Changes in the Magnitude of Annual and Monthly Streamflows in New England, 1902-2002

Scientific Investigations Report 2005-5135

U.S. Department of the Interior
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Conversion Factors

Multiply	By	To obtain
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
acre	0.4047	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F = 1.8\,(°C) + 32$$

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Abstract

Selected annual and monthly streamflow statistics for 27 streamflow-gaging stations in New England were computed and tested for changes over time. These 27 stations were considered to be free of substantial human influences such as regulation, diversion, and land use-changes and have an average of 71 years of record. The longest streamflow record extended from 1902 to 2002.

March mean streamflows increased significantly over time (Mann-Kendall test, $p < 0.1$) at 14 streamflow-gaging stations in northern New England, primarily in northern or mountainous sections of Maine, New Hampshire, and Vermont. March mean flows increased by 76 to 185 percent at the seven stations with the longest continuous records in areas of New England with the largest seasonal snowpack depths. These streamflow-gaging stations had continuous records from the late 1920's and the early 1930's through 2002. May mean streamflows significantly decreased at 10 stations in northern or mountainous sections of Maine and New Hampshire. May mean flows decreased by 9 to 46 percent at the seven stations with the longest continuous records. Despite the fact that March percentage increases were much larger than May percentage decreases, March streamflow increases (in cubic feet per second) were smaller than May decreases, except at one streamflow-gaging station. Increased March and April air temperatures over time may have caused earlier snowmelt and thus increased streamflows in March and decreased streamflows in May.

There were no significant changes over time in annual mean streamflows at the 27 stations; however, there were significant increases over time in various annual percentile streamflows (minimum, 25th percentile, median, 75th percentile, or maximum flows) at 22 of the stations. This indicates that flows increased over time at many streams in New England, but the increase was not enough to have caused significant changes in annual mean flows. October mean streamflows increased significantly at five stations in western New England. December minimum streamflows increased significantly at 13 stations in northern and southern New England.

Introduction

The flow of a stream represents an integrated basin response to climatic variables, especially precipitation and temperature. Changes over time in the flow of streams that drain unregulated basins with stable land use generally reflect changes in climatic variables and can be used as indicators of climate change. Streamflow data are collected by instruments that are independent of those used for other climatic variables, such as temperature, thus providing independent climatic analyses (Zhang and others, 2001).

Many researchers have shown the value of using historical streamflows as indicators of climatic variability. Changes in streamflows over time have been analyzed by various researchers at national and international scales (Hyvarinen and Leppajarvi, 1989; Lettenmaier and others, 1994; Lins and Michaels, 1994; Chiew and McMahon, 1996; Lins and Slack, 1999; Dettinger and Diaz, 2000; Douglas and others, 2000; Zhang and others, 2001; Burn and Hag Elnur, 2002; McCabe and Wolock, 2002). National and regional studies have looked at seasonal changes over time in streamflows by looking at the ratio of seasonal to annual streamflows (Aguado and others, 1992; Dettinger and Cayan, 1995), the magnitude of monthly flows (Lettenmaier and others, 1994; Zhang and others, 2001; Burn and Hag Elnur, 2002), or the timing of seasonal peak flows or a computed measure of the start or the center of seasonal streamflow (Burn, 1994; Cayan and others, 2001; Zhang and others, 2001; Hodgkins and others, 2003).

It is important to document changes, or lack of changes, in long-term hydrologic data in New England (the six states in the far northeastern USA: Maine, New Hampshire, Vermont, Massachusetts, Connecticut, and Rhode Island) and other regions of the world. Streams in different regions may show a range of responses to changes in variables such as temperature and precipitation. It is essential to understand the sensitivity of hydrologic variables to climatic change because aquatic and riparian ecosystems and human societies depend on the hydrologic cycle. Understanding the magnitude of any historical changes will help define their historical impact and the impact of potential future changes.

The purpose of this report is to document the long-term temporal variations of streamflow in New England in all seasons because of the possible sensitivity of streamflows to documented climate change in the last century. Annual temperatures and precipitation in New England increased during the 20th century (Intergovernmental Panel on Climate Change, 2001). High streamflows became earlier over time in parts of New England in the winter/spring season (Hodgkins and others, 2003). Hodgkins and others analyzed the changes over time in annual winter/spring (January 1 to May 31) high streamflows at 27 rural, unregulated streams in New England with an average of 68 years of record. All 11 of the streams in areas where snowmelt runoff has the most effect on spring streamflows (northern or mountainous sections of Maine and New Hampshire) had significantly earlier winter/spring high streamflows over time (Mann-Kendall test, $p < 0.1$). These high flows became earlier by 1 to 2 weeks with most of the change in the last 30 years. For the current report, selected annual and monthly streamflow magnitude statistics were computed and tested for changes over time to document any long-term changes in New England streamflow.

Description of Climate and Streamflow in New England

The climate of New England is complex and variable in both space and time. Latitude, proximity to the Atlantic Coast, and variations in land-surface elevation have a major effect on the climate. New England is about halfway between the equator and the North Pole and is affected by warm, moist air from the south and cold, dry air from the north. The Atlantic Ocean moderates air temperatures in both winter and summer. In winter, the ocean variably influences the location of snow/rain boundaries. Despite the influence of the ocean, the prevailing air flow is not from the Atlantic Ocean, but from the drier North American continent. The mountainous topography of New England influences both precipitation and air temperatures. Precipitation is higher on the windward side of mountains and lower on the leeward side. Storm tracks through the mountains, however, come from different directions, thereby changing which sides are windward or leeward. Increases in elevation lead to decreases in air temperatures (New England Regional Assessment Group, 2001).

Average annual temperature in New England is 44^{o} F and ranges from approximately 40^{o} F in northern areas to 50^{o} F in southern coastal areas. Average annual precipitation is approximately 40 inches per year (in./yr) and ranges from approximately 35 inches (in.) in northern areas to more than 50 in. in southern coastal areas (New England Regional Assessment Group, 2001). Median total seasonal snowfall ranges from more than 100 in. in northern New England to less than 40 in. in southern New England (Cember and Wilks, 1993).

The near-freezing temperatures present in the late fall, winter, and early spring make New England streamflows sensitive to small changes in temperature. The relative amount of precipitation falling as rain or snow directly affects the magnitude and timing of streamflow in these seasons. The largest streamflows in New England typically are in the spring when rain falls on a ripe snowpack or on saturated soils. For example, at the Swift River in northern New England (site 11; table 1, fig. 1), 46 percent of the total streamflow from 1929 to 2003 was in April and May (fig. 2). For the Yantic River in southern New England (site 21), 32 percent of the streamflow from 1930 to 2003 was in March and April (fig. 3) The smaller percentage of streamflow in the Yantic River corresponds with a smaller and earlier spring snowmelt runoff. Streamflows in New England recede as snowmelt ends and as evapotranspiration increases. This recession is frequently interrupted by runoff from rainstorms. The lowest warm-season flows of the year are usually in July, August, and September. In the fall, after evapotranspiration decreases substantially, repeated rains often saturate the soil, leading to high flows. Also in the fall, large amounts of rain can fall from hurricanes, tropical storms, or their remnants. Winter flows are generally low in northern areas of New England where typically most winter precipitation falls as snow (for example at the Swift River, fig. 2). Winter flows in southern areas are more variable than flows in northern areas; winter-flows tend to be higher in the southern areas because of more winter rain and snowmelt runoff. December through February monthly mean flows for the Yantic River were relatively high (fig. 3).

Methods of Streamflow Data Collection and Analysis

Long-term (greater than 50 years) temporal variations in streamflow were analyzed by computing annual and monthly flow statistics at selected locations in New England. To look for trends that are related to climatic changes, it was necessary to choose streamflow-gaging stations that were not substantially affected by human activities.

Selection of Streamflow-Gaging Stations

A network of streamflow-gaging stations whose basins are relatively free of human influences such as regulation, diversion, land-use change, or extreme ground-water pumpage was defined by Slack and Landwehr (1992). This Hydro-Climatic Data Network (HCDN) includes data from more than 1,500 streamflow-gaging stations across the United States. Hodgkins and others (2003) used all HCDN stations in New England with daily streamflows free of substantial human influences and at least 50 continuous years of record up through 2000 to look at changes over time in the timing of high winter/spring and fall-streamflows. Twenty-seven streamflow-gaging stations met the criteria of that study. For consistency, the same sites are used in this report (table 1, fig. 1). The data up through 2002 were

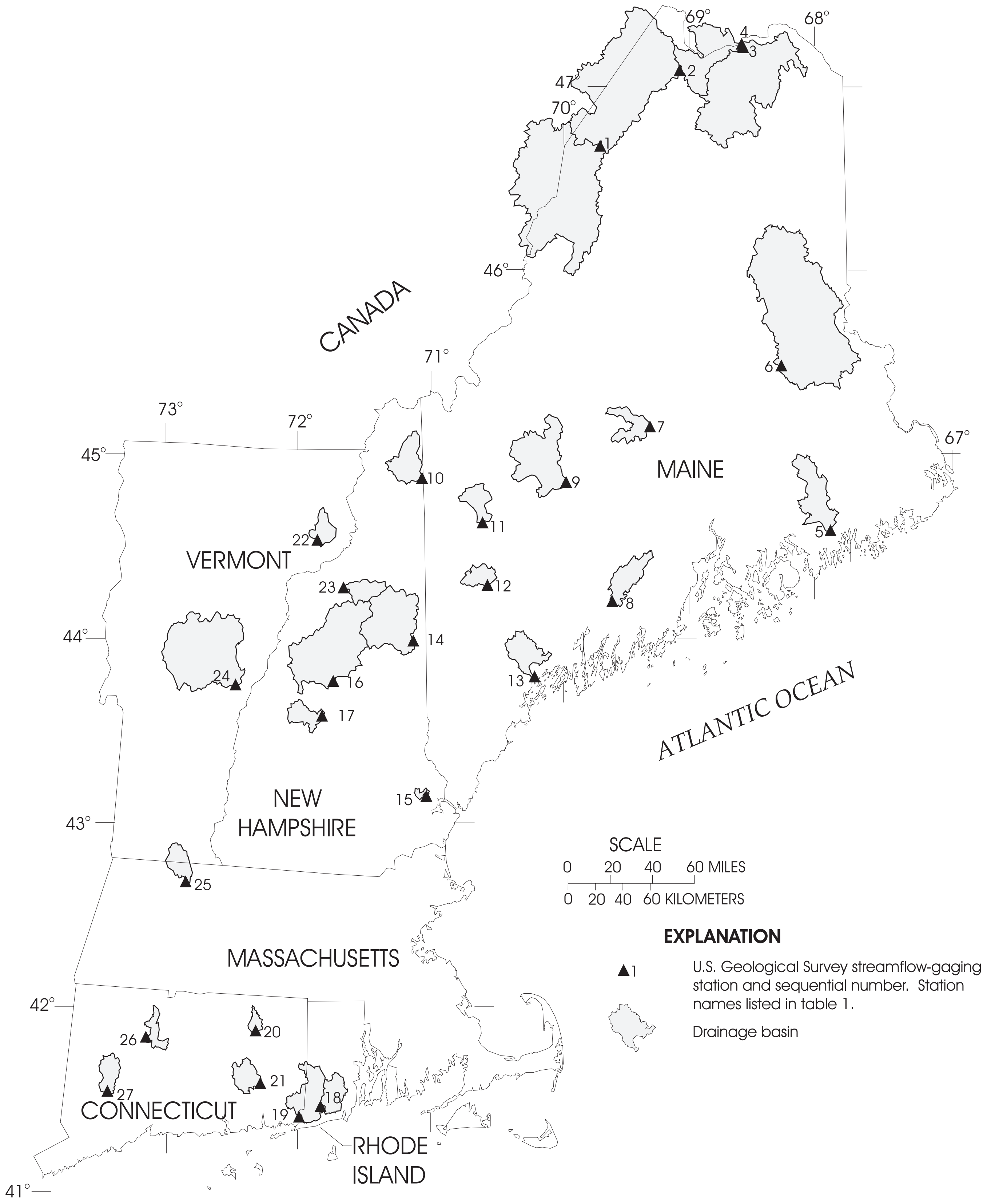

Figure 1. Location of the 27 U.S. Geological Survey streamflow-gaging stations in New England used in this study. Station names are listed in table 1.

Table 1. Streamflow-gaging stations in New England used in this study.

[USGS, U.S. Geological Survey]

Sequential number	USGS streamflow-gaging station number	USGS streamflow-gaging station name	Period of streamflow record
1	01010000	St. John River at Ninemile Bridge, Maine	1950-2002
2	01010500	St. John River at Dickey, Maine	1910-1911, 1946-2002
3	01013500	Fish River near Fort Kent, Maine	1903-1908, 1911, 1929-2002
4	01014000	St. John River below Fish River at Fort Kent, Maine	1926-2002
5	01022500	Narraguagus River at Cherryfield, Maine	1948-2002
6	01030500	Mattawamkeag River near Mattawamkeag, Maine	1934-2002
7	01031500	Piscataquis River near Dover-Foxcroft, Maine	1902-2002
8	01038000	Sheepscot River at North Whitefield, Maine	1938-2002
9	01047000	Carrabassett River near North Anson, Maine	1902-1907, 1925-2002
10	01052500	Diamond River near Wentworth Location, New Hampshire	1941-2002
11	01055000	Swift River near Roxbury , Maine	1929-2002
12	01057000	Little Androscoggin River near South Paris, Maine	1913-1924, 1931-2002
13	01060000	Royal River at Yarmouth, Maine	1949-2002
14	01064500	Saco River near Conway, New Hampshire	1903-1909, 1929-2002
15	01073000	Oyster River near Durham, New Hampshire	1935-2002
16	01076500	Pemigewasset River at Plymouth, New Hampshire	1903-2002
17	01078000	Smith River near Bristol, New Hampshire	1918-2002
18	01117500	Pawcatuck River at Wood River Junction, Rhode Island	1940-2002
19	01118500	Pawcatuck River at Westerly, Rhode Island	1940-2002
20	01121000	Mount Hope River near Warrenville, Connecticut	1940-2002
21	01127500	Yantic River at Yantic, Connecticut	1930-2002
22	01134500	Moose River at Victory, Vermont	1947-2002
23	01137500	Ammonoosuc River at Bethlehem Junction, New Hampshire	1939-2002
24	01144000	White River at West Hartford, Vermont	1915-2002
25	01169000	North River at Shattuckville, Massachusetts	1940-2002
26	01188000	Burlington Brook near Burlington, Connecticut	1931-2002
27	01204000	Pomperaug River at Southbury, Connecticut	1932-2002

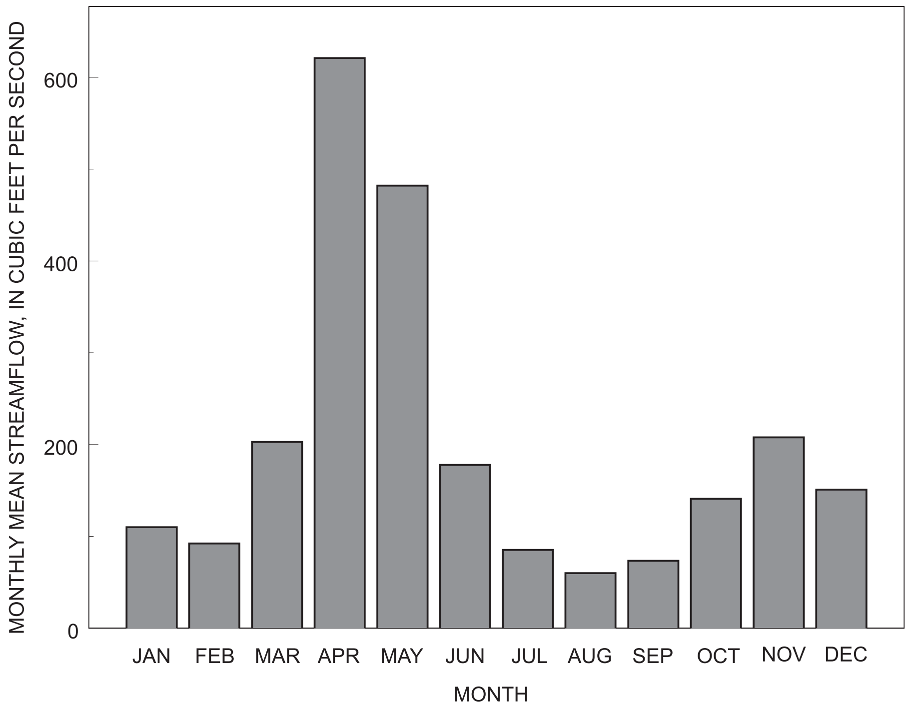

Figure 2. Monthly mean streamflows for Swift River near Roxbury, Maine, 1929-2003.

