Geographical Distribution and Potential for Adverse Biological Effects of Selected Trace Elements and Organic Compounds in Streambed Sediment in the Connecticut, Housatonic, and Thames River Basins, 1992-94

U.S. Geological Survey
Water-Resources Investigations Report 97-4169

NATIONAL WATER-QUALITY ASSESSMENT PROGRAM

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By ROBERT F. BREAULT and SANDRA L. HARRIS

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U.S. DEPARTMENT OF THE INTERIOR
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FOREWORD

The mission of the U.S. Geological Survey (USGS) is to assess the quantity and quality of the earth resources of the Nation and to provide information that will assist resource managers and policymakers at Federal, State, and local levels in making sound decisions. Assessment of water-quality conditions and trends is an important part of this overall mission.

One of the greatest challenges faced by water-resources scientists is acquiring reliable information that will guide the use and protection of the Nation's water resources. That challenge is being addressed by Federal, State, interstate, and local water-resource agencies and by many academic institutions. These organizations are collecting water-quality data for a host of purposes that include: compliance with permits and water-supply standards; development of remediation plans for specific contamination problems; operational decisions on industrial, wastewater, or water-supply facilities; and research on factors that affect water quality. An additional need for water-quality information is to provide a basis on which regional- and national-level policy decisions can be based. Wise decisions must be based on sound information. As a society we need to know whether certain types of water-quality problems are isolated or ubiquitous, whether there are significant differences in conditions among regions, whether the conditions are changing over time, and why these conditions change from place to place and over time. The information can be used to help determine the efficacy of existing water-quality policies and to help analysts determine the need for and likely consequences of new policies.

To address these needs, the U.S. Congress appropriated funds in 1986 for the USGS to begin a pilot program in seven project areas to develop and refine the National Water-Quality Assessment (NAWQA) Program. In 1991, the USGS began full implementation of the program. The NAWQA Program builds upon an existing base of water-quality studies of the USGS, as well as those of other Federal, State, and local agencies. The objectives of the NAWQA Program are to:

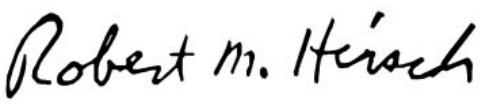
- Describe current water-quality conditions for a large part of the Nation's freshwater streams, rivers, and aquifers.
- Describe how water quality is changing over time.
- Improve understanding of the primary natural and human factors that affect water-quality conditions.

This information will help support the development and evaluation of management, regulatory, and monitoring decisions by other Federal, State, and local agencies to protect, use, and enhance water resources.

The goals of the NAWQA Program are being achieved through ongoing and proposed investigations of 59 of the Nation's most important river basins and aquifer systems, which are referred to as study units. These study units are distributed throughout the Nation and cover a diversity of hydrogeologic settings. More than two-thirds of the Nation's freshwater use occurs within the 59 study units and more than two-thirds of the people served by public water-supply systems live within their boundaries.

National synthesis of data analysis, based on aggregation of comparable information obtained from the study units, is a major component of the program. This effort focuses on selected water-quality topics using nationally consistent information. Comparative studies will explain differences and similarities in observed water-quality conditions among study areas and will identify changes and trends and their causes. The first topics addressed by the national synthesis are pesticides, nutrients, volatile organic compounds, and aquatic biology. Discussions on these and other water-quality topics will be published in periodic summaries of the quality of the Nation's ground and surface water as the information becomes available.

This report is an element of the comprehensive body of information developed as part of the NAWQA Program. The program depends heavily on the advice, cooperation, and information from many Federal, State, interstate, Tribal, and local agencies and the public. The assistance and suggestions of all are greatly appreciated.



Robert M. Hirsch
Chief Hydrologist

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CONVERSION FACTORS AND VERTICAL DATUM

CONVERSION FACTORS

Multiply	By	To obtain
foot	0.3048	meter
mile	1.609	kilometer
square mile	12.590	square kilometer
Million gallons per day (Mgal/d)	0.04381	cubic meter per second

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

$$°F=1.8°C+32.$$

Concentrations of chemical constituents in water are given either in parts per million (ppm) or parts per billion (ppb).

VERTICAL DATUM

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Geographical Distribution and Potential for Adverse Biological Effects of Selected Trace Elements and Organic Compounds in Streambed Sediment in the Connecticut, Housatonic, and Thames River Basins, 1992-94

By Robert F. Breault *and* Sandra L. Harris

Abstract

Streambed-sediment samples were collected in 1992-94 at selected sites in the Connecticut, Housatonic, and Thames River Basins to determine the geographical distribution of trace elements and organic compounds and their potential for adverse biological effects on aquatic organisms. Chromium, copper, lead, mercury, nickel, zinc, chlordane, DDT, PAHs, and PCBs were detected in samples from throughout the basins, but concentrations of these constituents generally were lowest in the northern forested drainage basins and highest in the southern urbanized drainage basins of Springfield, Massachusetts, and Hartford, New Haven and Bridgeport, Connecticut. Possible anthropogenic sources of these contaminants include industrial effluent; municipal wastewater; runoff from agricultural, urban and forested areas; and atmospheric deposition.

Some organic compounds pose the greatest threat to biological organisms in terms of exceedances of sediment-quality guidelines; those compounds are present at sufficiently high concentrations to potentially cause severe effects at several locations in the basins. Some trace elements represent the most geographically widespread threat to living organisms. These exceed sediment-quality guidelines over a wider geographical area, although usually by lower ratios of contaminant concentration to sediment-quality guideline than the organic compounds.

INTRODUCTION

The Connecticut, Housatonic, and Thames River Basins study unit is one of 59 National Water-Quality Assessment (NAWQA) study units nationwide. The study unit drainage basin comprises an area of almost 16,000 mi^2 and extends through parts of the Province of Quebec, Canada, eastern Vermont, western New Hampshire, west-central Massachusetts, nearly all of Connecticut, and small parts of New York and Rhode Island.

The study unit is entirely within the New England Physiographic Province (Fenneman, 1938), a plateau-like upland that rises gradually from the sea but includes numerous mountain ranges and individual peaks. Altitudes range from sea level in coastal Connecticut to 6,288 ft at the peak of Mount Washington in the White Mountains of New Hampshire (fig. 1).

Major streams in the study unit generally flow from north to south and all ultimately drain into Long Island Sound at the southern border of Connecticut. The study unit encompasses varied land uses (fig. 2), from forested wilderness in the north to densely populated cities in the south. About 78 percent of the land is forested, 12 percent is used for agriculture, and 10 percent is classified as urban (Mitchell and others, 1977).

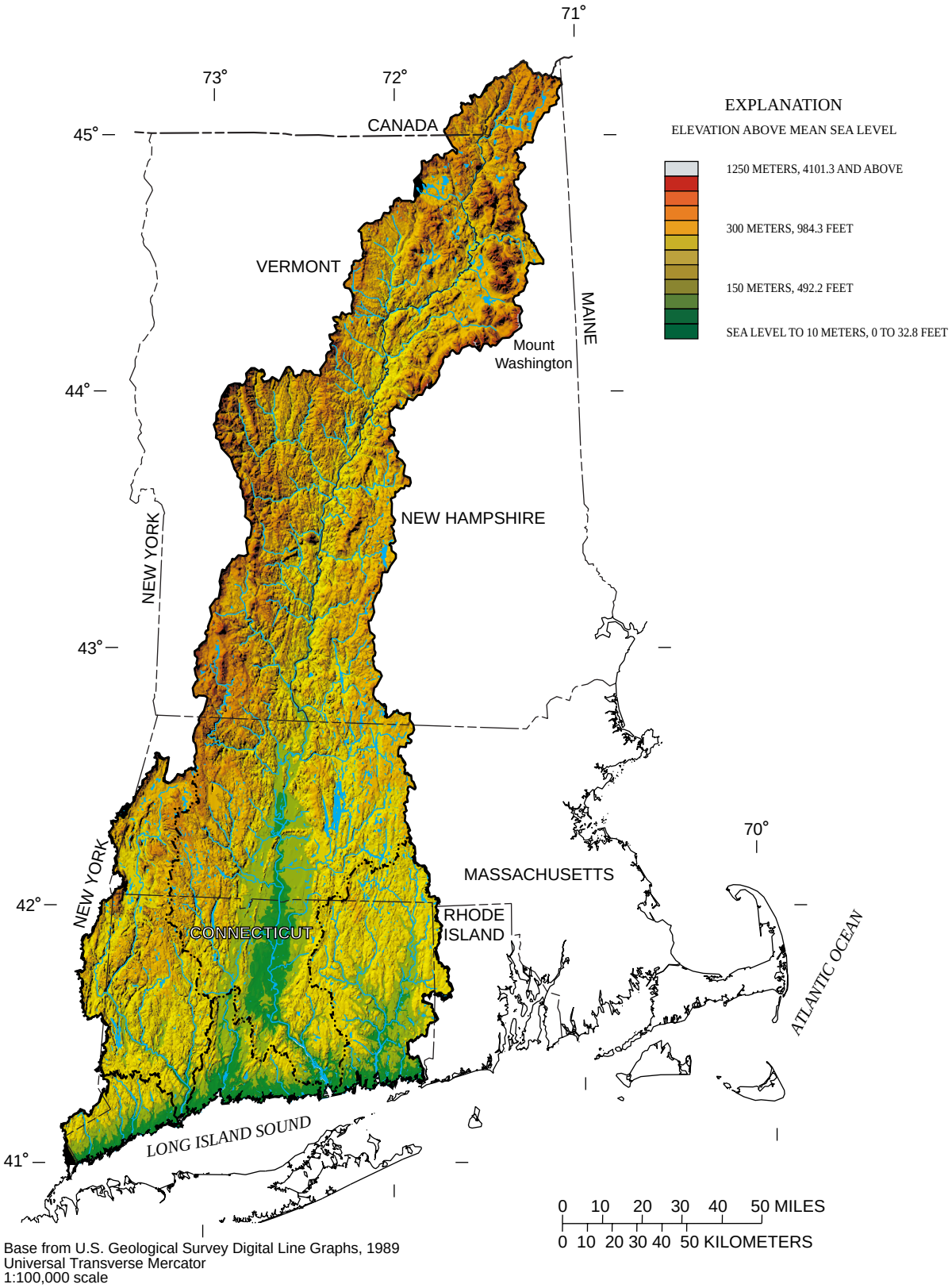

Figure 1. Topographic shaded relief map of the Connecticut, Housatonic, and Thames River Basins.

