United States Department of Agriculture
Natural Resources Conservation Service

From Dr. Church to the Cloud

100 years of Snow Data at your Fingertips

Jeff Anderson, Hydrologist

NRCS Snow Survey and Water Supply Forecasting Program

Reno, NV

Nevada Water Resources Association – Fall Meeting 2016

Ward Creek #2 snow course, Elev. 7,100ft
Lake Tahoe Basin, Year unknown
Photo Credit: UNR Archive

Dr. James E. Church 1869-1959

Photo Credit: UNR Archive

Scientist:
Father of Snow Surveying
Mountaineer:
1st European ascent
Mt Rose 1895

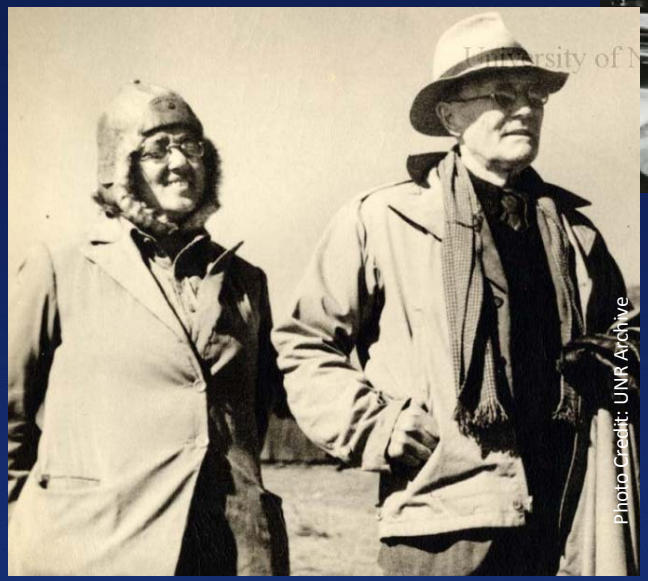


Photo Credit: UNR Archive

World Traveler:
Established snow survey programs in Himalaya and Andes in 1947 at age 78

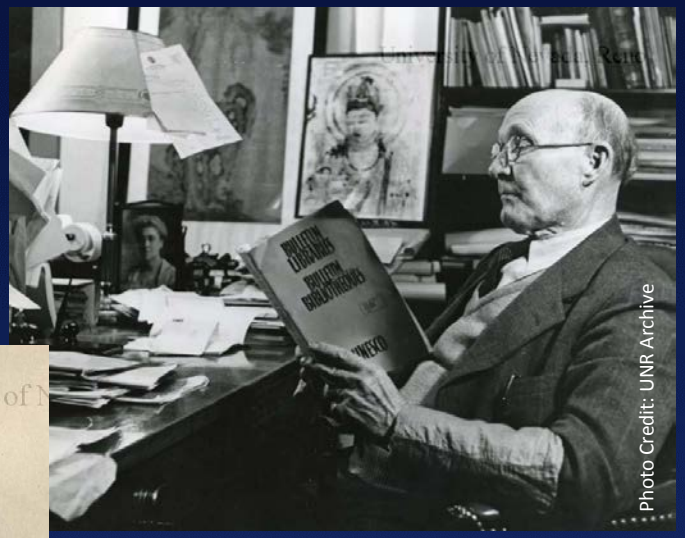
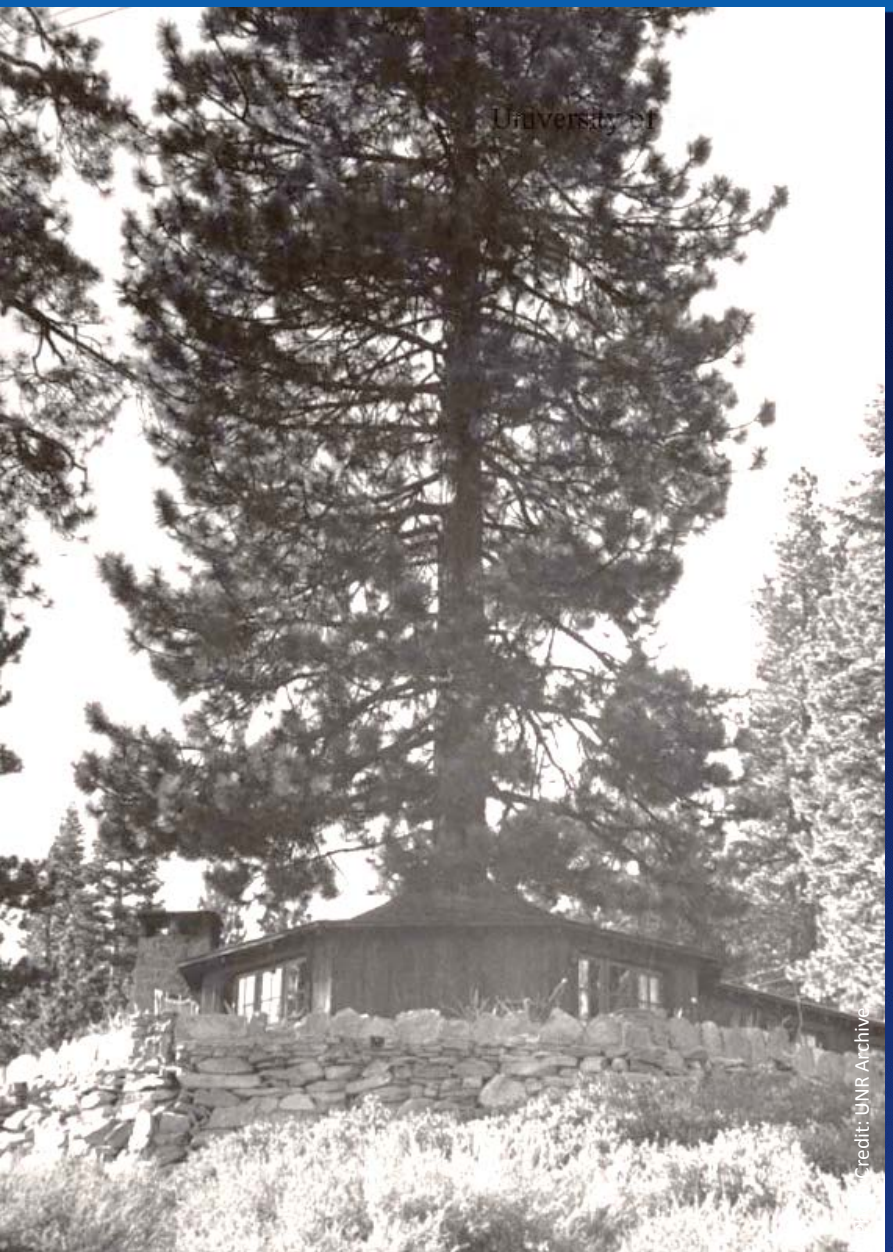


Photo Credit: UNR Archive

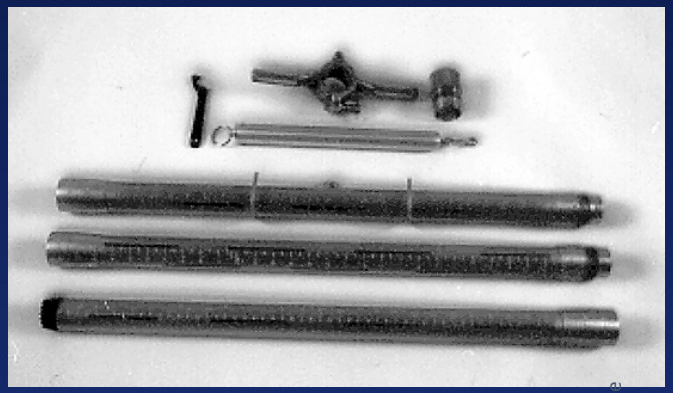
Classics Professor
University of Nevada, Reno
Taught: German, Latin, Literature, Art History
Helped establish Nevada Art Museum



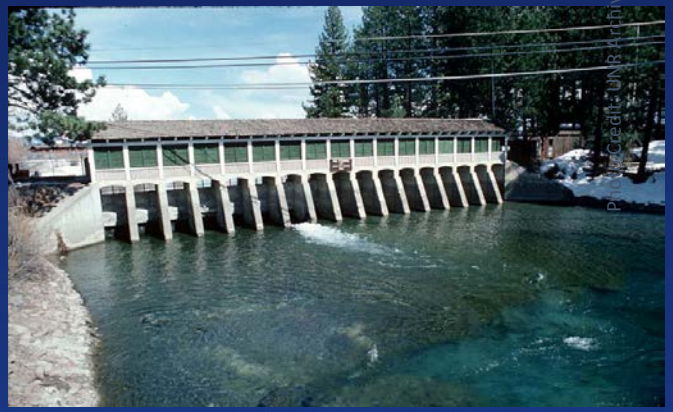
Owned a Circular, Tree House at Lake Tahoe

Caption on image: Tree House, Lake Tahoe, owned by James E. Church.
Photos: taken 1941 and 1955

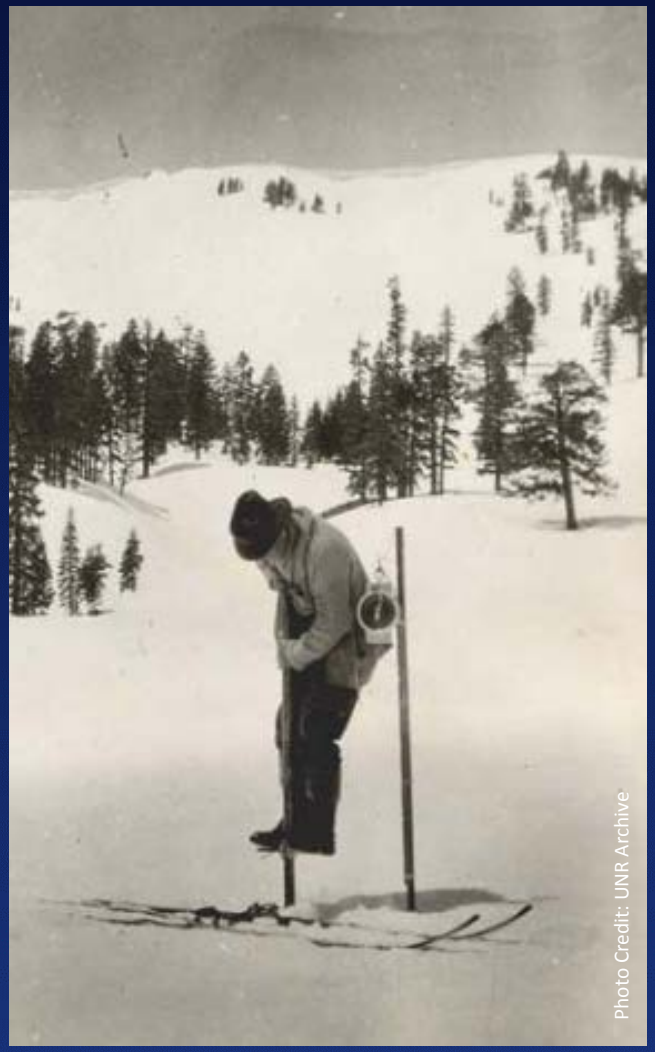
Established
Mt Rose Observatory
1906



Invented
Mt Rose Sampler
1908-1909



First Western
Water Supply Forecasts
Lake Tahoe Rise
1910



Established the earliest
Lake Tahoe snow courses
1910-1916

Dr. James Church with wife Florence

Photo Credit: UNR Archive

Mt Rose Sampler

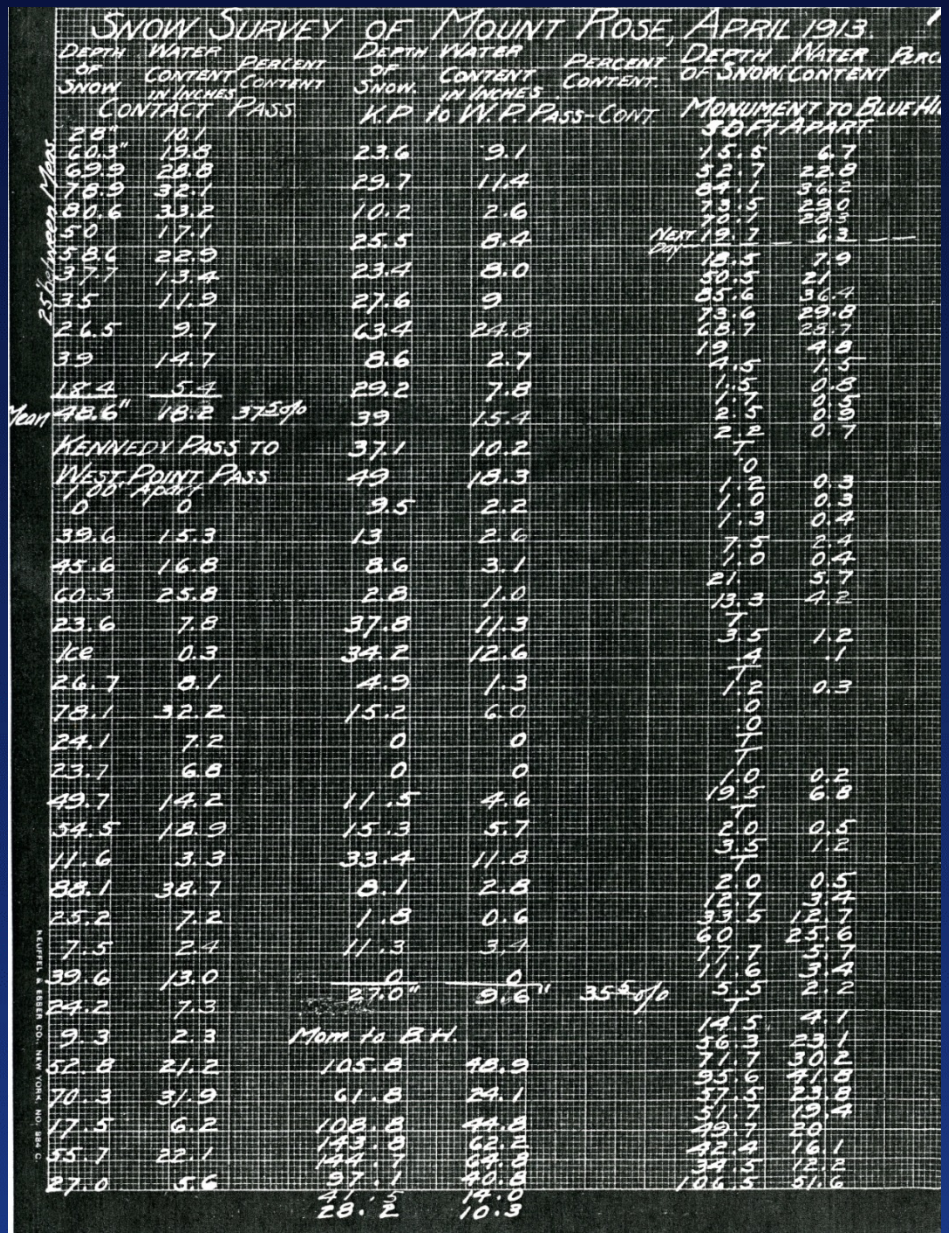
1908-1909

- Seamless, 20 gauge, steel tube
- Lengths up to 10ft, built in sections for deep snow
- Alternating slots 1/16” wide and 4” long.
- Outside of the tube is calibrated in inches.
- High carbon steel, serrated cutter.
- The inside diameter of the tube is larger than the diameter of the cutter, and the shoulder between them prevents the core from falling out when the tube is withdrawn from the snow.
- Tubes coated in shellac to prevent rusting and to keep the core from sticking.
- Inside diameter of cutter 1.5” which means 1 inch of water in the snow will weigh slightly more than 1 ounce.
- Specially calibrated scale is necessary for use with this tube.

