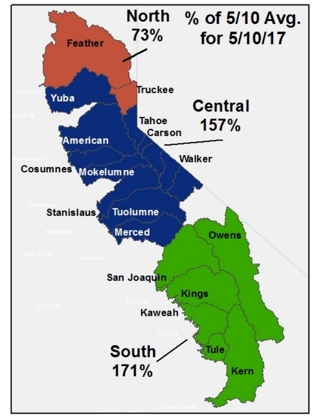
Real Time Snow Water Equivalent (SWE) Simulation
May 10, 2017
Sierra Nevada Mountains, California

Abstract

On May 10, 2017, percent of average May 10th SWE values for this date are 73% for the Northern watersheds, 157% for the Central, and 171% 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. 78 snow sensors in the Sierra network are 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.



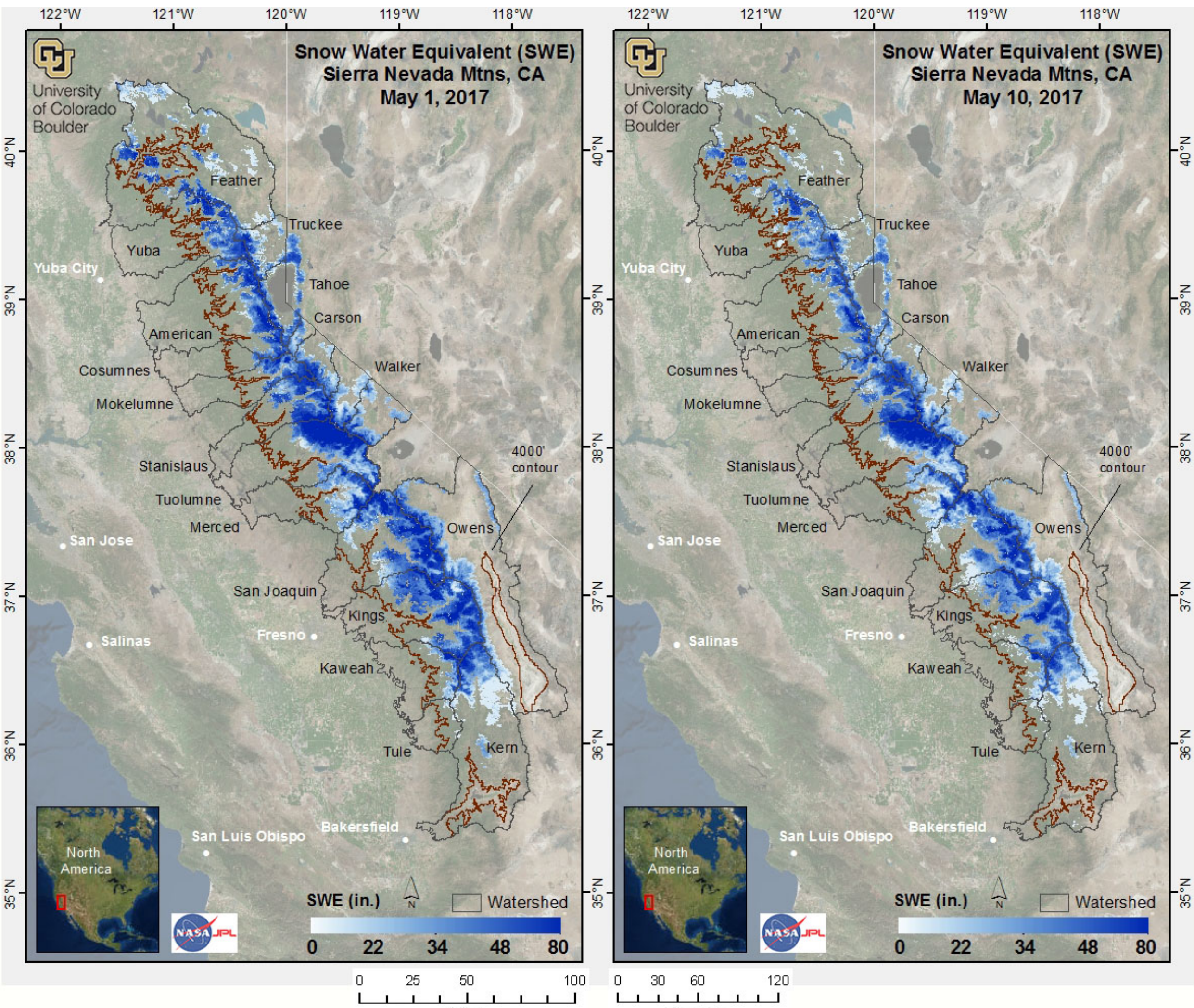


Figure 1. SWE amounts for May 1, 2017 are shown on the left and SWE amounts for May 10, 2017 are shown on the right.

