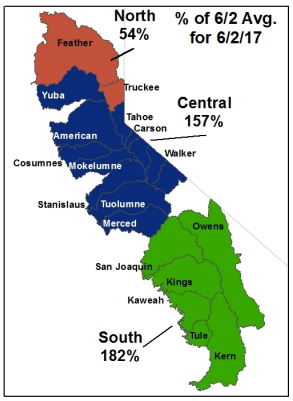
Real Time Snow Water Equivalent (SWE) Simulation
June 2, 2017
Sierra Nevada Mountains, California



Abstract

On June 2, 2017, percent of average June 2nd SWE values for this date are 54% for the Northern watersheds, 157% for the Central, and 182% 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.

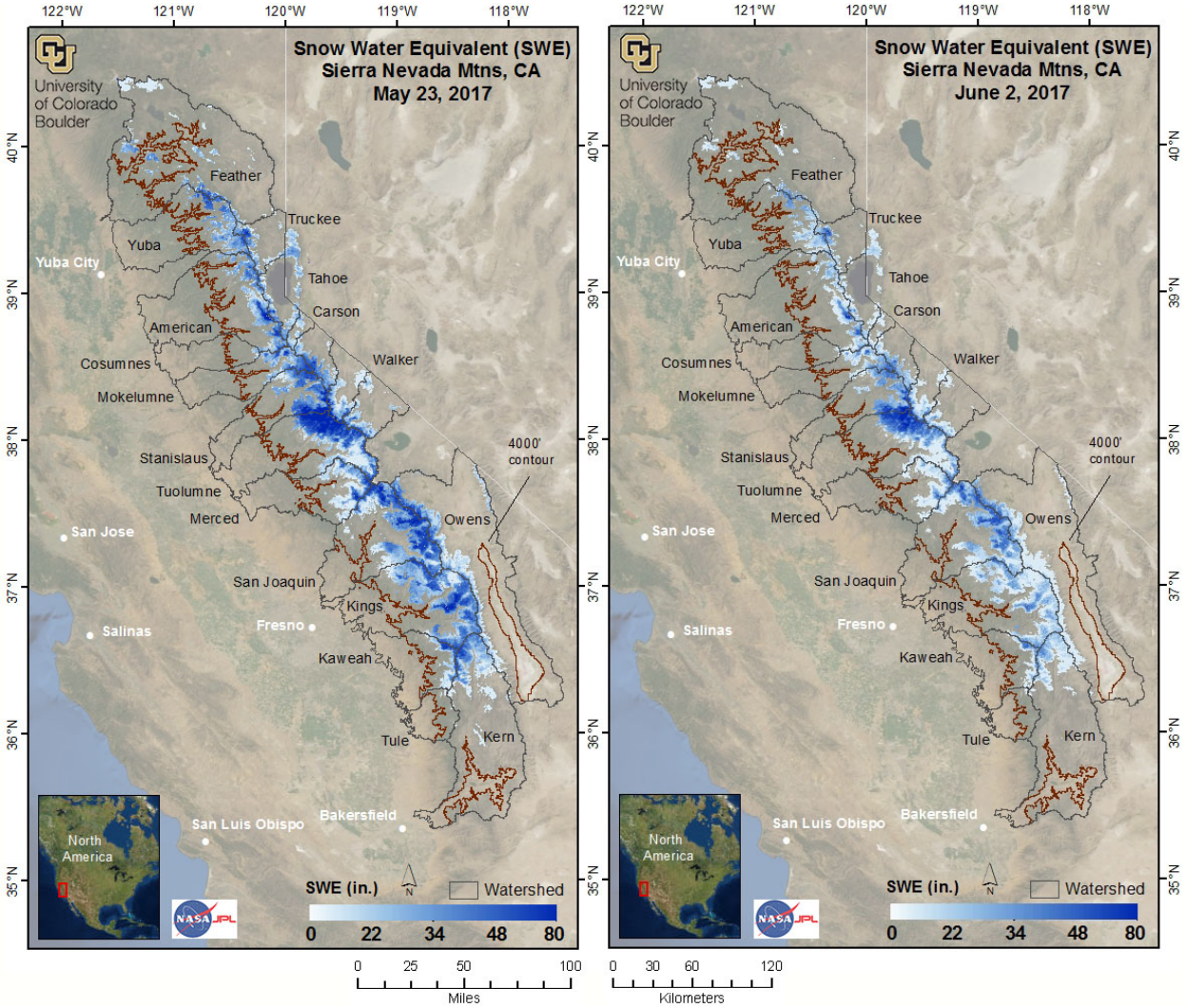


Figure 1. SWE amounts for May 23, 2017 are shown on the left and SWE amounts for June 2, 2017 are shown on the right.