Snow Courses

Snow courses are permanent measurement transects. Spaced snow tube measurements are made and averaged together.

Lamoille Canyon #5 Snow Course, Ruby Mtns, Humboldt Basin, Year unknown



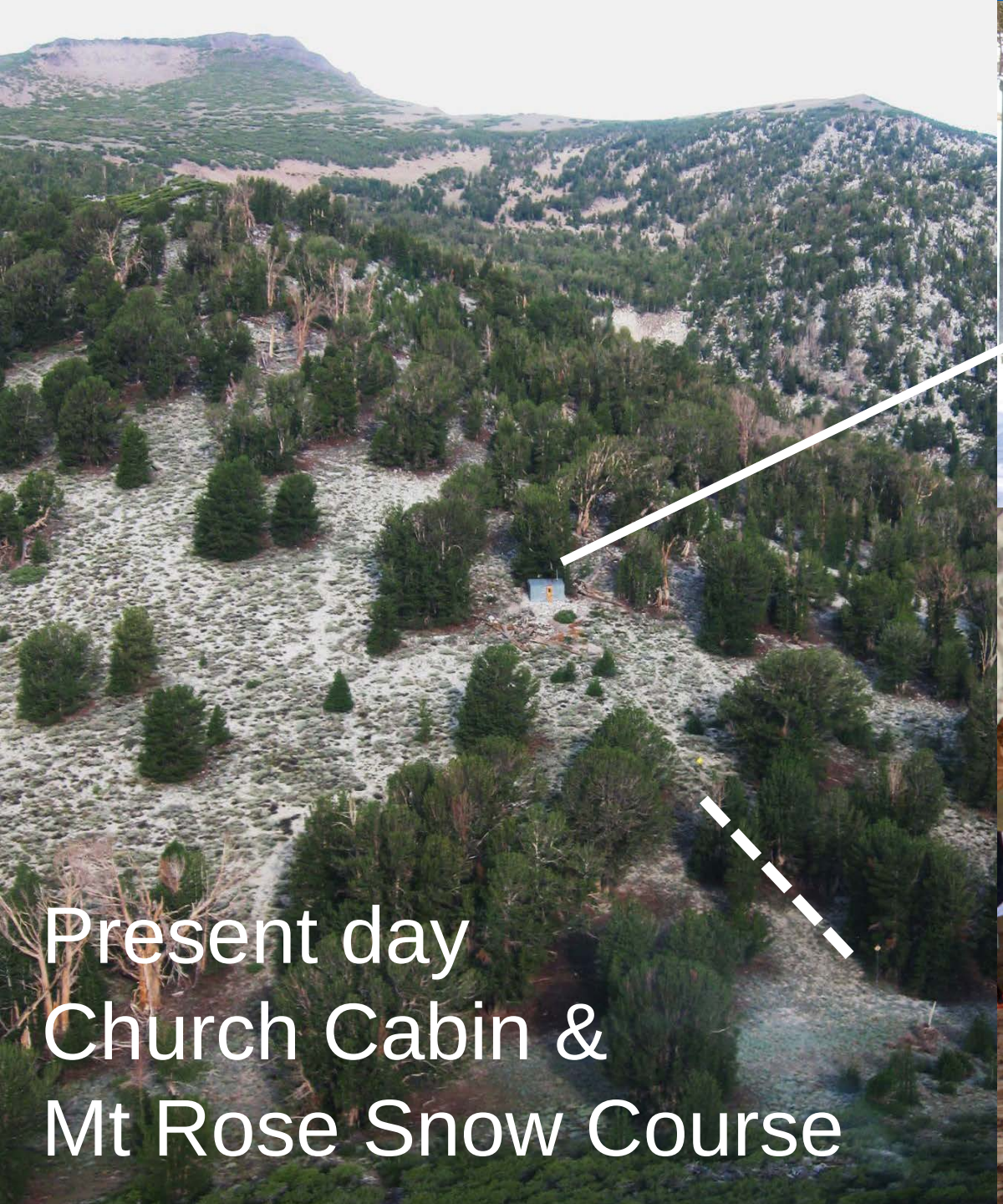
SNOW SURVEY OF MOUNT ROSE, APRIL 1913.

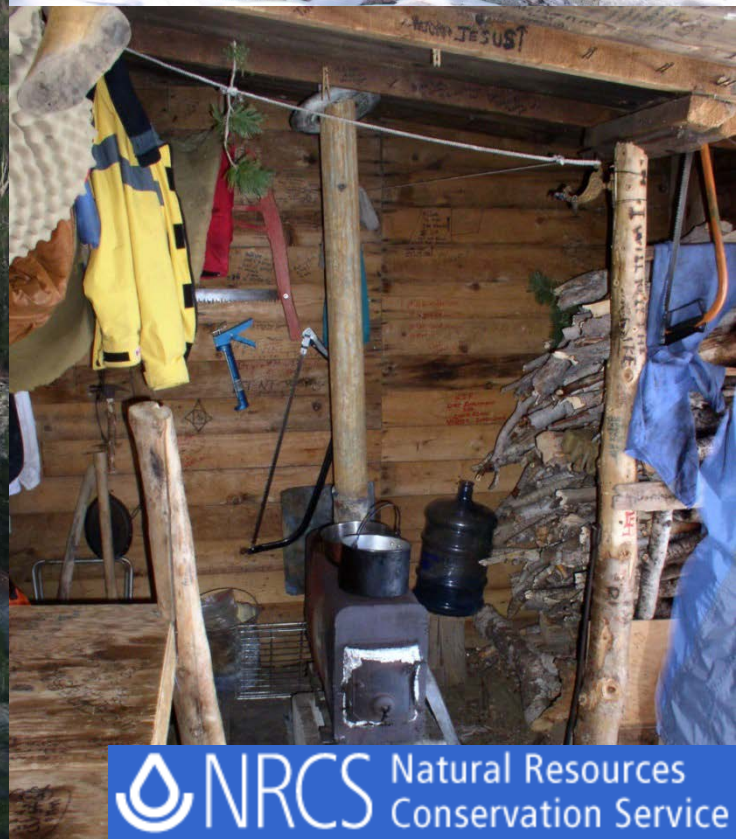
Depth of Snow	Water Content in Inches	Percent Content	Depth of Snow	Water Content in Inches	Percent Content	Depth of Snow	Water Content	Perc
Contact Pass			K.P to W.P. Pass-Cont.			Monument to Blue Hi 30 ft. Apart.		
28"	10.1					15.5	6.7	
60.3"	19.8		23.6	9.1		32.7	22.8	
69.9	28.8		29.7	11.4		64.1	36.2	
76.9	32.1		10.2	2.6		73.5	29.0	
80.6	33.2		25.5	8.4		70.1	20.3	
50	17.1		23.4	8.0		Next day 19.7	6.3	
58.6	22.9		27.6	9		18.5	7.9	
37.7	13.4		63.4	24.8		50.5	21	
35	11.9		8.6	2.7		85.6	36.4	
26.5	9.7		29.2	7.8		73.6	29.8	
39	14.7		39	15.4		68.7	25.7	
18.4	5.4		37.1	10.2		19	4.8	
Mean 42.6"	18.2	37.2%	49	18.3		4.5	1.5	
Kennedy Pass to West Point Pass 100 Apart.						1.5	0.8	
0	0		9.5	2.2		1.75	0.5	
39.6	15.3		13	2.6		2.5	0.9	
45.6	16.8		8.6	3.1		2.2	0.7	
60.3	25.8		2.8	1.0		T		
23.6	7.8		37.8	11.3		.0		
Ice	0.3		34.2	12.6		1.2	0.3	
26.7	8.1		4.9	1.3		1.0	0.3	
78.1	32.2		15.2	6.0		.4	.1	
24.1	7.2		0	0		T		
23.7	6.8		0	0		1.2	0.3	
49.7	14.2		11.5	4.6		.0		
34.5	18.9		15.3	5.7		.0		
11.6	3.3		33.4	11.8		T		
88.1	38.7		8.1	2.8		T		
25.2	7.2		1.8	0.6		1.0	0.2	
7.5	2.4		11.3	3.4		19.5	6.8	
39.6	13.0		0	0		T		
24.2	7.3		27.0"	9.6"	35.5%	2.0	0.5	
9.3	2.3		Mon to B.H.			3.5	1.2	
52.8	21.2		105.8	48.9		T		
70.3	31.9		61.8	24.1		2.0	0.5	
17.5	6.2		108.8	44.8		12.7	3.4	
55.7	22.1		149.8	62.2		33.5	12.7	
27.0	5.6		144.7	64.8		60	25.6	
			97.1	40.8		17.7	5.7	
			41.3	14.0		11.6	3.4	
			28.2	10.3		5.5	2.2	
						T		
						14.5	4.1	
						36.3	23.1	
						71.7	30.2	
						95.6	41.8	
						57.5	23.8	
						51.7	19.4	
						79.7	20	
						42.4	16.1	
						34.5	12.2	
						106.5	51.6	

This note from 1913 shows that the original Mt. Rose snow course consisted of 153 points.

In 1947 it was reduced to 12 points

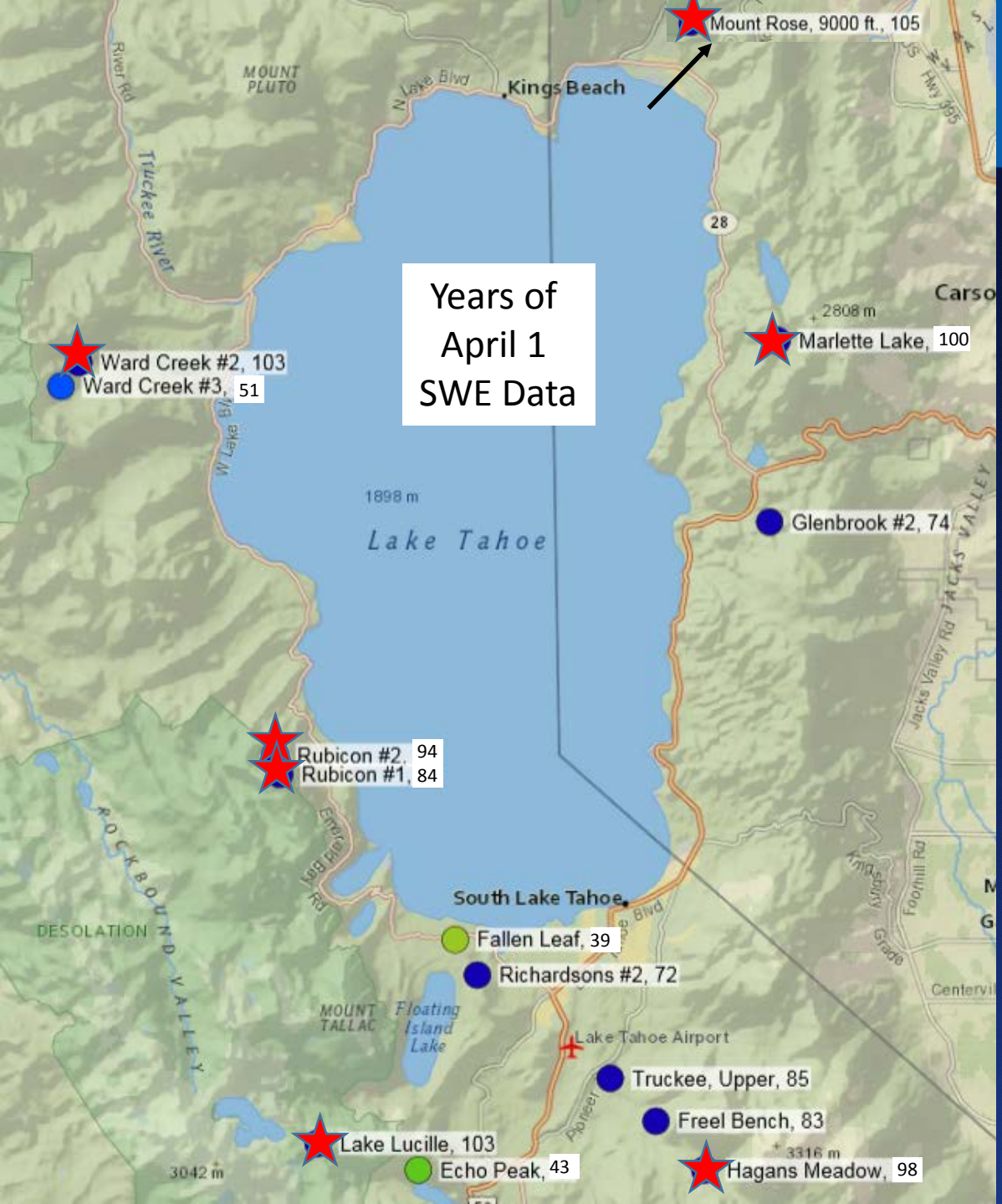
More recently it was been reduced to 5 points.





Present day Church Cabin & Mt Rose Snow Course

NRCS Natural Resources Conservation Service

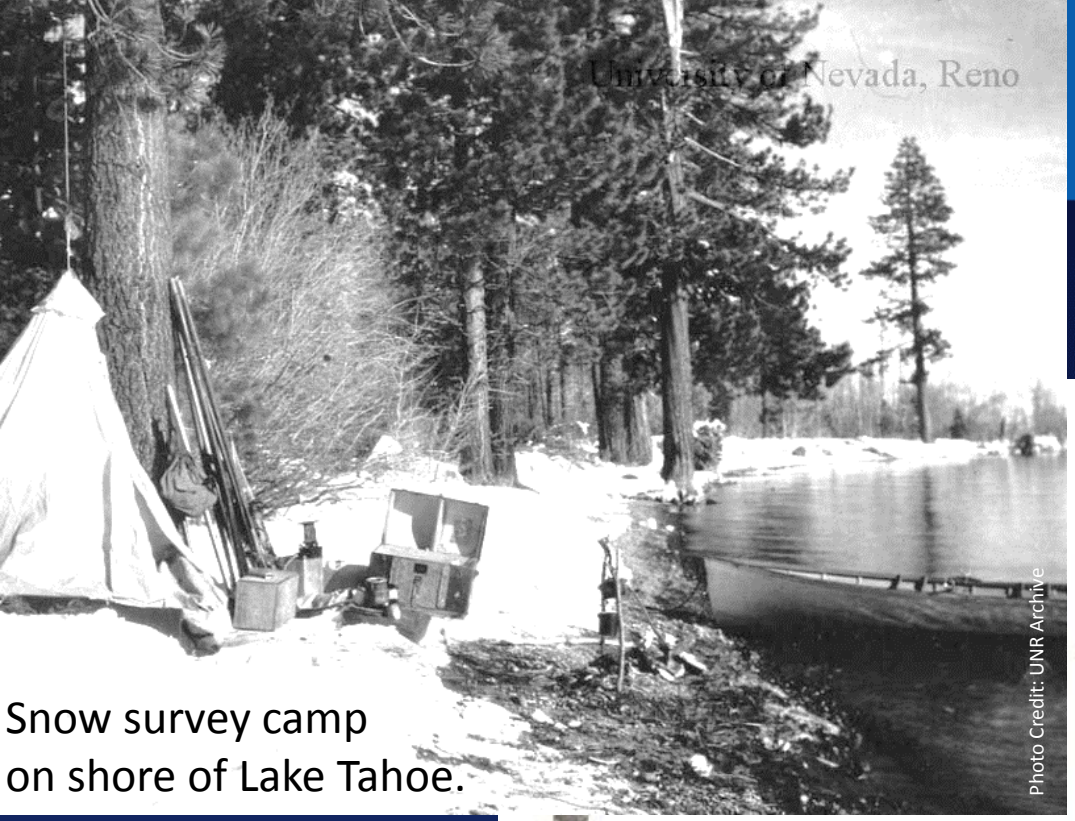


USDA NRCS

Lake Tahoe & Truckee Basin

7 sites have snow data records that start between 1910-1916

No other watershed in the US has an older snow water dataset



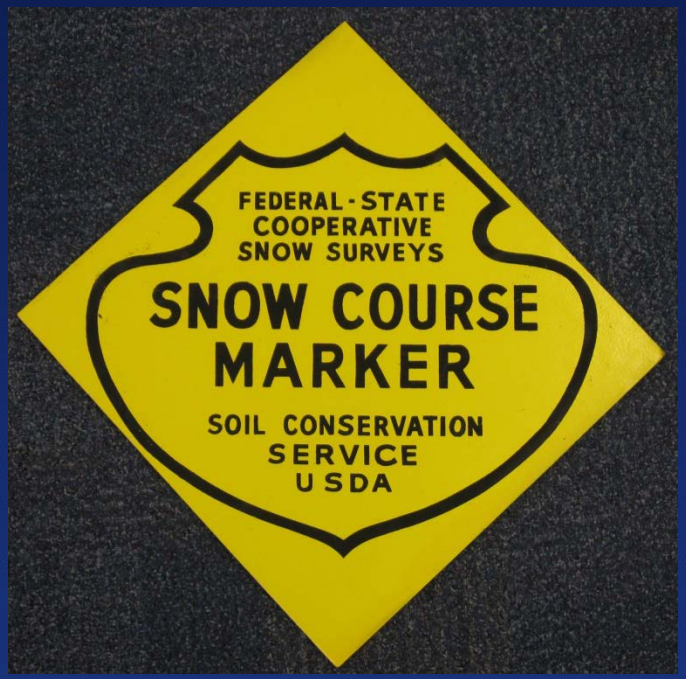
Snow survey camp on shore of Lake Tahoe.

