Trends in Surface-Water Quality in Connecticut

INTRODUCTION

Water quality is constantly changing in response to changes in physical, chemical, and biological conditions. Changes in water quality may occur hourly, daily, seasonally, or over a period of years, and may have significance for aquatic life, human health, or various water uses, whether these changes are driven by climatic variability or human activities. Variations in water quality may be cyclic, with a regular return to some typical condition, or there may be a direction, or trend, in the change.

A trend in water quality is a change over time in the chemical, physical, or biological characteristics of water. Information on trends in surface-water quality can be used to assess environmental conditions and changes. Water managers and planners use trend information to evaluate the effectiveness of public expenditures for water-quality improvement, to assess the status of achieving established water-quality goals, and to plan necessary remedial or preventive actions.

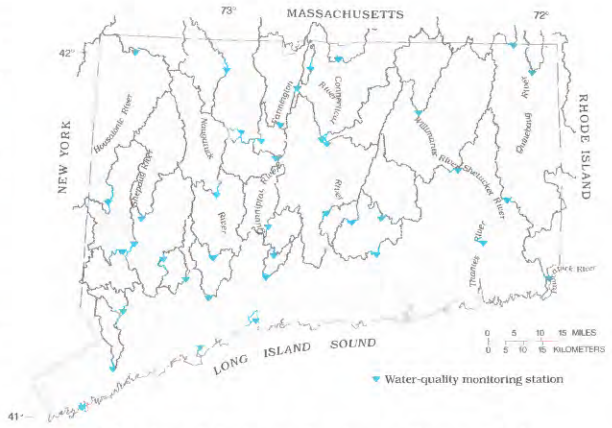
THE CONNECTICUT TREND STUDY

Surface-water-quality data for 39 monitoring stations in Connecticut were analyzed for trends by the U.S. Geological Survey (USGS). These data were collected by the USGS, in cooperation with the Connecticut Department of Environmental Protection. The stations included 26 freshwater stream sites, 7 tidally affected stream sites, 4 harbors, and 2 surface impoundments. Stations selected for the trend study have at least 5 years of record for the selected water-quality characteristics.

Three periods of record were examined for trends because sampling history has varied in different drainage basins. Water years 1969-88[1] include data for 11 water-quality characteristics at 8 stations. Water years 1975-88 include data for 23 water-quality characteristics at 35 stations. The period 1981-88 includes data for 29 water-quality characteristics at 38 stations. Seasonal-selection techniques and flow-adjustment procedures were used to remove the effects of seasonal and streamflow variability from water-quality data.

This fact sheet highlights the prevalent trends detected in the Connecticut water-quality trend study. Results for all stations and water-quality characteristics, and references for statistical methods used, can be found in Trench (1996).

[1]A water year is a 12-month period, October 1 through September 30. The water year is designated by the calendar year in which it ends. Thus, the year ending September 30, 1969 is the 1969 water year.



Monitored drainage basins in Connecticut.

A trend in water quality is a change over time in the chemical, physical, or biological characteristics of water.

FACTORS THAT AFFECT TRENDS IN SURFACE-WATER QUALITY

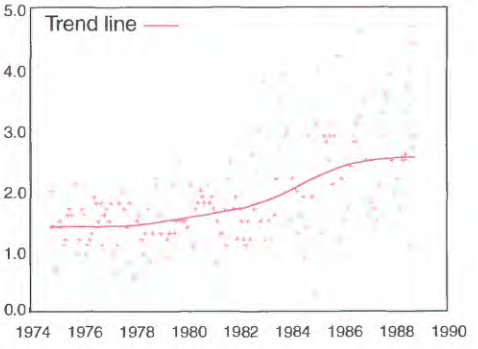
Changes in human use of land and water resources, trends in streamflow, and changes in sampling or analytical methods have affected the detected trends in surface-water quality in Connecticut. The relative magnitude of the effects of these factors is not known in most cases.

Human Use of Land and Water Resources

Most human uses of land and water resources have some effect on stream-water quality. Factors that may affect conditions and trends in water quality in Connecticut include changes in the quality or quantity of municipal and industrial wastewater discharges; increased urbanization, with consequent increases in wastewater discharges in urban areas and in nonpoint runoff in urban, suburban, and developing rural areas; changes in agricultural practices; and changes in atmospheric deposition of contaminants.

