

Real Time Snow Water Equivalent (SWE) Simulation May 23, 2017 Sierra Nevada Mountains, California

Abstract

On May 23, 2017, percent of average May 23rd SWE values for this date are 65% for the Northern watersheds, 162% for the Central, and 191% for the Southern watersheds (see map on right). Please note that this map covers only the Feather and Truckee watersheds for the Northern watersheds and is missing Mono for the Southern watersheds. 75 snow sensors in the Sierra network were operational out of a total of 99 sensors. The locations of sensors that aren't operational are shown in yellow in Figure 3, left map.

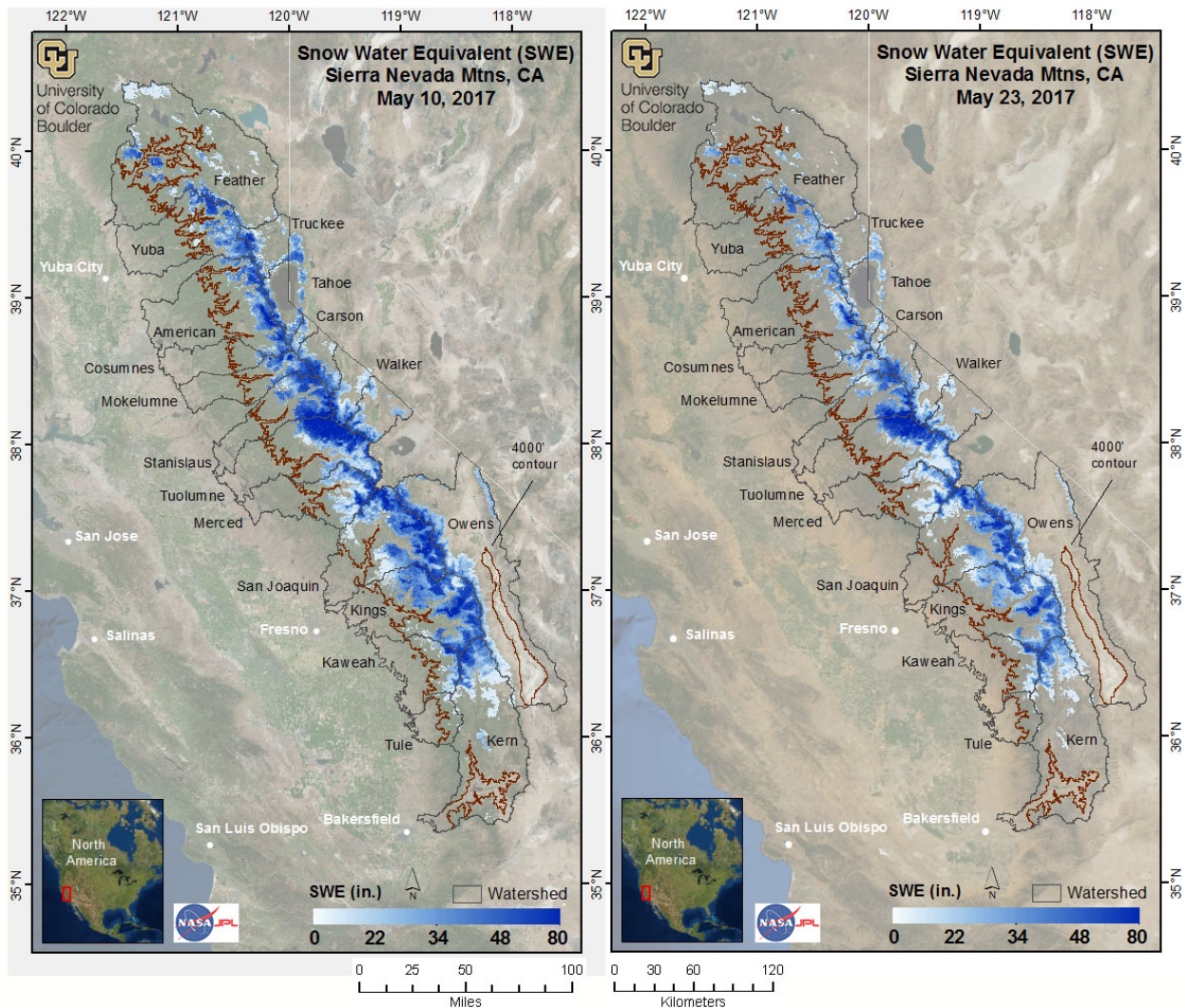
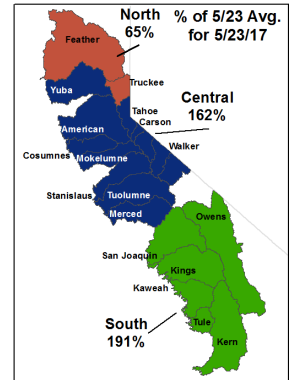