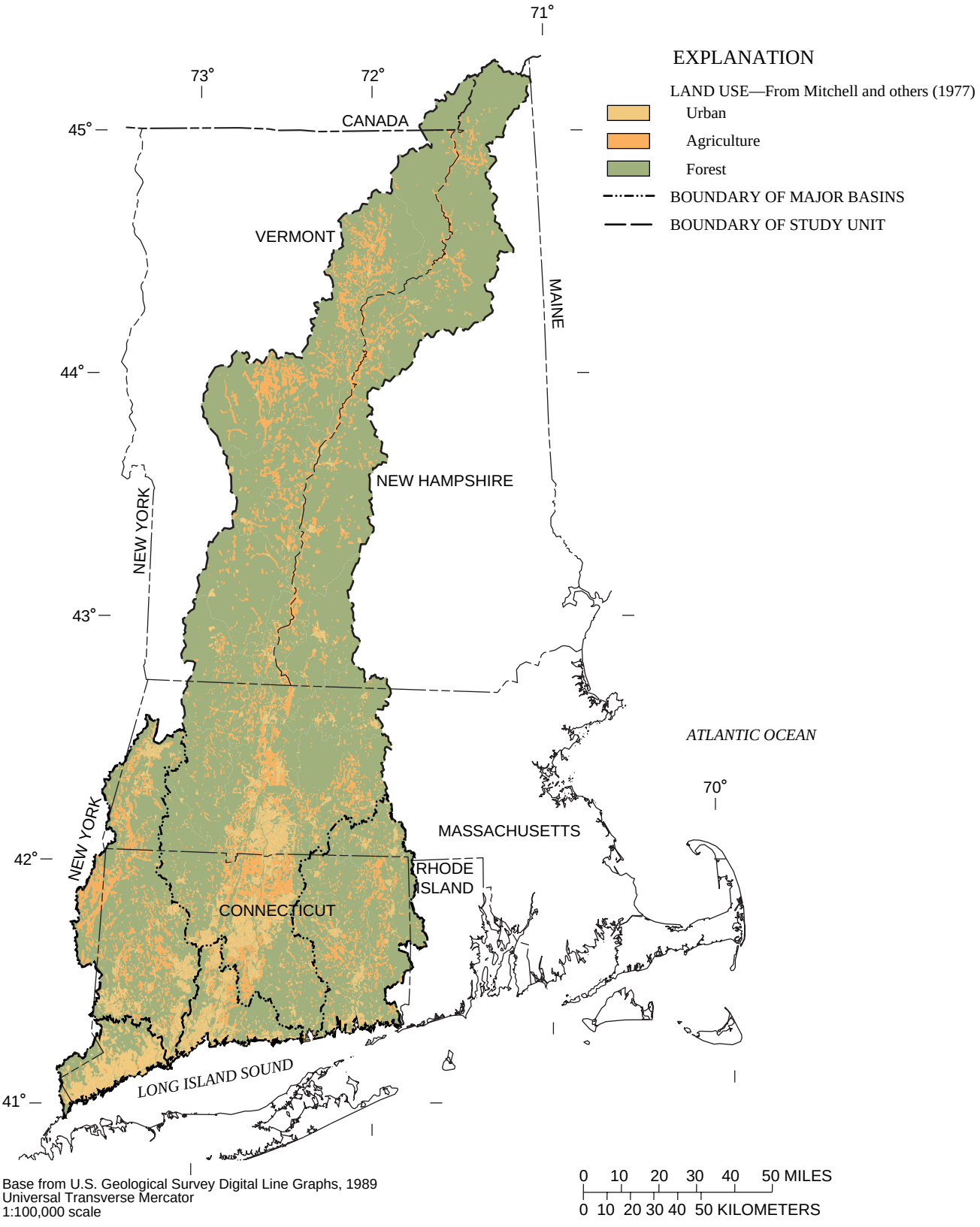

Figure 2. Generalized land use in the Connecticut, Housatonic, and Thames River Basins.

The study unit occupies less than one-half of 1 percent of the total area of the Nation, but is inhabited by 2 percent of the Nation's Population—about 4.5 million persons (Grady and Garabedian, 1991). Population density ranges widely across the study unit, from sparsely populated, rural agrarian, and wilderness of Northern Vermont and New Hampshire, to densely populated urban areas of southern Massachusetts and Connecticut (fig. 3).

Streambed sediment quality throughout the study unit has been adversely affected by various human activities and at some locations the sediments have been contaminated by trace elements and organic compounds. Streambed sediments are natural accumulators of these constituents; sediments have the capacity to concentrate and integrate trace elements and organic compounds from multiple natural, agricultural, and industrial sources. The occurrence of trace elements and organic compounds in streambed sediments reflect not only recent but also past inputs to the stream system that have been remobilized through the erosion of sediment stored in streambanks, soils, and floodplains (Horowitz and others, 1988).

The chemistry of streambed sediment influences the biotic quality of a stream as aquatic organisms ingest particulate matter and accumulate trace elements and organic compounds (Forstner and Wittmann, 1979; Luoma, 1983). The accumulation of trace elements and organic compounds in aquatic organisms can cause various physiological problems and even death of the organisms. Subsequent ingestion of aquatic organisms transfers the accumulated contaminants upward through the food chain.

The purpose of this report is to describe (1) the geographic distribution of selected trace elements and organic compounds in streambed sediments in mainstem channels and major tributaries in the Connecticut, Housatonic, and Thames River Basins, and (2) the potential frequency of adverse effects of those elements and compounds on benthic organisms. Sampling sites were selected to maximize the coverage of major basins in the study unit, with specific locations along rivers selected to insure the availability of fine-grained sediments and wadeable access to the sites for sample collection. Using these criteria, 43 sites were selected for sampling and separated into four groups by river basin—Connecticut River, Housatonic River, Thames River, and Long Island Sound Coastal Rivers (fig. 4 and table 1).

Streambed-sediment samples were collected during three sampling periods; June-November 1992, July-September 1993, and August-September 1994. A total of 87 samples were collected from the 43 sampling sites. A total of 45 samples were collected for trace-element analysis (one sample at each site and two replicate samples) and 42 samples were collected for organic-compound analysis (no sample was taken at site 7) At each of the 43 sampling sites, fine-grained streambed sediments were collected from a variety of depositional settings within stream reaches and composited. The samples were collected during summer or autumn low flows to minimize seasonal variability and the amount of fine-grained sediments in suspension. The samples were collected from the top 1 to 2 cm of fine-grained sediments using a stainless-steel scoop, following nationally consistent protocols (Shelton and Capel, 1994).

Samples for inorganic-constituent analysis were wet-sieved through a 63-μm mesh polyethylene sieve, digested to complete dissolution, and analyzed for 45 inorganic constituents. Details of inorganic dissolution and analytical methods are provided in Arbogast (1990). Samples for organic-constituent analysis were wet-sieved through a 2-mm stainless-steel sieve and analyzed for 32 organochlorine compounds, including total PCBs, and 64 semi-volatile organic compounds at the U.S. Geological Survey's National Water-Quality Laboratory (NWQL) in Arvada, Colorado. Details of organic separation and analytical methods are provided in Wershaw and others (1987) and Fishman (1993).

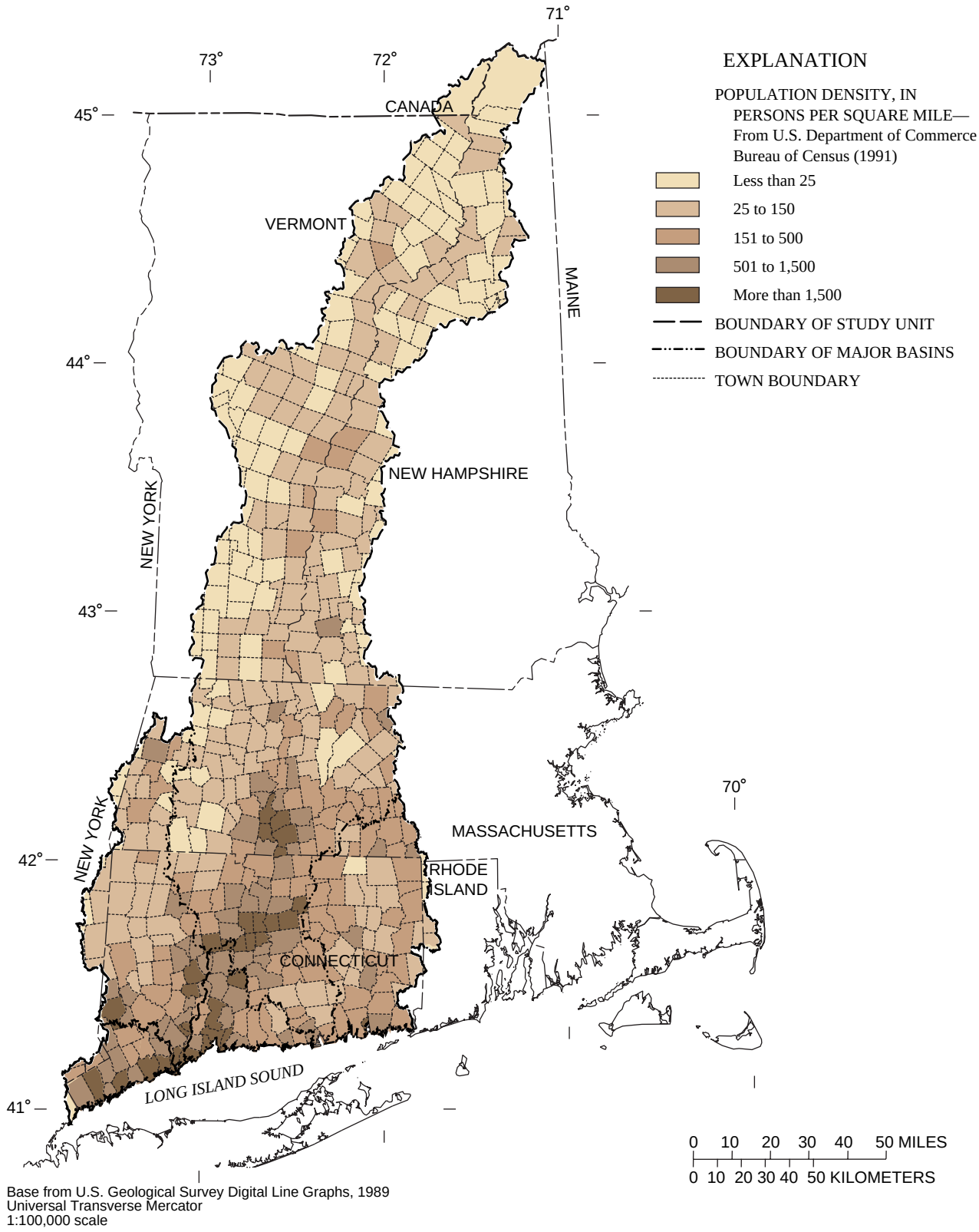

Figure 3. Population density by town in the Connecticut, Housatonic, and Thames River Basins, 1990.

