

California's Water Supply Forecasting

Water Education Foundation:
Challenges for Water Operations
February 23, 2016



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California Department of Water Resources



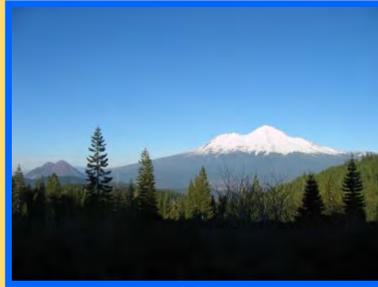
Background on Water Supply Forecasting Products

California's Snowpack and where Water Supply Forecasts are made

Central/Southern Sierra: Snow melt driven basins. Large variety in size of watersheds. Characterized by high elevations (up to 4270 m / 14000 ft.), upper elevations consist of large areas of exposed granite batholiths. Susceptible to snow melt floods in heavy snow pack years. Limited data above 3350 m/11000 ft. which can account for up to 15% of watershed.



You are here



Southern Cascades and Trinity: Mainly rainfall driven region with peak elevations around 3050 m/ 10000 ft. (other than Mt. Shasta and Mt. Lassen). Highly influenced by volcanic soils and some rain shadowed areas. Flood threats are driven by heavy precipitation events.



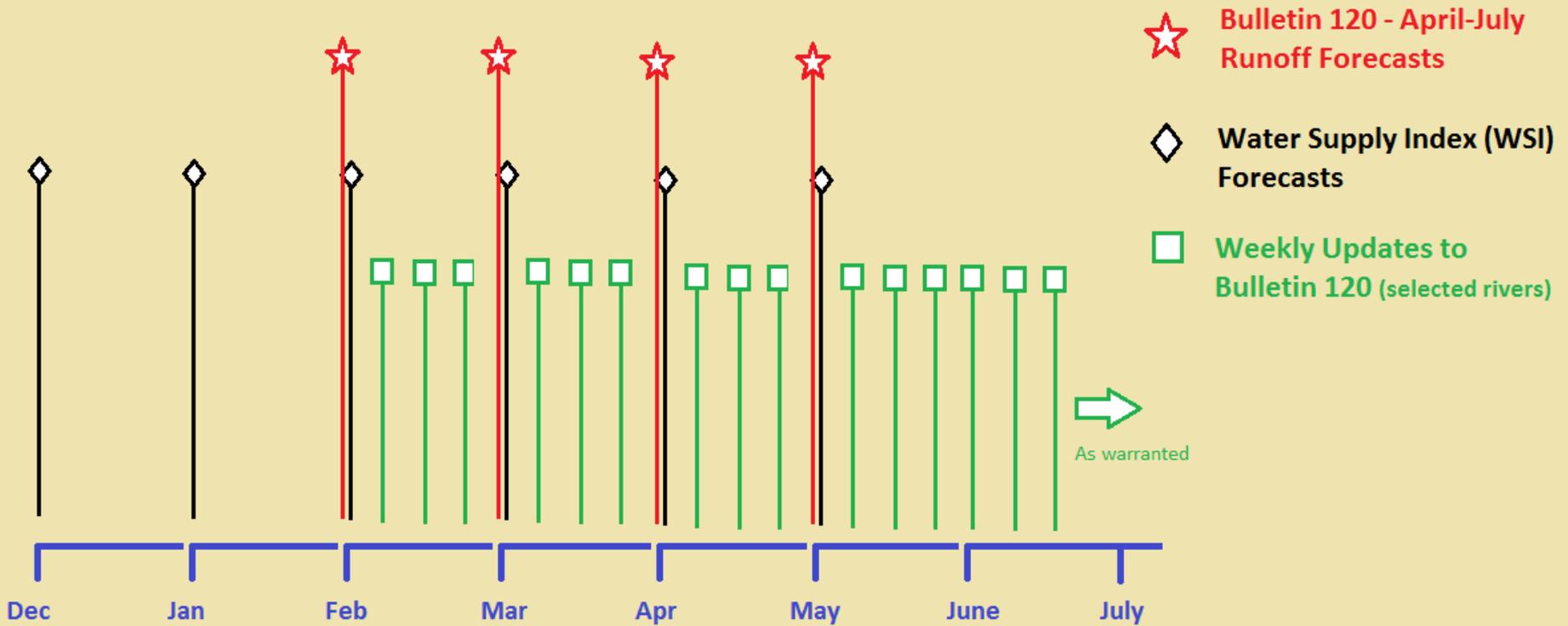
Northern Sierra: Rainfall driven region. Peak elevations top out at 3050-3350 m /10000-11000 ft. Heavy rainfall/snowfall events possible. Large area of upper Feather watershed sits in rain shadowed plateau. 1986 and 1997 extreme precipitation storms caused flooding downstream of this area.



Eastern Sierra/Owens River: High elevation, snow melt driven basins. Watersheds are in rain shadow from Sierra Nevada. Rivers drain to terminal sinks in Nevada desert. Gage data is extremely limited. Most susceptible to snow melt flood events.

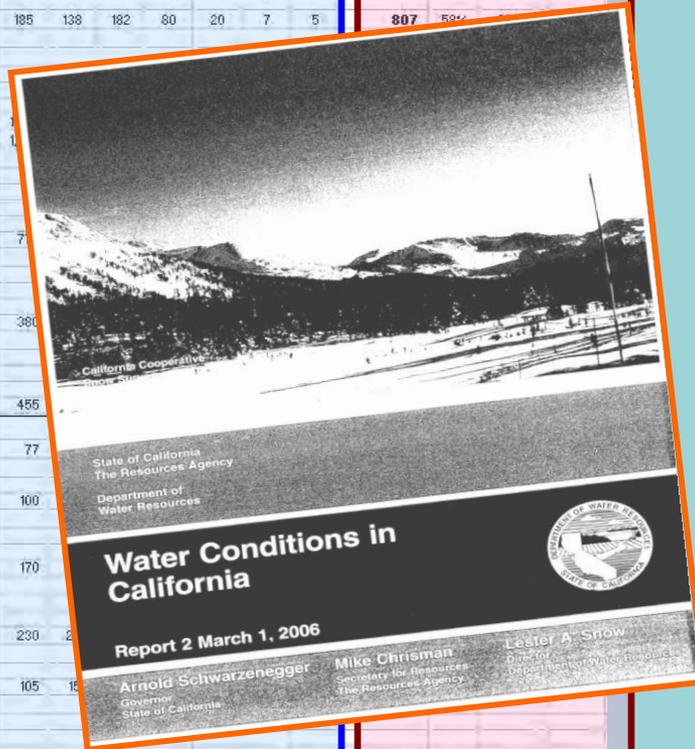
Bulletin 120 and Water Year Forecast Schedules