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 June 2, 2017. Figure 1 shows SWE amounts for May 23, 2017 and for June 2, 2017. On June 2, 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 6/2/17 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) June 2nd SWE for June 2, 2017 for the snow-covered area on left and on the right is the mean percent of the June 2nd average for June 2, 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 June 2nd on the left with snow sensors shown in yellow that were not operational on June 2, 2017 and in red for sensors that were operational on June 2, 2017; and a banded elevation map on the right. Table 1 shows mean SWE and mean percent of average (between 2000-2011) June 2nd SWE for June 2, 2017, mean SWE for May 23, 2017, change in SWE between May 23, 2017 and June 2, 2017, summarized for each watershed above 4000'. Table 2 shows mean SWE and mean percent of average June 2nd SWE for June 2, 2017, mean SWE for May 23, 2017, change in SWE between May 23, 2017 and June 2, 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.

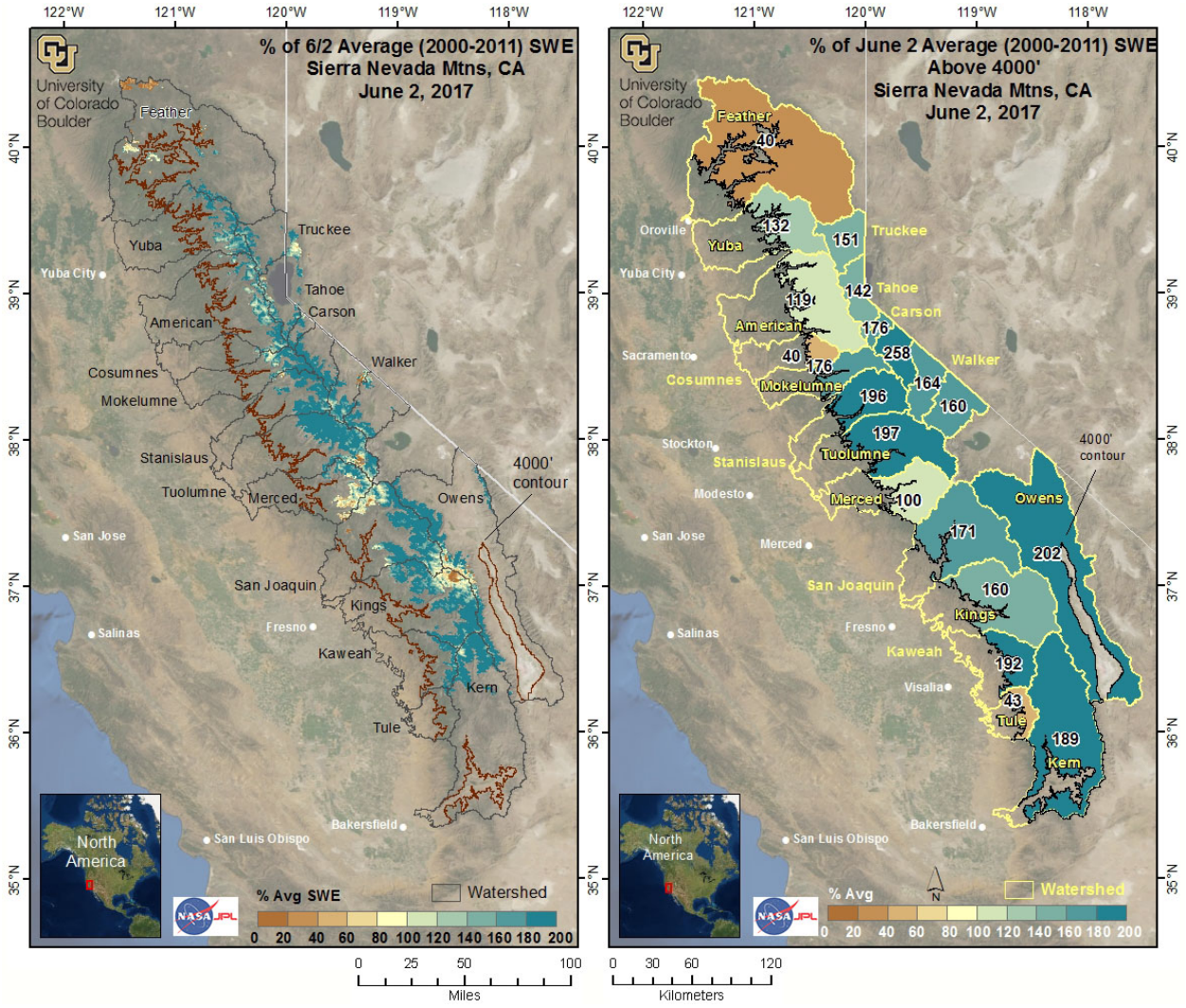


Figure 2. Percent of average June 2nd SWE (between 2000-2011) for June 2, 2017 for the entire Sierra (on left) and by watershed (on right). Watershed percentages are calculated for all model pixels above 4000' (shown as red line on left map).