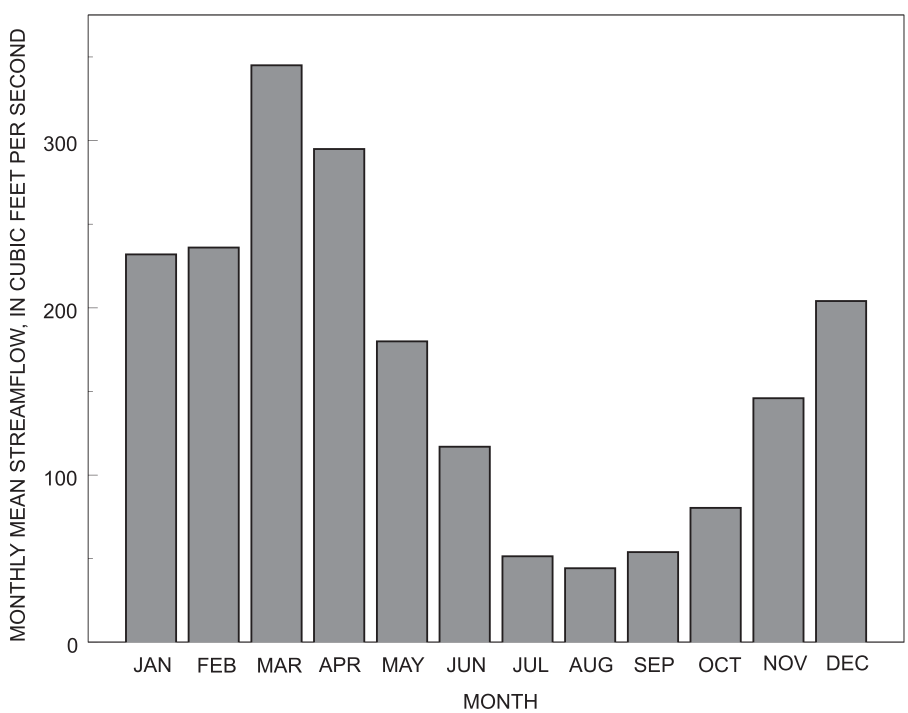

Figure 3. Monthly mean streamflows for Yantic River at Yantic, Connecticut, 1930-2003.

obtained from the U.S. Geological Survey (USGS) National Water Information System (NWIS) web site (http://waterdata.usgs.gov/nwis). The stations had periods of record ranging from 53 to 101 years, with an average of 71 years.

The data from each of these stations were analyzed further because low streamflows can be sensitive to even small amounts of regulation. The amount of regulation at each USGS streamflow-gaging station is reported in the annual USGS State Water-Data Reports and in their predecessor Water-Supply Papers. Most historical regulation on the New England HCDN streams was from upstream mills. If a stream was noted in the USGS reports as having low-flow regulation or significant storage regulation, low streamflows from those years affected were censored. If a stream was noted as having some, infrequent, or diurnal low-flow regulation, the flows were not censored. Plots of low flows for the period of record at all streams were used to verify the qualitative regulation criteria.

Based on these regulation criteria, certain annual and monthly low-flow data from seven streams (01031500 Piscataquis, 01047000 Carrabassett, 01057000 Little Androscoggin, 01117500 Pawcatuck, 01118500 Pawcatuck, 01127500 Yantic, and 01169000 North; table 1, fig. 1) were removed from the analyses. The August mean streamflow at a streamflow-gaging station was used as the threshold for determining what flows were considered to be low flows at that station. If the minimum flow in a percentile data series (such as annual or monthly minimum flows or 25th percentile flows) for a specific streamflow-gaging station was less than the minimum August mean streamflow for that station, that data series was censored. A few years of data affected by unusual regulation (such as temporarily damming a river during low streamflows to work on riverine structures) were censored at two streams in Maine (01022500 Narraguagus and 01060000 Royal Rivers). At these two streams, the monthly minimum (for the months in which the unusual regulation took place) and annual minimum data series were censored.

All of the streams used in this study were in rural areas. Streams in northern Maine, northern New Hampshire, and northern Vermont generally drained remote, undeveloped forests. Streams used for this study in other parts of New England generally drained rural areas with forests, towns, some pasture land, and low-density residential development. Large amounts of forest have replaced farmland in New England during the last 120 years. Counties in southern Maine that were 35 to 50 percent forested in 1880 were 70 to 80 percent forested in 1995. Counties in northern Maine that were 85 to 90 percent forested in 1880 were 90 to 95 percent forested in 1995 (Irland, 1998). The effects of reforestation on streamflows in New England are unknown. The possible influence of land-use change on historical streamflows is discussed further in the section titled "Annual and Monthly Mean Streamflows in New England."

Analysis of Streamflow Data

Changes over time in the magnitude of streamflows were evaluated using the Mann-Kendall test. This test indicates whether a variable increases or decreases over time. No assumption of normality is required (Helsel and Hirsch, 1992). The data were smoothed for plots and for serial-correlation testing by use of locally weighted regression (LOESS) (Cleveland and Devlin, 1988) with locally linear fitting, a robustness feature, and a weighting function of 45 years. LOESS, using these parameters, is very similar to LOWESS (Cleveland, 1979). These locally weighted regression techniques allow the data to dictate the shape of the smooth and do not assume linearity (Hirsch and others, 1993).

There must be no serial correlation for the Mann-Kendall test results to be correct. Serial correlations were analyzed by computing the Durbin-Watson statistic on the residuals of the LOESS smooths for each time series with significant changes ($p < 0.1$) for several annual and monthly streamflow data series. All data series with significant changes for March mean flows, May mean flows, October mean flows, December minimum flows, and annual 25th percentile streamflows (variables that had many significant changes) were tested. Two of 54 data series indicated significant ($p < 0.1$) positive serial correlation. This amount of serial correlation is likely due to chance.

Annual and Monthly Mean Streamflows in New England

Annual and monthly mean streamflows were tested for changes over time at 27 streamflow-gaging stations in New England (fig. 1, tables 2a and 2b). The number of significant changes (Mann-Kendall test, $p < 0.1$) are summarized in figure 4. There were no significant changes over time in the annual mean streamflows. There were many significant changes toward increasing streamflows over time in February, March, and April; March had the most with 14 significant changes (table 2a). All the streams with significant changes toward increasing March streamflows are in northern New England, primarily in northern or mountainous sections of Maine, New Hampshire, and Vermont (fig. 5).

As a visual example of the streamflow data over time and how LOESS smooth lines fit the data, historical March mean streamflows for the Saco River near Conway, New Hampshire, are shown in figure 6 with a LOESS smooth line through the data. The large interannual variability in the March mean streamflows and the general trend toward higher flows over time can be observed.

LOESS smooth lines for 11 streamflow-gaging stations in northern New England are shown in figure 7. The drainage basins for these 11 stations are in areas of New England with the largest median seasonal maximum snowpack depths (Hodgkins and others, 2003). For these LOESS smooth lines, only continuous data were used; older discontinuous data were not used. Based on the LOESS smooth lines, March mean streamflows increased by 76 to 185 percent at the seven stations that have the longest continuous streamflow records to the present. These stations had continuous records from the late 1920's or the early 1930's through 2002 (table 3).

Table 2a. Attained significance levels (p-values) for Mann-Kendall test results for changes over time in annual and January through June mean streamflows.

[Ann, Annual; Jan, January; Feb, February; Mar, March; Apr, April; Jun, June; bold numbers indicate p < 0.1; +, increasing streamflows over time; -, decreasing streamflows over time; USGS, U.S. Geological Survey]

Sequential number	USGS station number	Stream and state	Ann	Jan	Feb	Mar	Apr	May	Jun
1	01010000	St. John, Maine	0.10 +	0.20 +	0.31 +	**0.0050** +	**0.021** +	**0.098** -	0.90 -
2	01010500	St. John, Maine	0.34 +	0.19 +	0.29 +	**0.0086** +	**0.016** +	**0.077** -	0.44 -
3	01013500	Fish, Maine	0.18 +	**0.024** +	**0.0009** +	**0.0010** +	**0.0033** +	0.17 -	0.11 -
4	01014000	St. John, Maine	0.92 +	0.18 +	**0.016** +	**0.0005** +	**0.0035** +	**0.020** -	**0.015** -
5	01022500	Narraguagus, Maine	0.76 -	0.22 -	0.91 +	**0.078** +	0.45 -	0.65 -	0.59 +
6	01030500	Mattawamkeag, Maine	0.20 +	0.75 +	0.25 +	**0.020** +	**0.066** +	**0.058** -	0.14 -
7	01031500	Piscataquis, Maine	0.53 +	0.59 +	**0.026** +	**0.052** +	0.19 +	**0.016** -	0.83 -
8	01038000	Sheepscot, Maine	0.26 +	0.90 +	0.43 +	**0.082** +	0.79 -	0.73 -	0.69 +
9	01047000	Carrabassett, Maine	0.15 +	0.57 +	**0.0054** +	**0.019** +	0.32 +	**0.035** -	0.97 -
10	01052500	Diamond, New Hampshire	0.36 +	0.23 +	**0.015** +	**0.048** +	0.28 +	**0.048** -	0.96 -
11	01055000	Swift, Maine	0.21 +	0.68 +	**0.056** +	**0.0020** +	0.40 +	**0.040** -	0.53 +
12	01057000	Little Androscoggin, Maine	0.43 -	0.59 -	0.21 +	0.19 +	0.11 -	0.28 -	0.71 +
13	01060000	Royal, Maine	0.54 -	0.36 -	0.78 -	0.58 +	**0.059** -	0.94 -	0.56 +
14	01064500	Saco, New Hampshire	0.30 +	0.79 +	0.25 +	**0.096** +	0.57 +	**0.045** -	0.99 -
15	01073000	Oyster, New Hampshire	0.67 +	0.45 -	0.70 +	0.69 -	0.59 -	0.76 +	0.73 -
16	01076500	Pemigewasset, New Hampshire	0.96 -	0.94 +	**0.042** +	0.78 -	0.90 -	0.38 -	0.83 +
17	01078000	Smith, New Hampshire	0.73 +	0.68 -	0.10 +	0.78 +	0.80 -	0.99 +	0.26 +
18	01117500	Pawcatuck, Rhode Island	0.22 +	0.56 +	0.57 +	0.74 -	0.26 +	0.51 +	0.91 +
19	01118500	Pawcatuck, Rhode Island	0.27 +	0.53 +	0.69 +	0.69 -	0.25 +	0.61 +	0.86 -
20	01121000	Mount Hope, Connecticut	0.24 +	0.21 +	0.91 +	0.48 -	0.91 +	0.41 -	0.80 -
21	01127500	Yantic, Connecticut	0.32 +	0.42 +	0.45 +	0.41 -	0.57 -	0.76 +	0.18 -
22	01134500	Moose, Vermont	0.21 +	0.14 +	0.20 +	**0.034** +	0.64 -	0.21 -	0.66 -
23	01137500	Ammonoosuc, New Hampshire	0.62 -	0.23 +	0.14 +	**0.034** +	0.79 +	**0.033** -	0.24 -
24	01144000	White, Vermont	0.67 +	0.41 +	**0.028** +	0.79 +	0.52 -	0.68 -	0.65 +
25	01169000	North, Massachusetts	0.30 +	0.29 +	0.35 +	0.28 +	0.51 -	0.65 -	0.74 +
26	01188000	Burlington, Connecticut	0.12 +	0.74 +	0.39 +	0.81 +	0.67 -	0.49 +	0.87 +
27	01204000	Pomperaug, Connecticut	0.21 +	0.76 +	0.55 +	0.71 -	0.79 -	0.51 +	0.66 +

Table 2b. Attained significance levels (p-values) for Mann-Kendall test results for changes over time in July through December mean streamflows.

[Jul, July; Aug, August; Sep, September; Oct, October; Nov, November; Dec, December; bold numbers indicate p < 0.1; +, increasing streamflows over time; -, decreasing streamflows over time; USGS, U.S. Geological Survey]

Sequential number	USGS station number	Stream and state	Jul		Aug		Sep		Oct		Nov		Dec	
1	01010000	St. John, Maine	0.32	+	0.23	-	0.75	-	0.26	+	0.49	+	0.94	+
2	01010500	St. John, Maine	0.64	+	0.16	-	0.85	-	0.21	+	0.55	+	0.95	+
3	01013500	Fish, Maine	0.48	-	0.99	+	0.61	+	0.43	+	0.23	+	**0.046**	+
4	01014000	St. John, Maine	0.25	-	0.33	-	0.84	+	0.73	-	0.72	-	0.32	+
5	01022500	Narraguagus, Maine	0.25	+	0.80	+	0.79	+	0.53	+	0.15	-	**0.048**	-
6	01030500	Mattawamkeag, Maine	0.56	-	0.42	+	0.89	+	0.67	+	0.70	-	0.91	-
7	01031500	Piscataquis, Maine	0.73	-	**0.078**	-	0.42	-	0.84	-	0.16	+	0.33	+
8	01038000	Sheepscot, Maine	0.62	-	0.56	-	0.57	+	0.31	+	0.79	-	0.97	-
9	01047000	Carrabassett, Maine	0.83	-	0.74	-	0.92	-	0.97	-	0.11	+	0.28	+
10	01052500	Diamond, New Hampshire	0.52	+	0.38	+	0.29	+	0.38	+	0.93	+	0.44	+
11	01055000	Swift, Maine	0.19	+	0.52	+	0.86	+	0.28	+	0.21	+	0.33	+
12	01057000	Little Androscoggin, Maine	0.67	-	0.59	-	0.18	-	0.52	+	0.20	+	0.93	+
13	01060000	Royal, Maine	0.99	+	0.40	-	0.70	-	0.45	+	0.30	-	0.14	-
14	01064500	Saco, New Hampshire	0.98	+	0.51	+	0.82	-	0.27	+	**0.015**	+	**0.085**	+
15	01073000	Oyster, New Hampshire	0.73	+	0.54	+	0.36	+	**0.0069**	+	0.33	+	0.88	+
16	01076500	Pemigewasset, New Hampshire	0.84	-	0.59	-	0.40	-	0.61	+	**0.015**	+	0.16	+
17	01078000	Smith, New Hampshire	0.94	+	1.0		0.72	-	0.11	+	0.20	+	0.69	-
18	01117500	Pawcatuck, Rhode Island	0.98	+	0.79	-	0.28	+	0.23	+	0.85	+	0.75	+
19	01118500	Pawcatuck, Rhode Island	0.82	-	0.71	-	0.34	+	0.34	+	0.94	+	0.63	+
20	01121000	Mount Hope, Connecticut	1.0	-	0.57	+	0.10	+	**0.0033**	+	0.44	+	0.45	+
21	01127500	Yantic, Connecticut	**0.061**	-	0.40	-	0.20	-	0.10	+	**0.045**	+	0.23	+
22	01134500	Moose, Vermont	0.13	+	**0.016**	+	**0.0069**	+	**0.0081**	+	0.21	+	0.46	+
23	01137500	Ammonoosuc, New Hampshire	0.89	+	0.62	+	0.99	-	0.23	+	0.55	+	0.83	+
24	01144000	White, Vermont	0.44	-	0.29	+	0.30	+	0.16	+	0.20	+	0.16	+
25	01169000	North, Massachusetts	0.33	+	0.19	+	0.30	+	**0.018**	+	0.23	+	0.71	+
26	01188000	Burlington, Connecticut	0.73	+	0.80	+	0.98	-	0.13	+	0.20	+	0.60	+
27	01204000	Pomperaug, Connecticut	0.80	+	0.44	+	0.59	+	**0.082**	+	0.33	+	0.61	+

