Chapter 4 National Assessments of Physical and Chemical Factors that Influence Stream Health

Reduced stream health is often associated with manmade changes to the physical and chemical properties of streams. The presence and abundance of species in a biological community are a function of the inherent requirements of each species for specific ranges of physical and chemical conditions. When changes in land and water use in a river basin cause physical or chemical properties of streams to exceed their natural ranges, vulnerable aquatic species are eliminated, ultimately reducing biological condition and stream health. This chapter reports on national assessments of how land and water management influence the physical and chemical properties of streams.

U.S. Geological Survey photo by Martin Gurtz.

Land and Water Management Across the Nation

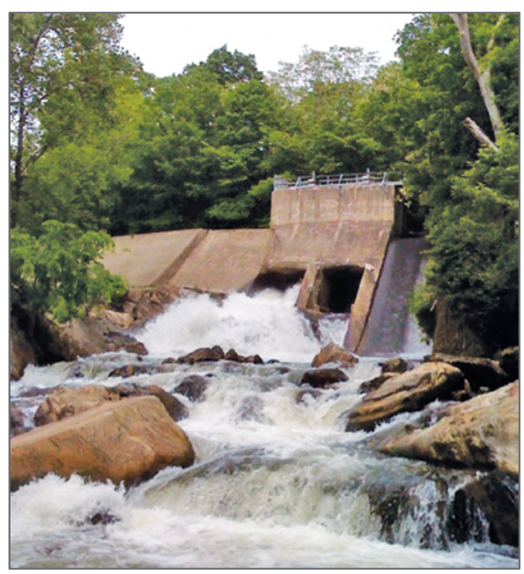
The United States has a great diversity of natural landscapes, which are the products of variation in climate, topography, soils, and geology. It is on this diverse backdrop that humans historically settled and currently manage land and water. Geographic differences in climate influence the kinds of crops grown on agricultural lands and the ways in which water is managed. As a result, the degree to which land and water management influences physical and chemical properties of streams—and ultimately stream health—varies widely across the Nation.

Urban land has expanded greatly over the past century. Urban development since 1900 was substantial along the eastern seaboard and within pockets of the Midwestern United States. The expansion of urban lands in the arid Southwest is even more striking and has major implications for water management given the scarcity of rainfall in this region. The current and possible future stresses of water scarcity for cities is a major issue in the Southwest.

The volume of stream flows stored in reservoirs has also expanded greatly over the past century. All parts of the United States experienced dramatic increases in reservoir storage since 1900. Reservoirs in arid regions of the West were primarily constructed for irrigation and municipal use, whereas reservoirs in wetter climates were constructed for flood control and municipal uses. The effect of reservoirs on stream health depends on the type of reservoir, how it is managed, and the types of biological communities that were naturally present (Collier and others, 1996).

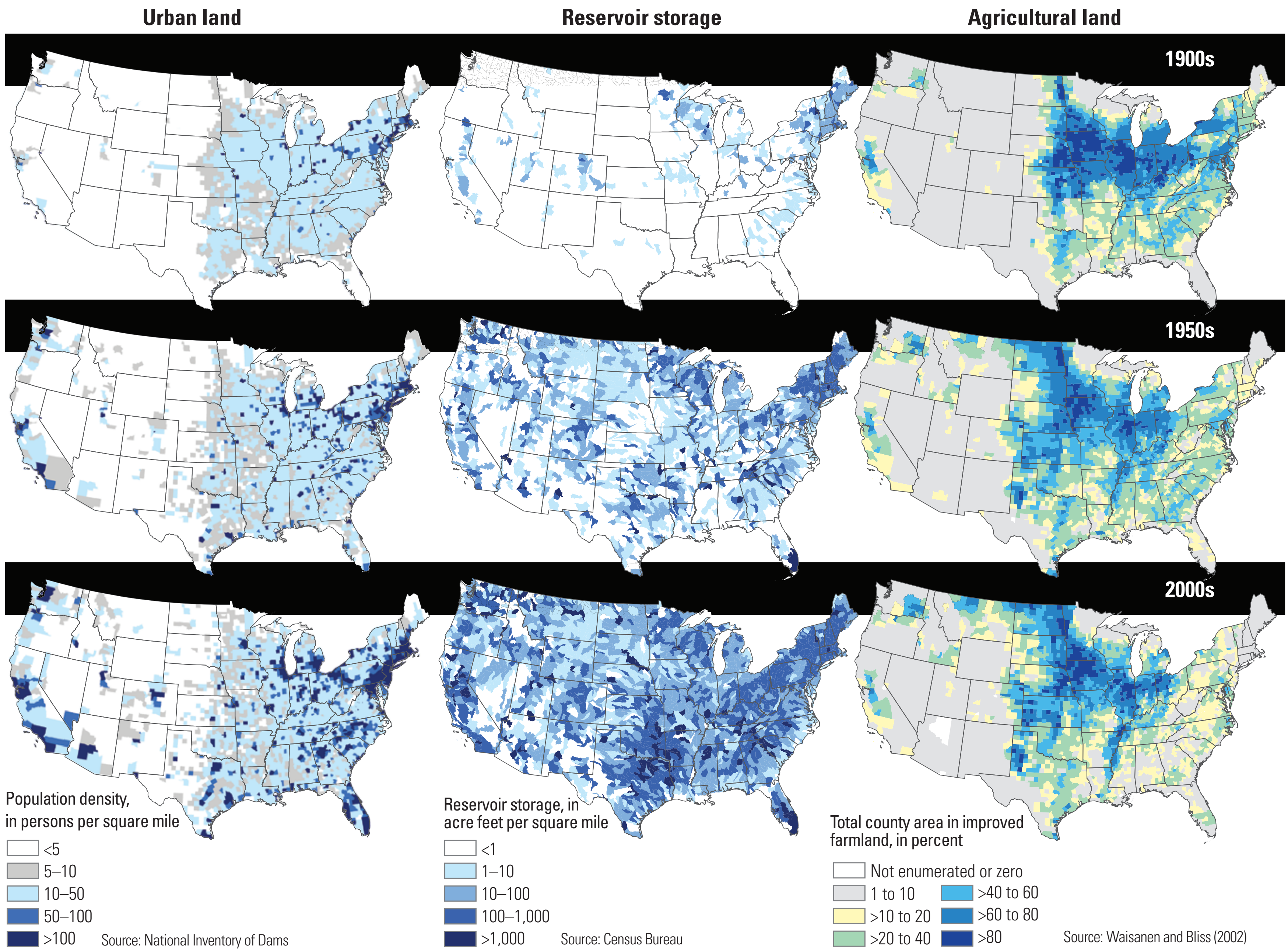
Relative to urban and reservoir development, the extent of agricultural lands has changed less since 1900. Expansion of agricultural lands occurred in the western plains and arid West due to the development of water for irrigation. In contrast to the arid West, agricultural land acreage in many States in the East declined since 1900, either due to fields being allowed to go fallow or because of conversion to urban lands.

Bureau of Reclamation photo.



U.S. Geological Survey photo by Daren Carlisle.

Water development in the arid Western United States typically aimed to divert and store streamflows for irrigation, as on the Carson River, Nevada (photo above). In contrast, water development in the East was typically intended for flood control or hydropower, as on the Housatonic River, Connecticut (right photo).



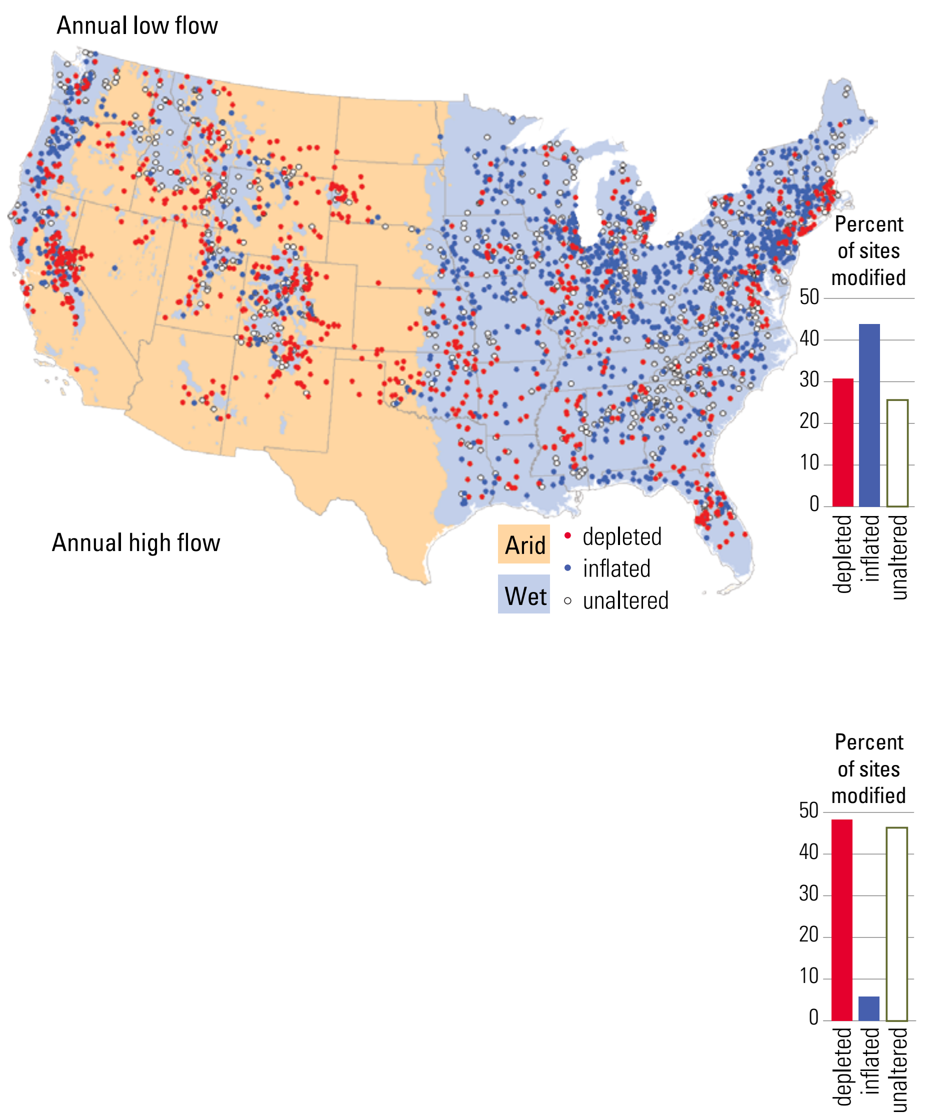
Maps of the conterminous United States showing the expansion of land and water management over the past century. This expansion has led to widespread modification of the properties of watersheds that influence stream health. Since 1900, expansion of urban lands and reservoir storage has been substantial across the Nation. In contrast, agricultural lands have expanded in irrigated areas of the West but declined in the Northeast and Southeast, often being replaced by urban development. (<, less than; >, greater than.)