Early Lake Tahoe Snow Surveys were accomplished by boat Using the cabin cruiser named Mt. Rose and smaller boat called Skidoo.

History of Snow Surveys

1908 - 1910 – Snow survey tools and techniques invented by UNR profs: Dr. Church and Dr. Boardman
1917 – California Cooperative Snow Survey Program begins - Sacramento and San Joaquin basins
1919 – Nevada Cooperative Snow Survey Program begins - Truckee, Carson and Walker basins
1920-1928 – Other western state cooperative programs follow in ID, WA, MT, UT, OR
1935 – Congress creates Federal Snow Survey Program as a result of Dust Bowl

1935-1939
Bureau of Ag Engineering



1939-1994
Soil Conservation Service

1994-present
Natural Resources
Conservation Service

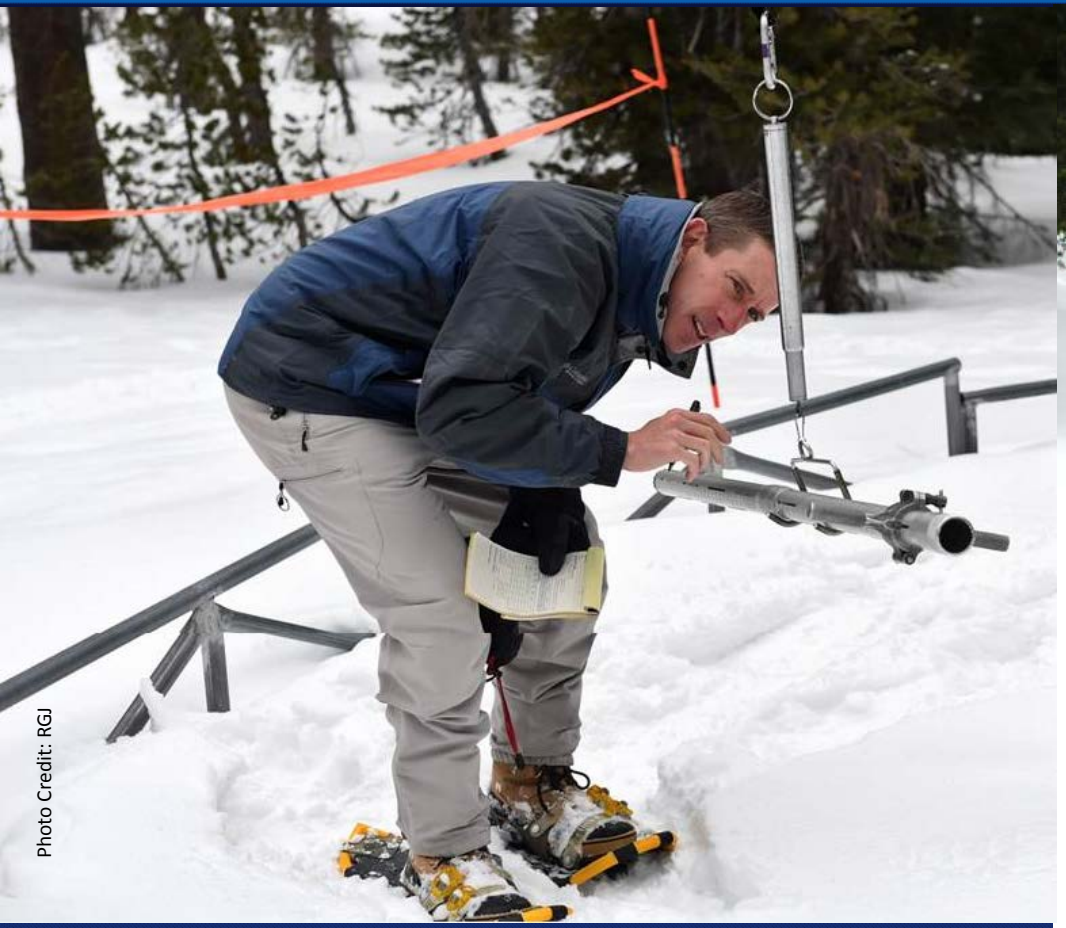
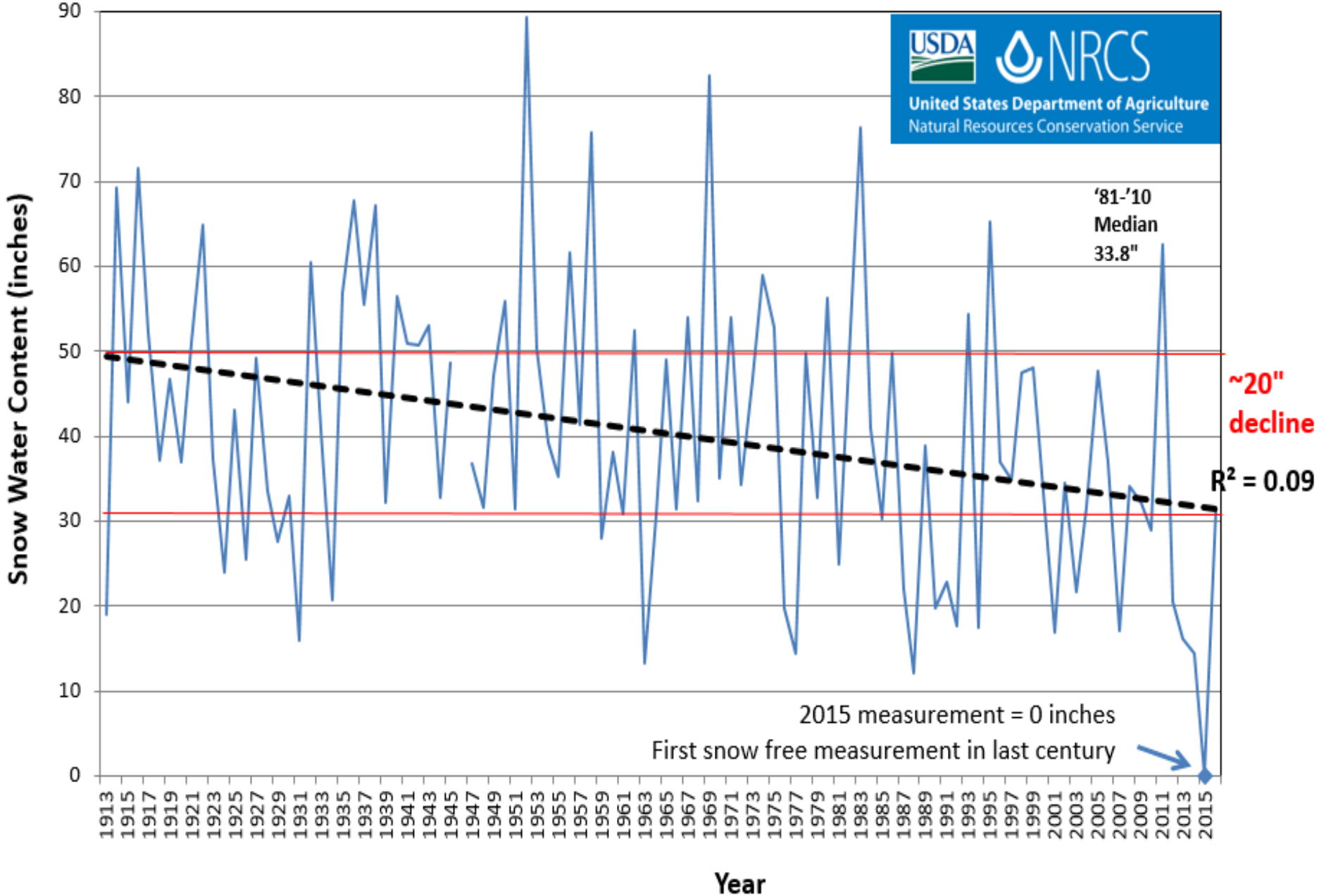


Photo Credit: RGJ

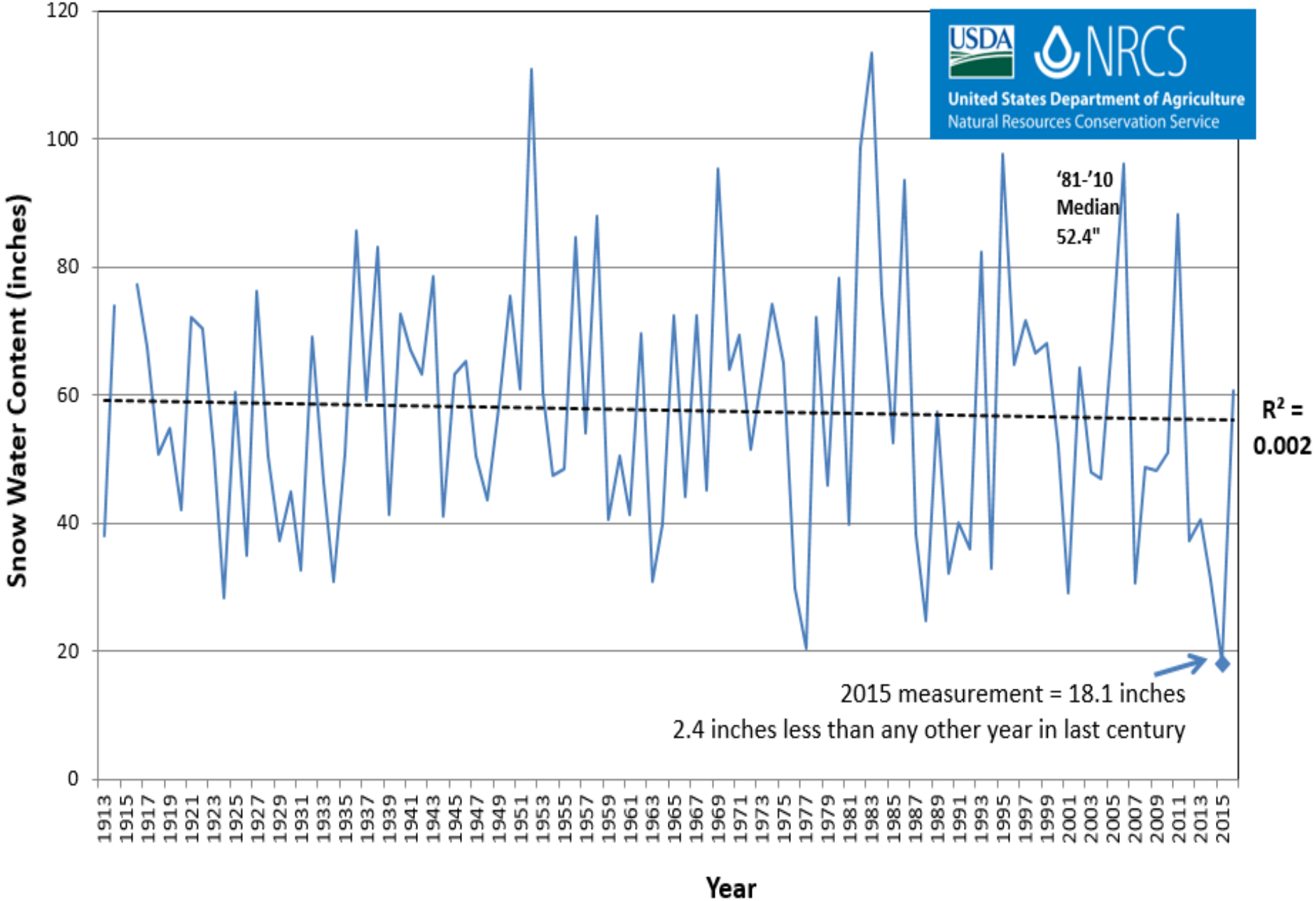
Photo Credit: NRCS Evan Smith

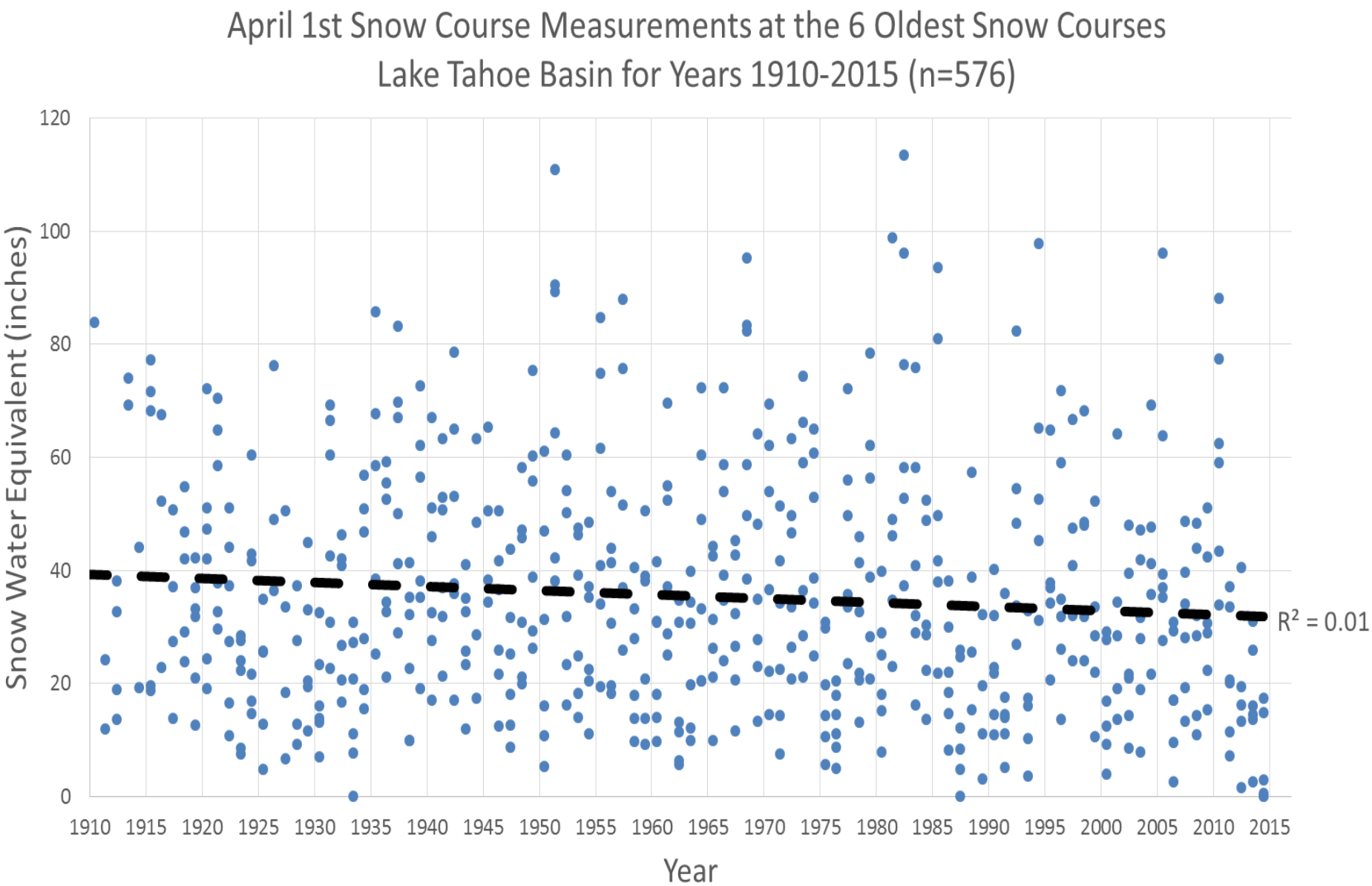
Today +300,000 snow course measurements to date

