



NPS

Yellowstone National Park Water Resources - 2015

Lamar, Yellowstone, and Madison Rivers

Background

Waters in Yellowstone National Park (NP), including the Lamar, Yellowstone, and Madison rivers, are largely unimpaired and of high quality. However, the chemistry of these waters is nearly as varied as the geologic terrain. Water quality is influenced by geothermal inputs and by meltwater from mountain snowpacks. The latter contributes disproportionately to early summer flows.

While waters in Yellowstone NP are protected, there are still several potential threats to water in the park, including high visitation, sewage treatment discharges, and dated infrastructure and utility systems. Waters are also threatened by various symptoms of the changing climate including changes in the hydrologic cycle resulting from less pre-

cipitation as snow and earlier snow-melt. The documented low-flow conditions and elevated air temperatures in the park also influence water temperatures. This in turn may influence visitor experiences in the park. Air and water temperature increases may trigger additional ecological changes including shifting biological communities and increasing threats from invasive or nuisance aquatic species.

Monitoring

Water has been monitored in Yellowstone NP for over a century. These long-term records provide unique opportunities to examine how water in the region may be responding to documented changes in air temperatures and snowpacks. The Greater Yellowstone Network monitors water quality and discharge (water flow) at sites co-located with U.S. Geological Survey streamflow gages in the Lamar River near Tower Ranger Station, WY; the Yellowstone River at Corwin Springs, MT; and the Madison River near West Yellowstone, MT. Between April and November, we measure core water quality parameters (e.g., dissolved oxygen, pH, and conductance) and collect depth and width integrated water samples. Air temperature and precipitation are recorded from local climate stations.

Highlights

- Flows in all three rivers were below the historic average for a majority of days in 2015.
- Lamar and Yellowstone rivers: 2015 peak flows were much lower than the long-term average (Tables 1 and 2) and daily flows dipped below the long-term average during much of the year.
- Madison River: 2015 daily flows were much lower than historic averages (at or below the 25th percentile of long-term daily flows).
- Across all sites, arsenic, calcium, chloride, and sodium concentrations were generally at minimum levels during high flows.
- Total arsenic in the Madison River exceeded the state of Montana's aquatic life criteria on all sampling occasions. Arsenic in the Madison River is likely naturally occurring from geothermal geology in the watershed.
- Flows in the Lamar and Yellowstone rivers are largely snow-melt driven, whereas groundwater contributes disproportionately more to flows in the Madison River.



River sampling at the Lamar River using a churn splitter to produce a representative sample of river conditions. NPS PHOTO.



During high flow conditions, river sampling is accomplished by lowering a suspension sampler and collection bottle with a reel and bridge board (Yellowstone River at Corwin Springs, MT).

Results

Temperature and Precipitation

Temperatures in 2015 were above the 30-year averages (1981-2010) at all three monitoring stations. Average annual maximum temperatures at Lamar, Yellowstone, and Madison rivers were 1.1°C, 1.6°C, and 1.4°C above the 30-year averages respectively. Average annual minimum temperatures were ~3.0°C, 1.8°C, and 1.3°C above the 30-year averages. Total annual precipitation in 2015 was similar to the 30-year average although monthly averages varied from historic averages.

Discharge

Hydrographs showed earlier onset of snowmelt runoff in 2015; warmer winter temperatures likely contributed to this pattern. Onset of baseflows occurred several days earlier than the long-term average and extended into fall and winter. Peak flows occurred earlier than historic peak flows at all three locations (see Tables) and peak flows were lower than the historic average at Yellowstone and Madison rivers. Patterns of earlier peak flows and lower annual flows also occurred at four other rivers in the region. The Yellowstone and Lamar rivers are characteristic of snow-driven systems; peak flows coincide with snowmelt at high elevations. In contrast, the Madison River hydrograph is more characteristic of a ground-water fed system.

Water Chemistry

Water quality varied seasonally at all sites. Water chemistry results at the Lamar, Yellowstone, and Madison rivers were indicative of high water quality with low levels of dissolved nutrients. Nitrogen and phosphorus were low at all monitoring sites and non-detectable results predominated for ammonia-nitrogen, nitrate + nitrite as nitrogen, and ortho-phosphorus. Surface water from the Madison River near West Yellowstone, MT exceeded the State of Montana's aquatic life criteria for total arsenic during all sampling events; arsenic is naturally occurring and associated with the geothermal activity in the watershed. Total arsenic levels in the Lamar and Yellowstone rivers did not exceed the Montana or Wyoming aquatic life criteria.

Table 1. Discharge metrics summary - Lamar River near Tower Ranger Station, WY (USGS 06188000).

Discharge Metric	Average for Period of Record (1923 to 1968, 1989 to 2014)	2015
Day of year of peak discharge (calendar date)	154 (June 3)	153 (June 2)
Peak discharge (in cfs)	8,190	5,280
Total volume (in billions ft ³)	27.5	24.3

Table 2. Discharge metrics summary - Yellowstone River at Corwin Springs, MT (USGS 06191500).

Discharge Metric	Average for Period of Record (1890 to 1892, 1911 to 2014)	2015
Day of year of peak discharge (calendar date)	160 (June 9)	153 (June 2)
Peak discharge (in cfs)	16,875	11,200
Total volume (in billions ft ³)	98.5	78.8

Table 3. Discharge metrics summary - Madison River at West Yellowstone, MT (USGS 06037500).

Discharge Metric	Average for Period of Record (1913 to 1973, 1989 to 2014)	2015
Day of year of peak discharge (calendar date)	145 (May 25)	137 (May 17)
Peak discharge (in cfs)	1,325	763
Total volume (in billions ft ³)	15.0	12.8

Conclusion

Water resources are important for visitor experiences and critical to the health and productivity of semi-arid landscapes like those found within Yellowstone NP. Continued monitoring will allow us to verify that these waters are meeting state and federal water quality standards and to examine trends in these important waters in the face of warming conditions in this snow-dominated region.

Full Report

Levandowski, M., and A. Ray. 2017. [Water quality summary for the Lamar River, Yellowstone River, and Madison River in Yellowstone National Park: Preliminary analysis of 2015 data](https://science.nature.nps.gov/im/units/gryn/). Natural Resource Report NPS/GRYN/NRR—2017/1389. National Park Service, Fort Collins, Colorado.

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