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 10, 2017. Figure 1 shows SWE amounts for May 1, 2017 and for May 10, 2017. On May 10, 2017 seventy-eight snow sensors in the Sierra network are operational out of a total of 99 sensors. Note the locations of sensors that aren't operational on 5/10/17 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 10th SWE for May 10, 2017 for the snow-covered area on left and on the right is the mean percent of the May 10th average for May 10, 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 10th on the left with snow sensors shown in yellow that recorded no snow on May 10, 2017 and in red for sensors that recorded snow on May 10, 2017; and a banded elevation map on the right. Table 1 shows mean SWE and mean percent of average (between 2000-2011) May 10th SWE for May 10, 2017, mean SWE for May 1, 2017, change in SWE between May 1, 2017 and May 10, 2017, summarized for each watershed above 4000’. Table 2 shows mean SWE and mean percent of average May 10th SWE for May 10, 2017, mean SWE for May 1, 2017, change in SWE between May 1, 2017 and May 10, 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.

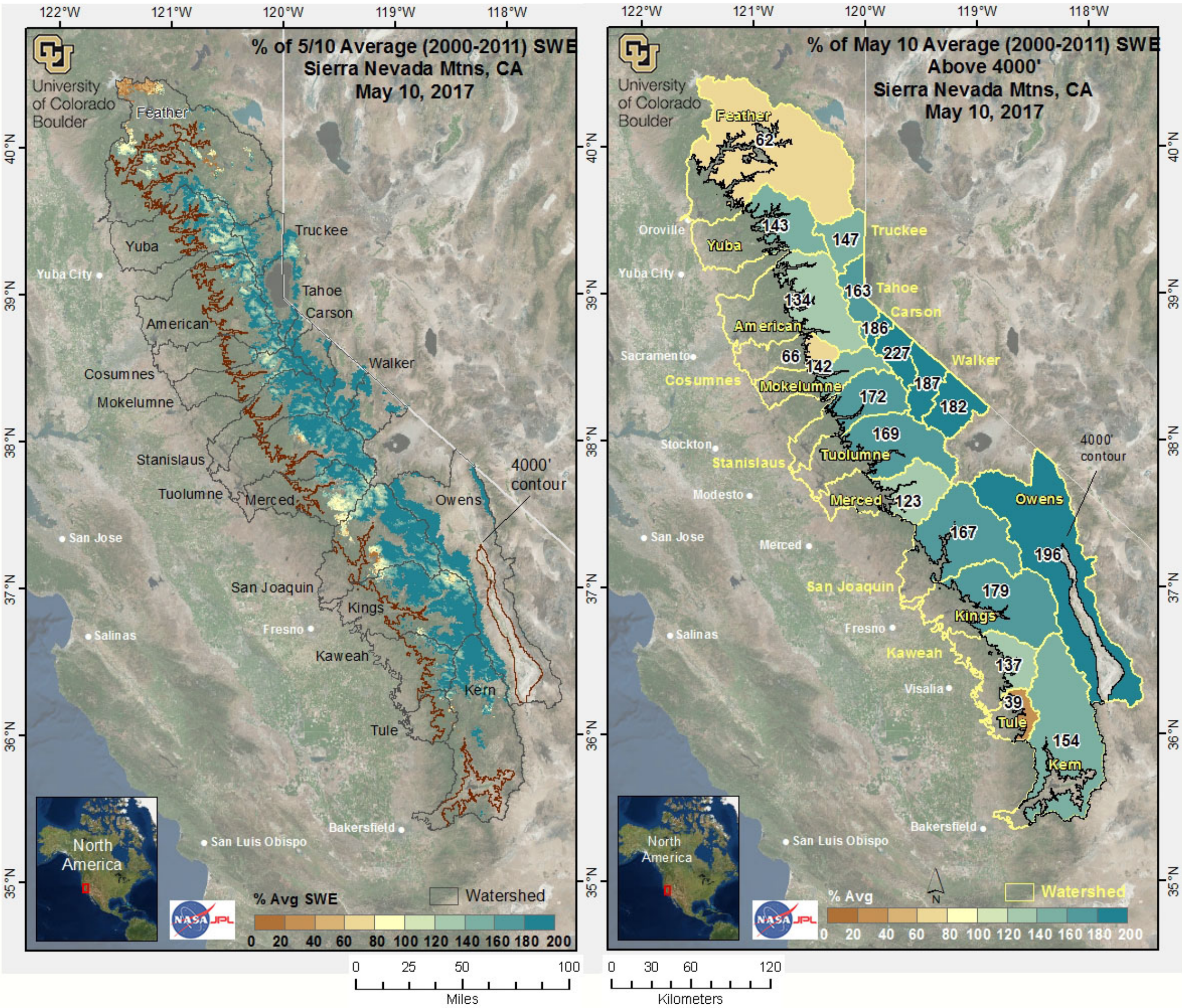


Figure 2. Percent of average May 10th SWE (between 2000-2011) for May 10, 2017 for the entire Sierra (on left) and by watershed (on right). Watershed percentages are calculated for all model pixels above 4000' (shown as red line on left map).

