USGS Mount Mansfield Stream Gages

Water Year 2012 report

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Introduction

This is the annual data report for the U.S. Geological Survey (USGS) stream gages at Ranch Brook and West Branch near Stowe, Vermont for Water Year (WY) 2012 (October 2011 through September 2012). The two gages were established in September 2000, and have been operated continuously by USGS since that time. The gaging was designed as a paired watershed study, with Ranch Brook (9.6 km^2) as the forested control watershed, and West Branch (11.7 km^2) as the developed watershed. West Branch contains nearly the entire expanse of Stowe Mountain Resort. Though the resort was well-established when the gaging began, it underwent a significant expansion during the course of the study. This report puts the WY12 streamflows in the context of the full 12-year record.

The gages, jointly funded through a cooperative agreement between the USGS and Vermont Monitoring Cooperative, provide needed information on mountain hydrology in Vermont, and how mountain landscapes respond to development and extreme events. To our knowledge these are the only gaged watersheds in existence at a ski resort. The gages have served as a locus for projects on snow hydrology and water quality by University of Vermont, Sterling College, Vermont ANR, and others. In particular, Beverley Wemple and students at University of Vermont have used the gaging as a base for student projects and hands-on learning, and to attract additional funding for value-added research.

Results

Following WY2011, which will be remembered for its floods (Lake Champlain record, Tropical Storm Irene), WY2012 was comparatively quiet (Figs. 1 and 2). Runoff at Ranch Brook was second lowest of the 12 years, higher only than the drought year 2001.

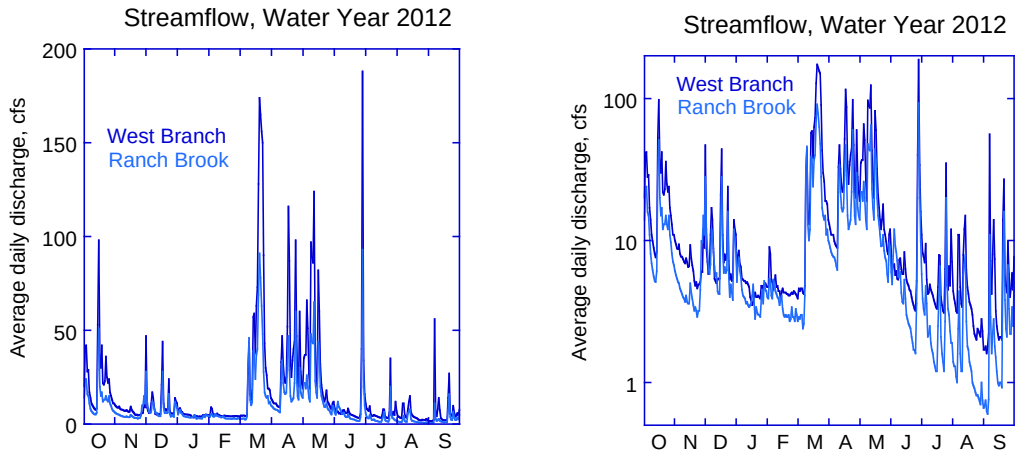

Figure 1. Streamflow at West Branch and Ranch Brook gages for Water Year 2012 (October 2011 through September 2012) in linear (left) and log (right) scales. The log scale plot illustrates the higher sustained base flow levels at West Branch.

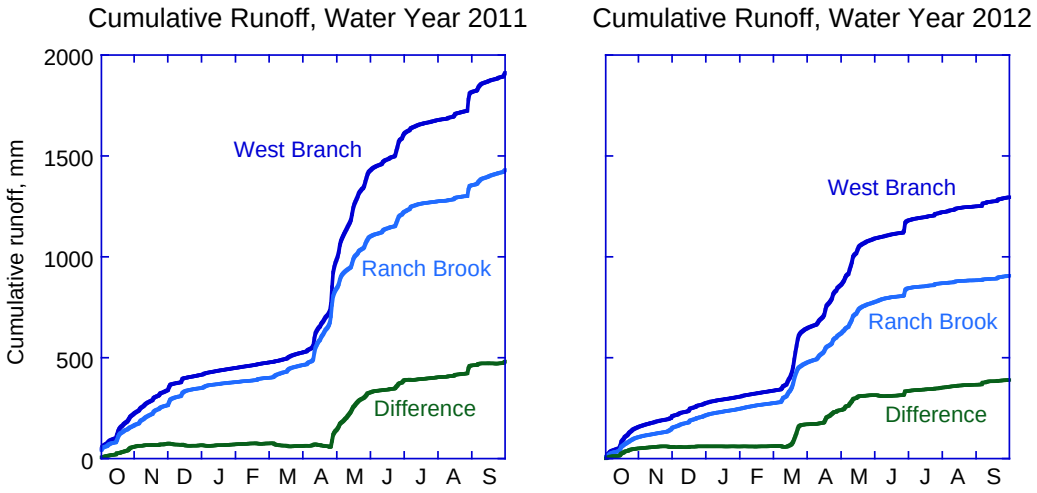

Figure 2. Comparison of cumulative runoff at West Branch and Ranch Brook for WY2011 (wet) and WY2012 (dry).

