

Mount Mansfield Paired Watershed Study

U.S. Geological Survey
Vermont Monitoring Cooperative

Water Year 2002

Water Year 2002 (October 2001 through September 2002) was the second full year of operation for the USGS/VMC stream gages on the east slope of Mt. Mansfield. The two gages are Little River near Bingham Falls (West Branch), and Ranch Brook near Stowe (Ranch Brook). West Branch watershed has an area of 11.84 km² and Ranch Brook watershed has an area of 9.84 km². West Branch drains the entire Stowe Mountain Resort, which occupies much of the basin. Ranch Brook is an undisturbed forested basin. The gages were set up to investigate differences in hydrology that may arise from these differences in land use, and to collect baseline information on West Branch prior to proposed expansion of the resort. This report is a brief summary of the hydrology of the two watersheds during the second full year of operation.

As in Water Year 2001, runoff (streamflow per unit area) at West Branch greatly exceeded that at Ranch Brook (Figure 1). Water Year 2002 was wetter overall, and runoff was greater in both basins compared to Water Year 2001 (Table 1). January and February of 2002 marked the only two months of either water year that runoff at Ranch Brook was greater than at West Branch. This was due to water withdrawals for snowmaking. The winter of 2002 had below-average natural snowfall, thus demand of water for snowmaking was much greater than during the abundant snowfall winter of 2001. As in Water Year 2001, flow per unit area at the two gages was again similar during peak snowmelt flows (not shown), but the differential runoff quickly redeveloped during snowmelt recession so that monthly runoff was again considerably greater at West Branch in April, May, and June. The runoff differential persisted even during an extremely dry period from mid-July to mid-September.

Although we anticipated some contrasts in hydrologic response due to the development at the ski resort, these large differences in runoff from adjacent basins that are similar in many respects apart from the development are a major surprise. There are several factors that would tend to produce greater runoff at West Branch: (1) greater storm and snowmelt runoff from greater area of impervious surface at West Branch; (2) redeposition of snow blown into the basin by westerly winds; (3) decreased evapotranspiration from the 10-20% of West Branch that is non-forested; (4) increased precipitation because of ~ 50

meters higher mean elevation at West Branch; (5) increased fog drip from a greater area of forest above 1000 meters elevation. However, even in total these factors can account for only a small part of the runoff difference. The single factor that we feel must be responsible is that West Branch basin receives anomalously high orographically-enhanced precipitation, well above and beyond what would be expected from its elevation. We have recently received an enhancement in funding from VMC (starting in Water Year 2003) to measure precipitation at many points in the two basins to test this hypothesis.

Based on regional analysis of streamflow, flow at Ranch Brook is close to the expected amount for its elevation (Figure 2). It has greater flow than two lower-elevation benchmark stations in Vermont, and has comparable flow to the Ellis River in New Hampshire, which drains part of Mt. Washington. In this regional context, the runoff from West Branch is anomalously high.

Aside from working to understand the flow differential in Water Year 2002, we continued our collaborations with Sterling College and UVM, who are working at the sites with independent funding. In collaboration with UVM we analyzed stream chemistry and sediment data, some of which had been collected in 2001. One finding from the water quality sampling is that the West Branch has elevated chloride year-round, most likely from deicing salts applied to the parking lot. A large spike of chloride appears in runoff at the onset of snowmelt in spring (Figure 3). Though these high concentrations are clearly an anomaly, this plot demonstrates the value of the paired watershed approach by showing the low background chloride concentrations in the control watershed.

Some of our results were presented on a UVM/USGS collaborative poster at the 2002 Fall Meeting of the American Geophysical Union in San Francisco (Wemple et al., 2002). Results were also included as a case study within an article on mountain hydrology published in 2002 by the Vermont Law Review (Shanley and Wemple, 2002).

References

Shanley, J.B. and B. Wemple, 2002. Water quantity and quality in the mountain environment. Vermont Law Review, 26, 717-751.

Wemple, B., J.B. Shanley, and J.C. Denner, 2002. Effects of an Alpine Ski Resort on Hydrology and Water Quality in the Northeastern U.S.: Preliminary Findings from a Field Study [Abs.], EOS, Trans. Amer. Geophys. Union, 83(47), Fall Meet. Suppl., Abstract H51B-0813, p. F436.