Figure 1. SWE amounts for May 10, 2017 are shown on the left and SWE amounts for May 23, 2017 are shown on the right.

Introduction

We have developed a real-time SWE estimation scheme based on historical SWE reconstructions between 2000-2014, a near real time MODIS/MODSCAG image (Painter et al, 2009 - snow.jpl.nasa.gov), and daily in situ SWE measurements for the Sierra Nevada in California (Molotch, 2009; Molotch and Margulis, 2008; Molotch and Bales, 2006; Molotch and Bales, 2005, Molotch, et. al., 2004 and Guan, et. al., 2013).

Discussion

The most recent cloud-free MODIS/MODSCAG image available is for May 23, 2017. Figure 1 shows SWE amounts for May 10, 2017 and for May 23, 2017. On May 23, 2017 seventy-five snow sensors in the Sierra network were operational out of a total of 99 sensors. The locations of sensors that aren't operational on 5/23/17 are shown in yellow in Figure 3, left map. Totals from sensors alone do not accurately calculate SWE for the entirety of each watershed. Figure 2 shows the percent of average (between 2000-2011) May 23rd SWE for May 23, 2017 for the snow-covered area on left and on the right is the mean percent of the May 23rd average for May 23, 2017 shown by watershed for all model pixels above 4000' (shown as the black elevation contour line on left map). Note that watershed averages are different than those calculated using snow sensors alone. Snow sensors produce a point value whereas the spatial SWE allows for areal calculations. Every square foot above 4000' in the watershed can be used to calculate the mean, therefore the mean value will be different than those calculated by snow sensor point data. Figure 3 shows the 12-year-modeled average SWE (between 2000-2011) for May 23rd on the left with snow sensors shown in yellow that were not operational on May 23, 2017 and in red for sensors that were operational on May 23, 2017; and a banded elevation map on the right. Table 1 shows mean SWE and mean percent of average (between 2000-2011) May 23rd SWE for May 23, 2017, mean SWE for May 10, 2017, change in SWE between May 10, 2017 and May 23, 2017, summarized for each watershed above 4000'. Table 2 shows mean SWE and mean percent of average May 23rd SWE for May 23, 2017, mean SWE for May 10, 2017, change in SWE between May 10, 2017 and May 23, 2017, summarized for each watershed above 4000', and area in square miles for each elevation band inside each watershed. The Owens watershed does not include the White Mountains in the banded elevation totals.

