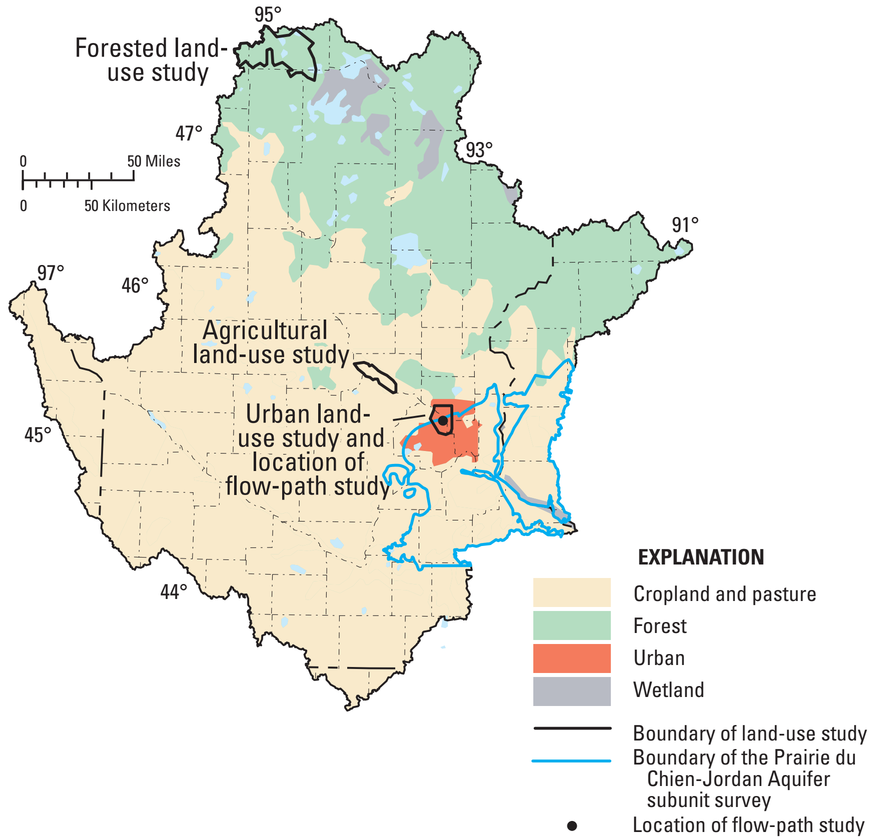
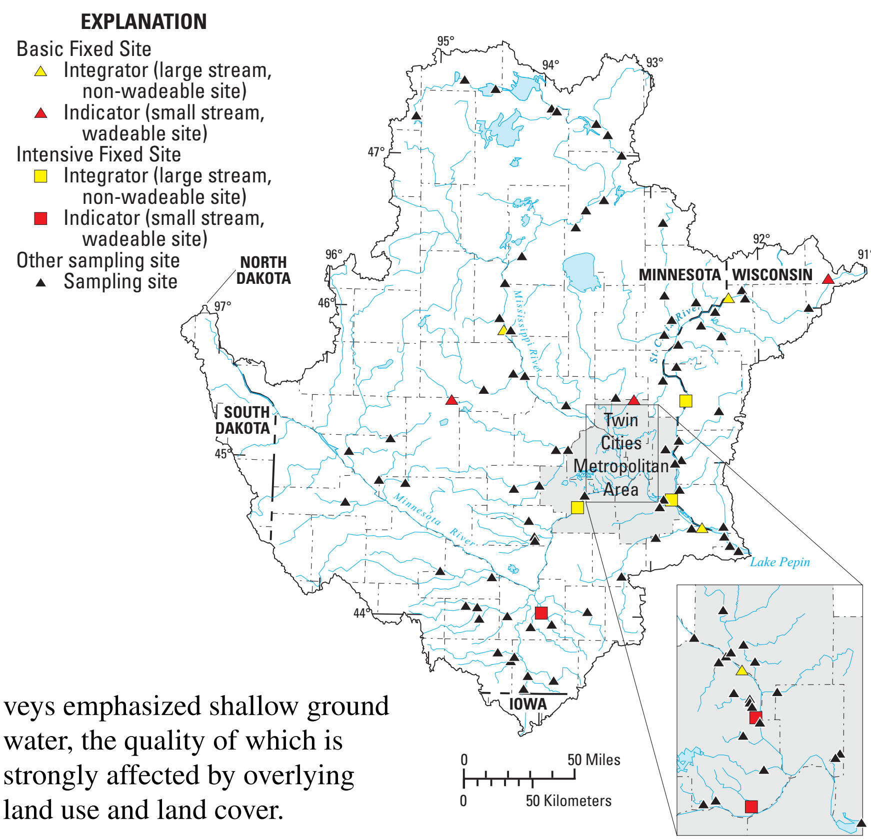
During 1996–98, about 4,200 water-quality aquatic-biological samples from about 240 sites were collected in the Study Unit, processed, and analyzed, using nationally consistent protocols and methods (Gilliom and others, 1995). The NAWQA design included physical, chemical, and aquatic-biological aspects of surface water and ground water for the entire Study Unit. Six sampling components were included in the sampling design. Each component involved measurements of water-quality or aquatic biological characteristics at one or more spatial or temporal scales. Three of the sampling components addressed surface water and aquatic biology, and three addressed ground water. A detailed description of the design and implementation of these water-quality studies is contained in Stark and others (1999).

Water quality in streams was assessed through water-chemistry and aquatic-biological studies. The surface-water and aquatic biology components included (1) stream sites that integrate multiple land uses and encompass large watersheds (integrator site network), (2) stream sites that indicate homogeneous and more specific land uses (indicator site network), and (3) stream sites sampled for special studies (synoptic surveys).

Ground-water quality was assessed for aquifer/land-use combinations using three sampling strategies: (1) a regional study of a selected major aquifer (subunit survey), (2) targeted-area studies in selected land uses (land-use studies), and (3) a localized study of processes occurring along shallow ground-water-flow paths (flow-path study). These studies and surveys emphasized shallow ground water, the quality of which is strongly affected by overlying land use and land cover.





