

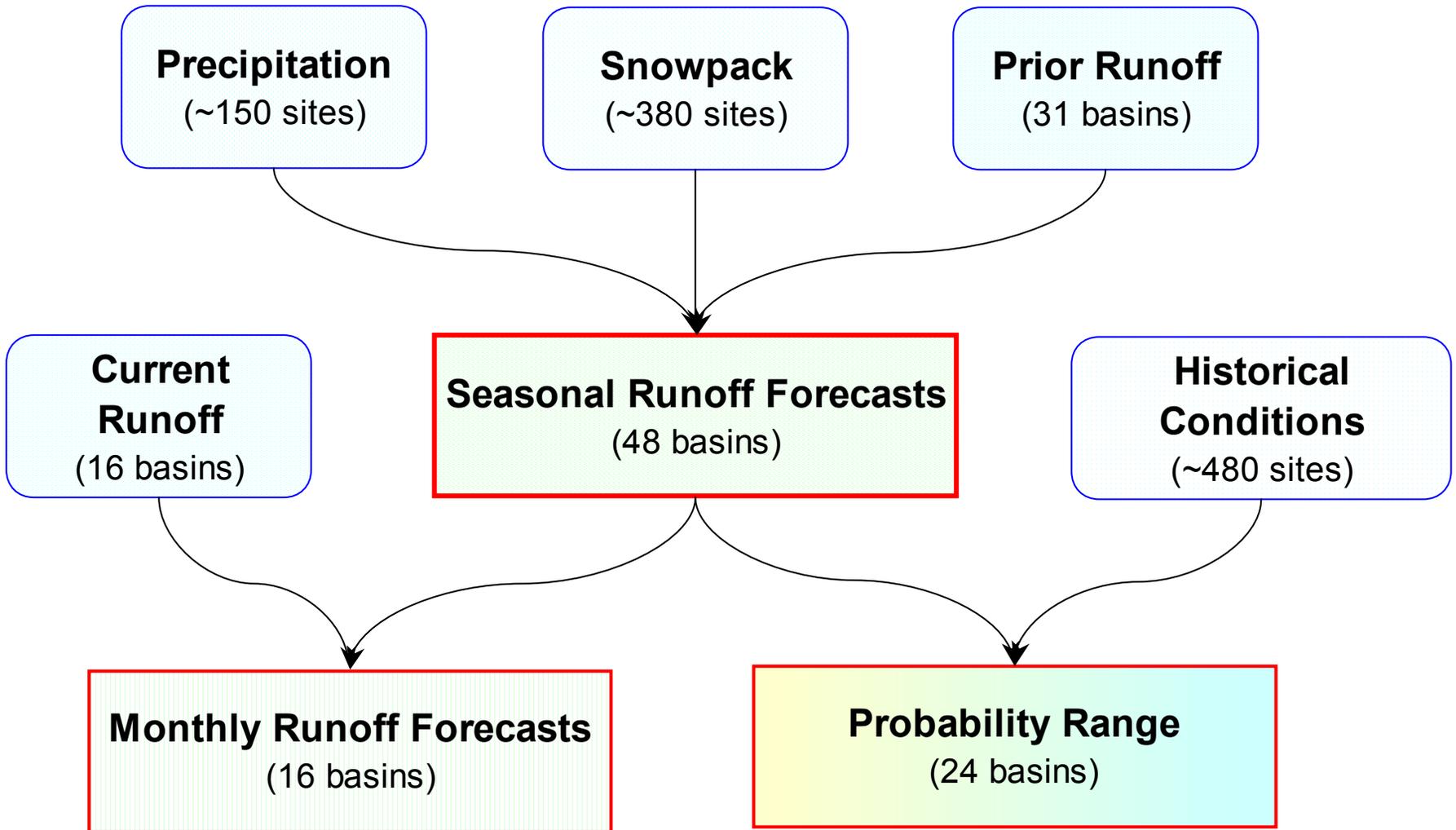
# Growth of Runoff Forecasting: Support to Today's Water Management

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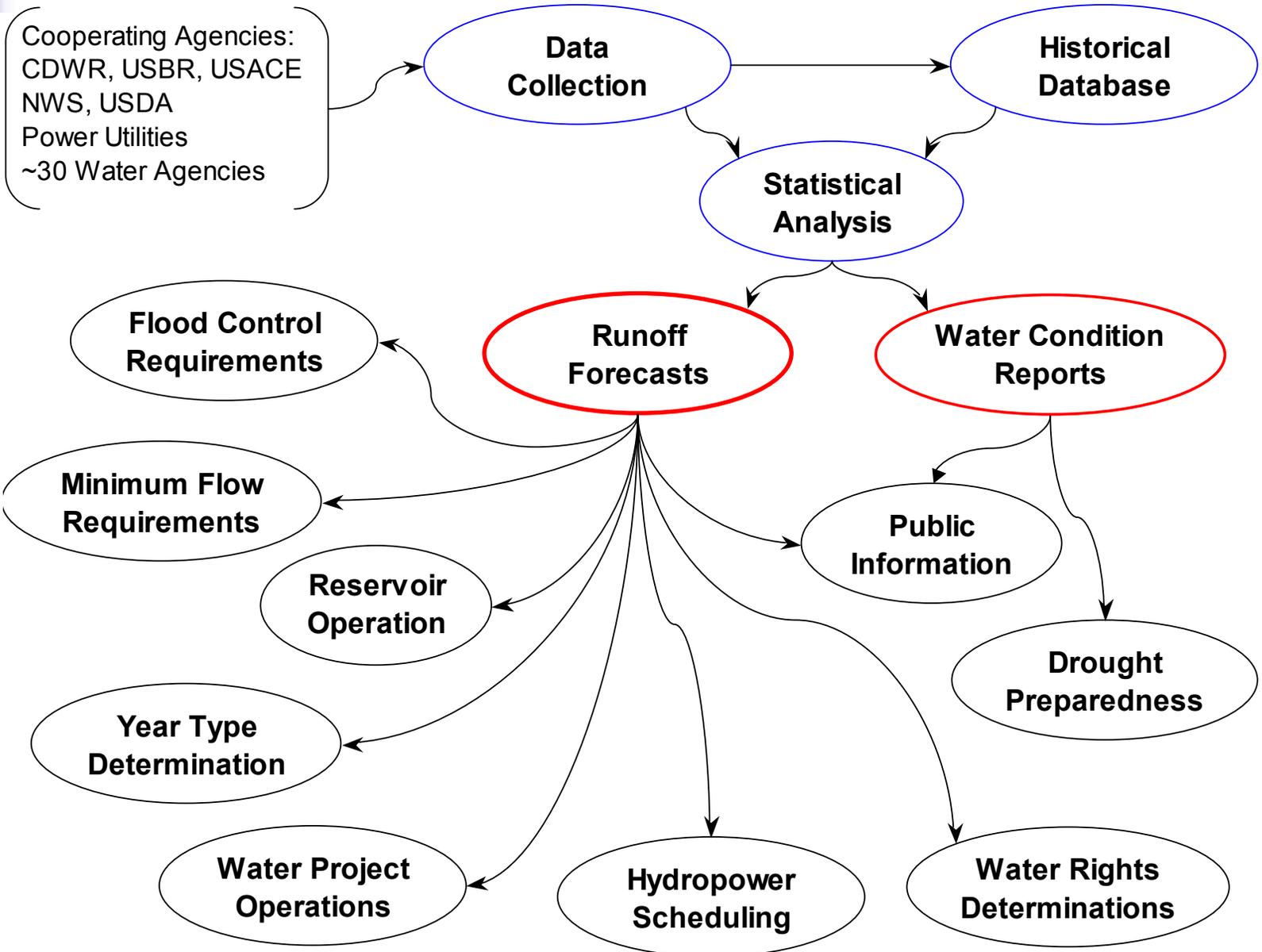