Ward Creek #2 Snow Course, Lake Tahoe Basin, 7100ft
April 1 Snow Water Content for Years 1913-2016

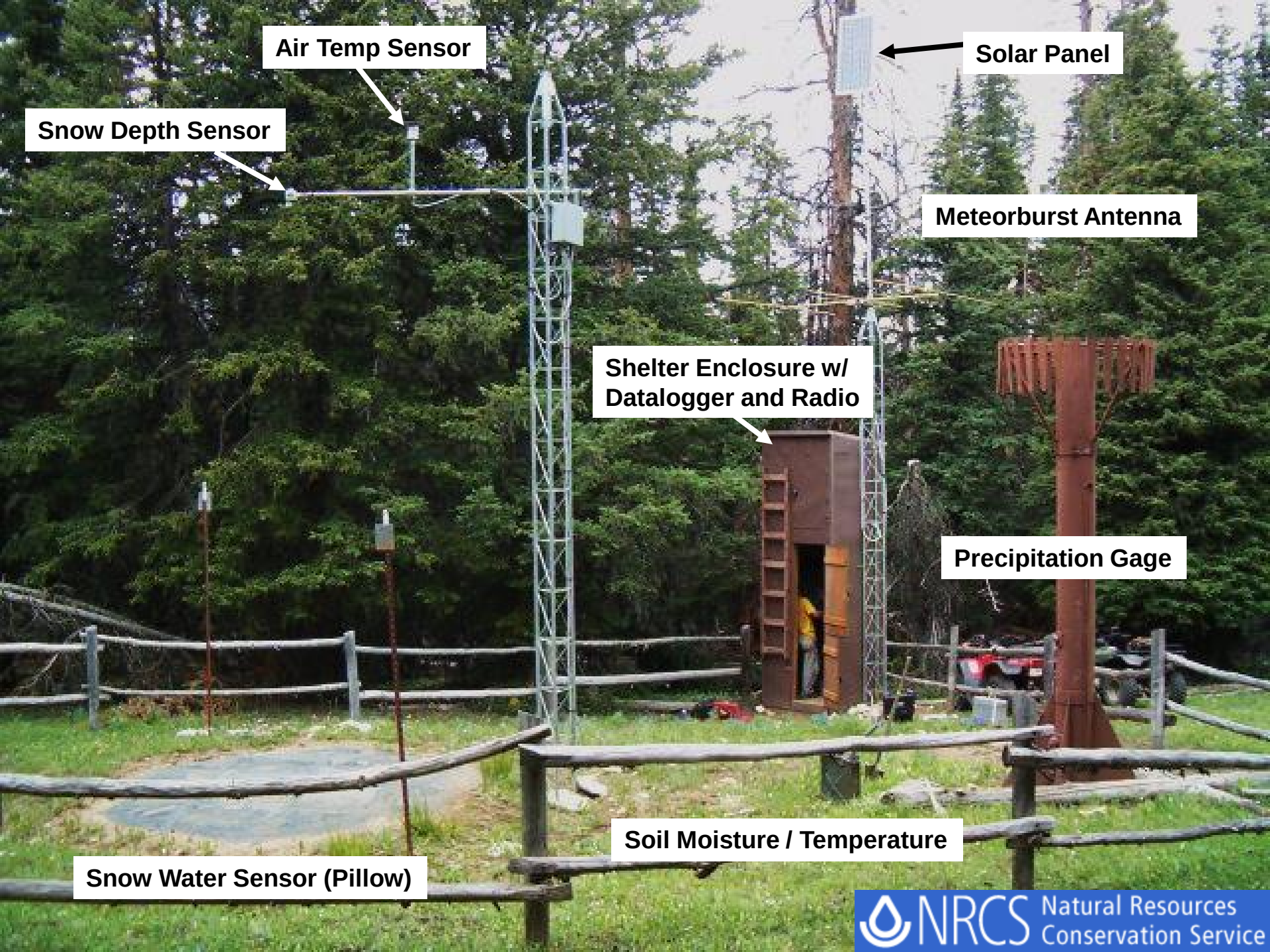


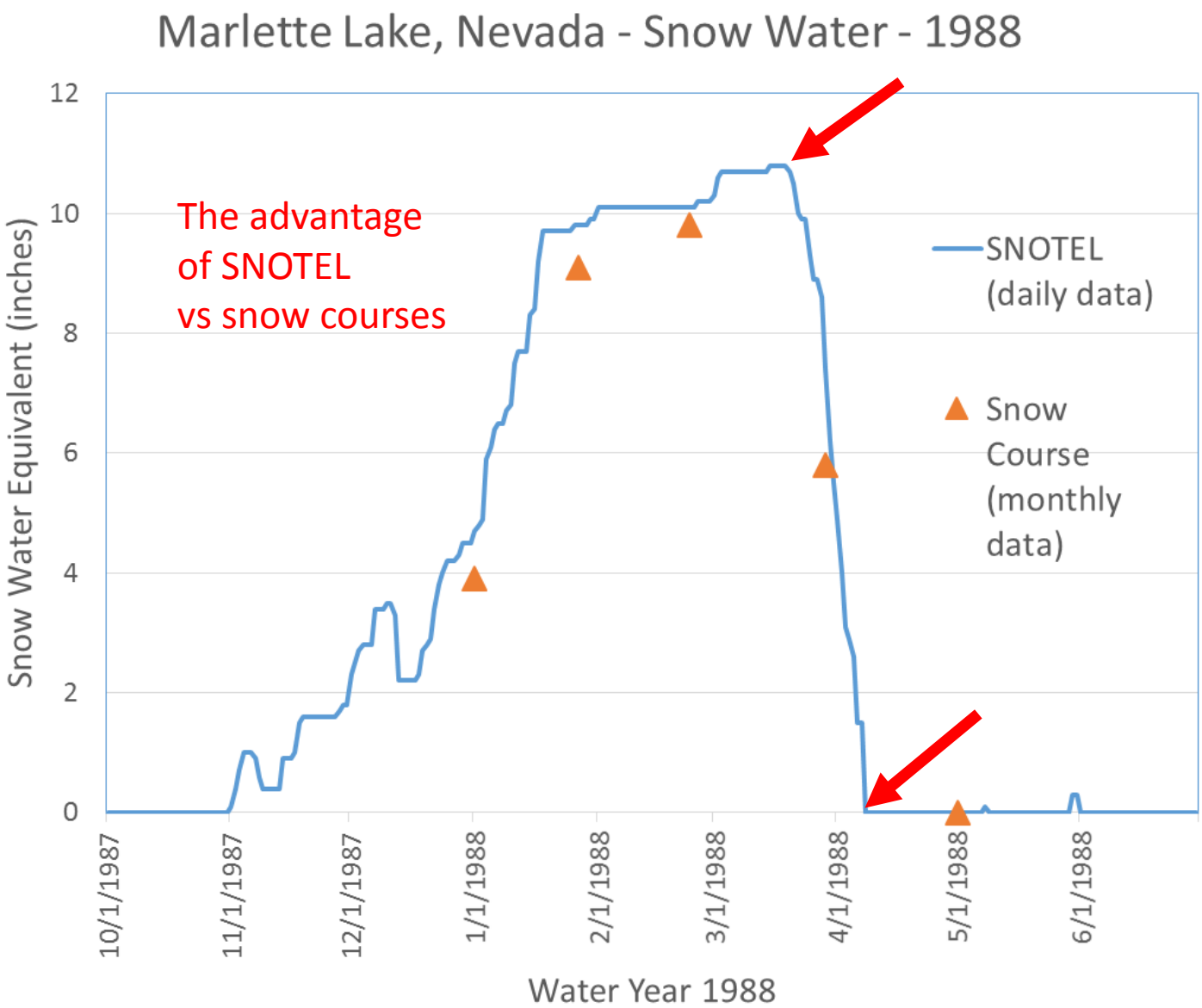
Lake Lucille Snow Course, Lake Tahoe Basin, 8,188ft
April 1 Snow Water Content for Years 1913-2016




April 1st Snow Course Measurements at the 6 Oldest Snow Courses
Lake Tahoe Basin for Years 1910-2015 (n=576)
Snow Water Equivalent (inches)
0
20
40
60
80
100
120
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Year
R² = 0.01

Beginning in late 1970s
SNOTEL
“Snow Telemetry”
NRCS Natural Resources Conservation Service

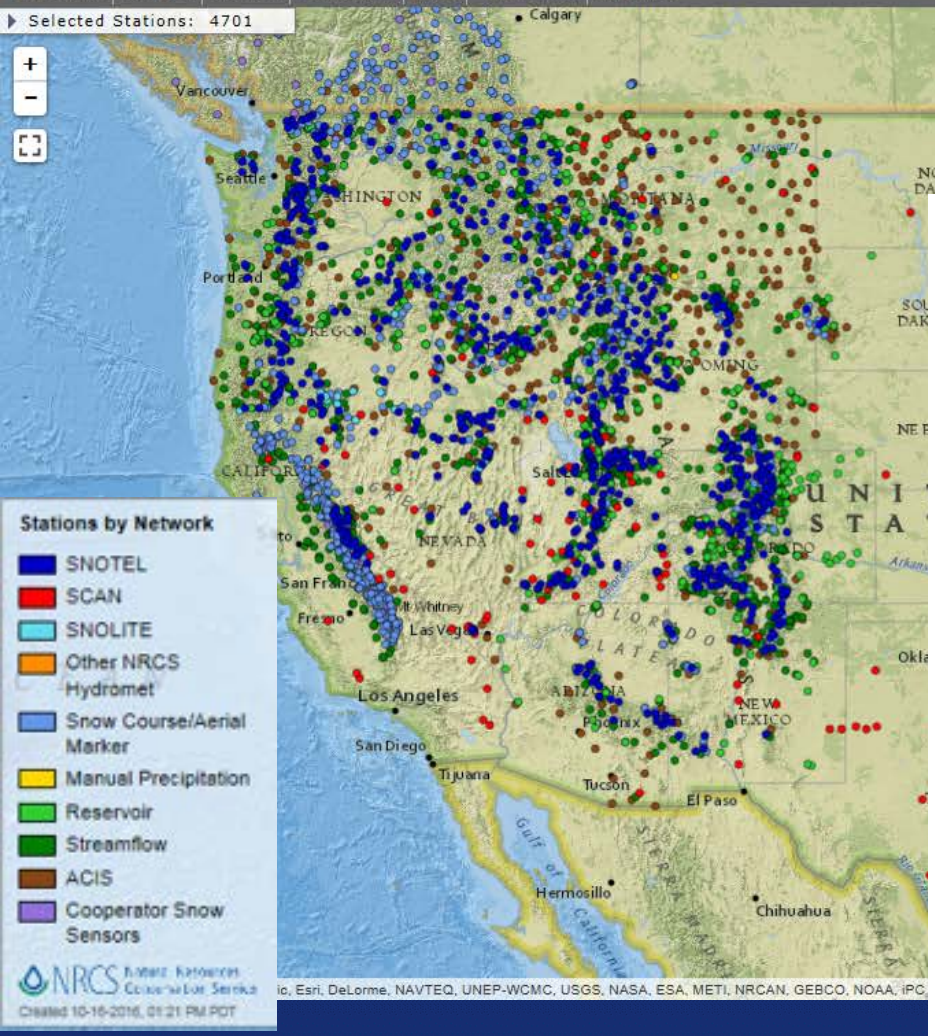

Air Temp Sensor
Solar Panel
Snow Depth Sensor
Meteorburst Antenna
Shelter Enclosure w/
Datalogger and Radio
Precipitation Gage
Soil Moisture / Temperature
Snow Water Sensor (Pillow)
NRCS Natural Resources
Conservation Service


Marlette Lake, Nevada - Snow Water - 1988
The advantage of SNOTEL vs snow courses
SNOTEL (daily data)
Snow Course (monthly data)
Snow Water Equivalent (inches)
0
2
4
6
8
10
12
10/1/1987
11/1/1987
12/1/1987
1/1/1988
2/1/1988
3/1/1988
4/1/1988
5/1/1988
6/1/1988
Water Year 1988

United States Department of Agriculture
NRCS Natural Resources Conservation Service
National Water and Climate Center

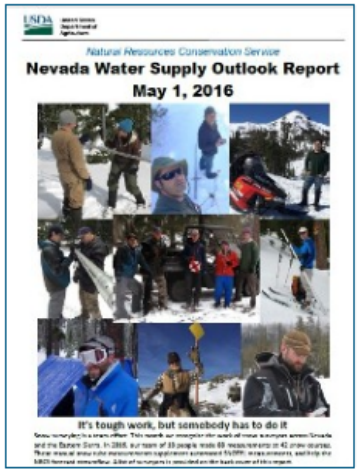
NWCC Home | About Us | Products | Publications | News | Partnerships | Contact Us | Map Help | Give us Feedback

Selected Stations: 4701



Nevada NRCS Snow Survey Program

The NRCS Snow Survey Program provides mountain snowpack data and streamflow forecasts for the western United States. Applications of snow survey products include water supply management, flood control, climate modeling, recreation, and conservation planning.