Annual low or high flows were modified in 86 percent of the almost 3,000 assessed streams.

Streamflow Modification

Flowing water is the defining feature of streams. Natural fluctuations of flows are crucial to stream health because they build and maintain physical habitats, influence physical and chemical characteristics of water, and provide important life-stage (for example, migration) cues for aquatic organisms.

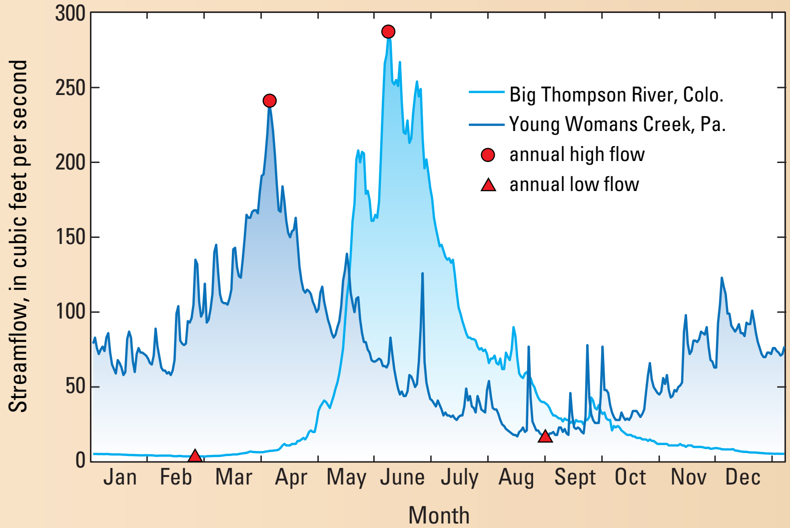
Land use and water management have dramatically changed natural streamflows across the United States. The magnitude of low streamflows was modified in 75 percent of assessed stream sites, and the magnitude of high streamflows was modified in 54 percent of assessed sites—resulting in a total of 86 percent of assessed streams having modified low flows or high flows or both. This national assessment builds on previous findings (National Research Council, 1992; Jackson and others, 2001; Baron and others, 2002; Postel and Richter, 2003) documenting widespread hydrological modification in watersheds across the Nation.



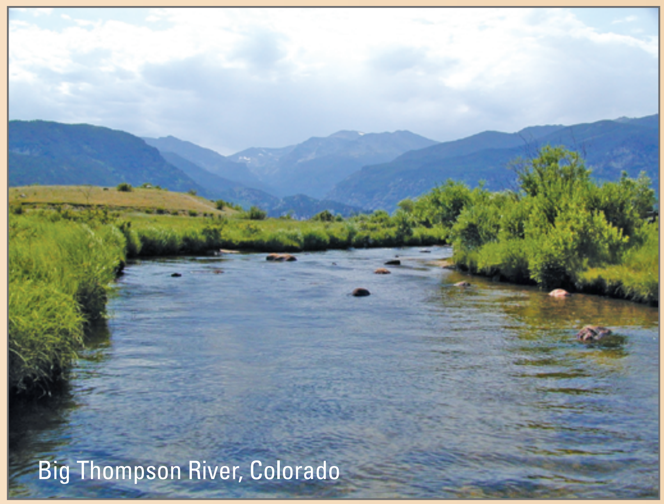
As shown on these maps of the conterminous United States, annual high or low streamflows were modified at 86 percent of stream sites assessed by NAWQA. Streamflow modification was depleted (less than), inflated (greater than), or unaltered relative to expected natural magnitudes. Although high flows were depleted throughout the Nation, low flows tended to be depleted in arid regions and inflated in wet regions. These results highlight the value of long-term streamflow data collected by the U.S. Geological Survey in cooperation with numerous local, State, and Federal partners.

Natural Patterns of Streamflow Vary Geographically

Seasonal patterns of natural streamflows are influenced by environmental factors such as climate, soils, and geology of the river basin. As shown in this graph of monthly streamflows averaged over several years, streamflows in the Northeastern United States (for example, Young Womans Creek, Pennsylvania) are typically highest in spring when accumulated snow melts, lowest in late summer, then increase again with rainfall events in fall and winter. In contrast, Rocky Mountain streams (for example, Big Thompson River, Colorado) experience their highest streamflows during summer when the accumulated snowpack melts but are lowest during the winter when all precipitation is snow.



U.S. Geological Survey photo by Lee Eicholtz.



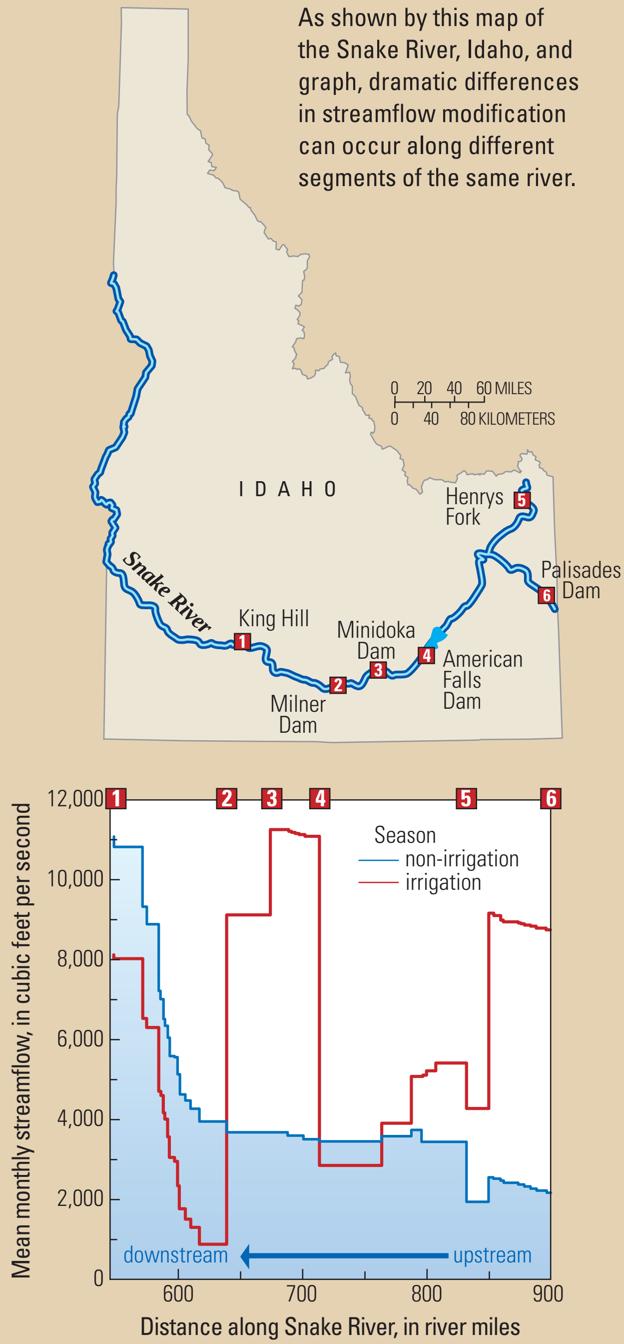
U.S. Geological Survey photo by Robert Zuellig.

Streamflow modification differed between arid and wet climates (Carlisle and others, 2011). Low-flow magnitudes in wet climates were often inflated, whereas low-flow magnitudes in arid climates were often depleted. The widespread depletion in streamflow magnitudes in arid regions is likely due to a variety of "consumptive" water uses—that is, water that evaporates or is transferred to other river basins and not returned to the stream channel. Water withdrawals for irrigation from streams and aquifers in arid areas have lowered groundwater and surface-water levels in many regions (Jackson and others, 2001). Reservoirs are also managed differently between arid and wet regions (Collier and others, 1996). Reservoirs in wet regions are typically used for flood control and therefore designed to eliminate high flows. Release of the stored water later during dry periods results in increased low flows relative to natural conditions. Reservoirs used for water storage and irrigation in arid regions also remove high flows and release water during dry periods but are also often filled during fall and winter. Thus, reduced low flows in arid areas are likely due to consumptive use of water (Poff and others, 2007) or the filling of water-storage systems. This relation among climate, water management, and streamflow modification suggests that the occurrence and severity of streamflow modification will continue to shift because water-management strategies will evolve and adapt to long-term climatic changes in temperature and the timing and quantity of precipitation.

Long-term shifts in climatic conditions and resulting changes in water-management strategies will influence the type and severity of streamflow modification.