# DWR Bulletin 120 Forecast Process



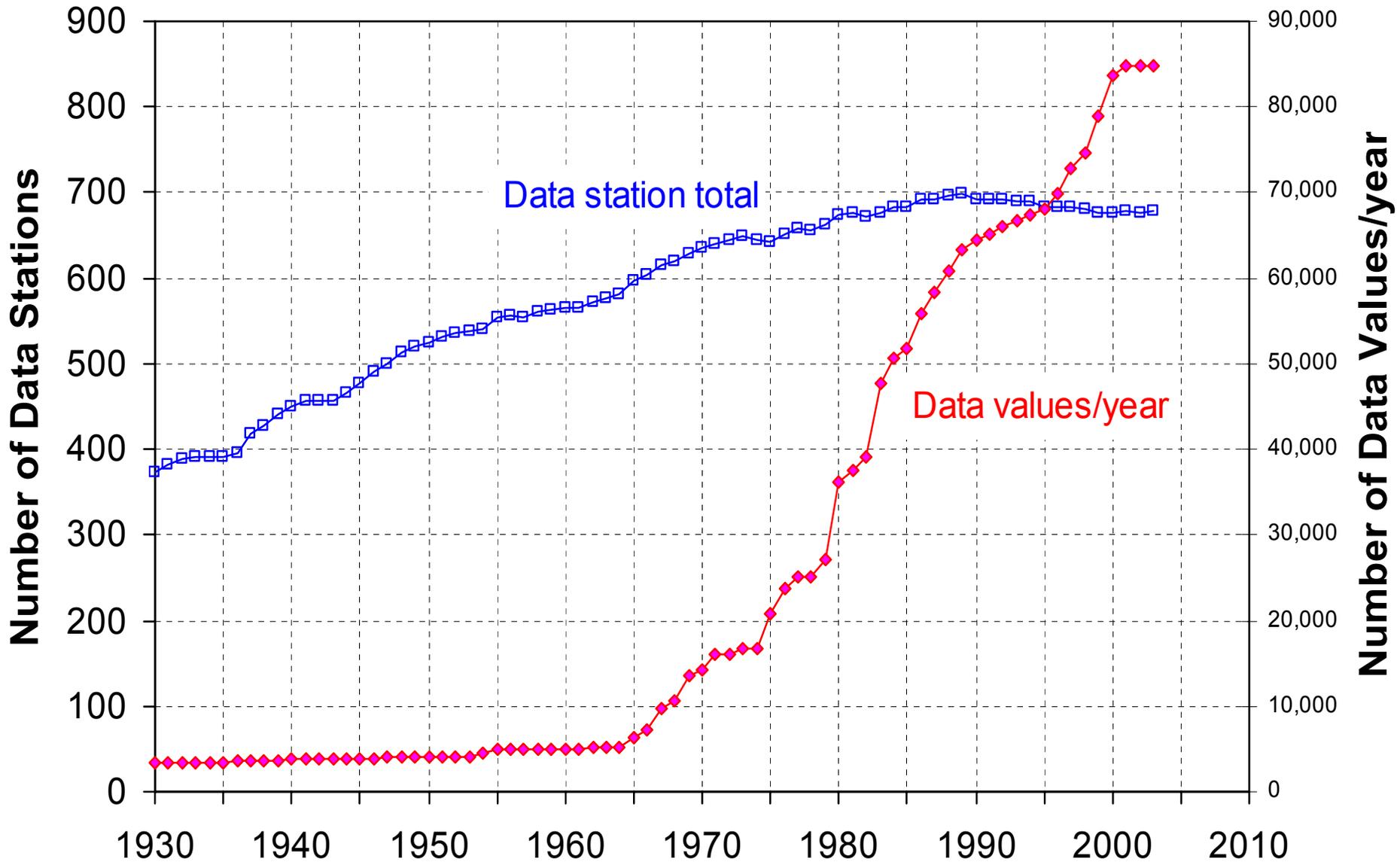


# Water Supply Forecasting Overview





# Data Inventory Timeline for California WS Forecasts





# Field Data Support Accounting

Support per Agency equals sum of:

- Data support
  - Measurement (precipitation, snow, unimpaired runoff terms)
  - Maintenance (including permits, equipment, clearing, maps, signs, accounting for courses, pillows, cabins, & other sites)
  - Data Acquisition & Filing (including share of data exchange, satellite telemetry, database, and website)
- Reimbursements to other Agencies
- Cash support to DWR Hydrology Branch
  
- Stations per Forecast Basin
  - Each basin's share of each station used in seasonal runoff forecasting for precipitation, snow, and runoff terms
  
- Annual Cost per Station
  - Based on sampling of current station costs for each type of station for measurement, maintenance, and acquisition



# Field Data Support by Agency (example)

## Field Data Costs/Agency for Water Supply Forecasting

11/17/03

snow & FNF calc

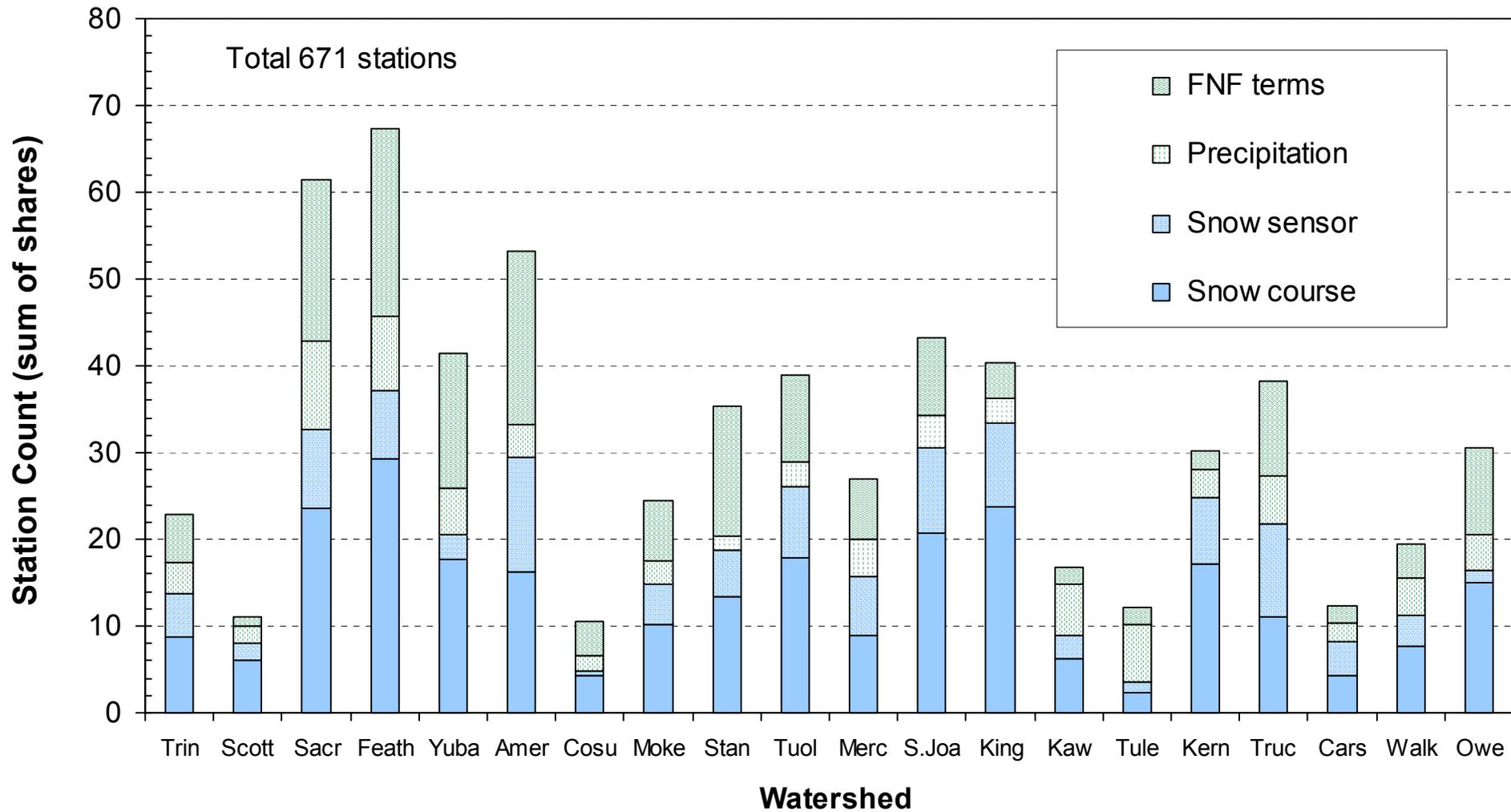
[annual costs in \$1000]

Agency	Precipitation				Snow courses & sensors						FNF terms					All data			Key data		
	#obs	#tele	labor	cash	cour	#sun	pillow	#cont	labor	cash	fnf	river	term	labor	cash	labor	cash	total	labor	cash	total
<b>Data Measurement</b>																					
S DWR DFM	0	13	7	0	27	101	7	24	60	0	13	0	0	39	7	106	7	112	99	0	99
S (less reimbursed)	0	0	0	0	(22)	(76)	(6)	(20)	(25)	0	0	0	0	0	0	(25)	0	(25)	(25)	0	(25)
S DWR O&M, SWC	0	0	0	0	10	48	3	12	29	0	0	0	9	27	7	56	7	63	29	0	29
S UC, CDF, CDP	5	0	20	0	3	12	1	3	7	0	0	0	0	0	0	27	0	27	7	0	7
F USBR	3	3	14	0	0	0	0	0	0	40	2	0	24	78	5	92	45	136	6	40	46
F NWS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F USACE	1	7	8	0	0	0	0	0	0	0	4	0	7	33	1	41	1	41	12	0	12
F USGS	0	0	0	0	0	0	0	0	0	0	0	17.0	1	54	0	54	0	54	0	0	0
F (less reimbursed)	0	0	0	0	0	0	0	0	0	0	0	(10)	0	(33)	0	(33)	0	(33)	0	0	0
F USFS	21	1	85	0	85	264	34	114	176	0	0	0	0	0	0	261	0	261	176	0	176
F (less reimbursed)	0	0	0	0	(43)	(132)	(17)	(57)	(90)	0	0	0	0	0	0	(90)	0	(90)	(90)	0	(90)
F NPS	5	0	20	0	21	78	10	37	70	0	0	0	0	0	0	90	0	90	70	0	70
F (less reimbursed)	0	0	0	0	(11)	(39)	(5)	(19)	(40)	0	0	0	0	0	0	(40)	0	(40)	(40)	0	(40)
F NRCS/NevCSS	0	2	1	0	9	20	23	4	12	0	0	0	0	0	0	13	0	13	12	0	12
U PG&E	2	13	15	0	63	213	16	58	130	7	0	0	33	99	7	243	14	257	130	7	137
U SMUD	0	0	0	0	2	8	6	24	14	2	0	0	4	12	0	26	2	28	14	2	16
U EBMUD	1	0	4	0	0	0	0	0	0	5	1	0	4	15	0	19	5	24	3	5	8
U NCPA	0	0	0	0	0	0	0	0	0	2	0	0	1	3	0	3	2	5	0	2	2
U HHW&P	2	0	8	0	0	0	0	0	0	15	0	0	6	18	3	26	18	44	0	15	15
U SCE	6	1	25	0	22	56	6	18	35	4	0	0	6	18	0	78	4	82	35	4	39
U LADWP	0	0	0	0	12	38	5	19	27	3	2	0	10	36	0	63	3	66	33	3	36