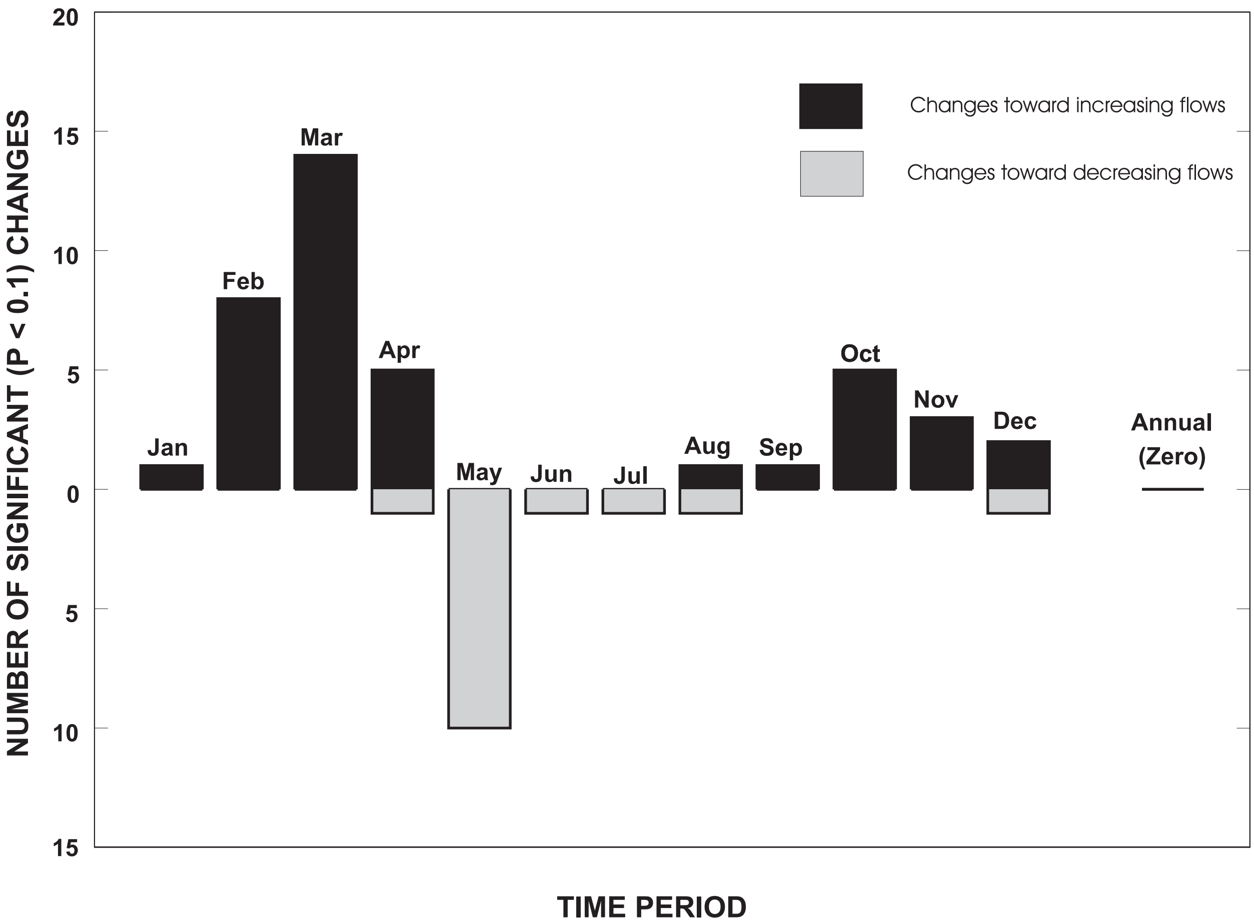

Figure 4. Number of significant changes over time in annual and monthly mean streamflows.

May mean streamflows significantly decreased at 10 streamflow-gaging stations in northern New England (table 2a). All of the stations with significantly decreasing flows are in northern or mountainous sections of Maine and New Hampshire (fig. 8). As a visual example of how LOESS smooth lines fit the data, historical May mean flows for the Swift River near Roxbury, Maine are shown in figure 9 with a LOESS smooth line through the data. LOESS smooth lines for 11 stations in northern New England (the same stations as in figure 7) are shown in figure 10. May mean streamflows decreased by 9 percent to 46 percent at the seven stations that had the longest continuous streamflow record through 2002 (table 3).

Despite the fact that March percentage increases were much larger than May percentage decreases, March streamflow increases (in cubic feet per second) were smaller than May decreases, except for one streamflow-gaging station (USGS station number 01057000) (table 3). The March increases and May decreases in flow, over time, in northern and mountainous sections of New England are consistent with the shift in the timing of winter/spring streamflows in New England found by Hodgkins and others (2003). The date by which half of the total volume of water, for the period January 1 to May 31, flowed past a streamflow-gaging station became significantly earlier at all 11 stations in areas of New England where snowmelt runoff had the most effect on winter/spring streamflows. These winter/spring center-of-volume dates advanced by 1 to 2 weeks. The dates were highly correlated ($r = -0.72$, $p < 0.0001$) with March through April air temperatures (Hodgkins and others, 2003). Increased March and April air temperatures may have caused the increased March streamflows and the decreased May streamflows through earlier melting of the winter snowpack.

It is unlikely that the significant March or May streamflow changes over time reported in this study were substantially affected by changes in land use over time. The most substantial land-use change in the stream basins was the conversion of farmland to forest, particularly in the more southern basins. This change, however, was gradual during the 20th century, at least in Maine (Irland, 1998), whereas changes in streamflows

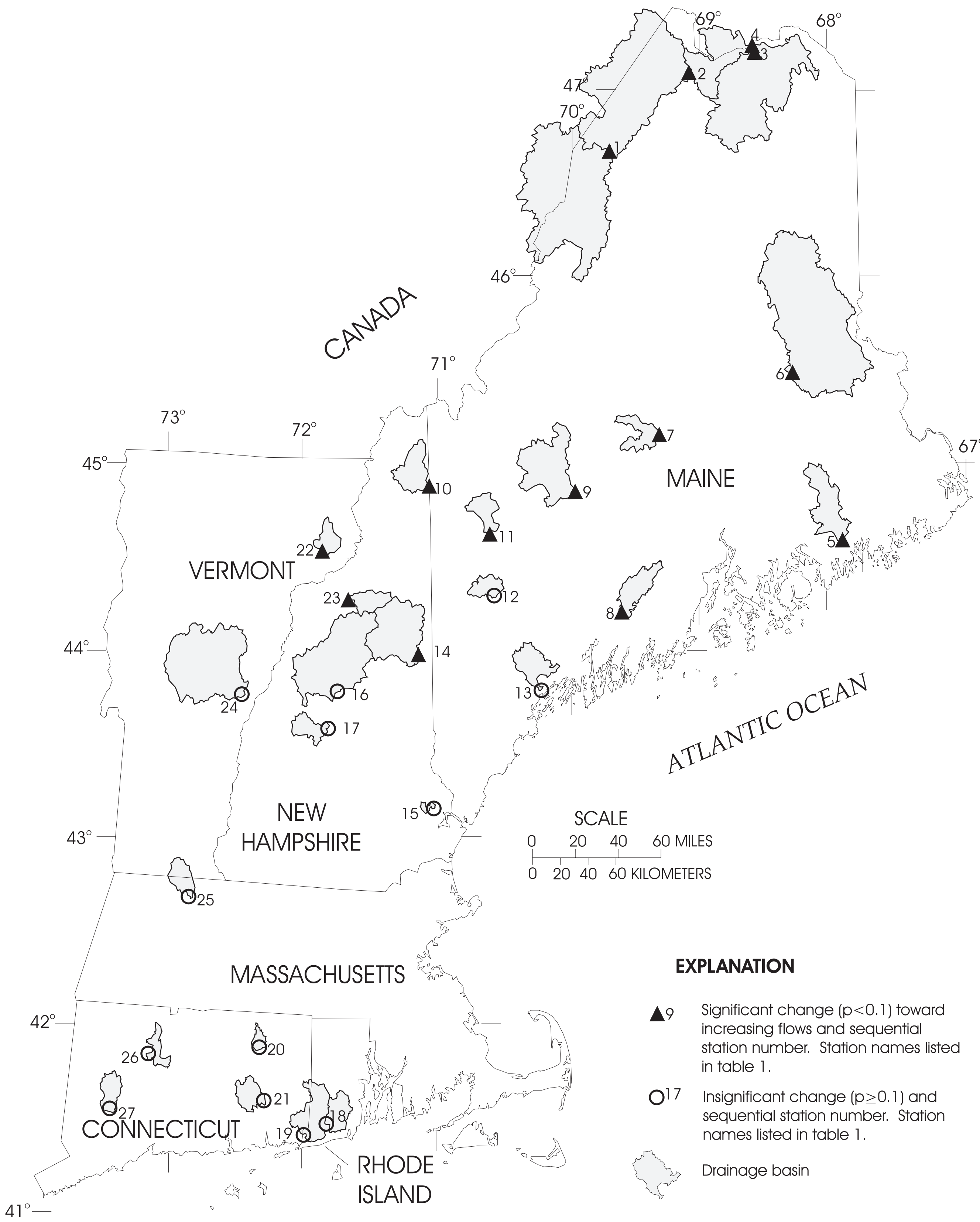

Figure 5. Geographic distribution of significant changes over time in March mean streamflows.

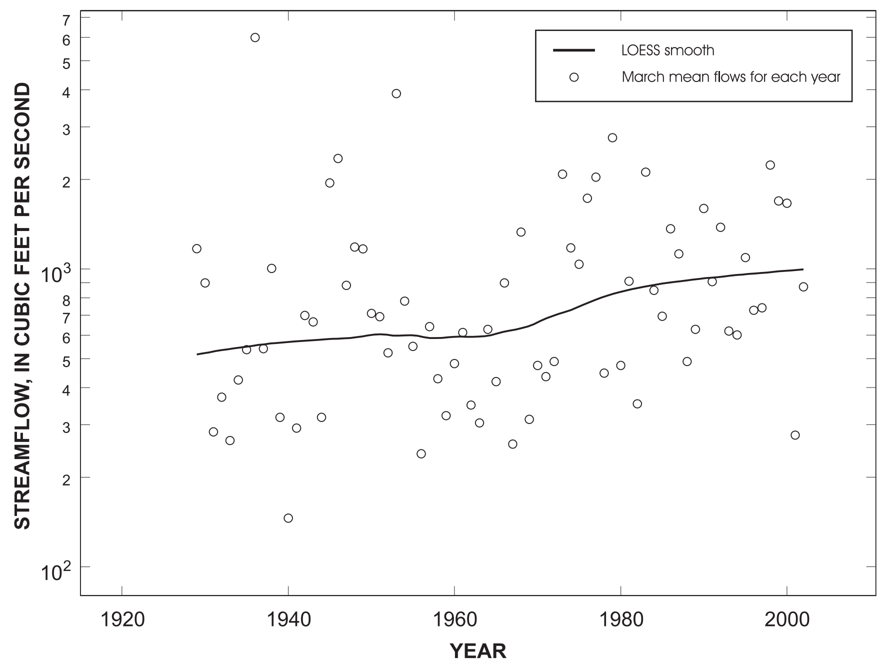

Figure 6. Historical March mean streamflows for the Saco River near Conway, New Hampshire, with a LOESS smooth.

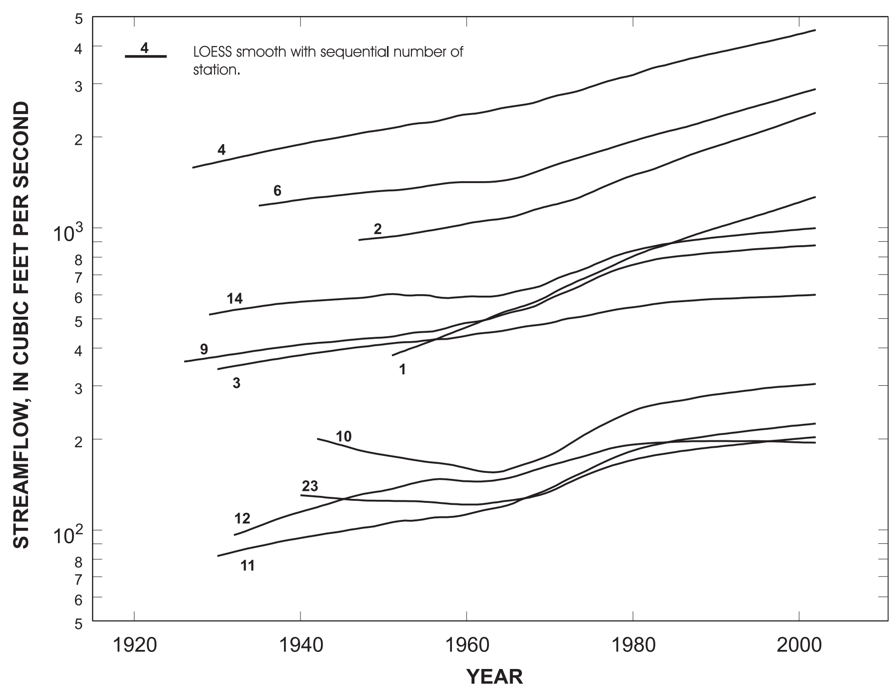

Figure 7. LOESS smooths of March mean streamflows for 11 streams in New England with the largest median seasonal maximum snowpack depths. Stream names are listed in table 3.

were not gradual for most streams (figs. 7 and 10). In addition, many of the streams with significant changes in streamflow over time are in northern and mountainous sections of New England where the amount of reforestation was relatively small; counties in northern Maine were 85 to 90 percent forested in 1880 and 90 to 95 percent forested in 1995 (Irland, 1998).

It is unknown whether changes in forest composition over time have contributed substantially to changes over time in March or May streamflows. As an example of changes in forest composition, a spruce budworm epidemic in northern Maine from the late 1960's through the mid-1980's resulted in extensive salvage harvests from the mid-1970's through the 1990's. This resulted in a decrease of spruce/fir tree acreage of about 500,000 acres from 1982 to 1995 and an increase of about 340,000 acres from 1995 to 2003 (McWilliams and others, 2005). Any substantial effect of changes in forest composition on streamflows is likely to be complex in both time and space. Jones and Post (2004) compared snowmelt runoff in three very small, 100-percent-harvested drainage basins in northern New Hampshire (Hubbard Brook Experimental Forest, 40- to 90-acre basins with deciduous forest) to a control basin. They found that snowmelt runoff occurred earlier in the harvested basins in the first decade after harvesting. Snowmelt occurred later in the harvested basins after about 30 years.

Other than the changes in winter/spring monthly streamflows, only one other month had more than three significant changes in monthly mean flows: five streamflow-gaging stations with significantly increased October mean streamflows (table 2b) were located across western New England in Vermont, New Hampshire, Massachusetts, and Connecticut (fig. 11). The increased flows may have been caused by increased October rainfall, over time, in western New England.

Table 3. Changes in the magnitude of March and May mean streamflows at 11 streams in northern and mountainous areas of New England.

[Changes based on LOESS smooth lines; USGS, U.S. Geological Survey]

Sequential number	USGS station number	Stream and state	Period of streamflow record used for LOESS smooth line	Increase in March mean streamflow (cubic feet per second)	Increase in March mean streamflow (percent)	Decrease in May mean streamflow (cubic feet per second)	Decrease in May mean streamflow (percent)
1	01010000	St. John, Maine	1950-2002	888	235	2,250	35
2	01010500	St. John, Maine	1946-2002	1,500	164	4,260	32
3	01013500	Fish, Maine	1929-2002	260	76	1,030	21
4	01014000	St. John, Maine	1926-2002	2,940	185	17,000	46
6	01030500	Mattawamkeag, Maine	1934-2002	1,700	143	2,250	39
9	01047000	Carrabassett, Maine	1925-2002	515	143	657	40
10	01052500	Diamond, New Hampshire	1941-2002	104	52	308	34
11	01055000	Swift, Maine	1929-2002	143	174	178	35
12	01057000	Little Androscoggin, Maine	1931-2002	98.4	102	15.4	9
14	01064500	Saco, New Hampshire	1929-2002	481	93	628	29
23	01137500	Ammonoosuc, New Hampshire	1939-2002	72.8	56	173	33

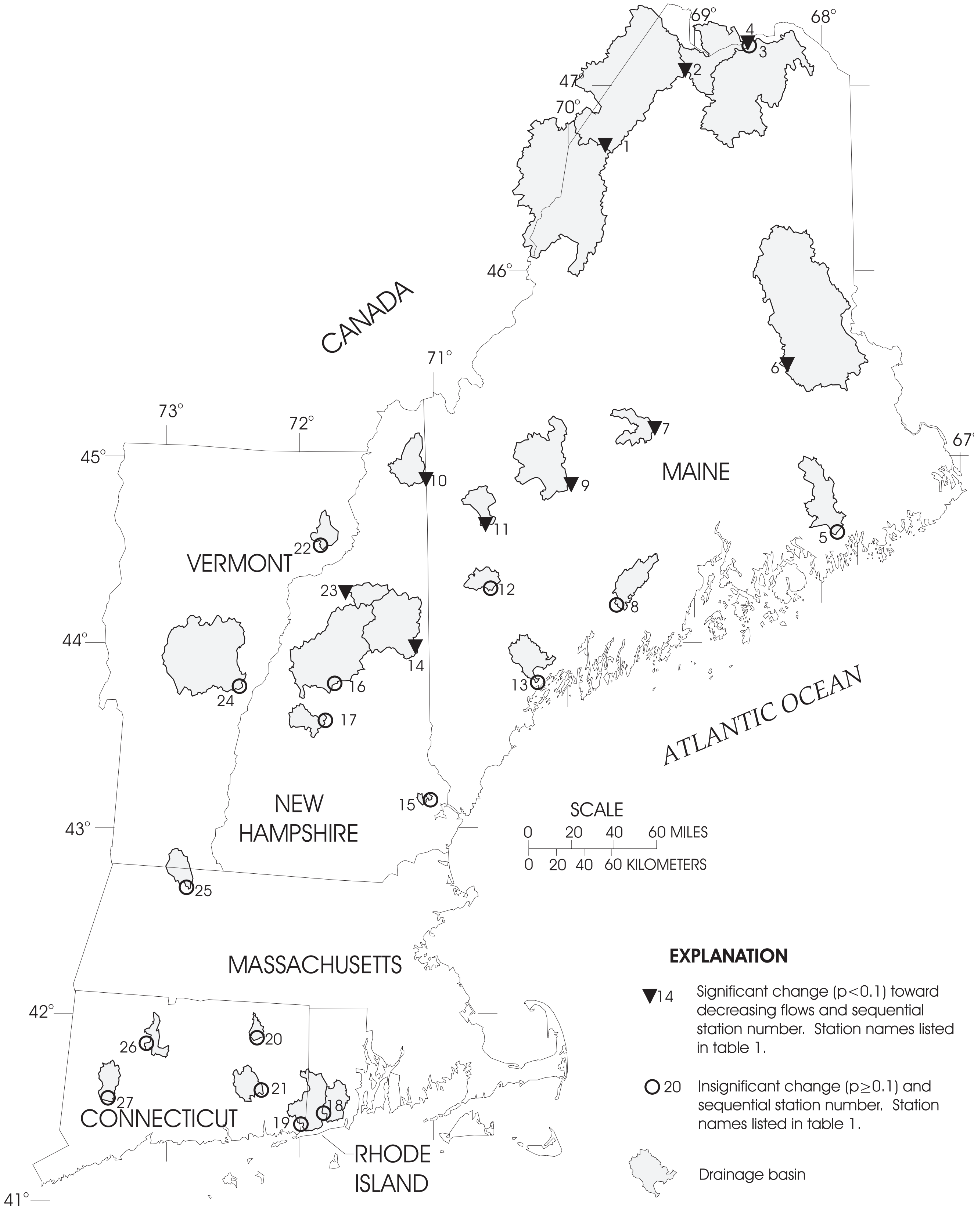

Figure 8. Geographic distribution of significant changes over time in May mean streamflows.

