Changes in Streamflow Timing in New England During the 20th Century

... from the National Streamflow Information Program

This Fact Sheet is one in a series that highlights information or recent research findings from the USGS National Streamflow Information Program (NSIP). The investigations and scientific results reported in this series require a nationally consistent streamgaging network with stable long-term monitoring sites and a rigorous program of data quality assurance, management, archiving, and synthesis. NSIP produces multi-purpose, unbiased surface water information that is readily accessible to all.

Introduction

The amount, timing, and form of precipitation (rain, sleet, or snow) directly affect the amount and timing of runoff into rivers and streams, particularly in northern and mountainous areas. If air temperatures were to warm in the future, the warming could decrease the fraction of precipitation occurring as snow or speed the start of spring snowmelt causing streamflow to occur earlier in the year with potential consequences for some aquatic life and human activities. Using long-term streamflow records from the U.S. Geological Survey (USGS) National Streamflow Information Program, it is possible to evaluate changes in the timing of streamflow of New England streams.

High streamflow on the St. John River in northern Maine, spring 2003.

Streamflow Data

The USGS started measuring streamflow in the United States about 115 years ago. Today, USGS streamflow data are available for thousands of streamgages throughout the Nation (*http://waterdata.usgs.gov/usa/nwis/sw*). Long-term, nationally consistent data-collection and reporting techniques increase the utility of these data for analysis of important local, regional, and national water issues, and make possible the confident analysis of historical data, including changes in the timing of seasonal streamflow (Hodgkins and others 2003).

Both the magnitude and timing of streamflow can be affected by watershed urbanization and reservoir operations. A subset of the USGS streamflow database, the USGS Hydro-Climatic Data Network (HCDN) (Slack and Landwehr, 1992) excludes streamflow records in which the effects of substantial land-use changes or regulation are present, and contains streamflow data most appropriate for climate studies. Of the approximately 1,600 HCDN streamgages in the Nation, 76 monitor rivers in New England.

In order to avoid the undue influence of short-term fluctuations, relatively long streamflow records (on the order of 50+ years) are needed for climate studies, and to be relevant to current conditions, these records should extend to recent years. Of the 76 HCDN streamgages in New England, 27 have 50 years or more of continuous record including the 50 years from 1951 to 2000. These 27 streamgages have an average period of record of 68 years and are well distributed throughout New England (fig. 1).

Changes in Streamflow Timing

The measures of streamflow timing used for this study were the dates by which half of the total volume of water (center of volume) for winter/spring (January 1 to May 31) and fall/winter (October 1 to December 31) seasons flowed past a streamgage. These measures were computed for every year of record at all 27 HCDN streamgages.

Significant trends toward earlier winter/spring streamflow were evident in the data for all 11 streamgages where snowmelt has the greatest effect on streamflow. These 11 streamgages measure flow from northern and mountainous areas in Maine and New Hampshire. Data from three of the remaining 16 streamgages in the rest of New England also exhibited trends toward earlier winter/spring streamflow. Data from 4 of the 27 streamgages exhibited significant trends in the timing of fall/winter streamflow; these data also tended toward earlier streamflow.

Plots of the center-of-volume data indicate significant annual variability but also reveal more specific information about the trends. For example, the dates for the winter/spring streamflow at Piscataquis River in central Maine has varied by approximately 6 weeks over the period of record (fig. 2), however since about 1970, the date has tended to occur earlier in the year and now occurs about 2 weeks earlier than in 1970. Plots of moving-average trend lines for the 13 streamgages with the longest streamflow records also show similar, coherent patterns (fig. 3). While some trends toward increasing dates (later winter/spring streamflow) are evident at several streamgages prior to about 1970, far more substantial, consistent, and steeper trends toward decreasing dates (earlier streamflow) occur at the northern and mountainous stations after about 1970. Over the last 30 years, winter/spring streamflows have become earlier by 1 to 2 weeks in northern and mountainous areas of New England. Changes in the timing of flows in southern New England are not as consistent.

