U.S. Department of the Interior
U.S. Geological Survey

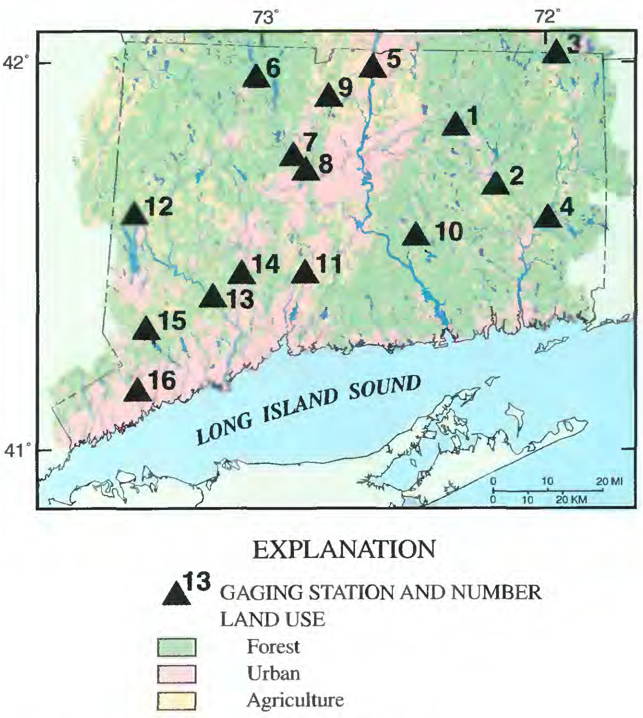
USGS

TRENDS IN NITROGEN AND PHOSPHORUS CONCENTRATIONS IN SOUTHERN NEW ENGLAND STREAMS, 1974-92

National Water-Quality Assessment
Fact Sheet 001-97

Connecticut, Housatonic, and Thames River Basins Study Unit

Trends in concentrations of nitrogen and phosphorus in southern New England streams since the passage of the Clean Water Act of 1972 are similar to National trends with total nitrogen concentrations commonly increasing and total phosphorus concentrations usually decreasing. Decreases in ammonia-nitrogen concentrations were associated with increases in nitrate-nitrogen concentrations and may indicate that improved wastewater treatment has had a beneficial effect on water quality. Increasing concentrations of total nitrogen, however, may contribute to eutrophication in Long Island Sound.



Location of surface-water quality stations.

INTRODUCTION

Following passage of the Clean Water Act of 1972, billions of dollars were spent as new municipal and industrial wastewater-treatment plants were built and existing plants were upgraded throughout southern New England. A recent study recommends the expenditure of 6 to 8 billion dollars more to decrease the amounts of the nutrients—nitrogen and phosphorus—discharged into Long Island Sound through the region's streams and rivers (U.S. Environmental Protection Agency, 1994). Few detailed regional assessments of changes in stream-water quality have documented the effect of improved wastewater treatment (Trench, 1996; Zimmerman and others, 1996). National-scale studies of water-quality trends found that (1) phosphorus concentrations had decreased in association with improvements in advanced wastewater treatment, and (2) nitrogen concentrations had increased in association with increases in two nonpoint sources: nitrogen fertilizer use and atmospheric deposition of nitrogen (Smith and others, 1987; U.S. Geological Survey, 1993).