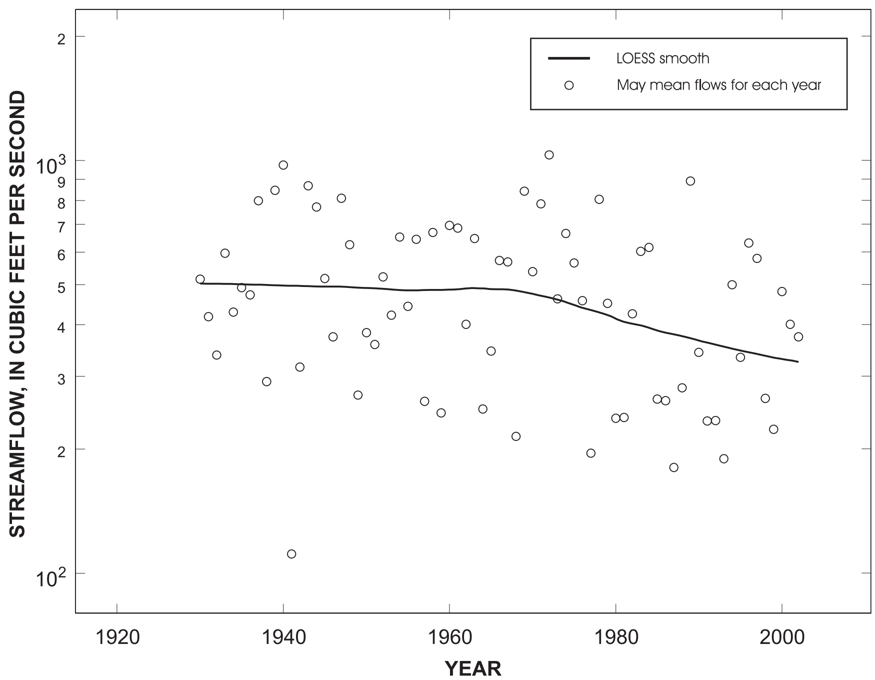

Figure 9. Historical May mean streamflows for the Swift River near Roxbury, Maine, with a LOESS smooth.

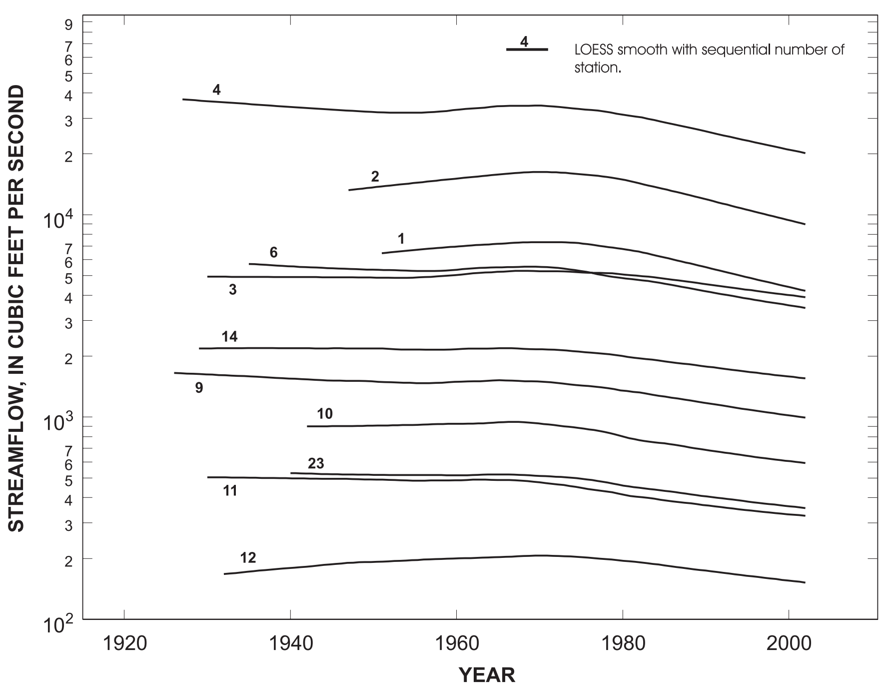

Figure 10. LOESS smooths of May mean streamflows for 11 streams in New England with the largest median seasonal maximum snowpack depths. Stream names are listed in table 3.

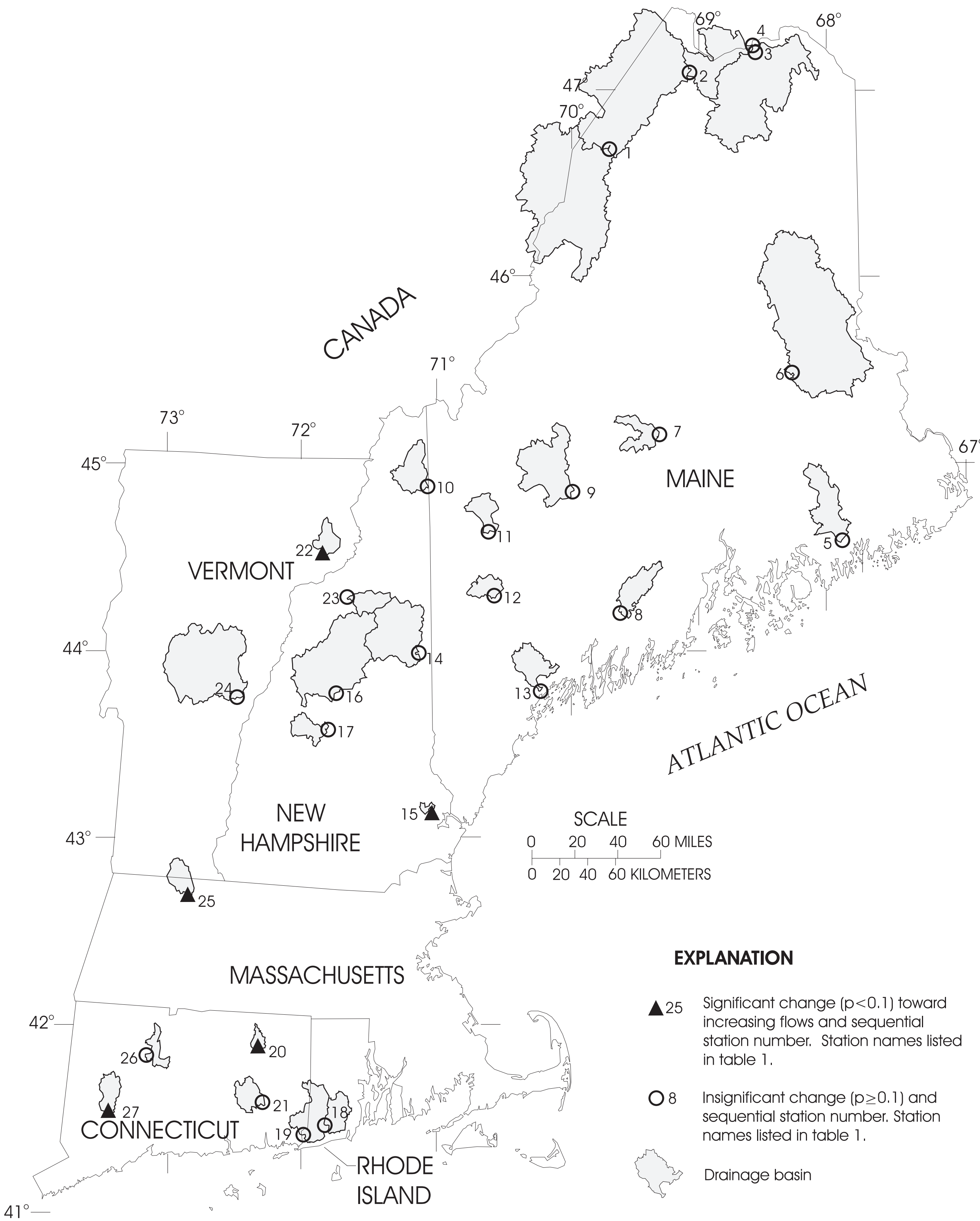

Figure 11. Geographic distribution of significant changes over time in October mean streamflows.

Annual and Monthly Percentile Streamflows in New England

Selected annual and monthly percentile streamflows were tested for changes over time at the same 27 streamflow-gaging stations in New England discussed in the previous section (fig. 1, tables 4-16 at back of report). The numbers of significant changes for the minimum, 25th percentile, median, 75th percentile, and maximum annual and monthly streamflows (Mann-Kendall test, $p < 0.1$) are summarized in figure 12. The pattern of significant changes has similarities to the pattern of significant changes for monthly mean streamflows (fig. 4): many significant changes toward increasing flows in February, March, and April, with the highest number of significant changes in March; many significant changes toward decreasing flows in May; and multiple significant changes toward increasing flows in October. Some differences in the pattern of significant changes between the mean flows and the percentile flows were observed: annual and December percentile flows had more significant changes than annual and December mean flows. These differences are discussed later in this section.

In general, if mean flows for a streamflow-gaging station indicated significant changes over time, a majority of the percentile flows at the station indicated significant changes over time. This can be observed in the February, March, April, May, and October mean streamflows (tables 2a and 2b) as compared with their respective percentile streamflows (tables 6, 7, 8, 9, and 14). As examples of percentile-flow changes over time at streamflow-gaging stations, LOESS smooth lines of March and May percentile flows over time for the St. John River at Fort Kent, Maine, are shown in figures 13 and 14, respectively, and similar plots for the Saco River near Conway, New Hampshire, are shown in figures 15 and 16, respectively.

Significant increases over time in annual percentile streamflows were observed at 22 streamflow-gaging stations (table 4) as compared to no significant changes over time in annual mean streamflows (table 2a). There was a significant decrease over time in the annual percentile flows at one streamflow-gaging station. This indicates that flows increased over time at many streams in New England, but the increases were not enough to have caused significant changes in the annual mean flows. Twenty-two out of 27 streamflow-gaging stations had an insignificant increase in annual mean flows (table 2a). Increased flows were likely caused by increased precipitation. The highest number of significantly increasing annual percentile flows were in the 25th percentile, median, and maximum flows. None of the stations had significantly increasing flows at all percentiles. The geographic distribution of the streams with significantly increasing flows over time differs between the annual 25th percentile flows and the annual maximum flows (figs. 17 and 18). Most of the streams with significant changes in the 25th percentile flows over time are in northern and mountainous sections of New England, whereas the streams with significant maximum streamflow changes are partly in northern New England and partly in southern New England.

The December percentile streamflows were the only monthly percentile flows with significantly changing streamflows to be concentrated in either the low or high percentiles. Most of the significant changes in December flows were in minimum or 25th percentile flows (table 16). The increases in December minimum flows are in both northern and southern New England (fig. 19). The increases in these flows may have been caused by increases over time in the frequency and (or) volume of small December rainfall events. The increases also could have been caused by less frozen water (snow or ice) in the stream basins in December in recent years.

Summary

Annual temperatures and precipitation in New England increased in the 20th century according to the Intergovernmental Panel on Climate Change. Because of the possible sensitivity of streamflows to documented climate change, selected annual and monthly streamflow statistics at 27 streamflow-gaging stations in New England were computed and tested for changes over time. The selected stations were considered to be free of substantial human influences such as regulation, diversion, land-use change, or extreme ground-water pumpage and have an average of 71 years of record. The longest streamflow record extended from 1902 to 2002.

March mean streamflows increased significantly over time (Mann-Kendall test, $p < 0.1$) at 14 stations in northern New England, primarily in northern or mountainous sections of Maine, New Hampshire, and Vermont. March mean flows increased by 76 percent to 185 percent at the seven streamflow-gaging stations with the longest continuous record in areas of New England with the largest median seasonal maximum snowpack depths. These stations had continuous streamflow records from the late 1920's or the early 1930's through 2002. May mean streamflows significantly decreased at 10 stations in northern or mountainous sections of Maine and New Hampshire. May mean flows decreased by 9 to 46 percent at the seven stations with the longest continuous records. Despite the fact that March percentage increases were much larger than May percentage decreases, March streamflow increases (in cubic feet per second) were smaller than May decreases, except at one streamflow-gaging station.

The March increases and May decreases in flow, over time, in northern and mountainous sections of New England are consistent with the shift in the timing of winter/spring streamflows in New England documented in a previous article. In that article, the date by which half of the total volume of water, from January 1 to May 31, flowed past a streamflow-gaging station became significantly earlier over time at all 11 stations in areas of New England where snowmelt runoff had the most effect on winter/spring streamflows. These winter/spring center-of-volume dates advanced by one to two weeks. The dates were highly correlated ($r = -0.72$, $p < 0.0001$) with March through April air

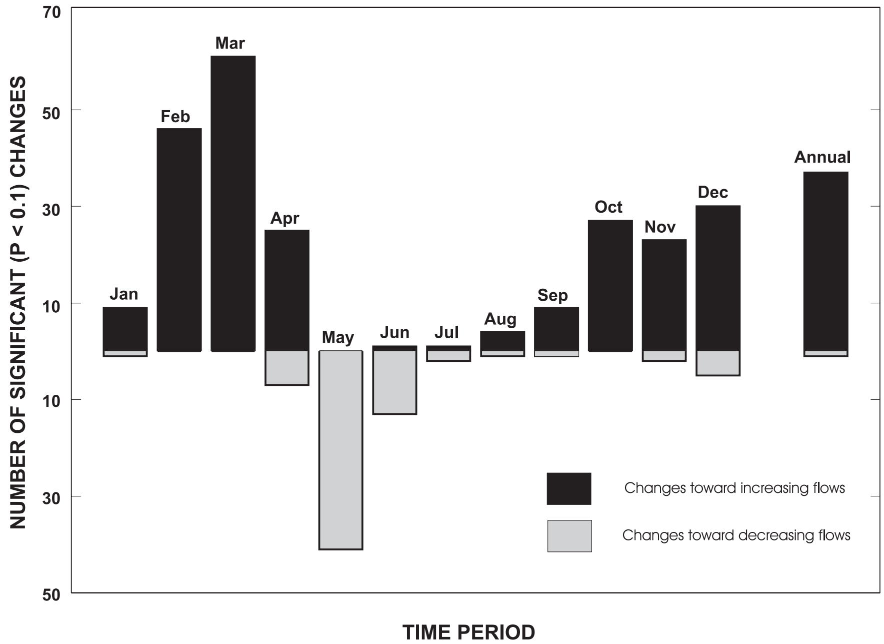

Figure 12. Number of significant changes over time in annual and monthly percentile streamflows.