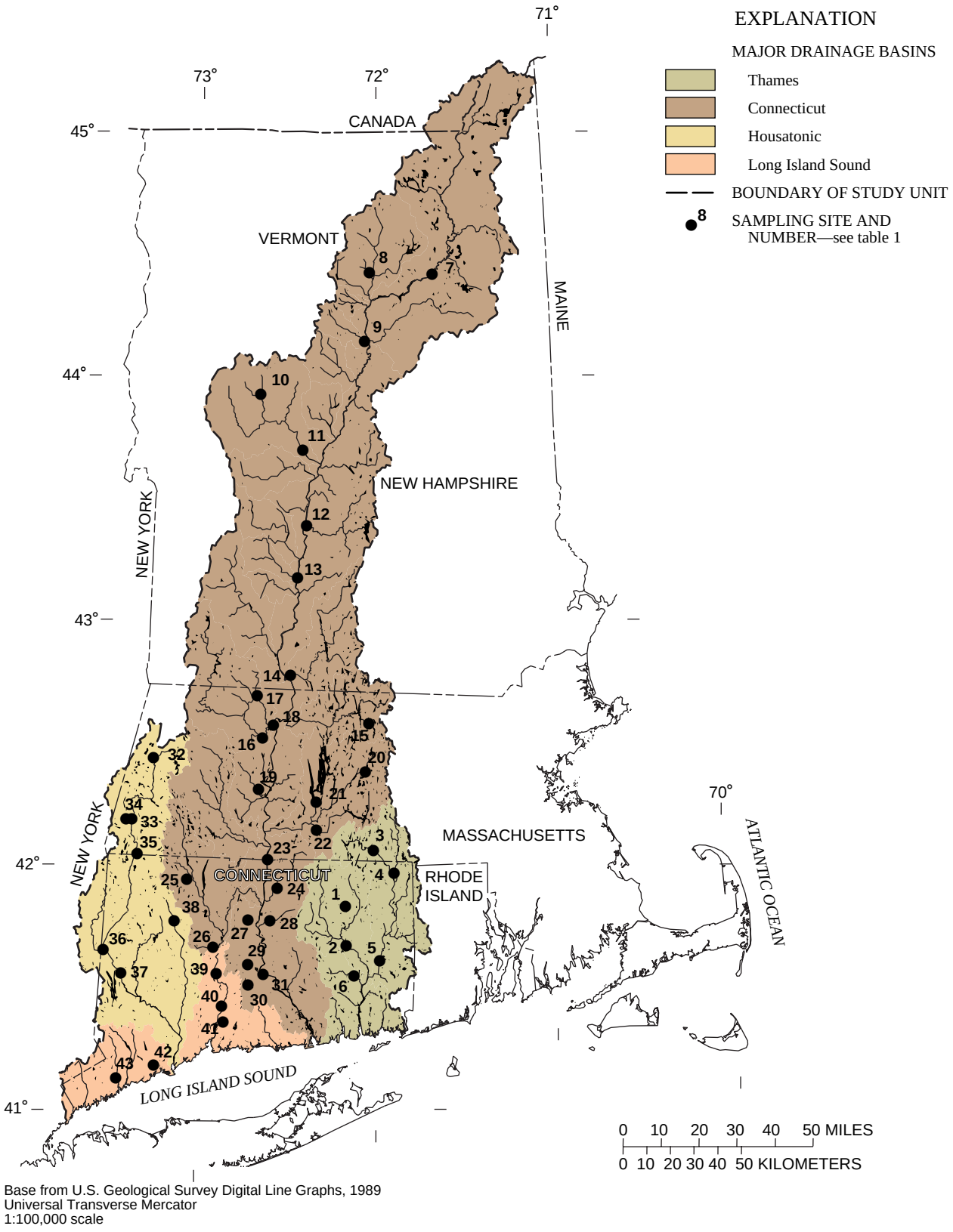

Figure 4. Location of streambed-sediment sampling sites in the Connecticut, Housatonic, and Thames River Basins.

Table 1. Streambed-sediment sampling sites in the Connecticut, Housatonic, and Thames River Basins, 1992-94

[Site locations shown in figure 4]

Site No.	USGS station No.	Site name	Date sampled
		Thames River Basin	
1	01121000	Mount Hope River near Warrenville, CT	09-03-93
2	01122610	Shetucket River at South Windham, CT	09-03-93
3	420420072010001	Quinebaug River at Saundersdale, MA	08-08-94
4	01125100	French River at North Grosvenordale, CT	08-04-94
5	01126850	Quinebaug River at Clayville, CT	07-20-93
6	01127500	Yantic River at Yantic, CT	09-03-93
		Connecticut River Basin	
7	01131400	Connecticut River near Lancaster, NH	07-22-93
8	01135300	Sleepers River near St. Johnsbury, VT	08-05-93
9	01139000	Wells River at Wells River, VT	09-07-93
10	01142500	Ayers Brook at Randolph, VT	09-07-93
11	01144010	White River near West Hartford, VT	08-04-93
12	01152540	Sugar River near West Claremont, NH	09-07-93
13	01153150	Connecticut River at South Charlestown, NH	07-16-93
14	01160990	Ashuelot River at Hinsdale, NH	09-08-93
15	01163200	Otter River at Otter River, MA	09-08-93
16	01170005	Deerfield River at West Deerfield, MA	09-08-93
17	01170103	Green River at East Colrain, MA	09-08-93
18	01170500	Connecticut River at Montague City, MA	07-15-93
19	01171500	Mill River at Northampton, MA	08-15-94
20	01173000	Ware River at Intake Works, near Barre, MA	09-08-93
21	01175500	Swift River at West Ware, MA	08-02-94
22	420910072200001	Quaboag River at Palmer, MA	08-02-94
23	01183850	Connecticut River near Longmeadow, MA	07-14-93
24	01184490	Broad Brook at Broad Brook, CT	10-22-92
25	415645073025001	Still River at Hartford, CT	08-17-94
26	01189000	Pequabuck River at Forestville, CT	11-17-92
27	01191000	North Branch Park River at Hartford, CT	08-11-94
28	01192500	Hockanum River near East Hartford, CT	10-21-92
29	413615072423001	Mattabasset River at Little River, CT	08-10-94
30	01192883	Coginchaug River at Middlefield, CT	08-10-94
31	01192990	Connecticut River near Portland, CT	07-13-93
		Housatonic River Basin	
32	422640073144501	East Branch Housatonic River at Pittsfield, MA	08-16-94
33	421140073214501	Housatonic River at Great Barrington, MA	08-16-94
33a	422102073142201	Housatonic River (Woods Pond) at Lenox, MA	05-15-96
34	01198000	Green River at Great Barrington, MA	08-16-94
35	01198200	Konkapot River at Ashley Falls, MA	08-17-94
36	01200000	Tenmile River near Gaylordsville, CT	10-19-92
37	01201335	Housatonic River near Town Hill, CT	07-21-93
38	414640073071001	West Branch Naugatuck River at Torrington, CT	08-17-94
		Long Island Sound Coastal River Basin	
39	413345072531001	Quinnipiac River at Stillmans Corner, CT	08-09-94
40	412600072511501	Quinnipiac River at Quinnipiac, CT	08-10-94
41	01196580	Muddy River near North Haven, CT	08-09-94
42	01208869	Rooster River near Fairfield, CT	06-29-93
43	01209710	Norwalk River at Winnipauk, CT	10-20-92

GEOGRAPHIC DISTRIBUTION OF SELECTED TRACE ELEMENTS AND ORGANIC COMPOUNDS

Trace Elements

Inorganic elements may be derived from the weathering of rocks or they may be introduced into the environment by human activities. Of the 45 inorganic elements analyzed, 41 were present in concentrations greater than the analytical detection limit (Harris, 1997). Most inorganic elements were detected in nearly every sample; 38 of the 41 were detected in at least 95 percent of the samples. In contrast, europium, molybdenum, and tin were detected relatively infrequently, each being detected in only 1 of the 43 samples. Bismuth, gold, holmium, and tantalum were not detected in any of the samples. Complete data on inorganic element concentrations are tabulated by Harris (1997).

Chromium, copper, lead, mercury, nickel, and zinc were selected for the presentation of results because of their relatively high concentrations and toxicity (table 2). These inorganic elements, considered trace elements (typically occur in concentrations less than 1,000 parts per million), are classified as Priority Pollutants by the U.S. Environmental Protection Agency (1994) and have been given high priority in the Agency's water-quality monitoring and abatement programs. With the exception of mercury, these six trace elements were detected in every streambed-sediment sample; mercury was detected at all but two sites, 7 and 10 (fig. 5). These trace elements all showed about a ten-fold range of concentrations between the minimum and maximum concentrations detected. The proportion of these selected trace elements due to contamination can be estimated by comparing sample concentrations to world-wide averages of elemental concentrations in the Earth's crust, or average crustal abundance. About one-half of all selected trace-element concentrations detected in the study unit exceeded their average crustal abundance and thus such elevated concentrations could potentially represent contamination by human activities. All measurements of lead and zinc were greater than the average crustal abundance, although only two sites contained nickel concentrations greater than the average crustal abundance. In addition, median concentrations for lead, mercury, and zinc were above the average crustal abundance, but those for chromium, copper and nickel were not (table 2). All maximum concentrations of the selected trace elements exceeded the average crustal abundance, and minimum concentrations of lead and zinc detected in the study unit were greater than the average crustal abundance.

Connecticut River Basin

About 53 percent of the measured concentrations of the six selected trace elements in streambed sediments in the Connecticut River Basin were greater than the average crustal abundance (fig. 5), indicating that the occurrence of these trace elements may be related to contamination by human activities. The median chromium concentration in the Connecticut River Basin was greater than in any other basin in the study unit. Although trace-element concentrations were high in some of the streambed sediments sampled in the Connecticut River Basin, many were among the lowest throughout the study.

Table 2. Statistical summary of trace-element concentrations in streambed sediment in the Connecticut, Housatonic, and Thames River Basins, 1992-94

[All concentations are in parts per million (ppm). Average crustal abundance from Weast, 1985]

Trace element	Minimum concentration	Lower quartile	Median	Upper quartile	Maximum concentration	Minimum reporting limit	Average crustal abundance
Chromium	38	70	90	110	700	1.0	100
Copper.....	14	35	54	110	620	1.0	55
Lead.....	20	39	80	150	310	4.0	12.5
Mercury.....	<.02	.07	.19	.31	1.2	.02	.08
Nickel.....	20	29	37	45	130	4.0	75
Zinc	87	160	210	360	1,300	4.0	70