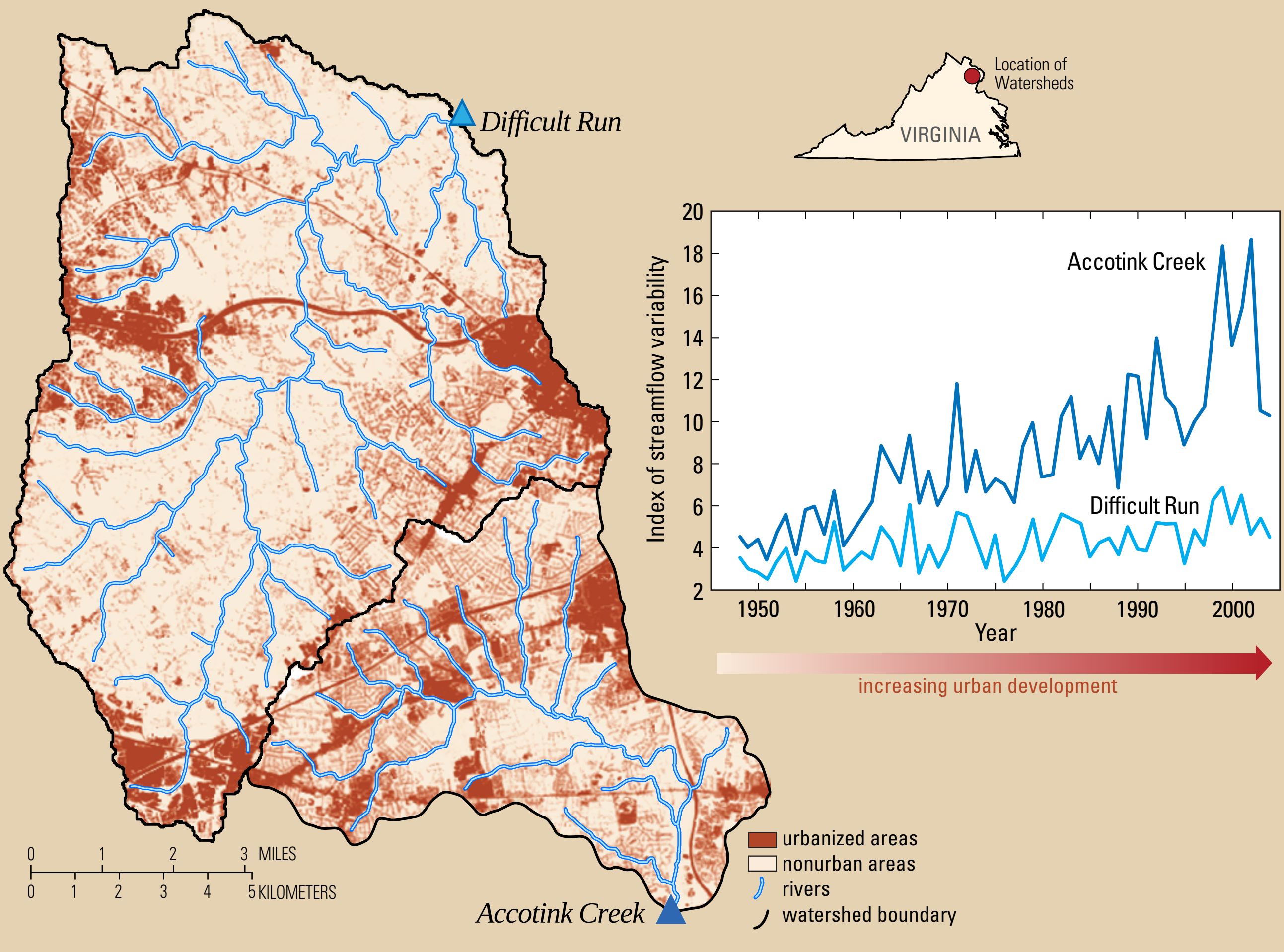
Streamflow Modification and Land Use

National-scale generalizations about streamflow modification and land use can be obscured by different land- and water-management practices within individual watersheds. In agricultural settings, drastically different types of streamflow modification can occur among adjacent segments of the same river because of the location and operations of specific water-management infrastructure. Flow during the non-irrigation season (for example, January) is typical of an unregulated stream—the flow magnitude increases with downstream distance. During the irrigation season (for example, August), streamflow in the Snake River fluctuates widely over its length in response to diversions, irrigation return flows, and groundwater discharge (Clark and others, 1998).



As shown by this map of the Snake River, Idaho, and graph, dramatic differences in streamflow modification can occur along different segments of the same river.

Local differences in land and water management within urban areas can also be dramatic. In general, urbanization reduces the amount of precipitation (rain and snow melt) that infiltrates into soils and groundwater, which causes increased variability in streamflows. However, there are intervening factors that can affect this pattern. For example, two adjacent watersheds in northern Virginia—Accotink Creek and Difficult Run—began to urbanize in 1950. Although streamflow variability was similar for the two streams in 1950, this similarity soon began to change. Over the next five decades, streamflow variability in Accotink Creek increased 100 to 500 percent. In contrast, streamflow variability in Difficult Run remained largely unchanged. The major differences between these watersheds is that the density of urban development is two times higher in Accotink Creek than in Difficult Run, which also has several small reservoirs in the headwaters that mitigate urban runoff. Also, the watershed of Accotink Creek is half the size of the Difficult Run watershed.



Local patterns of urbanization can lead to divergent effects on streamflow. This map shows urbanization that occurred in two adjacent watersheds in Virginia from 1950 to 2000. However, the expected increase in streamflow variability only occurred in Accotink Creek (see graph), which experienced much greater density of urban development within a smaller watershed than did Difficult Run.

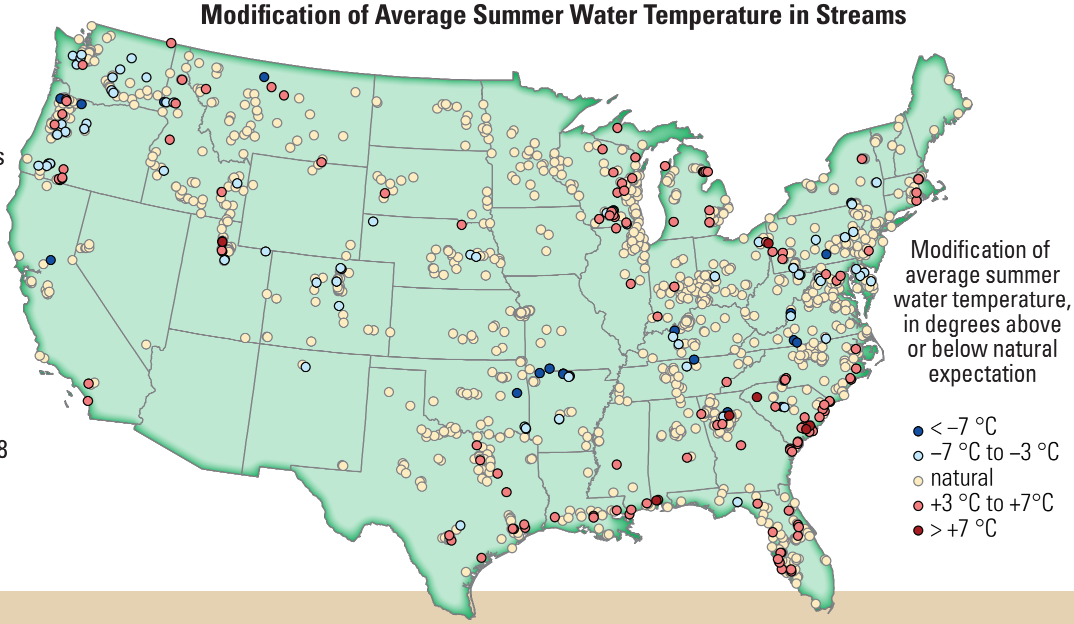
Summertime stream temperatures were modified throughout the Nation and in all types of land uses.

Stream Temperature

Most aquatic species have an optimal range of water temperature for growth and reproduction. Water temperature also influences water chemistry, such as the solubility of oxygen in water. As a result, water temperature has a major influence on water quality and stream health (chapter 2) (U.S. Environmental Protection Agency, 2002).

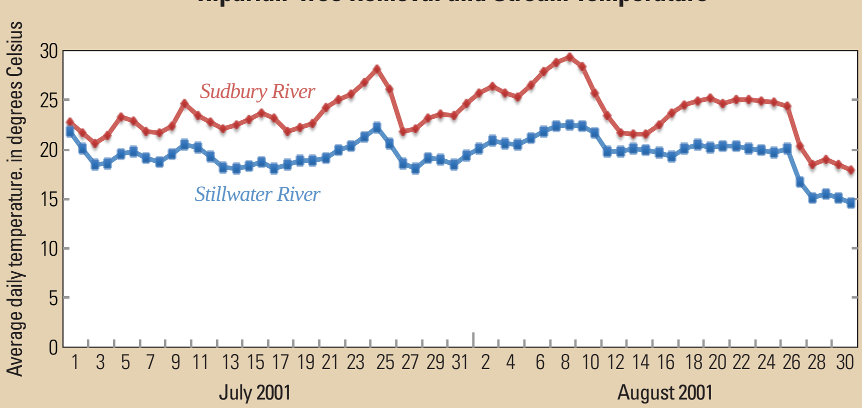
Average summertime water temperature was altered—either cooler or warmer than naturally expected—at 17 percent of assessed streams across the conterminous United States. A major cause of modified stream temperatures is the loss of shading from riparian trees, which occurs in all types of land-use settings. Because riparian tree canopies tend to insulate stream water from the surrounding air temperature, the loss of riparian trees can lead to warmer than natural temperatures in summer and cooler than natural temperatures in winter. Cooling of stream water can also result from artificial inputs of groundwater, water imported from other river basins, or the release of waters from the bottom of large reservoirs.