SUMMARY OF DATA COLLECTION IN THE UPPER MISSISSIPPI RIVER BASIN, 1995–98

Study component	Purpose of component and types of data collected	Types of sites sampled	Number of sites	Sampling frequency and period
Stream Chemistry				
Basic Fixed Sites— large rivers	Major ions, organic carbon, suspended sediment, nutrients, and streamflow were measured to describe concentrations and amounts of constituents transported in major tributaries in and from the Study Unit.	Sites on the Mississippi, Minnesota, and St. Croix Rivers draining 1,510 to 46,800 mi^2 that integrate the effects of agricultural, urban, and forested land use and physiographic regions.	4 in 1996–97; 3 in 1998	Monthly beginning in March 1996 and during selected runoff events
Basic Fixed Sites— indicator tributaries	Major ions, organic carbon, suspended sediment, nutrients, and streamflow were measured to determine the effects of land use (undeveloped, urban, or agricultural) and surficial geology on stream-water quality.	Streams draining 27.3 to 232 mi^2 of homogeneous agricultural, urban, or forested areas on unsorted or sorted surficial glacial deposits.	3 in 1996; 2 in 1997–98	Monthly beginning in March 1996 and during selected runoff events
Intensive Fixed Site— large rivers	Major ions, organic carbon, suspended sediment, nutrients, pesticides, and streamflow were determined to define short-term temporal variability.	Sites on the Mississippi, Minnesota, and St. Croix Rivers draining 6,150 to 37,000 mi^2.	3	Monthly beginning in March 1996 and during selected runoff events
Intensive Fixed Site— indicator tributaries	Major ions, organic carbon, suspended sediment, nutrients, pesticides, and streamflow were determined to define short-term temporal variability. Volatile organic compounds were determined at two urban sites.	Streams draining 28.2 to 130 mi^2 in homogeneous agricultural and urban areas.	3	Weekly or biweekly during April through August 1997
Snowmelt synoptic survey	Nutrients and suspended sediment were determined using modified NAWQA protocols to characterize instantaneous concentrations and yields during increasing streamflow of snowmelt runoff.	Streams draining 10 to 46,800 mi^2.	41	Once in March or April 1997
Stream Ecology				
Bed sediment and tissue	Trace elements and hydrophobic-organic compounds in fish tissue and streambed sediment to determine occurrence and distribution of these compounds throughout the Study Unit.	Sites with drainage areas from 20 to 47,300 mi^2 draining a variety of land use.	Fish sampled at 25 sites, streambed sediment at 27 sites.	1995–96
Basic Fixed Sites— indicator tributaries	Fish, benthic invertebrates, phytoplankton, periphyton, and instream habitat were sampled or characterized to determine the community structure and to evaluate the association between land use and aquatic communities.	Same as for stream chemistry	6 in 1996; 5 in 1997–98	One each fall 1996–98
Basic Fixed Sites— large rivers	Fish, benthic invertebrates, phytoplankton, periphyton, and instream habitat were sampled or characterized to determine the spatial distribution of aquatic communities and to evaluate the association between land use and aquatic communities.	Same as for stream chemistry	7	One each fall 1996–98
Urban synoptic study	Nutrients, suspended sediment, pesticides, organic carbon, phytoplankton, and chlorophyll-*a* were analyzed. Aquatic community sampling included fish and invertebrate community sampling and instream habitat to determine how water quality and aquatic communities differ in response to changes in population density.	Streams with drainage areas ranging from 9.9 to 152 mi^2 draining urban areas in the Twin Cities metropolitan area.	13	September-October 1997
Mid-continent agricultural synoptic study	Nutrients, suspended sediment, pesticides, organic carbon, phytoplankton and chlorophyll-*a* were analyzed. Aquatic community sampling included fish and invertebrate community sampling and instream habitat characterization to determine how water quality and aquatic communities differ in response to changes in local-scale riparian cover and to basin-scale soils.	Sites with drainage areas from 60 to 317 mi^2 draining land that was greater than 87 percent agricultural land use.	24	August 1997
Longitudinal synoptic study	Nutrients, suspended sediment, major ions, pesticides, organic carbon, chlorophyll-*a*, and organic compounds indicative of wastewater were analyzed. Aquatic community sampling included fish and invertebrates and instream habitat to characterize the water quality and aquatic communities along the Mississippi River.	Sites with drainage areas ranging from 32 to 46,800 mi^2 along the Mississippi River main stem from Lake Itasca to Red Wing, Minnesota.	Sampled aquatic communities at 12 sites and water chemistry at 19 sites.	July and August of 1998
Ground-Water Chemistry				
Bedrock aquifer survey	Major ions, nutrients, dissolved organic carbon, trace elements, pesticides, volatile organic compounds, radon, and tritium were analyzed to describe the water quality and natural chemical patterns in unconfined and confined portions of the most frequently used bedrock aquifer in the Study Unit.	Existing domestic wells completed in the Prairie du Chien-Jordan aquifer.	25 wells in the unconfined portion 25 wells in the confined portion	July-September 1996
Land-use effects— surficial aquifer	Major ions, nutrients, dissolved organic carbon, pesticides, volatile organic compounds, and tritium were analyzed to determine the effects of specific land uses (urban, agricultural, and forested) on the quality of shallow ground water.	Monitoring wells completed at the water table in the surficial sand and gravel aquifer.	30 wells in the urban study 29 wells in the agricultural study 15 wells in the forested study	June-July 1996, May-September 1998, June 1998
Variations along flow— surficial aquifer	Major ions, nutrients, dissolved organic carbon, trace elements, pesticides, volatile organic compounds, radon, tritium, dissolved gases, and chlorofluorocarbons were analyzed to describe the effects of urban land use on the quality of shallow ground water along ground-water flow from an area of recharge to an area of discharge to a stream.	Monitoring and multiport wells (open to the aquifer at different depths) completed in the surficial sand and gravel aquifer.	1 monitoring well and 6 multiport wells	July 1997, October 1997, August 1998

Alkalinity - The alkalinity of a solution is the capacity for solutes it contains to react with and neutralize acid.

Aquatic-life criteria - Water-quality guidelines for protection of aquatic life. Often refers to U.S. Environmental Protection Agency water-quality criteria for protection of aquatic organisms. See also Water-quality guidelines and Water-quality criteria.

Bioaccumulation - The biological sequestering of a substance at a higher concentration than that at which it occurs in the surrounding environment or medium. Also, the process whereby a substance enters organisms through the gills, epithelial tissues, dietary, or other sources.

Confined aquifer (artesian aquifer) - An aquifer that is completely filled with water under pressure and that is overlain by material that restricts the movement of water.

Degradation products - Compounds resulting from transformation of an organic substance through chemical, photochemical, and/or biochemical reactions.

Drinking-water standard or guideline - A threshold concentration in a public drinking-water supply, designed to protect human health. As defined here, standards are U.S. Environmental Protection Agency regulations that specify the maximum contamination levels for public water systems required to protect the public welfare; guidelines have no regulatory status and are issued in an advisory capacity.

EPT richness index - An index based on the sum of the number of taxa in three insect orders, Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), that are composed primarily of species considered to be relatively intolerant to environmental alterations.

Eutrophication - The process by which water becomes enriched with plant nutrients, most commonly phosphorus and nitrogen.

Human health advisory - Guidance provided by U.S. Environmental Protection Agency, State agencies or scientific organizations, in the absence of regulatory limits, to describe acceptable contaminant levels in drinking water or edible fish.

Index of Biotic Integrity (IBI) - An aggregated number, or index, based on several attributes or metrics of a fish community that provides an assessment of biological conditions.

Load - General term that refers to a material or constituent in solution, in suspension, or in transport; usually expressed in terms of mass or volume.

Nonpoint source - A pollution source that cannot be defined as originating from discrete points such as pipe discharge. Areas of fertilizer and pesticide applications, atmospheric deposition, manure, and natural inputs from plants and trees are types of nonpoint source pollution.

Organochlorine compound - Synthetic organic compounds containing chlorine. As generally used, term refers to compounds containing mostly or exclusively carbon, hydrogen, and chlorine. Examples include organochlorine insecticides, polychlorinated biphenyls, and some solvents containing chlorine.

Point source - A source at a discrete location such as a discharge pipe, drainage ditch, tunnel, wells, concentrated livestock operation, or floating craft.

Polychlorinated biphenyls (PCBs) - A mixture of chlorinated derivatives of biphenyl, marketed under the trade name Aroclor with a number designating the chlorine content (such as Aroclor 1260). PCBs were used in transformers and capacitors for insulating purposes and in gas pipeline systems as a lubricant. Further sale for new use was banned by law in 1979.