Latest Snow & Water Supply Information:

June 1, 2016 Streamflow Forecasts - NEW

May 1, 2016 Water Supply Outlook Report

Weekly El Niño Status Update (from NOAA)

Today's Snow & Precipitation Update Reports:

- Snow and Precipitation - Percent of Normal
- Precipitation - Month to Date | % of Monthly Ave
- Snowpack - Percent of Normal Peak
- Maps: Snow | Water Year Prec | Monthly Prec

Snow Survey Data

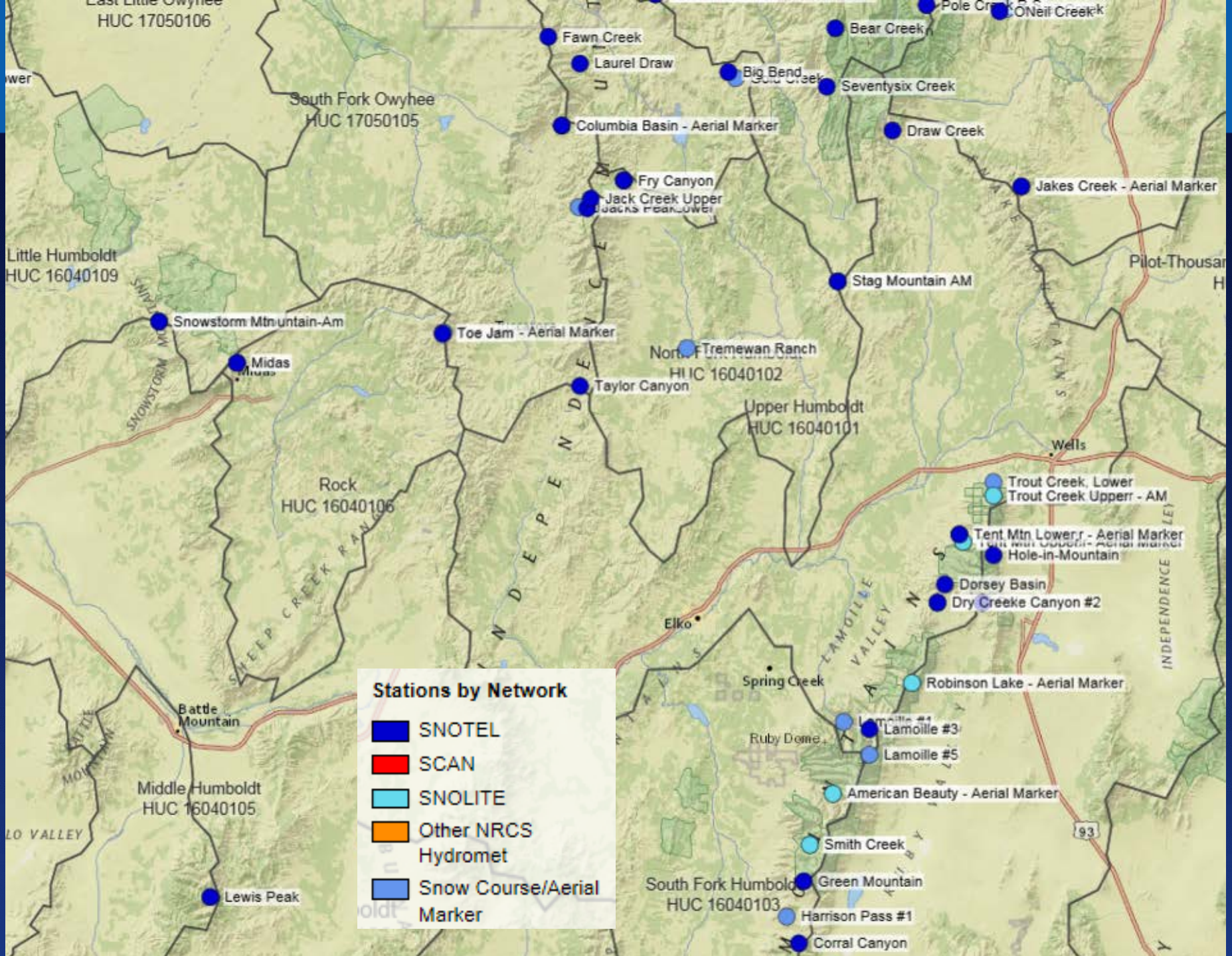
- **Site Pages:** Select a SNOTEL / SCAN site
- **Interactive Map:** (zoom, click site for data)
  SNOTEL | Snow Course | SCAN
  Interactive Map Conditions Links
- Current and Historic Data Reports
- **30 Year Normals**
- **Metadata:** Location | Site Photos

Water Supply Information

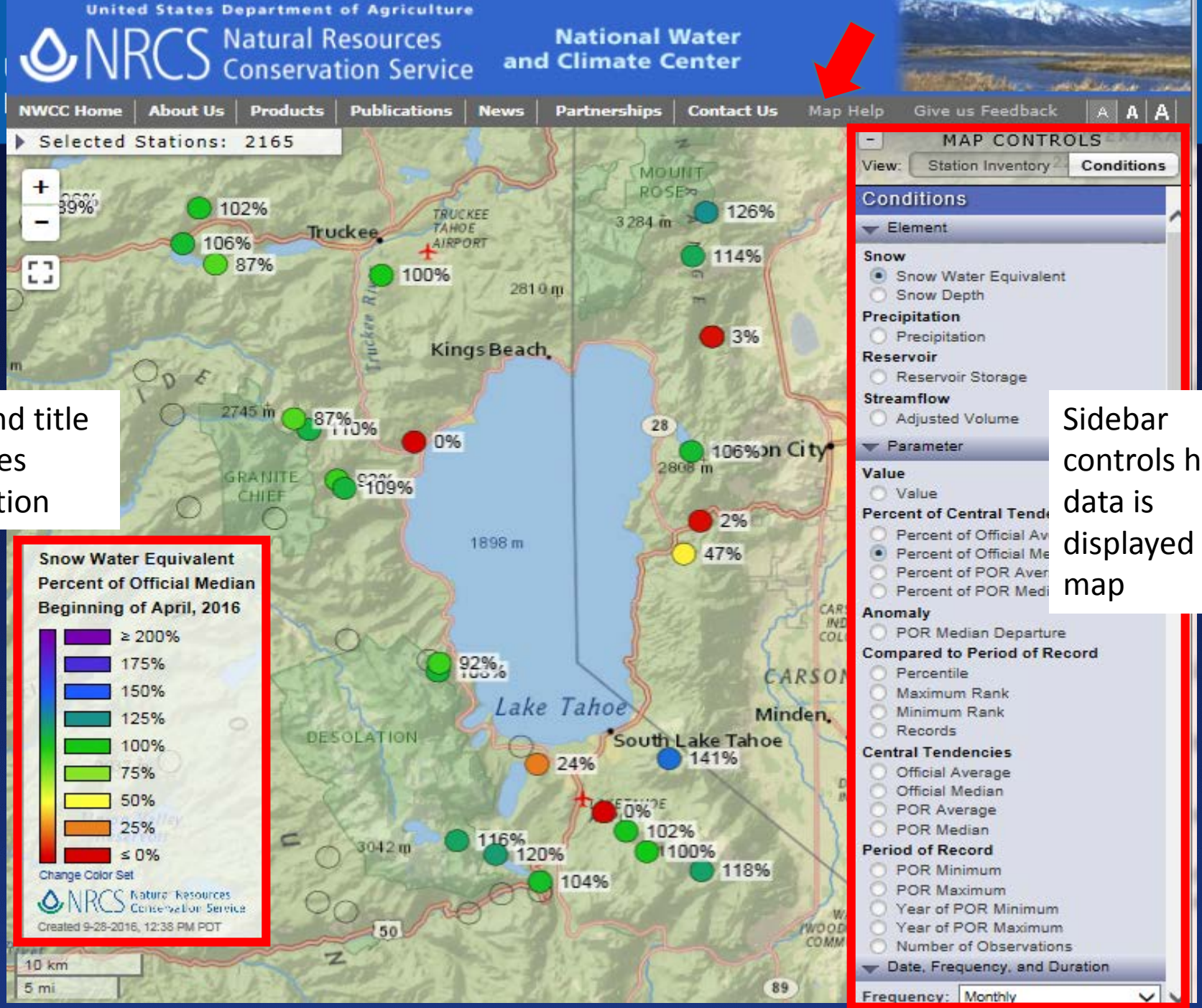
- **Outlook Reports:** Select a month
- **Streamflow Forecasts:** Select date
- **Streamflow Forecast Maps:** NV | West US
- **Daily Streamflow Forecasts**
- **Monthly Reservoir Report** (select reservoir)
- **USGS Conditions:** Stream | Reservoir
- **Historic Monthly Streamflow Data -NEW**
- **Past Water Supply Presentations**

Interactive Map

www.nv.nrcs.usda.gov/snow



East Little Owyhee
HUC 17050106
South Fork Owyhee
HUC 17050105
Little Humboldt
HUC 16040109
Rock
HUC 16040106
Middle Humboldt
HUC 16040105
Upper Humboldt
HUC 16040101
South Fork Humboldt
HUC 16040103
Fawn Creek
Laurel Draw
Big Bend
Bear Creek
Seventysix Creek
Columbia Basin - Aerial Marker
Draw Creek
Fry Canyon
Jack Creek Upper
Jakes Creek - Aerial Marker
Stag Mountain AM
Snowstorm Mtn untain-Am
Toe Jam - Aerial Marker
Midas
Tremewan Ranch
Taylor Canyon
Wells
Trout Creek, Lower
Trout Creek Upperr - AM
Tent Mtn Lower r - Aerial Marker
Hole-in-Mountain
Dorsey Basin
Dry Creeke Canyon #2
Elko
Spring Creek
Robinson Lake - Aerial Marker
Lamoille #3
Lamoille #5
Ruby Dome
American Beauty - Aerial Marker
Smith Creek
Green Mountain
Harrison Pass #1
Corral Canyon
Battle Mountain
Lewis Peak
Pilot-Thousan
93
Stations by Network
SNOTEL
SCAN
SNOLITE
Other NRCS Hydromet
Snow Course/Aerial Marker



Legend title defines selection

Sidebar controls how data is displayed on map

Map Controls

Element

- **Snow**
  - Snow Water Equivalent
  - Snow Depth
- **Precipitation**
  - Precipitation
- **Reservoir**
  - Reservoir Storage
- **Streamflow**
  - Adjusted Volume

Parameter

- **Value**
  - Value
- **Percent of Central Tendencies**
  - Percent of Official Average
  - Percent of Official Median
  - Percent of POR Average
  - Percent of POR Median
- **Anomaly**
  - POR Median Departure
- **Compared to Period of Record**
  - Percentile
  - Maximum Rank
  - Minimum Rank
  - Records
- **Central Tendencies**
  - Official Average
  - Official Median
  - POR Average
  - POR Median
- **Period of Record**
  - POR Minimum
  - POR Maximum
  - Year of POR Minimum
  - Year of POR Maximum
  - Number of Observations

SWE

Date, Frequency, and Duration

Frequency: Mo Daily Monthly

Streamflow / Prec

Date, Frequency, and Duration

Frequency: Monthly
Duration: Custom Months
or 60 months

Date (End of Period)

Year: 2016 + −
Month: April + −
Part: First of Month + −

Station Selection

Location

States All None
Missouri
Montana
Nebraska
Nevada
New Hampshire
New Mexico
New York
North Carolina
North Dakota

Counties All None
Churchill
Clark
Douglas
Elko
Eureka
Humboldt
Lander
Lincoln
Lyon

HUCs:
Minimum Elevation: ft.
Maximum Elevation: ft.

Collection Networks

- [x] Active Sites Only

Check All Uncheck All

USDA-NRCS Real-Time Networks

- [x] SNOTEL (42)
- [ ] SCAN (2)
- [ ] SNOLITE (0)
- [ ] Other NRCS Hydromet (0)

USDA-NRCS Non-Real-Time Networks

- [x] Snow Course/Aerial Marker (51)
- [ ] Manual Precipitation (0)

Other Networks

- [ ] Reservoir (0)
- [ ] Streamflow (0)
- [ ] ACIS (0)
- [ ] Cooperator Snow Sensors (0)

Overlays

Watershed Boundaries

- [ ] Region (2-Digit HUC)
- [ ] Subregion (4-Digit HUC)
- [ ] Basin (6-Digit HUC)
- [ ] Subbasin (8-Digit HUC)

Labels

Station Labels

- [ ] Name
- [ ] ID
- [ ] Elevation
- [x] Parameter

Watershed Labels

- [ ] Watershed Labels

United States Department of Agriculture

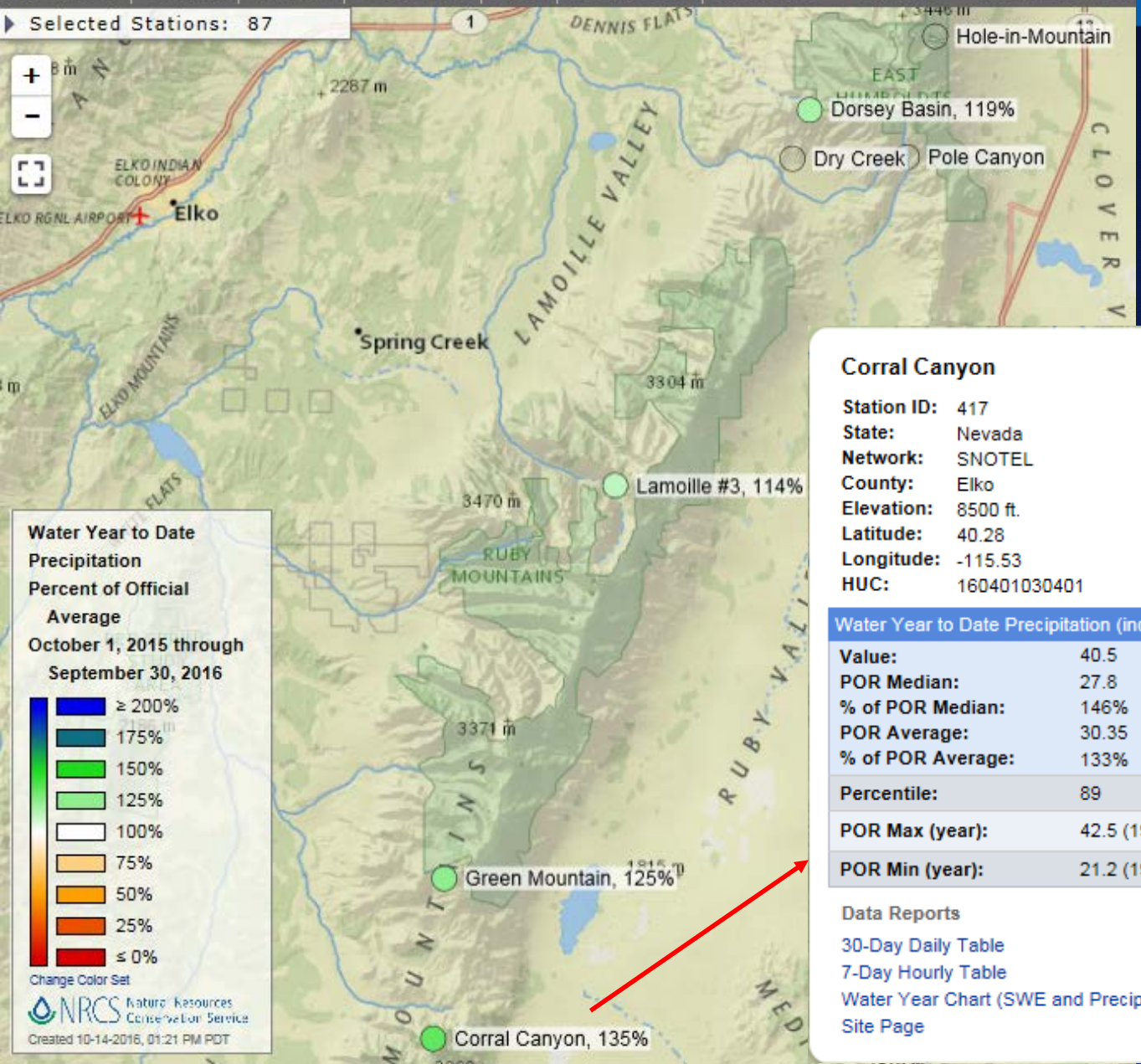
NRCS Natural Resources Conservation Service