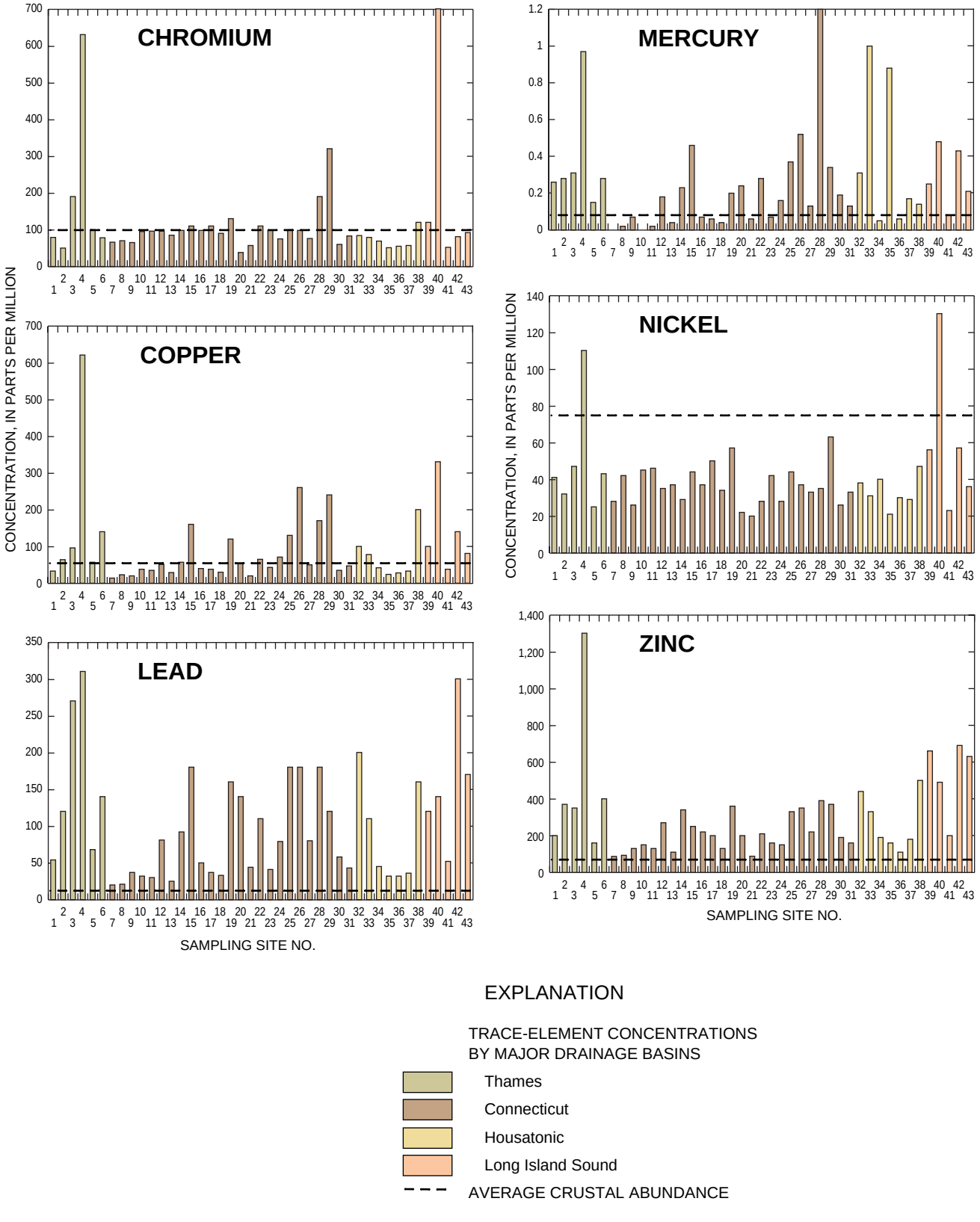

Figure 5. Geographic distribution of selected trace-element concentrations in the Connecticut, Housatonic, and Thames River Basins, 1992-94.

For example, mercury concentrations were highest—about 15 times the average crustal abundance—in streambed sediment at site 28 on the Hockanum River near East Hartford, Connecticut, however, mercury concentrations generally were lowest in the Connecticut River Basin compared to the other basins in the study. In addition, concentrations of copper, lead, and zinc were lowest in streambed sediment collected at site 7 on the Connecticut River near Lancaster, New Hampshire, one of the most northern streambed-sediment sites sampled in the study unit.

Housatonic River Basin

Concentrations of selected trace elements were greater than the average crustal abundance for about one-half of the streambed-sediment samples collected from the Housatonic River Basin (fig. 5). Although mercury concentrations were among the highest at two sites sampled, none of the sites in the Housatonic River Basin contained the maximum concentrations of any of the six trace elements. In addition, concentrations of all selected trace elements, with the exception of mercury, generally were lowest in the Housatonic River Basin in comparison to the other major basins in the study unit.

Thames River Basin

About 72 percent of the concentrations of the selected trace elements detected in sediment samples from the Thames River Basin exceeded natural crustal abundances; this was the highest exceedance percentage of all basins in the study unit. Median concentrations of all selected trace elements in this basin were greater than the median concentrations for the study unit as a whole. In particular, the median concentration of mercury was highest in the Thames River Basin. In addition, concentrations of copper, lead, and zinc in streambed sediments at site 4 on the French River at North Grovenordale in Connecticut were the highest detected in all samples.

Long Island Sound Coastal River Basins

Seventy percent of the selected trace-element concentrations detected in streambed sediments collected from the Long Island Sound Coastal River Basin were greater than the average crustal abundance (fig. 5). Concentrations of all selected elements, with the exception of chromium and mercury, generally were highest in the Long Island Sound Coastal River Basin. In particular, concentrations of chromium and nickel were highest in the study unit at site 40 on the Quinnipiac River, which drains a relatively small and densely populated and industrialized basin in southern Connecticut.

Organic Compounds

Unlike the inorganic elements that occur in streambed sediments, which can be derived from natural mineral sources as well as contamination from human activities, the occurrence of many organic compounds in streambed sediments can result only from contamination from human activities. Fifteen of the 32 organochlorine compounds were detected in concentrations greater than the minimum reporting limit. The most frequently detected organochlorine compounds included chlordane, dichlorodiphenyl-trichloroethane (DDT), and polychlorinated biphenyls (PCBs). Of the 64 semi-volatile organic compounds, 51 were detected in concentrations greater than the minimum reporting limit. The most frequently detected semi-volatile compounds were the polyaromatic hydrocarbons (PAHs), chrysene, fluoranthene, and pyrene. Complete data on organic-compound concentrations are tabulated by Harris (1997).

Four groups of the 96 organic compounds (table 3) were selected for the presentation of results because of their relatively high concentrations and toxicity. These groups of organic compounds contain constituents on the USEPA's Priority Pollutant list and have been given high priority in the Agency's water-quality monitoring and abatement programs (U.S. Environmental Protection Agency, 1994). Concentrations of these selected organic compound groups in streambed sediment are the sum of the concentrations of several related compounds and breakdown products (fig. 6). Total chlordane concentration is the sum of *cis*- and *trans*- chlordane, *cis*- and *trans*- nonachlor, and oxychlordane. Total DDT concentration is the sum of *o,p'*-DDT, *p,p'*-DDT, *o,p'*-DDE, *p,p'*-DDE, *o,p'*-DDD, and *p,p'*-DDD concentrations. Total PAH concentration is the sum of the concentration of the 27 PAHs on NWQL's list of analytes. Total PCBs were calculated as the sum of Aroclors 1042, 1254, and 1260.

Table 3. Statistical summary of organic-compound concentrations in streambed sediment in the Connecticut, Housatonic, and Thames River Basins, 1992-94

[All concentrations are in parts per billion (ppb); the lower limit of detection was raised for some individual compounds, thus, a range of concentrations are reported. Estimated concentrations of individual constituents were included in the sum of concentrations of related compounds. <, less than method detection limit]

Organic compound	Minimum concentration	Lower quartile	Median	Upper quartile	Maximum concentration	Minimum reporting limit
Chlordane, total.....	<1.0	<	<	6.0	43	1.0-3.0
DDT, total.....	<1.0	<	<	10	90	[1]1.0-7.0
PAHs, total	100	1,400	6,200	17,000	44,000	50
PCBs, total	<50	<	<	<	20,000	50-100

[1] Excludes one analysis with a high minimum reporting limit.

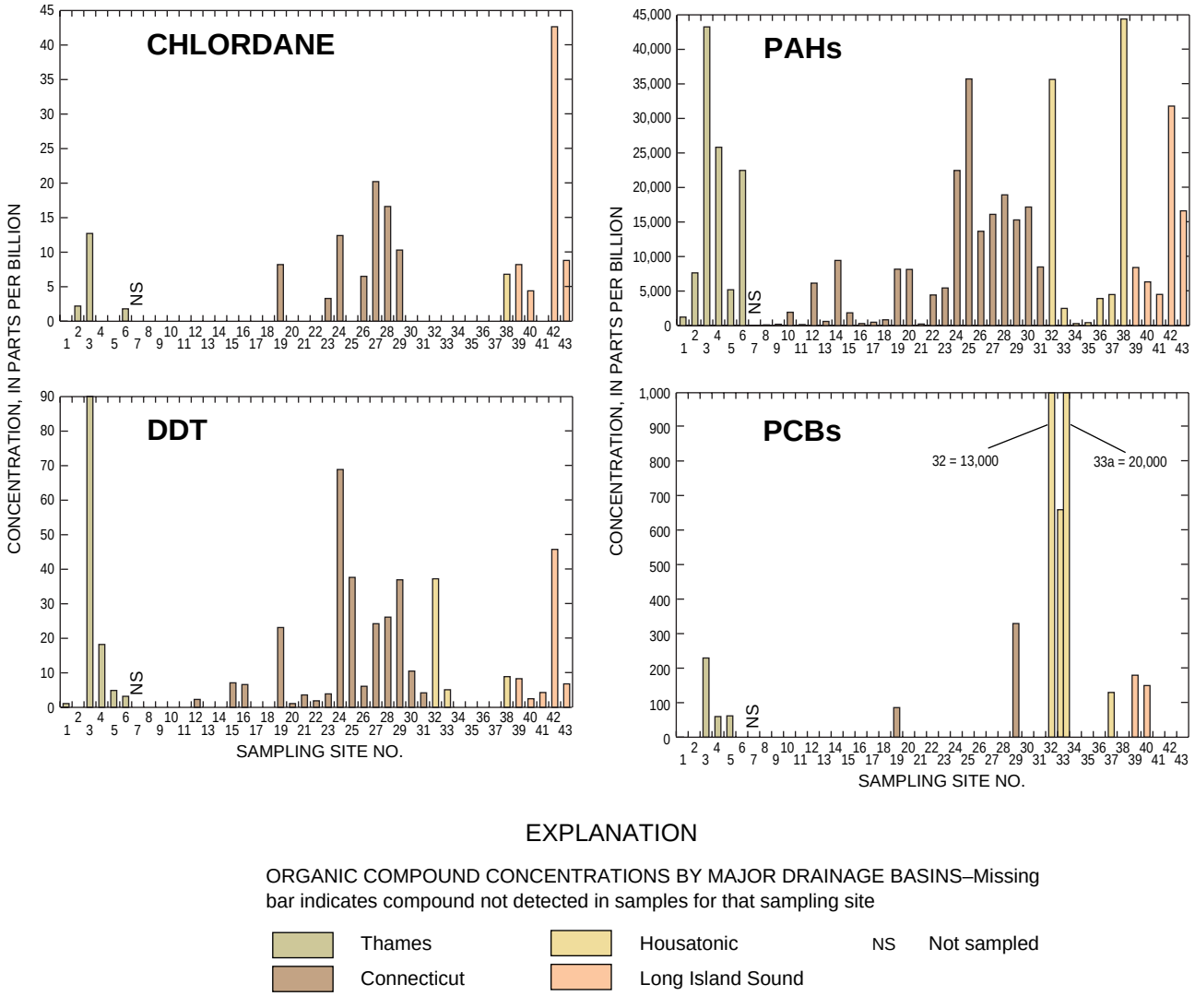

Figure 6. Geographic distribution of selected organic-compound concentrations in the Connecticut, Housatonic, and Thames River Basins, 1992-94.

The minimum reporting limit varied between sample analysis run for some organic compounds due to interference from co-eluding compounds (compounds that are not separated from the analyte during the sample analysis); thus, a range of minimum reporting limits are shown in table 3. In the discussion that follows, concentrations of the selected organic compounds greater than the minimum reporting limit for each sample analysis were considered detected. Concentrations less than the minimum reporting limit for each sample analysis were considered not detected.