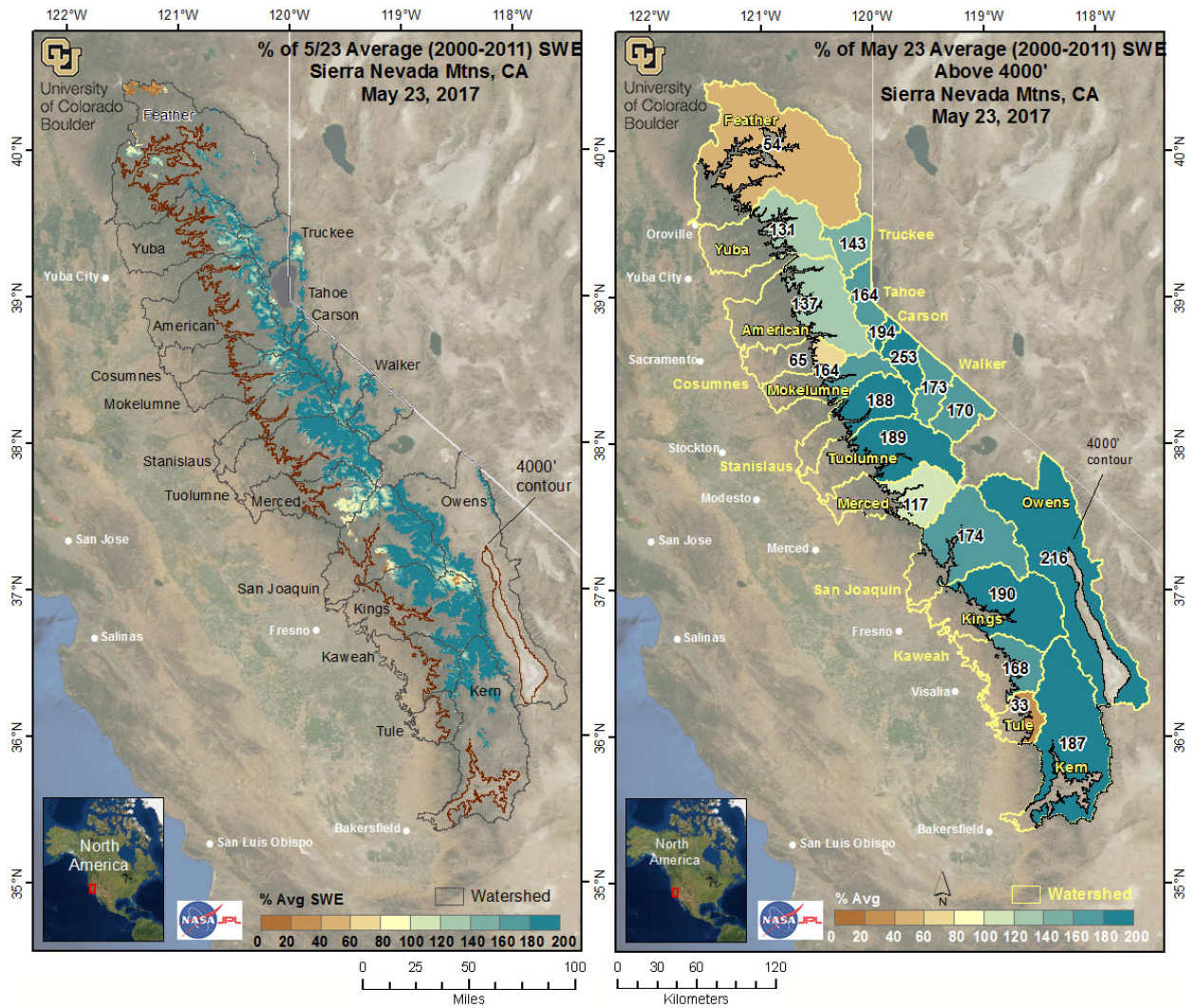


Figure 2. Percent of average May 23rd SWE (between 2000-2011) for May 23, 2017 for the entire Sierra (on left) and by watershed (on right). Watershed percentages are calculated for all model pixels above 4000' (shown as red line on left map).