# Field Data Use for Water Supply Forecasting

## Field Data Use for Water Supply Forecasts



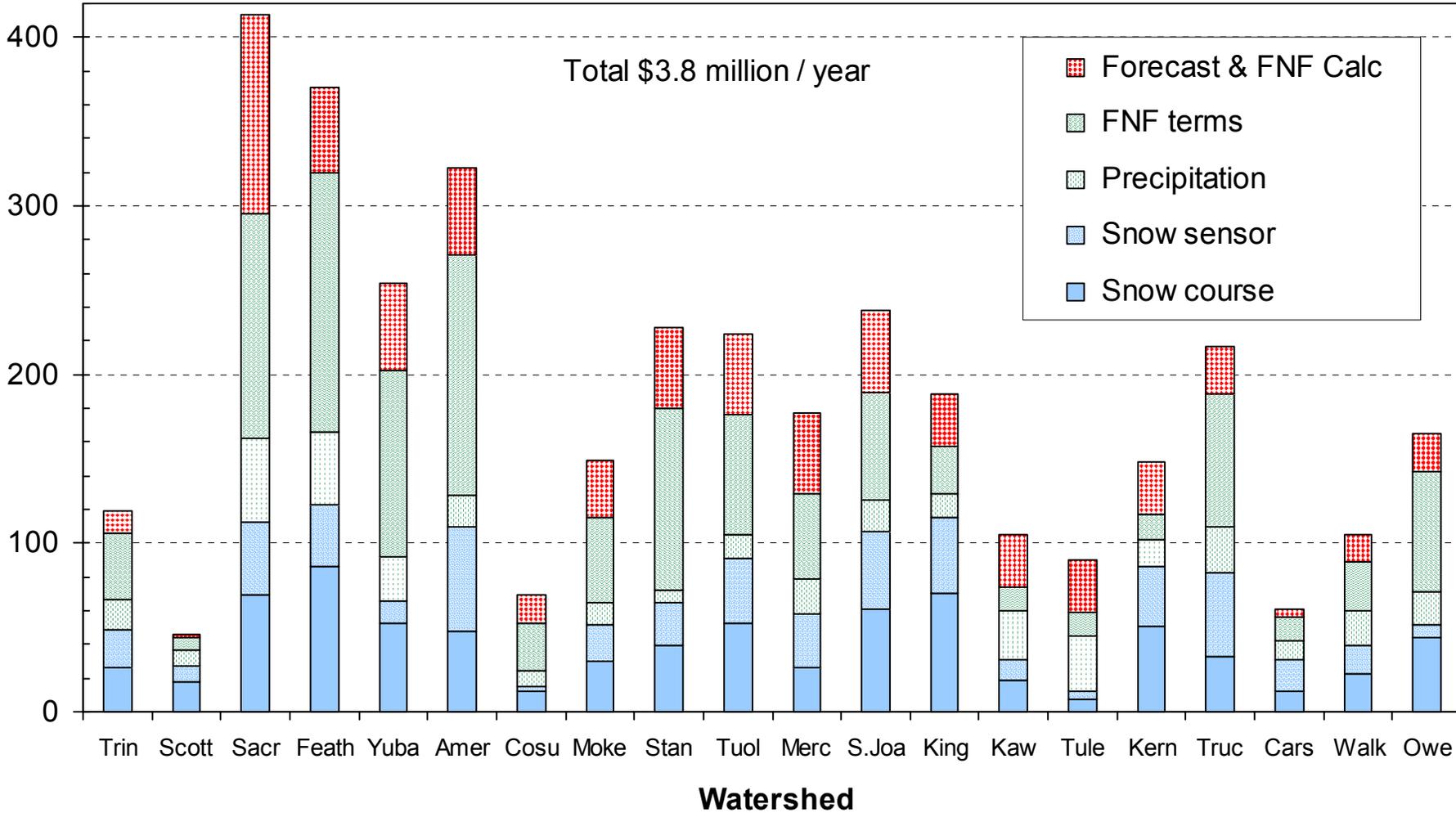
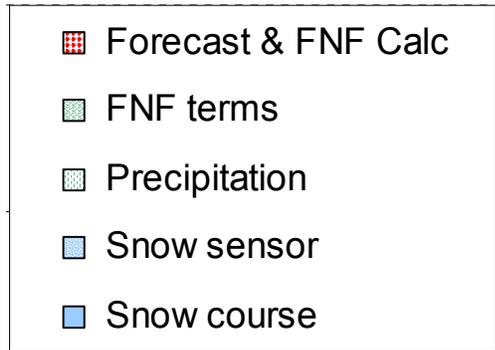


# Costs of Water Supply Forecasts & All Data

## Costs of Water Supply Forecasts & All Data

Total \$3.8 million / year

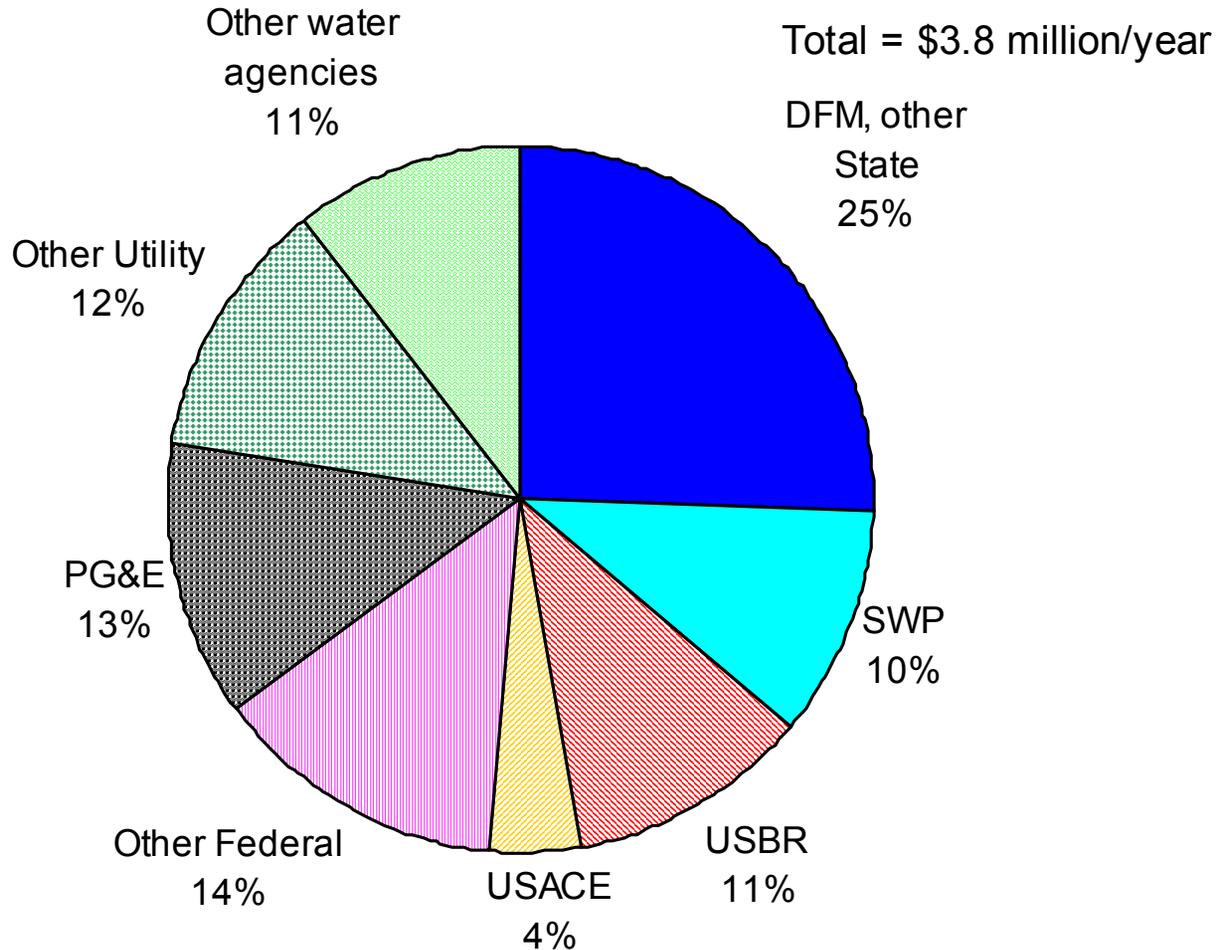
Basin Cost Share [\$1000/yr]