Annual Water Supply Forecast Schedule



Bulletin 120: Seasonal Runoff Forecasts

HYDROLOGIC REGION and Watershed	Unimpaired Runoff in 1,000 Acre-Feet (1)							Unimpaired Runoff in 1,000 Acre-Feet (1)											FORECAST			
	HISTORICAL		FORECAST					HISTORICAL		DISTRIBUTION									FORECAST			
	50 Yr Avg (2)	Max of Record	Min of Record	Apr-Jul Forecasts	Pct of Avg	80% Probability Range (1)	50 Yr Avg (2)	Max of Record	Min of Record	Oct Thru Jan*	Feb *	Mar *	Apr *	May	Jun	Jul	Aug	Sep	Water Year Forecasts	Pct of Avg	80% Probability Range (1)	
North Coast																						
Trinity River at Lewiston Lake (10)	654	1,593	8	420	64%	360 - 580	1,398	2,990	200	113	77	185	138	182	80	20	7	5	807	59%		
SACRAMENTO RIVER																						
Upper Sacramento River																						
Sacramento River at Delta above Shasta Lake	298	711	3	290	94%		887	1,965	165													
McCloud River above Shasta Lake	392	850	18	360	92%		1,217	2,353	55													
Pit River near Montgomery Creek - Squaw Creek	1,066	2,098	48	840	79%		3,159	5,150	1,488													
Total Inflow to Shasta Lake	1,919	3,525	72	1,600	88%	1,450 - 1,940	6,107	10,796	2,473	915	665											
Sacramento River above Bend Bridge, near Red Bluff	2,494	5,075	94	2,150	86%	1,890 - 2,600	8,907	17,180	3,294	1,215	1,035											
Feather River																						
Feather River at Lake Almanor near Prattville (3)	333	675	12	260	78%		780	1,269	366													
North Fork at Pulga (3)	1,028	2,416	24	770	75%		2,417	4,400	668													
Middle Fork near Cleo (4)	86	518	6	60	70%		219	637	24													
South Fork at Ponderosa Dam (3)	110	267	1	75	68%		291	562	32													
Feather River at Oroville	1,782	4,676	39	1,380	77%	1,150 - 1,720	4,620	9,492	894	475	475	7										
Yuba River																						
North Yuba below Goodyears Bar	279	647	5	240	86%		564	1,056	102													
Inflow to Jackson Mtns and Bowman Reservoirs (3)	112	236	2	95	85%		181	292	30													
South Yuba at Langs Crossing (3)	233	481	5	190	82%		379	565	98													
Yuba River near Smartsville plus Deer Creek	1,006	2,424	20	880	88%	760 - 1,010	2,373	4,926	368	205	230	380										
American River																						
North Fork at North Fork Dam (3)	282	716	4	210	80%		616	1,234	86													
Middle Fork near Auburn (3)	522	1,406	10	460	88%		1,070	2,675	144													
Silver Creek below Camanche Diversion Dam (3)	173	388	3	150	87%		318	705	53													
American River below Folsom Lake	1,240	3,074	22	1,110	90%	970 - 1,270	2,719	6,382	343	185	240	455										
SAN JOAQUIN RIVER																						
Cosumnes River at Michigan Bar	126	363		100	79%	75 - 135	390	1,253	20	18	34	77										
Mokelumne River																						
North Fork near West Point (5)	437	829	10	380	87%		626	1,009	193													
Total Inflow to Pardee Reservoir	461	1,065	10	430	93%	400 - 480	755	1,800	123	45	40	100										
Stanislaus River																						
Middle Fork below Beardsley Dam (3)	334	702	6	300	90%		471	929	88													
North Fork Inflow to McKays Point Dam (3)	224	503	3	200	89%																	
Stanislaus River below Goodwin Reservoir (7)	702	1,710	11	640	91%	570 - 720	1,171	2,952	159	95	75	170										
Tuolumne River																						
Cherry Creek & Eleanor Creek near Hetch Hetchy	315	727	9	290	92%		461	1,147	123													
Tuolumne River near Hetch Hetchy	604	1,392	15	560	93%		770	1,661	238													
Tuolumne River below La Grange Reservoir (A)	1,220	2,682	30	1,110	91%	1,030 - 1,260	1,851	4,631	388	200	115	230	2									
Merced River																						
Merced River at Pohono Bridge	372	888	8	320	86%		461	1,020	92													
Merced River below Merced Falls (9)	632	1,587	12	540	85%	490 - 630	1,007	2,787	150	85	60	105	15									
San Joaquin River																						
San Joaquin River at Mammoth Pool (7)	1,026	2,279	23	820	80%		1,337	2,964	308													
Big Creek below Huntington Lake (8)	91	264	3	70	77%		112	298	14													
South Fork near Florence Lake (7)	201	511	5	170	85%		248	653	7													
San Joaquin River inflow to Millerton Lake	1,254	3,355	28	970	77%	850 - 1,100	1,836	4,642	362	155	80	140	230	380	270	90	25	15	1,395	75%	1,250 - 1,520	
TULARE LAKE																						
Kings River																						
North Fork Kings River near Cliff Camp (3)	239	565	5	180	75%		284	607	58													
Kings River below Pine Flat Reservoir	1,224	3,113	27	940	77%	850 - 1,040	1,721	4,287	388	130	65	110	215	360	275	80	30	10	1,285	75%	1,190 - 1,400	
Kaweah River below Terminus Reservoir	286	814	6	200	70%	170 - 250	454	1,402	94	39	23	33	54	85	48	12	4	2	300	68%	260 - 360	
Tule River below Lake Success	64	259	3	31	49%	25 - 48	148	615	16	10	9	11	11	14	5	1	0	0	61	41%	50 - 80	
Kern River																						
Kern River near Kernville	384	1,203	8	240	63%		558	1,577	163													
Kern River inflow to Lake Isabella	461	1,687	8	270	59%	230 - 330	730	2,318	175	70	25	40	65	95	80	30	15	10	430	59%	380 - 500	



April-July Forecast and % of Average

April-July Forecast 80% Prob. Range

Water Year F'Cast Distribution

Water Year Forecast and % of Avg.

Water Year F'Cast 80% Prob. Range

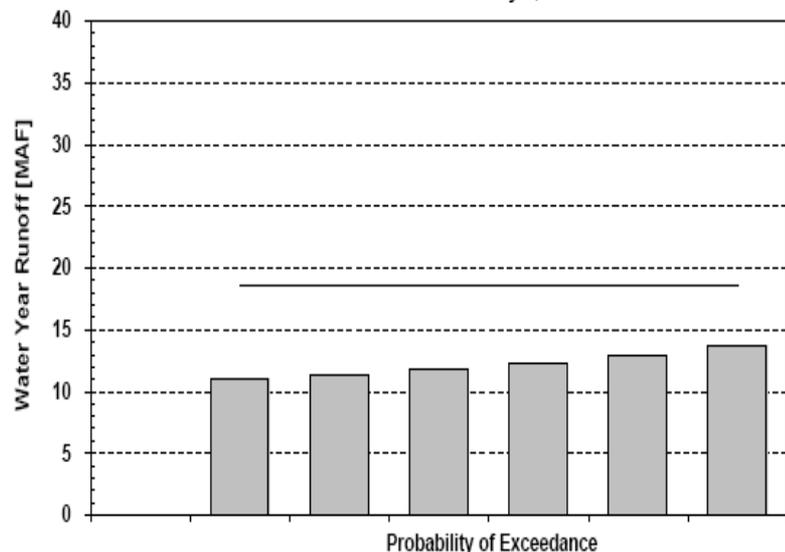
Water Supply Index (WSI) / Water Year Runoff Forecasts

Sacramento River Runoff (SRR)

Department of Water Resources

California Cooperative Snow Surveys

SACRAMENTO RIVER UNIMPAIRED RUNOFF 2009 Water Year Forecast as of May 1, 2009



Date of Forecast	99%	90%	75%	50%	25%	10%
Average	18.6	18.6	18.6	18.6	18.6	18.6
December 1, 2008	5.1 (27%)	8.2 (44%)	10.8 (58%)	14.8 (79%)	19.9 (107%)	24.8 (133%)
January 1, 2009	5.9 (32%)	8.4 (45%)	10.4 (56%)	13.5 (73%)	17.7 (95%)	21.8 (117%)
February 1, 2009	5.1 (27%)	5.9 (32%)	7.4 (40%)	9.6 (52%)	12.9 (69%)	16.1 (86%)
March 1, 2009	7.7 (41%)	8.4 (45%)	9.5 (51%)	11.1 (60%)	13.2 (71%)	15.8 (85%)
April 1, 2009	10.8 (58%)	11.2 (60%)	11.9 (64%)	12.8 (68%)	14.0 (75%)	15.6 (84%)
May 1, 2009	11.0 (59%)	11.3 (61%)	11.8 (63%)	12.3 (66%)	12.9 (69%)	13.7 (74%)

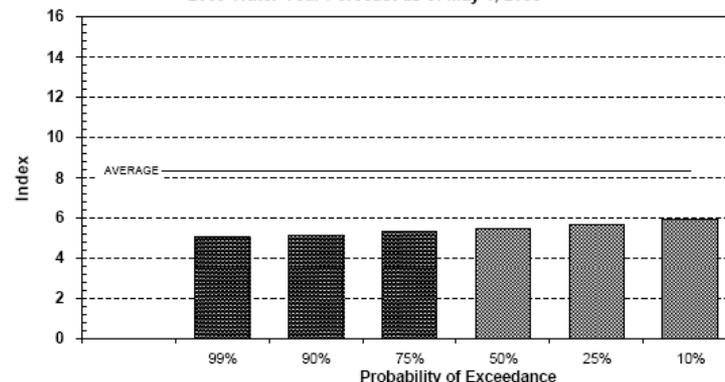
Water Year Runoff in million acre feet & (percent of average)

Sacramento Valley Index (SVI)

Department of Water Resources

California Cooperative Snow Surveys

SACRAMENTO VALLEY WATER YEAR TYPE INDEX (40-30-30) 2009 Water Year Forecast as of May 1, 2009



Date of Forecast	99%	90%	75%	50%	25%	10%
December 1, 2008	3.1	4.1	5.0	6.3	8.0	9.6
January 1, 2009	3.4	4.2	4.9	5.9	7.3	8.7
February 1, 2009	3.1	3.4	3.9	4.6	5.7	6.8
March 1, 2009	4.0	4.2	4.6	5.1	5.9	6.8
April 1, 2009	5.0	5.1	5.4	5.7	6.1	6.7
May 1, 2009	5.0	5.1	5.3	5.5	5.7	6.0

$$\text{Index} = 0.4 * \text{Current Apr-Jul Runoff}^{(1)} + 0.3 * \text{Current Oct-Mar Runoff}^{(1)} + 0.3 * \text{Previous Year's Index}^{(2)}$$

Notes:

(1) Runoff is the sum of unimpaired flow in million acre-feet at:

Sacramento River above Bend Bridge
Feather River at Oroville (aka inflow to Lake Oroville)
Yuba River near Smartville

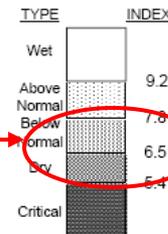
American River below Folsom Lake

(2) Maximum 10.0 for previous year index term

Previous Water Year Indices:

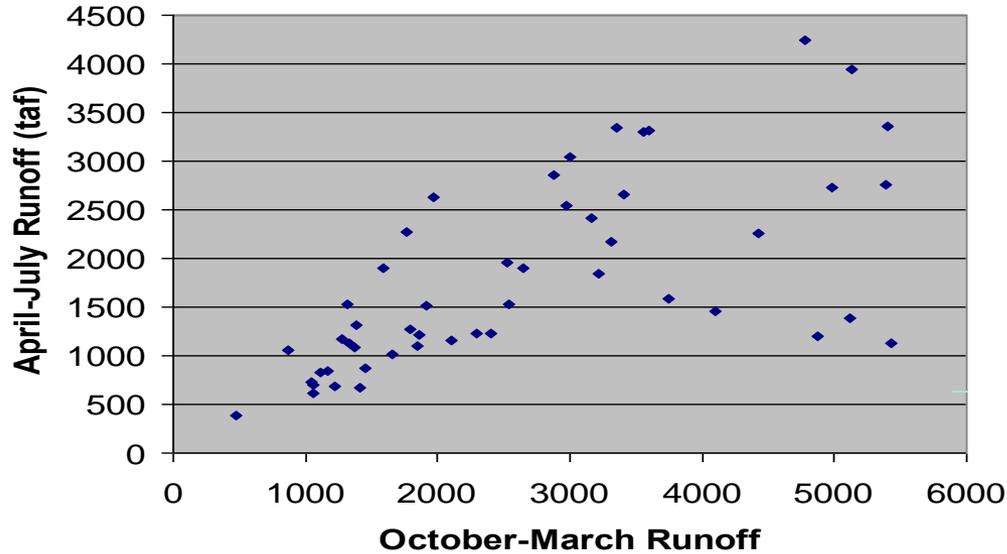
2008 =	5.1	62% of avg.
1977 (Min) =	3.1	37% of avg.
1983 (Max) =	15.3	184% of avg.
1956-2005 average =	8.3	

Year Classification



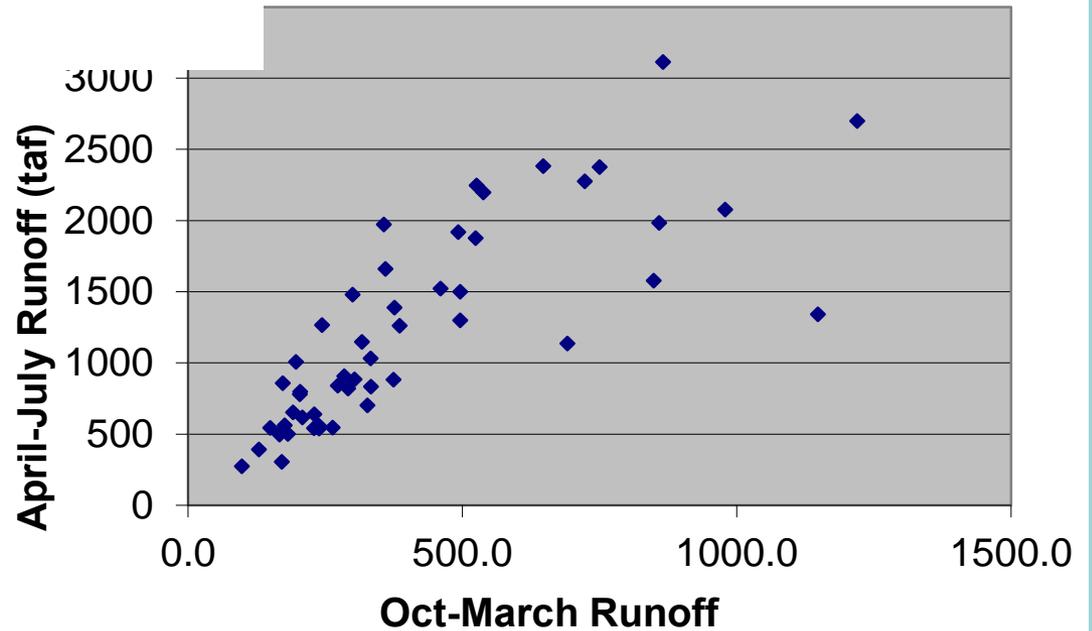
San Joaquin Valley Index is similar

Feather River



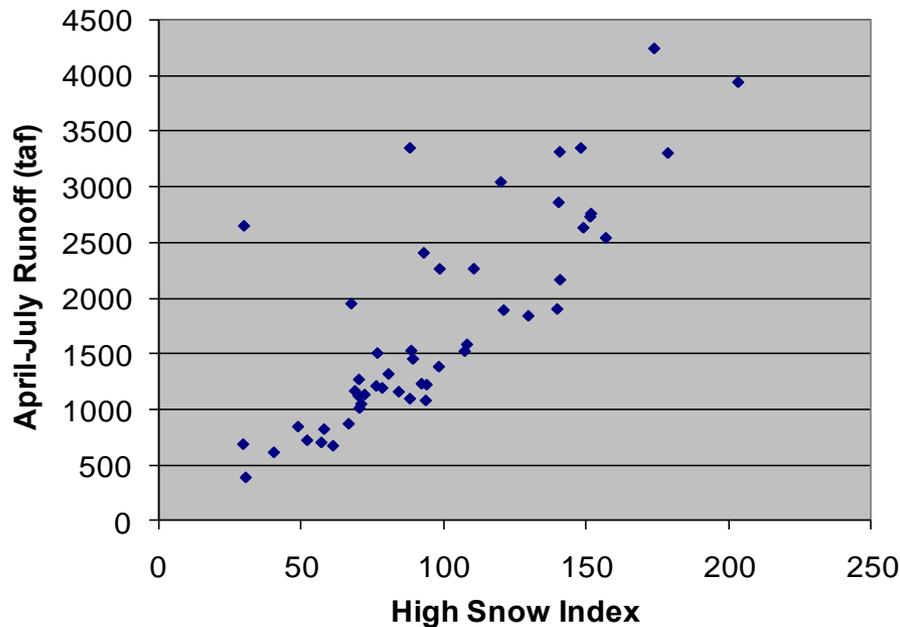
**How Well Does Fall /
Winter Unimpaired
Runoff
Predict of AJ Volumes?**