Modification of Average Summer Water Temperature in Streams

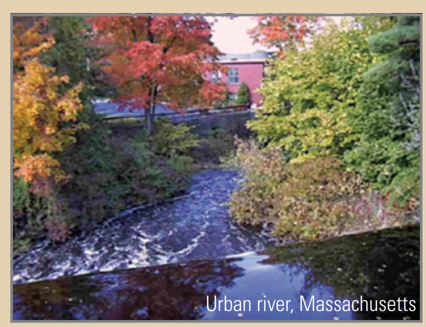


Map of the conterminous United States showing sites at which U.S. Geological Survey scientists measured summertime stream temperatures. Average summertime water temperature was either cooler or warmer than naturally expected in 17 percent of assessed streams. (A change of a degree Celsius (°C) is equivalent to a change of 1.8 degrees Fahrenheit (°F). <, less than; >, more than.)

Riparian-Tree Removal and Stream Temperature



Streams in urban settings (top photo) often experience warmer than natural water temperatures due to the removal of riparian tree canopies. For example, the Sudbury River, Massachusetts, has lost 10 percent of its riparian zone to urban development and is also influenced by many small impoundments (such as in the foreground of top photo). As shown by this graph, daily water temperature in the Sudbury River averaged 3 degrees Celsius (°C) warmer than the nearby Stillwater River (bottom photo), which is within a forested watershed. (Temperature in degrees Fahrenheit = 1.8×°C+32.)



U.S. Geological Survey photo by James Coles.

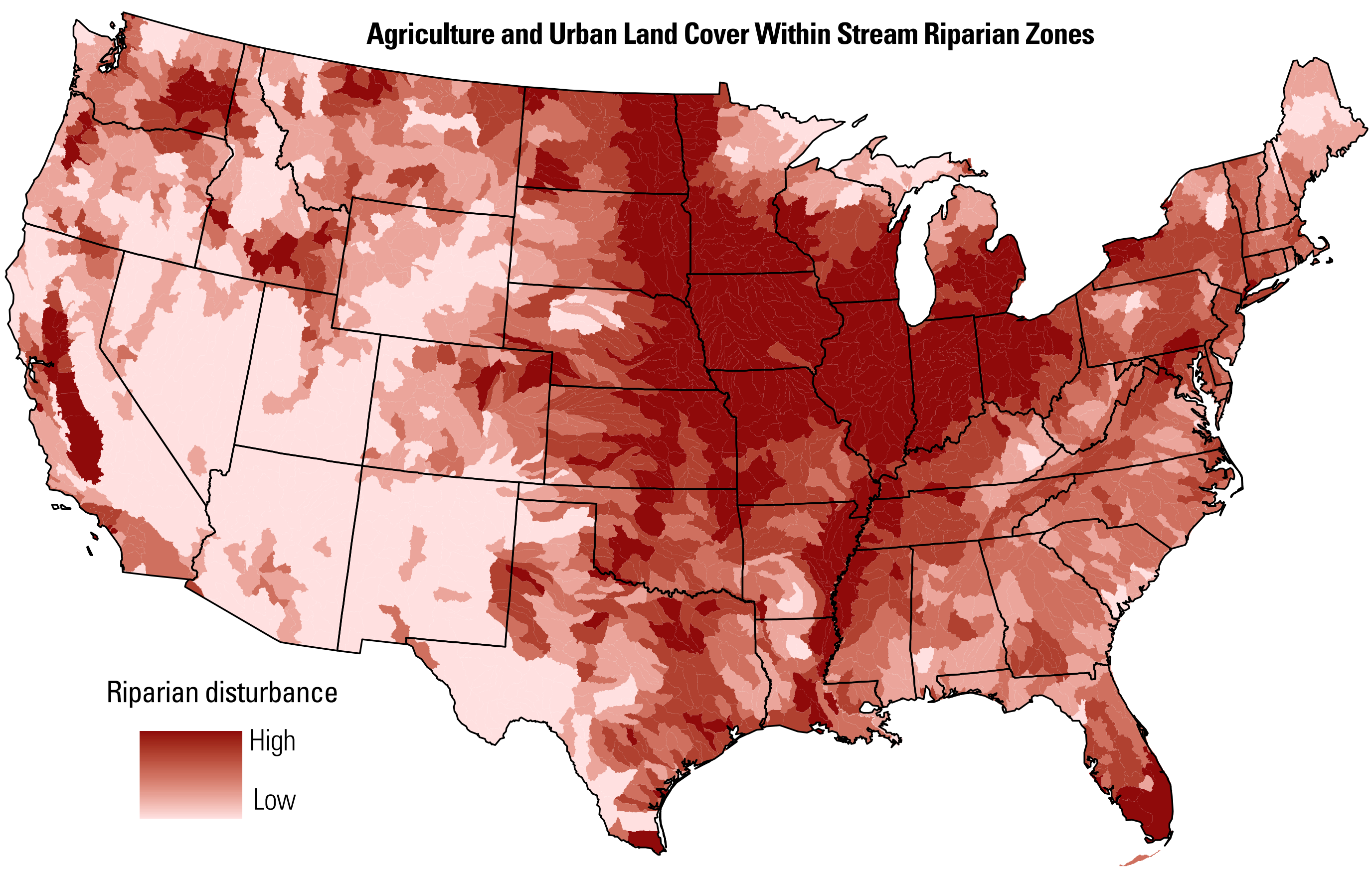
U.S. Geological Survey photo by Karen Beaulieu.

Stream Riparian Zones

Removal of stream-side trees and other natural vegetation by agriculture and urban development is widespread.

Stream-side trees and other vegetation, collectively known as riparian zones, are especially important to the health of stream ecosystems. This vegetation stabilizes stream banks and reduces soil erosion, provides food and habitat structure for stream organisms in the form of leaf litter and woody debris, and mitigates seasonal temperature extremes through shading of the stream channel (chapter 2). Manmade disturbance of riparian zones is identified as one of the major causes of reduced water quality and stream health nationwide (U.S. Environmental Protection Agency, 2006a).

Development of riparian zones and adjacent lands as a result of activities such as urbanization, agriculture, and mining often results in large-scale removal of stream-bank vegetation and other disturbances to riparian habitat. A national map of riparian land-cover development (see below) shows that disturbance to this important habitat is widespread but particularly severe in heavily agricultural areas such as the Midwest and western basins and in urban areas such as the Atlantic coast. Although other land-management activities, such as grazing and forestry, can also disturb riparian zones and are not represented on the map, this finding corroborates similar national assessments of stream habitats (Esselman and others, 2011) and supports the widespread concern that riparian-habitat loss is a potential cause of reduced stream health across the Nation (U.S. Environmental Protection Agency, 2006a).



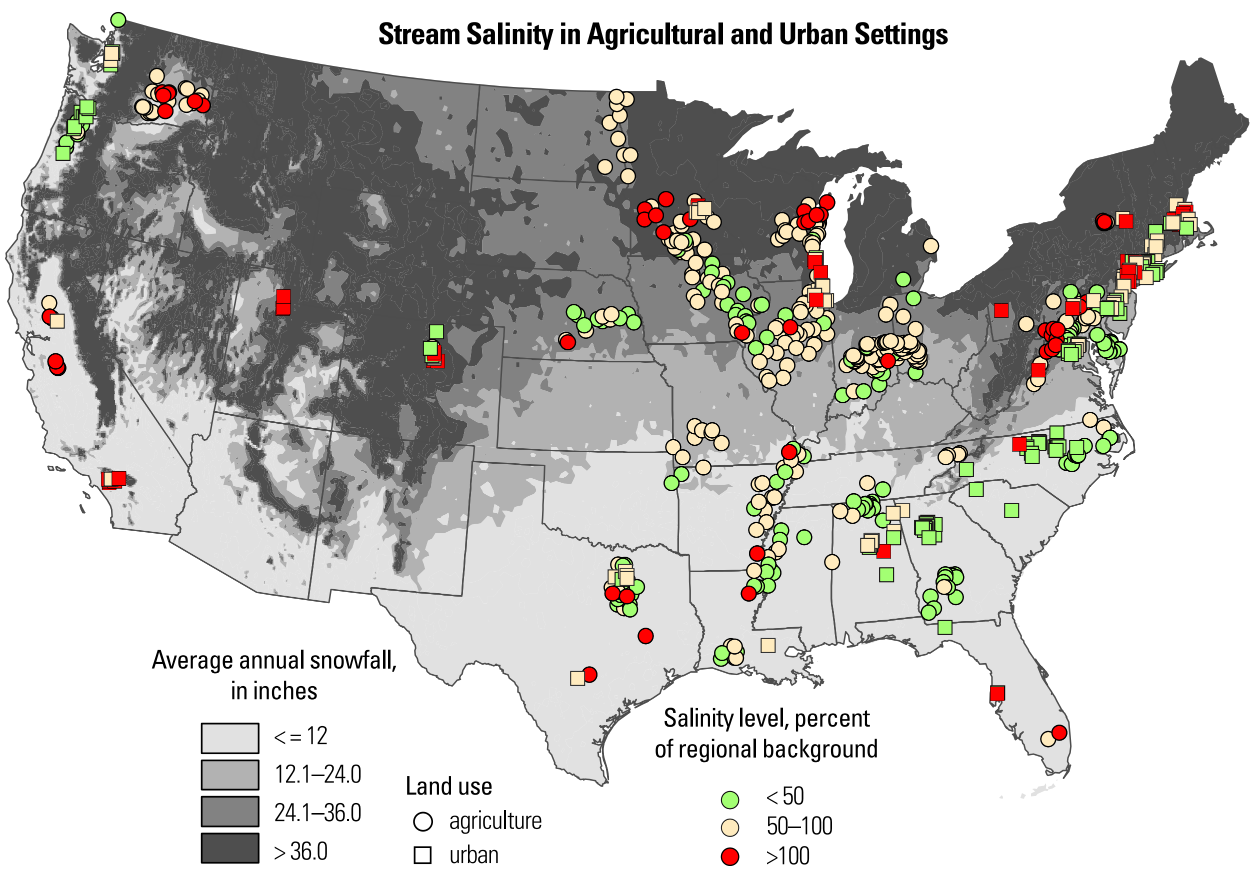
As this map of the conterminous United States shows, removal of streamside trees and other natural vegetation is widespread. Agricultural and urban land cover adjacent to streams and rivers occurs throughout the Nation but is more prevalent in regions like the Midwest and western agricultural areas. Riparian zones are defined as all lands within about 300 feet (100 meters) of streams. Importantly, this measure of riparian disturbance does not account for activities such as grazing and forestry, which can also disrupt riparian zones. (Source: National Land Cover Dataset 2006, http://landcover.usgs.gov/natlandcover.php.)