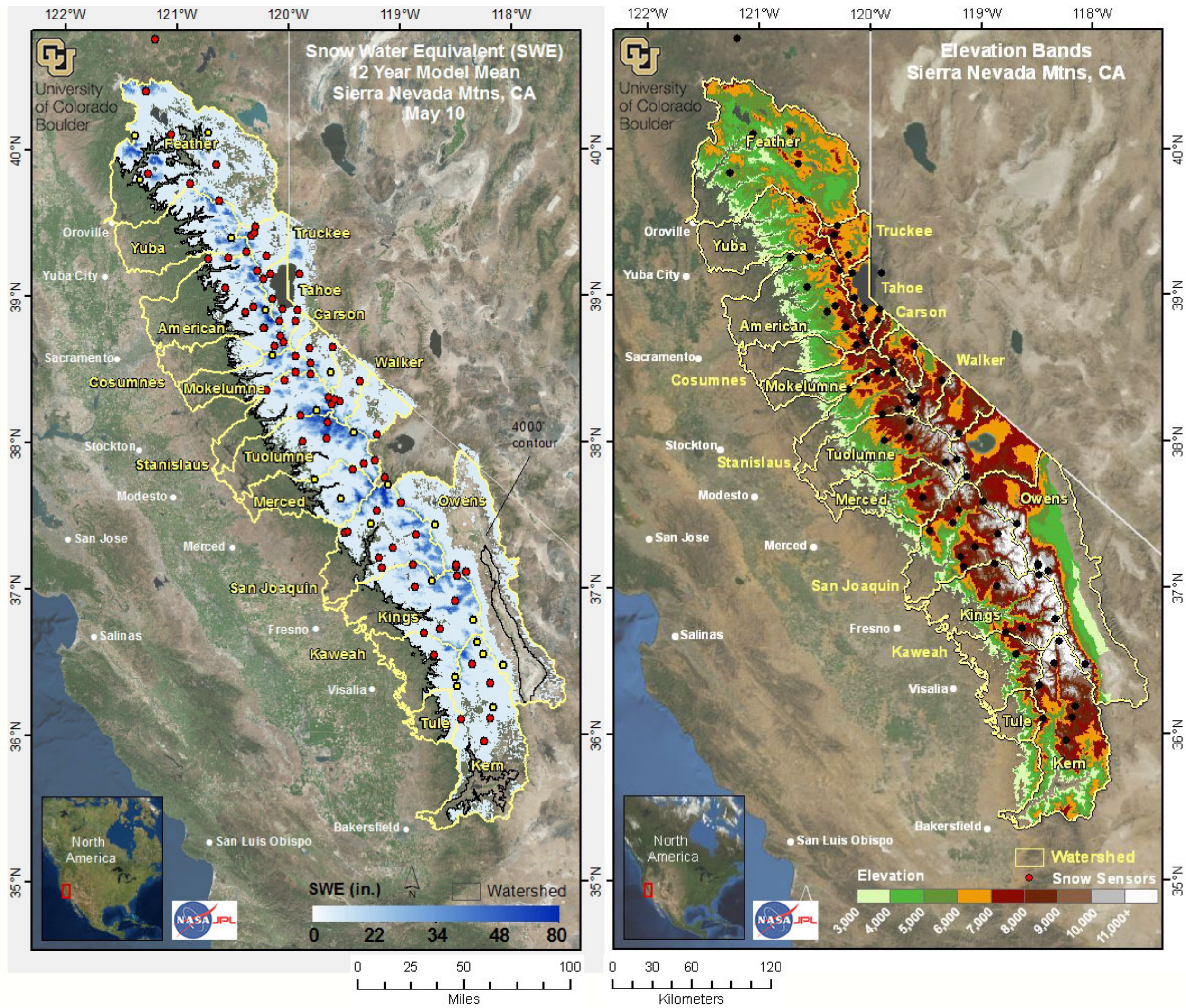


Figure 3. 12-year-modeled average SWE (between 2000-2011) for May 10th on the left with snow sensors shown in yellow that were not operatioanl and in red for sensors that were operational on May 10, 2017; and a banded elevation map on the right.

Methods

Results for the date of May 10, 2017 are based on May 10, 2017 real-time data from 78 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 10th SWE for May 10, 2017, mean SWE for May 1, 2017, change in SWE between May 1, 2017 and May 10, 2017, summarized for each watershed.

Watershed	5/10/17 % 5/10 Avg to Date	5/1/17 SWE (in)	5/10/17 SWE (in)	5/1/17 thru 5/10/17 Change in SWE (in)
AMERICAN	133.9	22.4	16.7	-5.7
COSUMNES	66.1	4.3	2.7	-1.6
EAST FORK CARSON RIVER	226.7	23.3	19.4	-3.9
EAST WALKER RIVER	182.3	17.3	12.8	-4.5
FEATHER	62.1	6.9	3.9	-2.9
KAWEAH	136.9	16.8	11.7	-5.1
KERN	154.4	8.5	6.3	-2.2
KINGS	178.6	33.1	27.8	-5.3
MERCED	123.3	21.6	16.9	-4.6
MOKELUMNE	141.6	24.6	19.7	-5.0
OWENS	195.8	9.0	7.3	-1.7
SAN JOAQUIN	167.0	31.0	26.8	-4.3
STANISLAUS	172.4	31.0	26.3	-4.8
TAHOE	162.9	31.4	24.1	-7.3
TRUCKEE	146.6	18.4	13.2	-5.2
TULE	39.2	1.6	1.1	-0.5
TUOLUMNE	169.2	33.8	27.6	-6.2
WEST FORK CARSON RIVER	186.4	27.4	19.9	-7.5
WEST WALKER RIVER	186.6	23.0	17.5	-5.4
YUBA	143.2	24.8	20.4	-4.4