Total PAHs were the most commonly detected compound. PAHs were detected in all 42 sites sampled. Total PAH concentrations ranged from 100 to 44,000 ppb, with 75 percent of the sites having concentrations greater than 1,400 ppb. Total DDT was detected in 29 of the 42 sites sampled. At the 29 sites where DDT was detected in streambed sediments, the concentrations ranged from 1.1 to 90 ppb; concentrations were greater than 3.9 ppb for 75 percent of those sites. Total chlordane was detected in 15 of the 42 sites sampled. At the 15 sites where total chlordane was detected in streambed sediments, the sum of concentrations ranged from 1.8 to 43 ppb; concentrations were greater than 5.5 ppb for 75 percent of those sites. PCBs were not commonly detected in streambed sediments collected in this survey; however, PCBs were detected in 10 of the 42 sites sampled. At the 10 sites where PCBs were detected in streambed sediments, the concentrations ranged from 60 to 20,000 ppb; concentrations were greater than 97 ppb for 75 percent of those sites.

Connecticut River Basin

About one-half (51 percent) of the selected organic compound concentrations in streambed sediments collected from the Connecticut River Basin were greater than the minimum reporting limit (fig. 6). Chlordane and DDT were detected relatively frequently in 29 and 67 percent of the samples, respectively. In contrast, PCBs were detected less frequently in streambed sediments collected from the Connecticut River Basin than any other basin sampled—at only two of the 24 sites. The median PAH concentrations were greater in this basin than in the other basins sampled.

Housatonic River Basin

One-half of the concentrations of selected organic compounds detected in streambed sediments collected from the Housatonic River Basin were greater than the minimum reporting limit. Chlordane and DDT were detected less often in streambed sediment samples collected from the Housatonic River Basin than in any other basin sampled—about 14 and 43 percent of the samples, respectively. In contrast, PCBs were frequently detected—in about 43 percent of the samples. Concentrations of PCBs were highest in streambed sediments at site 33a on the Housatonic River at Lenox, Massachusetts. The concentration of PCBs on the East Branch and mainstem Housatonic Rivers are among the highest PCB concentrations in the Nation (Thomas Lopes, U.S. Geological Survey, oral commun., 1997).

Thames River Basin

About 71 percent of the organic-compound concentrations detected in samples from this basin exceeded the minimum reporting limit—the second highest detected frequency in the study unit (fig. 6). PCBs were detected at elevated concentrations more frequently in streambed sediments from the Thames River Basin than any other basin in the study unit—about 50 percent. In addition, concentrations of chlordane and DDT were detected frequently in streambed sediments sampled in this basin—about 50 and 83 percent, respectively. DDT concentrations were highest in streambed sediments at site 3 on the Quinebaug River at Saundersdale, Massachusetts. The second highest PAH concentration also was detected in streambed sediments at site 3.

Long Island Sound Coastal River Basin

About 80 percent of the organic-compound concentrations detected in streambed sediments collected in the Long Island Sound Coastal River Basin were greater than the minimum reporting limit. Streambed sediments in this basin may be more highly contaminated with the four selected organic compounds than other basins in the study (fig. 6). Concentrations of chlordane and DDT greater than the

minimum reporting limit were detected most frequently in streambed sediments collected in the Long Island Sound Coastal River Basin—about 80 and 100 percent, respectively. Total chlordane concentrations were highest in streambed sediments at site 42 on the Rooster River near Fairfield in southern Connecticut. In addition, concentrations of PCBs were detected frequently—in about 40 percent of the samples.

Factors Contributing to Distribution of Contamination

The six selected trace elements and four groups of organic compounds in streambed sediments were generally detected at the lowest concentrations in the northern forested drainage basins and at the highest concentrations in the southern urbanized drainage basins. Concentrations were highest in urban drainage basins generally due to the larger number of land-use related non-point sources and point sources in these basins than in the forested basins. Larger drainage basins in which land use is varied and mixed may incorporate large urban areas that provide sources for the frequently detected concentrations. Conversely, predominately forested drainage basins would be expected to have the least number of detectable concentrations, as major point and non-point sources of trace elements and organic compounds are less likely to be located there.

Point Sources

Industrial effluent and municipal wastewater are major point sources for most trace elements and organic compounds in this study. More than 700 point sources are permitted to discharge into streams in the study unit (Harris, 1997); 177 of these discharge effluent with volumes exceeding 1 Mgal/d (fig. 7). Most of these point sources are in the urban centers of Massachusetts and Connecticut, and most discharge directly into the Connecticut, Quinebaug, Naugatuck, Pequabuck, and Quinnipiac Rivers, or to Long Island Sound. These discharges are from various industrial sources or activities, which include (1) wastewater-treatment facilities and food processing, (2) textile manufacturers, (3) paper and paperboard products manufacturers, (4) wood and paper products, stone, glass, and concrete manufacturers, (5) chemicals, plastics, and printing, (6) metals manufacturers, (7) heavy industries, (8) light industries, and (9) utilities and electricity production (Zimmerman and others, 1996; Harris, 1997).

An example of a industrial point source that is known to have released large quantities of industrial and municipal PCB-contaminated wastes is located in the Housatonic River Basin (fig. 8). In the 1970's, leakage of PCBs from an industrial facility in Pittsfield was determined to be responsible for the release of about 22,000 pounds of PCBs into the East Branch and mainstem Housatonic Rivers in Massachusetts (Gay and Frimpter, 1985). PCB concentrations detected in this study were highest (20,000 ppb) at site 33A on the Housatonic River just downstream of Pittsfield (fig. 8). This concentration diminishes downstream on the Housatonic River from the source to sites 33 (660 ppb) and to site 37 (130 ppb) about 70 mi downstream.

Non-Point Sources

Typically, the non-point sources considered have been of various forms of land drainage and atmospheric deposition. Land drainage can be further divided into runoff from urban, agricultural and forested areas, and solid waste leachate. Atmospheric loading includes chemicals in rain and dry deposition.

The interspersed nature of land-use development of New England (fig. 2) at a scale of acres to tens of acres commonly makes it difficult to determine which land uses are primarily responsible for the geographic distribution of trace-element and organic-compound concentrations. Although the exact sources cannot be determined, the enrichment of streambed sediments in general occurs within or near the major urban areas in the southern part of the study unit.

An illustration of a non-point source for a contaminant is the past widespread use of chlordane as an insecticide, and in particular for treatment of termite infestation in urban areas. This widespread application is the probable source of the high chlordane concentrations measured in streambed sediments in streams that drain urban areas. For example, site 42 is on the Rooster River near Fairfield, Connecticut, which has a highly urbanized drainage basin with one of the largest population densities in the study unit.

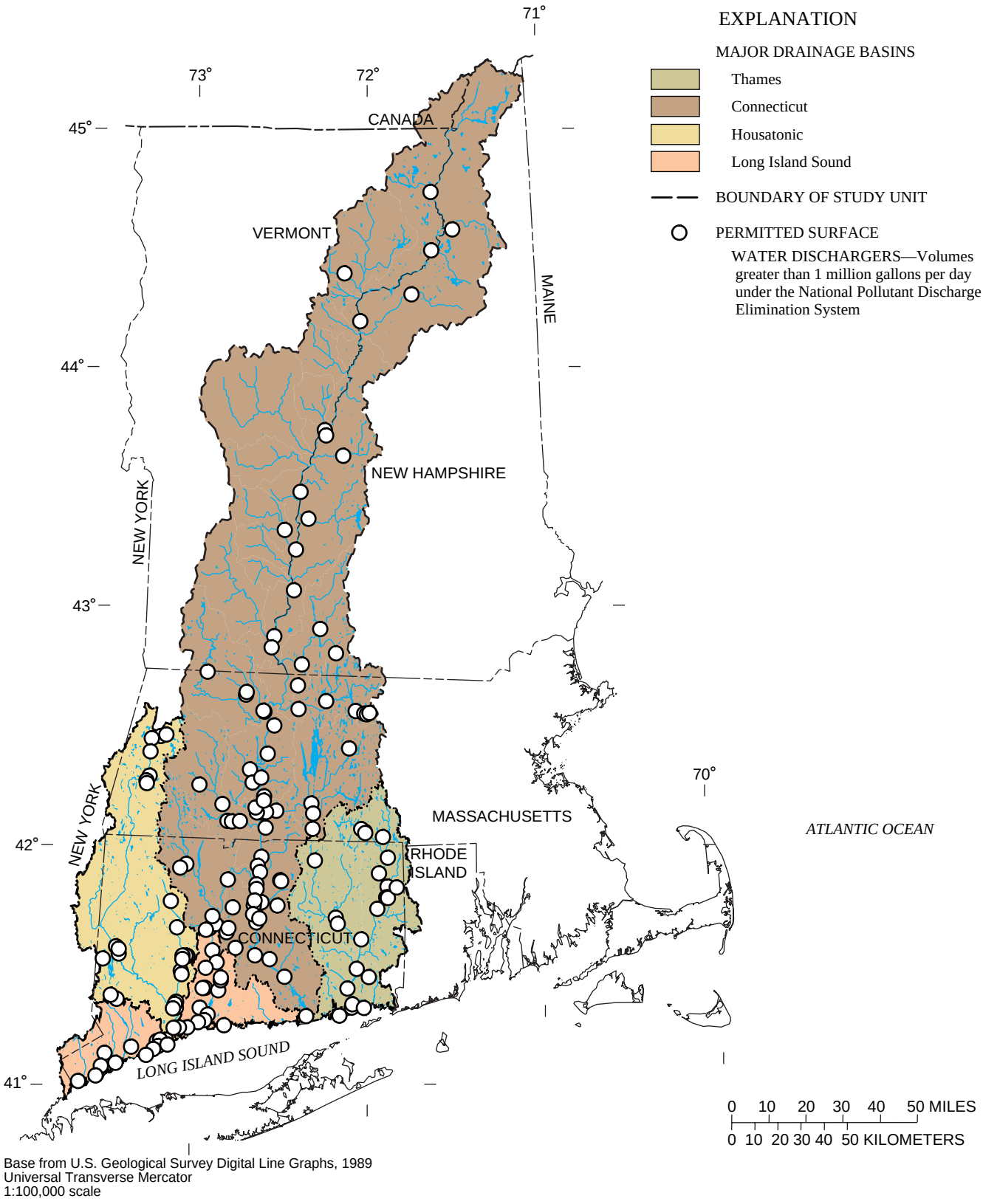

Figure 7. Geographic distribution of permitted surface-water dischargers with discharge volumes greater than 1 million gallons per day in the Connecticut, Housatonic, and Thames River Basins, 1992-94.