National Water and Climate Center

USDA NRCS

NWCC Home | About Us | Products | Publications | News | Partnerships | Contact Us | Map Help | Give us Feedback

Selected Stations: 87



Corral Canyon

Station ID:	417
State:	Nevada
Network:	SNOTEL
County:	Elko
Elevation:	8500 ft.
Latitude:	40.28
Longitude:	-115.53
HUC:	160401030401

Water Year to Date Precipitation (inches) October 1, 2015 through September 30, 2016			
Value:	40.5	**Anomaly:**	12.7
POR Median:	27.8	**Official Median:**	27.4
% of POR Median:	146%	**% of Official Median:**	148%
POR Average:	30.35	**Official Average:**	29.96
% of POR Average:	133%	**% of Official Average:**	135%
Percentile:	89	**# of Observations:**	38
POR Max (year):	42.5 (1984)	**Max Rank:**	5
POR Min (year):	21.2 (1987)	**Min Rank:**	34

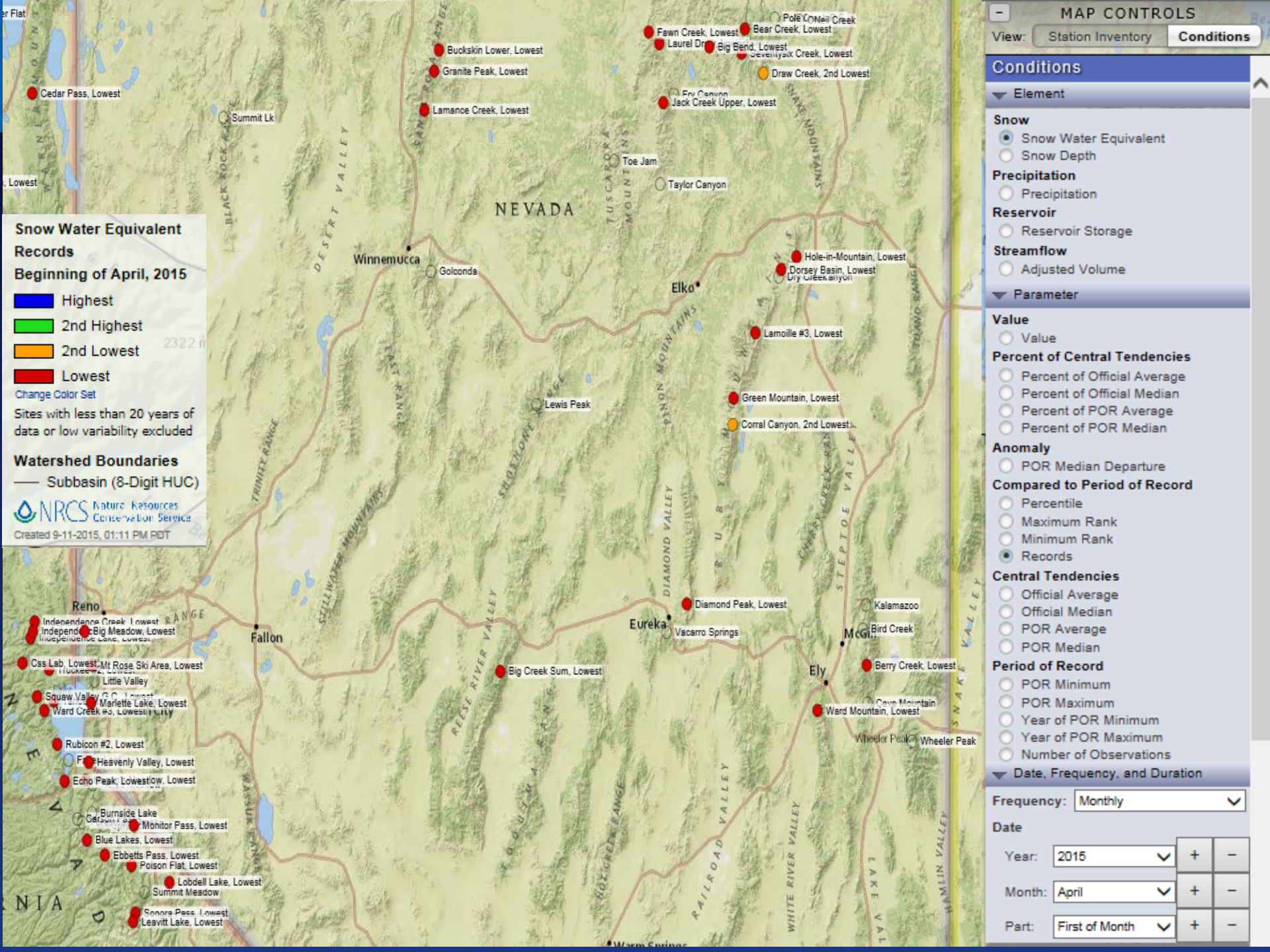
Data Reports

30-Day Daily Table

7-Day Hourly Table

Water Year Chart (SWE and Precip)

Site Page



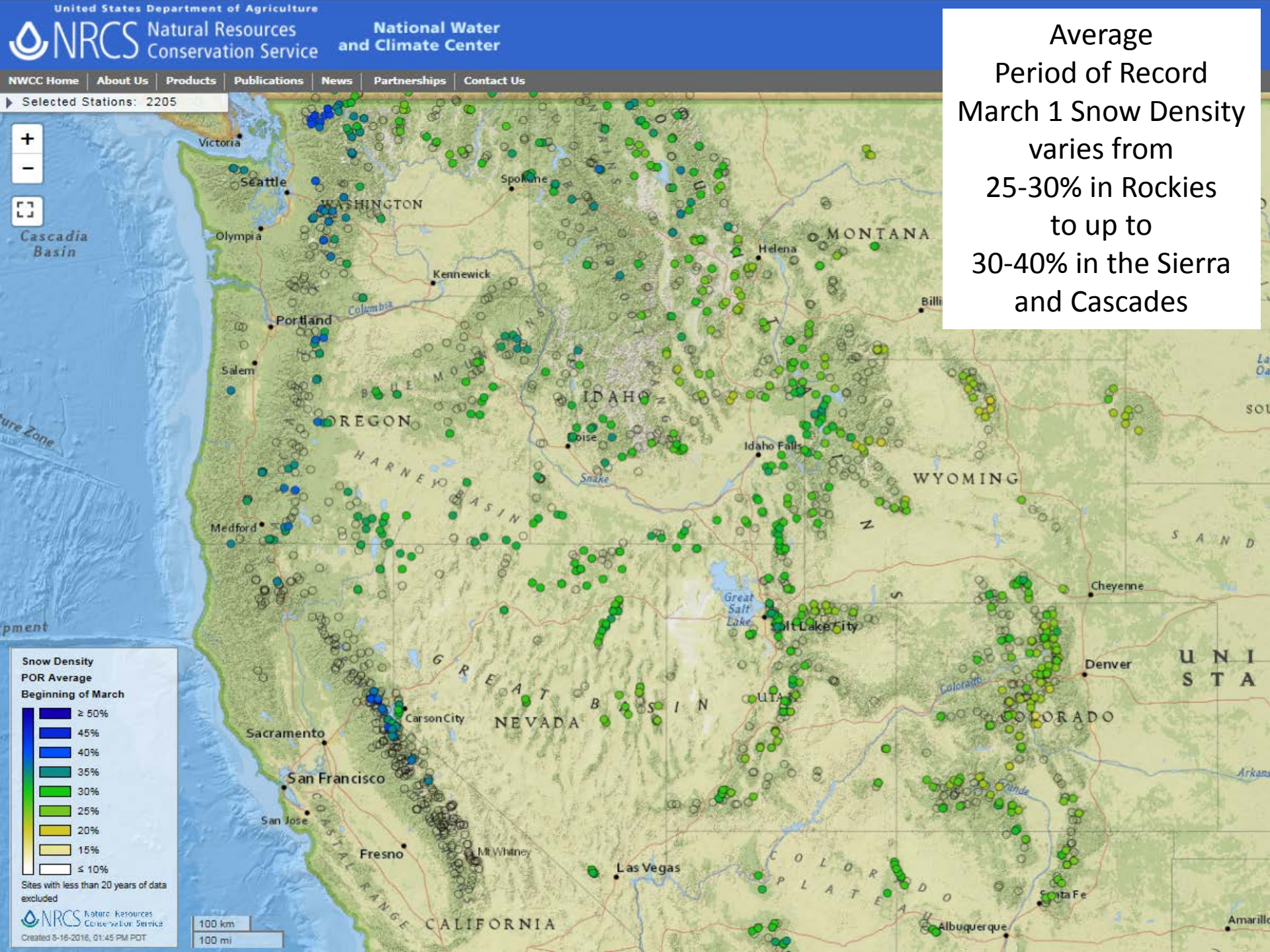
Snow Water Equivalent Records
Beginning of April, 2015
Highest
2nd Highest
2nd Lowest
Lowest
Change Color Set
Sites with less than 20 years of data or low variability excluded
Watershed Boundaries
Subbasin (8-Digit HUC)
NRCS Natural Resources Conservation Service
Created 9-11-2015, 01:11 PM PDT
NEVADA
Winnemucca
Golconda
Elko
Eureka
Ely
Fallon
Reno
Cedar Pass, Lowest
Summit Lk
Buckskin Lower, Lowest
Granite Peak, Lowest
Lamance Creek, Lowest
Fawn Creek, Lowest
Bear Creek, Lowest
Big Bend, Lowest
Draw Creek, 2nd Lowest
Jack Creek Upper, Lowest
Toe Jam
Taylor Canyon
Hole-in-Mountain, Lowest
Dorsey Basin, Lowest
Lamoille #3, Lowest
Green Mountain, Lowest
Corral Canyon, 2nd Lowest
Lewis Peak
Diamond Peak, Lowest
Vacarro Springs
Kalamazoo
Bird Creek
Berry Creek, Lowest
Ward Mountain, Lowest
Wheeler Peak
Big Creek Sum, Lowest
Independence Creek, Lowest
Big Meadow, Lowest
Css Lab, Lowest
Mt Rose Ski Area, Lowest
Little Valley
Marlette Lake, Lowest
Rubicon #2, Lowest
Heavenly Valley, Lowest
Echo Peak, Lowest
Burnside Lake
Monitor Pass, Lowest
Blue Lakes, Lowest
Ebbetts Pass, Lowest
Poison Flat, Lowest
Lobdell Lake, Lowest
Summit Meadow
Sonora Pass, Lowest
Leavitt Lake, Lowest
MAP CONTROLS
View: Station Inventory Conditions
Conditions
Element
Snow
Snow Water Equivalent
Snow Depth
Precipitation
Precipitation
Reservoir
Reservoir Storage
Streamflow
Adjusted Volume
Parameter
Value
Value
Percent of Central Tendencies
Percent of Official Average
Percent of Official Median
Percent of POR Average
Percent of POR Median
Anomaly
POR Median Departure
Compared to Period of Record
Percentile
Maximum Rank
Minimum Rank
Records
Central Tendencies
Official Average
Official Median
POR Average
POR Median
Period of Record
POR Minimum
POR Maximum
Year of POR Minimum
Year of POR Maximum
Number of Observations
Date, Frequency, and Duration
Frequency: Monthly
Date
Year: 2015
Month: April
Part: First of Month