Kings River

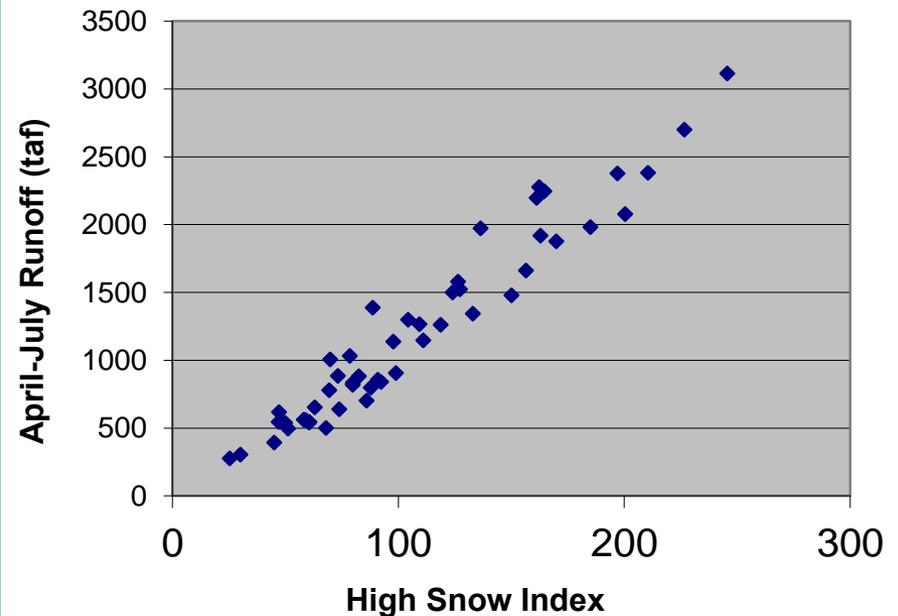


Correlation of AJ Runoff to High Elevation Snow Index

Feather River



Kings River



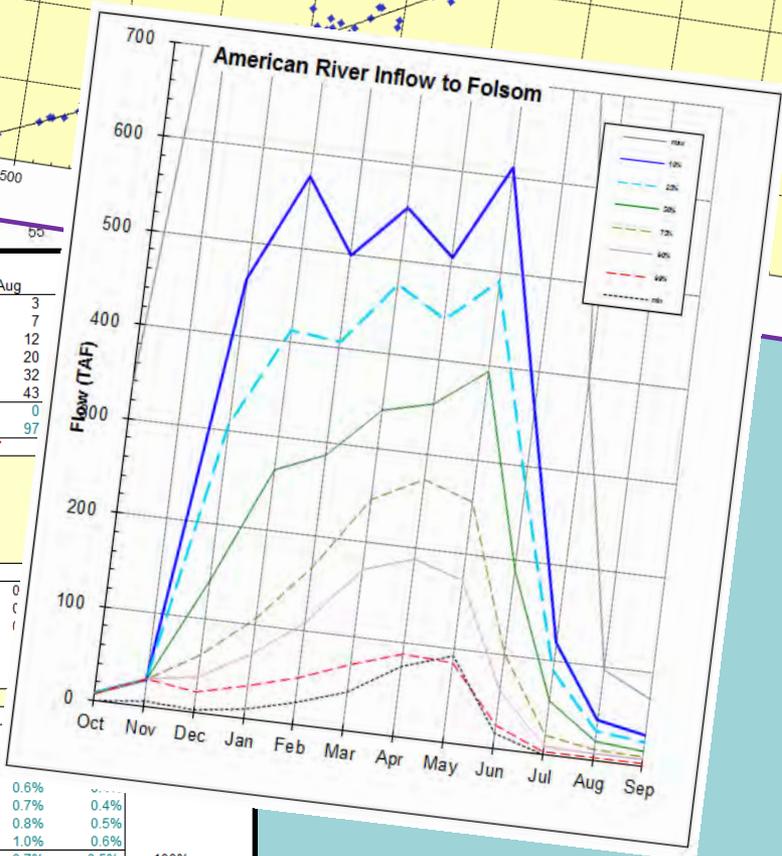
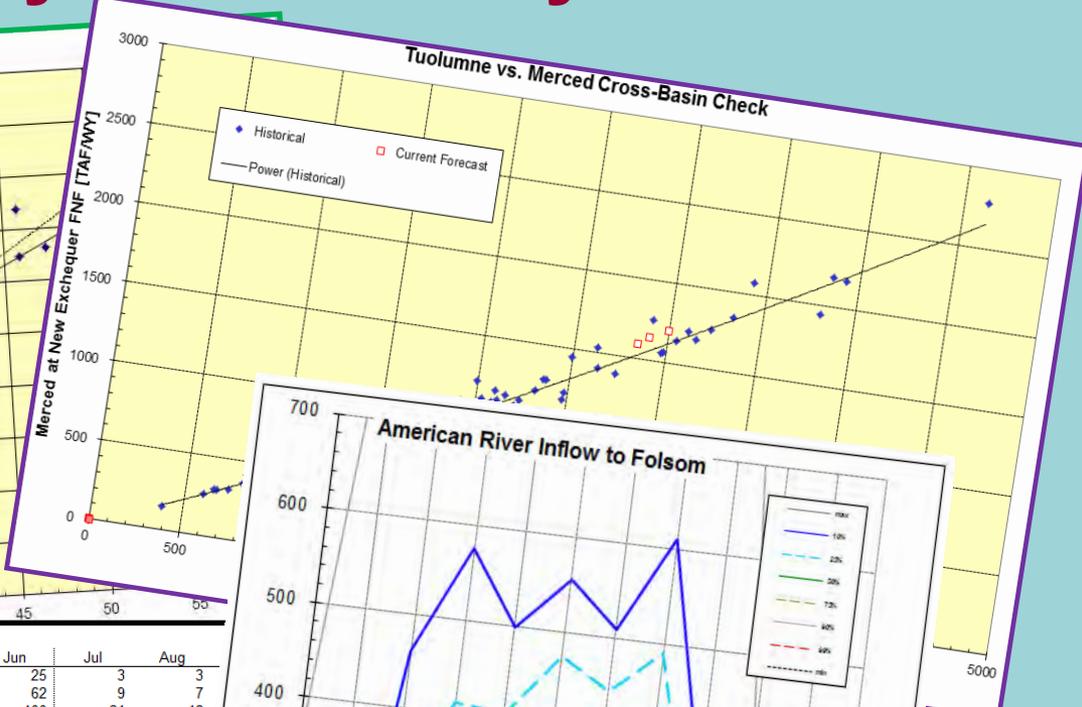
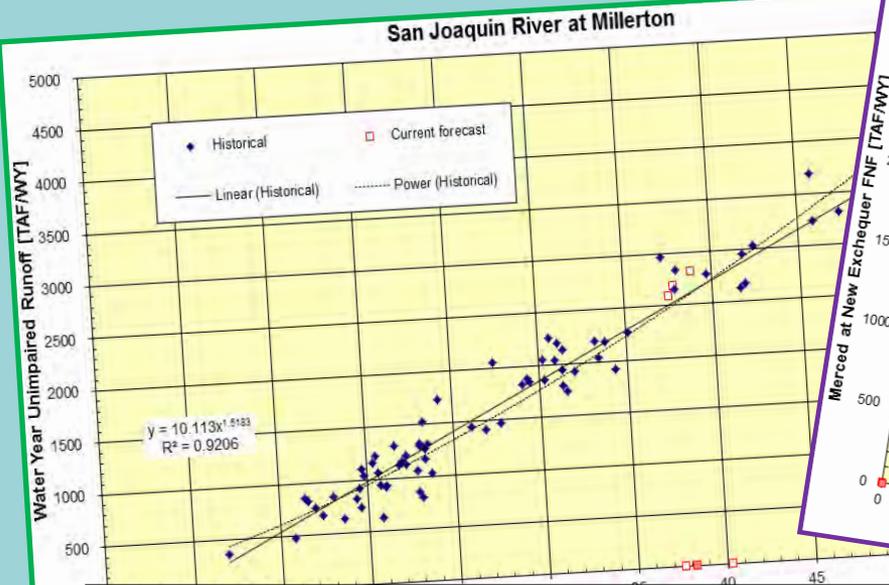
“Non Snow Driven” Basin (Feather)

vs.

“Snow Driven” Basin (Kings)

We analyze similar patterns and correlations for precipitation data

Graphical Analyses = Reality Check



American River Unimpaired Inflow to Folsom [taf]											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
99%	8	29	22	35	49	70	87	85	25	3	3
90%	8	29	38	69	108	171	189	173	62	9	7
75%	8	29	62	107	166	246	273	256	100	21	12
50%	8	29	140	264	287	340	353	395	191	57	20
25%	8	29	305	413	407	474	443	490	283	90	32
10%	8	29	461	577	500	555	510	611	364	119	43
min	0	6	3	11	24	42	75	92	17	0	0
max	335	985	1509	1988	1866	1525	1130	1136			97
Actual or Estimated (leave blank to use hist. distribution, enter, or link to observed or B120)											
99%	8	29				70		85			
90%	8	29									
75%	8	29									
50%	8	29				340					
25%	8	29						490			
10%	8	29									
Scaled percent of water year runoff for projected wy total flow											
99%	3.7%	4.1%	5.1%	8.3%	11.7%	18.8%	20.7%	19.1%	5.9%	0.8%	0
90%	2.8%	4.0%	4.3%	7.8%	12.1%	19.2%	21.1%	19.3%	6.9%	1.0%	0
75%	1.9%	3.7%	4.6%	8.0%	12.5%	18.5%	20.6%	19.3%	7.5%	1.6%	0
50%	1.7%	3.8%	6.4%	12.0%	13.0%	16.1%	16.0%	17.9%	8.7%	2.6%	0
25%	1.5%	4.0%	9.6%	13.0%	12.8%	14.9%	13.9%	16.8%	8.9%	2.8%	0
10%	1.3%	4.3%	11.5%	14.4%	12.5%	13.9%	12.7%	15.3%	9.1%	3.0%	0
scale	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Historical percent of water year runoff for given wy total flow (from QmonDist4.xls)											
0	4.1%	3.7%	5.9%	8.7%	11.2%	18.3%	21.2%	20.1%	5.5%	0.4%	
800	2.6%	3.7%	3.9%	7.6%	11.9%	19.1%	22.1%	20.4%	7.2%	0.7%	
1200	1.5%	3.4%	4.2%	7.3%	12.2%	18.6%	22.1%	20.5%	7.9%	1.3%	
2000	1.3%	3.5%	5.7%	11.7%	12.9%	16.1%	17.2%	19.2%	9.1%	2.4%	0.6%
3300	1.0%	3.8%	10.4%	13.1%	12.5%	14.4%	14.1%	17.6%	9.4%	2.7%	0.7%
4500	0.8%	4.3%	12.4%	15.7%	12.0%	13.0%	13.1%	14.8%	9.7%	2.9%	0.8%
5500	0.7%	4.0%	11.8%	16.5%	11.0%	12.6%	12.7%	14.5%	10.4%	4.1%	1.0%
av mo%	1.0%	3.1%	6.4%	10.7%	12.2%	15.2%	17.1%	19.2%	10.9%	2.9%	0.7%
											100%