Table 2. All calculations are for elevations above 4000'. Mean SWE and mean percent of average (between 2000-2011) May 10th SWE for May 10, 2017, mean SWE for May 1, 2017, change in SWE between May 1, 2017 and May 10, 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	5/10/17 % 5/10 Avg to Date	5/1/17 SWE (in)	5/10/17 SWE (in)	5/1/17 vs. 5/10/17 Change SWE (in)	Area Sq Mi
AMERICAN	4000-5000'	1	0.1	0.0	0.0	208.0
	5000-6000'	29	2.6	1.2	-1.4	287.2
	6000-7000'	136	28.2	19.9	-8.4	288.9
	7000-8000'	152	49.5	40.6	-8.9	171.6
	8000-9000'	155	62.3	54.4	-7.9	73.6
	9000-10,000'	154	76.4	67.5	-9.0	8.6
COSUMNES	4000-5000'	0	0	0	0	68.5
	5000-6000'	0	0.1	0.0	-0.1	62.8
	6000-7000'	71	12.6	7.1	-5.5	26.1
	7000-8000'	135	40.1	30.7	-9.4	9.1
E CARSON	5000-6000'	0	0.0	0.0	0.0	32.6
	6000-7000'	57	1.7	1.0	-0.8	74.4
	7000-8000'	244	17.4	14.2	-3.2	100.5
	8000-9000'	250	37.5	35.6	-1.9	94.6
	9000-10,000'	214	44.5	43.5	-1.1	30.8
	10,000-11,000'	196	44.3	43.5	-0.8	12.9
	> 11,000'	184	62.9	60.0	-2.9	0.3
E WALKER	6000-7000'	0	0.0	0.0	0.0	72.6
	7000-8000'	85	3.7	2.1	-1.5	152.4
	8000-9000'	211	17.9	12.1	-5.8	154.7
	9000-10,000'	219	35.6	30.7	-4.9	61.3
	10,000-11,000'	176	48.0	41.5	-6.5	48.0
	> 11,000'	167	49.2	42.7	-6.5	8.1
FEATHER	4000-5000'	3	0.2	0.1	-0.1	637.9
	5000-6000'	41	3.9	2.0	-1.9	1252.4
	6000-7000'	84	13.6	8.2	-5.4	840.6
	7000-8000'	80	24.5	14.6	-9.9	117.0
	8000-9000'	90	37.4	24.0	-13.4	5.1
KAWEAH	4000-5000'	4	0.0	0.1	0.1	49.8
	5000-6000'	9	0.0	0.2	0.2	60.4
	6000-7000'	25	0.3	0.8	0.5	62.8
	7000-8000'	69	5.2	4.2	-1.0	65.2
	8000-9000'	154	21.8	17.7	-4.1	56.1
	9000-10,000'	168	31.3	25.6	-5.7	39.7
	10,000-11,000'	171	51.7	45.4	-6.3	36.8
	> 11,000'	168	60.9	53.5	-7.4	9.1
KERN	4000-5000'	1	0.0	0.0	0.0	192.4
	5000-6000'	2	0.0	0.0	0.0	274.9
	6000-7000'	7	0.1	0.1	0.0	398.6
	7000-8000'	28	0.9	0.5	-0.3	337.5
	8000-9000'	84	5.8	3.4	-2.4	308.2
	9000-10,000'	183	14.0	10.3	-3.7	168.9
	10,000-11,000'	215	28.5	24.4	-4.1	150.5
	> 11,000'	198	47.4	41.5	-5.9	144.1
