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Runoff Conditions in Utah for Water Year 2011

Introduction

In May 2011, the snowpack conditions in the mountains of central and northern Utah had emergency planners and water managers preparing for levels of runoff similar to the record year of 1983 (The Salt Lake Tribune, 2011). The SNOwpack TELemetry (SNOTEL) records from the Natural Resources Conservation Service (NRCS) reported that the amount of water contained in the snowpack in May 2011 was greater than it was in either May of 1983 or 2005.

Despite the above average snowpack, which lasted into the summer of 2011, runoff from snowmelt in 2011 did not create the widespread damage observed in 1983 and 2005. Cooler than normal temperatures resulted in slower snowmelt rates, which produced a prolonged and elevated runoff. Annual streamflow for water year 2011 was well above average, but few records of peak streamflow were set. The increase in water-surface elevation of Great Salt Lake was also above average.

Ten streamgages in central and northern Utah, with records spanning greater than 20 years, have been selected to highlight the runoff conditions in Utah during water year 2011 (fig. 1). Streamflow on the Duchesne River near Randlett, Utah (09302000), and on the Bear River near Utah-Wyoming state line (10011500) is affected by several upstream diversions. These two streamgages were included in the analysis because their streamflow records have shown responses to spring snowmelt. The annual streamflow in all 10 of these streamgages was greater than 150 percent of average, and three streamgages set new records for total annual streamflow in water year 2011. One streamgage set a new peak streamflow record.

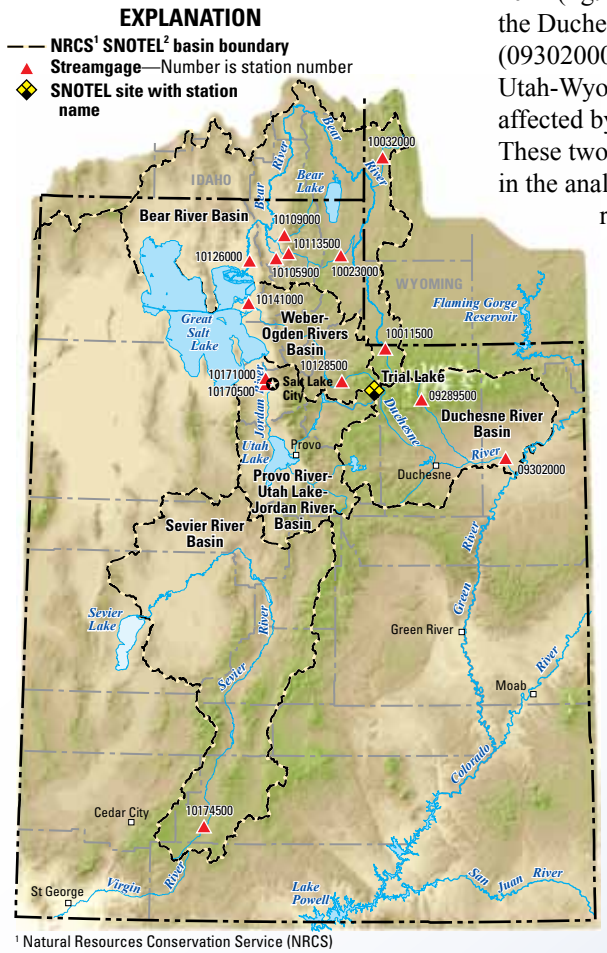


Figure 1. Selected streamflow gages and SNOTEL basin boundaries in Utah.

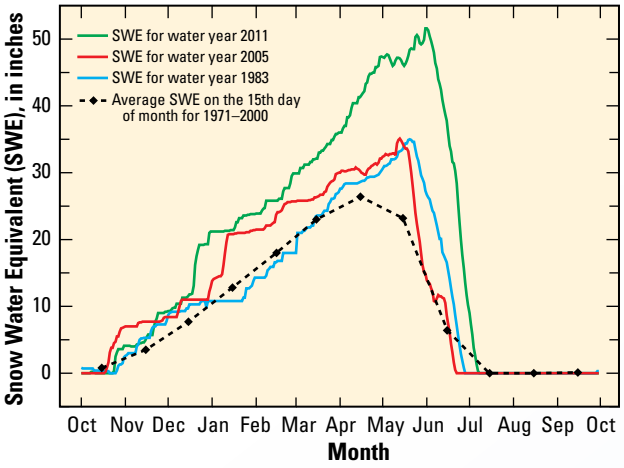


Figure 2. The Snow Water Equivalent (SWE) at the Trial Lake SNOTEL station for water years 1983, 2005, and 2011 and the 30-year average.