Elevated salinity levels in streams and rivers occur throughout the Nation in basins with substantial urban and agricultural land use.

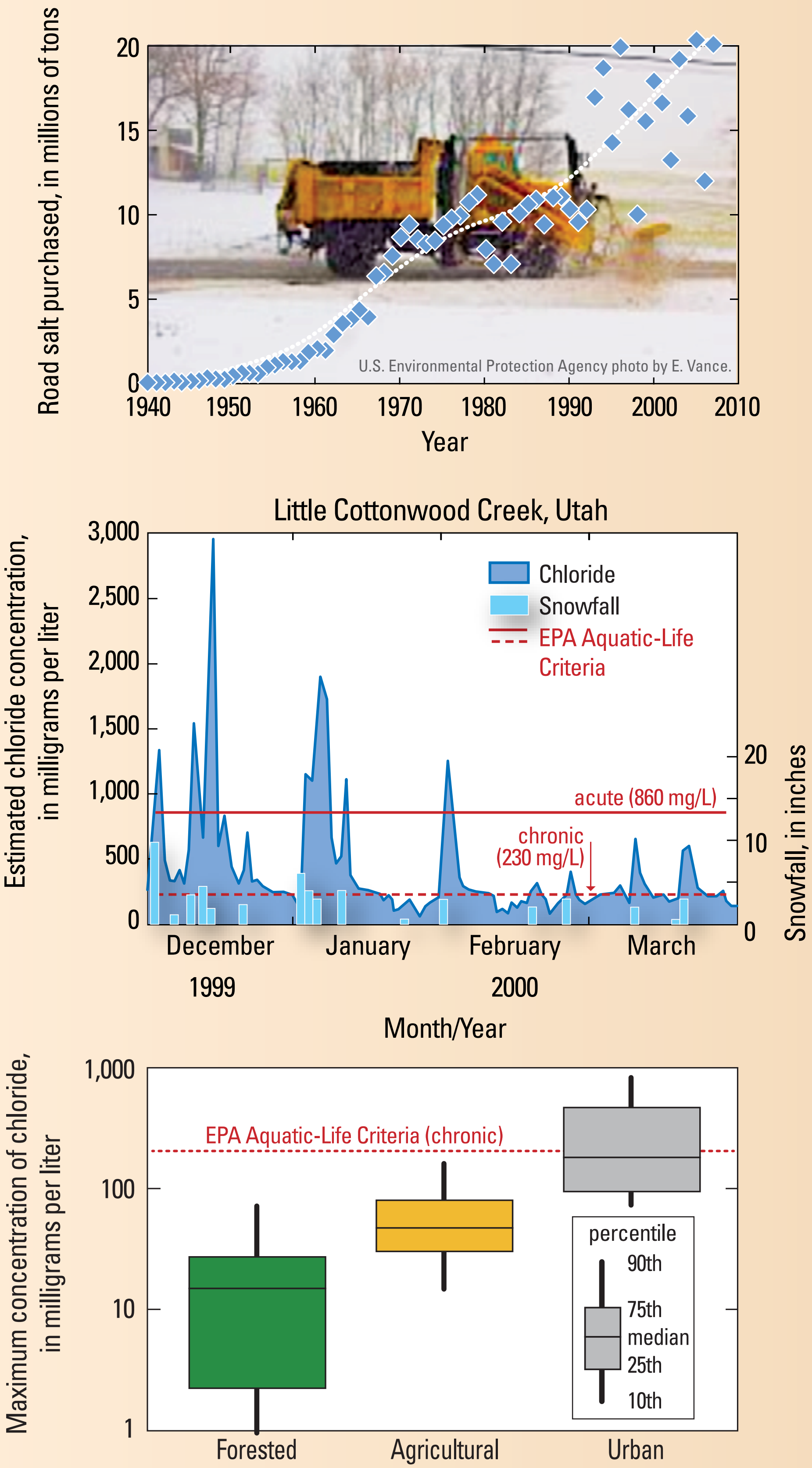
Stream-Water Salinity

The salinity of stream water is influenced naturally by geologic and soil properties of the watershed, but there is growing concern that human activities are increasing stream salinity throughout the Nation (Kaushal and others, 2005). Excess salinity in streams is a growing issue because salt has many domestic, industrial, and municipal uses; salt use has increased dramatically over the past 50 years (Mullaney and others, 2009); and there is growing evidence that salts from human uses accumulate in soils and groundwater (Lindsey and Rupert, 2012), which poses long-term threats to streams.

Streams with elevated salinity occur in urban and agricultural land-use settings throughout the Nation. Elevated salinity in urban settings is most prevalent in northern States that receive relatively high snowfall, which suggests that road de-icing is a major salt source (see facing page). Other sources of salinity in urban streams include waste-water effluent and aged septic systems. Elevated salinity in agricultural streams occurs throughout the Nation. The largest sources of excess salinity in agricultural streams include fertilizer applications and irrigation wastewater (Mullaney and others, 2009). Stream salinity in rural watersheds has also been linked to salt applications on roadways (Kelly and others, 2008).



This map shows stream salinity in the conterminous United States. Elevated salinity in urban streams is most prevalent in northern States that receive substantial amounts of snowfall. Elevated salinity in agricultural streams occurs throughout the Nation. Salinity was considered "elevated" for NAWQA stream sites where measured electrical conductivity, a measure of salinity, exceeded regional background levels. (<, less than; >, more than.)



Road De-icing and Stream Salinity

One source of elevated salinity in streams, particularly in urban and suburban areas, is the application of salt to roadways. The purchase of rock salt for highway use has increased dramatically over the past 70 years (Salt Institute, 2010). Although this application makes roadways safer for travel, once the salt dissolves it runs off roads and into soils and streams. Annually, nearly 9.5 million tons of salt is estimated to run off into streams in the United States (Stefan and others, 2008). Salt that percolates throughout soils can enter and remain in groundwater for months to years, leading to long-term increases in groundwater salinity.

NAWQA studies found evidence that road de-icing salts contributed to increased salinity in streams. For example, chloride concentrations (a measure of stream salinity) as high as 3,000 milligrams per liter (mg/L; 1 mg/L = 1 part per million) were recorded in an urban stream in Utah and often exceeded U.S. Environmental Protection Agency (EPA) guidelines for freshwater aquatic life. Peaks in salinity were associated with snowfall events (Waddell and others, 2004).

A regional analysis by NAWQA showed that elevated salinity in streams is widespread in urban areas of northern States (Mullaney and others, 2009). Chloride concentrations were higher in streams in urban areas than in those in agricultural areas and forests. In urban streams, the highest levels of chloride were measured during the winter months when salt and other chemicals are used for de-icing.

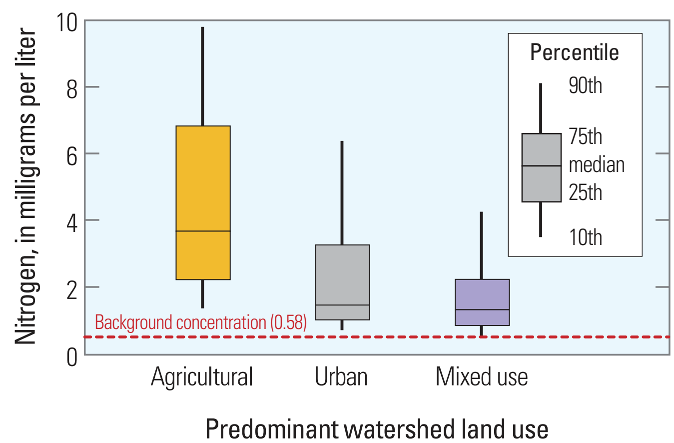
Nutrient concentrations in stream water are as much as six times greater than background levels in urban and agricultural lands across the Nation.

Nutrients in Stream Water

Although plant nutrients such as nitrogen and phosphorus are a basic need of aquatic ecosystems, excessive nutrients can have harmful effects on stream health (chapter 2). Nutrient concentrations in streams are directly related to water management, land use and associated fertilizer applications, and animal wastes in upstream watersheds.

