

Greater Yellowstone Network

RESOURCE BRIEF

National Park Service
U.S. Department of the Interior
Inventory & Monitoring Program



Changing Flows in the Bighorn River: A Summary of Water Years 1930 to 2013

Quick Facts

The 1930s are known in Western U.S. history as the Dust Bowl years; years of extreme drought. How does our climate today compare to then? You may be surprised to know:

- The amount of water coming in to Bighorn Lake from the Bighorn River has **decreased 47%** since the 1930s.
- Although weather varies year to year, the trend is a steady and significant **decline in water availability** since the 1930s.
- **Ten of the years since 2000 are considered below-normal flow years.**
- River flows have changed most dramatically in Spring (timing and volume of the Spring run-off). **Peak flows have decreased three fold** since the 1930s.

What does this mean?

Reduced peak flows limit the river's ability to clean sediments important for fish spawning, or deposit nutrients on floodplains important for young cottonwoods. Moreover, if these trends continue, further reductions in Bighorn River flow may affect when and how much water is available to Bighorn Lake.

The Importance of Water

Water resources are critical to the health and productivity of arid and semi-arid landscapes like those of Bighorn Canyon National Recreation Area (NRA). In addition, water resources have significant instream value (e.g., fisheries support), are important for human uses (e.g., consumption and recreational uses), and serve as the lifeblood of Western agriculture and resource-extraction industries (e.g., coal-mining).

Less Water These Days

While there is no question about the importance of water to Bighorn Canyon NRA and downstream users, recent analyses show that the Bighorn River contribution to



Bighorn Lake.

Bighorn Lake has been slowly declining since the 1930s. In fact, total *water-year* flows have dropped from a *median* annual flow of 1.94 billion *cubic meters* in the 1930s to a median annual flow of 1.18 billion cubic meters for water years 2000 to 2013. Although variable from year to year, this amounts to a median annual flow reduction of 754 million cubic meters between the 1930s and years since 2000. In lake volume terms, this reduction between 1930 and today is approximately 47% of the total lake volume at full pool.

Recent years have been among the lowest flow years recorded at the Kane, Wyoming USGS flow gauge. To better understand how low recent years have been, we compared all water years against the *25th percentile*, a benchmark value used to identify below-normal flows. Using this benchmark, 20 years out of the 84-year record for the Bighorn River (at Kane, Wyoming) are considered below normal. Two of the below normal water years occurred in the 1930s, three in the 1960s, two in the 1980s, and **TEN** have occurred since 2000.

Making Sense of Dynamic Change

Flows in the Bighorn River at Kane, Wyoming are not declining during all parts of the year. Rather, the most dramatic change (i.e., decline) has occurred during peak flows (Figure 1) in the spring. The median peak flow in the 1930s was 470 cubic meters per second (16,600 cfs). In contrast, the median peak flow since 2000 was approximately 150 cubic meters per second (5,300 cfs). This nearly, three-fold reduction in the median peak flows has been observed just since the 1930s.

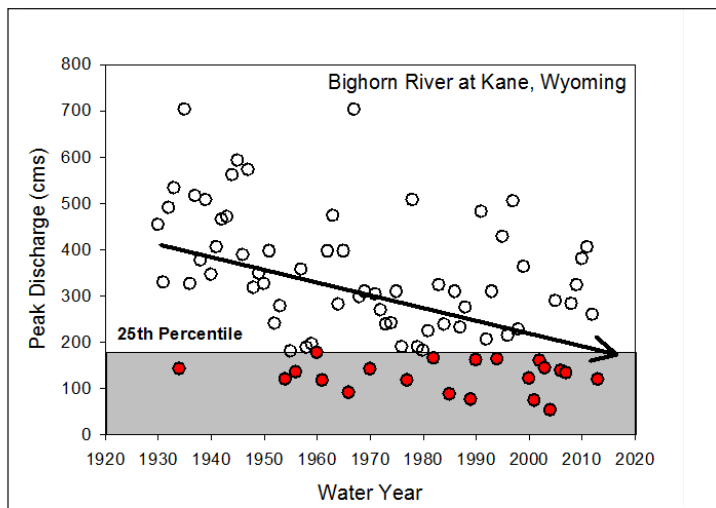


Figure 1. Plot of annual peak flow estimates (in cubic meters per second) for the Bighorn River. Points represent the maximum or peak flow value for each water year at the USGS Bighorn River gauge (Kane, Wyoming). Between water years 1930-2013 there has been a relatively clear decline in annual peak flows (black arrow). Also shown is the 25th percentile benchmark of all flows. This flow benchmark separates years with below normal peak flows (shown with red points) from all other years (shown with hollow points).