Water Supply Forecast Review

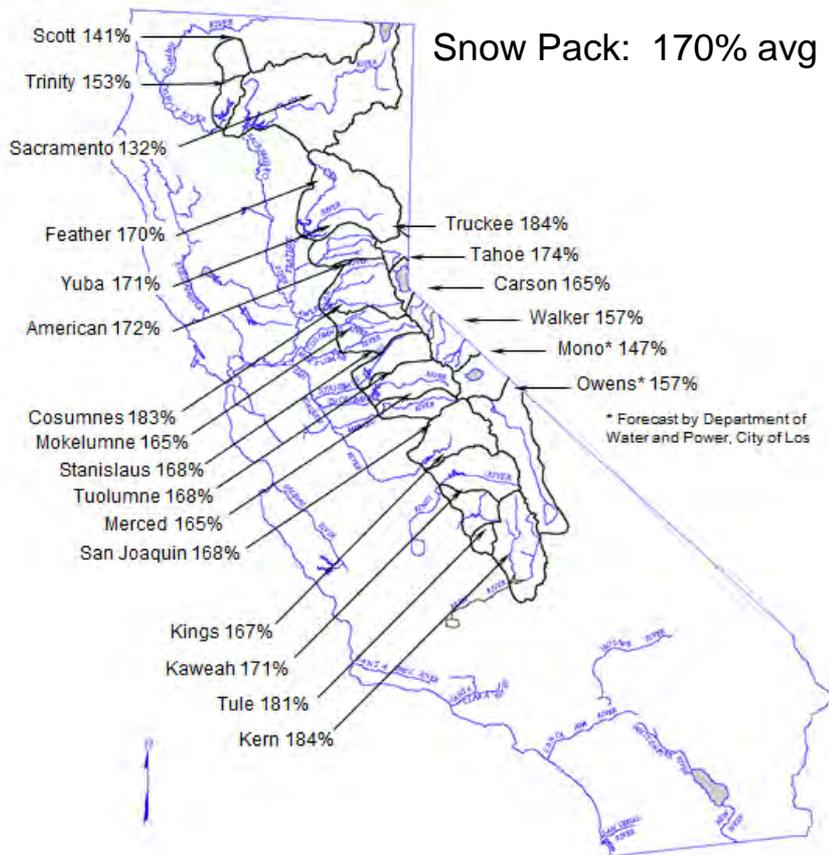
April and May Bulletin 120 Forecasts

2011

Department of Water Resources
 California Cooperative Snow Surveys
 Forecast of April through July Unimpaired Runoff
 in percent of historical average
 as of April 1, 2011

Statewide Precip: 140% avg

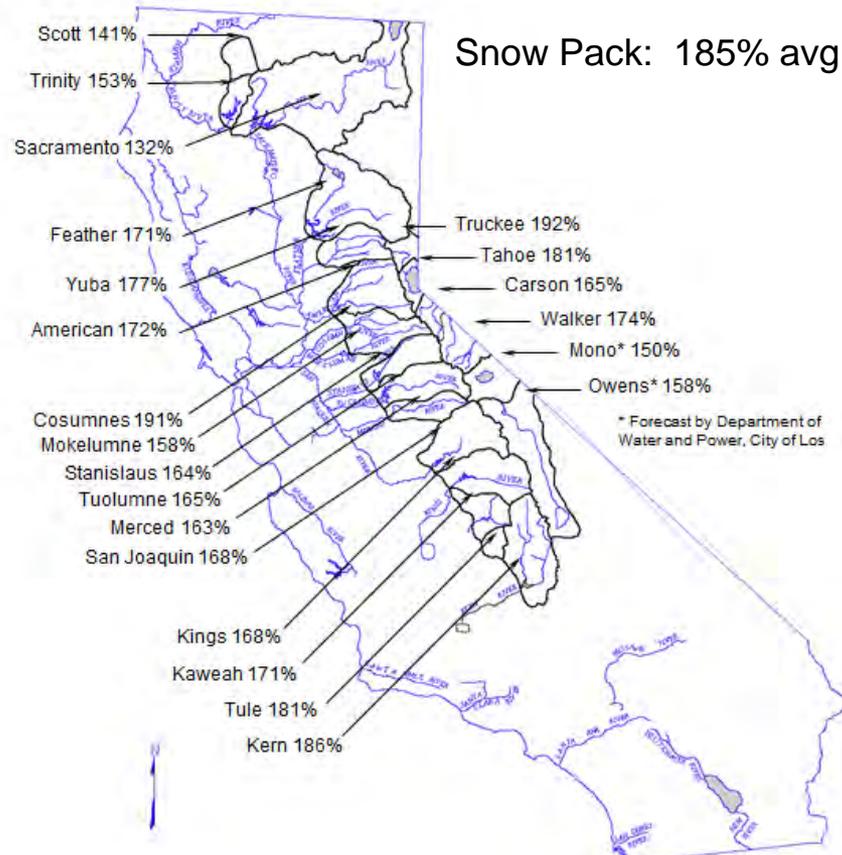
Snow Pack: 170% avg



Department of Water Resources
 California Cooperative Snow Surveys
 Forecast of April through July Unimpaired Runoff
 in percent of historical average
 as of May 1, 2011

Statewide Precip: 135% avg

Snow Pack: 185% avg



Water Supply Forecast Review

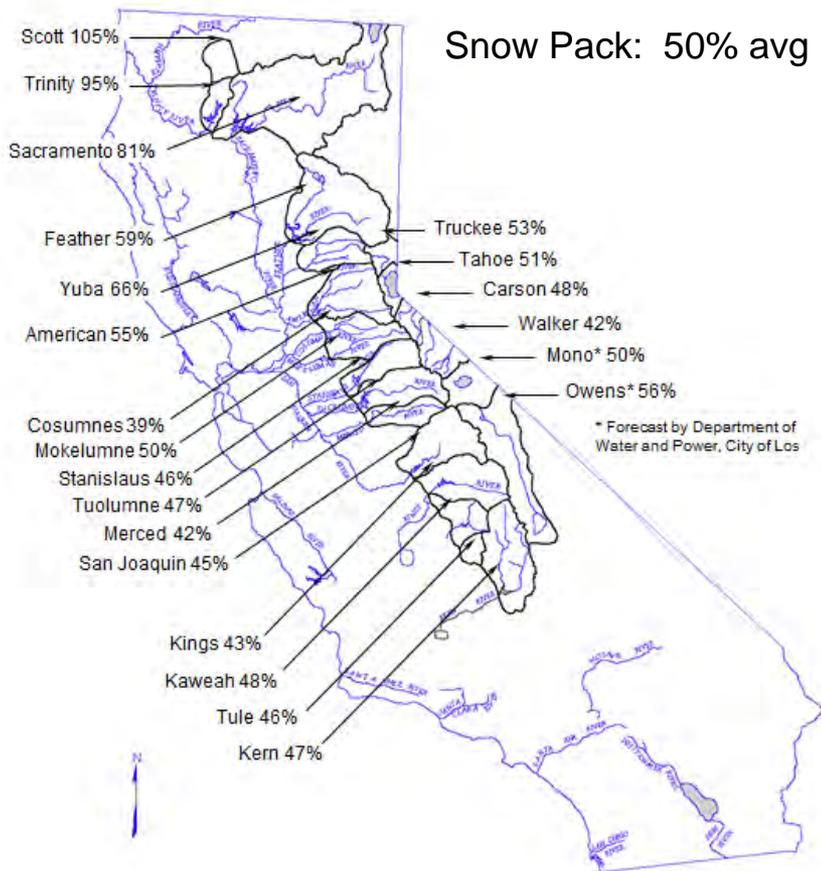
April and May Bulletin 120 Forecasts

2012

Department of Water Resources
California Cooperative Snow Surveys
Forecast of April through July Unimpaired Runoff
in percent of historical average
as of April 1, 2012

Statewide Precip: 70% avg

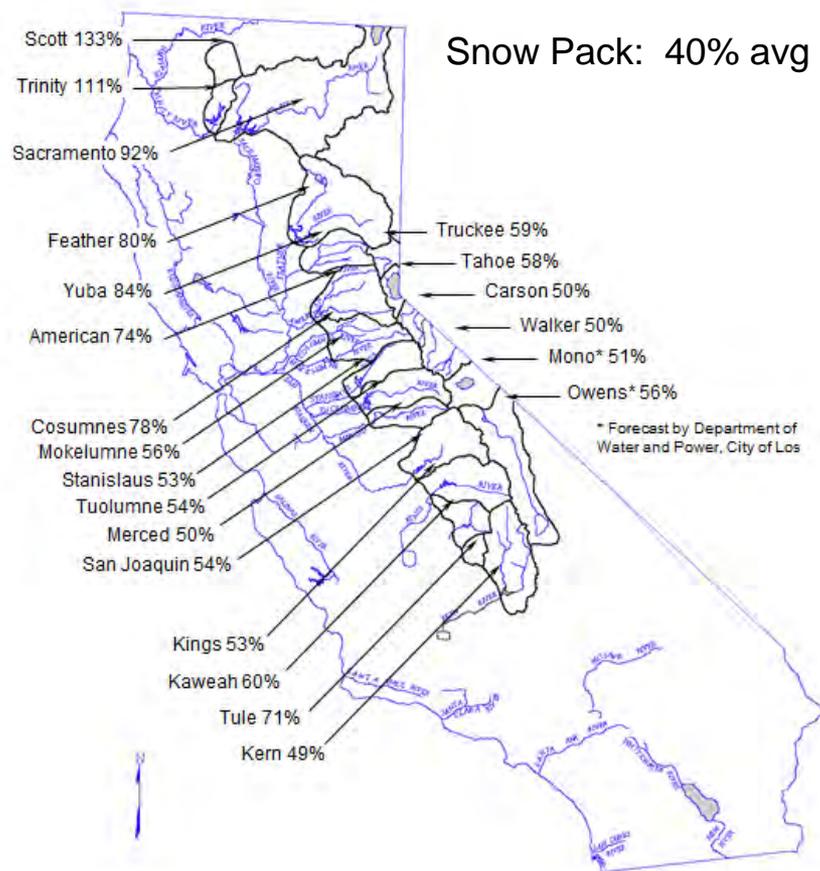
Snow Pack: 50% avg



Department of Water Resources
California Cooperative Snow Surveys
Forecast of April through July Unimpaired Runoff
in percent of historical average
as of May 1, 2012

