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Trends in Streamflow, River Ice, and Snowpack for Coastal River Basins in Maine During the 20th Century

Changes in water resources over time may affect public and private water supplies and the health of aquatic ecosystems. The U.S. Geological Survey is studying the relation between climate and water-resource variables in Maine and New England to provide resource managers, the scientific community, and the public with better information about the sensitivity of water resources to climate change and variability. The long-term collection and availability of high-quality water-resources data are crucial to these efforts.

Introduction

Air temperatures in New England have risen during the 20th century. The largest seasonal warming rates observed from 1976-2000 were during December, January, and February (Intergovernmental Panel on Climate Change, 2001). The response of streamflow timing and volumes to warmer winters may be significant because a major component of the hydrology of river basins in New England involves snowpack and the timing of snowmelt. Scientists with the U.S. Geological Survey, in cooperation with the Maine Atlantic Salmon Commission, analyzed trends in streamflow, river ice, and snowpack for coastal river basins in Maine to determine if any significant changes have taken place in response to observed changes in climate.

Of particular concern to the Maine Atlantic Salmon Commission are seasonal changes in water temperatures and streamflows that may affect the behavior and survival of Atlantic salmon in Maine. Atlantic salmon in Maine may be particularly sensitive to climatic changes that affect the prevailing patterns of streamflow and water temperatures because Maine's coastal rivers are at the southern extent of the Atlantic salmon's habitat range.

Key Findings

Streamflow data from six coastal streamflow gages in Maine were analyzed for this study (Dudley and Hodgkins, 2002). The coastal gages have an average period of streamflow record of 54 years. Trend test results for combined streamflow data spanning 1906-2000 (93-percent complete) indicate a significant trend in the timing of spring runoff toward earlier dates (fig. 1). The streamflow record also shows that streamflows have increased in winter and early spring and decreased in late spring and early summer; however, in general, no significant trends in annual total streamflow were observed. The most significant trends for increasing streamflows over time were in February, and the most significant trends for decreasing streamflows over time were in May and June. These months have highly significant trends for low, medium, and high streamflows.

River ice can affect the computation of streamflow at a gaging station if it is present in sufficient quantities. Because of this phenomenon, the USGS carefully records days of ice effect in its efforts to gage streamflows. The occurrence of ice can be discontinuous throughout the winter season. In general, results of trend tests indicate: the first day of ice-affected streamflow in the fall is later, the last day of ice-affected flow in the spring is earlier, and there are fewer total days of ice-affected flow (fig. 2). The trends in later fall ice formation are significant at two of the five rivers with available ice data, whereas trends for earlier spring ice melting and breakup are significant at four of five of

Ice conditions on the Sheepscot River in coastal Maine, late January 2001.

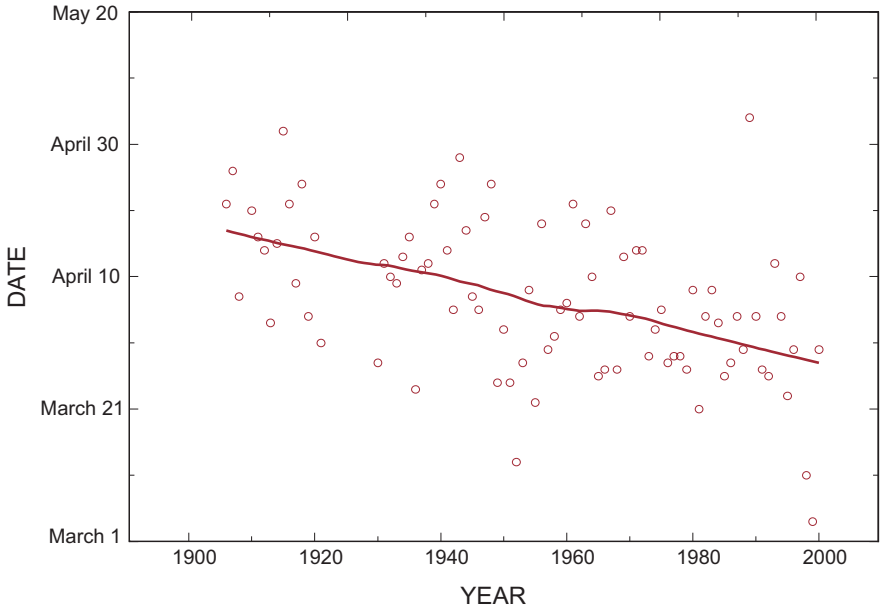

Figure 1. Trend toward earlier spring center-volume date—the date by which half of the total spring runoff has occurred—for combined streamflow data in coastal Maine.

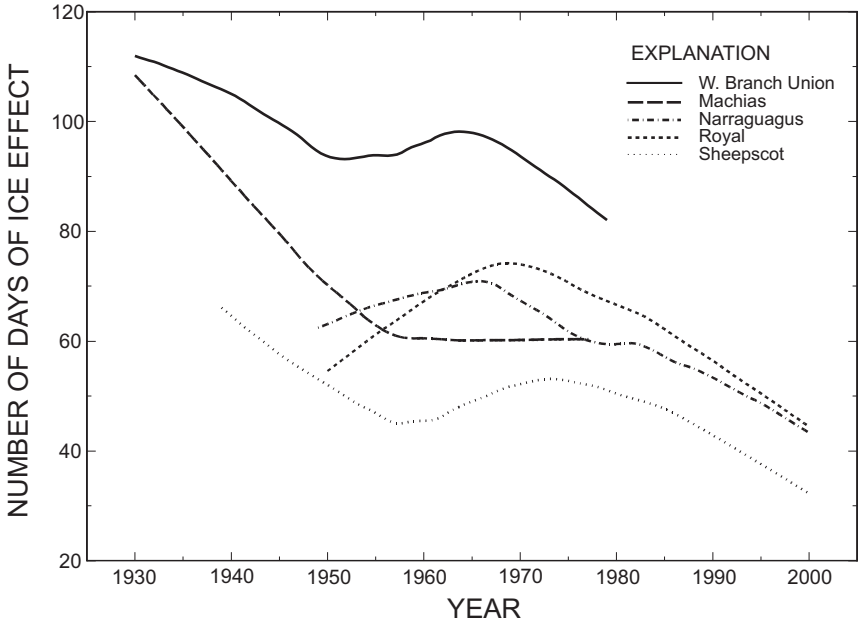

Figure 2. Trend toward decreasing number of days of ice for coastal rivers in Maine.

the rivers. Later freezing, earlier melting/breakup, and more intermittent ice during the winter contribute to a significant decrease in total winter days of ice-affected flow over time at four of five of the coastal rivers in Maine.

Snowpack data have been collected through the Maine Cooperative Snow Survey program from the early 1900's to the present. Two of the three stations in coastal Maine with periods of record beginning before 1945 have significant trends towards increasing snowpack density on or around March 1. These two sites had net increases of 12 and 10 percent in snow density during their periods of record.

The trends over time in streamflow statistics, timing and magnitude of runoff, ice occurrence, and snowpack data are all indicative of a shift towards earlier spring snowmelt runoff in coastal Maine. The findings from this study may be used to help determine if the changes in the timing and amount of streamflow and river ice are related to the timing of Atlantic salmon runs, numbers and (or) adult return rates, and other biological and population data.

References

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