Water Year 2011 Snowpack

During water year 2011, Utah experienced its wettest 90-day period in history (1948–2011) from March to May. On March 1, 2011, the basin-wide Snow Water Equivalent (SWE) in five basins ranged from 122 percent of average to 139 percent of average (table 1 and fig. 2). For the month of May, the Utah Climate Center reported 11.73 inches of precipitation at the Salt Lake City International Airport, making May 2011 the second wettest May on record (University of Utah, 2011). The Utah Climate Center also reported that in May most of Utah experienced temperatures 4 to 6 degrees Fahrenheit (°F) below the 30-year average (University of Utah, 2011). The wetter and cooler than normal conditions from March through June 2011 resulted in above average SWE in the mountains of Utah later into the spring. On June 1, 2011, the SWE in the five basins in Utah ranged from 27 inches in the Weber-Ogden Rivers Basin to 9 inches in the Sevier River Basin (table 1). On average, the SWE is usually 4 inches in these basins on June 1st because snowmelt runoff has usually commenced.

Water Year 2011 Runoff

Runoff for water year 2011 was characterized by a delay in the snowmelt runoff and above average total annual streamflow. This delay caused peak streamflows to occur about 14 to 43 days later than the median date of the peak streamflow (fig. 3) at 8 of the 10 northern and central Utah stations. At two stations, the peak streamflow occurred 1 day earlier than the median date of the peak streamflow. In general,

the recurrence intervals for the water year 2011 total annual streamflows at the selected stations were equal to or greater than the recurrence intervals for the water year 2011 peak streamflows (table 2). The total annual streamflow for the streamgages ranged from 152 percent of average for Smiths Fork near Border, Wyoming (10032000), to 250 percent of average for Big Creek near Randolph, Utah (10023000; fig. 4). Of the 10 stations presented here, record total annual streamflows were measured at the Bear River near Utah-Wyoming state line (10011500), Big Creek near Randolph, Utah (10023000), and Little Bear River at Paradise, Utah (10105900). The total

Table 1. Snow Water Equivalent (SWE) in selected basins in Utah on March 1, 2011, and June 1, 2011.

Basin Name	SWE, in inches on March 1, 2011	Average SWE for 1971–2000, in inches on March 1	SWE, in percent of average on March 1, 2011	SWE, in inches on June 1, 2011	Average SWE for 1971–2000, in inches on June 1	SWE, in percent of average on June 1, 2011
Bear River	22	17	127	25	5	502
Duchesne River	19	13	150	19	5	387
Provo River-Utah Lake-Jordan River	25	18	139	23	4	568
Sevier River	16	12	135	9	2	383
Weber-Ogden Rivers	25	19	130	27	5	513

Average high flow at streamgage on Duchesne River above Uinta River near Randlett, Utah.

High flow at streamgage on Duchesne River above Uinta River near Randlett, Utah, 2011.

Table 2. Water year 2011 streamflow data from 10 streamgages in Utah.

