

Patterns and Trends in Snowpack Water Equivalent at a Northern Vermont Site, 1960–2000

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EXTENDED ABSTRACT

Sleepers River Research Watershed in northeastern Vermont has a fairly complete record of weekly snow depth and water equivalent measurements at two sites since 1960, and at 11 additional sites since 1982. The sites are distributed within and just outside the 111-km² watershed, at elevations ranging from 210 to 632 m; the two longest-running stations are the highest elevation sites. For the period 1982 to 1998, mean annual maximum snow water equivalent (SWE_{max}) increased with elevation from 11.4 to 26.5 cm (Fig. 1). The standard deviation of annual SWE_{max} , as a percentage of the mean, decreased with increasing site elevation, indicating a more consistent snowpack from year to year at the higher elevations.

During the complete 40-year record at the two high-elevation sites, SWE_{max} exhibited cyclic patterns, reflecting the 1960s drought, a snowy period from the late 1960s to late 1970s, a low-snow period in the early 1980s, and a generally more stable period from 1984 to present (Fig. 2). The eight years with the greatest SWE occurred in the first one-half of the record; SWE_{max} exceeded 40 cm in both 1970–71 and 1977–78. Nonetheless, there was no monotonic trend in SWE_{max} with time, as determined by the nonparametric Mann–Kendall test. Annual maximum SWE was well correlated to total duration of seasonal snow cover and the date of SWE maximum. There was little relation between SWE_{max} and the El Niño/Southern Oscillation (ENSO) cycle (Fig. 3).

We tested the representativeness of our highest elevation site (R-1A) as a regional snow indicator by comparing its SWE_{max} to two other well-known snow benchmarks in Vermont: (1) the total seasonal snowfall at the Fairbanks Museum in St. Johnsbury, 16 km SE of R-1A at 213 m elevation, and (2) the annual maximum snow depth at the stake near the summit of Mount Mansfield, 50 km W of R-1A at 1204 m elevation (Fig. 4). Though both indicators correlated positively to the Sleepers River snow record, the better correlation was obtained with the Fairbanks Museum snow record, likely due to its closer proximity.

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Key Words: Sleepers River, Snow depth, Snow water equivalent

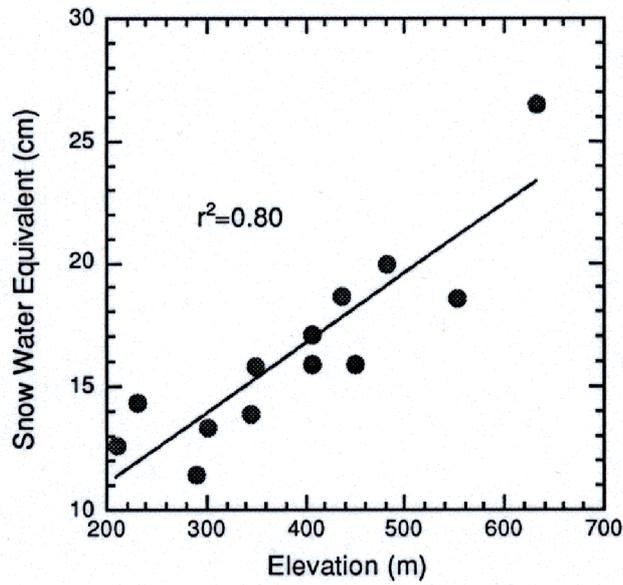


Figure 1. Mean annual maximum snow water equivalent at 13 Sleepers River stations vs. station elevation, 1982–1998.