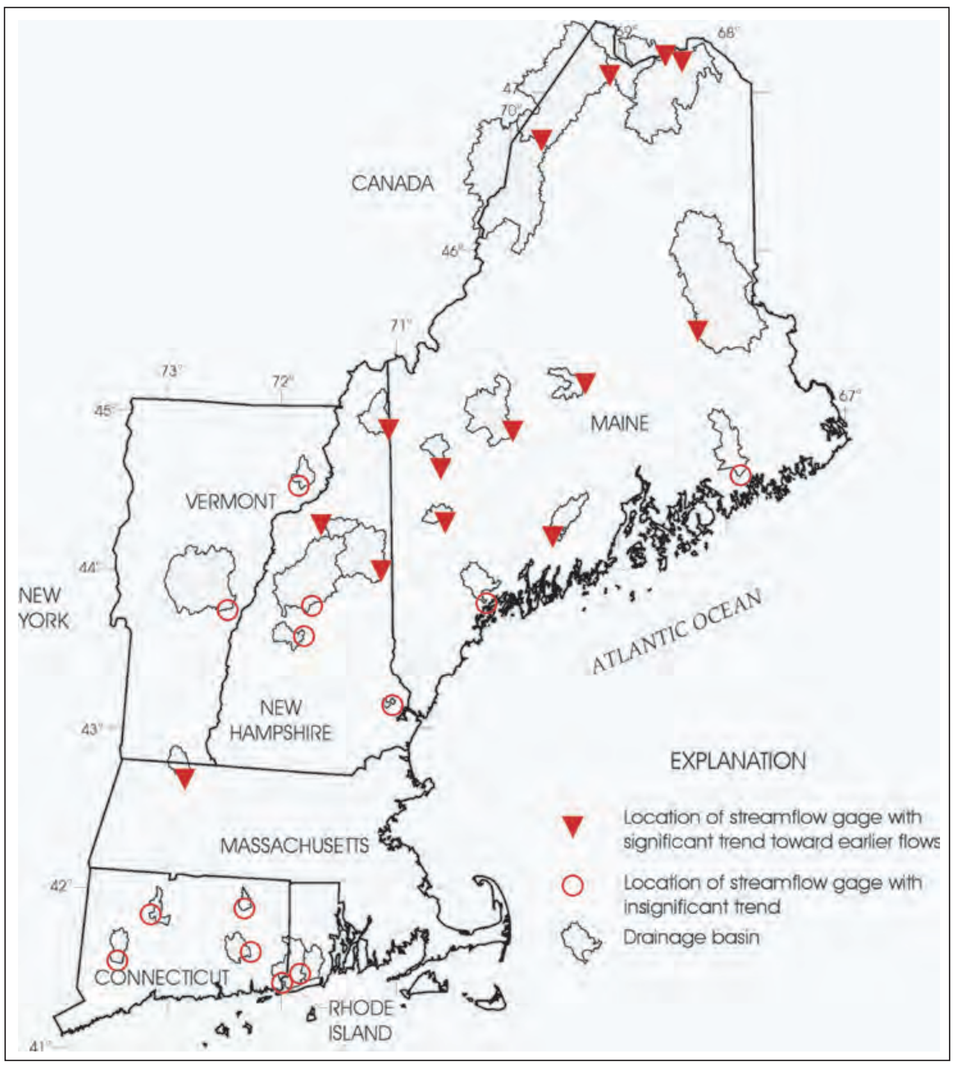

Figure 1. Location of the 27 streamgaging stations used in this study and summary of trend-test results.

While the cause of the earlier streamflow is not fully known, the year-to-year variability in the timing of winter/spring streamflow is strongly correlated to the year-to-year variability of March through April air temperatures and to a lesser extent, changes in January precipitation. Trends toward earlier streamflow in northern New England also are consistent with the findings of other studies of last-frost dates, lilac-bloom dates, lake-ice breakup dates, and spring air temperatures.

Changes in the timing of winter/spring streamflow in northern and mountainous parts of New England may have implications for some aquatic species and human activities. These changes may affect different life stages of aquatic organisms in streams and in coastal estuaries. Management of water-supply reservoirs may also need to adapt to changes in the arrival of spring snowmelt runoff. More research is needed to evaluate these changes. Both research and potential operational responses, however, will depend on the continued collection of streamflow data.

