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Water Resources Activities

New Hampshire-Vermont Water Science Center Newsletter

Science Center Web sites: http://nh.water.usgs.gov or vt.water.usgs.gov April 2006

USGS Active in New Hampshire Seacoast Water Resource Issues

The Seacoast region of southeastern New Hampshire, like many other coastal areas in the United States, is experiencing an increase in population and urban development. The proximity of the seacoast region to metropolitan Boston has led to a 36 percent population increase over the past 20 years. This population increase, and associated development, has been accompanied by an estimated 50 percent increase in the use of ground- and surface-water resources for drinking, industrial, and other purposes during the same period. The U.S. Geological Survey (USGS) is working in cooperation with the New Hampshire Department of Environmental Services (NHDES) on several projects related to water quality, ground-water availability, and the amount of water used in the region.

Methyl Tert-Butyl Ether (MTBE) in Ground Water

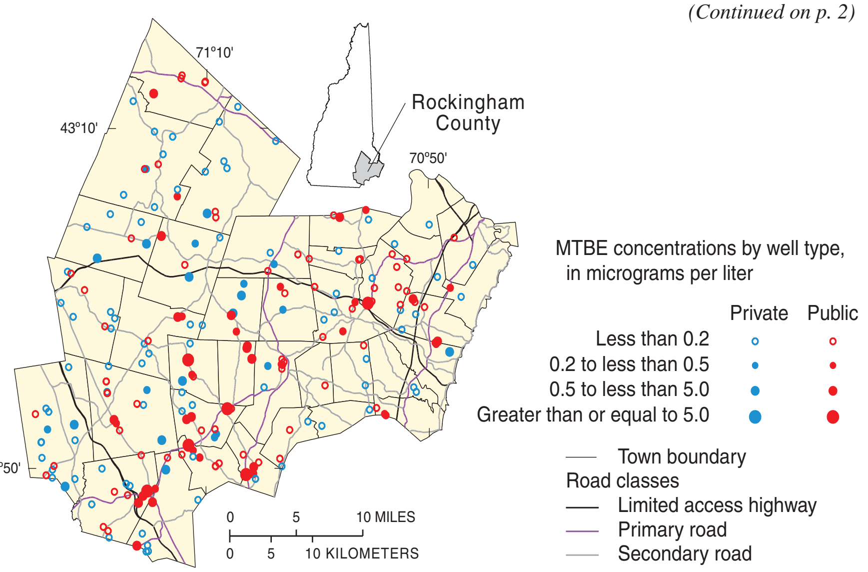
Routine monitoring by the NHDES found that the presence of methyl tert-butyl ether (MTBE), a gasoline additive, in public water-supply (PWS) wells has increased statewide from 12.7 percent in 2000 to 15.1 percent in 2002. MTBE has been added to gasoline since the late 1970s to increase octane and reduce vehicle emissions under National Clean Air Act rules.

In 2003, the USGS studied the occurrence of MTBE in public and private wells used for drinking water in Rockingham County. This County was selected because it has the second largest population in the state (280,500) and the largest population (more than 250,000) served by ground water.

Results of the study show that MTBE concentrations in the wells sampled were higher than the detection level of 0.2 micrograms per liter (µg/L) in 40 percent of the PWS wells and 21 percent of the privately owned wells. None of the private wells had concentrations that exceeded either the State drinking-water standard of 13 µg/L or the State action level of 5 µg/L that requires notification of well owner, although 4 PWS wells did exceed 13 µg/L.

The study showed that MTBE concentrations increased with increased well depth and with decreased yield in public wells. This means that there is probably more dilution of the MTBE in shallow wells then in deep wells. It is unclear how the contamination enters these wells. This contamination could come from MTBE leakage to geologic fractures or along the well casing. Concentrations greater than 20 µg/L of MTBE in ground water are likely a result of point-source contamination, but lower concentrations could be the result of either point or non-point sources. Study results were published in the journal *Environmental Science and Technology* and in a USGS fact sheet.