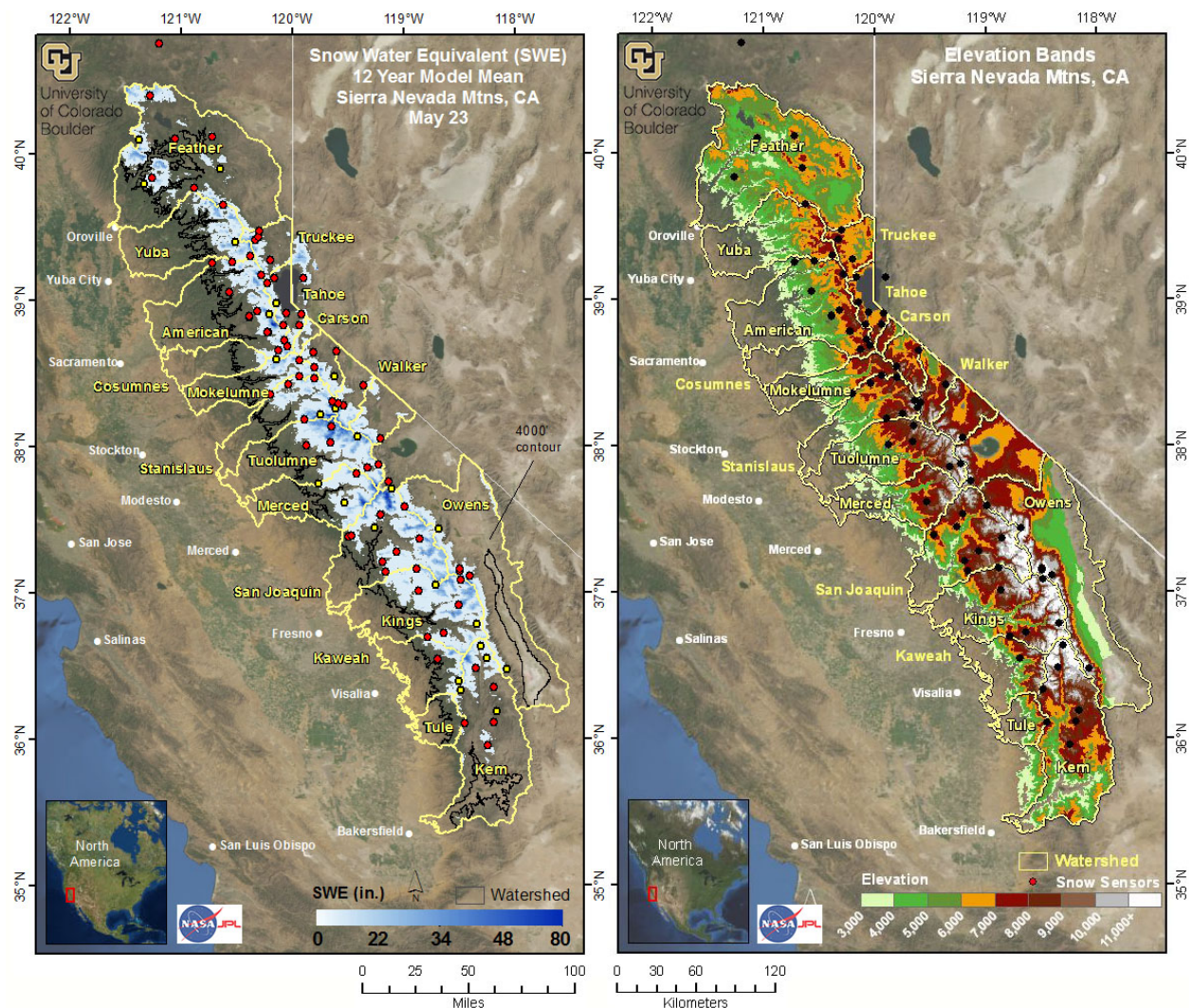


Figure 3. 12-year-modeled average SWE (between 2000-2011) for May 23rd on the left with snow sensors shown in yellow that were not operational and in red for sensors that were operational on May 23, 2017; and a banded elevation map on the right.

Methods

Results for the date of May 23, 2017 are based on May 23, 2017 real-time data from 75 in situ SWE measurements distributed across the Sierra Nevada, one Moderate Resolution Imaging Spectroradiometer (MODIS)/Terra Snow cover daily cloud-free image which has been processed using the MODSCAG fractional snow cover program (Painter, et. al. 2009), a normalized reconstructed spatial SWE image for March 1, 2006, and an anomaly map based on 12 years of modeled SWE (2000-2011). Relative to snow stations and the NWS SNODAS product, the spatial reconstructed SWE product correlates strongly with full natural flow, especially late in the snowmelt season (Guan, et. al. 2013).