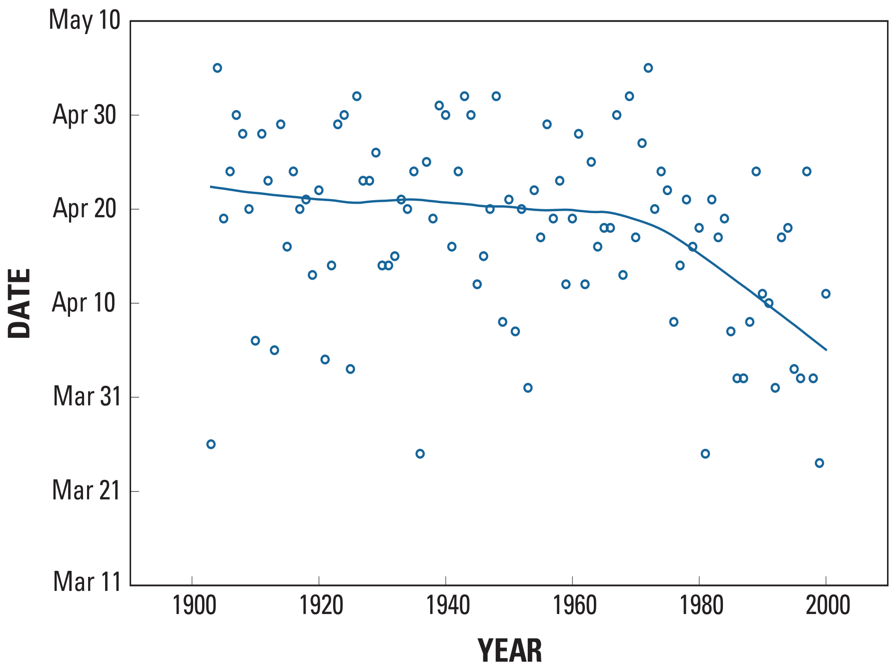

Figure 2. Annual winter/spring center-of-volume dates for the Piscataquis River in central Maine, and a moving-average trend line through the dates.

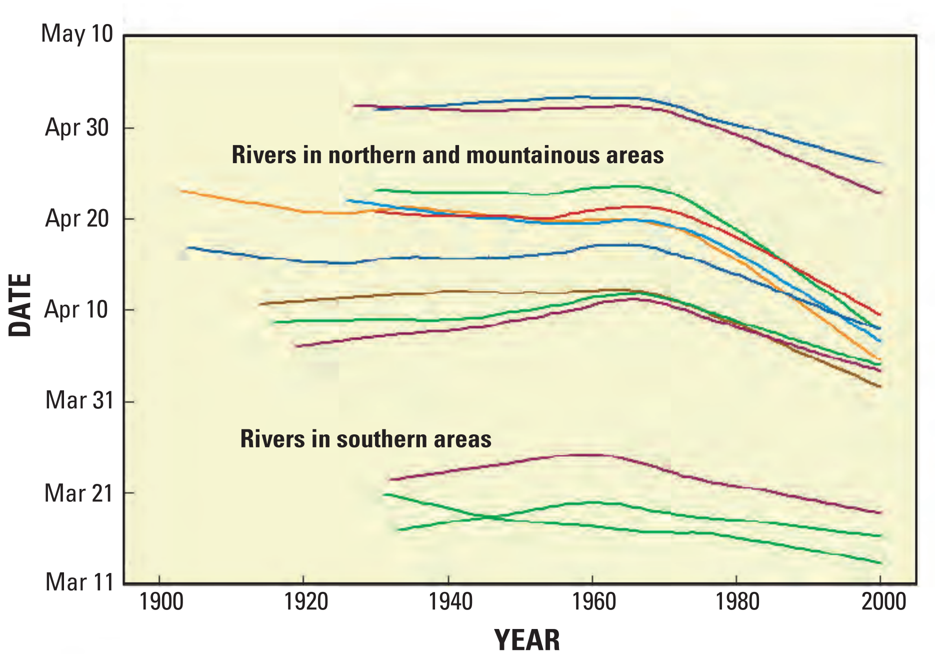

Figure 3. Average winter/spring center-of-volume dates for the 13 HCDN streamgages in New England with the longest periods of record.

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References

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