Polycyclic aromatic hydrocarbon (PAH) - A class of organic compounds with a fused-ring aromatic structure. PAHs result from incomplete combustion of organic carbon (including wood), municipal solid waste, and fossil fuels, as well as from natural or anthropogenic introduction of uncombusted coal and oil. PAHs include benzo(a)pyrene, fluoranthene, and pyrene.

Tolerant species - Those species that are adaptable to (tolerant of) human alterations to the environment and often increase in number when human alterations occur.

Unconfined aquifer - An aquifer whose upper surface in a water table; an aquifer containing unconfined ground water.

Water-quality criteria - Specific levels of water quality which, if reached, are expected to render a body of water unsuitable for its designated use. Commonly refers to water-quality criteria established by the U.S. Environmental Protection Agency. Water-quality criteria are based on specific levels of contaminants that would make the water harmful if used for drinking, swimming, farming, fish production, or industrial processes.

Suspended sediment - Particles of rock, sand, soil, and organic detritus carried in suspension in the water column, in contrast to sediment that moves on or near the streambed.

Water-quality guidelines - Specific levels of water quality which, if reached, may adversely affect human health or aquatic life. These are nonenforceable guidelines issued by a governmental agency or other institution.

Yield - The mass of material or constituent transported by a river in a specified period of time divided by the drainage area of the river basin.

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APPENDIX—WATER-QUALITY DATA FROM THE UPPER MISSISSIPPI RIVER BASIN IN A NATIONAL CONTEXT

For a complete view of Upper Mississippi River Basin data and for additional information about specific benchmarks used, visit our Web site at http://water.usgs.gov/nawqa/. Also visit the NAWQA Data Warehouse for access to NAWQA data sets at http://infotrek.er.usgs.gov/wdbctx/nawqa/nawqa.home.

This appendix is a summary of chemical concentrations and biological indicators assessed in the Upper Mississippi River Basin. Selected results for this basin are graphically compared to results from as many as 36 NAWQA Study Units investigated from 1991 to 1998 and to national water-quality benchmarks for human health, aquatic life, or fish-eating wildlife. The chemical and biological indicators shown were selected on the basis of frequent detection, detection at concentrations above a national benchmark, or regulatory or scientific importance. The graphs illustrate how conditions associated with each land use sampled in the Upper Mississippi River Basin compare to results from across the Nation, and how conditions compare among the several land uses. Graphs for chemicals show only detected concentrations and, thus, care must be taken to evaluate detection frequencies in addition to concentrations when comparing study-unit and national results. For example, acetochlor concentrations in the Upper Mississippi River Basin agricultural streams were similar to the national distribution, but the detection frequency was much higher (90 percent compared to 33 percent).

CHEMICALS IN WATER

Concentrations and detection frequencies, Upper Mississippi River Basin, 1995–98—Detection sensitivity varies among chemicals and, thus, frequencies are not directly comparable among chemicals

◆ Detected concentration in Study Unit

66 38 Frequencies of detection, in percent. Detection frequencies were not censored at any common reporting limit. The left-hand column is the study-unit frequency and the right-hand column is the national frequency

-- Not measured or sample size less than two

12 Study-unit sample size. For ground water, the number of samples is equal to the number of wells sampled

National ranges of detected concentrations, by land use, in 36 NAWQA Study Units, 1991–98—Ranges include only samples in which a chemical was detected

Streams in agricultural areas
Streams in urban areas
Streams and rivers draining mixed land uses
Shallow ground water in agricultural areas
Shallow ground water in urban areas
Major aquifers

Lowest 25 percent | Middle 50 percent | Highest 25 percent

National water-quality benchmarks

National benchmarks include standards and guidelines related to drinking-water quality, criteria for protecting the health of aquatic life, and a goal for preventing stream eutrophication due to phosphorus. Sources include the U.S. Environmental Protection Agency and the Canadian Council of Ministers of the Environment

| Drinking-water quality (applies to ground water and surface water)

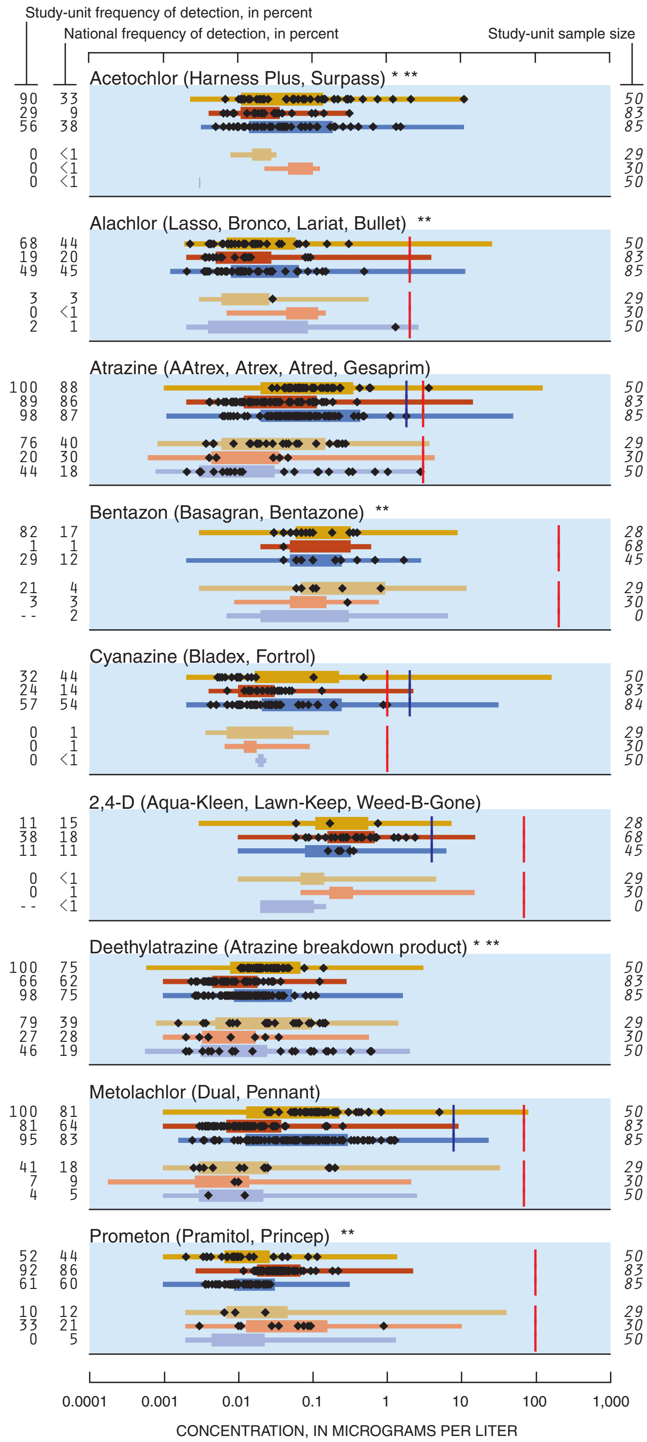
| Protection of aquatic life (applies to surface water only)

| Prevention of eutrophication in streams not flowing directly into lakes or impoundments