Statewide Precip: 75% avg

Snow Pack: 40% avg



Water Supply Forecast Review

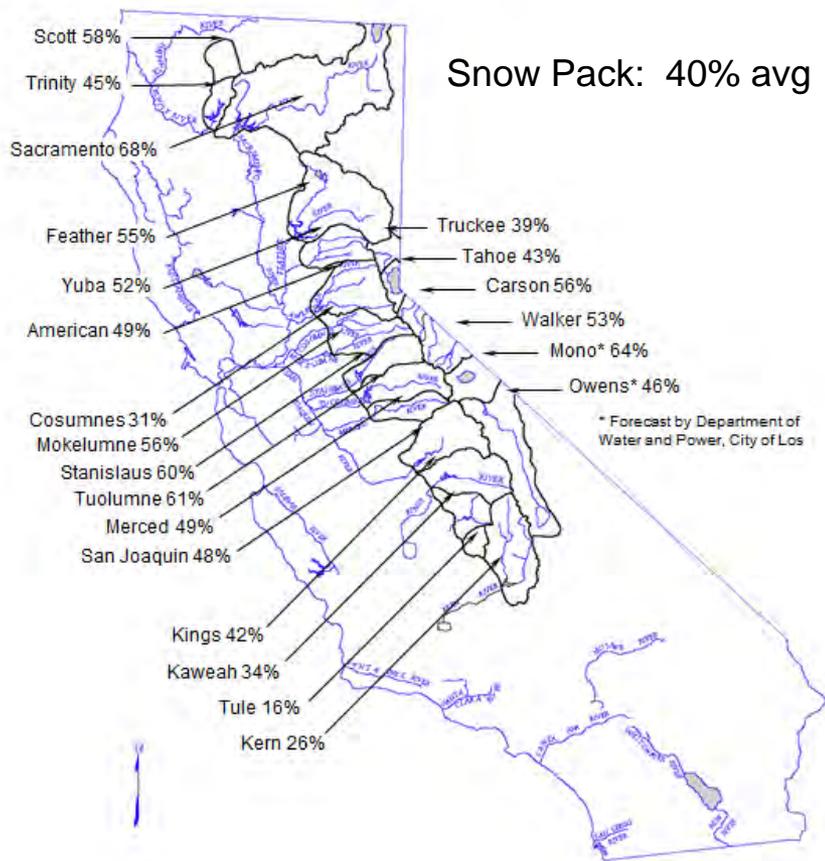
April and May Bulletin 120 Forecasts

2013

Department of Water Resources
 California Cooperative Snow Surveys
 Forecast of April through July Unimpaired Runoff
 in percent of historical average
 as of April 1, 2013

Statewide Precip: 75% avg

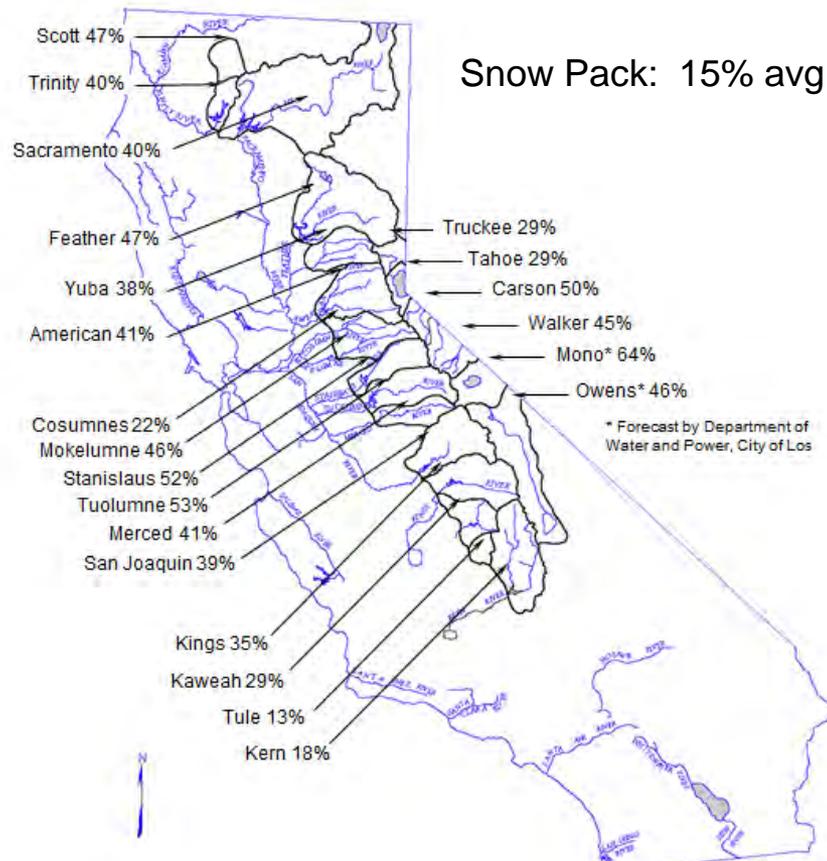
Snow Pack: 40% avg



Department of Water Resources
 California Cooperative Snow Surveys
 Forecast of April through July Unimpaired Runoff
 in percent of historical average
 as of May 1, 2013