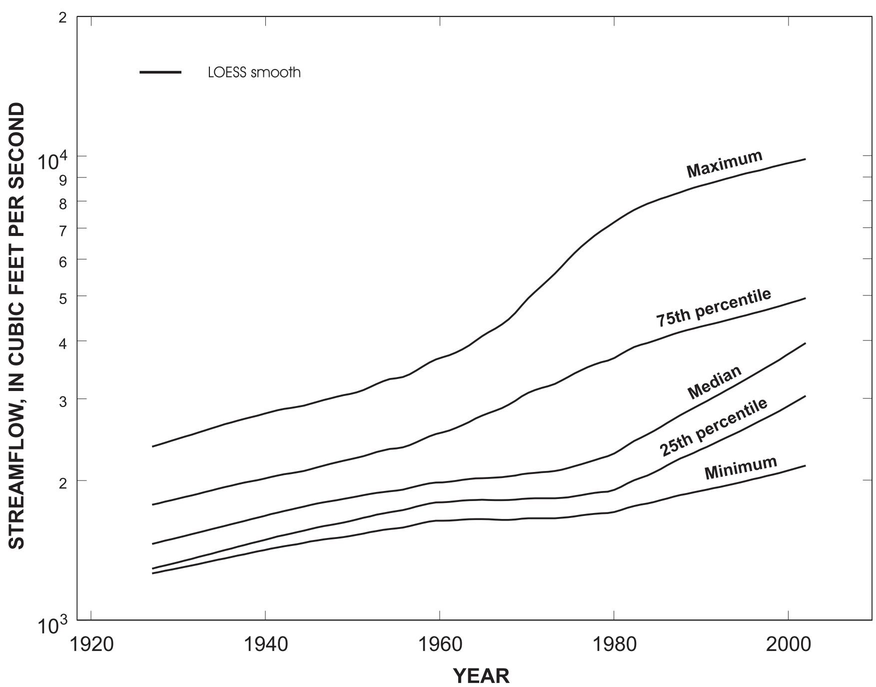

Figure 13. LOESS smooths of March percentile streamflows for the St. John River at Fort Kent, Maine.

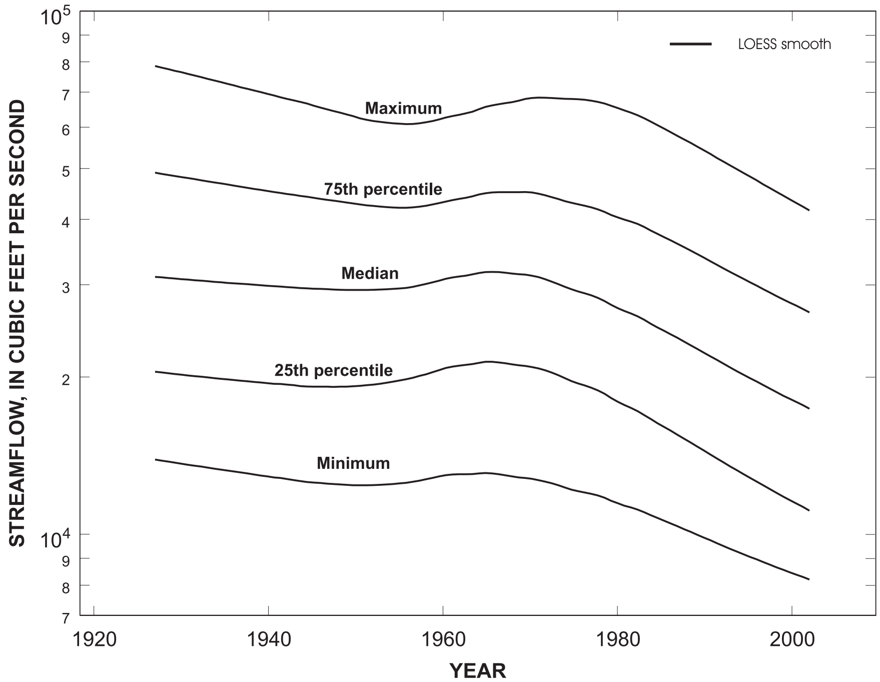

Figure 14. LOESS smooths of May percentile streamflows for the St. John River at Fort Kent, Maine.

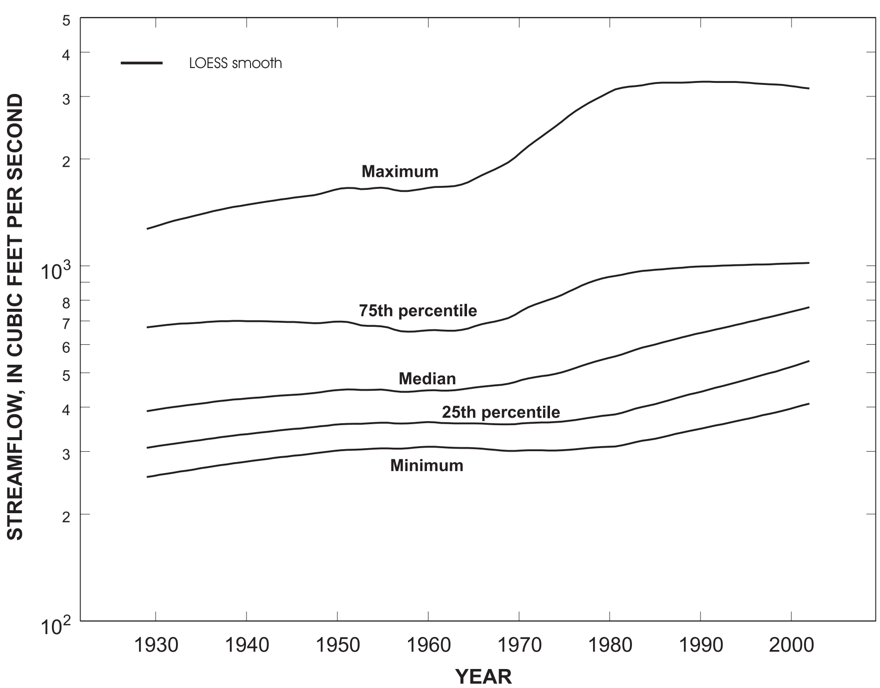

Figure 15. LOESS smooths of March percentile streamflows for the Saco River near Conway, New Hampshire.

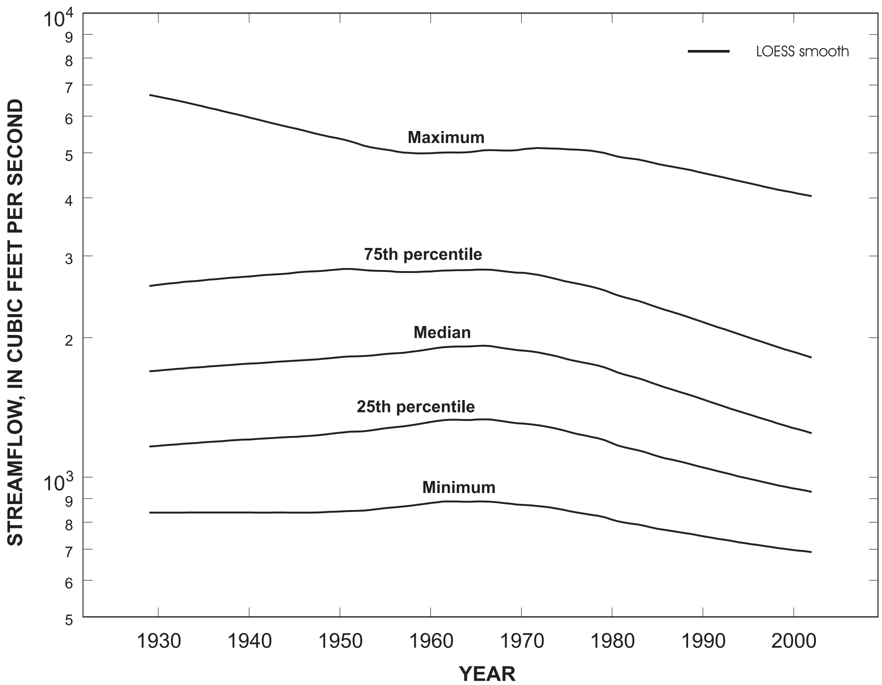

Figure 16. LOESS smooths of May percentile streamflows for the Saco River near Conway, New Hampshire.

temperatures. Increased March and April air temperatures mayhave caused the increased March streamflows and the decreased May streamflows through earlier melting of the winter snowpack.

Other than changes in winter/spring monthly flows, only one other month had more than three significant changes over time in monthly mean flows: five streamflow-gaging stations had significantly increased October mean flows. The streams with significant changes in October streamflows are located across western New England. The increased flows may have been caused by increased October rainfall over time in this area.

In general, significant changes over time in monthly mean flows for a streamflow-gaging station corresponded with significant changes over time for a majority of the percentile flows (minimum, 25th percentile, median, 75th percentile, and maximum flows) at the station. December percentile flows were the only monthly percentile flows with significant changes over time concentrated in either the low or high percentiles. Most of the significant changes in December streamflows were in minimum or 25th percentile flows. December minimum flows increased at 13 stations in northern and southern New England. The increases in these flows may have been caused by increases over time in the frequency and (or) volume of small December rainfall events or by less snow or ice in the stream basins in December.

No significant changes over time were observed in annual mean flows at the 27 streamflow-gaging stations; however, there were significant increases over time in various annual percentile flows for 22 stations. This indicates that flows increased over time at many streams in New England, probably because of increased precipitation, but the increase was not enough to have caused significant changes in annual mean flows.

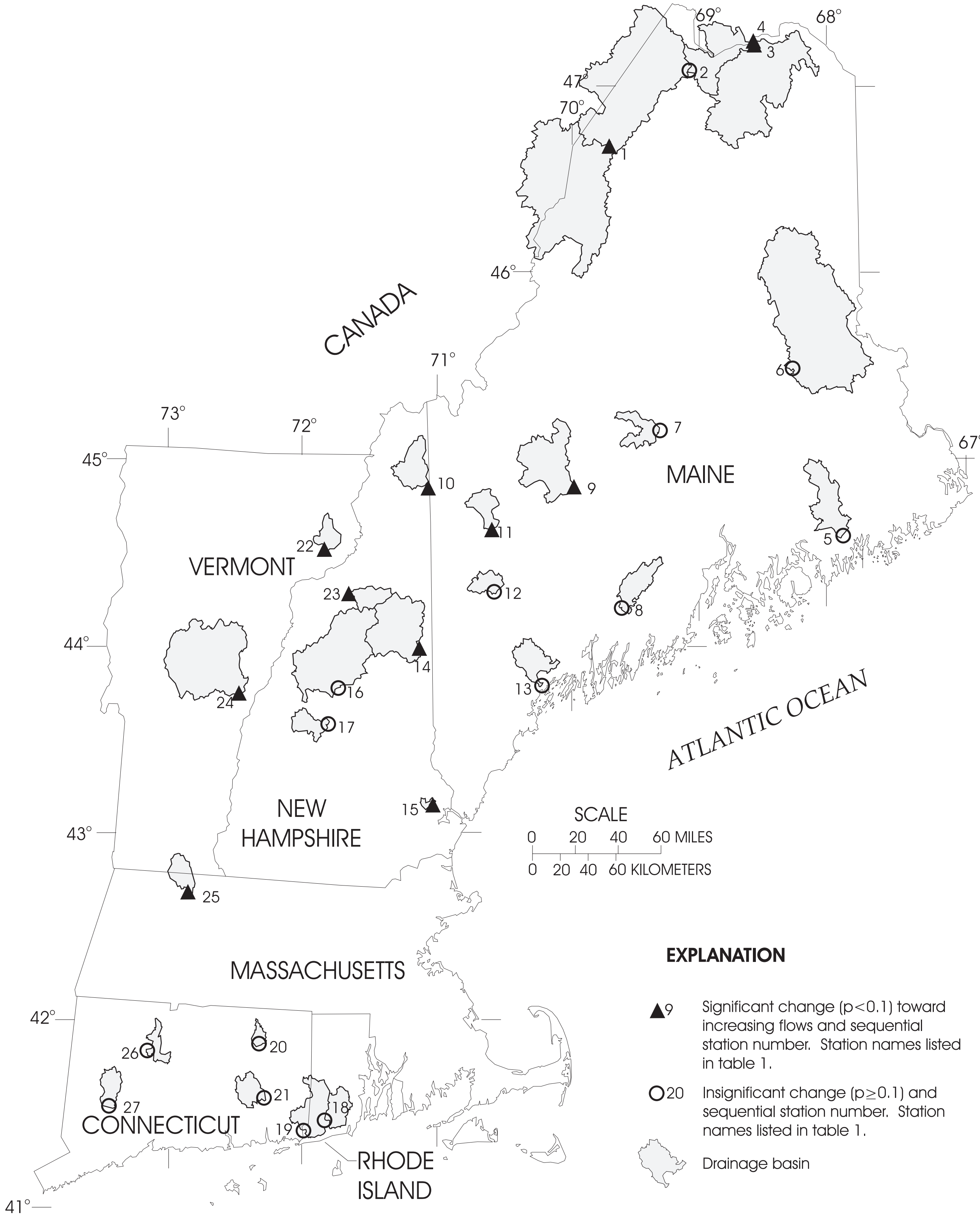

Figure 17. Geographic distribution of significant changes over time in annual 25th percentile streamflows.

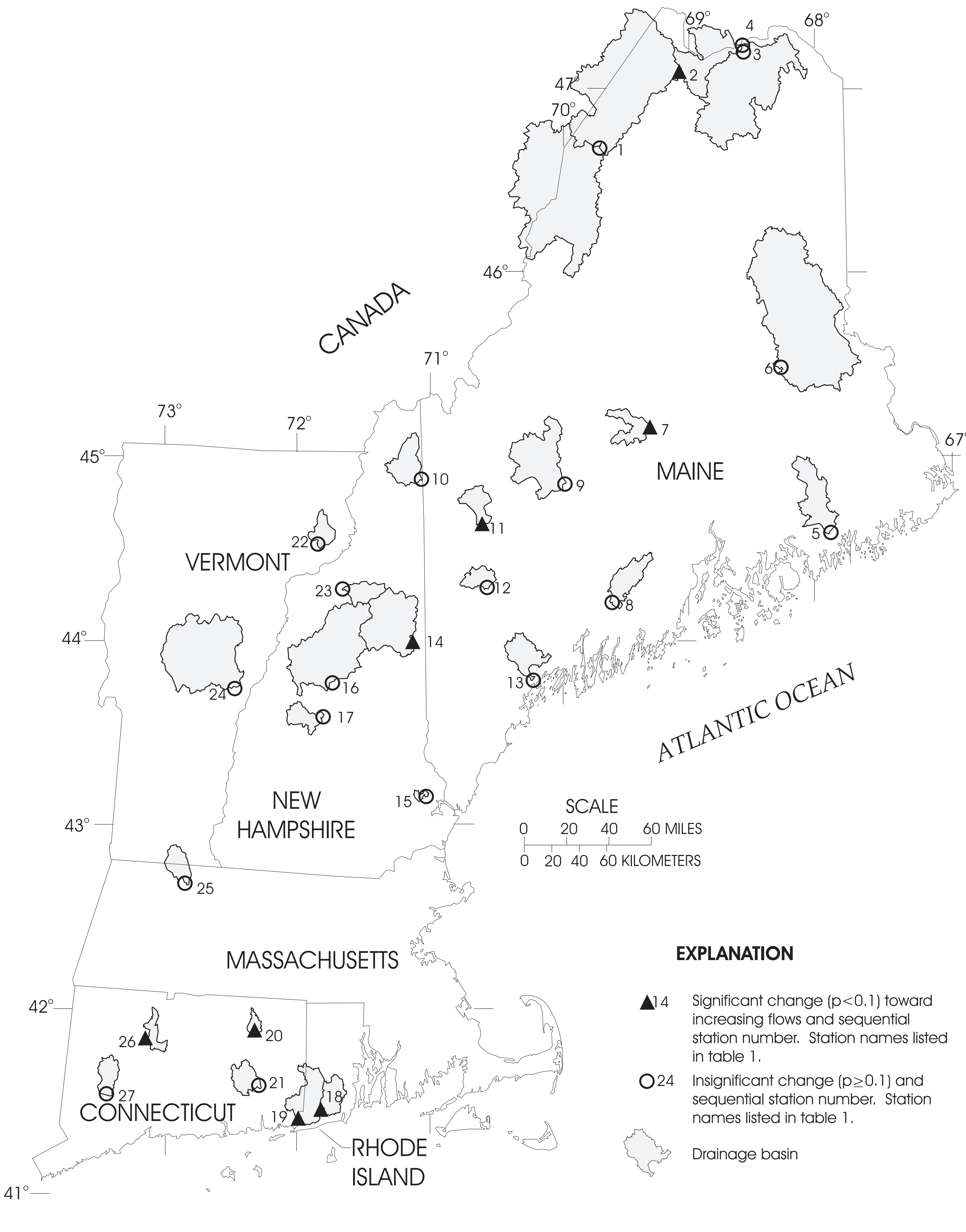

Figure 18. Geographic distribution of significant changes over time in annual maximum streamflows.