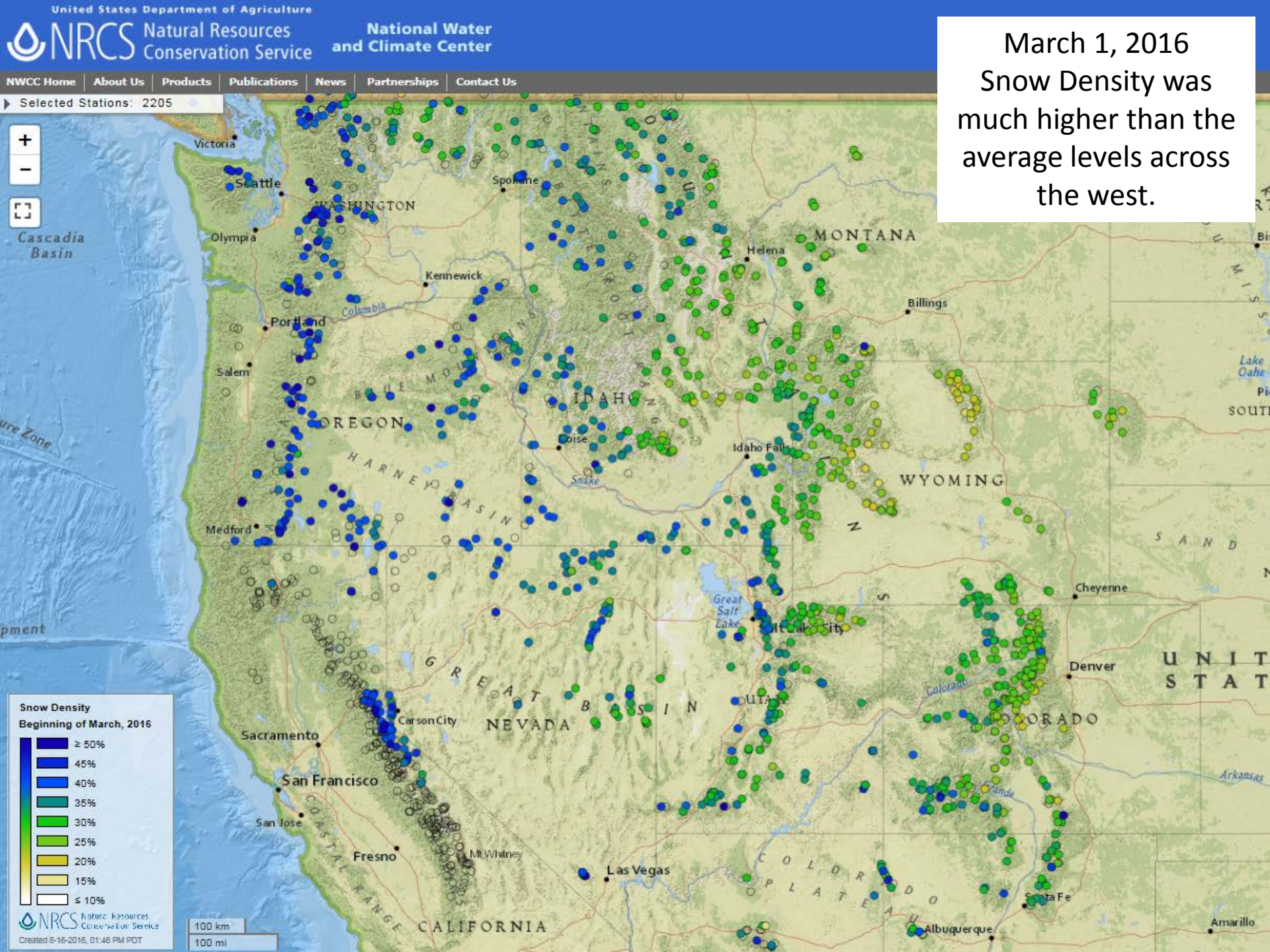
New Map Features – coming soon

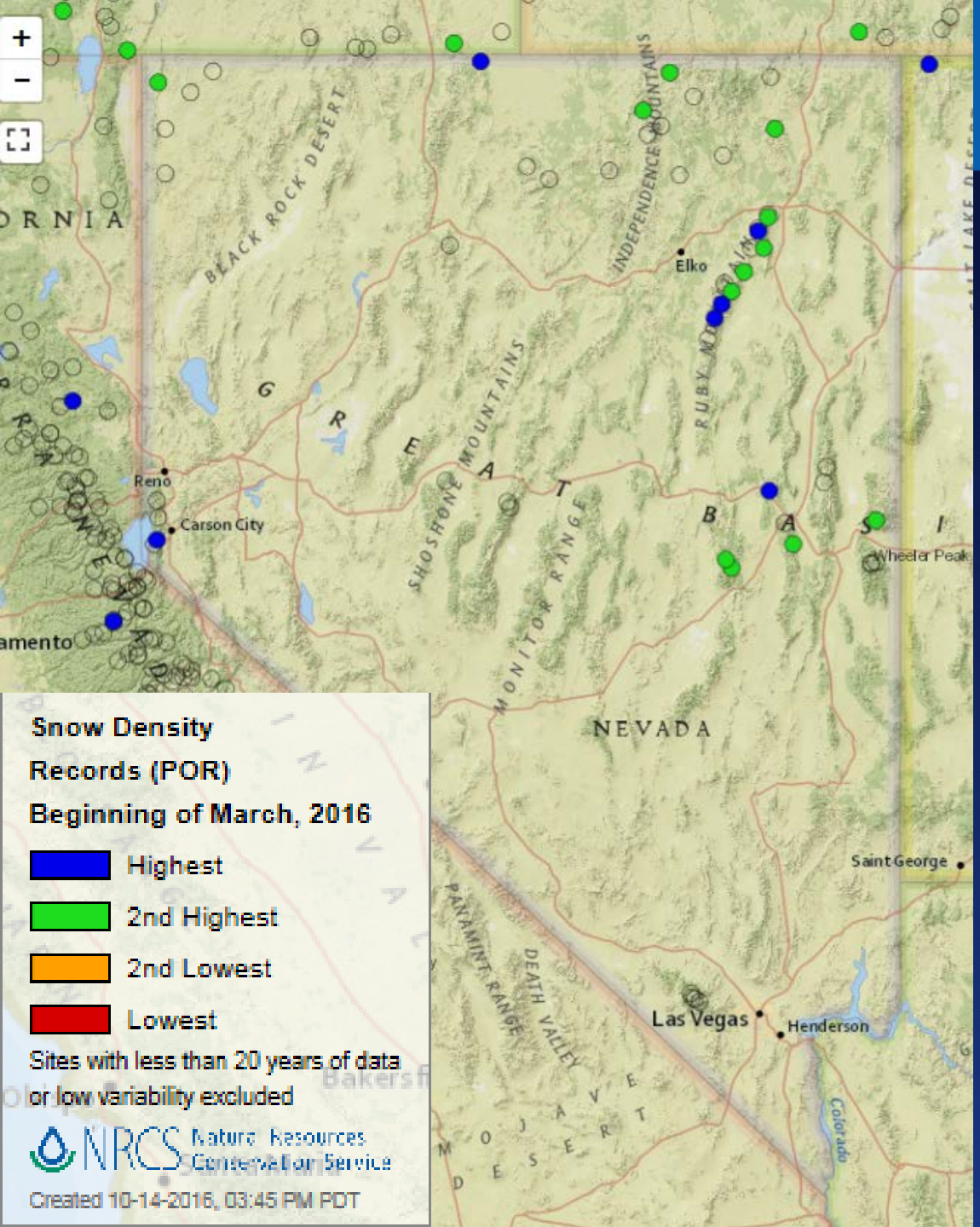
- New functions:
  - Delta, Snow Density, Water Year Peak
- Basin calculations based on HUCs
- Data analysis can be exported to .CSV

Beta Version features available for testing at:
http://www.wcc.nrcs.usda.gov/webmap_beta/index.html

Note: Data may not be updated in real time and bugs are still being worked out.

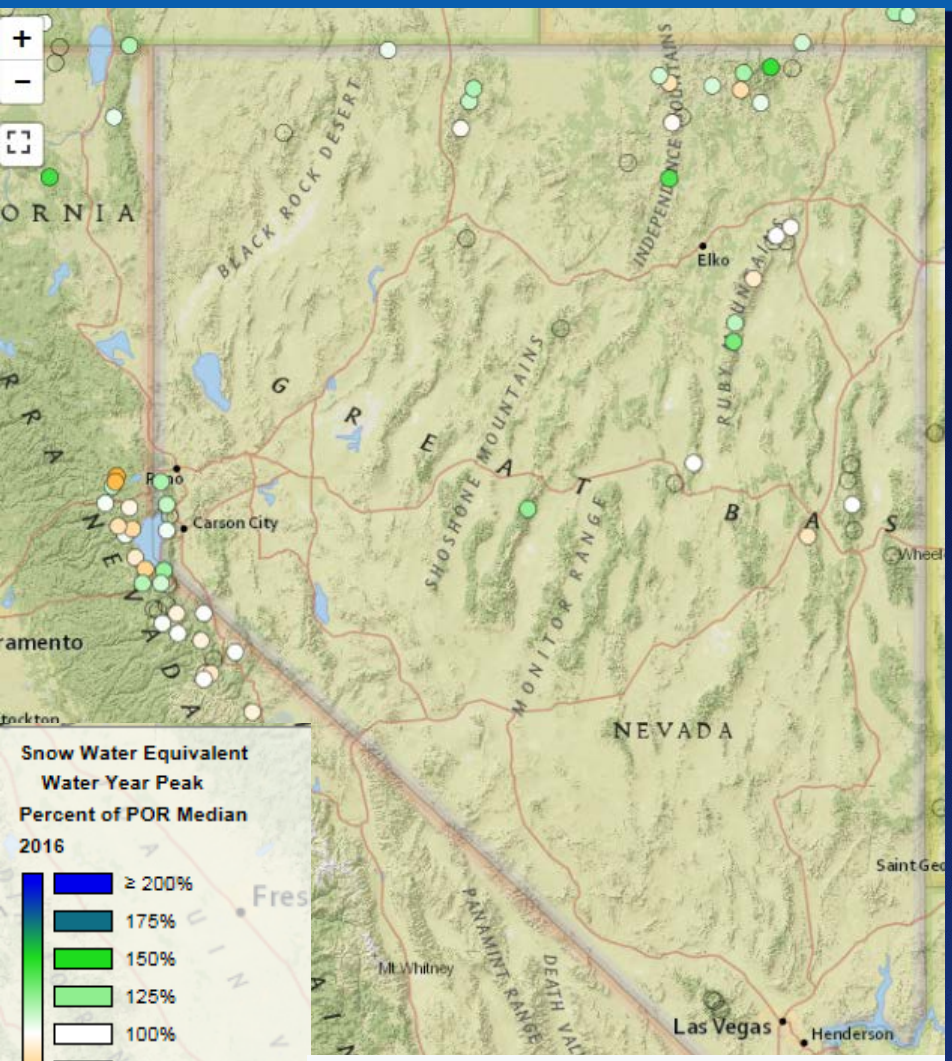

United States Department of Agriculture
NRCS Natural Resources Conservation Service
National Water and Climate Center
NWCC Home | About Us | Products | Publications | News | Partnerships | Contact Us
Selected Stations: 2205
Average
Period of Record
March 1 Snow Density
varies from
25-30% in Rockies
to up to
30-40% in the Sierra
and Cascades
Snow Density
POR Average
Beginning of March
≥ 50%
45%
40%
35%
30%
25%
20%
15%
≤ 10%
Sites with less than 20 years of data excluded
Created 8-16-2016, 01:45 PM PDT
100 km
100 mi
Victoria
Seattle
Spokane
WASHINGTON
Olympia
Cascadia Basin
Kennewick
Columbia
Portland
Salem
MONTANA
Helena
IDAHO
OREGON
Boise
Snake
Idaho Falls
WYOMING
HARNEY BASIN
Medford
Great Salt Lake
Salt Lake City
Cheyenne
Denver
GREAT BASIN
UTAH
COLORADO
Colorado
Carson City
NEVADA
Sacramento
San Francisco
San Jose
Fresno
Mt Whitney
Las Vegas
COLORADO PLATEAU
Santa Fe
Albuquerque
Amarillo
CALIFORNIA
COASTAL RANGE


United States Department of Agriculture
NRCS Natural Resources Conservation Service
National Water and Climate Center
NWCC Home | About Us | Products | Publications | News | Partnerships | Contact Us
Selected Stations: 2205
March 1, 2016
Snow Density was much higher than the average levels across the west.
Snow Density
Beginning of March, 2016
≥ 50%
45%
40%
35%
30%
25%
20%
15%
≤ 10%
NRCS Natural Resources Conservation Service
Created 8-16-2016, 01:46 PM PDT
100 km
100 mi
Victoria
Seattle
Spokane
WASHINGTON
Olympia
Kennewick
Portland
Columbia
Salem
OREGON
Medford
Cascadia Basin
MONTANA
Helena
Billings
IDAHO
Boise
Snake
Idaho Falls
WYOMING
Cheyenne
Great Salt Lake
Salt Lake City
Denver
Colorado
COLORADO
Arkansas
Rio Grande
Santa Fe
Albuquerque
Amarillo
Lake Oahe
HARNEY BASIN
GREAT BASIN
NEVADA
UTAH
Carson City
Sacramento
San Francisco
San Jose
Fresno
Mt Whitney
Las Vegas
COASTAL RANGE
CALIFORNIA
COLORADO PLATEAU

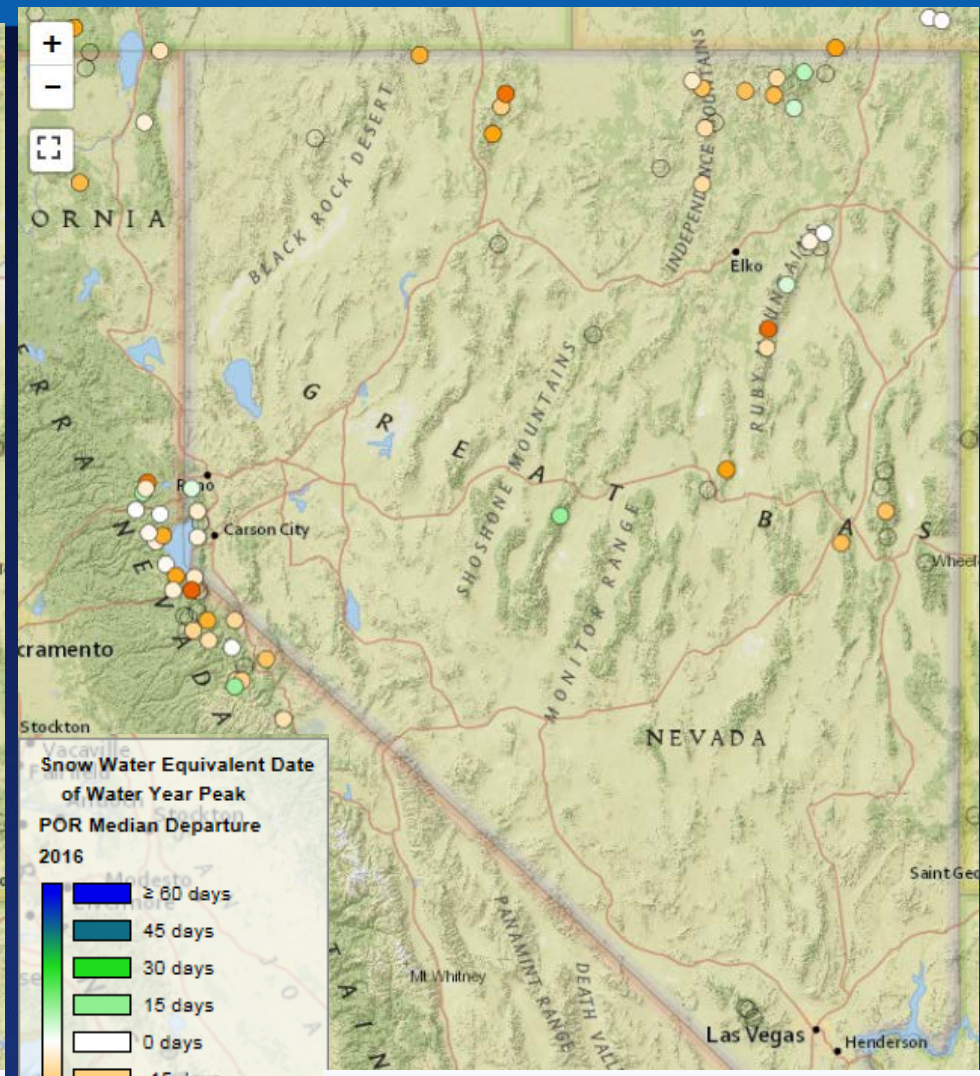


USDA NRCS

March 1, 2016
Snow Density
set, or came close to,
record levels in
eastern Nevada