(Continued on p. 2)



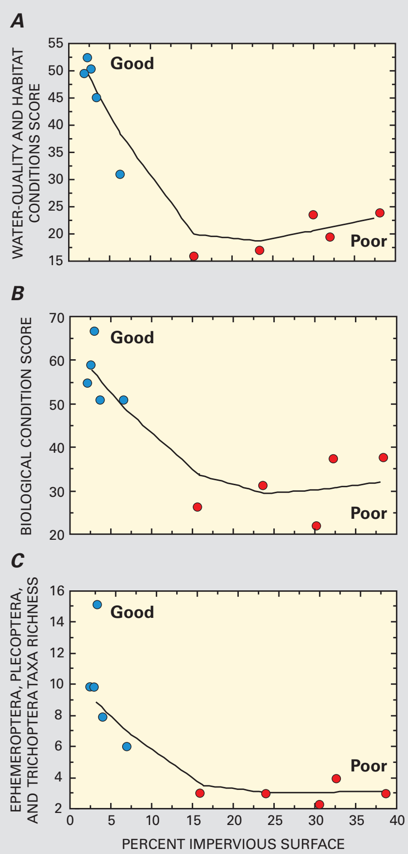
Concentrations of MTBE in public and private water-supply wells in Rockingham County, NH, during 2003 tended to be greatest in wells near roadways.

(Continued from p. 1)

To determine the extent of contamination statewide, the USGS is currently working with the NHDES to analyze MTBE concentrations from wells throughout the State. For a copy of the study fact sheet, visit the USGS Web site http://pubs.water.usgs.gov/fs20043119. (Contact Joseph Ayotte, 603-226-7810, or by e-mail at jayotte@usgs.gov)

Effects of Urbanization on Water Quality

The USGS and NHDES conducted a study to determine how urban land use, and the associated impervious surfaces (roads, parking lots, sidewalks, and rooftops) affect the quality of water in small streams of the Seacoast region. Increased impervious surfaces result in a loss of natural vegetation areas, which may cause an increase in watershed runoff.



Graphs show that as the amount of impervious surface in the Seacoast watershed increases, the quality of the water decreases.

To assess the effects of impervious surfaces on water quality, 10 stream sites were monitored for chemical and biological quality from 2001-03. Results from the chemical analysis found that water quality, as measured by a water-quality conditions score, was more degraded in watersheds with a high percentage of impervious surface than in watersheds with a low percentage of impervious surfaces (see figure A to the left). Results also indicated that streams draining forested watersheds had a greater abundance and a more diverse aquatic invertebrate community than did streams draining urban watersheds (see figures B and C to left). Overall, results from this study indicate that the percent of impervious surface in a watershed can be used as an indicator of stream quality.

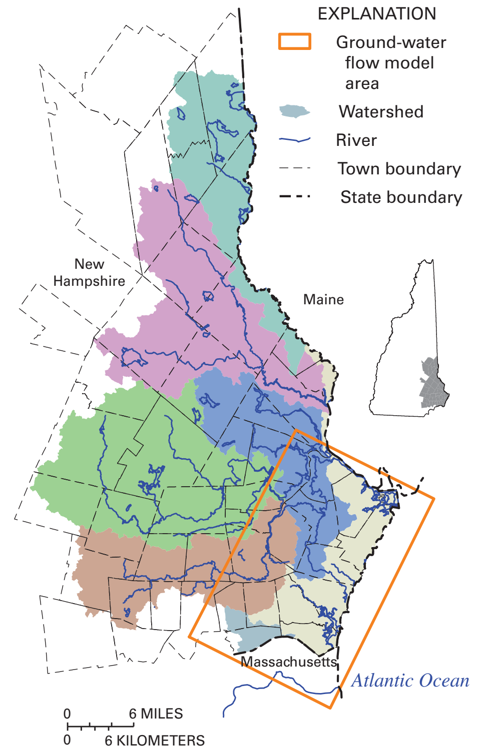
A copy of the published report from this study is available at http://pubs.water.usgs.gov/sir20055103. (Contact Jeff Deacon, at 603-226-7812, or by e-mail at jrdeacon@usgs.gov)

Assessment of Ground-Water Resources

Ensuring the future sustainability of water resources of the Seacoast area requires that water managers know how much water is stored in the surface- and ground-water systems, and understand current and future water demands.

