Chapter 2. Study Area

A general description of the Fox River watershed study area is provided in this chapter as well as an introduction to Geographic Information System (GIS) datasets that provide geospacially referenced data for the watershed as input or to generate input for watershed models. Datasets have been customized for the Fox River watershed and may be viewed at the Illinois Rivers Decision Support System, Fox River Watershed Investigation Web site (http://ilrdss.sws.uiuc.edu/fox). More information about the various datasets is available at referenced Web sites.

2.1. Watershed Description

The headwaters of the Fox River watershed are in Waukesha County, Wisconsin. The Fox River drains 938 square miles in Wisconsin and 1720 square miles in Illinois. The watershed in Illinois includes parts of McHenry, Lake, Kane, Cook, DuPage, DeKalb, Kendall, and LaSalle Counties, with minor drainage from Will, Grundy, and Lee Counties. Within Illinois, the Fox River watershed has distinctive natural segments. The uplands are relatively flat, with marshes and lakes. The Fox River flows through the Fox Chain of Lakes, and Stratton Dam near McHenry is operated to maintain minimum lake levels. As the Fox River flows through Kane County, the watershed narrows. The land becomes hilly with bluffs encroaching on the floodplain, and the watershed narrows to a minimum width of 10 miles near Geneva. South of Geneva, the watershed widens again, and the land is relatively flat. The Fox Chain of Lakes is a unique area defined at its downstream point by Stratton Dam. The proposed study area includes the urbanized and relatively flat region with numerous lakes and marshes downstream of Stratton Dam to Algonquin (McHenry and Lake Counties), the narrow, relatively hilly, urbanized and urbanizing area between Algonquin and Montgomery (Kane, Cook, and DuPage Counties) and the flatter, broader, still predominantly rural watershed between Montgomery and the mouth of the Fox River at Ottawa (DeKalb, Kendall, and LaSalle Counties). The Fox Chain of Lakes presents a complex system that initially will be treated as an upstream boundary condition. Thus, it will be possible to first focus efforts on the sources and processes in the study area. Once the water quality dynamics in the study area are understood, it will be important to address the impact of upstream activities.

In Illinois, the Fox River is unique in that the slope in upstream reaches is more gradual than in downstream reaches. The total length of the river is about 187 miles, with a total fall of about 460 feet and an average slope of 2.5 feet per mile. However, the slope is about 2 feet per mile from Algonquin to South Elgin, steepest between South Elgin and Yorkville (about 4.5 feet per mile), and becomes less steep (about 2.7 feet per mile) below Yorkville to Dayton (McConkey, et. al., 1992).

Between Stratton Dam and the confluence with the Illinois River, the Fox River is 97.8 miles long and drains 1399 square miles. There are 27 named tributaries to the Fox River below Stratton Dam (Table 2.1), and 25 of these tributaries drain 10 or more square miles. The three largest tributaries, Indian Creek, Big Rock Creek, and Somonauk Creek, as well as Buck, Brumbach, Hollenback, Mission, Morgan, Rob Roy, and Roods Creeks, are located in the

Table 2.1. Tributaries to the Fox River below Stratton Dam

Miles above mouth at Ottawa	*Stream name*	*Drainage area (sq mi)*
8.5	Buck Creek	40.9
9.4	Indian Creek	264.4
13	Brumbach Creek	11.7
15.8	Mission Creek	15.2
20.1	Somonauk Creek	83.0
21	Roods Creek	15.9
29.5	Hollenback Creek	15.3
31	Big Rock Creek	192.4
31.3	Rob Roy Creek	19.6
35.6	Blackberry Creek*	72.9
37.8	Morgan Creek	17.7
42.7	Waubansee Creek	29.4
44.8	Fox River tributary	2.8
49	Indian Creek	14.7
53	Mill Creek*	30.9
60.9	Ferson Creek*	54.1
62.4	Norton Creek	12.1
65.9	Brewster Creek*	15.5
68.8	Poplar Creek*	44.3
72.2	Tyler Creek*	40.0
74.6	Jelkes Creek	6.8
81.6	Crystal Creek	27.2
85.3	Spring Creek	25.8
89.4	Flint Creek*	36.8
90.8	Slocum Lake Outlet	11.5
94.3	Mutton Creek	12.4
96.9	Sleepy Hollow Creek	15.0

Note: ***Continuous gaging station discharge data available.
Source: Knapp and Meyers, 1999

southern part of the watershed, and land use within their watersheds and those of their tributaries is primarily agricultural. Blackberry, Ferson, Mill, and Tyler Creeks enter the Fox River from the west; the uplands of these watersheds are agricultural lands, but there is considerable development pressure and residential construction within these watersheds. Tributaries joining the Fox River from the east, such as Brewster, Norton, Waubansee, Indian (near Aurora), and Poplar Creeks have considerable urbanization in their watersheds. The watersheds of Crystal, Flint, and Spring Creeks in the northern part of the study watershed have both urban and forested areas. The Fox River and tributaries are shown in the map in Figure 2.1.

Tributary watersheds are shown in Figure 2.2. The tributary watershed boundaries are derived from the Hydrologic Unit Code (HUC12) boundaries. The HUC12 boundaries are a product of a collaborative effort led by the U.S. Department of Agriculture (USDA), Natural