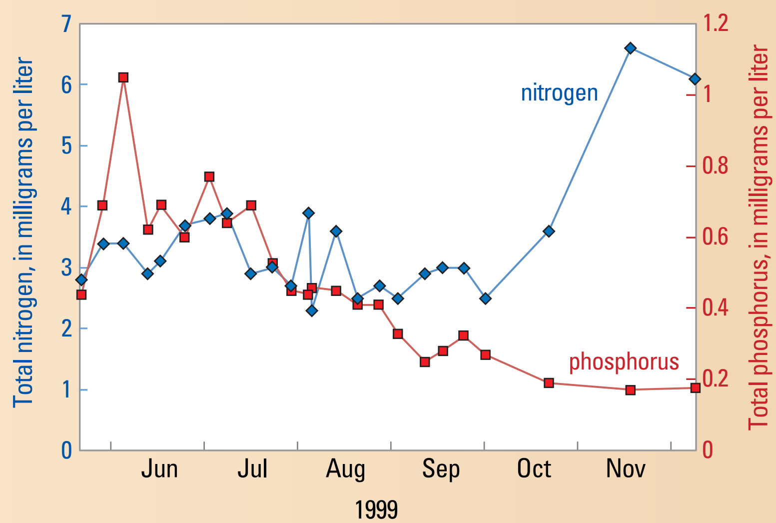
NAWQA conducted a national assessment of nutrient concentrations in streams and groundwater from 1992 through 2004 (Dubrovsky and others, 2010). Total nitrogen concentrations were higher in agricultural streams than in streams draining urban, mixed land-use, or undeveloped areas, with a median concentration of about 4 milligrams per liter (mg/L; 1 mg/L = 1 part per million)—about 6 times greater than background concentrations. Nitrogen concentrations in agricultural streams generally were highest in geographic areas such as the Northeast, Midwest, and the Northwest—which are areas with some of the most intense applications of fertilizer and manure in the Nation. Surveys by other Federal (U.S. Environmental Protection Agency, 2006a) and State agencies (http://iaspub.epa.gov/waters10/attains_nation_cy.control) have also reported that excess nutrients were among the leading factors associated with reduced stream health throughout the Nation.

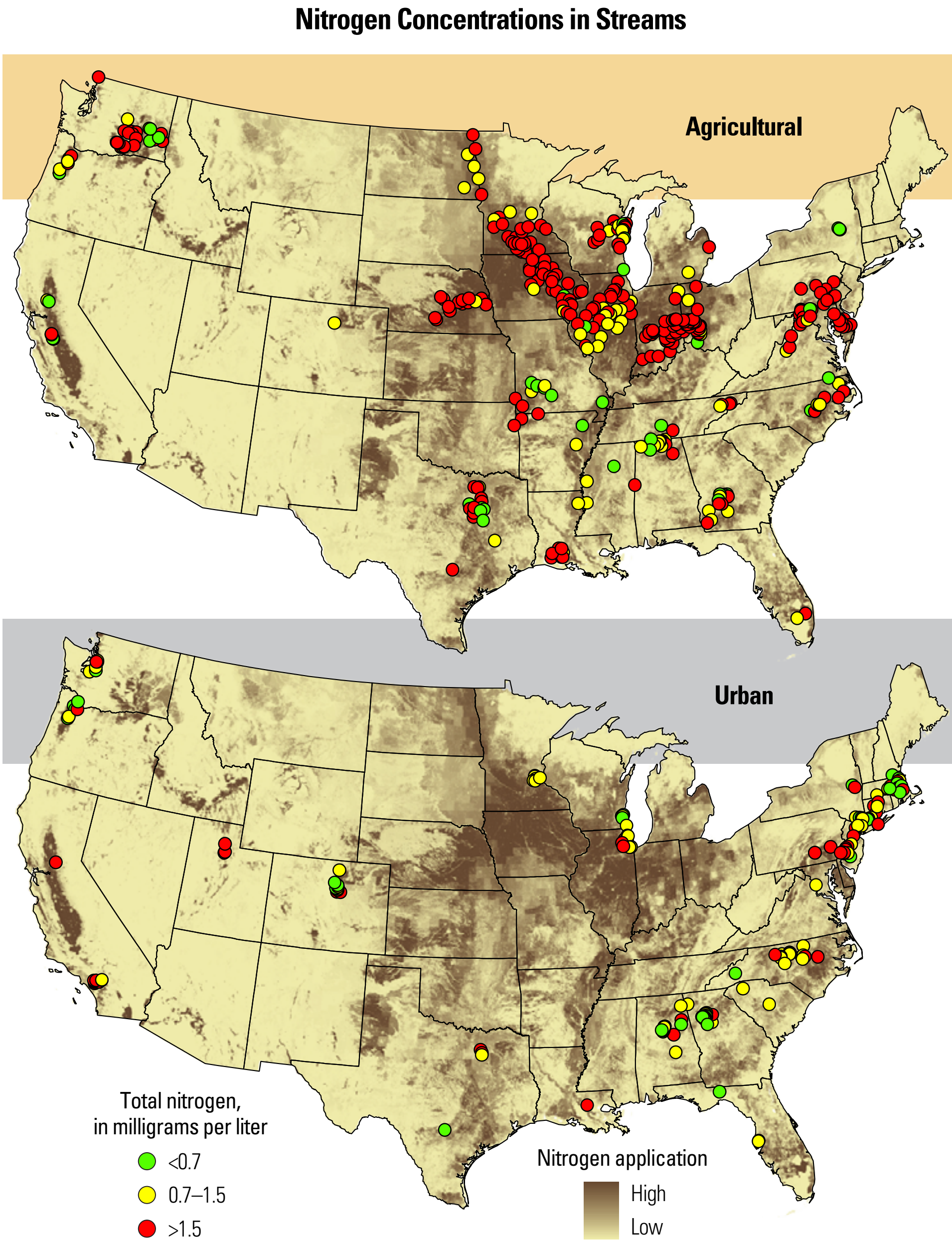
This graph shows that across the Nation concentrations of total nitrogen measured by NAWQA were higher in agricultural streams than in urban or mixed land-use streams. (1 milligram per liter = 1 part per million.)



Nutrient Concentrations in Streams Vary Seasonally

Concentrations of nitrogen and phosphorus in streams vary in response to their major transport pathways. An example of this is Granger Drain, Washington. This graph shows that nitrogen concentrations are highest during the non-irrigation season (fall and winter months), when groundwater is the primary source of water to the stream, whereas phosphorus concentrations are highest during the irrigation season (spring and summer months), when surface runoff transports phosphorus-rich sediment to the stream (Fuhrer and others, 2004). (1 milligram per liter = 1 part per million.)





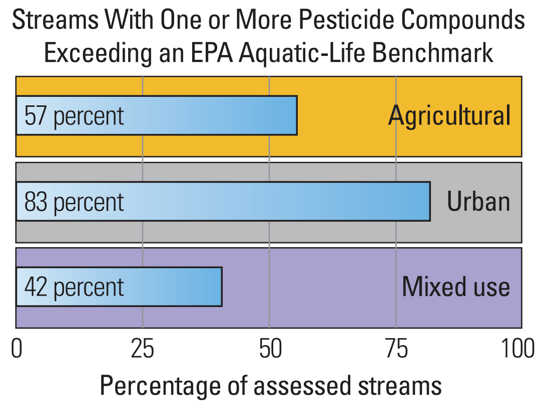
These maps of the conterminous United States show that total nitrogen concentrations measured by NAWQA were generally highest in streams within agricultural areas of the Midwest, Northwest, and Northeast, where the highest nitrogen fertilizer applications occur. Total nitrogen concentrations in urban areas were typically at intermediate levels. (<, less than; >, greater than.)

One or more pesticides exceeded Aquatic-Life Benchmarks in more than half of the streams assessed.

Dissolved Pesticides in Stream Water

Pesticides frequently occur in stream water in both agricultural and urban land-use settings and typically reflect patterns of land use in the watershed. NAWQA made a comprehensive national assessment of pesticide concentrations in streams from 1992 through 2001 and found that 56 percent of assessed streams had one or more pesticides in water that exceeded at least one U.S. Environmental Protection Agency Aquatic-Life Benchmark (Gilliom and others, 2006). Urban streams had pesticide concentrations that exceeded one or more benchmarks at 83 percent of sites—mostly for the insecticides diazinon, chlorpyrifos, and malathion. Agricultural streams had concentrations that exceeded one or more benchmarks at 57 percent of sites—most frequently for chlorpyrifos, azinphos-methyl, atrazine, dichlorodiphenyldichloroethylene (a breakdown product of DDT), and alachlor.

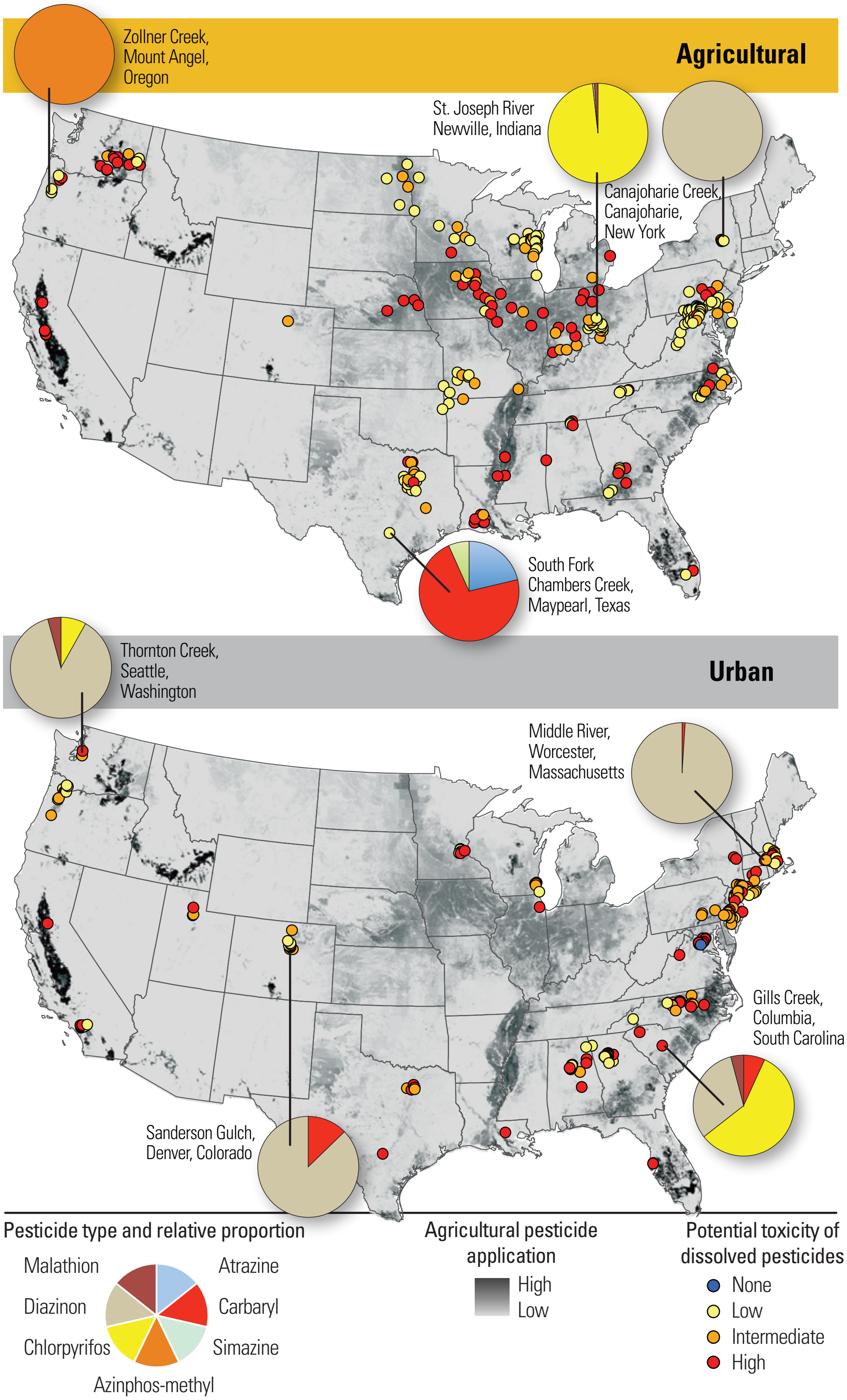
NAWQA found that across the Nation, pesticides have the ability to affect aquatic life, particularly in urban areas. This bar graph shows the relatively high proportion of urban streams with concentrations greater than U.S. Environmental Protection Agency (EPA) Aquatic-Life Benchmarks.