To help water managers obtain this information, the USGS has cooperated for the last 3 years with the New Hampshire Geological Survey (NHGS), New Hampshire Water Supply Engineering Bureau, and New Hampshire Coastal Program and 44 Seacoast towns to study water resources and water demand in the region (see map to the upper right).

The purpose of this study is to estimate how much water currently is used and will be needed in the region in 10 and 20 years (to 2025), and to model ground-water flow in aquifers in an effort to understand the potential availability of water resources for future supplies. The USGS has (1) compiled existing data on wells, ground-water levels, and aquifers; (2) installed and operated an expanded monitoring network for ground and surface water in the region; (3) determined current and future water demand including a water-use budget for each town in the region; (4) estimated general water availability in each town; and (5) evaluated effects of projected future water use on surface and ground water using a ground-water flow model for a part of the region (see map above). Reports are planned to be published in 2006 and 2007 describing these results.



Towns and watersheds included in the assessment of water resources in New Hampshire's Seacoast area.

The NHGS compiled a comprehensive database of ground-water conditions at 19,500 monitoring wells; digitized surficial geologic quadrangle maps of the seacoast area; and refined a regional recharge map that incorporates information on elevation, land use/land cover, soils and surficial geology, and daily precipitation data. The USGS used this data in the ground-water flow model. This collaboration between Federal and State agencies has enabled scientists to share expertise and develop a more accurate understanding of water resources available to towns for future supplies.

For additional information on this study, which ends in September 2006, visit the project Web site at http://nh.water.usgs.gov/projects/seacoast/index.htm. (Contact Tom Mack at 603-226-7805, or by e-mail at tjmack@usgs.gov)

A New Director for the NH-VT Water Science Center

In late December 2005, Keith W. Robinson became the new Director of the NH-VT Water Science Center. Keith replaces Brian Mrazik, who retired from Federal service earlier that month. Brian served as the Director (or District Chief, as the position was previously called) for the past 15 years. “I am stepping into some big shoes left by Brian,” says Keith. “Brian oversaw the expansion of USGS water programs in New Hampshire, Vermont, and the New England region, and created a solid foundation that I hope to build upon.”

Understanding the effects of continued urban expansion on the quantity and quality of the region’s surface and ground waters, helping to ensure safe and sustainable water supplies, creating stable and long-term water monitoring programs, knowing how the mix of natural and manmade contaminants affect human and environmental health, and providing data and assessment tools for water and other resource managers are major goals Keith has for the Water Science Center. “To achieve these goals we will need to work closely with our existing cooperators, as well as expand working relationships to other agencies and organizations. By working together I am optimistic that we can tackle the water issues in New Hampshire and Vermont and ensure adequate supplies for all water users,” states Keith. “I am also very impressed with the caliber and dedication of our Water Science Center employees. They will definitely make my job so much easier, and I truly look forward to working with them in my new role.”

Keith has worked in the NH-VT Water Science Center since 1993 as the project chief of the USGS National Water-Quality Assessment (NAWQA) program study in eastern New England and, most recently, as the chief of the Hydrologic Investigations and Research Section. Prior to moving to New Hampshire, Keith worked in the New Jersey office of the USGS and for the New Jersey Department of Environmental Protection.

Please feel free to contact Keith regarding any of the activities of the USGS in New Hampshire and Vermont or on water issues that you may be involved with. He can be reached by phone at 603-226-7807, or by e-mail at dc_nh@usgs.gov.