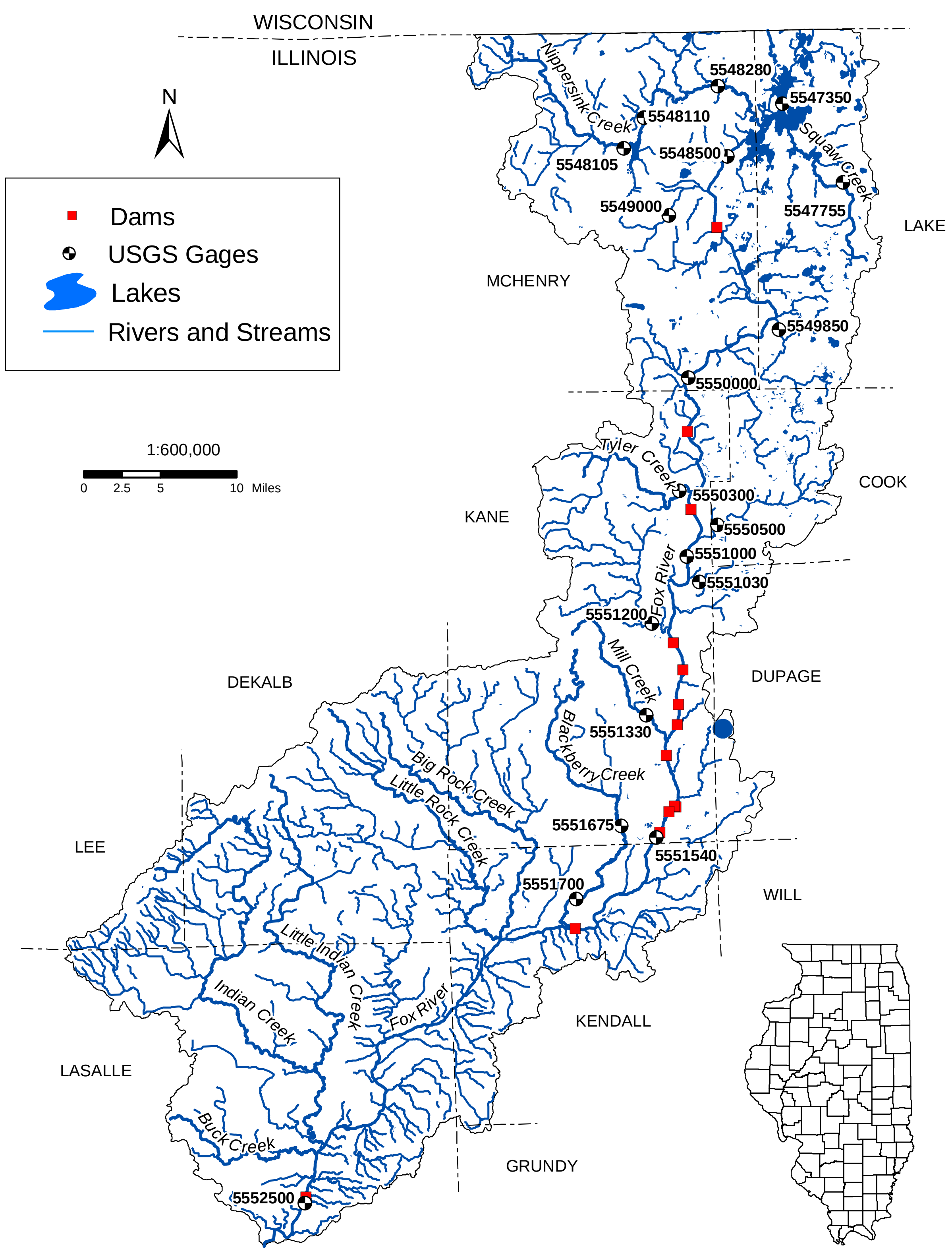

Figure 2.1. Fox River watershed, rivers, streams, USGS gages, and mainstem dams

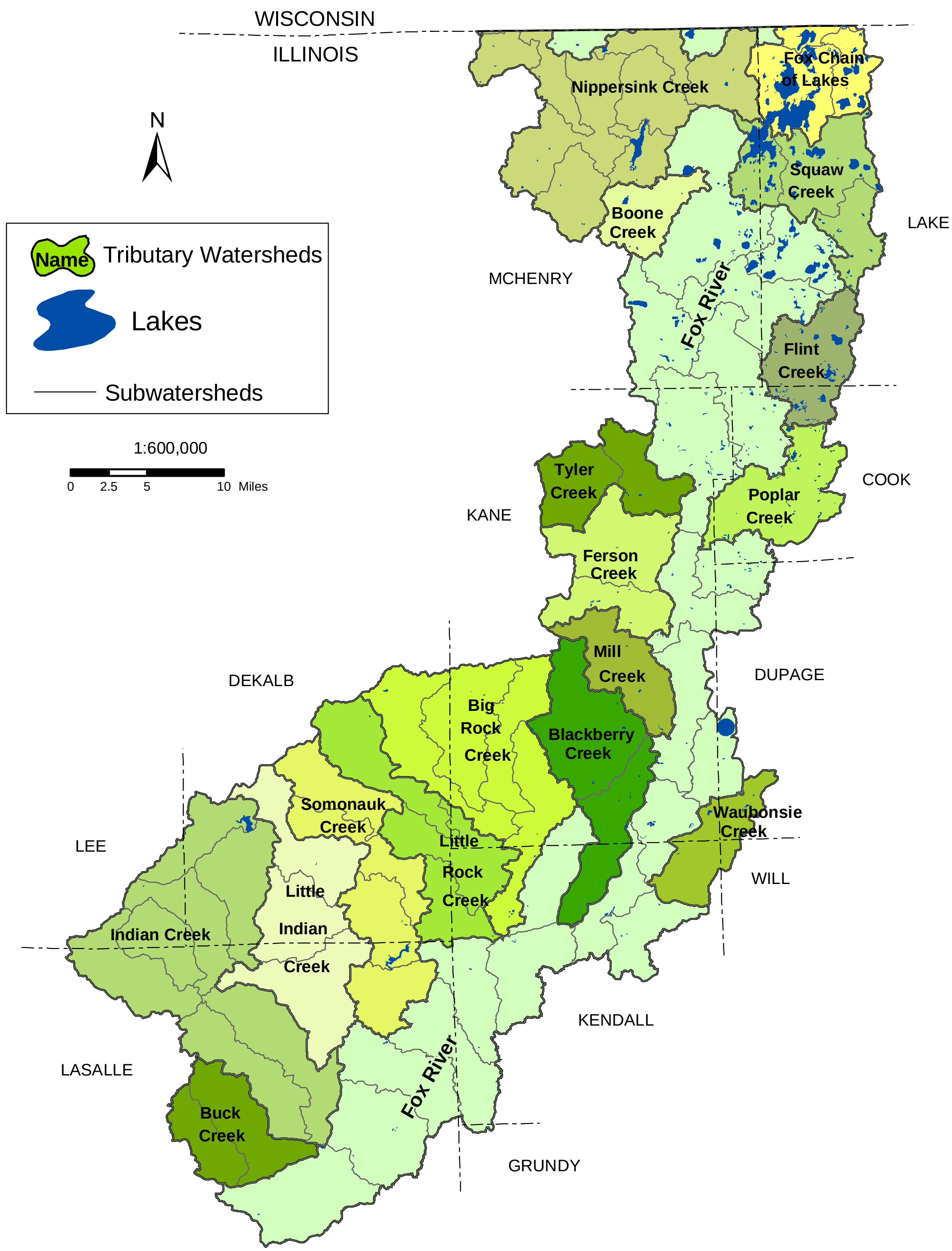

Figure 2.2. Fox River tributaries and watersheds

Resources Conservation Service (NRCS, 2003a). The dataset was developed by delineating the boundary lines on 1:24,000 base maps and digitizing the delineated lines. Digital Elevation Model (DEM) data may have been used in part of the process to establish preliminary boundaries. The tributary and sub-watershed boundary GIS coverages for the Fox River watershed are available at the Fox River Watershed Investigation Web site.

Currently, there are 15 dams on the mainstem of the Fox River and numerous smaller dams on its tributaries. Many of these dams originally were built in the 1800s to provide mechanical power for grist and lumber mills and have since been rebuilt to maintain the pools upstream of the dams (Santucci and Gephard, 2003). Dams on the mainstem of the Fox River are shown in Figure 2.1. A georeferenced database was created for this project with information about the dams compiled from several sources (Santucci and Gephard, 2003; Chicago Area Paddling/Fishing Guide, 2003). The locations of the dams were determined from digital orthoquadrangles at a 1:12,000 scale. Some of the attribute data in the database are listed in Table 2.2. East and West Stolp Island Dams are commonly referred to as a single dam.

Between 1997 and 2000, the Illinois Department of Natural Resources (IDNR), Office of Scientific Research and Analysis published five reports describing the Fox River Assessment Area (watershed), including geology (IDNR, 1998a), water resources (IDNR, 1998b), living resources (IDNR, 1998c), socio-economic profile, environmental quality, and archaeological resources (IDNR, 1997a), and an early account of the ecology of the Fox River area (IDNR, 2000). Those volumes provide a detailed discussion of watershed climate, geology, and soils, and the following sections contain excerpts and summaries from these publications. A summary of the natural resources is provided in *The Fox River Basin, An Inventory of the Regions' Resources* (IDNR, 1997b).