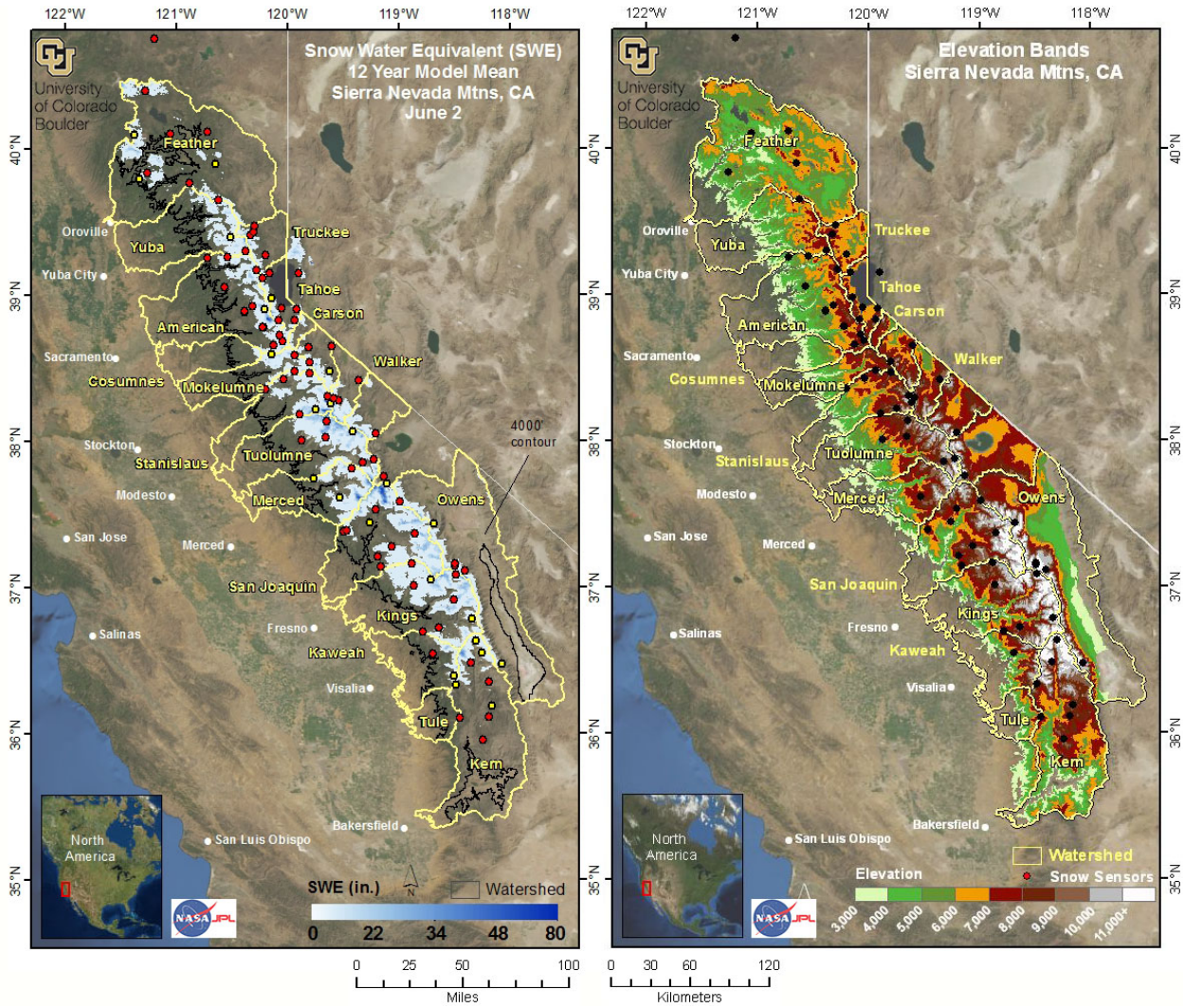


Figure 3. 12-year-modeled average SWE (between 2000-2011) for June 2nd on the left with snow sensors shown in yellow that were not operational and in red for sensors that were operational on June 2, 2017; and a banded elevation map on the right.

Methods

Results for the date of June 2, 2017 are based on June 2, 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) June 2nd SWE for June 2, 2017, mean SWE for May 23, 2017, change in SWE between May 23, 2017 and June 2, 2017, summarized for each watershed.

Watershed	6/2/17 % 6/2 Avg to Date	5/23/17 SWE (in)	6/2/17 SWE (in)	5/23/17 thru 6/2/17 Change in SWE (in)
AMERICAN	118.9	10.5	5.6	-4.9
COSUMNES	40.4	1.4	0.5	-0.9
EAST FORK CARSON RIVER	258.0	13.4	8.8	-4.6
EAST WALKER RIVER	160.3	7.4	4.3	-3.1
FEATHER	39.8	1.9	0.8	-1.1
KAWEAH	192.3	8.6	5.3	-3.3
KERN	189.3	4.6	2.6	-1.9
KINGS	159.7	20.1	10.9	-9.2
MERCED	100.0	10.9	5.9	-5.0
MOKELUMNE	176.5	14.3	9.3	-5.1
OWENS	202.4	4.8	2.8	-2.0
SAN JOAQUIN	171.2	19.7	13.2	-6.5
STANISLAUS	195.7	18.9	12.6	-6.4
TAHOE	142.4	14.7	7.8	-7.0
TRUCKEE	151.2	8.3	5.1	-3.1
TULE	42.6	0.4	0.2	-0.2
TUOLUMNE	197.2	21.2	14.8	-6.4
WEST FORK CARSON RIVER	176.5	12.2	6.6	-5.6
WEST WALKER RIVER	163.8	11.5	7.5	-4.0
YUBA	131.8	11.9	7.0	-4.9