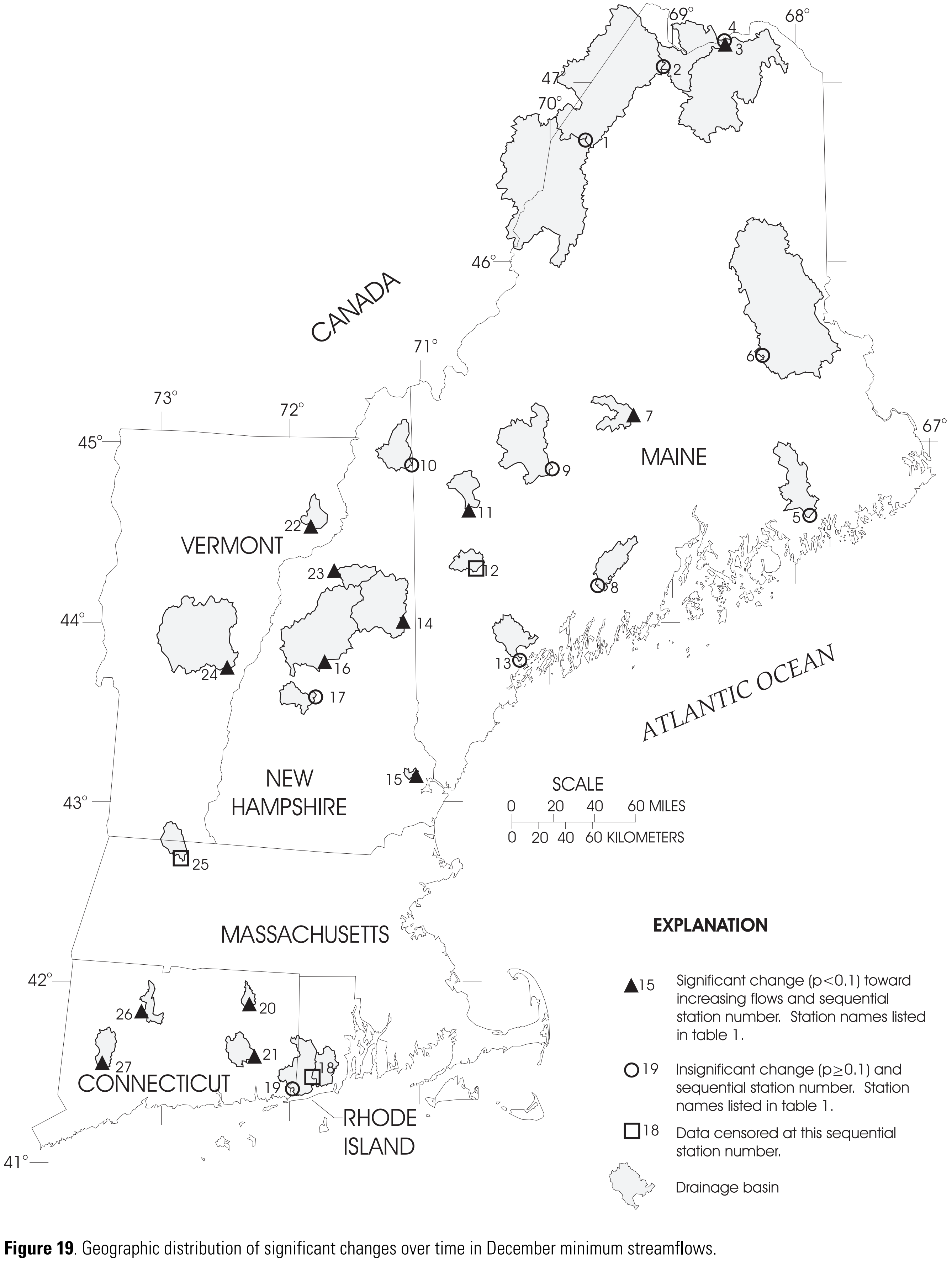

Figure 19. Geographic distribution of significant changes over time in December minimum streamflows.

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Tables 4 -16

Table 4. Attained significance levels (p-values) for Mann-Kendall test results for changes over time in annual percentile streamflows.

[c, censored; bold numbers indicate p < 0.1; +, increasing streamflows over time; -, decreasing streamflows over time; USGS, U.S. Geological Survey]

Sequential number	USGS station number	Stream and state	Minimum		25th percentile		Median		75th percentile		Maximum	
1	01010000	St. John, Maine	0.34	-	**0.048**	+	0.14	+	0.19	+	0.10	+
2	01010500	St. John, Maine	0.99	+	0.19	+	0.40	+	0.23	+	**0.098**	+
3	01013500	Fish, Maine	**0.076**	+	**0.016**	+	**0.043**	+	0.55	+	0.39	+
4	01014000	St. John, Maine	0.98	-	**0.023**	+	0.40	+	0.78	+	0.39	+
5	01022500	Narraguagus, Maine	c		0.58	+	0.86	-	0.77	-	0.19	-
6	01030500	Mattawamkeag, Maine	0.14	-	0.42	+	0.12	+	**0.093**	+	0.92	-
7	01031500	Piscataquis, Maine	c		0.26	+	0.37	+	0.50	+	**0.083**	+
8	01038000	Sheepscot, Maine	0.87	-	0.47	+	0.66	+	0.42	+	0.31	+
9	01047000	Carrabassett, Maine	c		**0.057**	+	**0.028**	+	**0.087**	+	0.19	+
10	01052500	Diamond, New Hampshire	**0.044**	+	**0.0071**	+	0.17	+	0.22	+	0.26	+
11	01055000	Swift, Maine	0.74	-	**0.0057**	+	**0.021**	+	0.30	+	**0.014**	+
12	01057000	Little Androscoggin, Maine	c		0.56	+	0.64	+	0.96	-	0.76	-
13	01060000	Royal, Maine	c		0.97	+	0.78	-	0.64	-	0.26	+
14	01064500	Saco, New Hampshire	**0.053**	+	**0.040**	+	0.14	+	0.31	+	**0.049**	+
15	01073000	Oyster, New Hampshire	0.29	-	**0.078**	+	0.34	+	0.97	+	0.18	+
16	01076500	Pemigewasset, New Hampshire	0.31	+	0.10	+	**0.033**	+	0.75	+	0.33	+
17	01078000	Smith, New Hampshire	**0.076**	+	0.10	+	**0.079**	+	0.43	+	0.75	-
18	01117500	Pawcatuck, Rhode Island	c		0.6	+	0.49	+	0.53	+	**0.0067**	+
19	01118500	Pawcatuck, Rhode Island	c		0.76	+	0.60	+	0.51	+	**0.055**	+
20	01121000	Mount Hope, Connecticut	0.35	+	0.28	+	0.13	+	0.53	+	**0.023**	+
21	01127500	Yantic, Connecticut	c		0.21	-	0.44	+	0.68	+	0.27	+
22	01134500	Moose, Vermont	0.31	+	**0.0005**	+	**0.0003**	+	**0.074**	+	0.50	+
23	01137500	Ammonoosuc, New Hampshire	0.22	+	**0.016**	+	0.24	+	0.89	+	0.26	+
24	01144000	White, Vermont	**0.0092**	+	**0.015**	+	**0.059**	+	0.60	+	0.77	-
25	01169000	North, Massachusetts	c		**0.086**	+	**0.016**	+	0.31	+	0.16	+
26	01188000	Burlington, Connecticut	**0.047**	-	0.59	+	0.22	+	0.96	+	**0.090**	+
27	01204000	Pomperaug, Connecticut	0.15	+	0.28	+	**0.061**	+	0.30	+	0.18	+

Table 5. Attained significance levels (p-values) for Mann-Kendall test results for changes over time in January percentile streamflows.

[c, censored; bold numbers indicate p < 0.1; +, increasing streamflows over time; -, decreasing streamflows over time; USGS, U.S. Geological Survey]

Sequential number	USGS station number	Stream and state	Minimum		25th percentile		Median		75th percentile		Maximum	
1	01010000	St. John, Maine	0.89	-	0.73	+	0.81	+	0.16	+	0.22	+
2	01010500	St. John, Maine	0.94	-	0.91	+	0.78	+	0.14	+	0.17	+
3	01013500	Fish, Maine	**0.063**	+	**0.052**	+	**0.065**	+	**0.018**	+	**0.0085**	+
4	01014000	St. John, Maine	0.32	+	0.40	+	0.66	+	0.18	+	0.11	+
5	01022500	Narraguagus, Maine	0.15	-	0.21	-	0.23	-	0.19	-	0.23	-
6	01030500	Mattawamkeag, Maine	0.34	-	0.59	-	0.39	-	0.66	+	0.36	+
7	01031500	Piscataquis, Maine	c		0.91	-	0.67	-	0.91	+	0.70	+
8	01038000	Sheepscot, Maine	0.80	-	0.74	+	0.66	-	0.75	-	0.94	-
9	01047000	Carrabassett, Maine	0.99	-	0.60	-	0.79	+	0.57	+	0.61	+
10	01052500	Diamond, New Hampshire	**0.019**	+	**0.036**	+	0.21	+	0.61	+	0.38	+
11	01055000	Swift, Maine	0.11	+	0.19	+	0.51	+	0.82	+	0.62	+
12	01057000	Little Androscoggin, Maine	c		c		0.35	-	0.50	-	0.46	-
13	01060000	Royal, Maine	0.61	-	0.55	-	0.15	-	0.31	-	0.48	-
14	01064500	Saco, New Hampshire	0.84	-	0.99	+	0.96	+	0.47	+	0.83	+
15	01073000	Oyster, New Hampshire	0.32	+	0.83	+	0.98	-	0.82	-	**0.095**	-
16	01076500	Pemigewasset, New Hampshire	0.29	+	0.73	+	0.60	+	0.97	+	0.60	-
17	01078000	Smith, New Hampshire	0.63	+	0.67	-	0.28	-	0.48	-	0.74	-
18	01117500	Pawcatuck, Rhode Island	0.68	+	0.79	+	0.86	+	0.73	+	0.44	+
19	01118500	Pawcatuck, Rhode Island	0.67	+	0.73	+	0.78	+	0.50	+	0.38	+
20	01121000	Mount Hope, Connecticut	0.34	+	0.17	+	0.31	+	0.39	+	0.16	+
21	01127500	Yantic, Connecticut	**0.033**	+	0.62	+	0.99	+	0.46	+	0.64	+
22	01134500	Moose, Vermont	0.10	+	0.11	+	0.28	+	0.15	+	0.16	+
23	01137500	Ammonoosuc, New Hampshire	0.60	+	0.17	+	0.28	+	**0.096**	+	0.13	+
24	01144000	White, Vermont	0.63	+	0.76	+	0.83	+	0.38	+	0.83	+
25	01169000	North, Massachusetts	0.12	+	0.16	+	0.25	+	0.43	+	0.74	+
26	01188000	Burlington, Connecticut	0.70	+	0.90	+	0.90	+	0.51	+	0.98	+
27	01204000	Pomperaug, Connecticut	0.70	+	0.67	+	0.82	+	0.90	+	0.59	-

Table 6. Attained significance levels (p-values) for Mann-Kendall test results for changes over time in February percentile streamflows.

[c, censored; bold numbers indicate $p < 0.1$; +, increasing streamflows over time; -, decreasing streamflows over time; USGS, U.S. Geological Survey]

Sequential number	USGS station number	Stream and state	Minimum		25th percentile		Median		75th percentile		Maximum	
1	01010000	St. John, Maine	0.67	+	0.65	+	0.39	+	0.33	+	0.22	+
2	01010500	St. John, Maine	0.32	+	0.27	+	0.25	+	0.30	+	0.42	+
3	01013500	Fish, Maine	**0.0002**	+	**0.0004**	+	**0.0023**	+	**0.0015**	+	**0.0012**	+
4	01014000	St. John, Maine	**0.025**	+	**0.020**	+	**0.027**	+	**0.012**	+	**0.011**	+
5	01022500	Narraguagus, Maine	0.68	-	0.79	-	0.87	+	0.76	+	0.96	+
6	01030500	Mattawamkeag, Maine	0.73	+	0.63	+	0.41	+	0.23	+	**0.050**	+
7	01031500	Piscataquis, Maine	c		**0.0057**	+	**0.0082**	+	**0.040**	+	0.10	+
8	01038000	Sheepscot, Maine	0.73	+	0.58	+	0.54	+	0.37	+	0.19	+
9	01047000	Carrabassett, Maine	**0.040**	+	**0.026**	+	**0.010**	+	**0.0089**	+	**0.0041**	+
10	01052500	Diamond, New Hampshire	**0.013**	+	**0.031**	+	**0.039**	+	0.11	+	**0.081**	+
11	01055000	Swift, Maine	**0.028**	+	**0.040**	+	**0.067**	+	**0.073**	+	**0.028**	+
12	01057000	Little Androscoggin, Maine	c		c		c		c		0.18	+
13	01060000	Royal, Maine	0.35	-	0.26	-	0.50	-	0.98	+	0.85	-
14	01064500	Saco, New Hampshire	0.20	+	0.39	+	0.16	+	0.28	+	0.12	+
15	01073000	Oyster, New Hampshire	0.77	+	0.70	+	0.84	+	0.66	+	0.81	-
16	01076500	Pemigewasset, New Hampshire	0.14	+	**0.046**	+	**0.029**	+	**0.074**	+	**0.050**	+
17	01078000	Smith, New Hampshire	**0.025**	+	**0.024**	+	0.10	+	**0.096**	+	**0.072**	+
18	01117500	Pawcatuck, Rhode Island	0.67	+	0.98	+	0.81	+	0.51	+	0.65	+
19	01118500	Pawcatuck, Rhode Island	0.59	+	0.67	+	0.78	+	0.66	+	0.87	+
20	01121000	Mount Hope, Connecticut	0.27	+	0.33	+	0.53	+	0.80	+	0.86	-
21	01127500	Yantic, Connecticut	**0.071**	+	0.58	+	0.57	+	0.63	+	0.26	+
22	01134500	Moose, Vermont	0.19	+	0.17	+	0.14	+	0.37	+	0.20	+
23	01137500	Ammonoosuc, New Hampshire	**0.076**	+	**0.076**	+	**0.068**	+	0.22	+	0.21	+
24	01144000	White, Vermont	**0.027**	+	**0.017**	+	**0.038**	+	**0.047**	+	**0.043**	+
25	01169000	North, Massachusetts	**0.085**	+	0.24	+	0.17	+	0.37	+	0.53	+
26	01188000	Burlington, Connecticut	0.45	+	0.51	+	0.62	+	0.58	+	0.16	+
27	01204000	Pomperaug, Connecticut	0.15	+	0.15	+	0.19	+	0.46	+	0.44	-

Table 7. Attained significance levels (p-values) for Mann-Kendall test results for changes over time in March percentile streamflows.