Outreach

USGS Lake Gage Exhibit at ECHO’s Waterfront Weather Station in Burlington, Vermont

If you live near Lake Champlain in Vermont and New York and ever wondered how much the lake level has changed over the last century, or what the water temperature is today, you can find out at the push of a button by visiting the new Weather Station exhibit on the waterfront at ECHO at the Leahy Center for Lake Champlain in Burlington, VT. The science center’s acronym ECHO stands for Ecology, Culture, History, and Opportunity. This exhibit was the result of a partnership between the ECHO, Burlington’s TV NewsChannel 5, and USGS.

The USGS has monitored Lake Champlain since 1907. In December 2004, the water-level monitoring equipment was moved to be collocated with the ECHO Weather Station. From this site, the USGS monitors the lake level, temperature, and specific conductance (a measure of the amount of dissolved material in water). These data are transmitted every 4 hours from the USGS gage to a satellite and then back to Earth (see photo to the left). These data are then translated into tables and graphs through a USGS Web site and used in ECHO’s Watershed Weather TV studio exhibit.

To find out how this lake gage works, the history of streamgaging in Lake Champlain and Vermont, and have access to the lake data being collected on the waterfront, visit the Web site http://vt.water.usgs.gov/echo_gage (Contact Debra Foster at 603-226-7837, or by e-mail at dhfoster@usgs.gov)

The New Hampshire Floods of October 2005

Cold River and Ashuelot River Watersheds

On October 8 and 9, between 4 and 12 inches of rain fell on southwestern New Hampshire, causing flooding in the Ashuelot and Cold River Basins. This flooding caused more than $4 million in damage and seven deaths statewide, four in the Cold River Basin. This storm also filled rivers, lakes, and ground water, leaving many areas saturated prior to the second round of precipitation between October 14 and 16. The second storm caused more widespread flooding statewide but less damage then during the October 8-9 storm. The table below lists the peak flows for selected streamflow gages in New Hampshire and Vermont.

USGS hydrologists estimated the peak flow of the Cold River at Drewsville, NH, downstream of Alstead, at 21,800 cubic feet per second on October 9th. This peak flow was computed using a hydraulic model of the Cold River calibrated to high-water marks left behind by the flooding in a 3,000-foot reach within a mile upstream of the discontinued streamflow gage at the Route 123 bridge in Drewsville. Historically, normal river flows at Drewsville during October are about 100 cubic feet per second. The peak flows in the Cold River on October 9 were more than three times as high as the previously recorded maximum of 6,700 cubic feet per second in 1973 during the streamflow gage's 1940-1978 period of operation. The October 9th peak flow was influenced by the failure of an upstream impoundment resulting in a peak greatly exceeding that which would be expected for a return interval of 500 years, known as the 500-year flood.

Return intervals are used by hydrologists to describe the magnitude and frequency of floods and represent the average interval of time over which floods of similar magnitudes may occur.

On October 9, peak flow at the USGS gage on the Ashuelot River in Hinsdale, NH, was measured at 11,700 cubic feet per second, which exceeded a 100-year return interval. This was the largest flood observed on the Ashuelot River since construction of the Surry Mountain and Otter Brook Reservoirs in the 1940s and 50s. Prior to completion of these reservoirs, the largest flood on record for the Ashuelot River at Hinsdale was 16,600 cubic feet per second in 1936.

Table 1. Peak river stages, discharges, and approximate recurrence intervals in New Hampshire and Vermont in October 2005.

[Provisional Data subject to revision; mi², square miles; ft, feet; ft³/s, cubic feet per second; POR, Period of record is less than 10 years, recurrence interval not determined. Recurrence Interval, average time interval between occurrences of a hydrological event in years.]