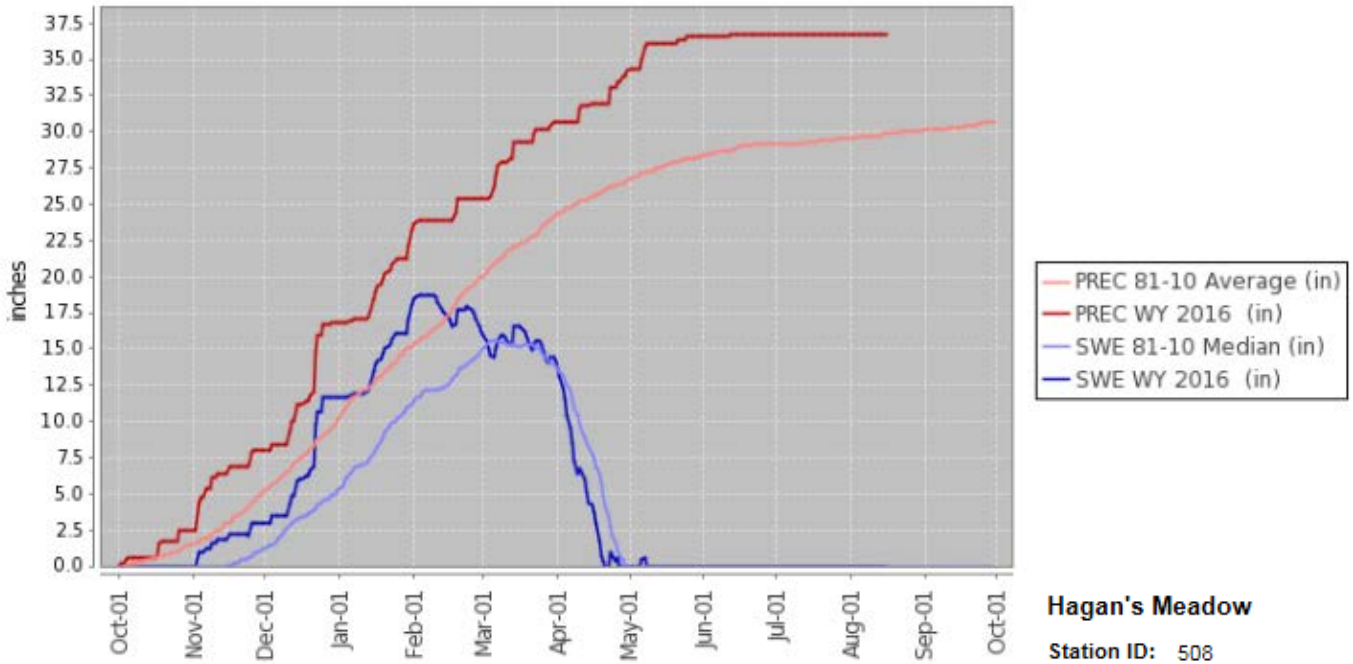


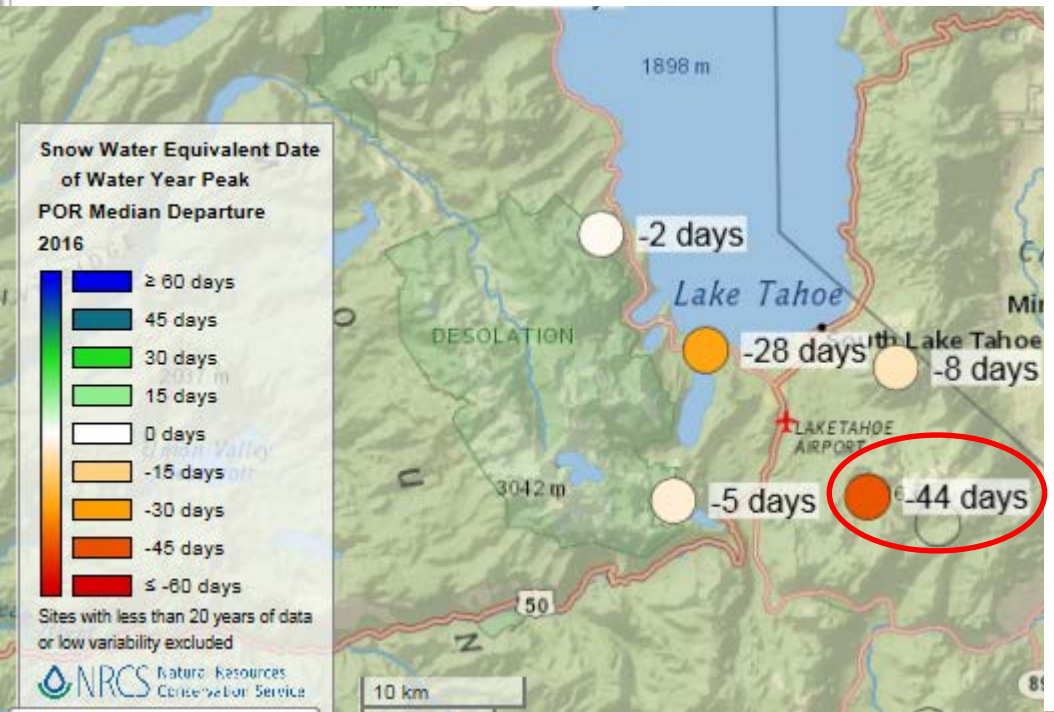
2016: Most sites had SWE peaked near to above median amounts.



2016: However, peaks were reached 15-40 days before POR median peak dates

Station (508) WATERYEAR=2016 (Daily) NRCS National Water and Climate Center - Provisional Data - subject to revision
Tue Aug 16 13:49:00 GMT-08:00 2016





Hagan's Meadow

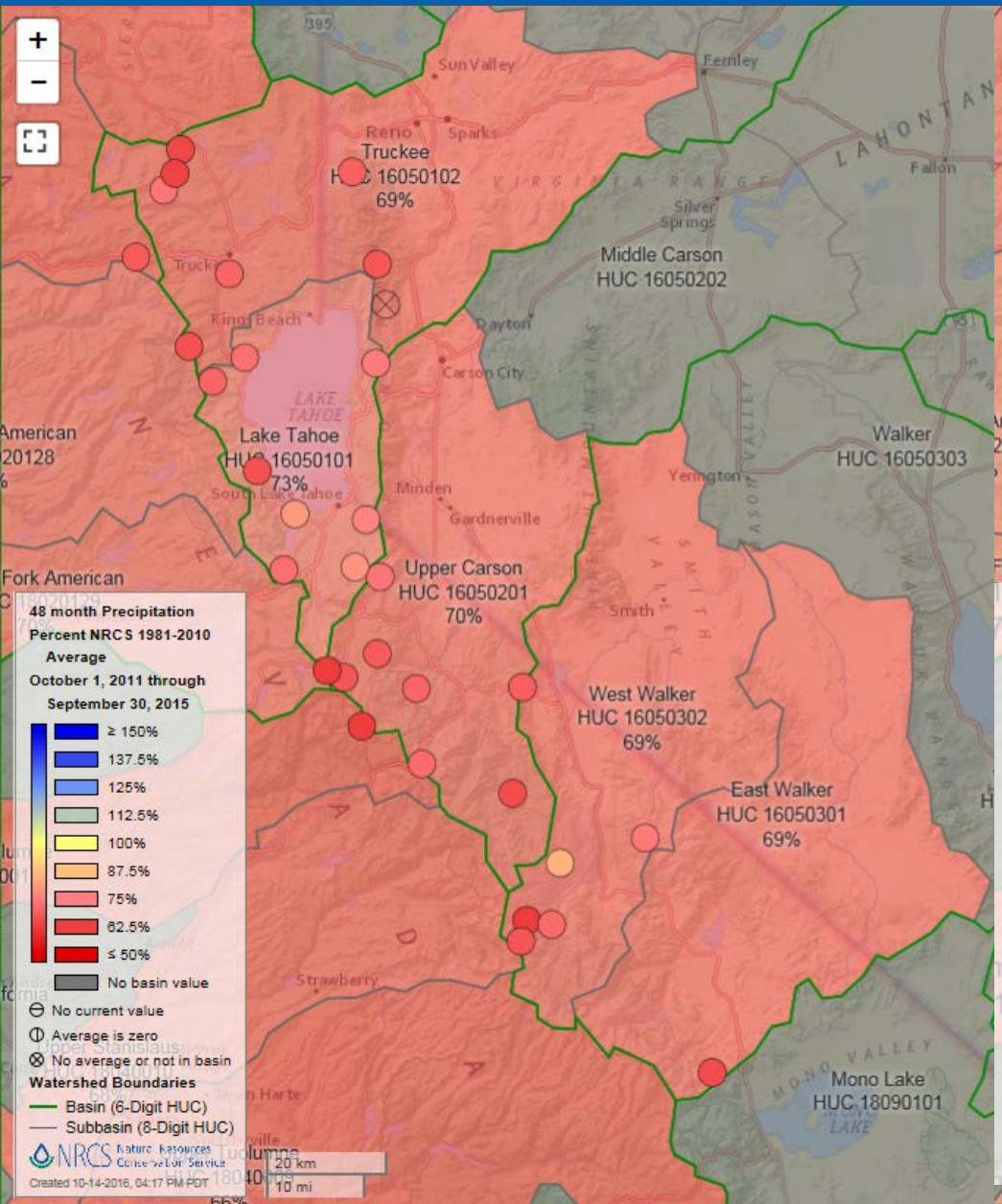
Station ID:	508
State:	California
Network:	SNOTEL
County:	El Dorado
Elevation:	7776 ft.
Latitude:	38.85
Longitude:	-119.94
HUC:	160501010302

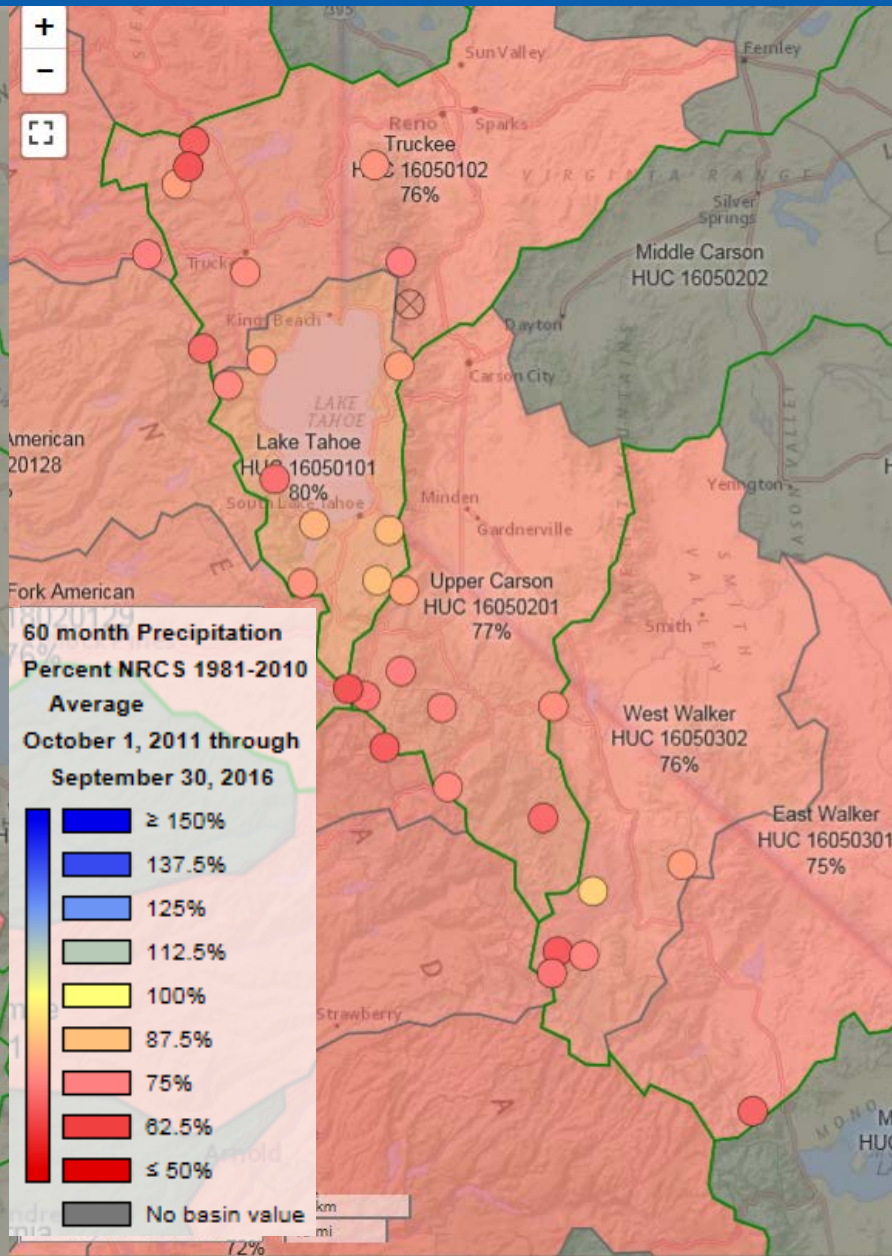
Snow Water Equivalent Date of Water Year Peak for 2016			
Value:	02-08	**Anomaly (POR):**	-44 days
POR Median:	03-23	**NRCS 1981-2010 Median:**	
% of POR Median:	75%	**% of NRCS 1981-2010 Median:**	
POR Average:	03-20	**NRCS 1981-2010 Average:**	
% of POR Average:	76%	**% of NRCS 1981-2010 Average:**	
Percentile (POR):	0	**# of Observations (POR):**	37
Maximum (POR) (year):	05-05 (1983)	**Maximum Rank (POR):**	38
Minimum (POR) (year):	02-09 (2015)	**Minimum Rank (POR):**	1

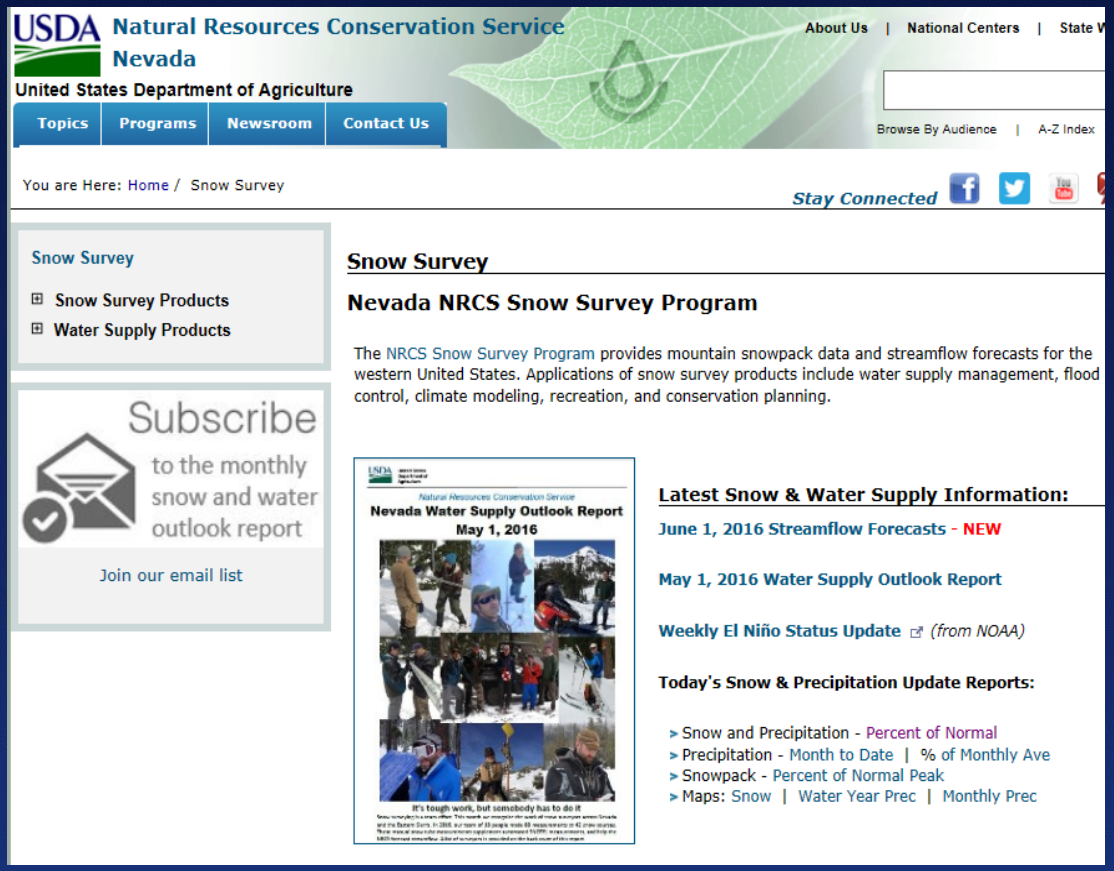
Data Reports

Export CSV

30-Day Daily Table
7-Day Hourly Table
Water Year Chart (SWE and Precip)
Site Page


Truckee
HUC 16050102
69%
Middle Carson
HUC 16050202
Lake Tahoe
HUC 16050101
73%
Walker
HUC 16050303
Upper Carson
HUC 16050201
70%
West Walker
HUC 16050302
69%
East Walker
HUC 16050301
69%
Mono Lake
HUC 18090101
48 month Precipitation
Percent NRCS 1981-2010
Average
October 1, 2011 through
September 30, 2015
≥ 150%
137.5%
125%
112.5%
100%
87.5%
75%
62.5%
≤ 50%
No basin value
No current value
Average is zero
No average or not in basin
Watershed Boundaries
Basin (6-Digit HUC)
Subbasin (8-Digit HUC)
Created 10-14-2016, 04:17 PM PDT


Truckee
HUC 16050102
76%
Middle Carson
HUC 16050202
Lake Tahoe
HUC 16050101
80%
Upper Carson
HUC 16050201
77%
West Walker
HUC 16050302
76%
East Walker
HUC 16050301
75%
60 month Precipitation
Percent NRCS 1981-2010
Average
October 1, 2011 through
September 30, 2016
≥ 150%
137.5%
125%
112.5%
100%
87.5%
75%
62.5%
≤ 50%
No basin value



For snowpack status and streamflow forecasts this winter visit:

www.nv.nrcs.usda.gov/snow

Also, subscribe to the

Nevada Snow & Water Supply Outlook Report

Questions:

Jeff.Anderson@nv.usda.gov

775-858-8500 x152