[c, censored; bold numbers indicate p < 0.1; +, increasing streamflows over time; -, decreasing streamflows over time; USGS, U.S. Geological Survey]

Sequential number	USGS station number	Stream and state	Minimum		25th percentile		Median		75th percentile		Maximum	
1	01010000	St. John, Maine	**0.074**	+	**0.042**	+	**0.028**	+	**0.014**	+	**0.0004**	+
2	01010500	St. John, Maine	**0.058**	+	**0.040**	+	**0.014**	+	**0.036**	+	**0.0061**	+
3	01013500	Fish, Maine	**0.0018**	+	**0.0019**	+	**0.0017**	+	**0.0010**	+	**0.0013**	+
4	01014000	St. John, Maine	**0.012**	+	**0.0012**	+	**0.0009**	+	**0.0008**	+	**0.0002**	+
5	01022500	Narraguagus, Maine	0.64	+	0.56	+	0.10	+	0.17	+	**0.013**	+
6	01030500	Mattawamkeag, Maine	**0.048**	+	**0.012**	+	**0.043**	+	**0.037**	+	**0.0024**	+
7	01031500	Piscataquis, Maine	c		**0.012**	+	0.26	+	0.14	+	**0.016**	+
8	01038000	Sheepscot, Maine	0.28	+	0.53	+	0.30	+	**0.079**	+	**0.0050**	+
9	01047000	Carrabassett, Maine	**0.0007**	+	**0.0024**	+	**0.048**	+	**0.075**	+	**0.0069**	+
10	01052500	Diamond, New Hampshire	**0.016**	+	**0.046**	+	**0.038**	+	0.27	+	**0.082**	+
11	01055000	Swift, Maine	**0.0014**	+	**0.0022**	+	**0.0113**	+	**0.033**	+	**0.0023**	+
12	01057000	Little Androscoggin, Maine	c		0.15	+	0.38	+	0.38	+	0.11	+
13	01060000	Royal, Maine	0.99	+	0.82	+	0.82	+	0.48	+	0.16	+
14	01064500	Saco, New Hampshire	**0.031**	+	**0.048**	+	**0.063**	+	0.41	+	**0.083**	+
15	01073000	Oyster, New Hampshire	0.77	+	0.82	-	0.28	-	0.51	-	0.65	+
16	01076500	Pemigewasset, New Hampshire	**0.012**	+	0.26	+	0.81	+	0.47	-	0.73	-
17	01078000	Smith, New Hampshire	**0.029**	+	0.27	+	0.84	-	0.82	-	0.59	+
18	01117500	Pawcatuck, Rhode Island	0.45	-	0.33	-	0.56	-	0.78	-	0.87	+
19	01118500	Pawcatuck, Rhode Island	0.84	-	0.47	-	0.43	-	0.59	-	0.84	+
20	01121000	Mount Hope, Connecticut	0.96	+	0.32	-	0.27	-	0.18	-	0.46	+
21	01127500	Yantic, Connecticut	0.95	+	0.13	-	0.13	-	0.40	-	0.80	-
22	01134500	Moose, Vermont	**0.026**	+	**0.038**	+	**0.018**	+	0.18	+	**0.034**	+
23	01137500	Ammonoosuc, New Hampshire	**0.038**	+	**0.025**	+	**0.070**	+	0.20	+	**0.042**	+
24	01144000	White, Vermont	**0.023**	+	0.11	+	0.71	+	0.78	-	0.99	-
25	01169000	North, Massachusetts	**0.048**	+	**0.047**	+	0.48	+	0.44	+	0.29	+
26	01188000	Burlington, Connecticut	0.42	+	0.85	-	0.22	-	0.28	-	0.11	+
27	01204000	Pomperaug, Connecticut	0.19	+	0.96	+	0.55	-	0.55	-	0.80	+

Table 8. Attained significance levels (p-values) for Mann-Kendall test results for changes over time in April percentile streamflows.

[c, censored; bold numbers indicate p < 0.1; +, increasing streamflows over time; -, decreasing streamflows over time; USGS, U.S. Geological Survey]

Sequential number	USGS station number	Stream and state	Minimum		25th percentile		Median		75th percentile		Maximum	
1	01010000	St. John, Maine	**0.0005**	+	**0.0037**	+	**0.018**	+	**0.027**	+	**0.029**	+
2	01010500	St. John, Maine	**0.0089**	+	0.10	+	**0.041**	+	**0.012**	+	**0.0099**	+
3	01013500	Fish, Maine	**0.0027**	+	**0.011**	+	**0.025**	+	**0.0049**	+	**0.0028**	+
4	01014000	St. John, Maine	**0.0008**	+	**0.0048**	+	**0.035**	+	**0.021**	+	**0.012**	+
5	01022500	Narraguagus, Maine	0.31	-	**0.075**	-	0.40	-	0.94	+	0.31	-
6	01030500	Mattawamkeag, Maine	**0.010**	+	**0.046**	+	0.15	+	0.17	+	0.65	+
7	01031500	Piscataquis, Maine	0.67	+	0.91	-	0.37	+	0.39	+	0.44	+
8	01038000	Sheepscot, Maine	0.32	-	0.32	-	0.43	-	0.80	-	0.72	+
9	01047000	Carrabassett, Maine	0.23	+	0.85	-	0.74	+	0.76	+	0.30	+
10	01052500	Diamond, New Hampshire	**0.097**	+	0.22	+	0.90	+	0.55	+	0.17	+
11	01055000	Swift, Maine	**0.048**	+	0.87	+	0.93	-	0.45	-	**0.089**	+
12	01057000	Little Androscoggin, Maine	0.19	-	**0.0060**	-	**0.026**	-	0.16	-	0.91	-
13	01060000	Royal, Maine	0.16	-	**0.038**	-	**0.033**	-	**0.039**	-	0.38	-
14	01064500	Saco, New Hampshire	0.67	+	0.76	-	0.80	-	0.85	-	0.14	+
15	01073000	Oyster, New Hampshire	0.15	-	0.30	-	0.35	-	0.32	-	0.56	+
16	01076500	Pemigewasset, New Hampshire	0.48	-	0.20	-	0.92	-	0.43	-	0.55	+
17	01078000	Smith, New Hampshire	0.36	-	0.15	-	0.12	-	0.66	-	0.33	+
18	01117500	Pawcatuck, Rhode Island	0.46	+	0.45	+	0.39	+	0.39	+	**0.091**	+
19	01118500	Pawcatuck, Rhode Island	0.42	+	0.51	+	0.38	+	0.34	+	0.19	+
20	01121000	Mount Hope, Connecticut	0.61	+	0.54	+	0.83	+	0.94	-	0.83	-
21	01127500	Yantic, Connecticut	1.0	0	0.56	-	0.41	-	0.32	-	0.98	-
22	01134500	Moose, Vermont	0.72	+	0.10	-	**0.039**	-	0.39	+	0.70	-
23	01137500	Ammonoosuc, New Hampshire	0.21	+	0.87	-	0.70	-	0.61	-	0.17	+
24	01144000	White, Vermont	0.20	-	0.12	-	0.30	-	0.62	-	0.22	+
25	01169000	North, Massachusetts	0.65	-	0.21	-	0.27	-	0.34	-	0.85	-
26	01188000	Burlington, Connecticut	0.50	-	0.39	-	0.78	-	0.66	-	0.88	-
27	01204000	Pomperaug, Connecticut	0.57	+	0.75	+	0.98	-	0.75	-	0.54	-

Table 9. Attained significance levels (p-values) for Mann-Kendall test results for changes over time in May percentile streamflows.

[c, censored; bold numbers indicate p < 0.1; +, increasing streamflows over time; -, decreasing streamflows over time; USGS, U.S. Geological Survey]

Sequential number	USGS station number	Stream and state	Minimum		25th percentile		Median		75th percentile		Maximum	
1	01010000	St. John, Maine	**0.072**	-	**0.023**	-	**0.043**	-	**0.072**	-	0.35	-
2	01010500	St. John, Maine	**0.049**	-	**0.020**	-	**0.024**	-	**0.080**	-	0.28	-
3	01013500	Fish, Maine	**0.064**	-	**0.067**	-	0.15	-	0.28	-	0.78	-
4	01014000	St. John, Maine	**0.043**	-	**0.032**	-	**0.027**	-	**0.020**	-	**0.052**	-
5	01022500	Narraguagus, Maine	0.59	-	0.80	-	0.92	+	0.67	-	0.42	-
6	01030500	Mattawamkeag, Maine	**0.086**	-	0.19	-	**0.081**	-	**0.057**	-	**0.072**	-
7	01031500	Piscataquis, Maine	0.21	-	**0.088**	-	**0.036**	-	**0.019**	-	**0.0052**	-
8	01038000	Sheepscot, Maine	0.66	-	0.80	-	0.88	-	0.51	-	0.90	-
9	01047000	Carrabassett, Maine	**0.044**	-	**0.031**	-	**0.043**	-	**0.038**	-	**0.079**	-
10	01052500	Diamond, New Hampshire	0.12	-	**0.047**	-	**0.068**	-	**0.048**	-	0.19	-
11	01055000	Swift, Maine	0.14	-	**0.070**	-	**0.090**	-	**0.044**	-	0.11	-
12	01057000	Little Androscoggin, Maine	0.50	-	0.55	-	0.34	-	0.25	-	0.25	-
13	01060000	Royal, Maine	0.72	-	0.92	-	0.74	-	0.93	-	0.61	+
14	01064500	Saco, New Hampshire	0.28	-	**0.096**	-	**0.030**	-	**0.056**	-	0.12	-
15	01073000	Oyster, New Hampshire	0.57	-	0.65	-	0.81	-	0.86	+	0.56	+
16	01076500	Pemigewasset, New Hampshire	0.96	-	0.30	-	0.34	-	0.57	-	0.46	-
17	01078000	Smith, New Hampshire	0.50	-	0.50	-	0.61	-	0.91	-	0.52	+
18	01117500	Pawcatuck, Rhode Island	0.54	-	0.84	-	0.89	+	0.43	+	0.11	+
19	01118500	Pawcatuck, Rhode Island	0.65	-	0.72	-	0.96	+	0.88	+	0.20	+
20	01121000	Mount Hope, Connecticut	0.25	-	0.22	-	0.77	-	0.49	-	0.80	-
21	01127500	Yantic, Connecticut	0.89	+	0.40	-	0.92	-	0.76	+	0.33	+
22	01134500	Moose, Vermont	0.45	-	0.10	-	**0.074**	-	0.15	-	0.80	-
23	01137500	Ammonoosuc, New Hampshire	0.14	-	**0.050**	-	**0.0092**	-	**0.042**	-	0.13	-
24	01144000	White, Vermont	0.99	+	0.61	-	0.61	-	0.61	-	0.94	+
25	01169000	North, Massachusetts	c		0.53	-	0.64	-	0.57	-	1.0	+
26	01188000	Burlington, Connecticut	0.28	-	0.57	-	0.79	-	0.68	+	0.16	+
27	01204000	Pomperaug, Connecticut	0.84	+	0.62	+	0.59	+	0.41	+	0.41	+

Table 10. Attained significance levels (p-values) for Mann-Kendall test results for changes over time in June percentile streamflows.

[c, censored; bold numbers indicate $p < 0.1$; +, increasing streamflows over time; -, decreasing streamflows over time; USGS, U.S. Geological Survey]

Sequential number	USGS station number	Stream and state	Minimum		25th percentile		Median		75th percentile		Maximum	
1	01010000	St. John, Maine	0.94	-	0.84	-	0.53	-	0.94	-	0.47	+
2	01010500	St. John, Maine	0.39	-	0.27	-	0.22	-	0.29	-	0.89	+
3	01013500	Fish, Maine	**0.048**	-	**0.014**	-	**0.062**	-	0.25	-	0.33	-
4	01014000	St. John, Maine	**0.018**	-	**0.010**	-	**0.0044**	-	**0.021**	-	0.10	-
5	01022500	Narraguagus, Maine	0.94	-	0.53	+	0.52	+	0.64	+	0.50	+
6	01030500	Mattawamkeag, Maine	**0.0078**	-	**0.069**	-	**0.065**	-	0.27	-	0.34	-
7	01031500	Piscataquis, Maine	0.36	+	0.98	+	1.0	0	0.52	-	0.95	+
8	01038000	Sheepscot, Maine	0.81	-	0.83	+	0.75	+	0.47	+	0.63	+
9	01047000	Carrabassett, Maine	0.30	+	0.38	+	0.51	+	0.93	-	0.94	+
10	01052500	Diamond, New Hampshire	0.48	+	0.90	+	0.82	+	1.0	0	0.45	-
11	01055000	Swift, Maine	0.40	+	0.34	+	0.16	+	0.45	+	0.28	+
12	01057000	Little Androscoggin, Maine	0.67	-	0.91	-	0.60	+	0.59	+	0.61	+
13	01060000	Royal, Maine	0.32	-	0.73	-	0.67	+	0.59	+	0.38	+
14	01064500	Saco, New Hampshire	0.68	-	0.98	-	0.68	+	0.99	-	0.99	+
15	01073000	Oyster, New Hampshire	0.93	-	0.87	+	0.97	+	0.67	-	0.62	-
16	01076500	Pemigewasset, New Hampshire	0.90	-	0.73	+	0.59	+	0.81	+	0.75	-
17	01078000	Smith, New Hampshire	0.65	+	0.34	+	0.19	+	0.22	+	0.13	+
18	01117500	Pawcatuck, Rhode Island	0.88	-	0.88	-	0.91	+	0.93	+	0.82	+
19	01118500	Pawcatuck, Rhode Island	0.39	+	0.66	-	0.72	-	0.99	-	0.95	-
20	01121000	Mount Hope, Connecticut	0.73	-	0.40	-	0.73	-	0.94	+	0.97	+
21	01127500	Yantic, Connecticut	**0.059**	+	**0.083**	-	**0.065**	-	0.21	-	0.41	-
22	01134500	Moose, Vermont	0.88	-	0.57	-	0.99	-	0.63	-	0.60	-
23	01137500	Ammonoosuc, New Hampshire	0.59	-	0.35	-	0.81	-	0.43	-	**0.030**	-
24	01144000	White, Vermont	0.71	+	0.93	+	0.63	+	0.61	+	0.74	+
25	01169000	North, Massachusetts	c		0.46	+	0.78	+	0.97	-	0.44	+
26	01188000	Burlington, Connecticut	0.91	+	0.68	-	0.77	-	0.85	+	0.56	+
27	01204000	Pomperaug, Connecticut	0.87	-	0.86	+	0.59	+	0.58	+	0.38	+

Table 11. Attained significance levels (p-values) for Mann-Kendall test results for changes over time in July percentile streamflows.

[c, censored; bold numbers indicate $p < 0.1$; +, increasing streamflows over time; -, decreasing streamflows over time; USGS, U.S. Geological Survey]

Sequential number	USGS station number	Stream and state	Minimum		25th percentile		Median		75th percentile		Maximum	
1	01010000	St. John, Maine	0.51	+	0.58	+	0.25	+	0.20	+	0.39	+
2	01010500	St. John, Maine	0.88	-	0.74	-	0.61	+	0.41	+	0.44	+
3	01013500	Fish, Maine	0.83	-	0.64	-	0.64	-	0.38	-	0.19	-
4	01014000	St. John, Maine	0.36	-	0.23	-	0.16	-	0.18	-	0.41	-
5	01022500	Narraguagus, Maine	0.52	+	0.28	+	0.28	+	0.22	+	0.34	+
6	01030500	Mattawamkeag, Maine	0.20	-	0.40	-	0.54	-	0.65	-	0.66	-
7	01031500	Piscataquis, Maine	0.95	+	0.35	-	0.47	-	0.76	-	0.92	-
8	01038000	Sheepscot, Maine	0.45	-	0.26	-	0.43	-	0.78	-	0.91	+
9	01047000	Carrabassett, Maine	0.56	-	0.70	-	0.91	+	0.88	-	0.88	-
10	01052500	Diamond, New Hampshire	0.29	+	0.45	+	0.61	+	0.63	+	0.30	+
11	01055000	Swift, Maine	0.34	+	0.23	+	0.14	+	0.21	+	0.32	+
12	01057000	Little Androscoggin, Maine	c		c		0.55	-	0.91	+	0.74	-
13	01060000	Royal, Maine	c		0.26	-	0.54	-	0.84	+	0.75	+
14	01064500	Saco, New Hampshire	0.40	+	0.79	+	0.69	+	0.97	+	0.81	-
15	01073000	Oyster, New Hampshire	0.46	-	0.99	-	0.92	-	0.68	+	0.71	+
16	01076500	Pemigewasset, New Hampshire	0.73	-	0.83	-	0.77	-	0.99	-	0.97	+
17	01078000	Smith, New Hampshire	0.90	-	0.52	-	0.52	-	0.95	+	0.63	+
18	01117500	Pawcatuck, Rhode Island	c		0.64	-	0.66	-	0.96	-	0.58	+
19	01118500	Pawcatuck, Rhode Island	c		0.64	-	0.49	-	0.64	-	0.72	-
20	01121000	Mount Hope, Connecticut	0.82	+	0.92	-	0.88	+	0.73	+	0.82	+
21	01127500	Yantic, Connecticut	c		c		**0.0086**	-	**0.016**	-	0.69	-
22	01134500	Moose, Vermont	0.79	+	0.58	+	0.28	+	0.28	+	**0.087**	+
23	01137500	Ammonoosuc, New Hampshire	0.54	+	0.59	+	0.98	-	0.63	-	0.97	+
24	01144000	White, Vermont	0.90	+	0.59	-	0.55	-	0.49	-	0.55	-
25	01169000	North, Massachusetts	c		c		0.53	+	0.42	+	0.18	+
26	01188000	Burlington, Connecticut	0.47	-	0.64	-	0.85	+	0.38	+	0.47	+
27	01204000	Pomperaug, Connecticut	0.79	-	0.71	-	0.82	-	0.53	+	0.61	+

Table 12. Attained significance levels (p-values) for Mann-Kendall test results for changes over time in August percentile streamflows.