Table 2. All calculations are for elevations above 4000'. Mean SWE and mean percent of average (between 2000-2011) June 2nd SWE for June 2, 2017, mean SWE for May 23, 2017, change in SWE between May 23, 2017 and June 2, 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	6/2/17 % 6/2 Avg to Date	5/23/17 SWE (in)	6/2/17 SWE (in)	5/23/17 vs. 6/2/17 Change SWE (in)	Area Sq Mi
AMERICAN	4000-5000'	0	0.0	0.0	0.0	208.0
	5000-6000'	2	0.2	0.0	-0.1	287.2
	6000-7000'	66	9.2	3.1	-6.2	288.9
	7000-8000'	149	28.0	15.7	-12.3	171.6
	8000-9000'	164	42.0	27.7	-14.3	73.6
	9000-10,000'	153	54.0	37.0	-17.0	8.6
COSUMNES	4000-5000'	0	0	0	0	68.5
	5000-6000'	0	0.0	0.0	0.0	62.8
	6000-7000'	13	2.2	0.3	-1.8	26.1
	7000-8000'	101	21.2	8.5	-12.7	9.1
E CARSON	5000-6000'	0	0.0	0.0	0.0	32.6
	6000-7000'	11	0.1	0.1	-0.1	74.4
	7000-8000'	227	7.1	3.7	-3.4	100.5
	8000-9000'	300	25.7	16.7	-9.0	94.6
	9000-10,000'	261	35.0	25.5	-9.5	30.8
	10,000-11,000'	213	35.4	25.9	-9.5	12.9
	> 11,000'	209	50.0	37.6	-12.4	0.3
E WALKER	6000-7000'	0	0.0	0.0	0.0	72.6
	7000-8000'	30	0.3	0.1	-0.2	152.4
	8000-9000'	128	4.4	1.6	-2.8	154.7
	9000-10,000'	194	20.0	11.2	-8.7	61.3
	10,000-11,000'	171	31.0	20.8	-10.1	48.0
	> 11,000'	158	32.4	22.0	-10.4	8.1
FEATHER	4000-5000'	0	0.0	0.0	0.0	637.9
	5000-6000'	6	0.4	0.1	-0.3	1252.4
	6000-7000'	55	4.3	1.7	-2.6	840.6
	7000-8000'	78	10.0	5.3	-4.7	117.0
	8000-9000'	73	18.3	11.0	-7.4	5.1
KAWEAH	4000-5000'	0	0.0	0.0	0.0	49.8
	5000-6000'	0	0.0	0.0	0.0	60.4
	6000-7000'	0	0.0	0.0	0.0	62.8
	7000-8000'	50	1.0	0.4	-0.6	65.2
	8000-9000'	182	11.1	4.8	-6.3	56.1
	9000-10,000'	251	20.9	12.4	-8.5	39.7
	10,000-11,000'	216	37.8	26.3	-11.5	36.8
	> 11,000'	178	44.7	30.9	-13.8	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	0.0	0.0	0.0	398.6
	7000-8000'	18	0.1	0.1	-0.1	337.5
	8000-9000'	36	1.2	0.2	-1.0	308.2