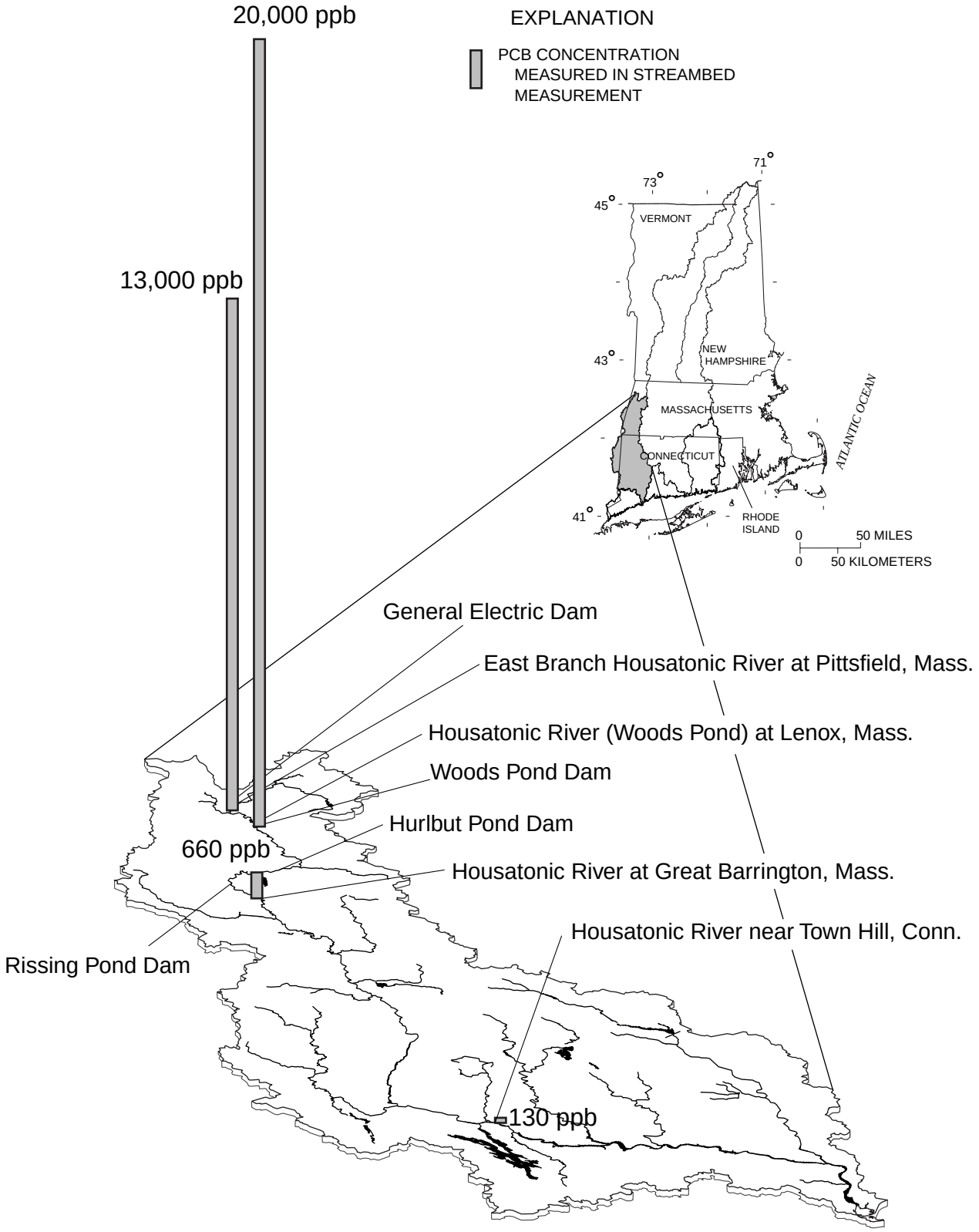

Figure 8. Geographic distribution of PCB concentrations sorbed to bottom sediments and the location of major dams on the East Branch and mainstem Housatonic Rivers in the Connecticut, Housatonic, and Thames River Basins,1992-94.

No permitted dischargers are currently disposing of effluent into the Rooster River, yet it had the highest concentrations of total chlordane detected in this study. Concentrations of the other selected trace elements and organic compounds also were high at site 42, with the exception of PCBs, which were not detected.

Sediment Transport

The geographic distribution of a contaminant in streambed sediments is controlled primarily by the regional occurrence of its sources. Once a contaminant is discharged into a river, however, it can be readily sorbed by the fine-grained sediments that are suspended in the water column and eventually settle out onto the streambed (Horowitz, 1991). The distribution of these sorbed contaminants within the streambed sediments depends on the physical processes controlling sediment-particle transport (Wittkowski and others, 1987). During high flows, the stream-water velocities may be sufficient to resuspend the sediment-associated contaminants, move them downstream, and redeposit them in another reach of the river. These sediment-associated contaminants will then tend to accumulate in reaches along the stream where the stream velocities decrease, such as behind a dam.

During the 1800's, many rivers in the study unit, including the Quinebaug, French, and Housatonic, were the sites of factories and mills that used the rivers as a source of power through the use of dams and impoundments. These remaining dams, along with dams built more recently for flood control, water supply, and recreation, accumulate sediments and can have a significant effect on the transport and spatial distribution of streambed-sediment contaminants.

For example, PCB concentrations were highest (20,000 ppb) in the bottom sediments along the Housatonic River between Pittsfield, Massachusetts, and the Woods Pond Dam in Lenox, Massachusetts (site 33A, table 1). Woods Pond is the first major impoundment on the Housatonic River below Pittsfield and acts as an effective sediment trap. About 50 percent of the PCBs released in the river are sorbed to sediments lying behind the dam at Woods Pond (Gay and Frimpter, 1985). The significant decrease in PCB concentration in the river below Lee and Lenox, Massachusetts, is attributed to the Woods Pond Dam and the influx of PCB free sediments from tributaries (fig. 8).

Comparison of Point and Non-Point Source Contributions to Streambed-Sediment Concentrations

The relation between enrichment of trace elements and organic compounds in streambed sediments and anthropogenic point and non-point sources were investigated using linear correlation coefficients (Pearson's *r* values). A positive Pearson's *r* value indicates a direct relation between two variables, a negative value indicates an inverse relation. The land use (fig. 2) and population density (fig. 3) are used as surrogates for non-point sources, and NPDES permitted discharges (fig. 7) were used for point sources.

Chromium, copper, lead, mercury, zinc, chlordane, DDT, and PAHs all showed strong associations with non-point sources, with Pearson's *r* values ranging from 0.5 to 0.8 (correlations were significant at the 95-percent confidence level or greater); nickel and PCBs, however, showed slightly weaker associations (less than 0.5). Point sources showed similar strong associations with chromium, copper, lead, mercury, zinc, DDT, PAHs, and PCBs; chlordane and nickel, however, showed weak associations (less than 0.5). Although these statistical-based associations do not provide conclusive evidence of causal relations, they do indicate that enrichment of these containments is likely related to anthropogenic point and non-point sources. Evidence for causation must come from outside the statistical analysis (Helsel and Hirsch, 1992).

Persistence of Contaminants

Many streambed-sediment contaminants are considered chemically stable and are not readily broken down by biological, chemical, and physical processes. Chlordane, DDT, and PCBs are examples of chemically persistent contaminants and their persistence in the environment has resulted in their continued occurrence at elevated concentrations throughout the study unit. For example, although use of chlordane, DDT, and PCBs have been banned for decades, high concentrations were detected at many sites across a substantial part of the study unit (fig. 6). Of the 42 sites sampled for organic compounds, many had concentrations greater than the minimum reporting limit, including chlordane (36 percent of all samples), DDT (69 percent), and PCBs (24 percent). Trace

elements are another example of environmentally persistent contaminants; although Best Management Practices (BMPs) and Source Reduction Programs have been implemented, and shown to reduce present-day discharge of these contaminants (Maurits la Riviere, 1990), the six selected trace elements were greater than background concentrations at many of the sites sampled. The chemical stability and persistence of these contaminants can mean a long-lasting presence of these constituents in the streambed sediments.

POTENTIAL FOR ADVERSE BIOLOGICAL EFFECTS

Concentrations of some contaminants biomagnify through increasing levels on the food chain. Biomagnification can directly affect humans because humans are higher on the food chain. The effects of contaminants in streambed sediments on human health were not directly measured as part of this study because of the complexity involved with the biomagnification process. The presence of trace elements and organic compounds in streambed sediments can be related, however, to their adverse effects on benthic organisms (for example, benthic insects, clams, crayfish, etc.)

The potential for adverse biological effects of contaminated sediment was assessed using interim sediment-quality guidelines (threshold effect levels or TELS, and probable effects levels or PELS) for freshwater sediments (Ecosystem Conservation Directorate Evaluation and Interpretation Branch, 1995). The TELs and PELs define concentration ranges that were rarely, occasionally, or frequently associated with adverse effects (also referred to as the minimal, possible, and probable effect ranges, respectively). The TEL adequately defines the concentration below which effects rarely occurred for all chemicals. The PEL adequately represented the concentration above which effects frequently occurred. Adverse effects include decreased numbers of species, increased occurrence of diseased fish, mortality of sensitive species, or a prediction of toxicity to these contaminants.

The National Status and Trends Program (NSTP) approach (Long and Morgan, 1990) with modifications was used to derive TEL and PEL values. This approach involves the evaluation and compilation of chemical and biological data from numerous studies (including models of equilibrium partitioning in sediments, sediment-quality assessment values, spiked sediment toxicity tests and field studies) conducted throughout North America. The available data covered a large and varied geographic area and included many different species and biological endpoints.

The following evaluation of the extent and frequency of exceedance of these interim sediment-quality guidelines (PELs and TELs) should be considered an informal screening to distinguish the chemicals and locations that are likely to be associated with adverse biological effects. These numerical guidelines were developed with the intention to be conservative in order to “sustain and protect aquatic life” (Ecosystem Conservation Directorate Evaluation and Interpretation Branch, 1995); they are not intended to preclude the use of site-specific biological assessments and other measures of biological effects. Therefore, the numerical guidelines (PELs and TELs) should be used in conjunction with other relative information to support practical and informed decision making regarding sediment quality.

Trace Elements

Although some trace elements are essential for life, all trace elements are toxic to living organisms at sufficiently high concentrations. The physical and geochemical redistribution of trace elements in aquatic environments as a result of human activities has a strong potential to adversely effect benthic organisms. The potential for adverse effects on benthic organisms was frequent for about 36 percent; occasional for about 47 percent; and rare for about 17 percent of all the detected trace-element concentrations at the sampled sites (fig. 9).

The potential for adverse effects on benthic organisms was frequent at 33 of the 43 sampled sites for at least one trace element (fig. 9). Fourteen of the 33 sites are in Connecticut, 13 are in Massachusetts, 3 are in New Hampshire, and 3 are in Vermont. PEL concentrations in streambed sediment were exceeded at 6 sites in the Thames River Basin, at 5 sites in the Long Island Sound Coastal River Basin, at 25 sites in the Connecticut River Basin, and at 5 sites in the Housatonic River Basin.