# Total Support by Agency

**Total Support**  
(% of all data, DWR forecasting cost)

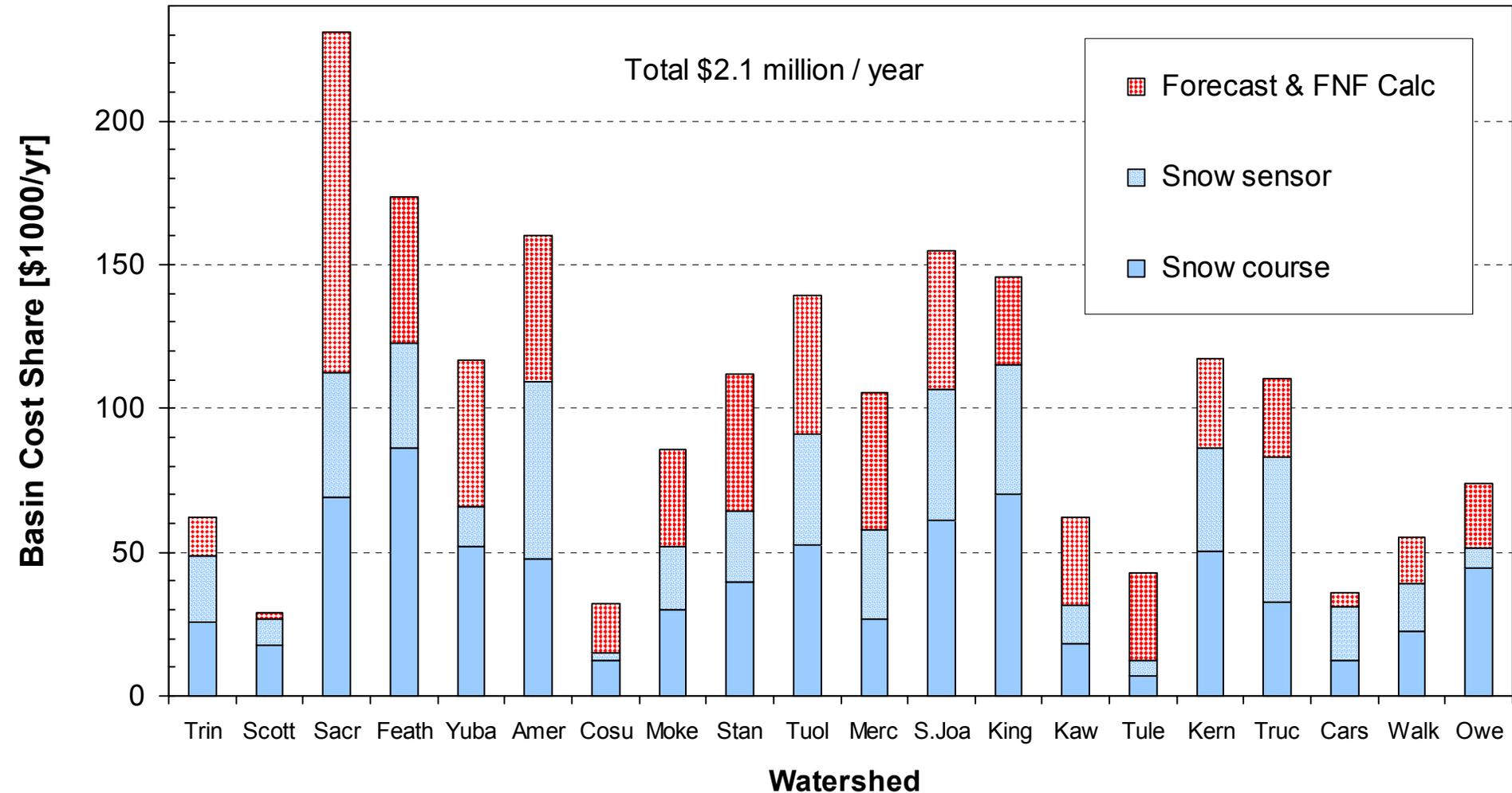


Includes precipitation & stage data required for other purposes than WS forecasting