	9000-10,000'	174	5.7	1.8	-3.9	168.9
	10,000-11,000'	272	18.7	10.9	-7.8	150.5
	> 11,000'	219	34.0	22.2	-11.8	144.1

KINGS	4000-5000'	0	0.0	0.0	0.0	72.7
	5000-6000'	5	0.1	0.0	-0.1	93.9
	6000-7000'	4	0.1	0.0	-0.1	136.3
	7000-8000'	25	3.2	0.6	-2.6	168.1
	8000-9000'	136	19.1	7.3	-11.8	207.9
	9000-10,000'	202	27.4	14.9	-12.5	190.3
	10,000-11,000'	203	37.7	22.3	-15.3	219.9
	> 11,000'	147	40.3	23.8	-16.5	198.1
MERCED	4000-5000'	0	0.0	0.0	0.0	72.9
	5000-6000'	0	0.0	0.0	0.0	73.9
	6000-7000'	2	0.2	0.0	-0.2	77.9
	7000-8000'	26	5.2	1.0	-4.2	129.2
	8000-9000'	92	14.2	6.3	-7.9	125.8
	9000-10,000'	135	22.9	13.6	-9.3	74.7
	10,000-11,000'	134	38.3	25.0	-13.3	49.5
	> 11,000'	108	51.6	36.3	-15.2	13.5
MOKELUMNE	4000-5000'	0	0.0	0.0	0.0	72.4
	5000-6000'	1	0.0	0.0	0.0	81.9
	6000-7000'	29	3.2	0.8	-2.4	71.1
	7000-8000'	172	25.2	15.0	-10.2	84.4
	8000-9000'	218	38.0	26.8	-11.3	80.2
	9000-10,000'	221	49.0	36.0	-13.0	7.2
OWENS	4000-5000'	0	0	0	0	376.1
	5000-6000'	0	0	0	0	257.7
	6000-7000'	5	0.0	0.0	0.0	252.5
	7000-8000'	44	0.3	0.2	-0.2	301.8
	8000-9000'	244	8.8	4.7	-4.1	162.5
	9000-10,000'	284	14.5	8.8	-5.7	113.6
	10,000-11,000'	268	21.5	12.5	-8.9	187.8
	> 11,000'	170	29.5	18.2	-11.4	166.8
SAN JOAQUIN	4000-5000'	0	0.0	0.0	0.0	76.5
	5000-6000'	0	0.1	0.0	-0.1	129.1
	6000-7000'	6	0.3	0.1	-0.2	184.5
	7000-8000'	55	4.8	1.5	-3.3	207.5
	8000-9000'	166	21.6	11.6	-10.0	196.2
	9000-10,000'	198	31.3	21.8	-9.4	173.6
	10,000-11,000'	193	43.4	32.0	-11.4	189.1
	> 11,000'	172	47.5	33.7	-13.8	143.2
STANISLAUS	4000-5000'	0	0.0	0.0	0.0	83.5
	5000-6000'	0	0.0	0.0	0.0	105.1
	6000-7000'	14	3.1	0.3	-2.8	139.9
	7000-8000'	188	23.8	11.9	-12.0	141.9
	8000-9000'	246	42.1	31.4	-10.7	121.3
	9000-10,000'	213	52.6	40.9	-11.6	45.8
	10,000-11,000'	183	63.3	49.1	-14.2	18.0
	> 11,000'	178	56.3	43.6	-12.7	0.4