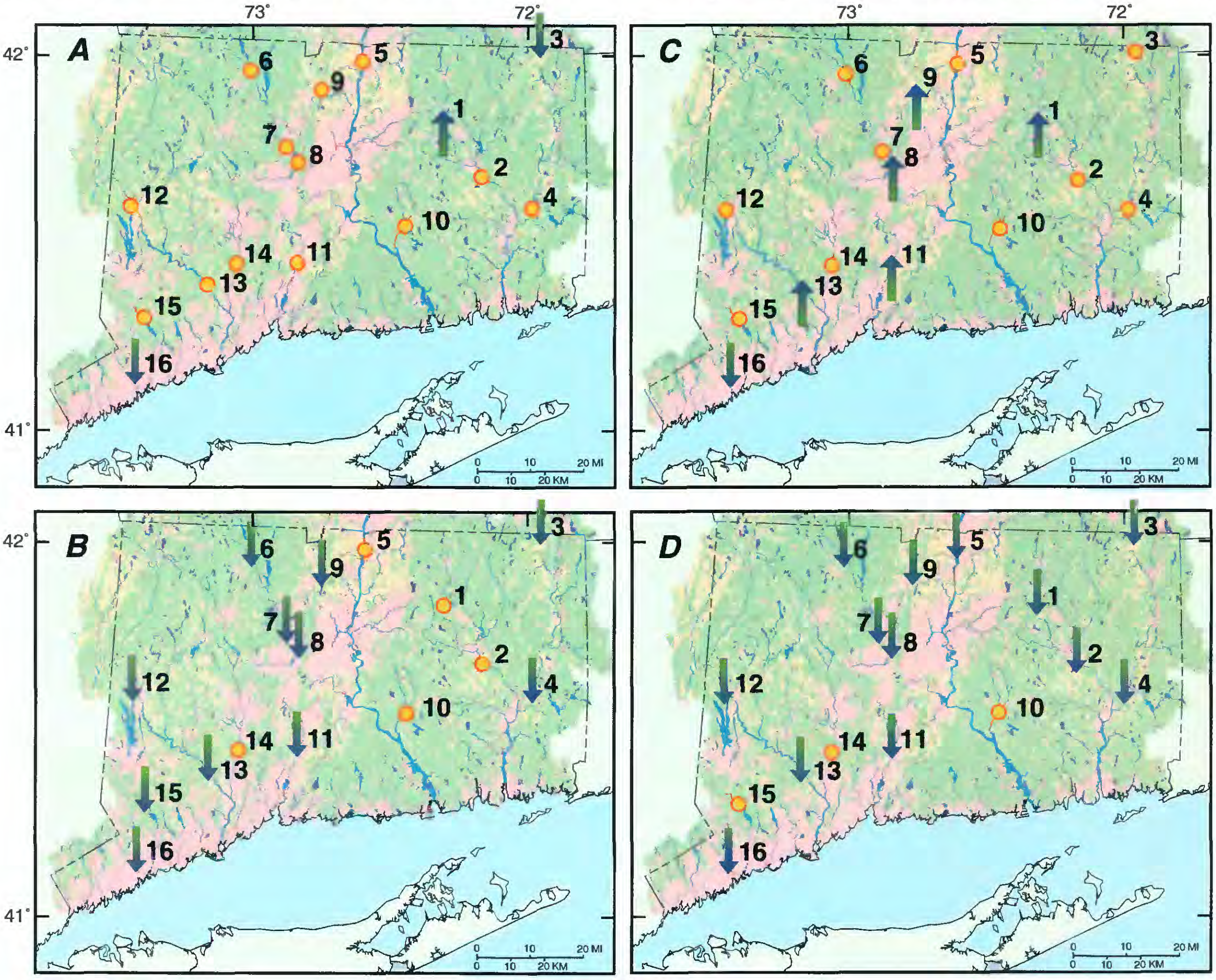
This report presents analyses of data from the long-term Connecticut Water-Quality Monitoring Program, a cooperative effort of the USGS and the Connecticut Department of Environmental Protection. Sixteen surface-water-quality monitoring stations having sufficient data for 1980-92 were selected for trend analysis. For many of the 16 stations, data were adequate to analyze trends since 1974. Water-quality constituents evaluated for trends in concentration include total nitrogen, total ammonia as nitrogen (referred to here as ammonia-nitrogen), total nitrite plus nitrate as nitrogen (referred to here as nitrate-nitrogen), and total phosphorus.

NATIONAL WATER-QUALITY ASSESSMENT PROGRAM

In order to make regional assessments and National-scale comparisons of the status and trends in the quality of the Nation's water resources and to develop a better understanding of the natural and human factors affecting water quality, the U.S. Geological Survey established the National Water Quality Assessment (NAWQA) Program. The Connecticut, Housatonic, and Thames River Basins, along with smaller Connecticut coastal river basins, constitute one of 60 NAWQA units.

TRENDS IN NITROGEN AND PHOSPHORUS CONCENTRATIONS

Each of the four water-quality constituents analyzed had a distinct trend pattern for 1980-92. Trends in total nitrogen concentrations were observed at only a few monitoring stations. The concentration of ammonia-nitrogen decreased at 11 of 16 stations and the concentration of nitrate-nitrogen increased at 5 of 16 stations. Improved wastewater treatment likely explains these observed trends. During wastewater treatment, reduced nitrogen compounds, such as ammonia-nitrogen, are oxidized and more of the discharged nitrogen occurs in the form of nitrate-nitrogen. The overall, or total, concentration of nitrogen may not change. Decreasing the concentration and



EXPLANATION

GAGING STATION AND NUMBER

9 16 Upward or downward trend–arrowhead indicates location of gaging station

14 No trend–dot indicates location of gaging station

LAND USE

Forest

Urban

Agriculture

Map No.	Station name	Drainage basin area (mi²)	Number of wastewater-treatment plants in drainage basin
1	Willimantic River at Merrow	94.0	2
2	Shetucket River at South Windham	408	2
3	Quinebaug River at Quinebaug	155	4
4	Quinebaug River at Jewett City	713	14
5	Conneticuit River at Thompsonville	9,660	80
6	Still River at Riverton	86.2	2
7	Farmington River at Unionville	378	4
8	Pequabuck River at Farmington	57.2	5