Station ID	Station Name	Period of Record	2011 peak streamflow (cubic feet per second)	Date of 2011 peak streamflow	Recurrence interval for 2011 peak streamflow (years)	Peak streamflow for period of record (cubic feet per second)	Date of peak streamflow for period of record	2011 total annual streamflow (acre-feet)	Recurrence interval for 2011 total annual streamflow (years)	Maximum total annual streamflow for period of record (acre-feet)	Year of maximum annual streamflow for period of record	Average total annual streamflow (acre-feet)
09289500	Lake Fork River above Moon Lake, near Mountain Home, UT	1933–1934, 1942–1955, 1963–2011	2,750	6/30/2011	25–50	3,090	6/5/2010	137,800	25–50	140,900	1995	81,501
10011500	Bear River near Utah-Wyoming state line	1942–2011	3,390	6/30/2011	25–50	3,390	6/30/2011	265,100	100–200	265,100	2011	140,519
10023000	Big Creek near Randolph, UT	1939–1944, 1949–1970, 1986–2011	159	5/16/2011	10–25	337	7/11/1957	23,960	10–25	23,960	2011	9,577
10032000	Smiths Fork near Border, WY	1942–2011	1,370	6/25/2011	5–10	2,100	6/4/1986	209,600	10–25	234,400	1986	137,610
10105900	Little Bear River at Paradise, UT	1992-2011	2,300	5/30/2011	10–25	4,800	4/28/2005	136,300	10–25	136,300	2011	67,654
10109000	Logan River above state dam, near Logan, UT	1953–2011	1,710	6/25/2011	10–25	1,980	5/31/1984	287,600	10–25	318,900	1986	140,769
10113500	Blacksmith Fork near Hyrum, UT	1913-1996, 2000-2011	1,450	5/16/2011	25–50	1,650	5/14/1984	173,200	25–50	213,900	1984	91,116
10128500	Weber River near Oakley, UT	1904–2011	3,430	7/1/2011	25–50	4,170	6/13/1921	265,300	25–50	300,200	1907	158,125
10174500	Sevier River at Hatch, UT	1911–1928, 1939–2011	1,520	6/17/2011	25–50	1,990	6/3/2005	196,300	25–50	245,200	2005	87,913
09302000	Duchesne River near Randlett, UT	1942–2011	9,930	7/1/2011	10–25	11,500	6/20/1983	995,800	10–25	1,257,000	1983	380,082

annual streamflow at six streamgages in the Bear River Basin for water year 2011 was over 190 percent of average. On June 30, 2011, a new peak streamflow record of 3,390 cubic feet per second was set at the streamgage on the Bear River near Utah-Wyoming state line (10011500) (fig. 5). The station at Weber River near Oakley, Utah (10128500), had 25–50-year recurrence intervals for both peak streamflow and total annual streamflow in water year 2011, but neither exceeded records set in the early 19th century. The peak streamflow for water year 2011 for Lake Fork River above Moon Lake, near Mountain Home, Utah (09289500), was 2,750 cubic feet per second and exceeded peak streamflows in 1983 and 2005. The peak streamflow and total streamflow for water year 2005 for the Sevier River at Hatch, Utah (10174500), was greater than the peak streamflow and total streamflow for water year 2011.

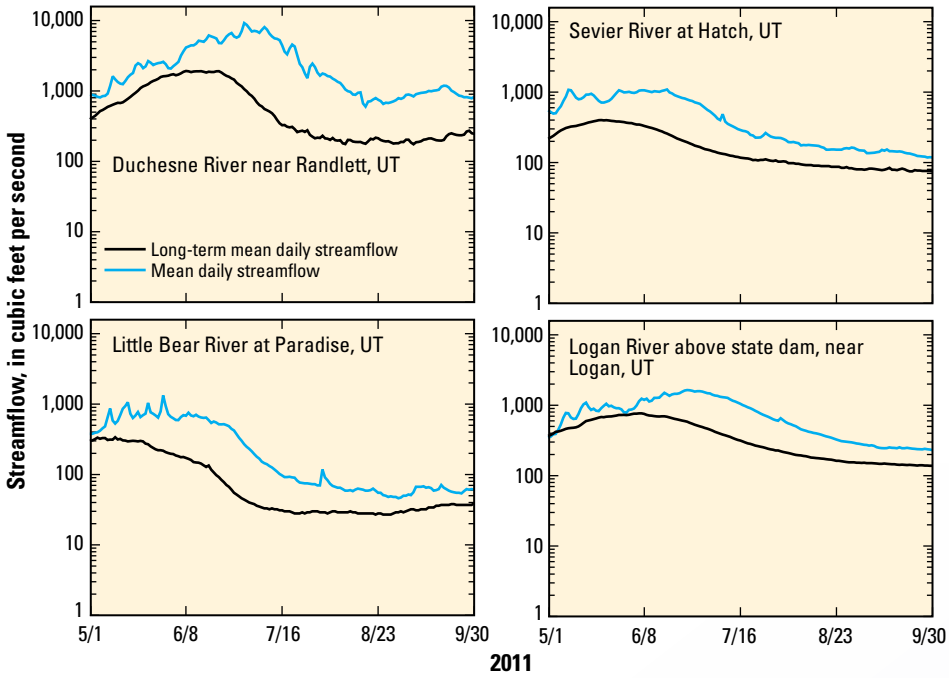
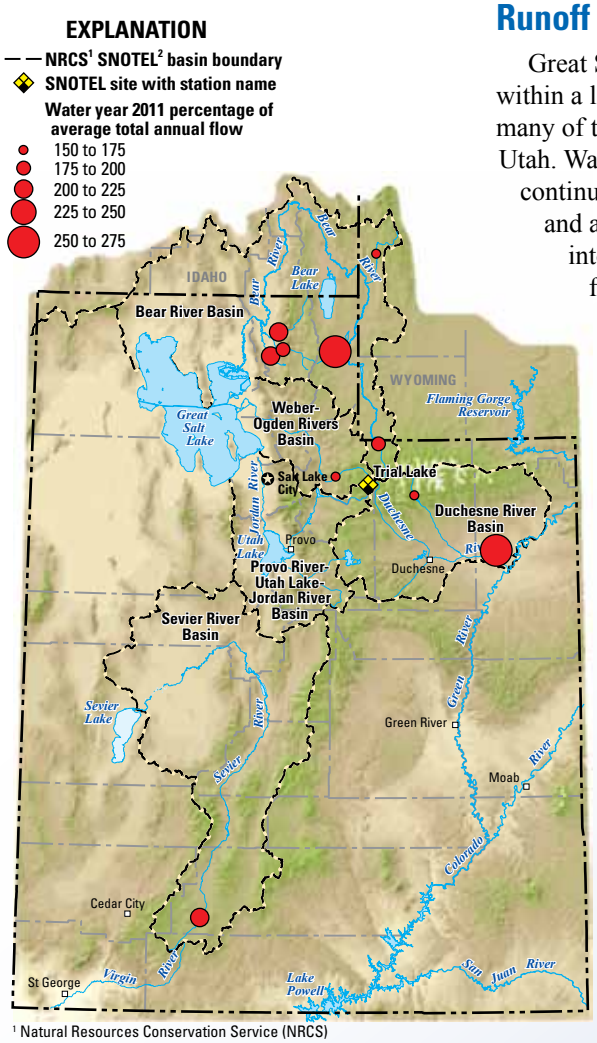