* No benchmark for drinking-water quality

** No benchmark for protection of aquatic life

Pesticides in water—Herbicides

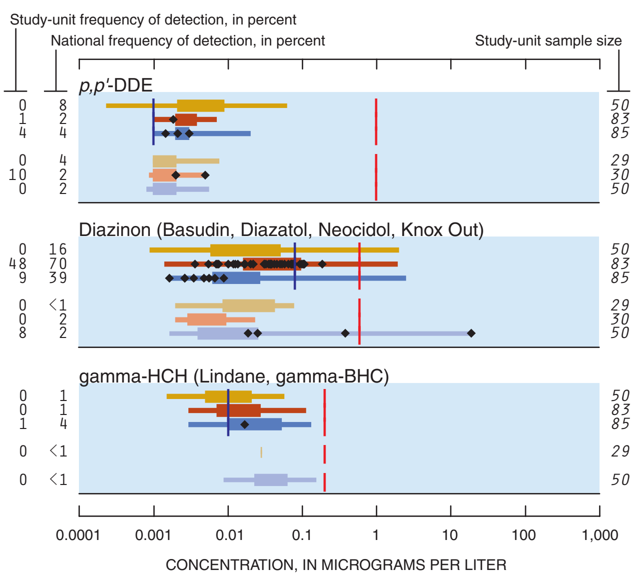


Other herbicides detected
Acifluorfen (Blazer, Tackle 2S) **
Benfluralin (Balan, Benefin, Bonalan) * **
Bromacil (Hyvar X, Urox B, Bromax)
Bromoxynil (Buctril, Brominal) *
DCPA (Dacthal, chlorthal-dimethyl) * **

Dicamba (Banvel, Dianat, Scotts Proturf)
2,6-Diethylaniline (Alachlor breakdown product) * **
Dinoseb (Dinosebe)
Diuron (Crisuron, Karmex, Diurex) **
EPTC (Eptam, Farmarox, Alirox) * **
Metribuzin (Lexone, Sencor)
Napropamide (Devrinol) * **
Oryzalin (Surflan, Dirimal) * **
Pendimethalin (Pre-M, Prowl, Stomp) * **
Propachlor (Ramrod, Satecid) **
Simazine (Princep, Caliber 90)
Tebuthiuron (Spike, Tebusan)
Thiobencarb (Bolero, Saturn, Benthiocarb) * **
Trifluralin (Treflan, Gowan, Tri-4, Trific)

Herbicides not detected
Butylate (Sutan +, Genate Plus, Butilate) **
Chloramben (Amiben, Amilon-WP, Vegiben) **
Clopyralid (Stinger, Lontrel, Transline) * **
2,4-DB (Butyrac, Butoxone, Embutox Plus, Embutone) * **
Dacthal mono-acid (Dacthal breakdown product) * **
Dichlorprop (2,4-DP, Seritox 50, Lentemul) * **
Ethalfluralin (Sonalan, Curbit) * **
Fenuron (Fenulon, Fenidim) * **
Fluometuron (Flo-Met, Cotoran) **
Linuron (Lorox, Linex, Sarclex, Linurex, Afalon) *
MCPA (Rhomene, Rhonox, Chiptox)
MCPB (Thistrol) * **
Molinate (Ordram) * **
Neburon (Neburea, Neburyl, Noruben) * **
Norflurazon (Evital, Predict, Solicam, Zorial) * **
Pebulate (Tillam, PEBC) * **
Picloram (Grazon, Tordon)
Pronamide (Kerb, Propyzamid) **
Propanil (Stam, Stampede, Wham) * **
Propham (Tuberite) **
2,4,5-T **
2,4,5-TP (Silvex, Fenoprop) **
Terbacil (Sinbar) **
Triallate (Far-Go, Avadex BW, Tri-allate) *
Triclopyr (Garlon, Grandstand, Redeem, Remedy) * **

Pesticides in water—Insecticides

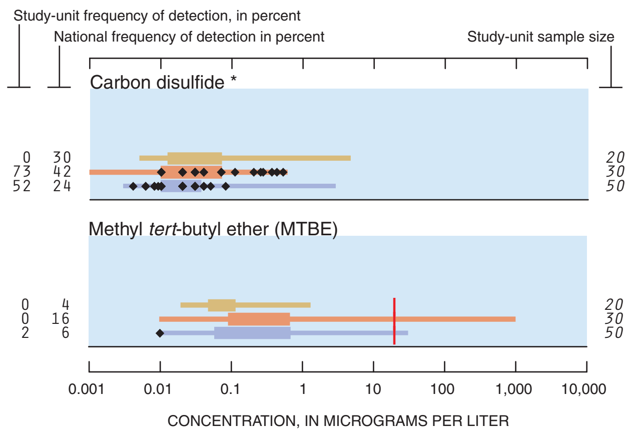


Other insecticides detected
Carbaryl (Carbamine, Denapon, Sevin)
Carbofuran (Furadan, Curaterr, Yaltox)
Chlorpyrifos (Brodan, Dursban, Lorsban)
Dieldrin (Panoram D-31, Octalox, Compound 497)
Ethoprop (Mocap, Ethoprophos) * **
Malathion (Malathion)
Methomyl (Lanox, Lannate, Acinate) **
Oxamyl (Vydate L, Pratt) **
Propargite (Comite, Omite, Ornamite) * **

Insecticides not detected
Aldicarb (Temik, Ambush, Pounce)
Aldicarb sulfone (Standak, aldoxycarb)
Aldicarb sulfoxide (Aldicarb breakdown product)
Azinphos-methyl (Guthion, Gusathion M) *
Disulfoton (Disyston, Di-Syston) **
Fonofos (Dyfonate, Capfos, Cudgel, Tycap) **
alpha-HCH (alpha-BHC, alpha-lindane) **
3-Hydroxycarbofuran (Carbofuran breakdown product) * **
Methiocarb (Slug-Geta, Grandslam, Mesurol) * **
Methyl parathion (Penncap-M, Folidol-M) **
Parathion (Roethyl-P, Alkron, Panthion, Phoskil) *
cis-Permethrin (Ambush, Astro, Pounce) * **
Phorate (Thimet, Granutox, Geomet, Rampart) * **
Propoxur (Baygon, Blattanex, Unden, Proprotox) * **
Terbufos (Contraven, Counter, Pilarfox) **

Volatile organic compounds (VOCs) in ground water

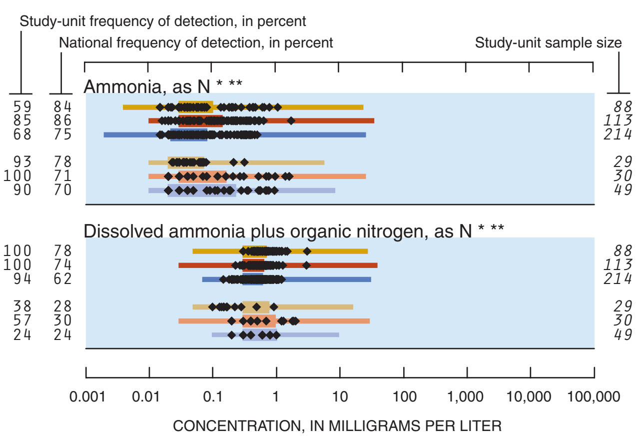
These graphs represent data from 16 Study Units, sampled from 1996 to 1998