Station number	Station name	Drainage area (mi²)	Flood peak: Stage (ft)	Flood peak: Discharge (ft³/s)	Flood peak: Date	Flood peak: Recurrence interval (years)	Previous maximum in record: Stage (ft)	Previous maximum in record: Discharge (ft³/s)	Previous maximum in record: Year
Androscoggin River Basin									
01052500	Diamond River near Wentworth Location, NH	152	10.14	8,280	Oct 16	25	12.11	12,800	1998
01054000	Androscoggin River near Gorham, NH	1,361	9.08	16,100	Oct 17	10*	Unknown	21,900	1923
Merrimack River Basin									
01081000	Winnipesaukee River at Tilton, NH	471	8.52	4,410	Oct 15	30*	8.68	4,580	1984
01082000	Contoocook River at Peterborough, NH	68	5.72	2,260	Oct 15	15*	6.82	3,210	2004
01084500	Beards Brook River near Hillsboro, NH	55	9.90	4,500	Oct 9	80*[1]	6.53	2,190	1959
01085000	Contoocook River near Henniker, NH	368	13.45	10,400	Oct 16	15*	21.30	22,200	1938
01086000	Warner River at Davisville, NH	146	9.90	4,780	Oct 9	10*	9.88	4,510	1953
01089100	Soucook River near Concord, NH	82	12.00	2,550	Oct 16	10*	11.59	2,320	1996
Connecticut River Basin									
01129200	Connecticut River near Pittsburg, NH	254	8.08	5,520	Oct 17	50	7.97	5,260	1996
01129500	Connecticut River at N. Stratford, NH	799	13.35	23,900	Oct 17	10	20.6	32,300	1998
01152500	Sugar River at W. Claremont, NH	269	8.96	9,760	Oct 9	20*	11.80	14,000	1936
01155000	Cold River at Drewsville, NH	83	23.70	21,800	Oct 9	>500*[2]	12.30	6,718	1973
01157000	Ashuelot River near Gilsum, NH	71.1	17.98	8,610	Oct 9	>200	12.24	5,220	1922
01160350	Ashuelot River at West Swanzey, NH	316	5.61	5,330	Oct 9	POR	3.81	3,620	1996
01161000	Ashuelot River at Hinsdale, NH	420	9.6	11,700	Oct 9	>100*	20.2	16,600	1936
Hudson River Basin									
01334000	Walloomsac River near North Bennington, VT	111	11.41	7,690	Oct 9	25*	12.04	8,450	1938
St. Lawrence River Basin									
04293000	Missisquoi River near North Troy, VT	131	11.65	7,530	Oct 17	20*	14.55	10,600	2002

[1] Gage discontinued in 1970. Peak estimated from high water mark in vicinity of gage structure by extrapolation of rating curve.
[2] Gage discontinued in 1978. Peak affected by failure of upstream impoundment.
* Recurrence interval estimates obtained from Federal Emergency Management Agency (FEMA) Flood Insurance Study reports.

This bridge over the Cold River collapsed during the October 9, 2005, flooding in Walpole, NH.

Statewide

During the October 14-16 period, USGS observed bankfull or higher river levels at 20 gages throughout the State. Flows on the Connecticut River near Pittsburg, NH, peaked at 5,430 cubic feet per second, the highest on record since the gage was installed in 1957. The estimated return interval for the Pittsburg peak was approximately 40 years. In Hillsboro, NH, at the discontinued USGS gage on Beards Brook in the Contoocook River Basin, the peak discharge was about 4,500 cubic feet per second, with a return interval of approximately 80 years. The Winnipesaukee River at Tilton peaked at 4,410 cubic feet per second on October 15, with a return interval of 30 years. This was the second highest level observed since gaging began at this site in 1937; exceeded only by the flood of May 31, 1984.

What USGS is Doing Since the Floods

The NH-VT Water Science Center currently is working with New Hampshire State agencies and the Federal Emergency Management Agency (FEMA) to document and describe the October floods in the Cold River watershed. Reports are planned for 2006, which will describe the results of these studies.