Figure 3. Mean daily streamflow for May–Sept 2011 and mean daily streamflow for the period of record.



[1] Natural Resources Conservation Service (NRCS)
[2] SNOwpack TELemetry (SNOTEL)

Figure 4. Water year 2011 percentage of average total annual streamflow for 10 streamgages in Utah.

Runoff into Great Salt Lake

Great Salt Lake is a terminal lake within a large closed basin that includes many of the mountain ranges in northern Utah. Water levels in the lake fluctuate continuously with changes in seasonal and annual climate. Sources of water into Great Salt Lake are streamflow, direct precipitation, and groundwater discharge. The Jordan, Weber, and Bear Rivers are the primary sources of streamflow into Great Salt Lake. The only source of outflow from Great Salt Lake is evaporation. During years of high inflows from runoff (1983–1987, 1995–1999), lake water levels increased (fig. 6). During periods of drought, as defined by the Palmer Drought Severity Index (PDSI), water levels in Great Salt Lake decreased (National Oceanic and Atmospheric Administration, 2012; fig. 6). Since 1988, there have been two periods of drought, and the water level in Great Salt Lake decreased by more than 16 feet (fig. 6). In water year 2011, inflow to Great Salt Lake from runoff was about 3.5 million acre-feet, the fifth largest (91st percentile) volume of inflow to the lake since 1950. The water level of Great

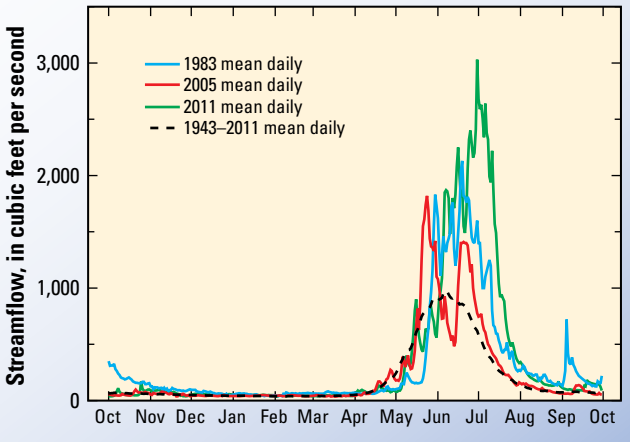


Figure 5. Mean daily streamflow at the Bear River near Utah-Wyoming state line streamgage for water years 1983, 2005, and 2011, and the mean daily streamflow for water years 1943 through 2011.