Statewide Precip: 75% avg

Snow Pack: 15% avg

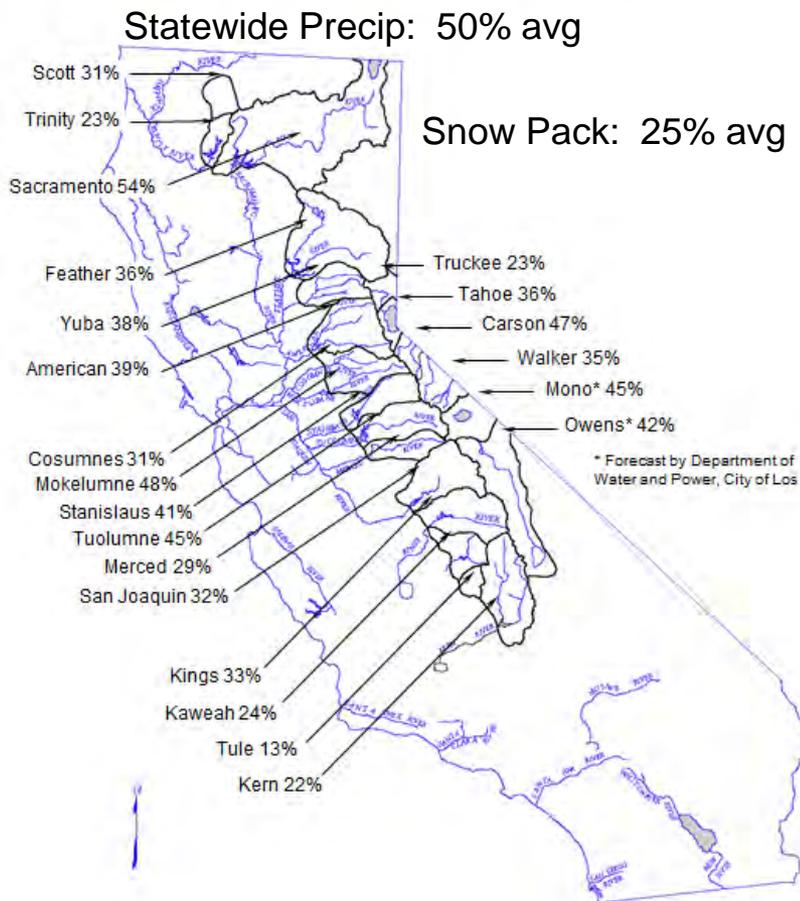


Water Supply Forecast Review

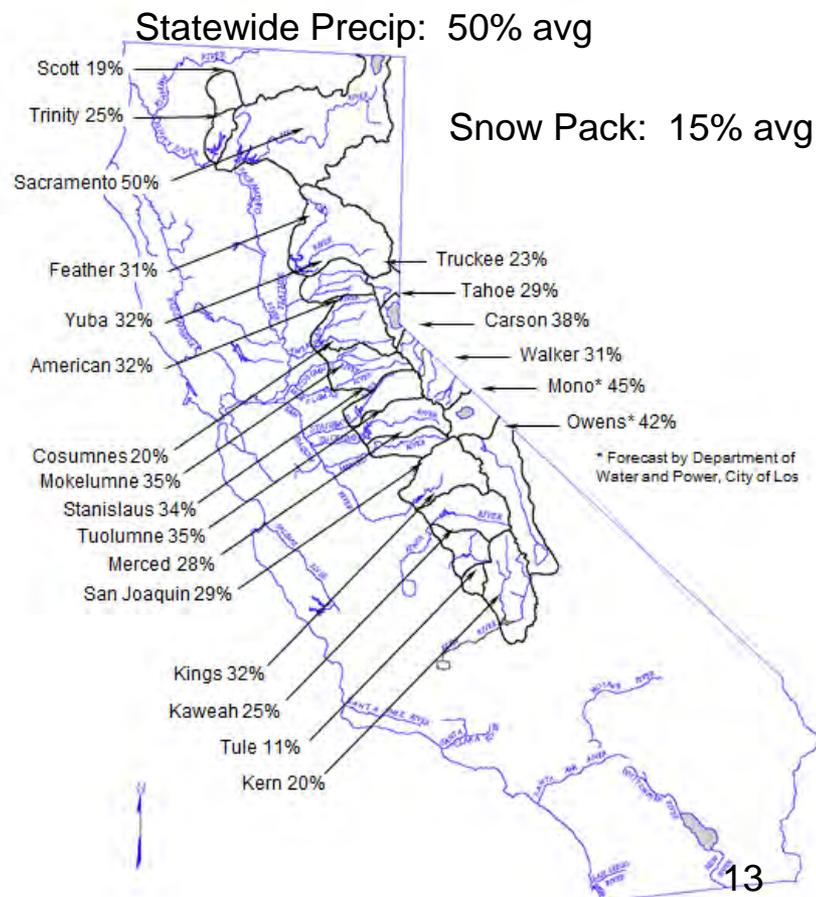
April and May Bulletin 120 Forecasts

2014

Department of Water Resources
California Cooperative Snow Surveys
Forecast of April through July Unimpaired Runoff
in percent of historical average
as of April 1, 2014



Department of Water Resources
California Cooperative Snow Surveys
Forecast of April through July Unimpaired Runoff
in percent of historical average
as of May 1, 2014



Water Supply Forecast Review

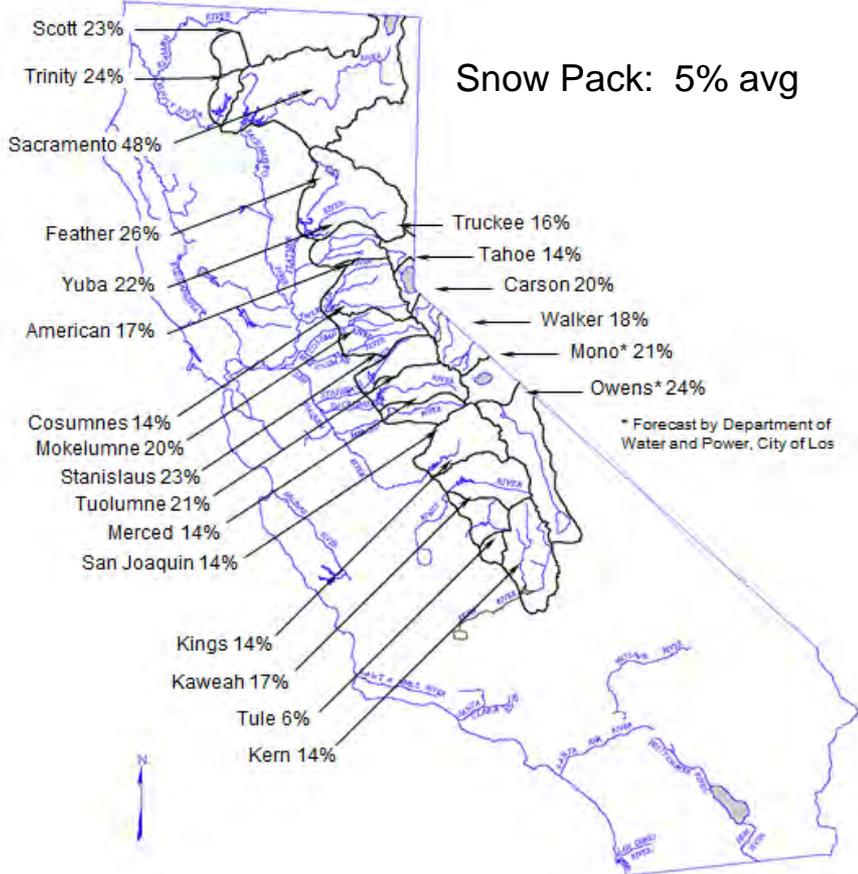
April and May Bulletin 120 Forecasts

2015

Department of Water Resources
 California Cooperative Snow Surveys
 Forecast of April through July Unimpaired Runoff
 in percent of historical average
 as of April 1, 2015

Statewide Precip: 75% avg

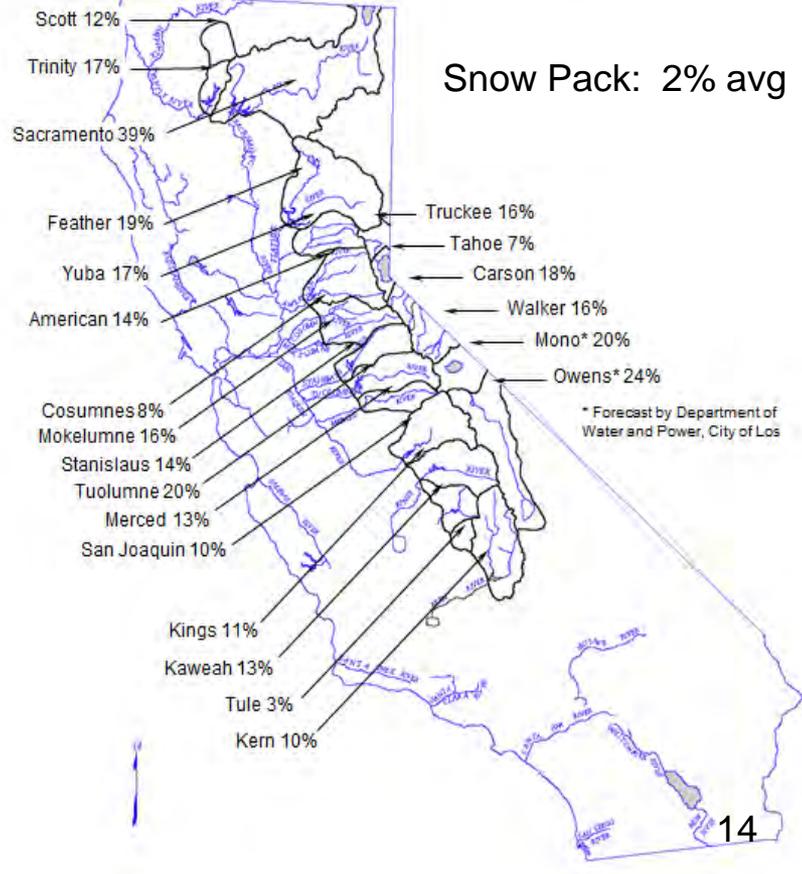
Snow Pack: 5% avg



Department of Water Resources
 California Cooperative Snow Surveys
 Forecast of April through July Unimpaired Runoff
 in percent of historical average
 as of May 1, 2015

Statewide Precip: 70% avg

Snow Pack: 2% avg

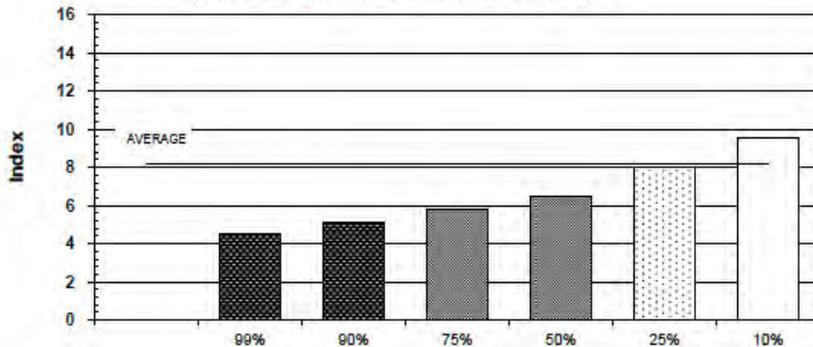


February 2016 Water Supply Index Forecasts

Department of Water Resources

California Cooperative Snow Surveys

SACRAMENTO VALLEY WATER YEAR TYPE INDEX (40-30-30) 2016 Water Year Forecast as of February 1, 2016