For Information

Current and historical flood data for all USGS sites are available at http://nh.water.usgs.gov/WhatsNew/newsreleases/flooddata10-05.htm. (Contact Ken Toppin at 603-226-7808, or by e-mail at ktoppin@usgs.gov)

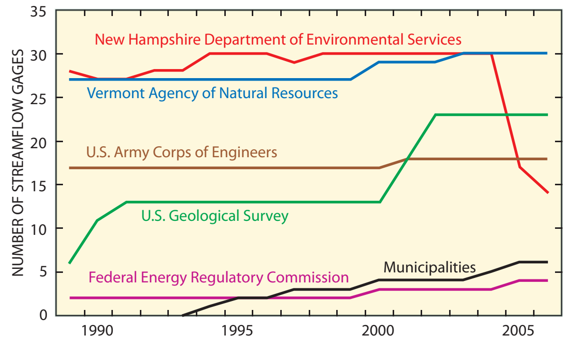
Status of Streamflow Gaging in New Hampshire and Vermont

Since 1887 the USGS has been the principal Federal agency providing water information needed to manage the Nation's water resources. The first gaging site in New Hampshire was established on the Pemigewasset River in 1903. The first site in Vermont was established on the Otter Creek, also in 1903.

In 2005, the USGS operated and maintained more then 100 real-time streamflow gaging stations on rivers and lakes in New Hampshire and Vermont. Some of the stations also collect precipitation, water temperature, and specific conductance.

On October 1, 2004, data collection at 12 sites was discontinued in New Hampshire by the USGS due to State and Federal funding reductions. Data collection will now be done by the NHDES at seven former USGS sites; the remaining five sites have been fully discontinued. Historic data will remain accessible for all 12 sites through the USGS Web site.

Since 1989, the total number of streamflow gages in the State/USGS Cooperative Water Program have decreased from 28 to 14 in New Hampshire and increased from 27 to 35 in Vermont (see figure to the right.) In New Hampshire, the NHDES has begun to operate their own gages. USGS-funded gages have increased the mostly in the two States due to support from the National Streamflow Information Program (NSIP).



Funding partners and number of streamflow gages for the USGS-operated streamflow-gage network in New Hampshire and Vermont from 1989 to 2006.

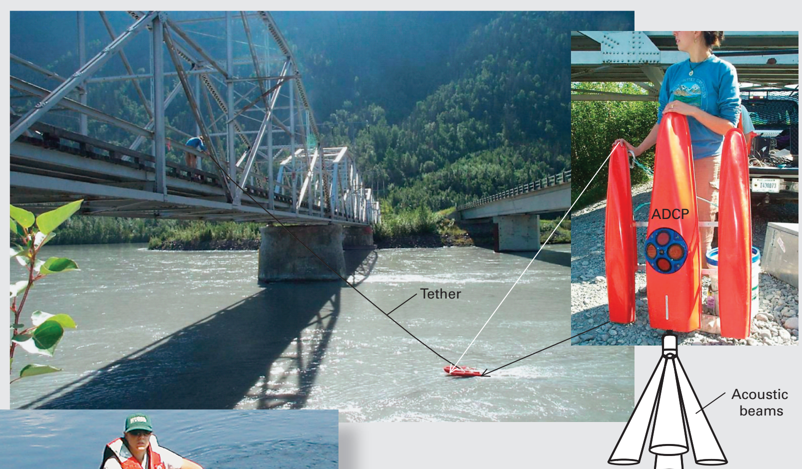
The USGS will be working with the New Hampshire Rivers Management Advisory Committee in 2006 to define a long-term strategy for stream-gaging in the State.