KINGS	4000-5000'	23	0.2	0.5	0.3	72.7
	5000-6000'	35	0.5	1.0	0.5	93.9
	6000-7000'	50	2.3	2.7	0.3	136.3
	7000-8000'	119	17.7	12.3	-5.4	168.1
	8000-9000'	200	34.8	29.1	-5.7	207.9
	9000-10,000'	209	41.9	36.3	-5.7	190.3
	10,000-11,000'	204	53.5	47.1	-6.4	219.9
	> 11,000'	173	57.8	50.7	-7.1	198.1

KINGS	4000-5000'	23	0.2	0.5	0.3	72.7
	5000-6000'	35	0.5	1.0	0.5	93.9
	6000-7000'	50	2.3	2.7	0.3	136.3
	7000-8000'	119	17.7	12.3	-5.4	168.1
	8000-9000'	200	34.8	29.1	-5.7	207.9
	9000-10,000'	209	41.9	36.3	-5.7	190.3
	10,000-11,000'	204	53.5	47.1	-6.4	219.9
	> 11,000'	173	57.8	50.7	-7.1	198.1
MERCED	4000-5000'	11	0.3	0.2	-0.1	72.9
	5000-6000'	8	0.3	0.2	-0.1	73.9
	6000-7000'	21	3.7	1.2	-2.5	77.9
	7000-8000'	106	20.8	13.7	-7.1	129.2
	8000-9000'	130	28.6	22.6	-6.0	125.8
	9000-10,000'	151	39.0	32.9	-6.1	74.7
	10,000-11,000'	148	58.0	49.9	-8.1	49.5
	> 11,000'	130	72.5	63.2	-9.3	13.5
MOKELUMNE	4000-5000'	0	0.0	0.0	0.0	72.4
	5000-6000'	10	1.0	0.3	-0.6	81.9
	6000-7000'	82	16.9	9.4	-7.5	71.1
	7000-8000'	149	44.0	35.4	-8.6	84.4
	8000-9000'	173	53.3	47.5	-5.8	80.2
	9000-10,000'	181	65.6	58.9	-6.7	7.2
OWENS	4000-5000'	0	0	0	0	376.1
	5000-6000'	0	0	0	0	257.7
	6000-7000'	9	0.4	0.1	-0.3	252.5
	7000-8000'	129	4.4	2.7	-1.7	301.8
	8000-9000'	248	21.2	16.5	-4.7	162.5
	9000-10,000'	249	26.9	22.7	-4.3	113.6
	10,000-11,000'	240	34.1	29.3	-4.8	187.8
	> 11,000'	186	44.3	38.3	-6.0	166.8
SAN JOAQUIN	4000-5000'	1	0.0	0.0	0.0	76.5
	5000-6000'	26	0.3	0.5	0.2	129.1
	6000-7000'	65	4.2	2.8	-1.4	184.5
	7000-8000'	146	18.7	14.7	-4.0	207.5
	8000-9000'	187	37.0	32.3	-4.8	196.2
	9000-10,000'	177	46.2	39.9	-6.3	173.6
	10,000-11,000'	174	58.9	51.9	-7.0	189.1
	> 11,000'	173	65.5	57.5	-8.0	143.2
STANISLAUS	4000-5000'	3	0.0	0.0	0.0	83.5
	5000-6000'	17	1.0	0.5	-0.5	105.1
	6000-7000'	117	19.5	11.7	-7.9	139.9
	7000-8000'	197	42.2	35.9	-6.4	141.9
	8000-9000'	191	56.0	51.8	-4.2	121.3
	9000-10,000'	178	66.0	62.3	-3.7	45.8
	10,000-11,000'	176	79.5	76.2	-3.2	18.0
	> 11,000'	187	70.5	69.1	-1.5	0.4