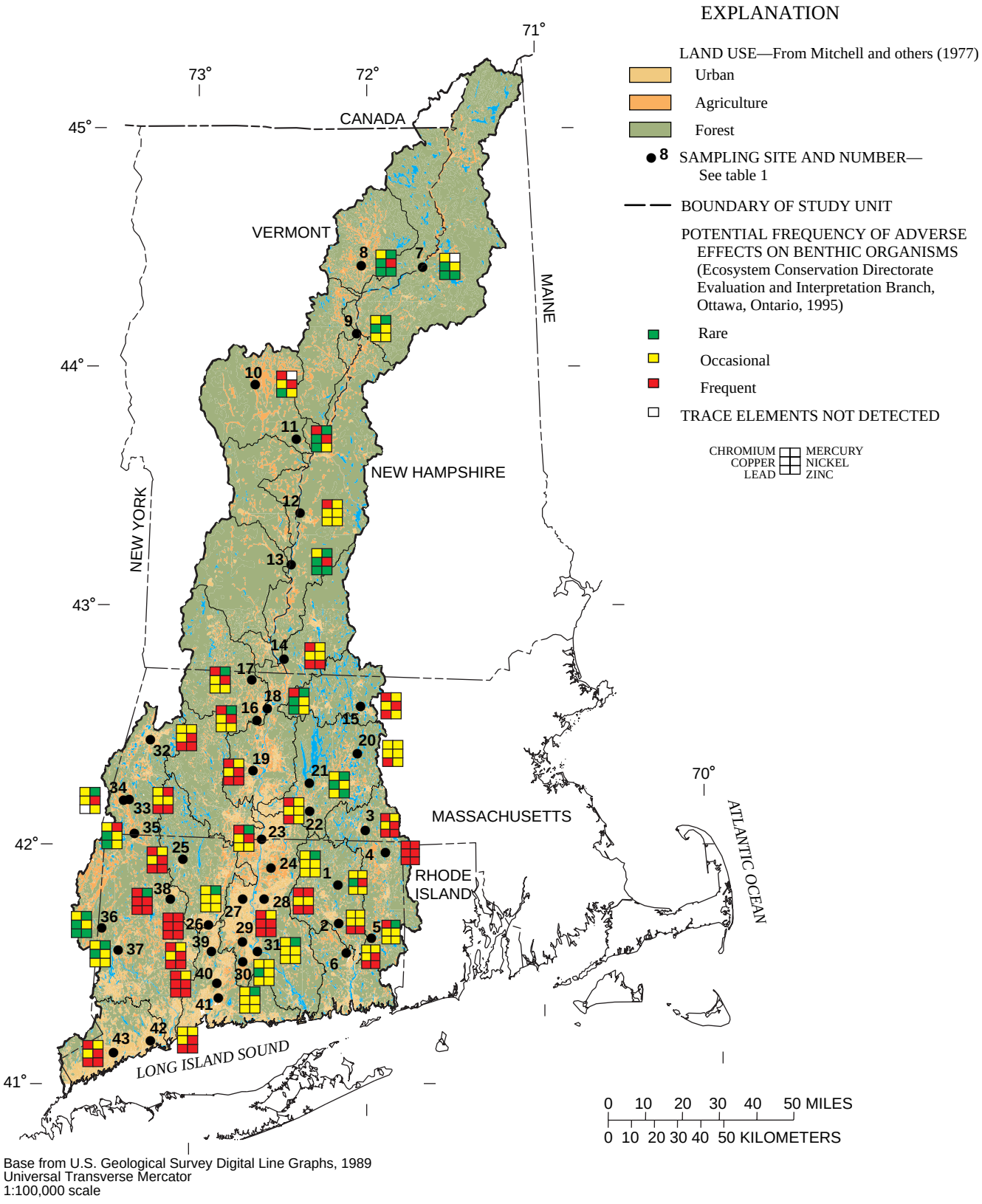

Figure 9. Potential frequency of adverse effects on benthic organisms relative to trace-element concentrations in streambed sediments in the Connecticut, Housatonic, and Thames River Basins, 1992-94.

The largest number of exceedances of the PEL concentration for streambed sediment was for nickel (35.9 ppm) with 23; followed by chromium (90.0 ppm) with 22; lead (91.3 ppm) with 20; zinc (315 ppm) with 17; and copper (197 ppm) and mercury (0.486 ppm), with 5 each. The PEL concentration of all six selected trace elements was exceeded at site 26, Pequabuck River at Forestville, Connecticut, and site 4, French River at North Grosvenorville, Connecticut. Multiple exceedance of the PEL concentration of chromium, copper, nickel, lead and zinc in streambed sediments also were detected at sites 29, 38, and 40. At site 40, Quinnipiac River at Quinnipiac, Connecticut, chromium was 7.7 times the PEL concentration, this was the large exceedance of all the selected trace elements among the 43 sites sampled.

The potential for occasional adverse effects on benthic organisms by at least one trace element is likely to occur at all of the streambed-sediment sampling sites; these concentration ranges are less than the PEL but greater than the TEL. The largest number of exceedances of the TEL concentration of streambed sediment was for copper (35.7 ppm) with 26, followed by chromium (37.3 ppm), and zinc (123 ppm) with 21 each; nickel (18 ppm) with 20; mercury (0.174 ppm) with 18; and lead (35 ppm) with 15 (fig. 9). The median concentration (table 2) for all six selected trace elements range from 1.1 to 2.4 times the TEL concentrations of streambed sediment.

Organic Compounds

Chlordane, DDT, PCBs, and high concentrations of PAHs are found in streambed sediments only as a result of human activities. As many biological systems are not well adapted to the effects of these constituents, they may be toxic or in some way harmful to aquatic organisms at very low concentrations. The potential frequency of adverse effects on benthic organisms was frequent for about 5 percent of the concentrations greater than the minimum reporting limit for chlordane, DDT, PAHs, and PCBs; occasional for about 33 percent; and rare for 18 percent.

The potential for adverse effects on benthic organisms was frequent at 8 of the 42 sites sampled by at least one organic compound (fig. 10). Five of these 8 sites are in Connecticut and three sites are in Massachusetts. PEL concentrations of all selected organic compounds in streambed sediments were not exceeded in New Hampshire and Vermont. However, at least one site exceeded a PEL concentration in streambed sediments in each of the four major drainage basins. About 17 percent of the sites sampled in the Connecticut River Basin (4 sites) exceeded a PEL concentration of streambed sediment (table 4); about 29 percent in the Housatonic River Basin (2 sites); about 20 percent in the Long Island Sound Coastal River Basin (1 site); and about 17 percent in the Thames River Basin (1 site).

The largest number of exceedance of the PEL concentrations for streambed sediment was total chlordane with six; followed by total PCBs with three. None of the total DDT and total PAH concentrations of the sampled streambed sediments were greater than the PEL concentration of streambed sediment. However, some individual PAH compounds were detected in high enough concentrations to exceed their individual PEL concentrations. The number of PEL exceedances for organic compounds (total chlordane and PCBs) were largest for the streambed sediment of the Mattabasset River at Little River, Connecticut (site 29); DDT and PAH were detected at concentrations less than the PEL but greater than the TEL concentration at this site. The concentration of one organic compound was greater than the PEL at five streambed-sediment sampling sites in Connecticut (sites 24, 27, 28, and 42) and three in Massachusetts (sites 3, 32, and 33).

Table 4. Streambed-sediment-quality guidelines and their relation to the potential frequency of adverse effects on benthic organisms

[Interim freshwater sediment quality guidelines: Threshold effect levels (TELS)—Concentrations below which adverse biological effects are observed rarely. Probable effect levels (PELS)—Concentrations above which adverse biological effects are observed frequently]

Constituent	Threshold effect levels (TELS)	Probable effects level (PELS)
Trace Elements, in parts per million (ppm)		
Chromium	37.3	90.0
Copper	35.7	197
Lead	35	91.3
Mercury	.174	.486
Nickel	18	35.9
Zinc	123	315
Organic Compounds, in parts per billion (ppb)		
Chlordane	4.5	8.9
DDT	5.98	4,450
PAHs	4,000	100,000
PCBs	34.1	277

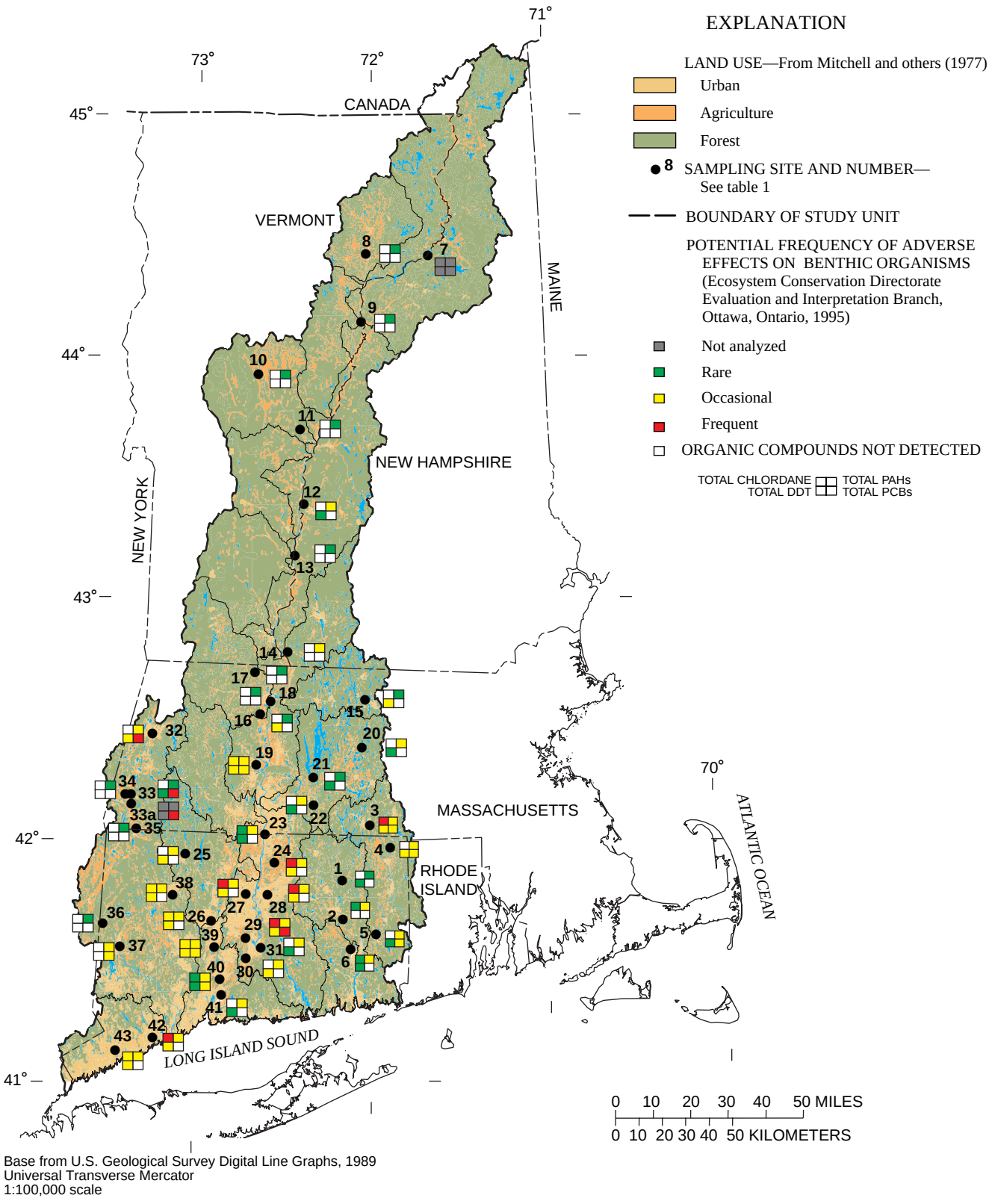

Figure 10. Potential frequency of adverse effects on benthic organisms relative to organic-compound concentrations in streambed sediments in the Connecticut, Housatonic, and Thames River Basins, 1992-94.

PCB concentrations exceeded the PEL concentration of streambed sediment at site 33A, the Housatonic River at Lenox, Massachusetts by about 72 times; this was the highest exceedance of any PEL concentration for streambed sediment in the study unit.