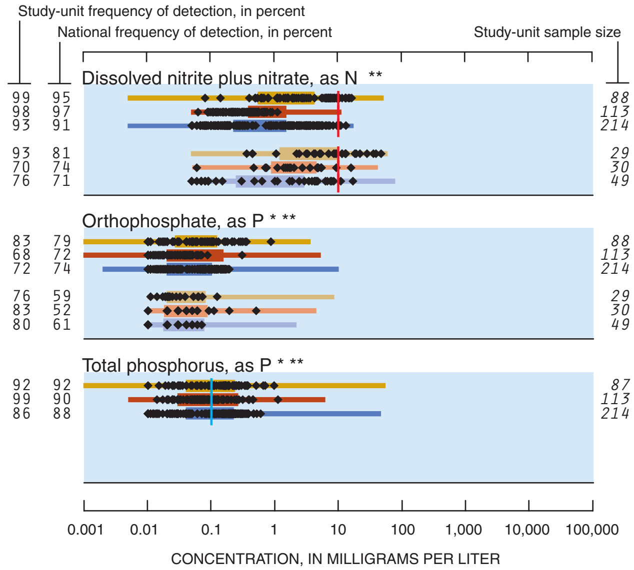


Other VOCs detected
Benzene
Bromodichloromethane (Dichlorobromomethane)
2-Butanone (Methyl ethyl ketone (MEK)) *
Chlorobenzene (Monochlorobenzene)
Chlorodibromomethane (Dibromochloromethane)
Chloroethane (Ethyl chloride) *
Chloromethane (Methyl chloride)
Dichlorodifluoromethane (CFC 12, Freon 12)
1,1-Dichloroethane (Ethylidene dichloride) *
cis-1,2-Dichloroethene ((Z)-1,2-Dichloroethene)
Dichloromethane (Methylene chloride)
Diethyl ether (Ethyl ether) *
1-4-Epoxy butane (Tetrahydrofuran, Diethylene oxide) *
Ethenylbenzene (Styrene)
Iodomethane (Methyl iodide) *
p-Isopropyltoluene (*p*-Cymene) *
4-Methyl-2-pentanone (Methyl isobutyl ketone (MIBK)) *
Methylbenzene (Toluene)
2-Propanone (Acetone) *
Tetrachloroethene (Perchloroethene)
1,2,3,4-Tetramethylbenzene (Prehnitene) *
Tribromomethane (Bromoform)
1,1,1-Trichloroethane (Methylchloroform)
Trichloroethene (TCE)
Trichlorofluoromethane (CFC 11, Freon 11)
Trichloromethane (Chloroform)
1,2,4-Trimethylbenzene (Pseudocumene) *

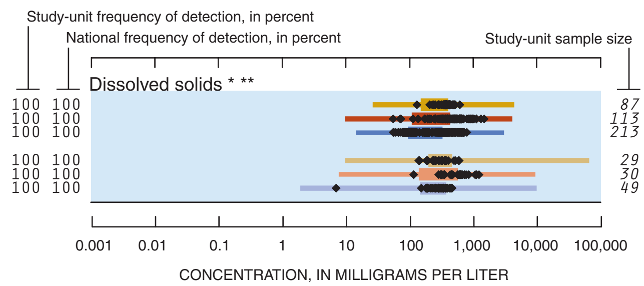
VOCs not detected
tert-Amylmethylether (*tert*-amyl methyl ether (TAME)) *
Bromobenzene (Phenyl bromide) *
Bromochloromethane (Methylene chlorobromide)
Bromoethene (Vinyl bromide) *
Bromomethane (Methyl bromide)
n-Butylbenzene (1-Phenylbutane) *
sec-Butylbenzene *
tert-Butylbenzene *
3-Chloro-1-propene (3-Chloropropene) *
1-Chloro-2-methylbenzene (*o*-Chlorotoluene)
1-Chloro-4-methylbenzene (*p*-Chlorotoluene)
Chloroethene (Vinyl chloride)
1,2-Dibromo-3-chloropropane (DBCP, Nemagon)
1,2-Dibromoethane (Ethylene dibromide, EDB)
Dibromomethane (Methylene dibromide) *
trans-1,4-Dichloro-2-butene ((Z)-1,4-Dichloro-2-butene) *
1,2-Dichlorobenzene (*o*-Dichlorobenzene)
1,3-Dichlorobenzene (*m*-Dichlorobenzene)
1,4-Dichlorobenzene (*p*-Dichlorobenzene)
1,2-Dichloroethane (Ethylene dichloride)
1,1-Dichloroethene (Vinylidene chloride)
trans-1,2-Dichloroethene ((E)-1,2-Dichlorothene)
1,2-Dichloropropane (Propylene dichloride)
2,2-Dichloropropane *
1,3-Dichloropropane (Trimethylene dichloride) *
trans-1,3-Dichloropropene ((E)-1,3-Dichloropropene)
cis-1,3-Dichloropropene ((Z)-1,3-Dichloropropene)
1,1-Dichloropropene *
Diisopropyl ether (Diisopropylether (DIPE)) *
1,2-Dimethylbenzene (*o*-Xylene)
1,3 & 1,4-Dimethylbenzene (*m*-&*p*-Xylene)
Ethyl methacrylate *
Ethyl *tert*-butyl ether (Ethyl-*t*-butyl ether (ETBE)) *
1-Ethyl-2-methylbenzene (2-Ethyltoluene) *
Ethylbenzene (Phenylethane)
Hexachlorobutadiene
1,1,1,2,2,2-Hexachloroethane (Hexachloroethane)
2-Hexanone (Methyl butyl ketone (MBK)) *
Isopropylbenzene (Cumene) *
Methyl acrylonitrile *
Methyl-2-methacrylate (Methyl methacrylate) *
Methyl-2-propenoate (Methyl acrylate) *
Naphthalene
2-Propenenitrile (Acrylonitrile)
n-Propylbenzene (Isocumene) *
1,1,2,2-Tetrachloroethane *
1,1,1,2-Tetrachloroethane
Tetrachloromethane (Carbon tetrachloride)
1,2,3,5-Tetramethylbenzene (Isodurene) *
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113) *
1,2,4-Trichlorobenzene
1,2,3-Trichlorobenzene *
1,1,2-Trichloroethane (Vinyl trichloride)
1,2,3-Trichloropropane (Allyl trichloride)
1,2,3-Trimethylbenzene (Hemimellitene) *
1,3,5-Trimethylbenzene (Mesitylene) *