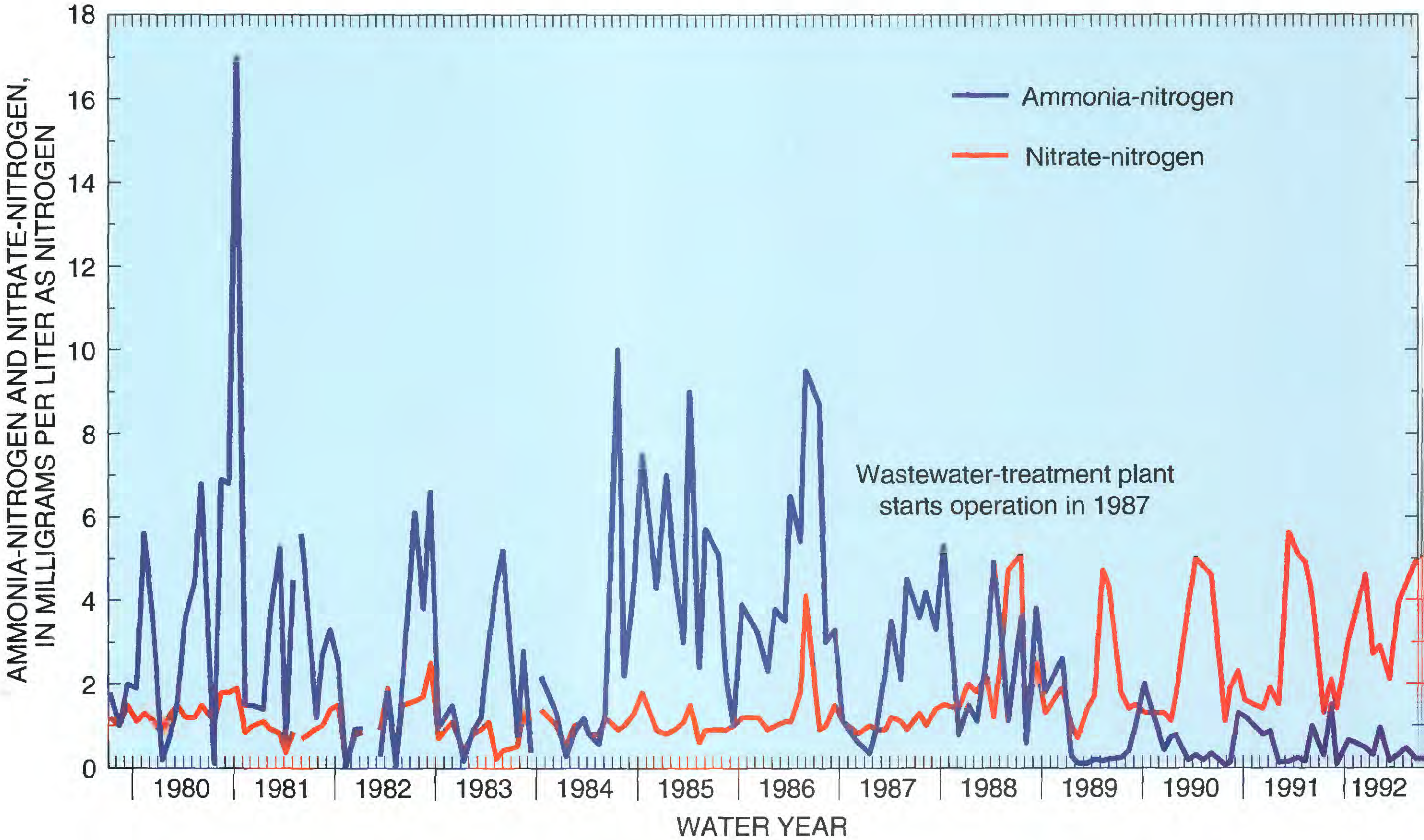
Map No.	Station name	Drainage basin area (mi²)	Number of wastewater-treatment plants in drainage basin
9	Farmington River at Tariffville	577	10
10	Salmon River near East Hampton	100	0
11	Quinnipiac River at Wallingford	115	1
12	Housatonic River near New Milford	1,022	12
13	Housatonic River at Stevenson	1,544	19
14	Naugatuck River at Beacon Falls	260	8
15	Saugatuck River near Redding	21.0	0
16	Norwalk River at Winnipauk	33.0	0

Trends in concentration of (*A*) total nitrogen, (*B*) ammonia-nitrogen, (*C*) nitrate-nitrogen, and (*D*) total phosphorus in Connecticut, 1980-92.