Table 2.2. Dams on the Mainstem of the Fox River

Name	*River mile*	*Length (feet)*	*Height (feet)*	*Crest elevation (feet, NGVD 1929)*	*Gates*
Stratton Lock and Dam	98.90	275	7.0	736.8	Yes
Algonquin Dam	82.60	308	10.5	730.3	Yes
Carpentersville Dam	78.20	378	9.0	720.7	No
Elgin Dam	71.90	325	13.0	708.4	No
South Elgin Dam	68.20	357	8.3	700.0	No
St. Charles Dam	60.60	294	10.3	684.6	No
Geneva Dam	58.70	441	13.0	675.4	No
North Batavia Dam	56.30	244	12.0	665.1	No
South Batavia Dam (east)	54.90	143	6.0	653.9	No
South Batavia Dam (west)	54.90	203	5.0	654.2	No
North Aurora Dam	52.60	375	9.0	646.0	No
East Stolp Island Dam	48.90	177	11.0	628.4	No
West Stolp Island Dam	48.90	170	15.0	628.4	No
Hurd's Island Dam	48.40	365	2.8	619.0	No
Montgomery Dam	46.80	325	8.0	614.0	No
Yorkville Dam	36.50	530	7.0	575.0	No
Dayton Dam	5.70	600	29.6	498.8	Yes

2.2. Climate and Hydrology

The climate of the Fox River watershed is typically continental, due to its changeable weather and the wide range of temperature extremes. Summer maximum temperatures are generally in the 80s or low 90s with lows in the 50s to 60s, while daily high temperatures in winter are generally in the 20s or 30s, with lows in the teens or 20s (^{o}F). Mean annual precipitation is 36.88 inches, with more rainfall in the spring and summer than in fall and winter (IDNR, 1998b). Locations within the Fox River watershed in Illinois where precipitation is recorded are listed in Table 2.3. The listed stations are operated by the USGS (USGS, 2003a) or are part of the cooperators network reporting to the National Weather Service (Angel, 2003). Most of these stations are located in the northern part of the study watershed. In the southern half of the watershed, only daily total precipitation is recorded at Newark and Paw Paw. The Illinois Climate Network station located at St. Charles records a full spectrum of climate data.

The mean annual streamflow is an estimated 1818 cubic feet per second (cfs), on the basis of streamflow records for the Fox River at Dayton, Water Years 1915-2002 (USGS, 2003a). The highest mean monthly streamflow of all streams and rivers generally occurs during March and April, and the lowest mean monthly flows are in August, September, and October. The stream network for the Fox River watershed is illustrated (Figure 2.1). The rivers and streams shown are from the National Hydrography Dataset prepared by the U.S. Geological Survey (USGS) and retrieved from their Web site (USGS, 2003b). Data for the Fox River

Table 2.3. Precipitation Stations in the Fox River Watershed in Illinois

Station location	*Period of record*
Antioch*	1901 - present
Aurora*	1887 - present
Barrington*	1962 - present
Blackberry Creek near Montgomery	October 1999 - present
Crystal Lake*	1991 - present
DuPage County Airport near St. Charles	February 1986 - present
Elburn*	1999 - present
Elgin Water Treatment Facility at Elgin	March 1989 - September 1995 and March 1997 - present
Elgin*	1898 - present
Ferson Creek near St. Charles	August 2000 - present
McHenry Lock and Dam	1948 - present
Mill Creek near Batavia	October 1999 - present
Newark*	1999 - present
Nippersink Creek near Spring Grove	October 1999 - present
Paw Paw*	1913 - present
Rain Gage at well number 4 at Elburn	September 2000 - present
St. Charles* - Illinois Climate Network	1990 - present
Tyler Creek at Elgin	October 1998 - present

Note: * = hourly readings.

watershed are, at the time of this writing, available at a 1:100,000 scale. The USGS currently is processing a high-resolution dataset, 1:24,000 scale. Also shown in Figure 2.1 are USGS gaging stations in the Fox River watershed in Illinois, where continuous discharge data have been collected. Information about theses stations is given in Table 2.4.

In the study area (watershed downstream of Stratton Dam) ten continuous monitoring gaging stations were active during all or part of 1998 through 2002. Three stations are located on the mainstem of the Fox River at Algonquin, Montgomery, and Dayton. The others are located on tributaries. These continuous monitoring stations are operated by the USGS. Stage is recorded at 15-minute intervals and converted to discharge values using rating tables maintained by the USGS.

Stage information is recorded at Stratton Dam, which has a lock, five movable gages, and a free-flowing spillway. The Illinois Department of Natural Resources (IDNR) owns and operates the dam. Vern Knapp and Karla Andrew of the Illinois State Water Survey (ISWS), in collaboration with operations staff and staff from the IDNR Office of Water Resources, have developed a database to provide real-time information for the gate settings for water level

Table 2.4. USGS Continuous Discharge Gaging Stations in the Fox River Watershed in Illinois

USGS station	*Name*	*Drainage area (sq mi)*	*Period of record (Water Year)*
Active stations			
5552500	Fox River at Dayton	2642.2	1915 - present
5551540	Fox River at Montgomery	1732.0	2002 - present
5550000	Fox River at Algonquin	1403.0	1916 - present
5548280	Nippersink Creek near Spring Grove	192.0	1966 - present
5551700	Blackberry Creek near Yorkville	70.2	1961 - present
5551675	Blackberry Creek near Montgomery	55.0	1998 - present
5551200	Ferson Creek near St. Charles	51.7	1961 - present
5550300	Tyler Creek at Elgin	38.9	1998 - present
5550500	Poplar Creek at Elgin	35.2	1951 - present
5551330	Mill Creek near Batavia	27.6	1998 - present
5547755	Squaw Creek at Round Lake	17.2	1990 - present
5551030	Brewster Creek at Valley View	14.0	2002 - present
Discontinued stations			
5551000	Fox River at South Elgin	1556.0	1990 - 1998
5548500	Fox River at Johnsburg	1205.0	1998
5547350	Grass Lake Outlet at Lotus Woods	919.0	1998
5548110	Nippersink Creek below Wonder Lake	97.3	1995 - 1997
5548105	Nippersink Creek above Wonder Lake	84.5	1995 - 2001
5549850	Flint Creek near Fox River Grove	37.0	1990 - 1995
5549000	Boone Creek near McHenry	15.5	1949 -1981

Note: Water Year = October 1–September 30.

regulation. The database presently is maintained at the ISWS. Relationships have been developed to estimate the flow through the gages and the flow over the spillway as a function of the water level (stage). Stage readings are made twice a day by the dam lockmaster. The daily average flow at Stratton Dam was estimated from this information for the period 1998-2002.

A continuous recording gage was operated at South Elgin from 1990 to 1998. Due to funding reductions, the gage was converted to a stage-only gage. While stages continue to be recorded, routine discharge measurements and observations of flow conditions have been discontinued. The rating curve used to convert a stage reading to a discharge has not been updated since 1998; thus, estimates of discharge cannot be made with the same accuracy or reliability of other USGS gages. Any estimate of discharge using the measured stages and the outdated rating curve is subject to error and can only serve as a general guide to the flow conditions.

Average monthly discharges for the period 1998-2002 are shown (Figures 2.3–2.12) for the Fox River at Stratton Dam, Algonquin, South Elgin, Montgomery, and Dayton, and for Blackberry, Ferson, Poplar, Mill, and Tyler Creeks. Also shown in each plot are lines showing the flows corresponding to the 10-, 50-, and 90-percent chance of exceedence for each month. These flows were computed using the Illinois Stream Flow Assessment Model or ILSAM (Knapp and Myers, 1999). Information recorded at the stations on the mainstem of the Fox River was used to estimate daily flow values at water quality sampling sites when flow was not measured. Flow relationships used in the ILSAM model were used to interpolate flow values for sampling sites.

Average 1998-2002 monthly flows in the Fox River were often at or above the 50 percent exceedence level, i.e., the median flow for each month for the period record at the station. Flows exceeding the 10 percent exceedence flow occurred in February and June of 1999 between Stratton Dam and South Elgin. In June 2000 and February 2001, the average monthly flows were high from Stratton Dam to Dayton. Average monthly flows for July, November, and December 2002 were below the median flow at most station on the Fox River. However, in any month, at any station, daily flows or instantaneous flows may be higher or lower than typical flows. The daily and/or instantaneous flow coincident with water quality sampling was considered in the water quality data analysis in this study.

Average monthly flows recorded at stations on tributaries show a wide range of flow conditions occurred between 1998 and 2002. Average monthly flows ranged from above the 10 percent chance of exceedence to below the 90 percent chance of exceedence for most months.