Changes in Wastewater Discharges

Changes in wastewater discharges may result in improvement or deterioration in stream-water quality. Removal or reduction of toxic substances in waste sources, improvements in wastewater treatment, or reduction of wastewater discharges are likely to result in water-quality improvements. Increases in wastewater discharges are likely to cause deterioration in stream-water quality. Improvements in the quality of wastewater discharges in Connecticut are compatible with detected downward trends in total phosphorus, total organic carbon, turbidity, ammonia, fecal coliform bacteria, and fecal streptococcal bacteria, and upward trends in dissolved oxygen. Increases in nitrate concentrations indicate deterioration in stream quality and



Variations in concentration of total nitrite-plus-nitrate as N (in milligrams per liter) over time, Quinnipiac River at Wallingford, 1975-88.

Summary of the most prevalent trends in surface-water quality in Connecticut, water years 1969-88, 1975-88, and 1981-88

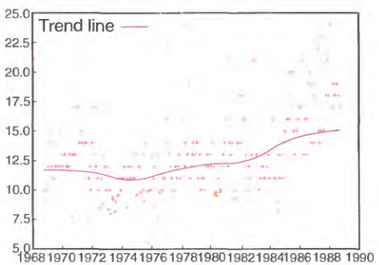
[--, insufficient data for trend analysis; the term "few trends" indicates that fewer than 25 percent of the stations had trends and the detected trends could include both upward and downward trends]

Property or constituent		1969-88 (except as noted)		1975-88 (except as noted)		1981-88		Possible environmental causes of detected trends
		Direction of trend	Area of trend	Direction of trend	Area of trend	Direction of trend	Area of trend	
PHYSICAL PROPERTIES	Specific conductance	Few trends		Upward	Central and western areas	Upward	Statewide	Point discharges, nonpoint runoff
	Turbidity	--		Downward	Statewide (1978-88)	Downward	Connecticut River Basin (except Farmington River Basin) and southwestern areas	Wastewater treatment improvements
MAJOR CHEMICAL CONSTITUENTS AND RELATED PROPERTIES	Total solids	--		Upward	Scattered statewide	Few trends		Effects of urbanization
	Dissolved solids	--		Upward	Central and western areas	Few trends		Effects of urbanization
	Calcium	Few trends		Upward	Southwestern areas and scattered statewide	Few trends		Effects of urbanization
	Magnesium	Upward	Scattered statewide	Upward	Statewide	Upward	Scattered statewide (except Connecticut River Basin)	Effects of urbanization
	Chloride	Upward	Central and western areas	Upward	Statewide	Upward	Statewide	Point discharges, road salt in nonpoint runoff
	Sulfate	Downward	Scattered statewide (1969-82)	Upward	Eastern and western areas (1975-82)	--		Point discharges, changes in atmospheric deposition
	Dissolved oxygen	Upward	Scattered statewide	Upward	Scattered statewide	Few trends		Wastewater treatment improvements
	Dissolved oxygen (percent saturation)	Upward	Scattered statewide	Upward	Scattered statewide	Upward	Central areas, Quinebaug River Basin	Wastewater treatment improvements
	pH	Upward	Central and western areas	Upward	Statewide	Upward	Statewide	Wastewater treatment improvements
NUTRIENTS	Total nitrogen	--		Upward	Statewide	Few trends		Point discharges, nonpoint runoff, atmospheric deposition
	Total organic nitrogen	--		Upward	Statewide	Few trends		Point discharges, nonpoint runoff
	Total nitrite-plus-nitrate	--		Upward	Central areas and scattered statewide	Few trends		Point discharges, nonpoint runoff, atmospheric deposition, conversion of ammonia to nitrate in wastewater treatment facilities
	Total ammonia nitrogen	--		--		Downward	Southwestern areas and scattered statewide	Wastewater treatment improvements
	Total phosphorus	--		Downward	Statewide (except Farmington River Basin)	Downward	Statewide	Wastewater treatment improvements, decline in agricultural land use, decline in use of detergents containing phosphorus
	Total organic carbon	--		Downward	Statewide	Few trends		Wastewater treatment improvements
TRACE METALS	Dissolved iron	--		Downward	Western and central areas and Connecticut River Basin (except Farmington River Basin)	Downward	Scattered statewide	Declining metals industries, wastewater treatment improvements
	Dissolved manganese	Downward	Scattered statewide	Downward	Scattered statewide	Few trends		Declining metals industries, wastewater treatment improvements
	Dissolved and total nickel	--		--		Downward	Statewide	Declining metals industries, wastewater treatment improvements
	Total copper	--		--		Downward	Central and southwestern areas	Declining metals industries, wastewater treatment improvements
	Total zinc	--		--		Downward	Statewide	Declining metals industries, wastewater treatment improvements
BACTERIA	Fecal coliform bacteria	--		Downward	Scattered statewide	Downward	Central areas and scattered statewide	Wastewater treatment improvements, improved agricultural management practices
	Fecal streptococcal bacteria	--		Few trends (1977-88)		Downward	Statewide	Wastewater treatment improvements, improved agricultural management practices