Date of Forecast	Probability of Exceedance					
	99%	90%	75%	50%	25%	10%
December 1, 2015	2.4	3.3	4.0	5.3	6.8	8.5
January 1, 2016	3.4	4.1	4.8	5.9	7.2	8.6
February 1, 2016	4.5	5.1	5.8	6.5	8.0	9.5

Water Year Index based on flow in million acre feet

$$\text{Index} = 0.4 * \text{Current Apr-Jul Runoff}^{(1)} + 0.3 * \text{Current Oct-Mar Runoff}^{(1)} + 0.3 * \text{Previous Year's Index}^{(2)}$$

Notes:

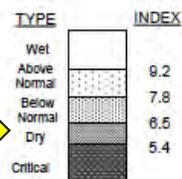
- (1) Runoff is the sum of unimpaired flow in million acre-feet at:
 Sacramento River above Bend Bridge
 Feather River at Oroville (aka inflow to Lake Oroville)
 Yuba River near Smartville
 American River below Folsom Lake

- (2) Maximum 10.0 for previous year index term

Previous Water Year Indices:

2015 =	4.0	48% of avg.
1977 (Min) =	3.1	38% of avg.
1983 (Max) =	15.3	186% of avg.
1961-2010 average =	8.2	

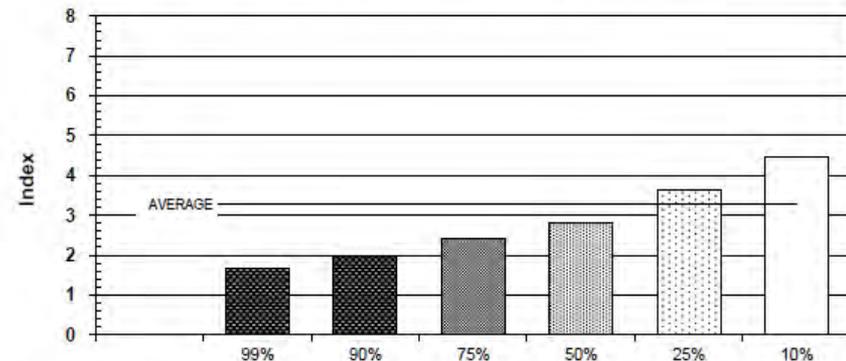
Year Classification



Department of Water Resources

California Cooperative Snow Surveys

SAN JOAQUIN VALLEY WATER YEAR TYPE INDEX (60-20-20) 2016 Water Year Forecast as of February 1, 2016



Date of Forecast	Probability of Exceedance					
	99%	90%	75%	50%	25%	10%
December 1, 2015	0.6	1.1	1.5	2.2	3.0	4.0
January 1, 2016	1.0	1.4	1.9	2.4	3.1	3.9
February 1, 2016	1.7	2.0	2.4	2.8	3.7	4.5

Water Year Index based on flow in million acre feet

$$\text{Index} = 0.6 * \text{Current Apr-Jul Runoff}^{(1)} + 0.2 * \text{Current Oct-Mar Runoff}^{(1)} + 0.2 * \text{Previous Year's Index}^{(2)}$$

Notes:

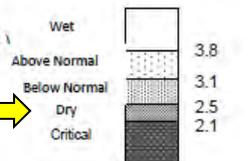
- (1) Runoff is the sum of unimpaired flow in million acre-feet at:
 Stanislaus River below Goodwin Reservoir (aka inflow to New Melones Res.)
 Tuolumne River below La Grange (aka inflow to New Don Pedro Reservoir)
 Merced River below Merced Falls (aka inflow to Lake McClure)
 San Joaquin River inflow to Millerton Lake

- (2) Maximum 4.5 for previous year index term

Previous Water Year Indices:

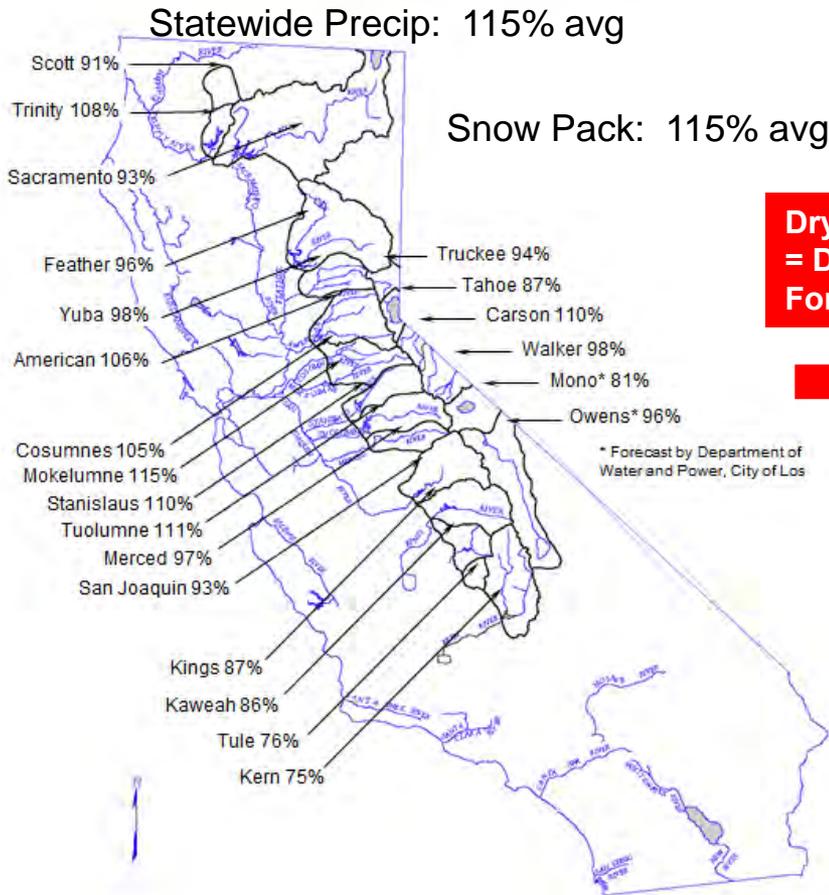
2015 =	0.8	25% of avg.
2015 (Min) =	0.8	25% of avg.
1983 (Max) =	7.2	219% of avg.
1961-2010 average =	3.3	

Year Classification TYPE INDEX



February 2016 Bulletin 120 Forecasts

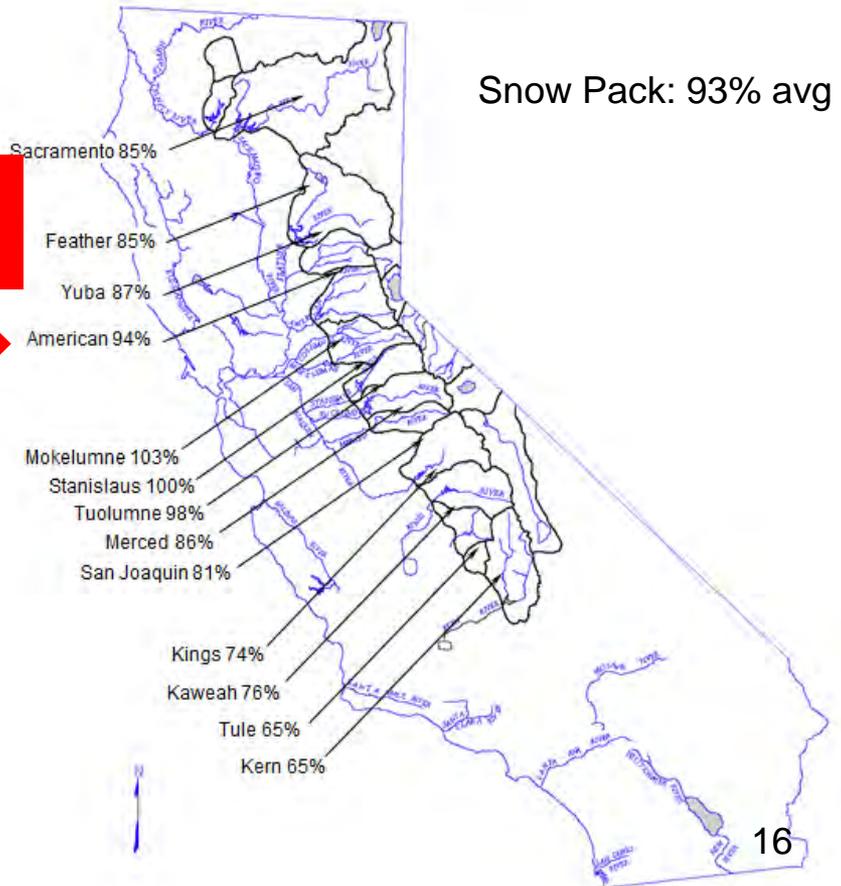
Department of Water Resources
California Cooperative Snow Surveys
Forecast of April through July Unimpaired Runoff
in percent of historical average
as of February 1, 2016



**Dry Feb.
= Drop in
Forecast**



Department of Water Resources
California Cooperative Snow Surveys
Forecast of April through July Unimpaired Runoff
in percent of historical average
as of February 18, 2016



Questions?