For access to data from all streamflow gages in New Hampshire and Vermont, visit the Web site http://nh.water.usgs.gov/WaterData/index.htm. (Contact Kenneth Toppin at 603-226-7808, or by e-mail at ktoppin@usgs.gov)

Hydroacoustics: A New Technology Used for Streamflow Gaging

The USGS continues to develop and utilize new technologies to measure streamflow less expensively and more accurately in safer ways. In recent years, as a result of advances in technology, the USGS has made discharge measurements by means of hydroacoustics. A hydroacoustic discharge measurement uses the principles of the Doppler effect to measure the velocity of water. The Doppler effect is the change in the observed sound pitch that results from sound changing as it approaches and passes by a stationary point. An example of this effect is the phenomenon we experience when passed by a car that is sounding its horn. As the car passes, the pitch of the sounding horn suddenly decreases. If the decrease in pitch is measured, it can be used to calculate the speed of the car.

The Doppler effect is used to determine water velocity by sending a sound or acoustic pulse into the water and measuring the change in frequency of that acoustic pulse as it is reflected back by sediment or other particulates being transported in the water. The change in frequency can be translated into water velocity.



The Acoustic Doppler Current Profiler (ADCP) is used for measuring the discharge of a river. The ADCP's acoustic beams are directed down into the water as it is guided across a river channel using a tether from a bridge or attached to a small boat.

A common type of hydroacoustic discharge-measuring equipment used by the USGS in New Hampshire and Vermont is the Acoustic Doppler Current Profiler (ADCP). The ADCP is used on large rivers to determine a profile of water velocity from river bottom to water surface. To make a discharge measurement, the ADCP is mounted to a boat or attached to a tether from a bridge. The ADCP is then guided across the water surface, either by a driver in the boat or remotely from a shoreline or bridge, to measure velocity and depth across the river channel. A Global Positioning System (GPS) or the ADCP's river-bottom tracking capability is used to track the ADCP's progress across the channel and measure the channel width.

Understanding Nitrogen Transport in the Upper Connecticut River Basin

Nitrogen has been recognized as the primary cause of low concentrations of dissolved oxygen in Long Island Sound (LIS). In response to this problem, the U.S. Environmental Protection Agency (USEPA) and the States of Connecticut and New York developed a Total Maximum Daily Load (TMDL) that specifies the amount of nitrogen that can be discharged to LIS without violating water-quality standards for dissolved oxygen. The LIS TMDL also specifies the need for additional actions including reduction of nitrogen from sources north of Connecticut (New Hampshire, Vermont, and Massachusetts). The USGS, in cooperation with the USEPA and the New England Interstate Water Pollution Control Commission (NEIWPCC), assessed nitrogen loads and transport in the upper Connecticut River Basin from December 2002 to September 2005.

Assessing Total Nitrogen Loads

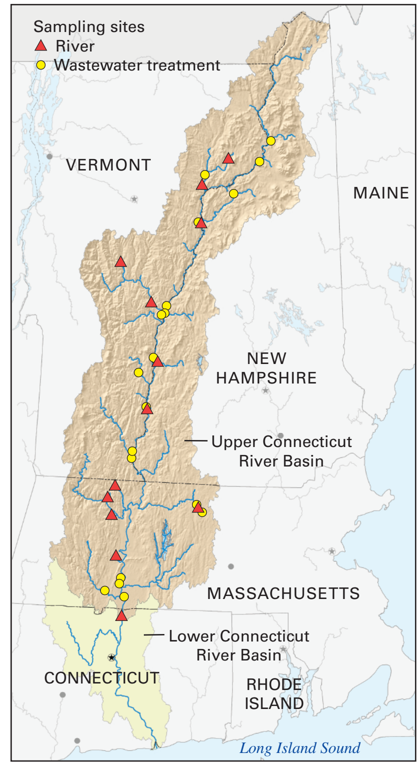
To assess the current nitrogen loads in the upper basin, the USGS designed and operated a surface-water quality monitoring network. These data were used to determine the current nitrogen concentrations and loads from sites representing different land uses and sites representing wastewater-treatment effluent. Thirteen river sites and 19 wastewater-treatment facilities were selected for the study. Ten of the river sites were selected to represent forested, agricultural, and developed land-use contributions of nitrogen, and three of the river sites were selected on the mainstem of the Connecticut River to assess the cumulative nitrogen loads in the river.