Precipitation and measured flows provide information on the quantity of water passing through the watershed and its river network; however, the characteristics of the stream channels influence the velocity, width, and depth of flow, which are important factors for water quality modeling. The rate of transport (velocity) through the river system is significant for computation of time-dependent chemical transformations, the depth of flow influences the mixing with the substrate and light penetration, and the width of flow defines the surface area exposed to the air, thus influencing aeration and other physical processes with impacts on water chemistry. Channel geometry varies from river to river, tributary to tributary, and reach to reach. Detailed information on stream channel geometry is available from hydraulic models developed for flood

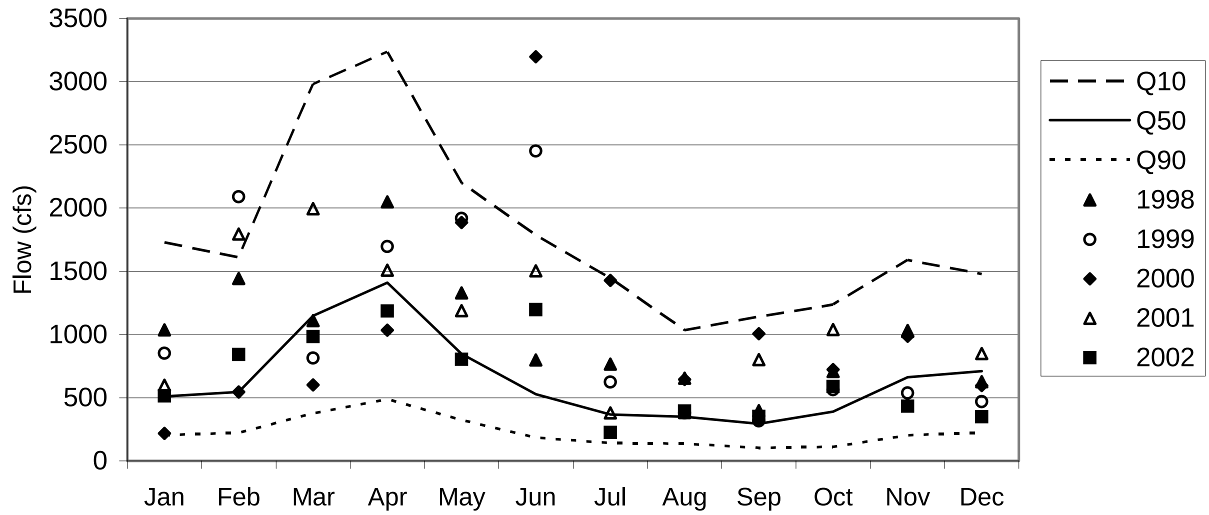

Figure 2.3. Average monthly flows, Fox River at Stratton Dam

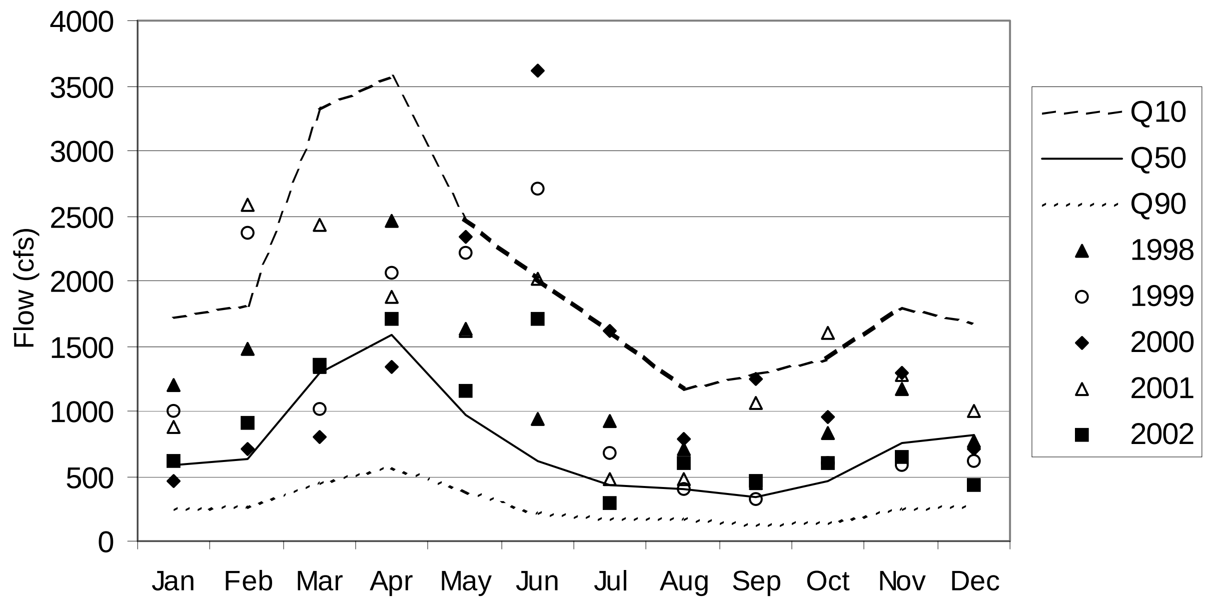

Figure 2.4. Average monthly flows, Fox River, USGS Station 05550000 at Algonquin

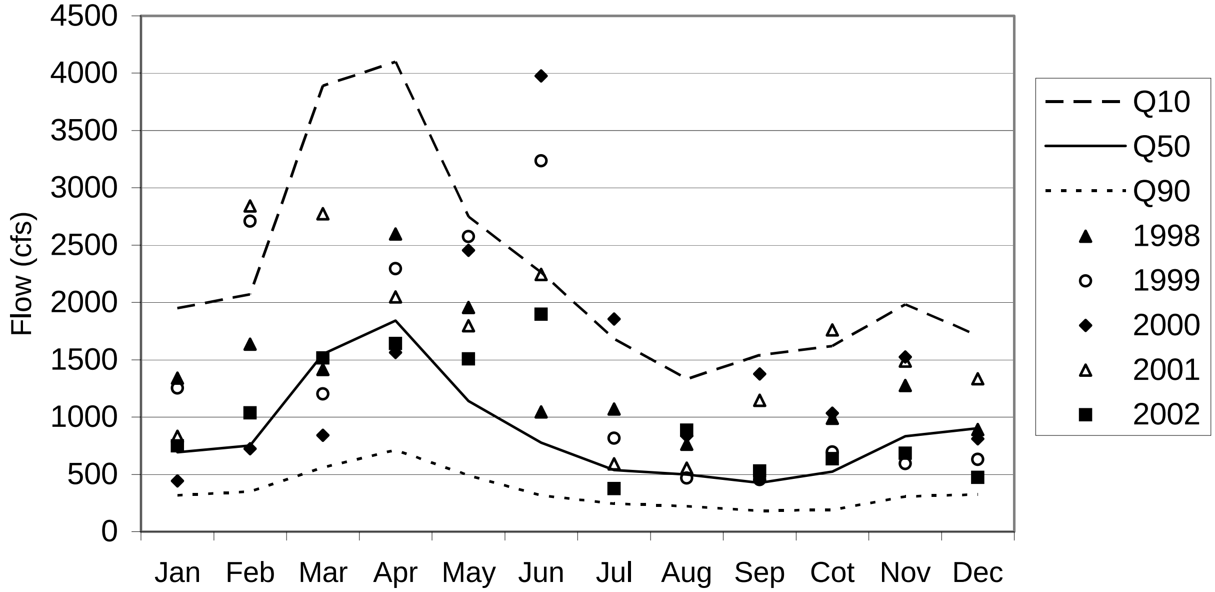

Figure 2.5. Average monthly flows, Fox River at South Elgin

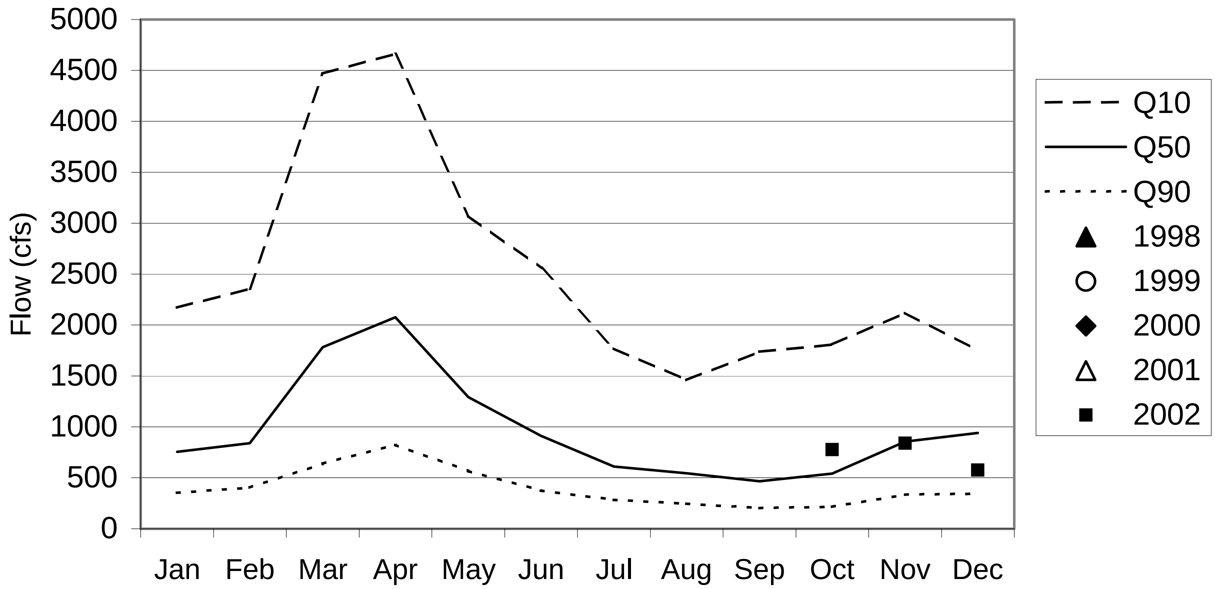

Figure 2.6. Average monthly flows, Fox River, USGS Station 05551540 at Montgomery

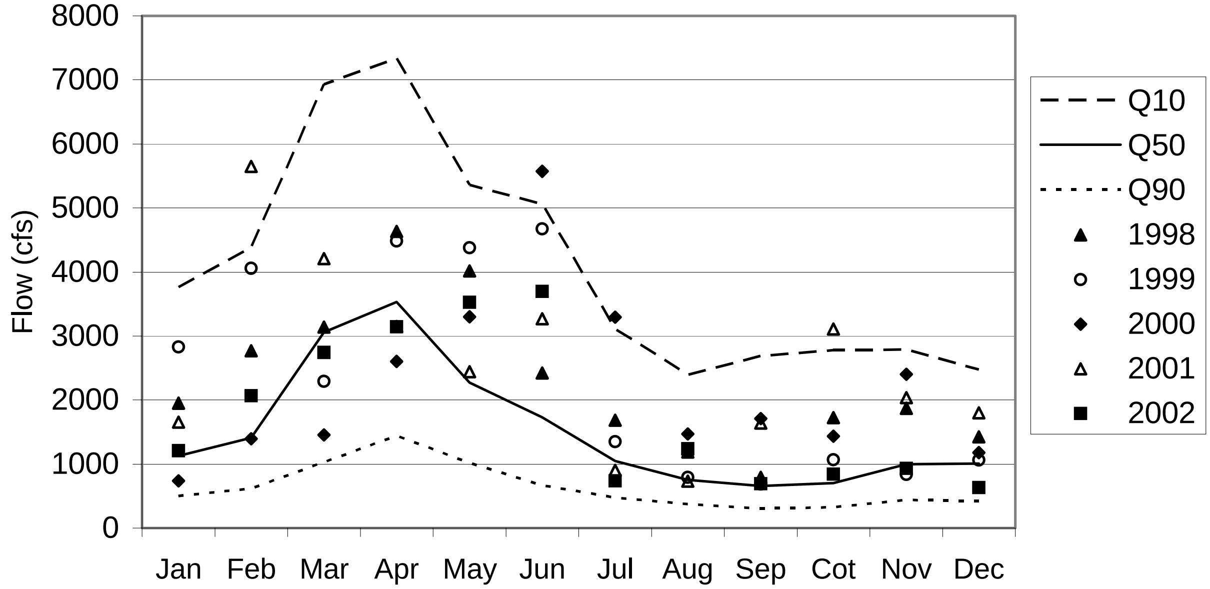

Figure 2.7. Average monthly flows, Fox River, USGS Station 05552500 at Dayton

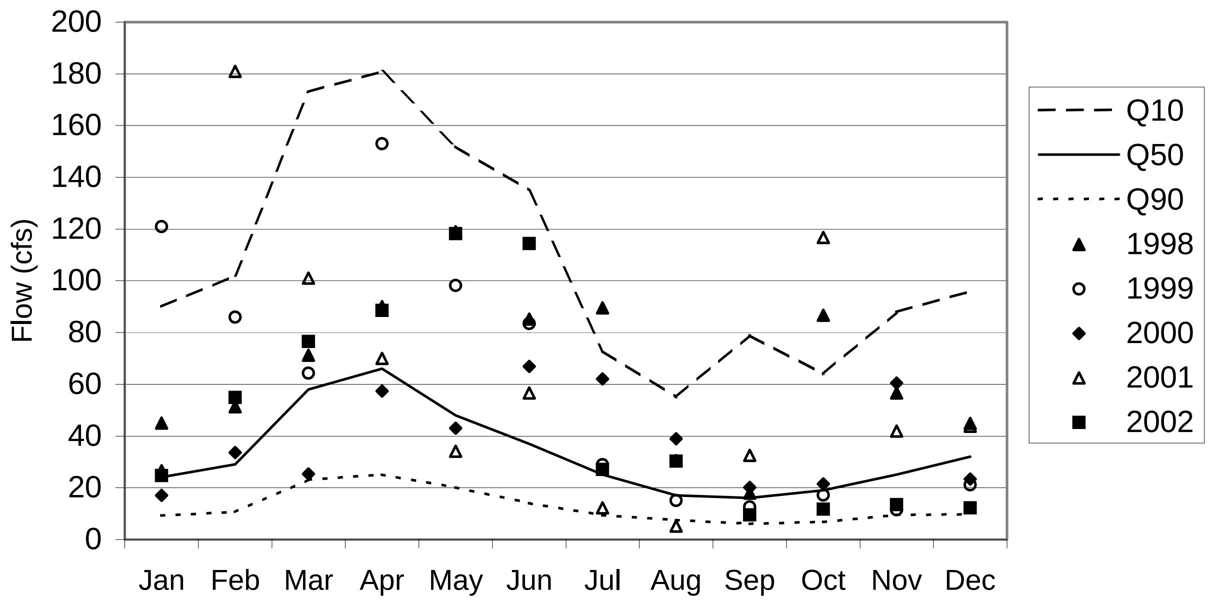

Figure 2.8. Average monthly flows, Blackberry Creek, USGS Station 05551700 near Yorkville