The specific pesticide compounds contributing to the potential toxicity of pesticide mixtures vary geographically according to their use across the Nation (see facing page). Insecticides are the dominant compounds contributing to potentially high toxicity, largely because these compounds have much lower toxic thresholds than other pesticides due to the fact that they were designed to kill insects. For example, the insecticide chlorpyrifos was used during the study period in both urban and agricultural areas, such as on corn in the central United States and suburban lands in South Carolina. Diazinon was also used extensively in urban areas across the Nation, as well as in some agricultural areas. Other heavily used insecticides include malathion, azinphosmethyl, and carbaryl, which were also used in agricultural and urban areas (Gilliom and others, 2006).

Estimating the Potential Toxicity of Pesticide Mixtures

The toxicity of dissolved pesticide mixtures was estimated by NAWQA using a pesticide toxicity index (PTI) (Munn and others, 2006; Gilliom and others, 2006). The PTI accounts for the concentration of each compound measured in a water sample, the toxicity of each compound measured, and the possibility that multiple compounds have additive effects on aquatic organisms. Importantly, the PTI does not measure actual toxicity but is a relative index of potential toxicity—the higher the PTI value, the greater the potential toxicity of dissolved pesticides. The PTI is based on available toxicity data for major groups of aquatic organisms (Munn and others, 2006). In this Circular, the PTI for cladocerans (small crustaceans found in most freshwater habitats) was used because toxicity data for this common invertebrate are available for a large number of compounds. Relations among PTI and biological communities were therefore only examined for macroinvertebrates. For each stream site, PTI values were computed for each water sample collected within 90 days before macroinvertebrates were collected. The maximum of these separate PTIs was used to indicate the potential for toxicity of dissolved pesticides at each site.



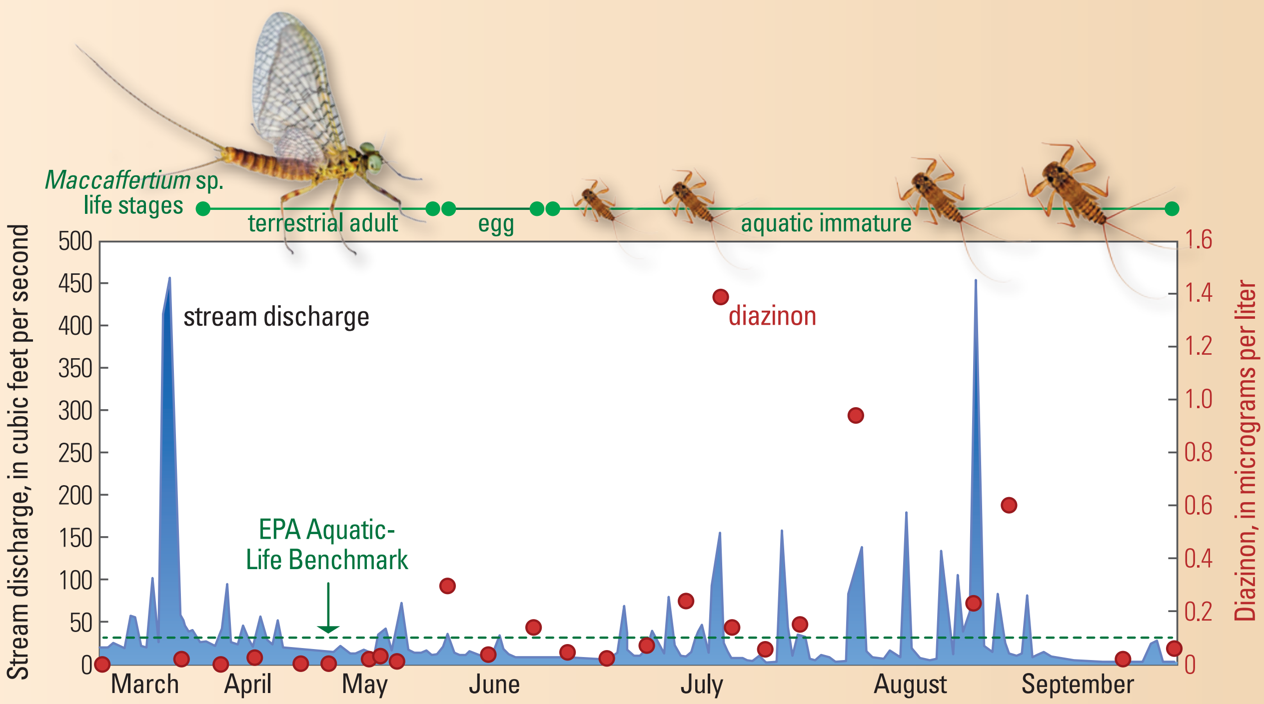
These maps of the conterminous United States show the potential toxicity of pesticide mixtures in agricultural and urban areas during a 1992–2001 NAWQA study (Gilliom and others, 2006). Patterns in the relative contribution of different pesticides to the potential toxicity of mixtures reflect the geographic distribution of crop types among agricultural settings. Insecticides were the dominant pesticides contributing to potential toxicity. In urban settings, diazinon was the dominant insecticide contributing to potential toxicity, but sales for residential use were phased out by the U.S. Environmental Protection Agency at the end of 2004.

The pesticides contributing to the potential toxicity of mixtures vary geographically according to their use across the Nation.

Pesticide Concentrations in Stream Water Vary Seasonally

Pesticide concentrations in stream water vary by season, with lengthy periods of low concentrations punctuated by seasonal pulses of much higher concentrations. This variation occurs because transport to streams is controlled, in large part, by the timing of precipitation and associated runoff relative to pesticide applications (Leonard, 1990). For example, before sales for residential use were phased out in 2004, diazinon was commonly used during the growing season to control insects on lawns and gardens. During 1994, concentrations of diazinon during summer frequently exceeded levels known to be harmful to aquatic life in Accotink Creek, Virginia (see map earlier in this chapter).

Seasonal variation in pesticide concentrations in stream water has important biological implications because of the timing of the life cycles of aquatic organisms. For example, aquatic insects are especially vulnerable to dissolved contaminants early in life because of their relatively small body sizes (Liess and others, 2005). A mayfly, *Maccaffertium* sp., that was common in a nearby reference stream was absent from Accotink Creek (see graph below). This aquatic insect species emerges from the stream as a terrestrial adult during the spring, then deposits fertilized eggs back into the water soon thereafter. By early summer, the eggs hatch and the small immature insects begin their aquatic life. This species would have been extremely vulnerable to diazinon and likely was eliminated from Accotink Creek because its early life stages coincided with the highest concentrations of dissolved insecticides. (EPA, U.S. Environmental Protection Agency; 1 microgram = 1 part per billion.)