Results of the monitoring found that nitrogen concentrations at forested sites were less than those from agricultural and developed sites; nitrogen concentrations at agricultural and developed sites were similar. Results also indicated that nitrogen concentrations from the effluent at wastewater treatment facilities were greater than those from forested, agriculture, and developed river sites. Nitrogen yields at forested sites generally were less than yields at agricultural and developed sites; however, nitrogen yields at agricultural sites generally were greater than yields at developed sites.

Nitrogen load estimates from this study were also used to revise an existing New England water-quality model for nitrogen (SPARROW Model). Ongoing water-quality monitoring of nitrogen loads and the revision to water-quality models in the basin will be important to assess the effects of nitrogen-reduction strategies on the Connecticut River and ultimately LIS. A USGS report summarizing the results of this study is planned for release in 2006.

Nitrogen Transport and Loss

The USGS studied nitrogen transport in two reaches of the upper Connecticut River to determine rates of nitrogen loss. In one study, samples were collected from all major tributaries and at the upstream and downstream ends of each study reach (34 and 41 miles in length), and were analyzed for ammonia, nitrite, nitrate, and organic nitrogen.



Thirteen river sites and 19 wastewater-treatment facilities were sampled for total nitrogen in the upper Connecticut River Basin.

Total nitrogen loads (mass transport) entering and exiting the study reaches were computed from the nitrogen concentrations and streamflow measured during sampling. A downstream decrease in the nitrogen load within a reach indicates that nitrogen is lost. To assess the effects of different hydrologic conditions and water temperatures on nitrogen loss, the study reaches were sampled during spring high flows and again in summer.

In a second study, dissolved nitrogen gas was measured on a 6-mile subreach of the Connecticut River to estimate the rate of denitrification. SF_6 gas and sodium bromide also were injected and measured in the study reach to account for atmospheric gas exchange and dispersion.

The results from these studies will be used to verify water-quality model predictions of nitrogen inputs, transport, and loss, and are planned to be released in a report in 2007. (Contact Jeff Deacon at 603-226-7812, or by e-mail at jrdeacon@usgs.gov; or Thor Smith at 603-226-7814, or by e-mail at tesmith@usgs.gov)

Hydrologists collect water samples from the upper Connecticut River for nitrogen analysis.

Selected NH-VT Water Science Center Publications from 2001 to 2005

These and other reports published by the Water Science Center are available online at ***http://nh.water.usgs.gov/Publications.***
(Contact Debra Foster, Information Specialist, at 603-226-7837 or by e-mail at dhfoster@usgs.gov)

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Assessing the Contribution of Roads to Salt Levels in Vermont Streams

The USGS, in cooperation with the Vermont Agency of Transportation, is studying the effects of deicing salts on stream-water quality near State roads in Vermont. In this study, salt levels in streams are monitored upstream and downstream of three State roads in Chittenden County. The three streams and roads are Allen Brook at Route 2A in Williston, Alder Brook at Route 289 in Essex, and Mill Brook at Route 117 in Jericho.

Continuous specific conductance data are being measured along with routine monitoring of salt elements commonly used for deicing—chloride, sodium, and calcium. These data will be used to establish a relation between specific conductance and the salt loads so that salt levels in the stream can be continuously estimated from the conductance data. Results from the monitoring program will be used to determine how much salt from State road deicing activities enters the stream in runoff during rainfall and snowmelts in comparison to other salt sources in the watershed. The data will also be used to determine if chloride levels are exceeding water-quality criteria for the protection of aquatic life. (Contact Jon Denner at 802-828-4417, or by e-mail at jdenner@usgs.gov.)

A USGS scientist wades a river in Chittenden County, Vermont, to collect a water-quality sample.

USGS science for a changing world

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