[c, censored; bold numbers indicate p < 0.1; +, increasing streamflows over time; -, decreasing streamflows over time; USGS, U.S. Geological Survey]

Sequential number	USGS station number	Stream and state	Minimum		25th percentile		Median		75th percentile		Maximum	
1	01010000	St. John, Maine	0.23	-	0.43	-	0.20	-	0.27	-	0.37	-
2	01010500	St. John, Maine	0.34	-	0.44	-	0.15	-	0.15	-	0.14	-
3	01013500	Fish, Maine	0.75	-	0.75	-	0.95	-	0.85	+	0.58	+
4	01014000	St. John, Maine	0.41	-	0.30	-	0.35	-	0.17	-	0.36	-
5	01022500	Narraguagus, Maine	0.79	-	0.97	+	0.94	+	0.94	+	0.66	+
6	01030500	Mattawamkeag, Maine	0.17	-	0.65	-	0.85	+	0.36	+	0.11	+
7	01031500	Piscataquis, Maine	c		c		c		**0.052**	-	0.24	-
8	01038000	Sheepscot, Maine	1.0	+	0.58	-	0.34	-	0.46	-	0.62	-
9	01047000	Carrabassett, Maine	c		c		c		0.89	-	0.54	-
10	01052500	Diamond, New Hampshire	0.14	+	0.22	+	0.41	+	0.31	+	0.40	+
11	01055000	Swift, Maine	0.77	+	0.35	+	0.23	+	0.29	+	0.90	-
12	01057000	Little Androscoggin, Maine	c		c		c		0.54	-	0.85	+
13	01060000	Royal, Maine	0.14	-	0.23	-	0.28	-	0.25	-	0.48	-
14	01064500	Saco, New Hampshire	0.56	+	0.43	+	0.40	+	0.42	+	0.97	+
15	01073000	Oyster, New Hampshire	0.28	-	0.76	-	1.0	-	0.74	+	0.33	+
16	01076500	Pemigewasset, New Hampshire	0.39	-	0.38	-	0.77	-	0.83	-	0.38	-
17	01078000	Smith, New Hampshire	0.99	-	0.49	-	0.84	-	0.88	-	0.65	+
18	01117500	Pawcatuck, Rhode Island	c		c		c		0.84	-	0.84	+
19	01118500	Pawcatuck, Rhode Island	c		c		c		0.59	-	0.87	-
20	01121000	Mount Hope, Connecticut	0.58	+	0.48	+	0.63	+	0.45	+	0.81	+
21	01127500	Yantic, Connecticut	c		c		c		0.19	-	0.75	-
22	01134500	Moose, Vermont	0.16	+	**0.028**	+	**0.040**	+	**0.022**	+	**0.04**	+
23	01137500	Ammonoosuc, New Hampshire	0.32	+	0.46	+	0.63	+	0.67	+	0.89	-
24	01144000	White, Vermont	0.35	+	0.87	+	0.45	+	0.29	+	0.17	+
25	01169000	North, Massachusetts	c		c		c		0.31	+	0.26	+
26	01188000	Burlington, Connecticut	0.44	-	0.61	-	0.97	-	0.81	+	0.75	+
27	01204000	Pomperaug, Connecticut	0.49	+	0.60	+	0.31	+	0.39	+	0.44	+

Table 13. Attained significance levels (p-values) for Mann-Kendall test results for changes over time in September percentile streamflows.

[c, censored; bold numbers indicate $p < 0.1$; +, increasing streamflows over time; -, decreasing streamflows over time; USGS, U.S. Geological Survey]

Sequential number	USGS station number	Stream and state	Minimum		25th percentile		Median		75th percentile		Maximum	
1	01010000	St. John, Maine	0.36	-	0.34	-	0.73	-	0.50	-	0.94	-
2	01010500	St. John, Maine	0.25	-	0.21	-	0.53	-	0.68	-	0.84	+
3	01013500	Fish, Maine	0.65	+	0.75	+	0.63	+	0.61	+	0.64	+
4	01014000	St. John, Maine	0.95	-	0.52	-	0.90	+	0.94	-	0.83	+
5	01022500	Narraguagus, Maine	c		0.45	-	0.54	-	0.97	-	0.99	-
6	01030500	Mattawamkeag, Maine	0.38	-	0.42	-	0.99	+	0.94	-	0.54	+
7	01031500	Piscataquis, Maine	c		c		0.15	-	0.32	-	0.97	+
8	01038000	Sheepscot, Maine	1.0	+	0.92	-	0.76	+	0.62	+	0.27	+
9	01047000	Carrabassett, Maine	c		c		c		0.66	-	0.79	+
10	01052500	Diamond, New Hampshire	0.19	+	0.26	+	0.27	+	0.39	+	0.88	+
11	01055000	Swift, Maine	0.90	+	0.60	+	0.46	+	0.43	+	0.94	+
12	01057000	Little Androscoggin, Maine	c		c		c		c		c	
13	01060000	Royal, Maine	0.16	-	0.11	-	0.37	-	0.99	+	0.81	-
14	01064500	Saco, New Hampshire	0.20	+	0.38	+	0.76	+	0.90	-	0.68	-
15	01073000	Oyster, New Hampshire	0.66	-	0.49	+	0.30	+	0.32	+	0.59	+
16	01076500	Pemigewasset, New Hampshire	0.83	-	0.18	-	0.19	-	0.61	-	0.29	-
17	01078000	Smith, New Hampshire	0.68	+	0.25	-	0.39	-	0.83	-	0.98	-
18	01117500	Pawcatuck, Rhode Island	c		c		c		0.20	+	**0.038**	+
19	01118500	Pawcatuck, Rhode Island	c		c		c		c		0.24	+
20	01121000	Mount Hope, Connecticut	0.39	+	**0.089**	+	**0.095**	+	**0.014**	+	0.43	+
21	01127500	Yantic, Connecticut	c		c		c		0.22	-	0.34	-
22	01134500	Moose, Vermont	0.11	+	**0.058**	+	**0.018**	+	**0.0091**	+	**0.015**	+
23	01137500	Ammonoosuc, New Hampshire	0.90	+	0.71	+	0.57	+	0.72	+	0.53	-
24	01144000	White, Vermont	**0.057**	+	0.40	+	0.33	+	0.30	+	0.44	+
25	01169000	North, Massachusetts	c		c		c		c		0.79	+
26	01188000	Burlington, Connecticut	**0.057**	-	0.17	-	0.80	-	0.77	+	0.86	+
27	01204000	Pomperaug, Connecticut	0.20	+	0.80	+	0.92	+	0.49	+	0.85	+

Table 14. Attained significance levels (p-values) for Mann-Kendall test results for changes over time in October percentile streamflows.

[c, censored; bold numbers indicate p < 0.1; +, increasing streamflows over time; -, decreasing streamflows over time; USGS, U.S. Geological Survey]

Sequential number	USGS station number	Stream and state	Minimum		25th percentile		Median		75th percentile		Maximum	
1	01010000	St. John, Maine	0.30	+	0.32	+	0.46	+	0.28	+	0.41	+
2	01010500	St. John, Maine	0.19	+	0.21	+	0.25	+	0.22	+	0.25	+
3	01013500	Fish, Maine	0.18	+	0.28	+	0.33	+	0.58	+	0.53	+
4	01014000	St. John, Maine	0.32	+	0.69	+	0.75	-	0.45	-	0.71	-
5	01022500	Narraguagus, Maine	0.63	+	0.47	+	0.31	+	0.39	+	0.96	+
6	01030500	Mattawamkeag, Maine	0.47	+	0.61	+	0.46	+	0.57	+	0.64	+
7	01031500	Piscataquis, Maine	c		0.53	+	0.98	+	0.89	-	0.76	-
8	01038000	Sheepscot, Maine	0.37	+	0.27	+	0.17	+	0.13	+	0.49	+
9	01047000	Carrabassett, Maine	c		0.58	+	0.63	+	0.90	+	0.71	-
10	01052500	Diamond, New Hampshire	0.17	+	0.23	+	0.37	+	0.53	+	0.61	+
11	01055000	Swift, Maine	0.18	+	**0.053**	+	**0.084**	+	0.33	+	0.55	+
12	01057000	Little Androscoggin, Maine	c		c		0.51	+	0.71	+	0.40	+
13	01060000	Royal, Maine	0.93	+	0.59	+	0.17	+	0.22	+	0.62	+
14	01064500	Saco, New Hampshire	0.10	+	0.23	+	0.26	+	0.38	+	0.49	+
15	01073000	Oyster, New Hampshire	0.22	+	**0.044**	+	**0.0085**	+	**0.014**	+	**0.030**	+
16	01076500	Pemigewasset, New Hampshire	0.38	+	0.69	+	0.56	+	0.57	+	0.82	+
17	01078000	Smith, New Hampshire	0.21	+	0.27	+	0.13	+	**0.078**	+	0.23	+
18	01117500	Pawcatuck, Rhode Island	c		c		0.21	+	0.18	+	0.65	+
19	01118500	Pawcatuck, Rhode Island	c		c		0.26	+	0.38	+	0.78	-
20	01121000	Mount Hope, Connecticut	**0.056**	+	**0.0058**	+	**0.0008**	+	**0.0010**	+	**0.089**	+
21	01127500	Yantic, Connecticut	c		c		c		0.20	+	0.24	+
22	01134500	Moose, Vermont	**0.0011**	+	**0.0012**	+	**0.0021**	+	**0.0025**	+	**0.048**	+
23	01137500	Ammonoosuc, New Hampshire	0.31	+	0.27	+	0.30	+	0.25	+	0.39	+
24	01144000	White, Vermont	**0.040**	+	**0.045**	+	**0.092**	+	**0.086**	+	0.54	+
25	01169000	North, Massachusetts	c		c		c		c		**0.044**	+
26	01188000	Burlington, Connecticut	0.92	+	0.12	+	0.17	+	**0.062**	+	0.17	+
27	01204000	Pomperaug, Connecticut	**0.059**	+	**0.067**	+	**0.072**	+	**0.073**	+	0.19	+

Table 15. Attained significance levels (p-values) for Mann-Kendall test results for changes over time in November percentile streamflows.

[c, censored; bold numbers indicate p < 0.1; +, increasing streamflows over time; -, decreasing streamflows over time; USGS, U.S. Geological Survey]

Sequential number	USGS station number	Stream and state	Minimum		25th percentile		Median		75th percentile		Maximum	
1	01010000	St. John, Maine	0.13	-	0.89	+	0.50	+	0.64	+	0.35	+
2	01010500	St. John, Maine	0.19	-	0.97	-	0.81	+	0.40	+	0.26	+
3	01013500	Fish, Maine	0.33	+	0.29	+	0.15	+	0.21	+	0.26	+
4	01014000	St. John, Maine	0.79	-	0.58	-	0.67	-	0.76	-	0.99	-
5	01022500	Narraguagus, Maine	0.89	+	0.94	+	0.54	-	0.21	-	**0.013**	-
6	01030500	Mattawamkeag, Maine	0.64	+	0.53	+	0.90	+	0.34	-	0.24	-
7	01031500	Piscataquis, Maine	c		0.53	+	0.43	+	0.18	+	**0.054**	+
8	01038000	Sheepscot, Maine	0.44	+	0.89	+	0.83	-	0.99	+	0.56	-
9	01047000	Carrabassett, Maine	0.62	+	0.36	+	0.33	+	0.20	+	**0.085**	+
10	01052500	Diamond, New Hampshire	0.53	-	0.52	-	0.81	-	0.86	+	0.22	-
11	01055000	Swift, Maine	0.36	+	0.20	+	0.28	+	0.32	+	0.28	+
12	01057000	Little Androscoggin, Maine	c		0.22	+	**0.084**	+	0.22	+	0.23	+
13	01060000	Royal, Maine	0.91	-	0.80	+	0.94	+	0.56	-	**0.068**	-
14	01064500	Saco, New Hampshire	**0.059**	+	**0.026**	+	**0.023**	+	**0.048**	+	**0.034**	+
15	01073000	Oyster, New Hampshire	**0.062**	+	0.10	+	0.18	+	0.39	+	0.66	+
16	01076500	Pemigewasset, New Hampshire	**0.077**	+	**0.0060**	+	**0.0073**	+	**0.012**	+	0.13	+
17	01078000	Smith, New Hampshire	0.24	+	0.12	+	0.11	+	0.18	+	0.27	+
18	01117500	Pawcatuck, Rhode Island	c		0.56	+	0.73	+	0.69	+	0.92	+
19	01118500	Pawcatuck, Rhode Island	c		0.65	+	0.85	+	0.87	+	0.75	-
20	01121000	Mount Hope, Connecticut	0.37	+	0.27	+	0.34	+	0.67	+	0.88	+
21	01127500	Yantic, Connecticut	**0.0002**	+	**0.011**	+	**0.073**	+	**0.084**	+	**0.081**	+
22	01134500	Moose, Vermont	**0.029**	+	**0.068**	+	**0.089**	+	0.32	+	0.96	-
23	01137500	Ammonoosuc, New Hampshire	0.17	+	0.44	+	0.45	+	0.79	+	0.87	+
24	01144000	White, Vermont	**0.081**	+	**0.092**	+	0.11	+	0.10	+	0.78	+
25	01169000	North, Massachusetts	c		c		0.20	+	0.22	+	0.75	+
26	01188000	Burlington, Connecticut	0.34	+	0.26	+	0.30	+	0.41	+	0.24	+
27	01204000	Pomperaug, Connecticut	0.34	+	0.37	+	0.41	+	0.39	+	0.36	+

Table 16. Attained significance levels (p-values) for Mann-Kendall test results for changes over time in December percentile streamflows.

[c, censored; bold numbers indicate p < 0.1; +, increasing streamflows over time; -, decreasing streamflows over time; USGS, U.S. Geological Survey]

Sequential number	USGS station number	Stream and state	Minimum		25th percentile		Median		75th percentile		Maximum	
1	01010000	St. John, Maine	0.26	-	0.49	-	0.84	-	0.79	+	0.73	+
2	01010500	St. John, Maine	0.61	-	0.61	-	0.75	-	0.91	+	0.70	+
3	01013500	Fish, Maine	**0.081**	+	**0.048**	+	**0.040**	+	**0.044**	+	0.11	+
4	01014000	St. John, Maine	0.89	+	0.59	+	0.32	+	0.25	+	0.19	+
5	01022500	Narraguagus, Maine	0.14	-	**0.063**	-	**0.028**	-	**0.038**	-	**0.070**	-
6	01030500	Mattawamkeag, Maine	0.74	-	0.90	+	0.91	-	0.83	-	0.98	-
7	01031500	Piscataquis, Maine	**0.057**	+	0.25	+	0.74	+	0.45	+	0.37	+
8	01038000	Sheepscot, Maine	0.95	-	0.98	+	0.78	-	0.73	-	0.47	-
9	01047000	Carrabassett, Maine	0.11	+	**0.046**	+	0.11	+	0.13	+	0.85	+
10	01052500	Diamond, New Hampshire	0.81	+	0.78	-	0.89	+	0.73	+	0.33	+
11	01055000	Swift, Maine	**0.0088**	+	**0.024**	+	0.16	+	0.47	+	0.97	-
12	01057000	Little Androscoggin, Maine	c		0.52	+	0.73	+	0.80	+	0.57	-
13	01060000	Royal, Maine	0.80	-	0.51	-	0.27	-	**0.075**	-	0.40	-
14	01064500	Saco, New Hampshire	**0.015**	+	**0.0049**	+	**0.016**	+	**0.038**	+	0.51	+
15	01073000	Oyster, New Hampshire	**0.024**	+	0.20	+	0.64	+	0.97	+	0.37	-
16	01076500	Pemigewasset, New Hampshire	**0.028**	+	**0.011**	+	**0.031**	+	0.11	+	0.72	+
17	01078000	Smith, New Hampshire	0.54	+	0.99	-	0.80	-	0.85	-	0.42	-
18	01117500	Pawcatuck, Rhode Island	c		0.60	+	0.73	+	0.95	+	0.56	+
19	01118500	Pawcatuck, Rhode Island	0.71	+	0.50	+	0.68	+	0.88	+	0.60	+
20	01121000	Mount Hope, Connecticut	**0.072**	+	0.15	+	0.28	+	0.59	+	0.56	-
21	01127500	Yantic, Connecticut	**0.0015**	+	**0.082**	+	0.25	+	0.38	+	0.45	+
22	01134500	Moose, Vermont	**0.0072**	+	**0.016**	+	0.10	+	0.58	+	0.90	-
23	01137500	Ammonoosuc, New Hampshire	**0.072**	+	**0.092**	+	0.11	+	0.31	+	0.36	-
24	01144000	White, Vermont	**0.024**	+	**0.016**	+	**0.090**	+	0.12	+	0.80	-
25	01169000	North, Massachusetts	c		**0.068**	+	0.17	+	0.50	+	0.78	-
26	01188000	Burlington, Connecticut	**0.026**	+	0.17	+	0.41	+	0.90	+	0.71	+
27	01204000	Pomperaug, Connecticut	**0.059**	+	**0.098**	+	0.25	+	0.69	+	0.78	-

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