# Costs of Water Supply Forecasts & Key Data

## Costs of Water Supply Forecasts & Key Data

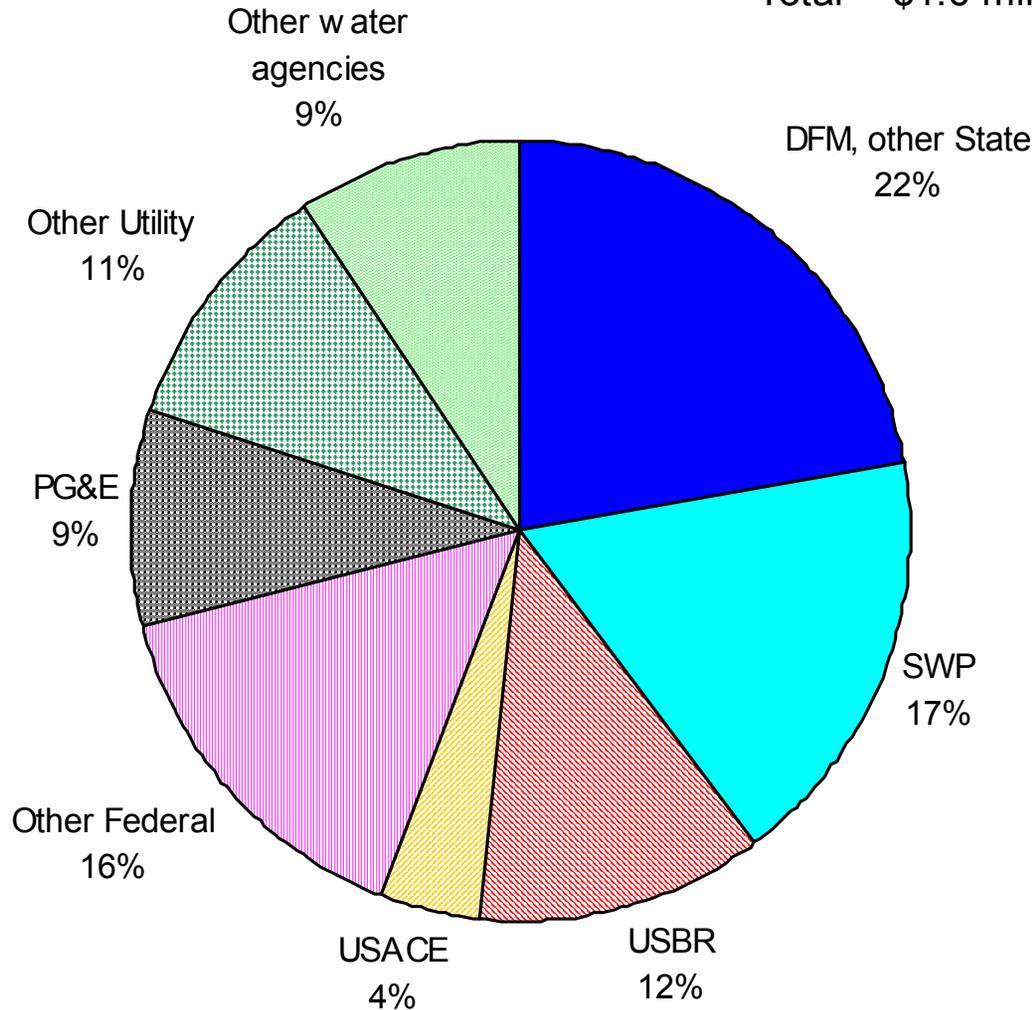




# Key Data Support by Agency

## Key Data Support (% of snow data, FNF calc, d'base cost)

Total = \$1.6 million/year



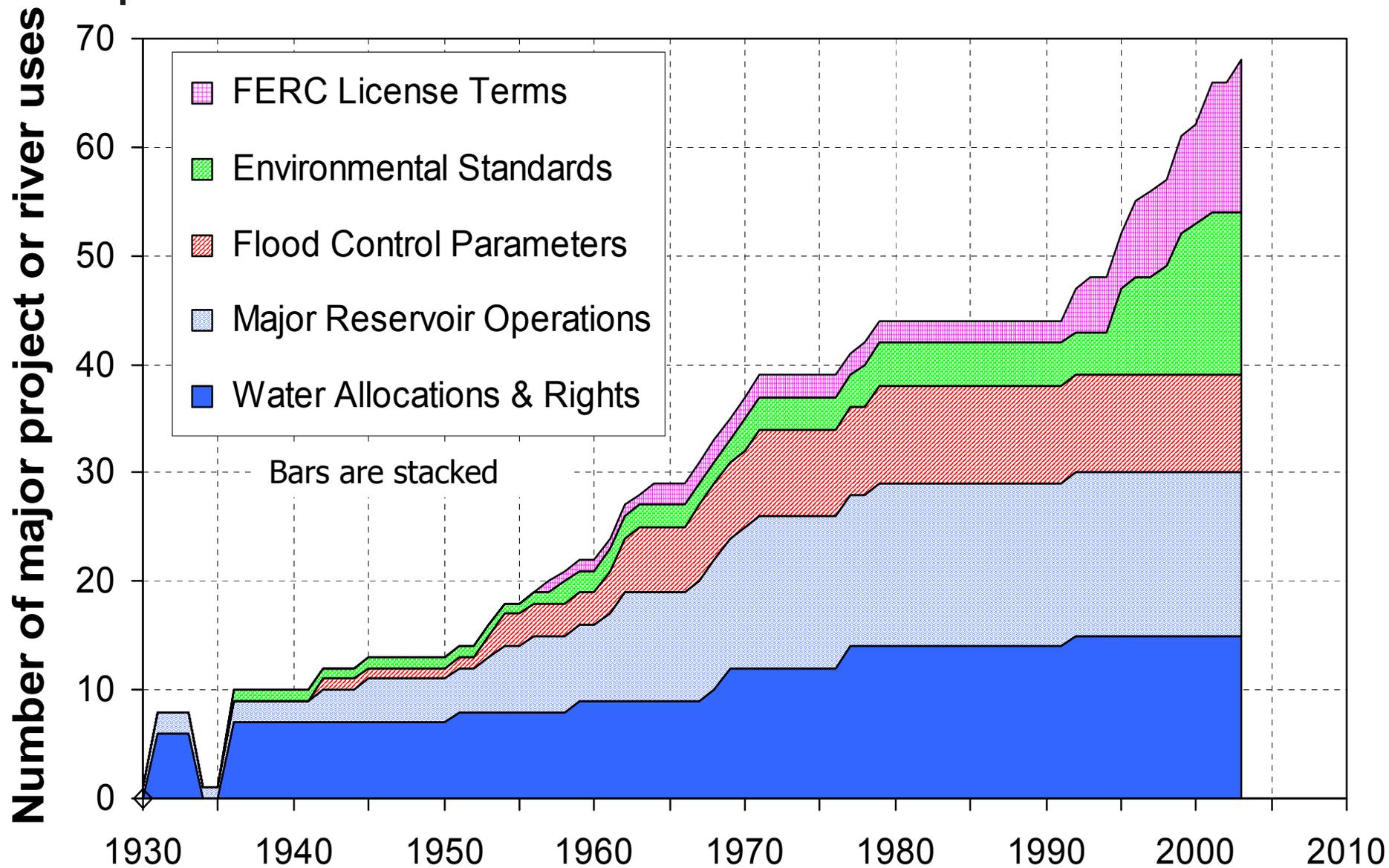


# Water Supply Forecast History Handouts

- California Forecasting History
- Water Supply / Snow Survey Products
- Use of CDWR Water Supply Forecasts