may be detrimental to Long Island Sound; some increases in nitrate concentration, however, are paired with decreases in ammonia nitrogen, which can indicate enhanced wastewater treatment upstream and improved water quality for aquatic life (Zimmerman, 1997).

Increased Urbanization

Increases in population and changes in the distribution of population during 1969-88 have resulted in new and increased wastewater discharges in urbanized areas and increased nonpoint runoff in urban, suburban, and less developed areas. Statewide increases in specific conductance of surface waters and in the concentrations of several dissolved chemical constituents, including chloride, are consistent with the effects of increased urbanization.



Variations in chloride concentration (in milligrams per liter) over time, Saugatuck River near Redding, 1969-88.

Changes in Agricultural Practices

Nitrogen and phosphorus are major components of fertilizer and animal manure. Manure also contains bacteria that may be transported to streams by surface runoff. Decreases in the concentration of total phosphorus, fecal coliform bacteria, and fecal streptococcal bacteria may be related to decreased agricultural activity in some parts of the State or to improved agricultural management practices. Increases in some forms of nitrogen in rural areas during 1975-88, however, also could be caused in part by agricultural activities, so the relation of water-quality trends to agriculture is unclear.

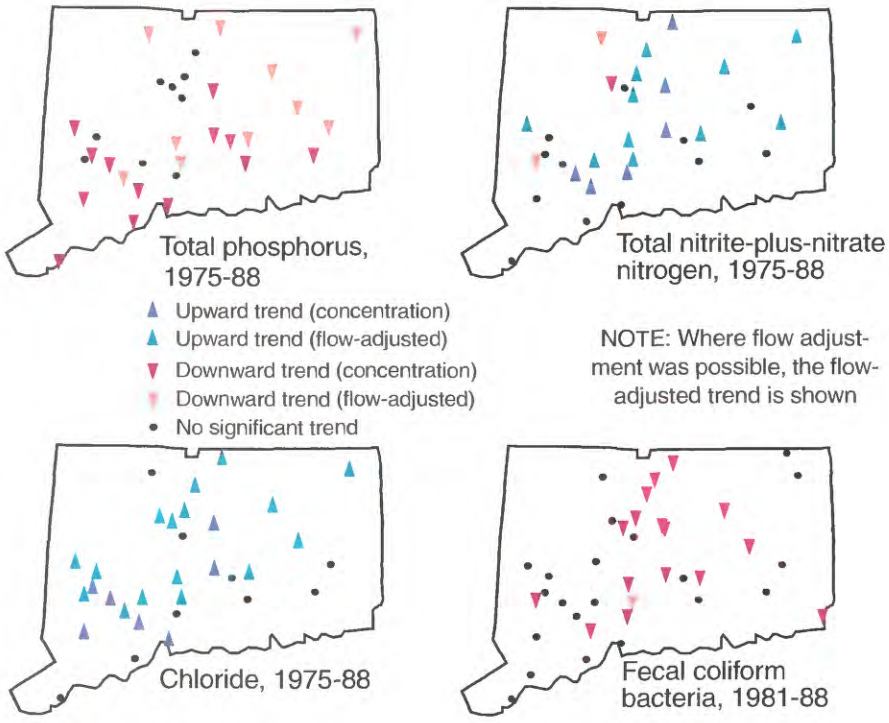
Atmospheric Deposition

Connecticut is in the path of major storm systems that transport atmospheric contaminants from the urbanized and industrialized northeastern United States. Increases in specific conductance and several dissolved constituents, including nitrate and sulfate, may be partly related to the effects of atmospheric deposition. These increases are found in rural as well as in urban and suburban areas.