Table 1. Runoff in millimeters from West Branch and Ranch Brook for Water Years 2001 and 2002.

| Water Year | West Branch | Ranch Brook |
|------------|-------------|-------------|
| 2001 | 1201 | 802 |
| 2002 | 1397 | 1028 |

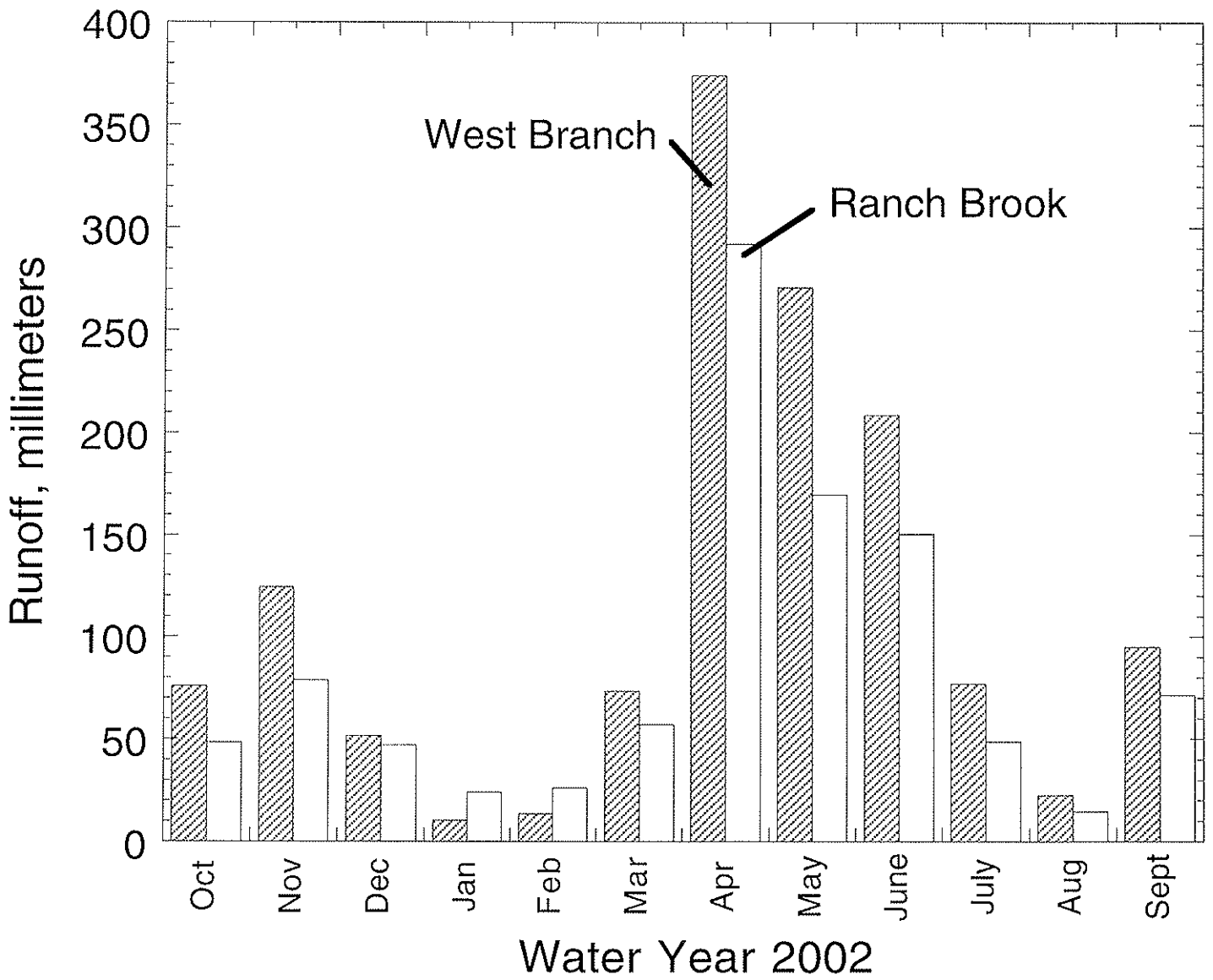
Figure captions

Figure 1. Monthly runoff at West Branch and Ranch Brook for Water Year 2002.