TAHOE	6000-7000'	100	10.0	6.3	-3.7	99.2
	7000-8000'	176	39.2	32.1	-7.1	73.9
	8000-9000'	178	49.7	42.6	-7.1	51.4
	9000-10,000'	177	50.2	42.7	-7.5	11.9
	10,000-11,000'	165	45.0	37.1	-7.8	0.6
TRUCKEE	5000-6000'	0	0.2	0.0	-0.2	50.1
	6000-7000'	134	11.5	6.6	-4.9	245.3
	7000-8000'	158	37.3	29.6	-7.7	108.3
	8000-9000'	146	57.3	50.4	-6.9	14.2
TULE	4000-5000'	1	0.0	0.0	0.0	40.0
	5000-6000'	1	0.0	0.0	0.0	52.2
	6000-7000'	4	0.0	0.1	0.1	45.0
	7000-8000'	36	1.8	1.6	-0.2	27.9
	8000-9000'	72	6.7	5.3	-1.4	15.4
	9000-10,000'	135	18.8	14.2	-4.6	6.1
TUOLUMNE	4000-5000'	0	0.0	0.0	0.0	125.9
	5000-6000'	16	0.4	0.3	-0.2	168.4
	6000-7000'	63	8.9	4.4	-4.6	148.1
	7000-8000'	180	39.7	30.3	-9.5	147.6
	8000-9000'	194	56.1	47.1	-9.0	171.1
	9000-10,000'	183	63.4	54.8	-8.6	151.1
	10,000-11,000'	168	64.2	55.9	-8.3	113.2
	> 11,000'	149	57.6	51.1	-6.5	29.9
W CARSON	4000-5000'	0	0	0	0	1.4
	5000-6000'	7	0.3	0.1	0	15.9
	6000-7000'	92	7.2	4.3	-2.8	8.7
	7000-8000'	188	25.3	17.9	-7.3	36.1
	8000-9000'	198	36.0	30.5	-5.5	30.1
	9000-10,000'	191	43.8	37.5	-6.3	9.5
	10,000-11,000'	179	51.9	43.8	-8.1	2.2
W WALKER	5000-6000'	0	0	0	0	45.7
	6000-7000'	24	0.5	0.2	-0.2	59.4
	7000-8000'	154	5.8	3.9	-2.0	89.4
	8000-9000'	239	21.5	18.8	-2.7	92.5
	9000-10,000'	188	42.2	39.5	-2.8	71.6
	10,000-11,000'	171	52.8	49.5	-3.4	41.1
	> 11,000'	172	40.4	35.4	-5.0	2.5
YUBA	4000-5000'	102	0.1	2.2	2.0	161.6
	5000-6000'	136	7.9	8.7	0.7	178.0
	6000-7000'	155	39.1	31.4	-7.8	234.8
	7000-8000'	135	49.7	41.5	-8.2	119.2
	8000-9000'	138	65.9	57.1	-8.8	5.8

Location of Reports and Excel Format Tables
ftp://snowserver.colorado.edu/pub/fromLeanne/forCADWR/Near_Real_Time_Reports/

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