The winter of 2012 had a low snowpack and early melt. The main melt sequence began in early to mid-March (Figs. 1 and 2), about one month earlier than average. Fall 2011 and summer 2012 were relatively dry, punctuated by a few significant storms (Fig. 1). Despite the low snowmelt, a wet spring sustained high flows well into May (Fig. 1).

Throughout the 12 years we have consistently observed higher flows per unit area at West Branch relative to Ranch Brook (Wemple et al., 2007) (Fig. 3). [Note: runoff per unit area (volume/time divided by area) works out to units of depth/time. In Fig. 2 the daily values (depth/day) are simply summed and accumulated. The resulting mm of runoff can then be directly compared to mm of precipitation (unfortunately not available for this site) to see what portion of the precipitation runs off.] WY2012 had the highest difference between the two streams for any of the 12 years on a percentage basis (43%) and the second highest absolute difference in mm runoff (389 mm). Only WY11 had a greater runoff difference (482 mm). The reason for the consistently higher runoff at West Branch remains unclear, but in many years it is linked to a relatively greater snowpack at West Branch. The second consecutive year of a high differential in WY2012 may reflect a carry-over effect from a filling of water storage capacity during the extreme wet year of WY2011. Hydrologic effects of the resort development may also be a factor, though the build out was largely complete well before these larger-than-average runoff differences in the past two years.

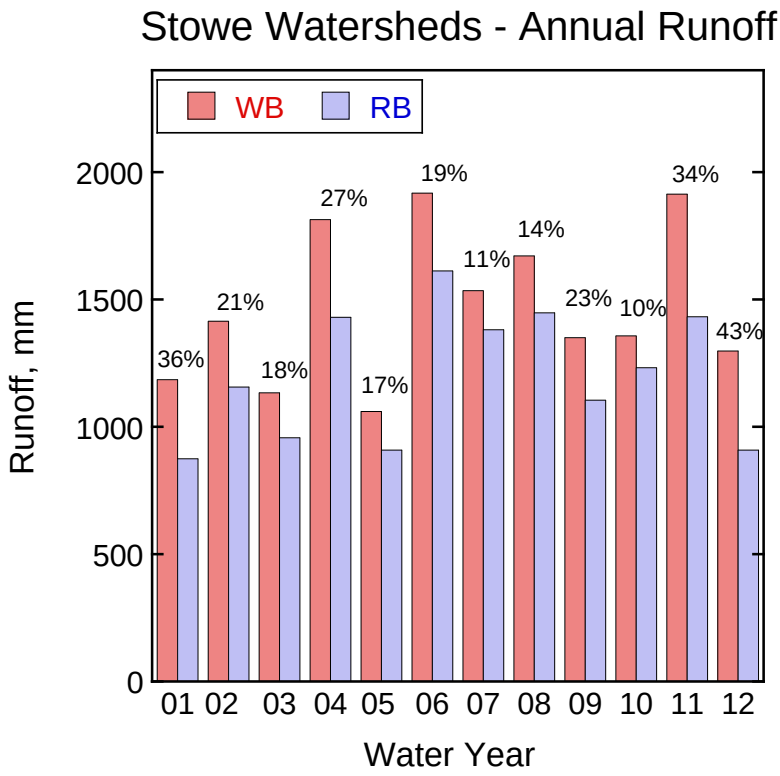

Figure 3. Annual runoff in mm at West Branch (WB) and Ranch Brook (RB) for the duration of study though the present report year. Percentage of greater runoff at WB relative to RB is given over each pair of bars.

The VMC/USGS gages have attracted several student thesis projects during the 12 years. The most recent and ongoing project is led by Alejandro del Peral, a student of Beverley Wemple at U. Vermont. Alejandro is applying the distributed soil-hydrology-vegetation model (DHSVM) (Wigmosta et al., 1994), which tries to capture the important soil and land surface features that drive the hyrologic processes generating streamflow. Alejandro has a working version of DHSVM calibrated to the two stream watersheds, and is now testing how modeled streamflow will respond to perturbations. He modeled flow in West Branch with full forest cover and showed that historical flows (pre-resort) would have been lower than today because evapotranspiration from the full forest would have been higher (Fig. 4). One interesting application Alejandro is testing now is to remove the ski resort from West Branch and adding it to Ranch Brook, to see if the flow discrepancy reverses.