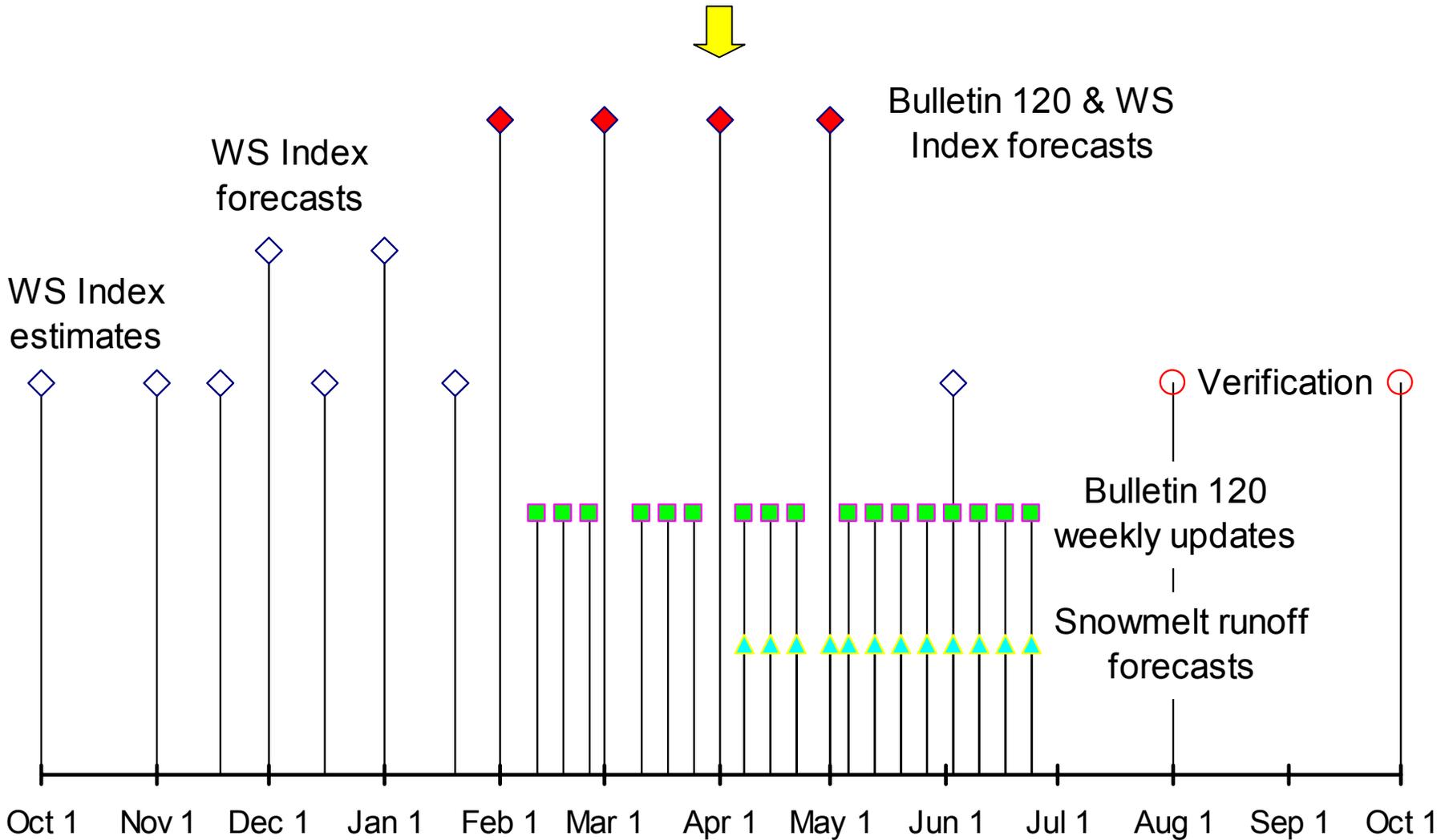


# California Water Supply Forecast Use Timeline



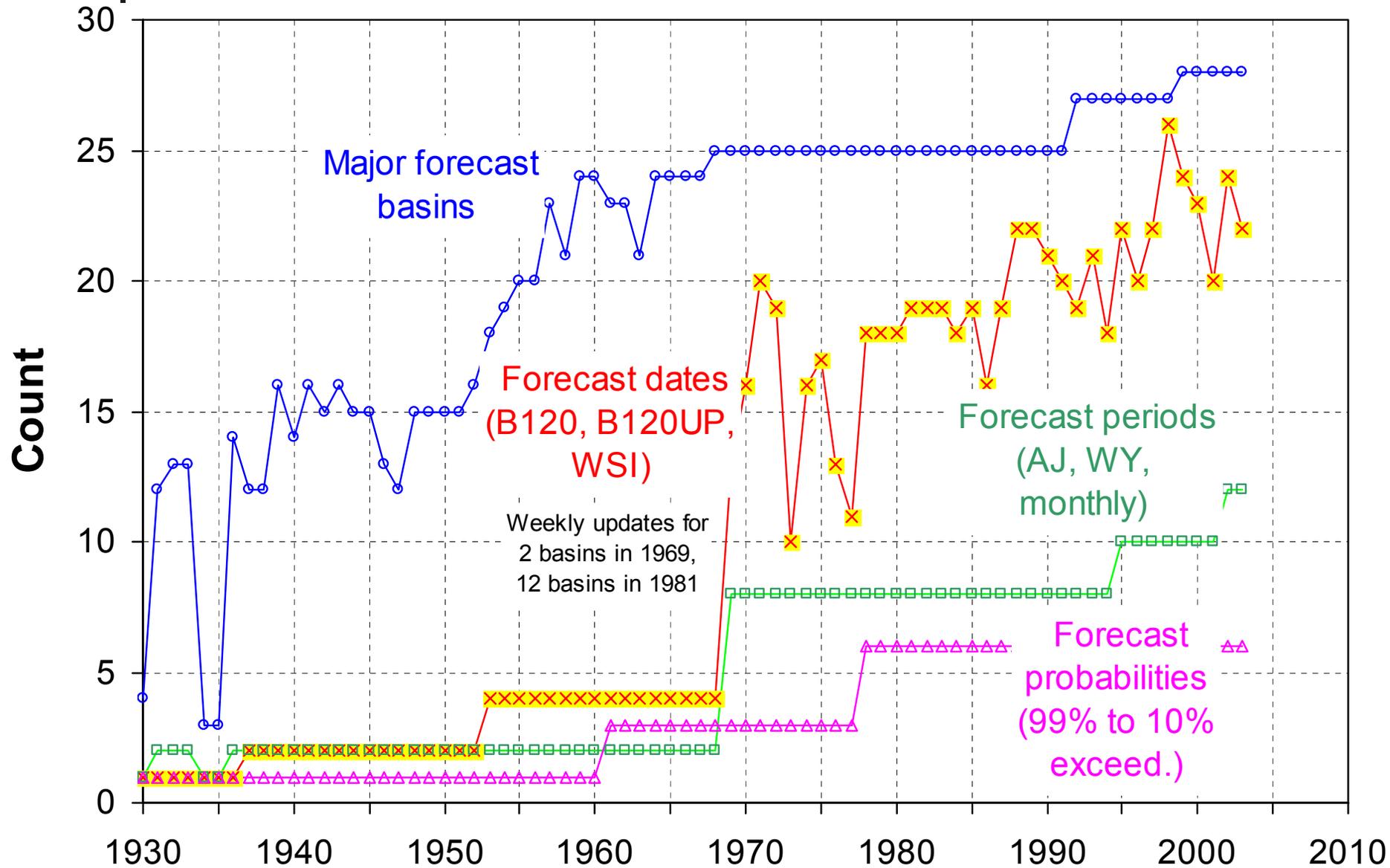


# Water Supply Forecast Schedule



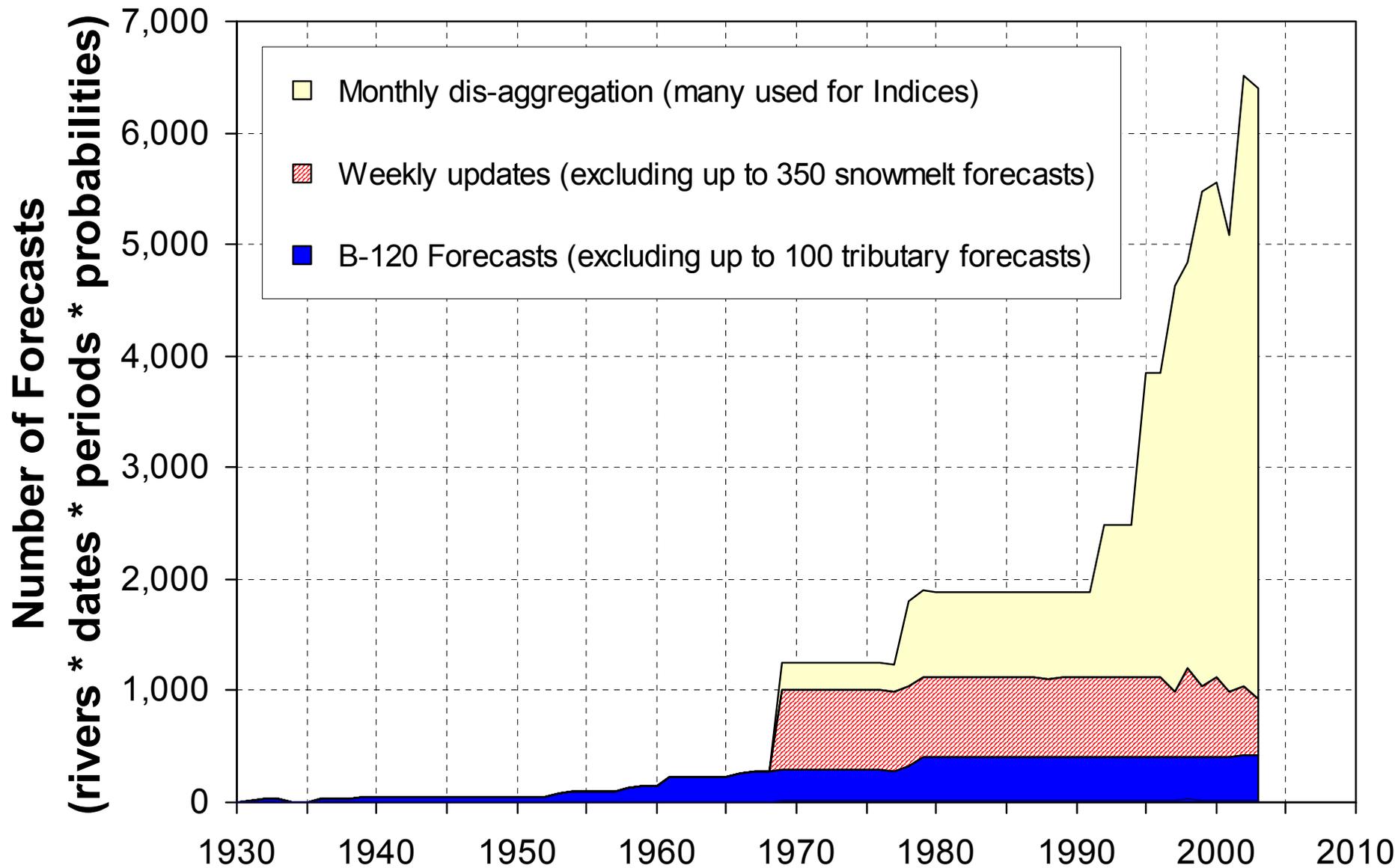


# Water Supply Forecast Scenario Timeline





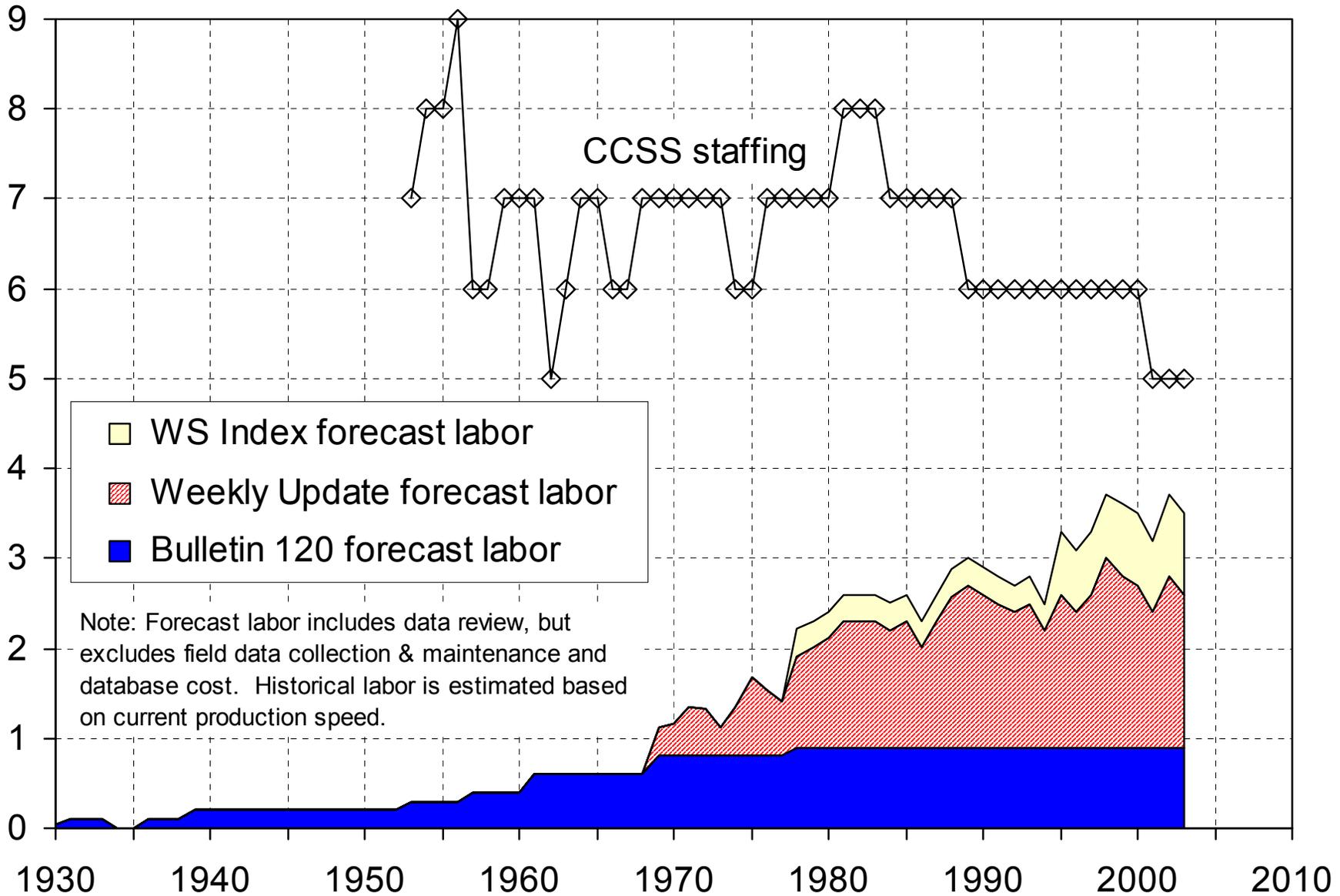
# Water Supply Forecast **Count** Timeline