Streamflow and diazinon concentrations in Accotink Creek, Virginia, 1994

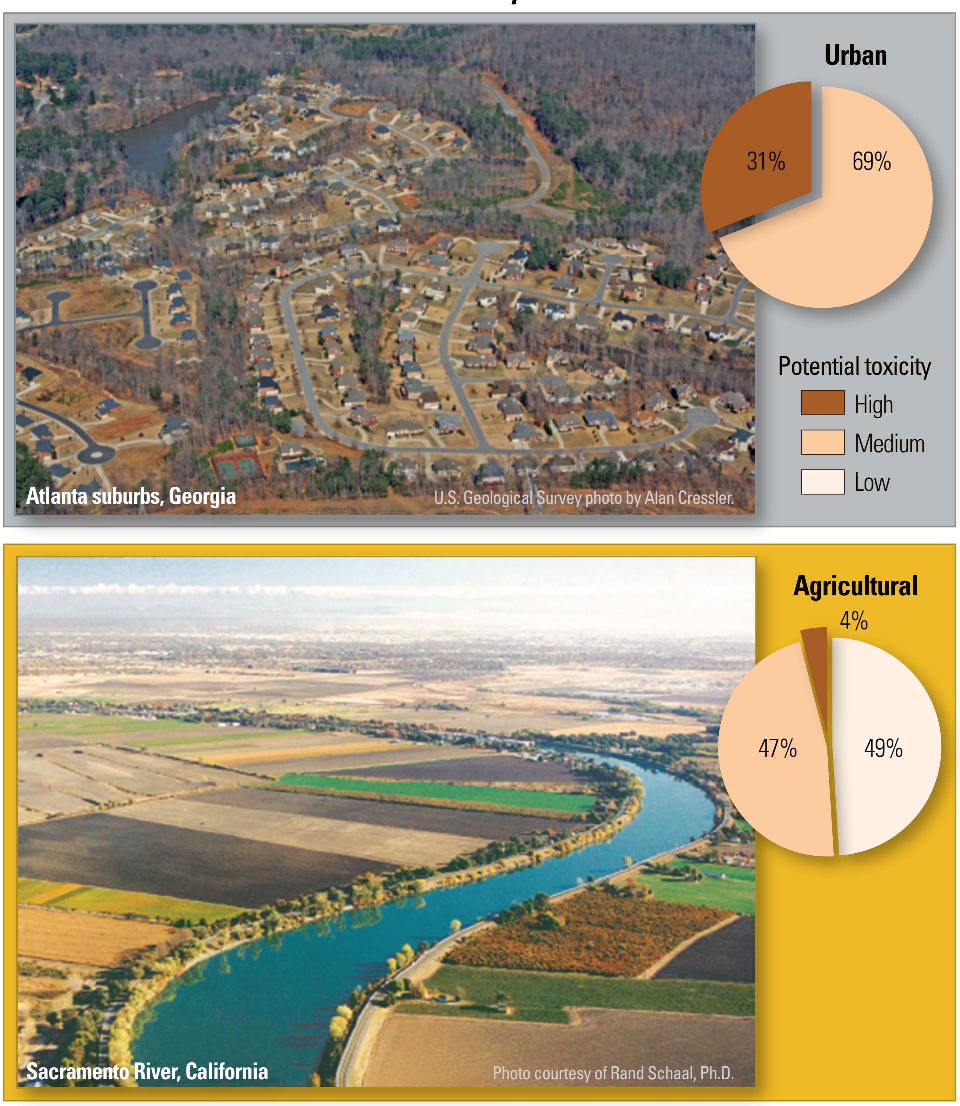
Pesticides and Other Organic Contaminants in Stream Sediments

NAWQA found that contaminants associated with streambed sediments were frequently present at concentrations that may adversely affect stream health. A national assessment of the occurrence and distribution of contaminants in streambed sediments reported that U.S. Environmental Protection Agency Aquatic-Life Benchmarks for pesticide compounds were exceeded at 70 percent of assessed streams in urban settings and 30 percent of streams in agricultural settings (Gilliom and others, 2006). As with dissolved pesticides, sediment contaminants generally occurred in complex mixtures of multiple compounds.

Potentially toxic sediment-contaminant mixtures occurred in 31 percent of urban streams, compared to 4 and 6 percent in agriculture and mixed-use settings, respectively. This finding suggests that relative to other land-use settings, human activities in urban areas lead to higher amounts of contaminants in stream sediments, which is consistent

The potential toxicity of contaminant mixtures in stream sediments was higher in urban than in agricultural streams.

Land Use and the Potential Toxicity of Sediment Contaminants



NAWQA found that the potential toxicity of sediment contaminants in streams in the United States was highest in urban areas. Mixtures most likely to be toxic occurred in 31 percent of urban streams (top photo), compared to just 4 percent of agricultural streams (bottom photo). (%, percent.)

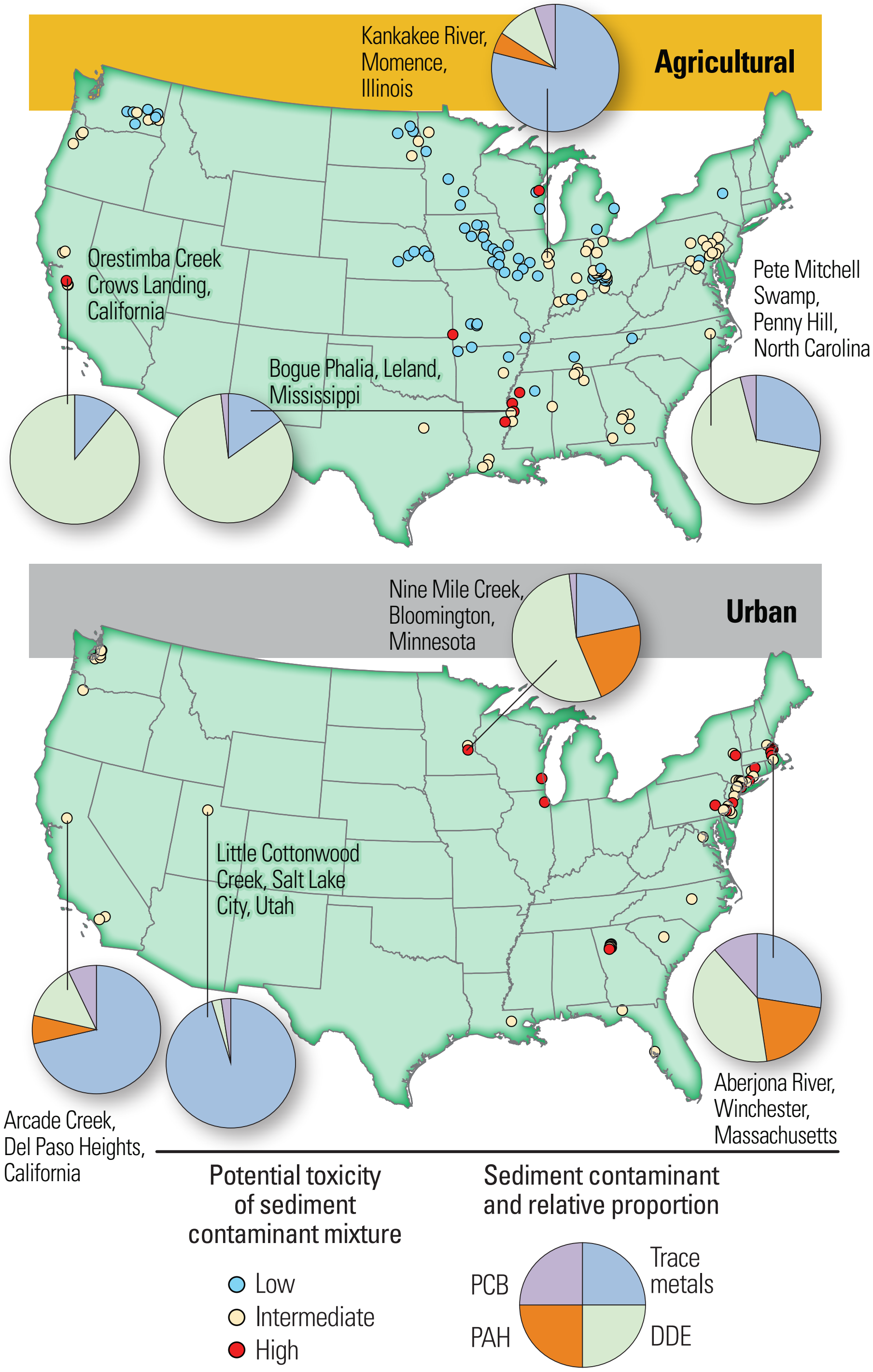
Estimating the Potential Toxicity of Streambed-Sediment Contaminants

An index of relative potential toxicity derived from scientific consensus-based freshwater sediment-quality guidelines was used to assess the potential effects of sediment contaminant mixtures on biological condition (MacDonald and others, 2000). Each contaminant in a sample is divided by its respective sediment-quality guideline (SQG), which is the concentration above which toxic effects are expected based on laboratory toxicity tests. The mean SQG provides a basis for screening whether sediment samples are toxic to aquatic life (Long and others, 2006).

NAWQA sediment samples were categorized into one of three ranges of mean SQGs identified by Long and others (2006) that represent classes of increasing likelihood of toxicity to sediment-dwelling aquatic organisms. Importantly, mean SQGs include only those compounds for which sediment-quality guidelines have been developed and include organochlorine insecticides, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and trace metals such as mercury and zinc. Other important limitations of this approach are presented in Long and others (2006).

with other NAWQA studies that found high concentrations of pesticides and other organic contaminants (Bryant and others, 2007) and trace elements (Coles and others, 2012) in urban streams.

The types of compounds contributing to potential sediment toxicity are related to land use (see facing page). In agricultural areas, high potential toxicity was largely the result of elevated concentrations of legacy organochlorine compounds, such as DDT. In urban areas, high potential toxicity was mostly the result of elevated concentrations of polycyclic aromatic hydrocarbons (PAHs), many of which are known to be highly toxic to aquatic life (Albers, 2003). Recent USGS studies (Mahler and Van Metre, 2011) have identified coal-tar-based sealcoat—the black, viscous liquid sprayed or painted on asphalt pavement such as parking lots—as a major source of PAH contamination in urban areas for large parts of the Nation. Macroinvertebrates are particularly susceptible to PAH contamination, especially those that live in the fine stream-bed sediments where PAHs tend to accumulate.



NAWQA studies found that patterns in the relative contribution of different compounds to potential toxicity of sediment-contaminant mixtures reflect dominant land uses in a watershed. As shown on these maps of the conterminous United States, sediment-contaminant mixtures in agricultural sites often include legacy organochlorine insecticides such as dichlorodiphenyldichloroethylene (DDE), which is a breakdown product of dichlorodiphenyltricloroethane (DDT). More generally, sediment-contaminant mixtures in urban streams are often dominated by polycyclic aromatic hydrocarbons (PAHs). Polychlorinated biphenols (PCBs) are another major contaminant.