Table 1. All calculations are for elevations above 4000', Shown are mean SWE and mean percent of average (between 2000-2011) May 23rd SWE for May 23, 2017, mean SWE for May 10, 2017, change in SWE between May 10, 2017 and May 23, 2017, summarized for each watershed.

Watershed	5/23/17 % 5/23 Avg to Date	5/10/17 SWE (in)	5/23/17 SWE (in)	5/10/17 thru 5/23/17 Change in SWE (in)
AMERICAN	136.9	16.7	10.5	-6.2
COSUMNES	65.4	2.7	1.4	-1.3
EAST FORK CARSON RIVER	253.1	19.4	13.4	-5.9
EAST WALKER RIVER	170.1	12.8	7.4	-5.4
FEATHER	53.9	3.9	1.9	-2.1
KAWEAH	168.0	11.7	8.6	-3.1
KERN	186.9	6.3	4.6	-1.8
KINGS	190.4	27.8	20.1	-7.6
MERCED	117.2	16.9	10.9	-6.0
MOKELUMNE	163.9	19.7	14.3	-5.3
OWENS	215.8	7.3	4.8	-2.5
SAN JOAQUIN	173.7	26.8	19.7	-7.0
STANISLAUS	187.7	26.3	18.9	-7.3
TAHOE	164.3	24.1	14.7	-9.3
TRUCKEE	143.2	13.2	8.3	-5.0
TULE	32.5	1.1	0.4	-0.7
TUOLUMNE	188.6	27.6	21.2	-6.4
WEST FORK CARSON RIVER	194.3	19.9	12.2	-7.7
WEST WALKER RIVER	172.7	17.5	11.5	-6.1
YUBA	130.5	20.4	11.9	-8.5

Table 2. All calculations are for elevations above 4000'. Mean SWE and mean percent of average (between 2000-2011) May 23rd SWE for May 23, 2017, mean SWE for May 10, 2017, change in SWE between May 10, 2017 and May 23, 2017, summarized for each elevation band inside each watershed, and area in square miles for each elevation band inside each watershed. The Owens watershed does not include White Mountain SWE in the banded elevation totals.