# Water Supply Forecast Labor Timeline

Staff Labor [person-years]





# Service Reductions 2001-2003

- Streamline statewide water conditions data collection and reporting
- Defer some snow course and snow sensor maintenance
- Terminate early reporting of river flows in USGS contract
- Accept delays due to increased reliance on data from other agencies
  
- Allow additional day to post runoff forecasts
- Eliminate weekly forecast updates in first & last weeks of Feb-May
- Redirect Flood Forecasting staff to support water supply forecasting
- Transfer 5-20 day snowmelt forecast work to Flood Forecasters
  
- Delay review of historical snow & FNF data QC backlog
- Minimize current & historical precipitation data QC efforts
- Delay recalibration & reformulation of runoff forecast procedures
- Terminate USGS contract to develop daily precip.-runoff model



# Snow Survey / WS Program Funding & Services

## ■ FY 2003-04 Funding

■ General Fund Program 10 (Local Assist.)	\$498,000
■ General Fund Program 30 (Public Safety)	\$189,000
■ SWP and CVP (share of Branch support)	\$356,000
■ Other Cooperating Agencies	<u>\$ 88,000</u>
■ SUM All (excludes pass-through for surveys)	\$1,131,000
■ Contracts & Operating Expense	<u>-\$350,000</u>
■ SUM available for Personnel	\$781,000

## ■ Current Service Provided (person-years)

■ CCSS Coordination, Supervision	0.75
■ Field Data Measurement, Maint., Research	2.25
■ Data Processing, Review, Archiving, Reports	3.90
■ Seasonal Runoff Forecasting & Development	<u>1.10</u>
■ SUM	8.00

## California Water Supply Forecasting History

<u>Year begun</u>	<u>Forecast type</u>
1930	First report. Apr-Jul North Lahontan Apr 1 forecasts (w/ Nevada Snow Surveys).
1931	Apr 1 forecasts of water year runoff, major rivers. (Sacramento at Red Bluff through Kern at Bakersfield)
1932	Apr 1 forecasts of Apr-Jul runoff, major rivers. (American at Fair Oaks through Kern at Bakersfield) Tributary forecasts begin for 13 sub-basins
1934-35	No forecasts (legislature cut funding for surveys).
1937	May 1 forecasts of Apr-Jul runoff, major rivers & some tributaries. (American at Fair Oaks through North Lahontan)
1938-41	May 1 forecasts of water year runoff (Sac. through Kern) Apr 1 & May 1 Apr-Jul northern forecasts. (Pit at Ydalpom through Yuba at Smartville)
1953	Feb 1 & Mar 1 forecasts of Apr-Jul runoff. (Shasta inflow through Kern at Bakersfield) Apr 1 & May 1 Trinity & Owens Apr-Jul forecasts.
1957-58	May 1 forecasts of water year runoff (Sac. through Kern) Apr 1 & May 1 Shasta tributaries Apr-Jul forecasts. Feb 1 & Mar 1 Trinity & Owens Apr-Jul forecasts. Calif. Mar 1, Apr 1, May 1 forecasts of North Lahontan runoff.
1961	Apr-Jul 90% & 10% probability range
~1967	Snowmelt runoff forecasts
1968	Current (2000) forecast suite. (Feb 1 through May 1, Apr-Jul & WY, Trinity through Owens)
1969	Weekly updates Feb-Jun (S.Joaquin & Kings) Monthly disaggregation of median forecasts (Feb-Sep)
1978	Water year 90% & 10% probability range SRI forecasts (Dec - May 99%, 90%, 75%, 50%, 25%, 10% probability of exceedence)
1979-81	Transition from forecast nomographs to statistical equations Weekly updates for 12 basins
1988	Drop Surprise Valley & Goose Lake tributaries (begun 1963, 1977)
1993	Upper Feather forecasts
1995	Sac. Valley Index, SJ Valley Index & 8 River Index forecasts (Dec - May, 99% to 10% probability of exceedence)
1999	Sac. Valley net Accretions forecasts
2002	Oct 1, Nov 1 Sac. Valley Index, SJ Valley Index & 8 River Index forecasts

# Water Supply / Snow Survey Products

<u>Subject / Product</u>	<u>Media</u>	<u>Dates</u>	<u>Frequency</u>
<b>DWR Publications</b>			
Bulletin 120	published, web (.pdf format)	Feb-May	monthly
Bulletin 132 (hydrology summary)	published	variable	annual
SWP Operation Report ( " " )	published	variable	annual
<b>Runoff Forecasts (Trinity through Kern)</b>			
Water Supply Indices (SRI,SVI,SJI,8RI)	web (WSI), fax, paper, e-mail	Dec-May	monthly +
April-July, WY volume	B120, web (B120), e-mail	Feb-May	monthly
April-July update	web (B120UP), fax, e-mail	Feb-Jun+	weekly
Snowmelt 5-20 day runoff	web (RFC: snowmelt.htm)	Apr-Jun+	weekly
Hindcasts & verification	meeting topic	Jul,Nov	biannual
Historical Water Supply Indices	web (WSIHIST)	fall	annual
Historical Forecast	archive (HisFcasDat.xls)	summer	annual
Historical Snow & Precip Indices	archive (HisIndx.xls)	summer	annual
E-mail announcement & discussion	e-mail, DFM activities report	Dec-Jun	weekly
<b>Water Conditions Reports/Plots/Data/Summaries</b>			
Monthly Precipitation	web (PRECIPOUT.yyyy, ..)	all year	monthly
Monthly Precipitation summary	web (PRECIPSUM.yyyy)	all year	monthly
Daily Precipitation	web (PRECIPLY.bsn.yyyyymm, ..)	all year	weekly
N.Sierra precipitation index plot	web (PlotESI)	all year	daily
Historical N.Sierra precipitation index	web (8STATIONHIST)	fall	annual
Historical Precipitation data	web archive (sens_num=2,45)	all year	continuous
50 year Precipitation averages	database	every 5 years	
Water Year FNF report	web (FNFSUM.yyyy)	all year	monthly
Monthly/Seasonal FNF report	web (FLOWOUT.yyyyymm)	all year	monthly
Daily FNF report	web (FNF.yyyyymm), plots	all year	daily
Historical FNF data	web archive (sens_num=8,65)	all year	continuous
50 year FNF averages	database	every 5 years	
Monthly Reservoir report	web (STORAGE.yyyyymm)	all year	monthly
Weekly Reservoir report	web (RESVSUM.yyyyymmdd)	all year	weekly
Daily Reservoir report	web (RES.dd)	all year	daily
Historical Reservoir storage	web archive (sens_num=15)	all year	continuous
50 year Reservoir storage averages	database	every 5 years	
State River & Reservoir summary	web (NEWSOUT)	all year	daily
Regional River summaries	web (PAGE1.dd, PAGE4.dd)	all year	daily
Snow course report	web (COURSES.mmm.html)	Jan-Jun	monthly
Snow sensor report	web (PAGE6.yyyyymmdd)	Oct-Jun+	daily
Snow sensor summary report	web (DLYSWEQ.yyyyymmdd)	Oct-Jun+	daily
Snow sensor plots	web (pillowplots/....)	Oct-Jun+	daily
Snow sensor controls report	web (CONTROLS)	Dec-Jun	~monthly
Snow sensor outage report	web (outages)	Dec-Jun	as needed
Snow measurement schedule	web (schedule.html)	fall	annual
Historical Snow data	web archive (sens_num=3,82)	all year	continuous
50 year Snow water content averages	database	every 5 years	
Water conditions summary	web (EXECSUM)	all year	~weekly
Water conditions 10 yr plot	web (PlotCONDSUM)	all year	monthly
Water conditions for Reclamation Bd	text	all year	monthly
Water conditions for Colorado R Bd	e-mail (data)	all year	monthly
Water conditions presentations	conferences, media interviews	variable	variable
Station metadata	web queries	all year	continuous

## Current Use of CDWR Water Supply Forecasts

partial inventory as of 11/14/03

All direct use of DWR forecasts as primary guidance except as noted. \* DWR forecast cited as sole source in legal order or agreement.

