185	62	64	76
		MSO		365	279	264	170	52	27	25
	1-Apr	B120			234	195	137	43	68	76
		MSO			212	197	141	42	27	27
	1-May	B120				163	109	40	68	76
		MSO				163	121	40	29	29

Questions?