TAHOE	6000-7000'	40	2.3	0.8	-1.5	99.2
	7000-8000'	142	19.3	9.4	-9.9	73.9
	8000-9000'	176	28.8	16.7	-12.1	51.4
	9000-10,000'	177	29.8	17.4	-12.4	11.9
	10,000-11,000'	144	24.5	14.1	-10.3	0.6
TRUCKEE	5000-6000'	0	0.0	0.0	0.0	50.1
	6000-7000'	90	2.8	1.2	-1.6	245.3
	7000-8000'	173	20.2	13.1	-7.1	108.3
	8000-9000'	163	40.9	31.1	-9.8	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	0.0	0.0	0.0	45.0
	7000-8000'	0	0.2	0.0	-0.2	27.9
	8000-9000'	94	1.8	0.8	-1.0	15.4
	9000-10,000'	192	8.5	4.3	-4.2	6.1
TUOLUMNE	4000-5000'	0	0.0	0.0	0.0	125.9
	5000-6000'	2	0.0	0.0	0.0	168.4
	6000-7000'	31	0.8	0.4	-0.3	148.1
	7000-8000'	210	20.4	11.9	-8.5	147.6
	8000-9000'	246	37.0	26.1	-11.0	171.1
	9000-10,000'	212	44.3	32.0	-12.3	151.1
	10,000-11,000'	175	45.3	32.4	-12.9	113.2
	> 11,000'	149	43.2	31.9	-11.3	29.9
W CARSON	4000-5000'	0	0	0	0	1.4
	5000-6000'	0	0.0	0.0	0	15.9
	6000-7000'	15	0.6	0.2	-0.4	8.7
	7000-8000'	109	8.1	3.2	-4.9	36.1
	8000-9000'	211	21.0	12.0	-9.0	30.1
	9000-10,000'	217	26.7	16.4	-10.4	9.5
	10,000-11,000'	190	30.7	19.0	-11.7	2.2
W WALKER	5000-6000'	0	0	0	0	45.7
	6000-7000'	0	0.0	0.0	0.0	59.4
	7000-8000'	27	0.6	0.1	-0.5	89.4
	8000-9000'	193	9.6	5.3	-4.4	92.5
	9000-10,000'	175	28.6	19.2	-9.5	71.6
	10,000-11,000'	155	37.5	26.7	-10.8	41.1
	> 11,000'	142	24.5	14.3	-10.2	2.5
YUBA	4000-5000'	0	0.0	0.0	0.0	161.6
	5000-6000'	12	1.0	0.2	-0.8	178.0
	6000-7000'	132	17.8	9.0	-8.8	234.8
	7000-8000'	169	32.3	21.9	-10.4	119.2
	8000-9000'	144	46.0	34.2	-11.8	5.8

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

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