Nutrients in water

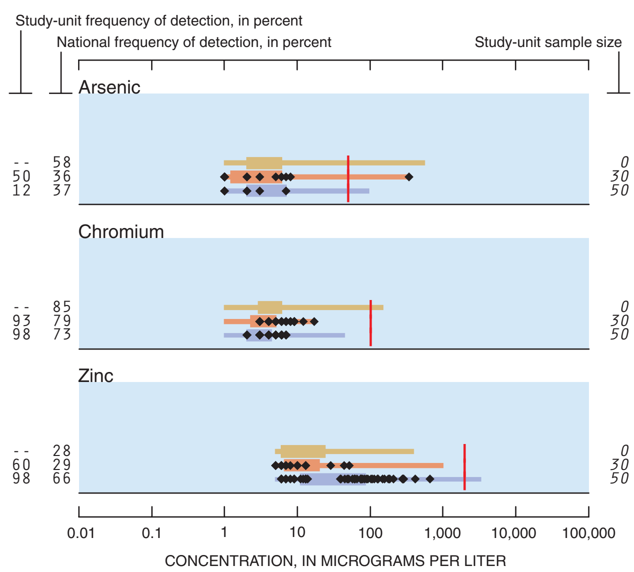


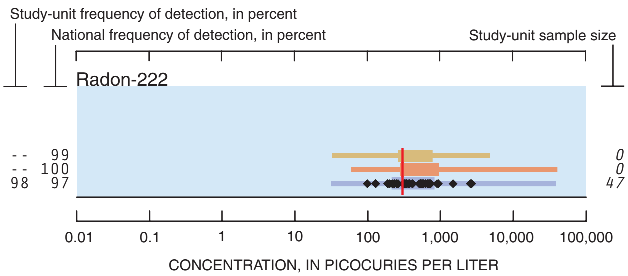


Dissolved solids in water



Trace elements in ground water

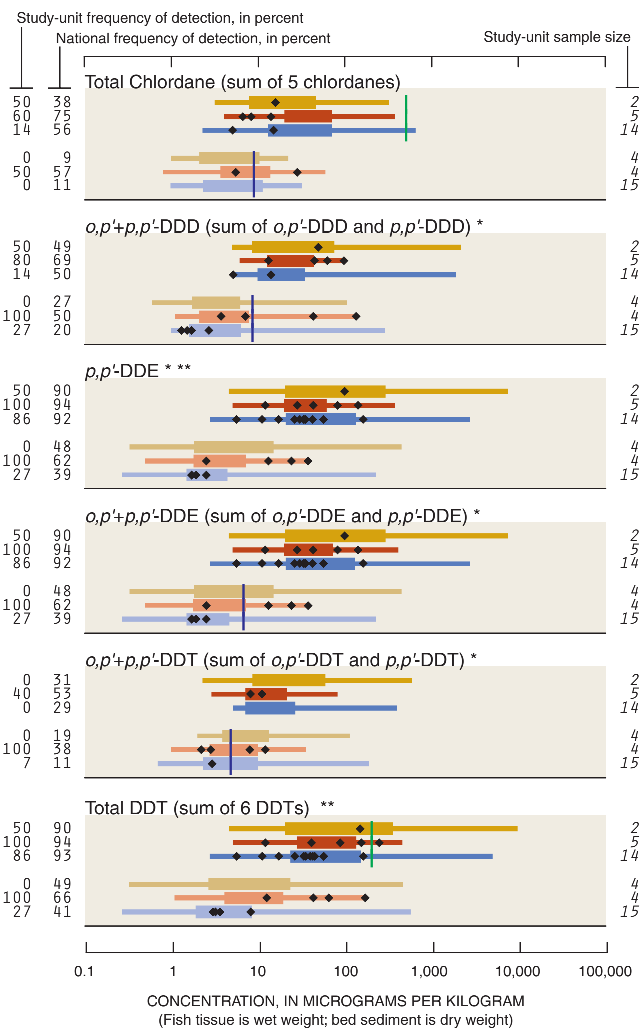




Other trace elements detected
Lead
Selenium
Uranium

Trace elements not detected
Cadmium

Organochlorines in fish tissue (whole body) and bed sediment



CHEMICALS IN FISH TISSUE AND BED SEDIMENT

Concentrations and detection frequencies, Upper Mississippi River Basin, 1995–98—Detection sensitivity varies among chemicals and, thus, frequencies are not directly comparable among chemicals. Study-unit frequencies of detection are based on small sample sizes; the applicable sample size is specified in each graph

◆ Detected concentration in Study Unit

66 38 Frequencies of detection, in percent. Detection frequencies were not censored at any common reporting limit. The left-hand column is the study-unit frequency and the right-hand column is the national frequency

-- Not measured or sample size less than two

12 Study-unit sample size

National ranges of concentrations detected, by land use, in 36 NAWQA Study Units, 1991–98—Ranges include only samples in which a chemical was detected

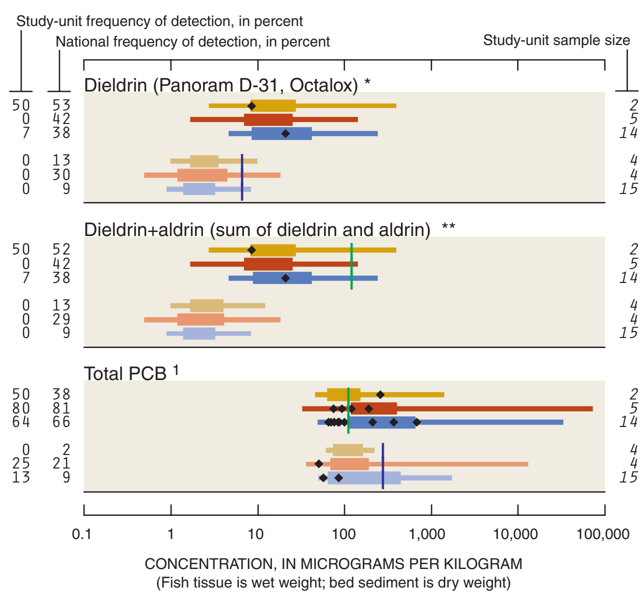
Fish tissue from streams in agricultural areas
Fish tissue from streams in urban areas
Fish tissue from streams draining mixed land uses
Sediment from streams in agricultural areas
Sediment from streams in urban areas
Sediment from streams draining mixed land uses

Lowest 25 percent | Middle 50 percent | Highest 25 percent

National benchmarks for fish tissue and bed sediment

National benchmarks include standards and guidelines related to criteria for protection of the health of fish-eating wildlife and aquatic organisms. Sources include the U.S. Environmental Protection Agency, other Federal and State agencies, and the Canadian Council of Ministers of the Environment

| Protection of fish-eating wildlife (applies to fish tissue)
| Protection of aquatic life (applies to bed sediment)
* No benchmark for protection of fish-eating wildlife
** No benchmark for protection of aquatic life