Watershed	Elevation	5/23/17 % 5/23 Avg to Date	5/10/17 SWE (in)	5/23/17 SWE (in)	5/10/17 vs. 5/23/17 Change SWE (in)	Area Sq Mi
AMERICAN	4000-5000'	0	0.0	0.0	0.0	208.0
	5000-6000'	8	1.2	0.2	-1.0	287.2
	6000-7000'	111	19.9	9.2	-10.6	288.9
	7000-8000'	166	40.6	28.0	-12.6	171.6
	8000-9000'	170	54.4	42.0	-12.4	73.6
	9000-10,000'	163	67.5	54.0	-13.5	8.6
COSUMNES	4000-5000'	0	0	0	0	68.5
	5000-6000'	0	0.0	0.0	0.0	62.8
	6000-7000'	41	7.1	2.2	-5.0	26.1
	7000-8000'	152	30.7	21.2	-9.5	9.1
E CARSON	5000-6000'	0	0.0	0.0	0.0	32.6
	6000-7000'	18	1.0	0.1	-0.8	74.4
	7000-8000'	251	14.2	7.1	-7.0	100.5
	8000-9000'	290	35.6	25.7	-9.9	94.6
	9000-10,000'	243	43.5	35.0	-8.5	30.8
	10,000-11,000'	209	43.5	35.4	-8.1	12.9
	> 11,000'	201	60.0	50.0	-10.0	0.3
E WALKER	6000-7000'	0	0.0	0.0	0.0	72.6
	7000-8000'	28	2.1	0.3	-1.8	152.4
	8000-9000'	156	12.1	4.4	-7.7	154.7
	9000-10,000'	218	30.7	20.0	-10.7	61.3
	10,000-11,000'	179	41.5	31.0	-10.5	48.0
	> 11,000'	168	42.7	32.4	-10.3	8.1
FEATHER	4000-5000'	0	0.1	0.0	-0.1	637.9
	5000-6000'	15	2.0	0.4	-1.6	1252.4
	6000-7000'	78	8.2	4.3	-3.9	840.6
	7000-8000'	88	14.6	10.0	-4.6	117.0
	8000-9000'	90	24.0	18.3	-5.6	5.1
KAWEAH	4000-5000'	0	0.1	0.0	-0.1	49.8
	5000-6000'	0	0.2	0.0	-0.2	60.4
	6000-7000'	0	0.8	0.0	-0.8	62.8
	7000-8000'	36	4.2	1.0	-3.3	65.2
	8000-9000'	180	17.7	11.1	-6.6	56.1
	9000-10,000'	222	25.6	20.9	-4.7	39.7
	10,000-11,000'	201	45.4	37.8	-7.6	36.8
	> 11,000'	184	53.5	44.7	-8.8	9.1
KERN	4000-5000'	0	0.0	0.0	0.0	192.4
	5000-6000'	0	0.0	0.0	0.0	274.9
	6000-7000'	0	0.1	0.0	-0.1	398.6
	7000-8000'	14	0.5	0.1	-0.4	337.5
	8000-9000'	71	3.4	1.2	-2.2	308.2
	9000-10,000'	215	10.3	5.7	-4.5	168.9
	10,000-11,000'	264	24.4	18.7	-5.7	150.5
	> 11,000'	227	41.5	34.0	-7.4	144.1

KINGS	4000-5000'	4	0.5	0.0	-0.4	72.7
	5000-6000'	5	1.0	0.1	-0.9	93.9
	6000-7000'	5	2.7	0.1	-2.5	136.3
	7000-8000'	55	12.3	3.2	-9.1	168.1
	8000-9000'	209	29.1	19.1	-10.0	207.9
	9000-10,000'	237	36.3	27.4	-8.8	190.3
	10,000-11,000'	231	47.1	37.7	-9.4	219.9
> 11,000'	182	50.7	40.3	-10.5	198.1	
MERCED	4000-5000'	1	0.2	0.0	-0.2	72.9
	5000-6000'	0	0.2	0.0	-0.2	73.9
	6000-7000'	7	1.2	0.2	-1.0	77.9
	7000-8000'	68	13.7	5.2	-8.5	129.2
	8000-9000'	125	22.6	14.2	-8.4	125.8
	9000-10,000'	150	32.9	22.9	-10.0	74.7
	10,000-11,000'	149	49.9	38.3	-11.6	49.5
> 11,000'	125	63.2	51.6	-11.7	13.5	
MOKELUMNE	4000-5000'	0	0.0	0.0	0.0	72.4
	5000-6000'	3	0.3	0.0	-0.3	81.9
	6000-7000'	51	9.4	3.2	-6.1	71.1
	7000-8000'	172	35.4	25.2	-10.2	84.4
	8000-9000'	204	47.5	38.0	-9.4	80.2
	9000-10,000'	209	58.9	49.0	-9.9	7.2
OWENS	4000-5000'	0	0	0	0	376.1
	5000-6000'	0	0	0	0	257.7
	6000-7000'	3	0.1	0.0	-0.1	252.5
	7000-8000'	40	2.7	0.3	-2.3	301.8
	8000-9000'	250	16.5	8.8	-7.7	162.5
	9000-10,000'	276	22.7	14.5	-8.2	113.6
	10,000-11,000'	288	29.3	21.5	-7.8	187.8
> 11,000'	198	38.3	29.5	-8.8	166.8	
SAN JOAQUIN	4000-5000'	0	0.0	0.0	0.0	76.5
	5000-6000'	6	0.5	0.1	-0.4	129.1
	6000-7000'	13	2.8	0.3	-2.5	184.5
	7000-8000'	85	14.7	4.8	-9.8	207.5
	8000-9000'	191	32.3	21.6	-10.6	196.2
	9000-10,000'	195	39.9	31.3	-8.6	173.6
	10,000-11,000'	191	51.9	43.4	-8.5	189.1
> 11,000'	184	57.5	47.5	-10.0	143.2	
STANISLAUS	4000-5000'	0	0.0	0.0	0.0	83.5
	5000-6000'	1	0.5	0.0	-0.5	105.1
	6000-7000'	58	11.7	3.1	-8.6	139.9
	7000-8000'	216	35.9	23.8	-12.0	141.9
	8000-9000'	225	51.8	42.1	-9.7	121.3
	9000-10,000'	199	62.3	52.6	-9.7	45.8
	10,000-11,000'	182	76.2	63.3	-12.9	18.0
> 11,000'	184	69.1	56.3	-12.7	0.4	