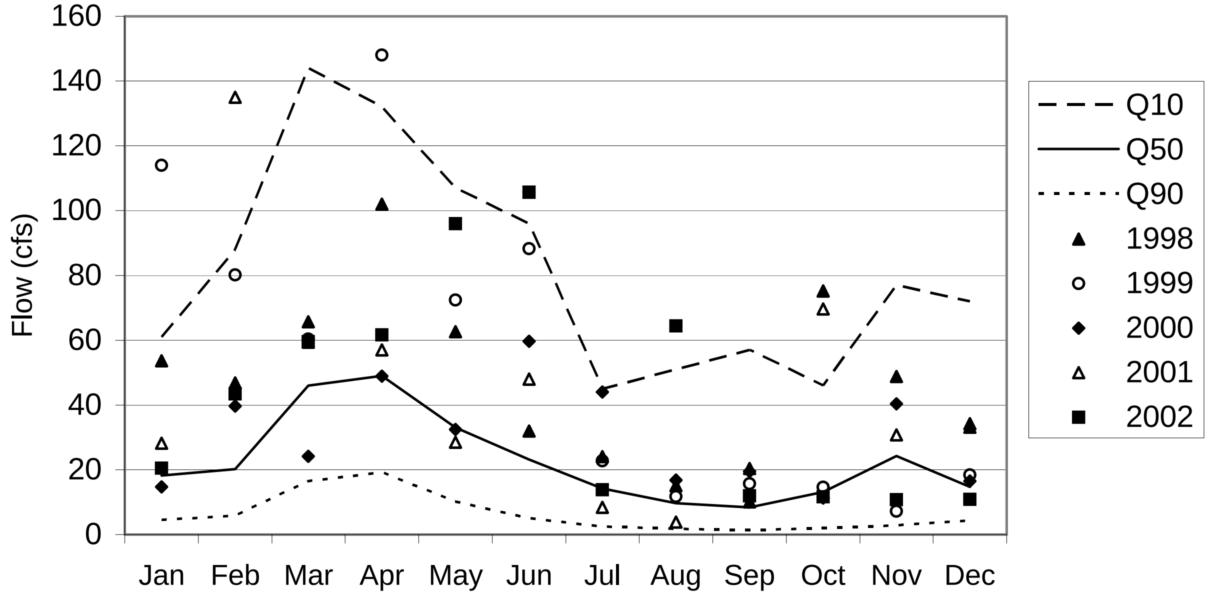

Figure 2.9. Average monthly flows, Ferson Creek, USGS Station 05551200 near St. Charles

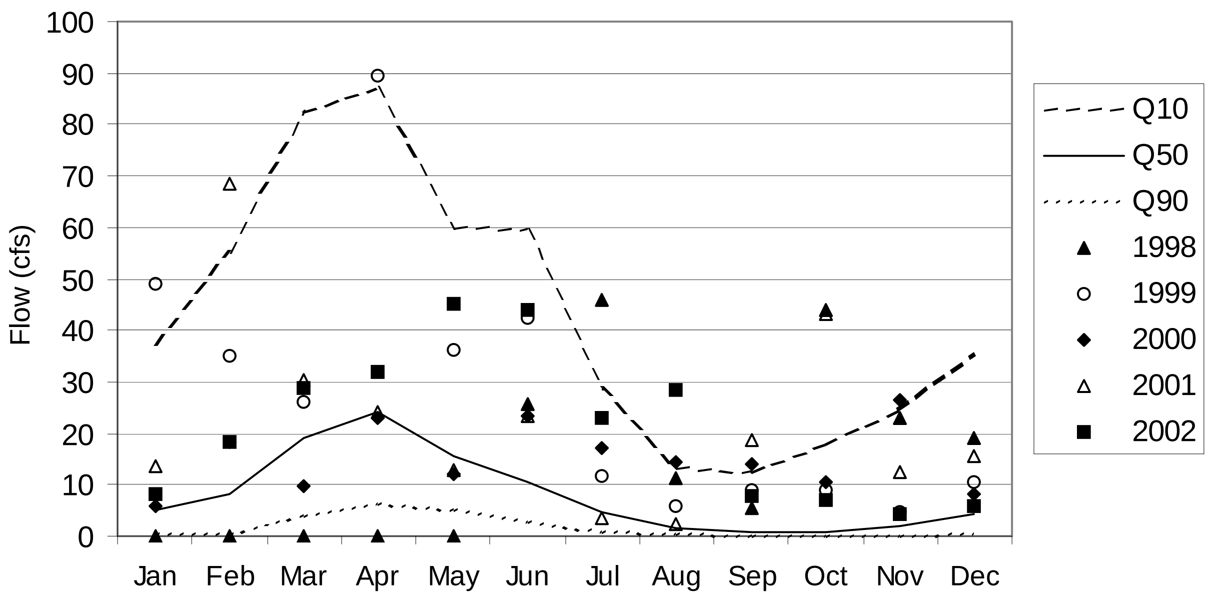

Figure 2.10. Average monthly flows, Mill Creek, USGS Station 05551330 near Batavia