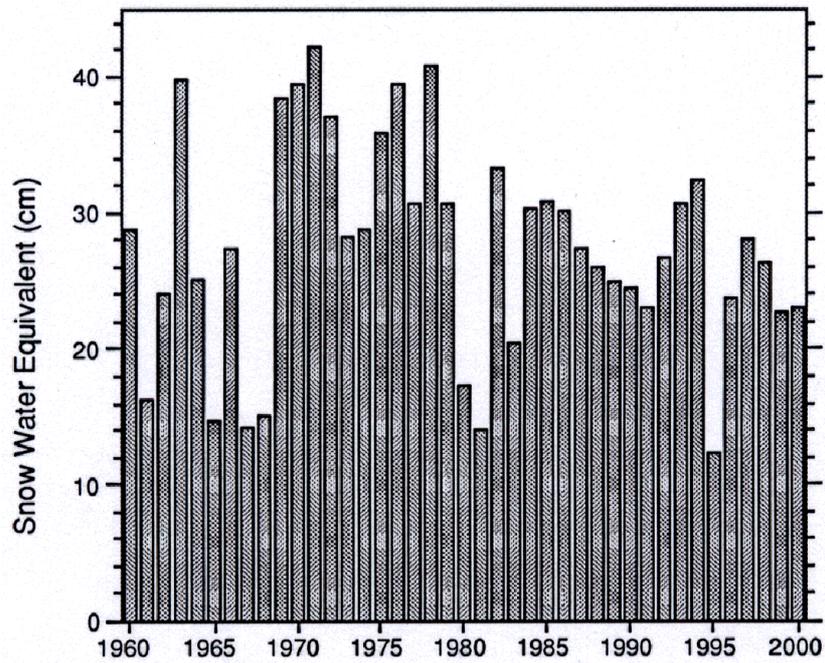


Figure 2. Maximum annual snow water equivalent at Sleepers River site R-1A, elevation 632 m.

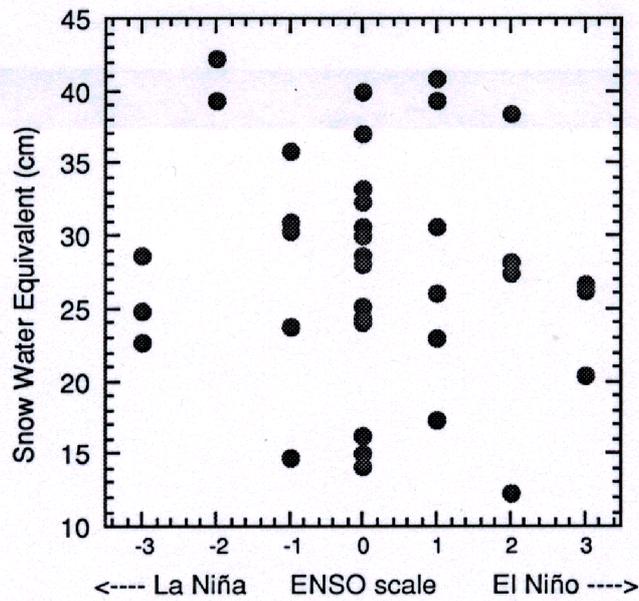


Figure 3. Maximum annual snow water equivalent at Sleepers River site R-1A related to the ENSO cycle for the period 1960–2000. Relative strength of La Niña and El Niño winters indicated by scale adapted from National Climate Prediction Center designations.

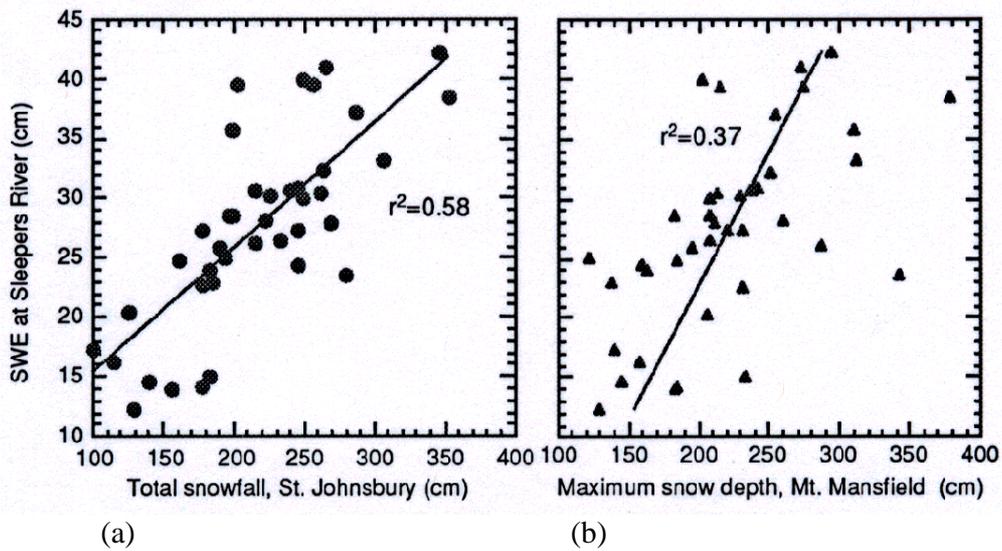


Figure 4. Maximum seasonal SWE at Sleepers River site R-1A related to (a) total seasonal snowfall at the Fairbanks Museum, St. Johnsburly, and (b) the maximum seasonal snow depth at the stake atop Mount Mansfield.