West Branch data are accessible at
http://waterdata.usgs.gov/vt/nwis/uv?site_no=04288225.
Ranch Brook data are accessible at
http://waterdata.usgs.gov/vt/nwis/uv?site_no=04288230.

References

Wemple B, Shanley J, Denner J, Ross D, Mills K., 2007. Hydrology and water quality in two mountain basins of the northeastern US: assessing baseline conditions and effects of ski area development. Hydrological Processes 21(12):1639-1650.

Wigmosta M.S., Vail L.W., Lettenmaier D.P., 1994. A distributed hydrology-vegetation model for complex terrain. Water Resources Research 30(6):1665-1680.

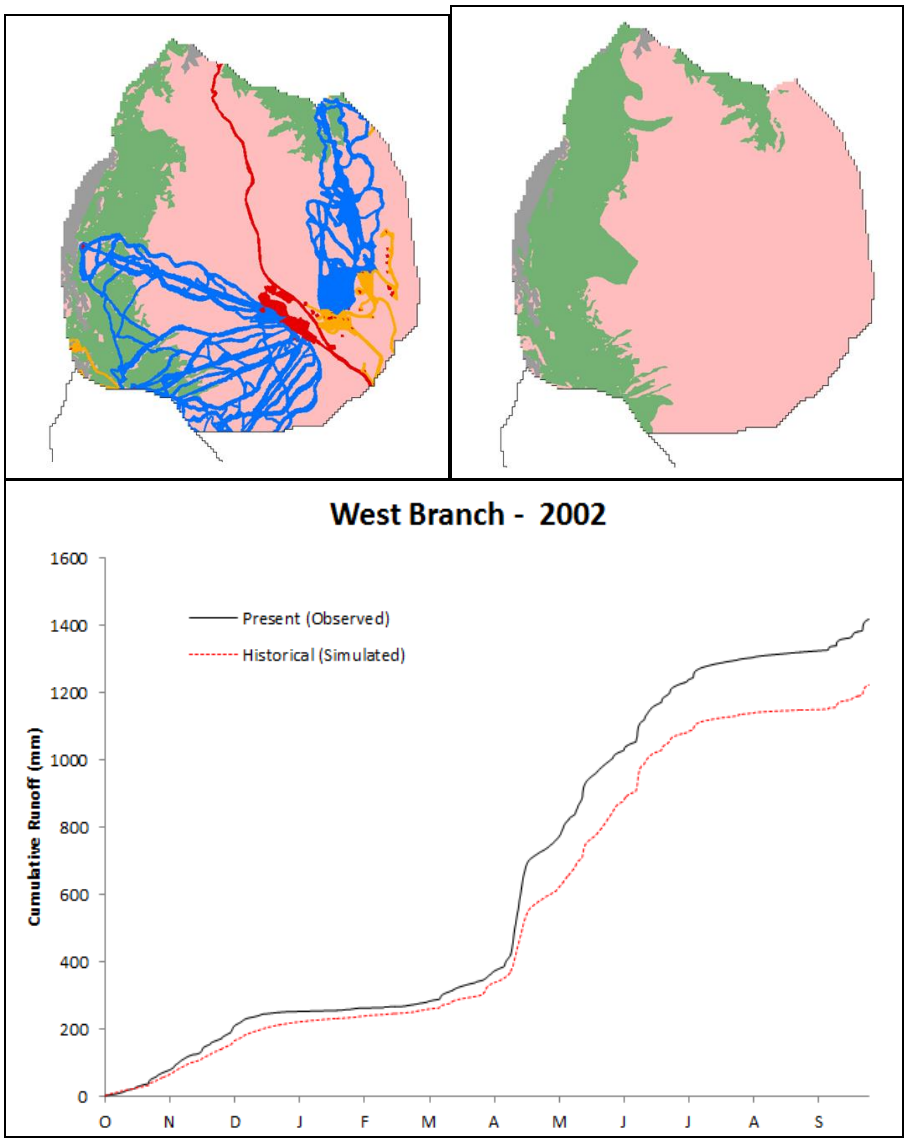

Figure 4. Simulation (red line) using DHSVM of WY2002 flow at West Branch with ski resort removed and native forest restored (depicted in maps at top) compared to observed flows (black line). These results suggest that lower evapotranspiration associated with forest removal is one driver of the high present-day flows (del Peral, M.S. thesis, in preparation).