Upward trends in pH at many stations during 1975-88 and 1981-88 indicate less acidic conditions in Connecticut streams. These trends are of interest, given the relatively acidic nature of precipitation in the northeastern United States. Trend results for pH at most stations indicate that factors other than precipitation chemistry have had a substantial effect on the pH of many streams.

Trends in Streamflow

During 1975-88, 12 of 20 stations with discharge data had downward trends in streamflow. Even though water-quality data have been flow adjusted, the presence of trends in streamflow complicates the interpretation of trends in water quality. Increases in specific conductance and in concentrations of calcium, magne-



Trends in water quality in Connecticut streams

sium, chloride, sulfate, and dissolved solids were all common during this period. The concentrations of these constituents in streams tend to be high at low flows, and thus the overall trends in water-quality characteristics are consistent with the effects of a downward trend in streamflow. Similar trends in these characteristics also were detected, however, at several stations that had no trend in streamflow, which indicates that other environmental factors in addition to streamflow changes are causing these trends. Information on trends in streamflow is important in evaluating changing environmental conditions and planning for future water-quality management.

Changes in Sampling or Analytical Methods

Sampling and analytical methods improved and became increasingly sophisticated during 1969-88. The possible effects of such changes need to be considered in evaluating trend results.

Some graphs of constituent concentration as a function of time show abrupt changes in concentration or data variability that may indicate changes in sampling or analytical methods. Water-quality characteristics in this study that exhibit this pattern are dissolved oxygen, which increased about 1974, total organic carbon, which decreased about 1981-82, and turbidity, which decreased in the mid-1980's.

Historical changes in sampling and analytical methods also may have affected the detected concentrations of trace metals in Connecticut. For this reason, trend analysis on dissolved and total trace metals was limited to those metals where changes related to sampling and analysis are believed to be minor relative to actual concentrations in the streams.

SUMMARY

For water-quality characteristics with trends at many stations in Connecticut, most trends—

- were typically in the same direction,
- were geographically widespread, and
- were not confined to particular basins.

Several trends indicate improvements in stream-water quality related to improved wastewater treatment. Other trends, however, indicate subtle but widespread deterioration in water quality related to statewide increases in human use of land and water resources.

Thirty years of water-quality data for Connecticut represent a large resource of information. Additional investigation will yield further insight into factors affecting trends in water quality.

Water-quality data have been collected in Connecticut for more than 30 years, and the monitoring program continues to evolve in response to needs for information on stream quality. Additional investigation will yield further insight into changing water-quality conditions and trends in the State.

SUGGESTED READINGS

Healy, D.F., Pizzuto, E.J., and Hoffman, G.F., 1994, Water-quality data for selected rivers and harbors in Connecticut, 1973-85: Connecticut Water Resources Bulletin 44, 293 p.

Paulson, R.W., Chase, E.B., Williams, J.S., and Moody, D.W. (compilers), 1993, National water summary 1990-91--Hydrologic events and stream water quality: U.S. Geological Survey Water-Supply Paper 2400, 590 p.

Robinson, K.W., Lazaro, T.R., and Pak, Connie, 1996, Relations between water-quality trends in New Jersey streams and drainage-basin characteristics, 1975-86: U.S. Geological Survey Water-Resources Investigations Report 96-4119, 148 p.

Zimmerman, M.J., 1997, Trends in nitrogen and phosphorus concentrations in southern New England streams, 1974-92: U.S. Geological Survey Fact Sheet FS-001-97, 4 p.

—Elaine C. Todd Trench and B.A. Korzendorfer

This fact sheet is based on:

Trench, E.C.T., 1996, Trends in surface-water quality in Connecticut, 1969-88: U.S. Geological Survey Water-Resources Investigations Report 96-4161, 176 p.

For further information contact:
District Chief
U.S. Geological Survey
450 Main Street, Room 525
Hartford, CT 06103
(860) 240-3060
Internet--http://www.usgs.gov

☆ U.S. GOVERNMENT PRINTING OFFICE: 1997–547-724