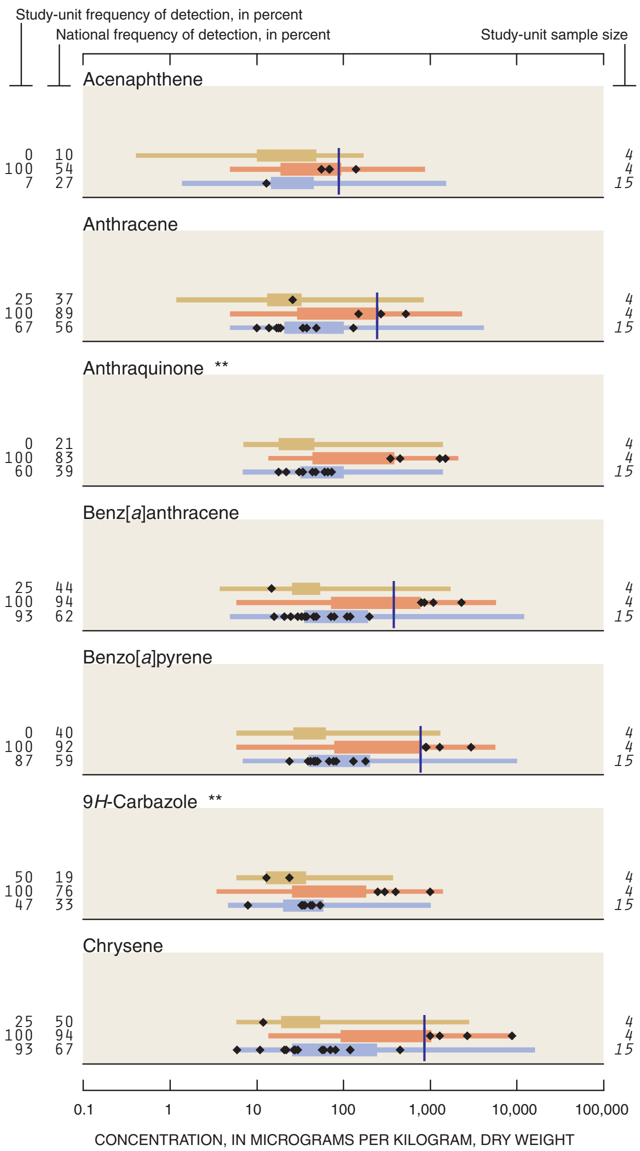


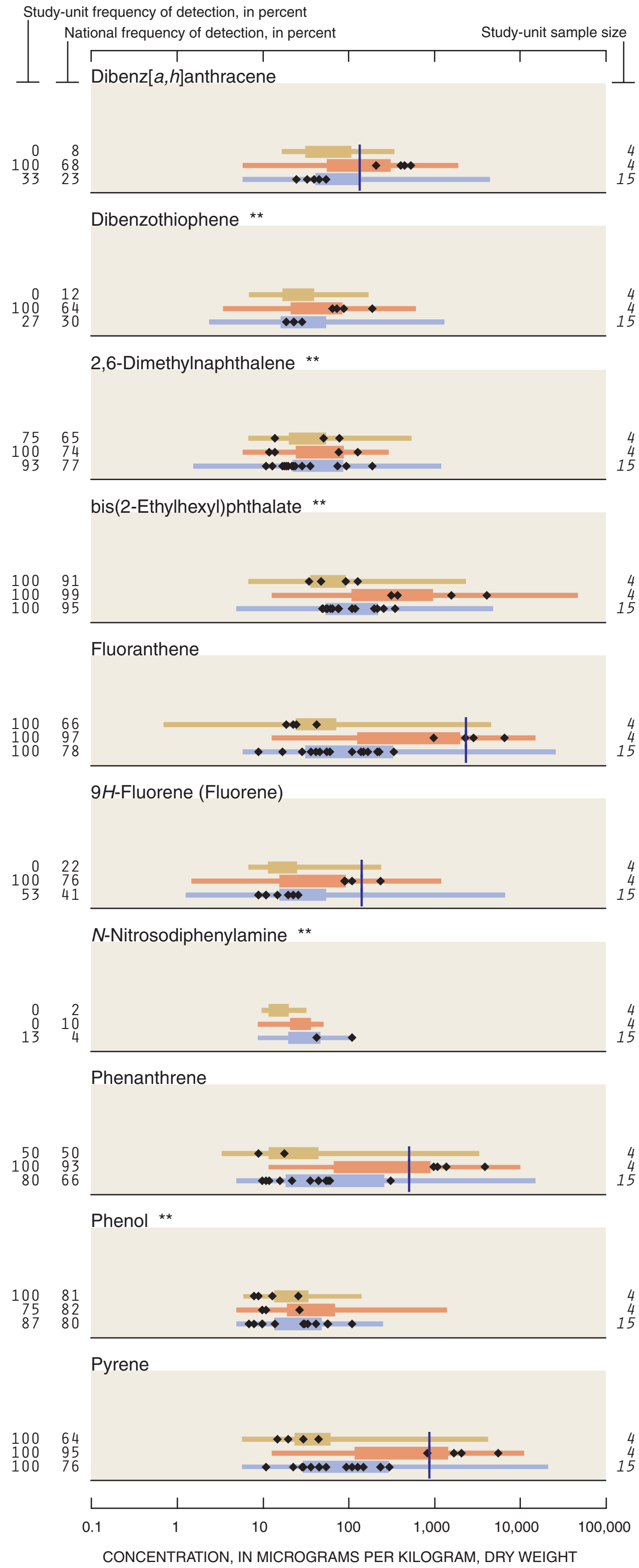
[1] The national detection frequencies for total PCB in sediment are biased low because about 30 percent of samples nationally had elevated detection levels compared to this Study Unit. See http://water.usgs.gov/nawqa/ for additional information.

Other organochlorines detected
Endosulfan I (alpha-Endosulfan, Thiodan) * **

Organochlorines not detected
Chloroneb (Chloronebe, Demosan) * **
DCPA (Dacthal, chlorthal-dimethyl) * **
Endrin (Endrine)
gamma-HCH (Lindane, gamma-BHC, Gammexane) *
Total-HCH (sum of alpha-HCH, beta-HCH, gamma-HCH, and delta-HCH) **
Heptachlor epoxide (Heptachlor breakdown product) *
Heptachlor+heptachlor epoxide (sum of heptachlor and heptachlor epoxide) **
Hexachlorobenzene (HCB) **
Isodrin (Isodrine, Compound 711) * **
p,p'-Methoxychlor (Marlate, methoxychlore) * **
o,p'-Methoxychlor * **
Mirex (Dechlorane) **
Pentachloroanisole (PCA) * **
cis-Permethrin (Ambush, Astro, Pounce) * **
trans-Permethrin (Ambush, Astro, Pounce) * **
Toxaphene (Camphechlor, Hercules 3956) * **

Semivolatile organic compounds (SVOCs) in bed sediment

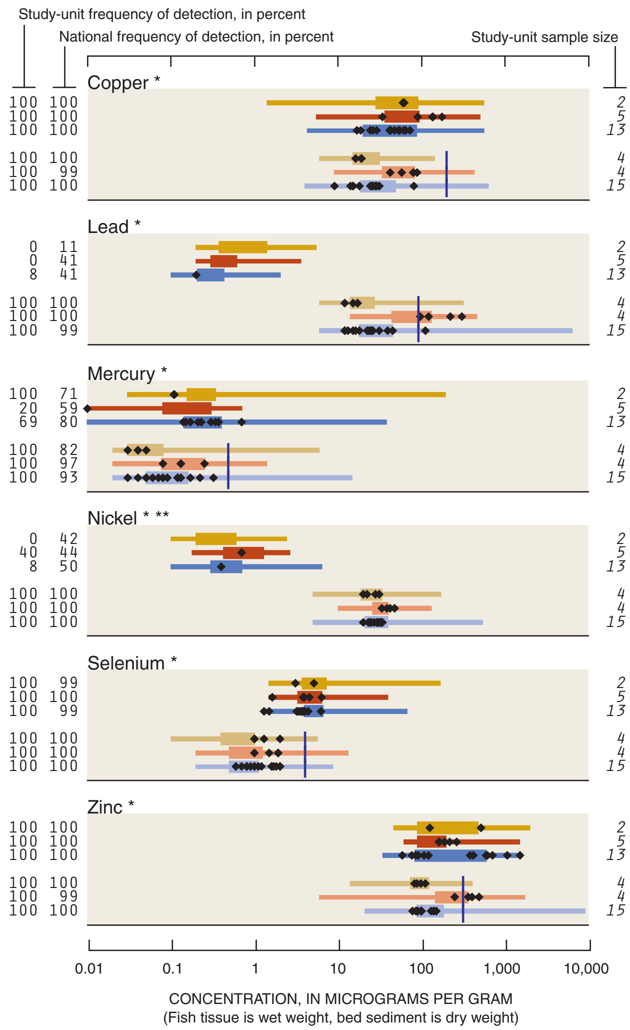




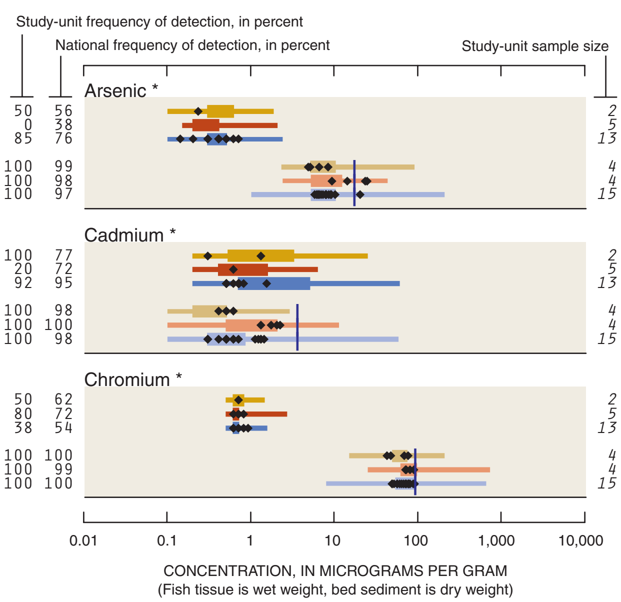
Other SVOCs detected
Acenaphthylene
Acridine **
Azobenzene **
Benzo[*b*]fluoranthene **