Across the Bighorn Subbasin, maximum air temperatures during spring (March, April, and May) have varied among years (Figure 2), but climate projections (using two scenarios: RCP 4.5 and 8.5) strongly suggest warming spring air temperatures over the next century. Warmer temperatures are projected to reduce soil moisture and increase evaporation rates. In addition, monthly snow estimates for the Bighorn Subbasin show corresponding reductions during future, warmer spring temperatures.

The extent to which changes in spring temperatures, spring snowpacks, increased evaporation rates, or operations of upstream dams (Boysen Reservoir since 1951) and diversions have contributed to the Bighorn River flow declines is difficult to untangle. Regardless of the drivers, cumulative flow reductions in the Bighorn River have been measured with the most pronounced changes occurring during spring or peak runoff.

Reduced peak flows could limit the river's ability to clean sediments important for fish spawning or deposit nutrients on floodplains important for young cottonwoods. Moreover, if these trends continue, further reductions in Bighorn River flow may affect when and how much water is available to Bighorn Lake.

* This figure was generated from freely available data generated from Alder, J. R. and S. W. Hostetler, 2013. USGS National Climate Change Viewer. US Geological Survey. http://www.usgs.gov/climate_landuse/clu_rd/nex-dcp30.asp doi:10.5066/F7W9575T. Data provided represent averages from 30 recognized climate models. These data should be considered projections only.

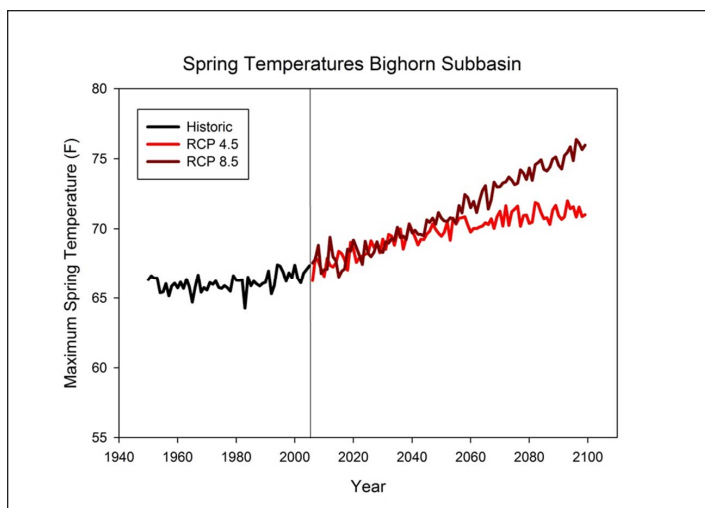


Figure 2.* Historic and projected maximum spring (March, April, and May) air temperatures in the Bighorn Subbasin (Hydrologic Unit Code 1008). Historic values are shown in black from 1950 to 2005. Projected temperatures (2006 to 2100) are shown in red are estimated using two climate scenarios (RCP 4.5=red and RCP 8.5=maroon).

Important Terms

Water Year: a water supply term that refers to a 12-month period between October 1st for a given year and September 30th the following year. Here, and for simplicity, we use the closing year to represent the water year. For example, 2013 represents water year beginning October 1, 2012 and ending September 30, 2013.

Median: the middle number in a sorted list of numbers.

Cubic Meter: a volumetric measurement equivalent to 35 cubic feet; 1 acre-foot is equivalent to 1,233 cubic meters

Percentile: a value, on a scale of one hundred, that indicates the percentage of observations that are equal to or below that value.

Representative Concentration Pathways (RCPs): Used in climate projections, RCPs integrate natural and manmade emissions, future carbon dioxide and methane concentrations, and land use and vegetation changes (agents that affect climate) using projections of population growth, development patterns, and technological change. Typically, four different scenarios (RCP 3, 4.5, 6, and 8.5) are used to characterize a range of climate possibilities by the end of this century, with 3 being the most conservative and 8.5 the greatest change.