TAHOE	6000-7000'	69	6.3	2.3	-4.0	99.2
	7000-8000'	174	32.1	19.3	-12.8	73.9
	8000-9000'	189	42.6	28.8	-13.8	51.4
	9000-10,000'	188	42.7	29.8	-12.9	11.9
	10,000-11,000'	162	37.1	24.5	-12.7	0.6
TRUCKEE	5000-6000'	0	0.0	0.0	0.0	50.1
	6000-7000'	106	6.6	2.8	-3.8	245.3
	7000-8000'	162	29.6	20.2	-9.4	108.3
	8000-9000'	151	50.4	40.9	-9.5	14.2
TULE	4000-5000'	0	0.0	0.0	0.0	40.0
	5000-6000'	0	0.0	0.0	0.0	52.2
	6000-7000'	0	0.1	0.0	-0.1	45.0
	7000-8000'	9	1.6	0.2	-1.4	27.9
	8000-9000'	56	5.3	1.8	-3.4	15.4
	9000-10,000'	141	14.2	8.5	-5.8	6.1
TUOLUMNE	4000-5000'	0	0.0	0.0	0.0	125.9
	5000-6000'	2	0.3	0.0	-0.2	168.4
	6000-7000'	22	4.4	0.8	-3.6	148.1
	7000-8000'	200	30.3	20.4	-9.8	147.6
	8000-9000'	228	47.1	37.0	-10.0	171.1
	9000-10,000'	205	54.8	44.3	-10.5	151.1
	10,000-11,000'	178	55.9	45.3	-10.6	113.2
	> 11,000'	157	51.1	43.2	-7.9	29.9
W CARSON	4000-5000'	0	0	0	0	1.4
	5000-6000'	0	0.1	0.0	0	15.9
	6000-7000'	25	4.3	0.6	-3.8	8.7
	7000-8000'	158	17.9	8.1	-9.8	36.1
	8000-9000'	224	30.5	21.0	-9.5	30.1
	9000-10,000'	217	37.5	26.7	-10.8	9.5
	10,000-11,000'	194	43.8	30.7	-13.1	2.2
W WALKER	5000-6000'	0	0	0	0	45.7
	6000-7000'	0	0.2	0.0	-0.2	59.4
	7000-8000'	60	3.9	0.6	-3.2	89.4
	8000-9000'	207	18.8	9.6	-9.2	92.5
	9000-10,000'	184	39.5	28.6	-10.8	71.6
	10,000-11,000'	163	49.5	37.5	-12.0	41.1
	> 11,000'	162	35.4	24.5	-10.9	2.5
YUBA	4000-5000'	0	2.2	0.0	-2.2	161.6
	5000-6000'	29	8.7	1.0	-7.6	178.0
	6000-7000'	144	31.4	17.8	-13.6	234.8
	7000-8000'	154	41.5	32.3	-9.2	119.2
	8000-9000'	140	57.1	46.0	-11.1	5.8

Location of Reports and Excel Format Tables

ftp://snowserver.colorado.edu/pub/fromLeanne/forCADWR/Near_Real_Time_Reports/

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