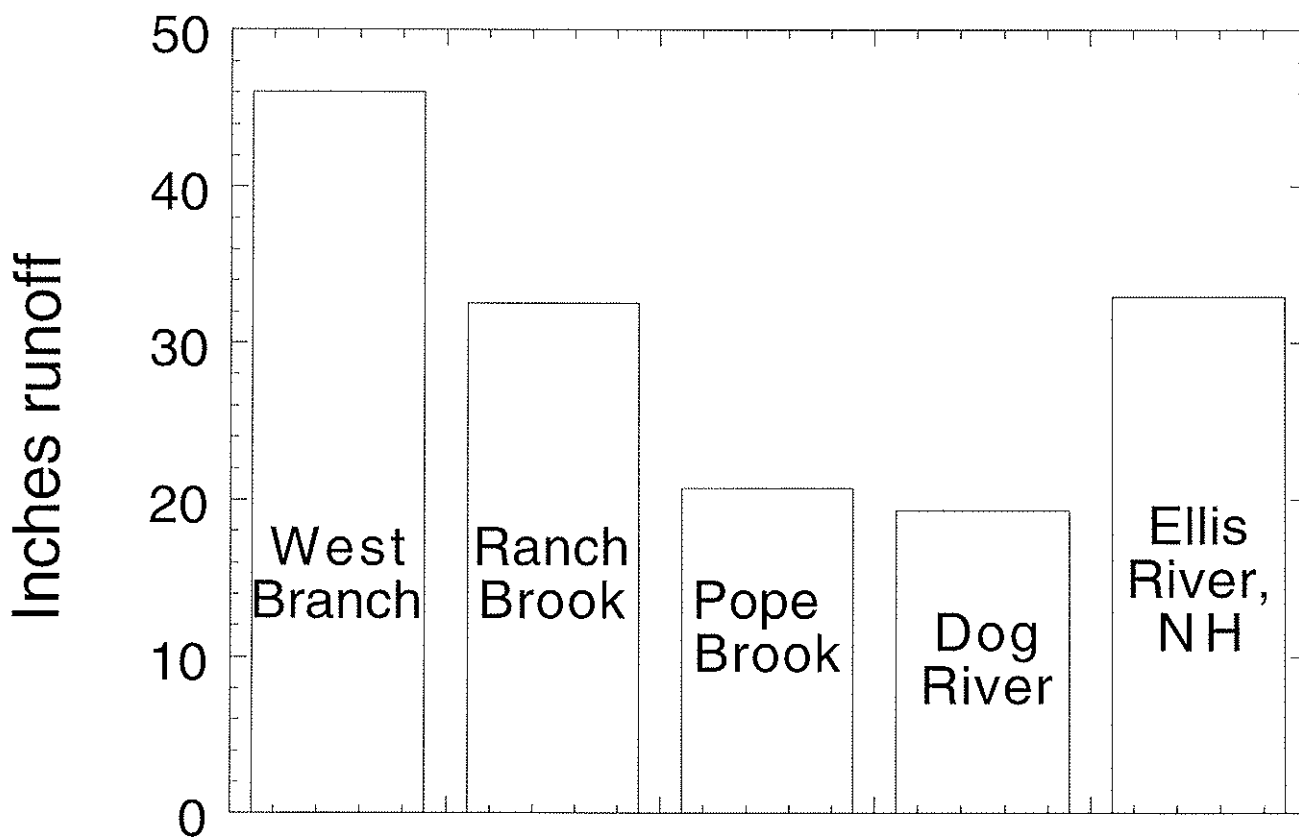
Figure 2. Regional runoff comparison for Water Year 2001 for four Vermont streams and one New Hampshire stream.

Figure 3. Chloride concentrations during the 2001 spring flush at West Branch and Ranch Brook. Only the West Branch hydrograph is shown for simplicity.

Monthly runoff at Mt. Mansfield



Regional runoff comparison Water Year 2001



Salt in snowmelt runoff