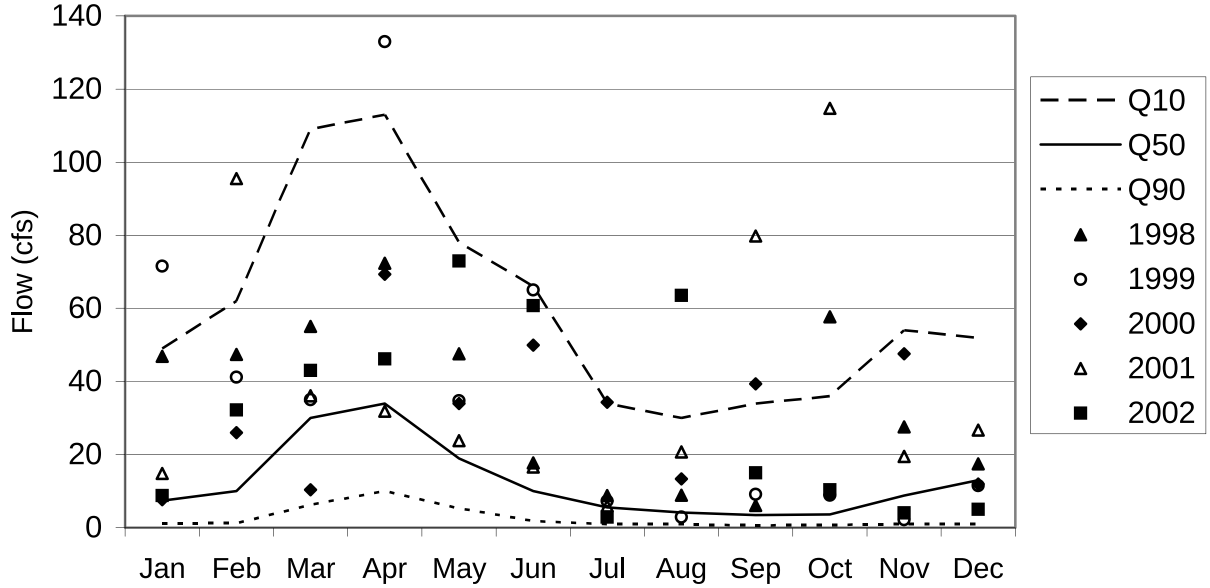

Figure 2.11. Average monthly flows, Poplar Creek, USGS Station 05550500 at Elgin

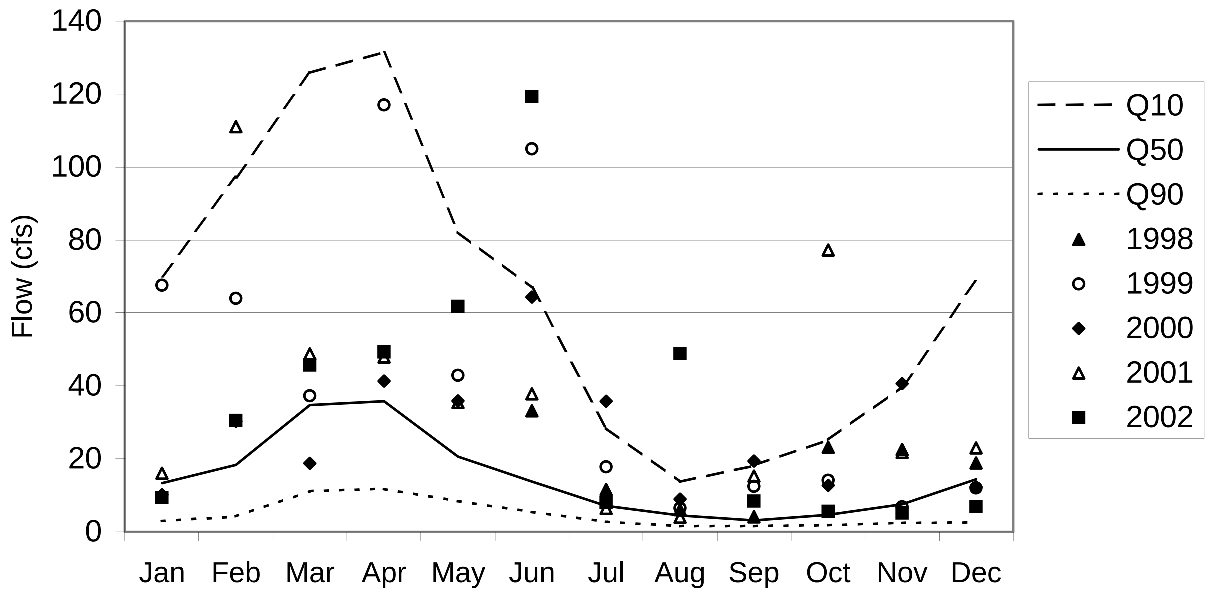

Figure 2.12. Average monthly flows, Tyler Creek, USGS Station 05550300 at Elgin

insurance studies throughout much of the watershed. These hydraulic models are customized with cross-section data from surveys of the stream or river. The ISWS serves as the State Repository for Floodplain Information and holdings include a vast collection of the hydraulic models used for flood insurance studies. Federal Emergency Management, Flood Insurance Studies for counties and communities within the Fox River watershed were reviewed to determine where hydraulic models have been prepared. An inventory of models for the Fox River and its tributaries was conducted for this project, and the map in Figure 2.13 shows where hydraulic models previously have been prepared for streams and rivers in the Fox River watershed. The oldest models date back to the early 1980s, the newest to 2002. Stream cross-section data can be used to develop flow relationships for water quality models.

2.3. Geology, Soils, and Topography

The top of the bedrock surface in the Fox River area is a complex surface containing buried valleys, lowlands, and uplands. Several large buried valleys in the bedrock surface traverse the watershed area. The Fox River is eroding into bedrock in a few areas, primarily south of Elgin. Sediments left by the earliest glaciers to enter Illinois have been almost entirely eroded away in the Fox River watershed. Glacial drift overlying bedrock consists of a complex interfingering of beds and lenses of outwash with layers of tills. Deposits of glacial origin range from less than 100 feet to more than 400 feet thick (IDNR, 1998a).

Loess, till, outwash, and lacustrine materials are the dominant parent materials of the soils on the watershed uplands. Silty materials and some sandy deposits dominate major drainageways and floodplains. These materials differ significantly in their permeability, erodibility, and physical and chemical characteristics. By affecting water table elevation, erosion, sedimentation, and water chemistry, these differences create localized habitats (IDNR, 1998a).

Soil texture and composition affect the chemistry and infiltration rate of water and are an important feature of the watershed used in modeling. The USDA, NRCS has constructed soils maps for the United States, and these are available in digital format (NRCS, 2003b, 2003c). The State Soil Geographic Database STATSGO is available for the entire Fox River watershed and has a scale of 1:250,000. A sample of the soil permeability information from this database for the Fox River watershed is illustrated in Figure 2.14. The State Soil Geographic Database SSURGO, has a higher resolution, with mapping scales from 1:12,000 to 1:63,360. However, the SSURGO data are available for only selected counties in the Fox River watershed: Kane, McHenry, DuPage, DeKalb, and Will Counties. The SSURGO database is linked to a Map Unit Interpretations Record (MUIR) attribute database, which gives the proportionate extent of the component soils and their properties for each map unit. The SSURGO map units consist of one to three components each. The MUIR database includes more than 25 physical and chemical soil properties. Examples of information that can be queried from the database are: available water capacity, soil reaction, salinity, flooding, water table, and bedrock; building site development and engineering uses; cropland, woodland, rangeland, pastureland, and wildlife; and recreational development (NRCS, 2003c).

Watershed boundaries, land slope, and stream slope are topographic features that significantly influence watershed processes. Traditionally, topographic maps such as those

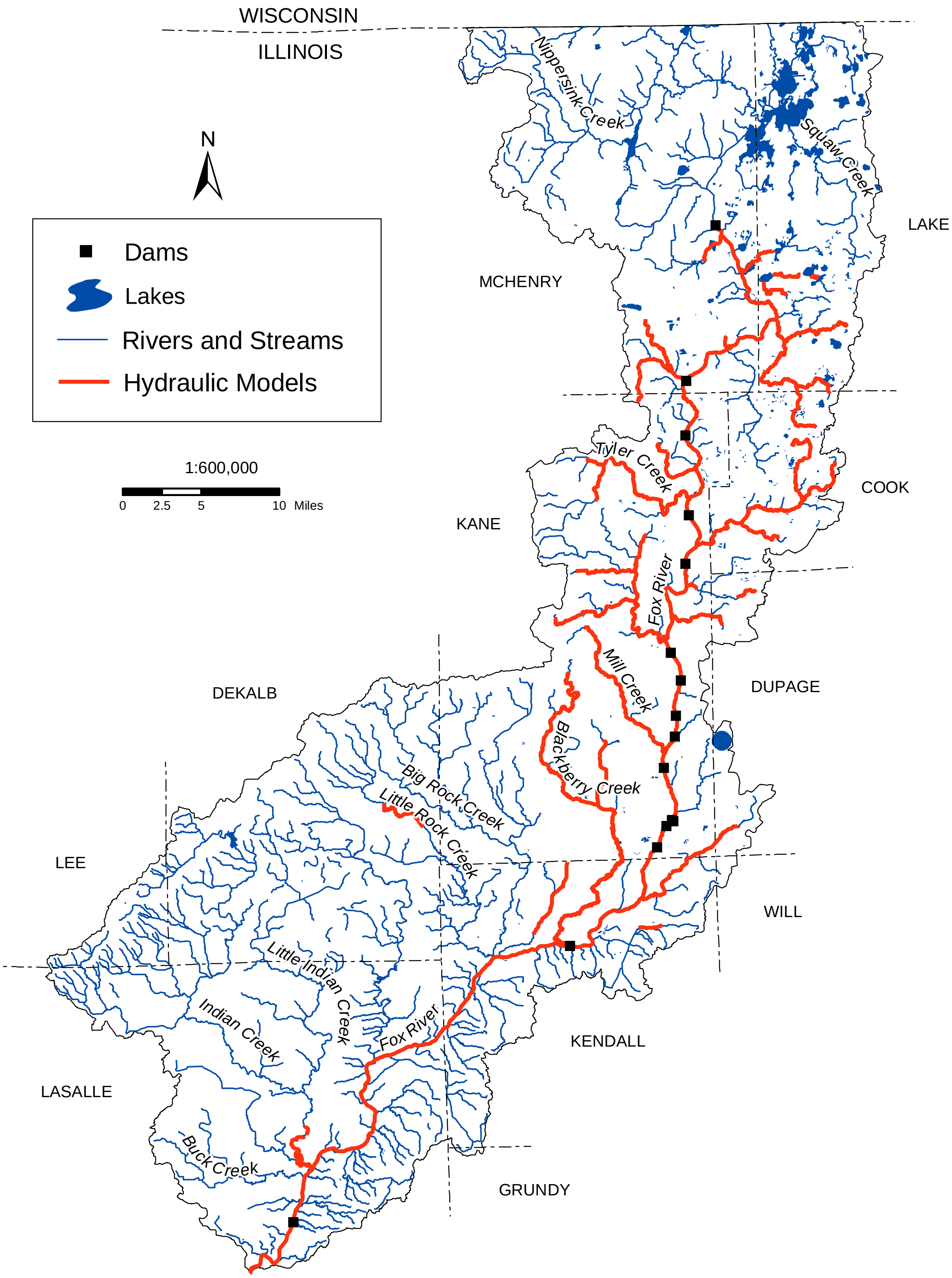

Figure 2.13. Fox River and stream reaches for which hydraulic models were developed for flood insurance studies