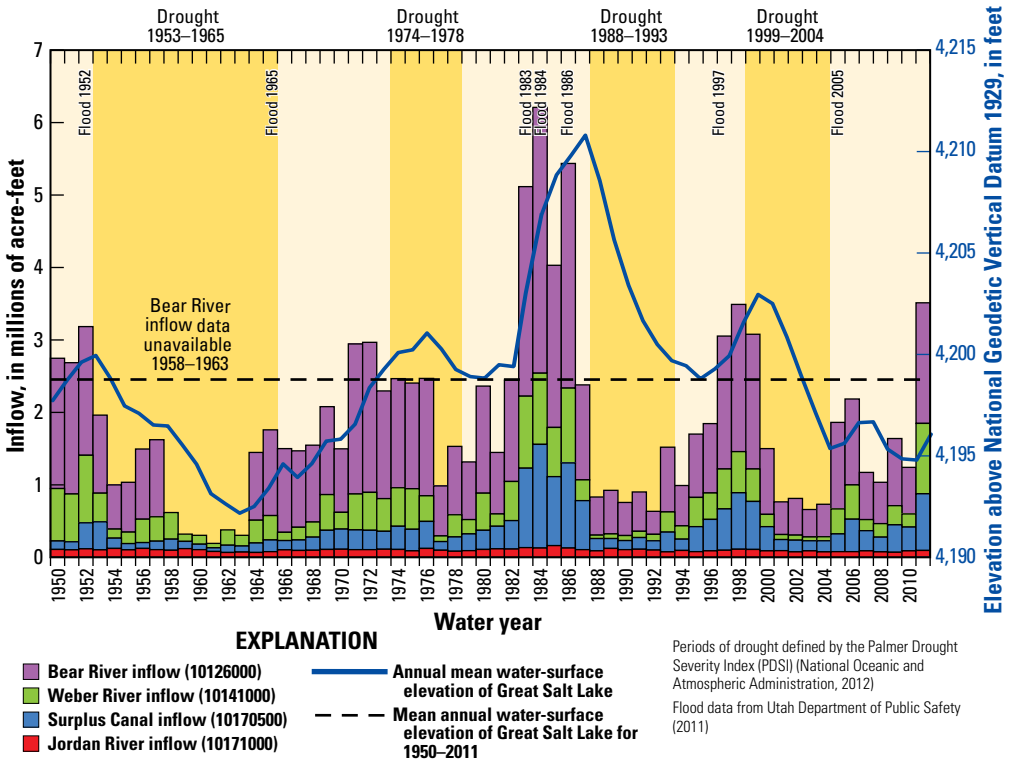


Figure 6. Annual inflow to Great Salt Lake from runoff and annual mean water-surface elevations, 1950–2011.

Salt Lake increased by approximately 5 feet from October 2010 to July 2011, resulting in a decrease in lake salinity. The salinity of Great Salt Lake decreased from 15.4 percent in December 2010 to 10.4 percent in June 2011 and increased again to 11.7 percent by October 2011. Since 2003, the water level of Great Salt Lake has been below the recorded period average, and, in spite of the well above average inflow to the lake in water year 2011, the water-surface elevation was still approximately 2.7 feet below the recorded average (fig. 6).

Summary

While the snowpack conditions in the mountains of central and northern Utah were at or near record highs, widespread damage from flooding was averted due to below average springtime temperatures. The cooler spring temperatures reduced the rate of snowmelt, which prolonged runoff. Ten streamgages that were analyzed had near record total annual streamflows, and three streamgages set historic total annual streamflow records. Only one new historic peak streamflow record was set for water year 2011 despite the prolonged snowmelt and near record annual streamflow. The fifth largest inflow to Great Salt Lake since 1950 was measured in water year 2011, but the water-surface elevation remained below the recorded average.

USGS Streamflow-Monitoring Program

For more than 100 years, the USGS Utah Water Science Center has been collecting streamflow data in Utah with support from Federal, State, and local cooperators. Streamgages with a long period of record, such as the streamgage at Weber River near Oakley, Utah, enable users to understand extreme events, hydrologic variability, and long-term climate trends. The USGS operates more than 150 streamgages in Utah. Real-time data from most of these stations are available on the Utah Water Science Center website at http://ut.water.usgs.gov.

References Cited

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Additional information about 2011 flooding can be accessed online at

http://ut.water.usgs.gov/

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