<u>Regulation / Project</u>	<u>DWR Forecast</u>	<u>Agencies affected</u>	<u>Potential Impacts</u>	
			[TAF/year] [Saftey/Envir./Econ.]	
<b>US Army Corps of Engineers Flood Control Requirements (Flood control diagram snowmelt parameter)</b>			(max-min req'mt)	
Camanche storage	Mokelumne AJ f'cast	USACE, East Bay MUD	200 Saftey	Econ.
New Melones storage	Stanislaus AJ f'cast	USACE, Central Valley Project	450 Saftey	Econ.
New Don Pedro storage	Tuolumne AJ f'cast	USACE, Modesto ID, Turlock ID	1000 Saftey	Econ.
Exchequer storage	Merced AJ f'cast	USACE, Merced ID	400 Saftey	Econ.
Millerton storage	San Joaquin AJ f'cast	USACE, Central Valley Project	520 Saftey	Econ.
Pine Flat storage	Kings AJ f'cast	USACE, Kings River CD & WA	1000 Saftey	Econ.
Terminus storage	Kaweah AJ f'cast	USACE, Kaweah Delta WCD	140 Saftey	Econ.
Success storage	Tule AJ f'cast	USACE, Tule River Assoc.	80 Saftey	Econ.
Isabella storage	Kern AJ f'cast	USACE, Kern agencies	560 Saftey	Econ.
<b>Environmental Regulations</b>			(max-min req'mt)	
<b>State Water Resources Control Board (Decision #):</b>				
Sac-SJ Delta flow & WQ (D-1641)	Sacram. Valley Index*	SWRCB, State Water Project, Central Valley Project	>5000	Envir. Econ.
Sac-SJ Delta flow & WQ (D-1641 & Sacram. River Index*		SWRCB, State Water Project, Central Valley Project	incl. above	Envir. Econ.
Sac-SJ Delta flow & WQ (D-1641)	8 River Index*	SWRCB, State Water Project, Central Valley Project	incl. above	Envir. Econ.
S.Joaquin R flow & WQ (D-1641)	San Joaquin Index*	SWRCB, State Water Project, Central Valley Project	~300	Envir. Econ.
S.Joaquin R flow (D-1641)	San Joaquin Index*	SWRCB, Merced ID, Turlock ID, Modesto ID, Oakdale ID, +	110	Envir. Econ.
Mokelumne releases (D-1641)	Mokelumne WY f'cast*	SWRCB, East Bay MUD	110	Envir. Econ.
Mokelumne releases (D-1641)	Mokelumne WY f'cast*	SWRCB, Woodbridge ID	40	Envir. Econ.
Yuba releases (D-1644)	Yuba River Index*	SWRCB, Yuba County Water Agency	180	Envir. Econ.
Folsom releases (D-893)	Folsom WY forecast	SWRCB, Central Valley Project	60	Envir. Econ.
<b>Environmental Decisions (1993 Winter-run Biological Opinion, 2000 Trinity R Mainstem Fishery ROD, 1983 DFG agreement):</b>				
Trinity releases	Trinity WY f'cast	Central Valley Project	446	Envir. Econ.
Sacramento R temperatures	Sacram. River Index*	Central Valley Project, USFWS	>500	Envir. Econ.
Wilkins 'navigation' flow	Shasta WY f'cast	Central Valley Project	~180	Envir. Econ.
Feather R flow	Feather AJ obs'd & f'cast	State Water Project, DFG	190	Envir. Econ.
<b>Central Valley Project Improvement Act</b>				
Vernalis Adaptive Management	Stan-S.Joaq monthly f'casts	CVP, Modesto ID, Turlock ID, Merced ID, +	>100	Envir. Econ.
Environmental Water Account	SWP allocation (indirect)	State Water Project, Central Valley Project, +	~200	Envir. Econ.
<b>Federal Energy Regulatory Commission licenses (Project #):</b>				
McCloud R ___ (P-2106)	___ f'cast	FERC, Pacific Gas & Electric	___	Envir. Econ.
NF Feather R releases (P-1962)	Feather WY f'cast*	FERC, USFS, Pacific Gas & Electric	266	Envir. Econ.
Upper American rel. (P-2101)	American WY f'cast*	FERC, Sacramento MUD	___	Envir. Econ.
SF American release (P-184)	American WY f'cast*	FERC, El Dorado ID	___	Envir. Econ.
Mokelumne R releases (P-137)	Mokelumne WY f'cast*	FERC, USFS, Pacific Gas & Electric	182	Envir. Econ.
L.Mokel. Joint Settlement (P-2916)	Mokelumne WY f'cast	FERC, East Bay MUD, USFWS, DFG	~110	Envir. Econ.
NF Stanislaus release (P-2019)	Stanislaus AJ f'cast*	FERC, Utica Power Authority, N.Cal. Power Agency	53	Envir. Econ.
MF,SF Stanislaus rel. (P-2130)	Stanislaus AJ f'cast*	FERC, USFS, Pacific Gas & Electric/Tri-Dam (pending)	60	Envir. Econ.
SF Stanislaus release (P-1061)	S.Joaquin Index(?)*	FERC, USFS, Pacific Gas & Electric	3	Envir. Econ.
Tuolumne releases (P-2299)	S.Joaquin Index*	FERC, Turlock ID, Modesto ID, H.Hetchy, USFWS, DFG	207	Envir. Econ.
Merced releases (P-2179)	___	FERC, Merced ID	17	Envir. Econ.
Kaweah R release (P-298)	Kaweah WY f'cast(*)	FERC, CDFG, Southern California Edison	5	Envir. Econ.
Tule R releases (P-1333)	Tule WY f'cast*	FERC, CDFG, Pacific Gas & Electric	1	Envir. Econ.
Lundy project operation (P-1390)	Mono f'cast(*)	FERC, FWS, BLM, USFS, CDFG, So. California Edison	-	Envir.

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			[TAF/year]	[Saftey/Envir./Econ.]	
MANY more ....					
<b>Water Rights Agreements</b>			(max-min req'mt)		
Deficiency criteria	Feather AJ f'cast*	SWP, Joint WD Board, Western Canal WD	285		Econ.
Deficiency criteria	Frenchman, Davis f'cast*	SWP, Upper Feather water rights holders	—		Econ.
Storage Cost Agreement	Mokelumne WY f'cast*	East Bay MUD, N. San Joaquin WCD	n/a		Econ.
Kern member allocations	Kern __ f'cast	N.Kern WSD, Kern Delta WD, Bakersfield, Buena Vista WSD	~700		Econ.
CVP Deficiency criteria	Shasta WY f'cast	San Joaquin Exchange Contractors	>200		Econ.
CVP Deficiency criteria	Shasta WY f'cast	Sacramento River water rights contractors	>500		Econ.
MANY more ....					
<b>Project Water Allocations</b>			(estim. avg. magnitude)		
SWP deliveries	Sac-SJ monthly f'casts	State Water Project, ~20 water agencies	~3500		Econ.
CVP project deliveries	Trin-SJ monthly f'casts	Central Valley Project, ~110 water agencies	~5200		Econ.
Yuba River deliveries	Yuba monthly f'casts	Yuba County WA, Nevada ID	~400		Econ.
American River deliveries	American monthly f'casts	Placer Co. WA, Eldorado ID	~200		Econ.
Mokelumne River deliveries	Mokelumne monthly f'casts	East Bay MUD, Woodbridge ID	~300		Econ.
Stanislaus River deliveries	Stanislaus monthly f'casts	Tri-Dam Project: S. San Joaquin ID, Oakdale ID	~600		Econ.
Tuolumne River deliveries	Tuolumne monthly f'casts	Turlock ID, Modesto ID, Hetch Hetchy W&P	~1300		Econ.
Merced River deliveries	Merced monthly f'casts	Merced ID	~600		Econ.
Kings R Service Area deliveries	Kings monthly f'casts	Kings River WA	~1500		Econ.
MANY more ....					
<b>Major Reservoir Operations</b>			(capacity)		
Trinity Lake	Trinity WY f'cast	Central Valley Project	1410	Saftey Envir.	Econ.
Lake Shasta	Sacramento WY f'cast	Central Valley Project, State Water Project	6200	Saftey Envir.	Econ.
Lake Oroville	Feather WY f'cast	State Water Project, Central Valley Project	4770	Saftey Envir.	Econ.
Bullards Bar Res.	Yuba WY f'cast	Yuba County Water Agency, SWP, CVP	2460	Saftey Envir.	Econ.
Folsom Lake	American WY f'cast	Central Valley Project, State Water Project	2830	Saftey Envir.	Econ.
Camanche & Pardee Res.	Mokel. WY f'cast (secondary)	East Bay MUD	770	Saftey Envir.	Econ.
New Melones Reservoir	Stanislaus WY f'cast	Central Valley Project, State Water Project	1200	Saftey Envir.	Econ.
New Don Pedro Reservoir	Tuolumne WY f'cast	Modesto ID, Turlock ID, CVP, SWP	1970	Saftey Envir.	Econ.
Exchequer Reservoir	Merced WY f'cast	Merced ID, CVP, SWP	1010	Saftey Envir.	Econ.
Millerton Lake	San Joaquin WY f'cast	Central Valley Project, State Water Project	1850	Saftey Envir.	Econ.
Pine Flat Reservoir	Kings WY f'cast	US Army Corps of Engineers, Kings River CD & WA	1740	Saftey Envir.	Econ.
Terminus Reservoir	Kaweah WY f'cast	US Army Corps of Engineers, Kaweah Delta WCD	460	Saftey Envir.	Econ.
Lake Success	Tule WY f'cast	US Army Corps of Engineers, Tule River Assoc.	150	Saftey Envir.	Econ.
Lake Isabella	Kern WY f'cast	US Army Corps of Engineers, Kern agencies	740	Saftey Envir.	Econ.
Lake Tahoe	Tahoe AJ f'cast (secondary)	Truckee Water Master	180	Saftey Envir.	Econ.