Organic compounds at 30 of the 42 sites were detected in concentrations less than the PEL concentration, but greater than the TEL concentration, by at least one organic contaminant (fig. 10).The most exceedances of the TEL for streambed sediments was total PAH with 27, total DDT with 17, total PCBs with 7, and total chlordane with 5. The TEL concentration was exceeded for all four of the selected organic compounds at Mill River at Northampton, Massachusetts (site 19) and Quinnipiac River at Stillmans Corner, Connecticut (site 39). The TEL concentration was exceeded by at least two organic compounds at many streambed-sediment sampling sites throughout the basins. About 36 percent of the sites sampled in Massachusetts (sites 17, 18, 21, 34, and 35) did not exceed TEL concentrations of streambed sediments; about 8 percent in Connecticut (sites 1 ad 36); about 25 percent in New Hampshire (site 13); and all the sites sampled in Vermont (sites 8, 9, 10, and 11). The potential for adverse effects on benthic organisms was rare relative to all selected organic compounds at these sites.

Synergistic Effects of Contaminants

At many sites, more than one of the selected trace elements and/or organic compounds are present at high concentrations. The presence of multiple contaminants is important for the assessment of the toxicity of the sediment, or of the water from which they are collected because of possible synergistic effects among the contaminants. Synergistic effects could cause a combination of contaminants to be more toxic than any single contaminant.

Benthic organisms have the potential to be adversely affected by more than one contaminant at many sites throughout the study unit. For example, at least two trace elements were detected in concentrations greater than the PEL concentration for streambed sediments at 24 of the 43 sampling sites. Multiple exceedance of TEL concentrations for trace elements at the sampled sites are more likely; for example two or more constituents were detected in concentrations greater than the TEL concentrations for streambed sediment at all of the sites sampled.

When considering trace elements and organic compounds together, the potential frequency for adverse effects on benthic organisms by more than seven of the ten selected constituents was rare at only three sites (sites 8, 13, and 36) sampled in this study. The magnitude of synergistic effects for the 10 contaminants shown here can not be determined; however, the widespread occurrence of multiple contaminants in the study unit indicates that synergistic effects may increase the potential toxicity to benthic organisms in this region.

Bioaccumulation in Fish Tissue

Once in streams or streambed sediments, trace elements and organic compounds can be absorbed or be ingested by aquatic organisms. If benthic organisms become contaminated, they can act as a source of contaminants to fish. Many of the hydrophobic and lipophilic contaminants are readily stored in the fatty tissue of fish, where they tend to bioaccumulate, and commonly are not readily metabolized. Fish biomagnify these compounds both through uptake from food and directly from water passing over their gills. Fish-eating mammals and birds consume the contaminated fish, and continue to pass contaminants up the food chain. This accumulation of streambed sediment contaminants in fish tissues increases the likelihood that these contaminants will be detected; thus, tissue analysis can be used to provide information about the occurrence and distribution of stream-associated contaminants at otherwise undetectable concentrations (Westman, 1985).

Concentrations of 28 organochlorine compounds in whole fish samples (white sucker) were measured at 31 of the streambed-sediment-sampling sites, and concentrations of 22 trace elements in composited fish liver samples were measured at 14 of the 31 sites (Coles, 1996). The most frequently detected organochlorine compounds were total DDT at 31 sites; total PCBs at 27 sites; and total chlordane at 25 sites. Copper and zinc were detected at all 14 sites, and mercury was detected at 12 sites. Complete data on fish assays and methodology were tabulated in Coles (1996).

DDT, PCBs, and chlordane were detected in fish at 100, 87, and 81 percent of the sites sampled, whereas concentrations greater than the minimum reporting limit were detected at only 80, 27, and 40 percent of the concurrently sampled streambed-sediment sites, respectively. This difference in the frequency of detection may be due to the fact that fish are better accumulators of contaminants (than sediments) over space and time. In addition, sediments were not collected at impoundments where many of these contaminants tend to accumulate. Also, the detection limits for organic compounds in fish tissues are approximately equal to those for streambed sediments, with the exception of PCBs, which is about one-half that of the PCB detection limit for streambed sediment.

In contrast to the organic compounds, only copper and zinc of the six selected trace elements were detected in all fish tissue samples, whereas the selected trace elements were much more frequently detected in streambed sediments. This occurred despite the fact that the detection limits for the trace elements for fish tissue range from about 0.5 to 40 times less than the detection limits for streambed sediments, with the exception of mercury; mercury detection limits are five times lower for streambed sediments than fish tissues. The lack of detections of trace elements in fish tissues relative to those in streambed sediments are likely due to the lack of accumulation of these elements in fish livers (fish livers were sampled for trace elements as part of the sampling protocol).

In general, correlations were weak between most contaminants in streambed sediments and in fish with the exception of total chlordane, total DDT, and total PCBs. These constituents showed strong correlations between concentrations in streambed sediments and fish (fig. 11). This indicated that there may be a direct relation between the occurrence and distribution of total chlordane, total DDT, and total PCBs in streambed sediments and the presence of these contaminants in fish tissue. This association between concentrations of total chlordane, total DDT, and total PCBs in fish and in sediments is expected because these contaminants are highly lipophilic and hydrophobic and, therefore, tend to reside in the fatty tissues of fish (Smith and Ruhl, 1996) and within streambed sediments. Because of biomagnification and bioaccumulation of these compounds, they were detected in fish at concentrations about 10 times the concentrations detected in streambed sediments

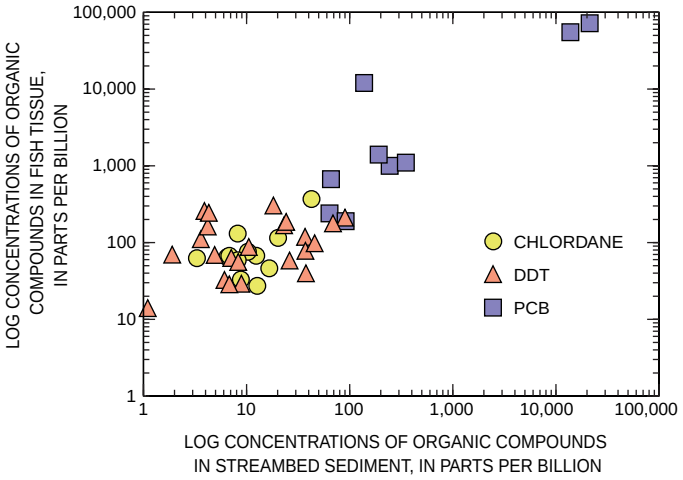

Figure 11. Concentrations of total chlordane, total DDT, and total PCB of white suckers and streambed sediments sampled at the same location in the Connecticut, Housatonic, and Thames River Basins, 1992-94.

sampled at the same location (fig. 11). This association between streambed sediments and fish concentrations may be used to assess the potential accumulation of total chlordane, total DDT, and total PCBs from streambed sediments into biological organisms and hence, to become a direct threat to human health and to fish-eating wildlife.

Potential Human Health Impacts—Fish Consumption Advisories

Threats to human health through consumption of contaminated fish has received much attention by State Regulatory and Health Officials and has resulted in bans or restrictions on the human consumption of some species of fish in the study unit. Currently (1997), a fish consumption advisory is in effect for mercury-contaminated water bodies in Massachusetts (Massachusetts Office of Water Pollution Control, Office of Watershed Management, 1995), and Statewide advisories on mercury contamination have been issued in New Hampshire (New Hampshire Department of Environmental Services, 1996) and Vermont (Vermont Department of Environmental Conservation, 1996). These advisories limit the number of fish of certain species that should be consumed by specific members of the population, most importantly by pregnant women and young children. In addition, bans are in effect on the consumption of selected fish species from specific

stream reaches because of PCB contamination. These stream reaches include those along the Housatonic, Millers, and Otter Rivers in Massachusetts (Massachusetts Office of Water Pollution Control—Office of Watershed Management, 1995); and along the Connecticut and Housatonic Rivers in Connecticut (Connecticut Department of Environmental Protection, 1994).

SUMMARY

Streambed-sediment quality in the Connecticut, Housatonic, Thames, and Long Island Sound Coastal River Basins of New England has been adversely effected by various human activities and at some locations the sediments have been contaminated by trace elements and organic compounds. Chromium, copper, lead, mercury, nickel, zinc, chlordane, DDT, PAHs, and PCBs were detected in samples from throughout the study unit, but concentrations of these constituents generally were lowest in the northern forested drainage basins and highest in the southern urbanized basins. The occurrence and distribution of trace elements and organic compounds in the study unit appears to be controlled primarily by the geographical distribution of point and non-point sources of those elements and compounds; the spatial distribution also is influenced by sediment-transport processes and the location of dams and impoundments throughout the study unit.

With the exception of mercury, these six trace elements were detected in every streambed-sediment sample; mercury was detected at all but two sites. About 72 percent of the concentrations of the selected trace elements detected in sediment samples from the Thames River Basin exceeded natural crustal abundances; this was the highest exceedance percentage of all the basins in the study unit. This indicates that in general, streambed sediments at sampled sites in the Thames River Basin have been contaminated with trace elements more so than other basins in the study unit.

The most frequently detected organic compounds included chlordane, dichlorodiphenyltrichloroethane (DDT), polychlorinated biphenyls (PCBs), and the polyaromatic hydrocarbons (PAHs)—chrysene, fluoranthene, and pyrene. About 80 percent of the organic-compound concentrations detected in streambed sediments collected in the Long Island Sound Coastal River Basin were greater than the minimum reporting limit. Streambed sediments in this basin may be more highly contaminated with the four selected organic compounds than other basins in the study unit.

Some trace elements represent the most geographically widespread threats to living organisms. These exceed sediment-quality guidelines over a wider geographical area, although usually by lower ratios of contaminant concentration to sediment-quality guideline value than the organic compounds. The potential frequency for adverse effects on benthic organisms was frequent for about 36 percent; occasional for about 47 percent; and rare for about 17 percent of the detected trace-element concentrations in the study unit. About 80 percent of the sites sampled in the Long Island Sound Coastal Basin (4 sites) exceeded sediment-quality guidelines for trace-element concentrations of streambed sediment (table 2); about 71 percent in the Housatonic River Basin (5 sites); 100 percent in the Thames River Basin (6 sites); and about 72 percent in the Connecticut River Basin (18 sites).

Some organic contaminants pose the greatest biological threat in terms of exceedances of sediment-quality guideline concentrations; they are present at sufficiently high concentrations to cause severe effects at a limited number of locations in the study unit. The potential frequency for adverse effects on benthic organisms was frequent for about 5 percent of the selected organic compound concentrations greater than minimum reporting limit in the study unit; occasional for about 33 percent; and rare for about 18 percent. About 17 percent of the sites sampled in the Connecticut River Basin (4 sites) exceeded organic compound sediment-quality guideline concentrations (table 4); about 42 percent in the Housatonic River Basin (3 sites); about 20 percent in the Long Island Sound Coastal River Basin (1 site); and about 16 percent in the Thames River Basin (1 site).

Fish concurrently collected with streambed sediments had elevated concentrations of contaminants, however, these concentrations showed weak correlations to most of the selected contaminants in the streambed sediments, with the exception of the organic compounds chlordane, DDT, and PCBs. Human consumption of contaminated fish and terrestrial animals may pose a threat to human health. This human health threat has received much attention by State Regulatory and Health Officials and has resulted in bans or restrictions on the human consumption of certain fish in certain stream reaches throughout the study unit.

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