Benzo[*ghi*]perylene **
Benzo[*k*]fluoranthene **
2,2-Biquinoline **
Butylbenzylphthalate **
4-Chloro-3-methylphenol **
p-Cresol **
Di-*n*-butylphthalate **
Di-*n*-octylphthalate **
Diethylphthalate **
1,6-Dimethylnaphthalene **
Dimethylphthalate **
2-Ethylnaphthalene **
Indeno[1,2,3-*cd*]pyrene **
Isoquinoline **
1-Methyl-9*H*-fluorene **
2-Methylanthracene **
4,5-Methylenephenanthrene **
1-Methylphenanthrene **
1-Methylpyrene **
Naphthalene
Phenanthridine **

SVOCs not detected
C8-Alkylphenol **
Benzo[*c*]cinnoline **
4-Bromophenyl-phenylether **
bis(2-Chloroethoxy)methane **
2-Chloronaphthalene **
2-Chlorophenol **
4-Chlorophenyl-phenylether **
1,2-Dichlorobenzene (*o*-Dichlorobenzene) **
1,3-Dichlorobenzene (*m*-Dichlorobenzene) **
1,4-Dichlorobenzene (*p*-Dichlorobenzene) **
1,2-Dimethylnaphthalene **
3,5-Dimethylphenol **
2,4-Dinitrotoluene **
Isophorone **
Nitrobenzene **
N-Nitrosodi-*n*-propylamine **
Pentachloronitrobenzene **
Quinoline **
1,2,4-Trichlorobenzene **
2,3,6-Trimethylnaphthalene **



Trace elements in fish tissue (livers) and bed sediment



BIOLOGICAL INDICATORS

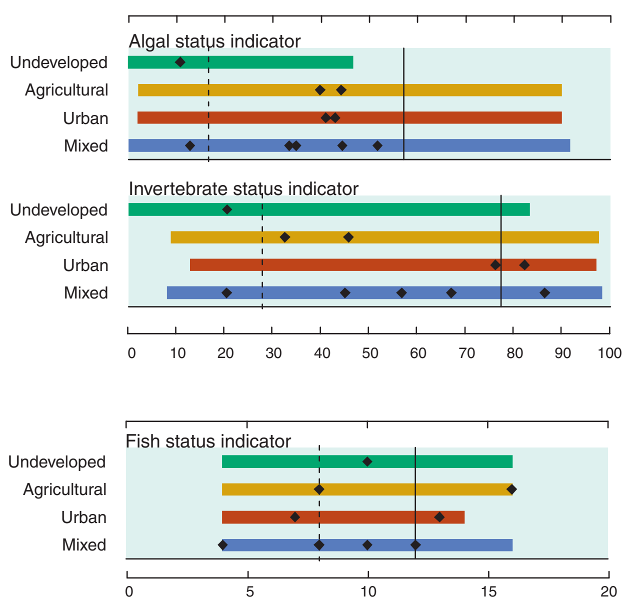
Higher national scores suggest habitat disturbance, water-quality degradation, or naturally harsh conditions. The status of algae, invertebrates (insects, worms, and clams), and fish provides a record of water-quality and stream conditions that water-chemistry indicators may not reveal. **Algal status** focuses on the changes in the percentage of certain algae in response to increasing siltation, and it often correlates with higher nutrient concentrations in some regions. **Invertebrate status** averages 11 metrics that summarize changes in richness, tolerance, trophic conditions, and dominance associated with water-quality degradation. **Fish status** sums the scores of four fish metrics (percent tolerant, omnivorous, non-native individuals, and percent individuals with external anomalies) that increase in association with water-quality degradation

Biological indicator value, Upper Mississippi River Basin, by land use, 1995–98

◆ Biological status assessed at a site

National ranges of biological indicators, in 16 NAWQA Study Units, 1994–98

- Streams in undeveloped areas
- Streams in agricultural areas
- Streams in urban areas
- Streams in mixed-land-use areas
- 75th percentile
- 25th percentile



A COORDINATED EFFORT

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Hennepin Conservation District
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Legislative Commission on Minnesota Resources
McKnight Foundation
Metropolitan Council
Minneapolis Water Works
Minnesota Board of Water and Soil Resources
Minnesota Department of Agriculture
Minnesota Department of Health
Minnesota Department of Natural Resources
Minnesota Extension Service
Minnesota Geological Survey
Minnesota Pollution Control Agency
Minnesota State Planning Agency
Minnesota-Wisconsin Boundary Area Commission
Mississippi River Headwaters Board
Montgomery Watson
National Park Service
National Weather Service
Northern States Power Company
Rivers Council of Minnesota
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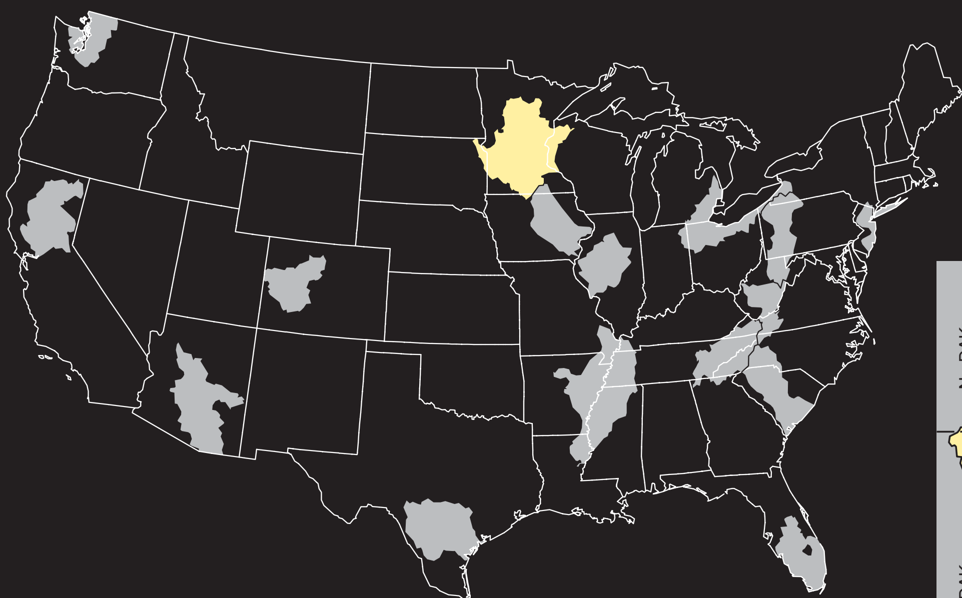
NAWQA

National Water-Quality Assessment (NAWQA) Program
Upper Mississippi River Basin



Stark and others—Water Quality in the Upper Mississippi River Basin
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