amount of ammonia-nitrogen released to streams means that less depletion of dissolved oxygen will occur in the streams—an important factor in maintaining good stream-water quality. Therefore, decreases in ammonia-nitrogen concentrations combined with increases in nitrate-nitrogen at specific stations can indicate enhanced wastewater treatment upstream. For example, in 1987 an advanced wastewater-treatment plant in Bristol, Conn., began operation upstream from the water-quality-monitoring station at the Pequabuck River at Farmington. Prior to that time, ammonia concentrations generally were much higher than nitrate concentrations. During 1988, nitrate concentrations increased to approximately equal the ammonia concentrations that had downward trends. After 1989, nitrate concentrations were consistently higher than ammonia concentrations.

Aerial view of the wastewater reclamation facility in Bristol, Connecticut. Photograph taken by Albert Emmert, City of Bristol.

Upward trends in nitrate-nitrogen concentrations were found at monitoring stations that had either a downward trend in ammonia concentration or an upward trend in total-nitrogen concentration (table 1). Most stations with increases in nitrate-nitrogen concentration represent either urban settings or large drainage basins with multiple land-use settings. Basins in these settings contain many wastewater-treatment plants. The upward trend in nitrate-nitrogen concentration in the relatively small forested basin (94 square miles) represented by the Willimantic River at Merrow, Conn., may be due to the presence of two wastewater-treatment plants.



Ammonia-nitrogen and nitrate-nitrogen concentrations in the Pequabuck River at Farmington, Connecticut, 1980-92.

Table 1. Summary of numbers of trends in concentrations of selected nitrogen and phosphorus constituents at 16 selected stations in Connecticut, water years 1980-92, 1974-80, and 1974-92

Trend type	Nitrogen, total	Ammonia-nitrogen	Nitrate-nitrogen	Phosphorus, total
1980-92				
Downward	2	11	1	13
Upward	1	0	5	0
None	13	5	10	3
Insufficient data	0	0	0	0
1974-80				
Downward	0	3	2	8
Upward	1	0	6	0
None	13	1	6	6
Insufficient data	2	12	2	2
1974-92				
Downward	0	1	0	13
Upward	8	0	8	0
None	6	0	6	1
Insufficient data	2	15	2	2

During 1980-92, concentrations of total phosphorus decreased at 13 of 16 stations representing a wide range of basin sizes and land-use characteristics. The downward trends in total phosphorus concentrations may be due to a combination of improvements in wastewater treatment, changes in agricultural fertilization practices, decreasing agricultural land use, and elimination of phosphate from some laundry detergents.

Monitoring stations representing primarily forested, low population-density drainage basins, such as the Salmon River near East Hampton, Conn., and the Saugatuck River near Redding, Conn., usually have no major point or nonpoint sources. Therefore, concentrations of total nitrogen and total phosphorus are historically low in comparison to more developed drainage basins and total phosphorus trends are not significant during 1980-92. The ammonia-nitrogen concentration exhibits a downward trend at the Saugatuck River.

No concentration trends were detected for any of the four constituents during 1980-92 at the Naugatuck River at Beacon Falls, Conn., a monitoring station downstream from major urban areas. The Naugatuck River Basin has some of the highest total nitrogen and total phosphorus concentrations in the study area. The absence of trends in that basin during water years 1980-92 may be related to the timing of improvements in wastewater treatment. All the municipal plants that discharge to the Naugatuck River achieved improved wastewater treatment by 1976. Major upgrades of the municipal wastewater-treatment plant did not take place during the period covered by the trend analysis. Advanced treatment projects in this basin are planned for completion in the late 1990's.

Expanding the period of trend analysis for the nitrogen constituents to 1974 provides more insight into short-term and long-term trends (see table 1). Few increases in total nitrogen were observed for 1974-80 or 1980-92. However, when taken together, trends in total nitrogen concentration for 1974-92 were upward at 8 of 16 stations. Ammonia-nitrogen concentrations were not measured during 1974-80, making it impossible to relate the increases in nitrate-nitrogen concentrations to decreases in ammonia-nitrogen concentrations at six stations. On the basis of other analyses presented here, improved wastewater treatment likely played an important role in effecting these trends.

Upward trends in total nitrogen concentrations during 1974-92 may be attributable to the increase in population (about 9 percent from 1970-90) in the study area or to increases in atmospheric nitrogen deposition and nitrogen fertilizer use. Because the effect of these nonpoint nitrogen sources on the concentrations of nitrogen constituents in streams is difficult to assess, wastewater treatment alone may not be responsible for changes in ammonia-nitrogen and nitrate-nitrogen concentrations.

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