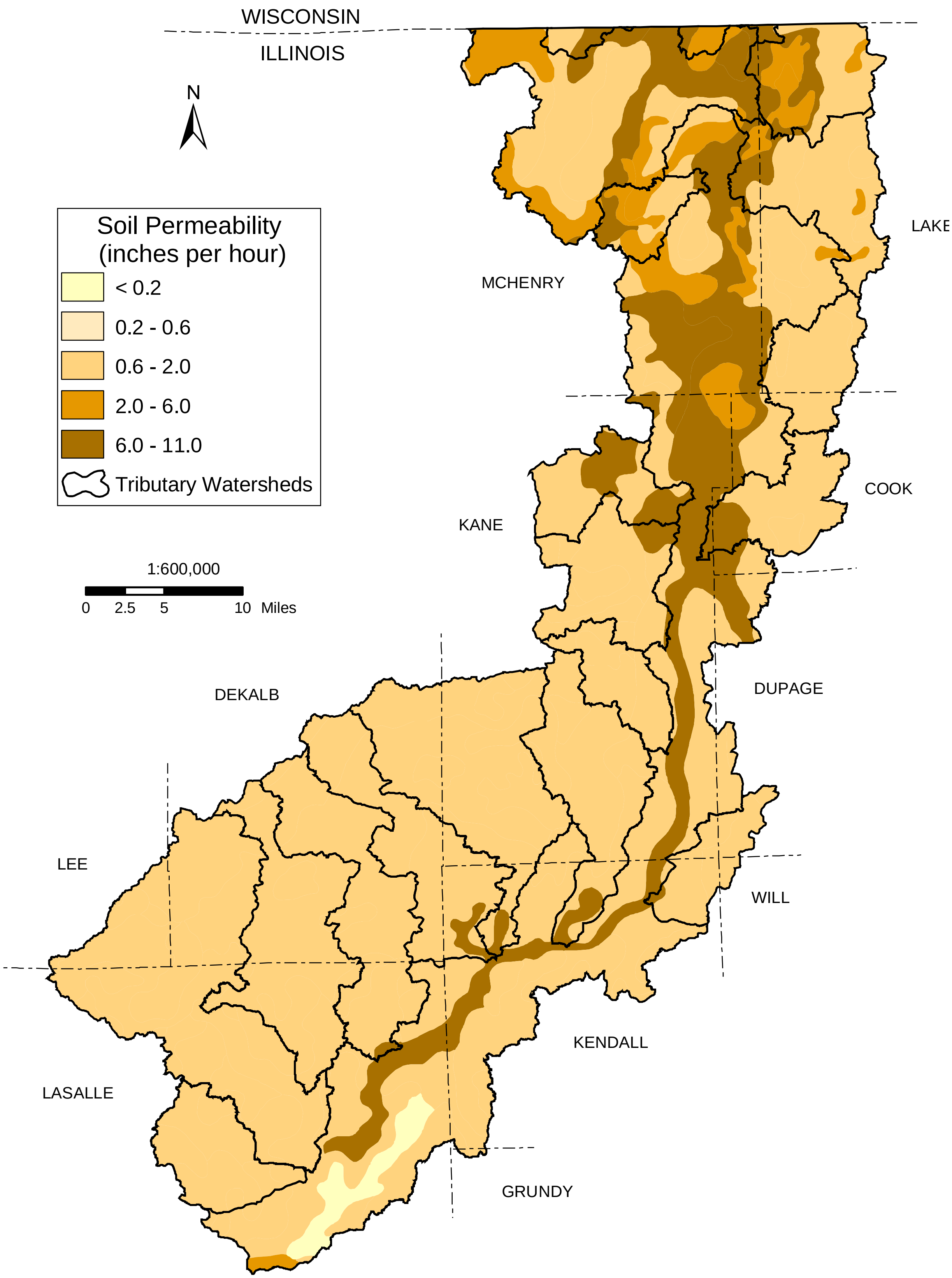

Figure 2.14. Fox River watershed soil permeability

published by the USGS have provided the basis for delineation of watershed boundaries and calculation of land slopes. The DEMs now are commonly used to delineate topography in applications using georeferenced data as Geographic Information Systems (GIS) datasets. The USGS produces DEMs and distributes them through the Internet (USGS, 2000). In Illinois, the Illinois State Geological Survey shared costs with the USGS to update a number of the DEMs from Level 1 (low quality) elevation data to Level 2 (best quality) to make this the highest resolution, statewide DEM coverage currently available (Luman et al., 2002). The DEMs were derived from USGS 30-meter DEMs. The DEM displayed in Figure 2.15 shows the surface topographical relief of the Fox River watershed in Illinois, with the highest elevation (1183 feet) and the lowest elevation (411 feet, NGVD 1929).

2.4. Land Use/Land Cover

In recent decades, urbanization has increased westward from the City of Chicago, a pattern that pressures the development of the Fox River watershed. The wide range of land use in the Fox River watershed covers parts of 11 counties: McHenry, Lake, DeKalb, Kane, DuPage, Cook, LaSalle, Kendall, Lee, Grundy, and Will. A very small part of the watershed lies in Lee, Grundy, and Will Counties. The Illinois Interagency Landscape Classification Project (IILCP) has prepared an inventory of land cover for Illinois from satellite imagery acquired from three dates during the spring, summer, and fall seasons of 1999 and 2000. Through this effort, various data products are available including a GIS dataset, Land Cover of Illinois 1999-2000 Classification, and tabular data available in electronic format, Land Cover of Illinois 1999-2000 On-Line Statistical Summary (IDOA, 2003). Six land cover categories from the 1999-2000 Classification are shown (Figure 2.16). Agricultural Land, Forested Land, Urban Land, and Wetland are major categories; Surface Water and Barren Land are subcategories of the major category Other. There are 23 different subcategories used in the 1999-2000 classification, and statistical summaries listing values as a percentage of county area are presented in Table 2.5 for the eight counties that have significant land area in the Fox River watershed. The statistics show that LaSalle and Kendall Counties have primarily agricultural land cover, followed by McHenry and Kane Counties. Urban and Built-Up areas dominate in Cook and DuPage Counties, followed by Lake and Kane Counties. There are no areas classified as swamps in any of these counties. The IDOA (2003) reports that watershed statistics have been calculated using watershed boundaries of the 12 digit Hydrologic Unit Coverage (HUC); however, at the time of this writing, they are not posted at their Web site. Other useful products planned by the IDOA are comparison of 1991-1995 and 1999-2000 land use/cover inventories.

An inventory of land cover in Illinois was prepared by IDNR from satellite imagery acquired during the 1991-1995 spring and fall seasons and distributed on compact disk (IDNR, 1996). The majority of the source imagery was acquired during 1992. Using this data, land cover statistics by tributary watershed were computed for the Fox River watershed as part of the IDNR Critical Trends Assessment Project (IDNR, 1998a). Land cover statistics by watershed have also been prepared using the 1999-2000 land cover data and the HUC-12 boundaries (IDOA, 2003). The techniques in satellite imagery collection and interpretation and the watershed boundaries differ between these two datasets, resulting in slight differences in area and land cover assignment. However, a comparison of the land cover type as a percentage of land area does indicate general changes in land cover between 1992 and 2000. The major land cover categories,

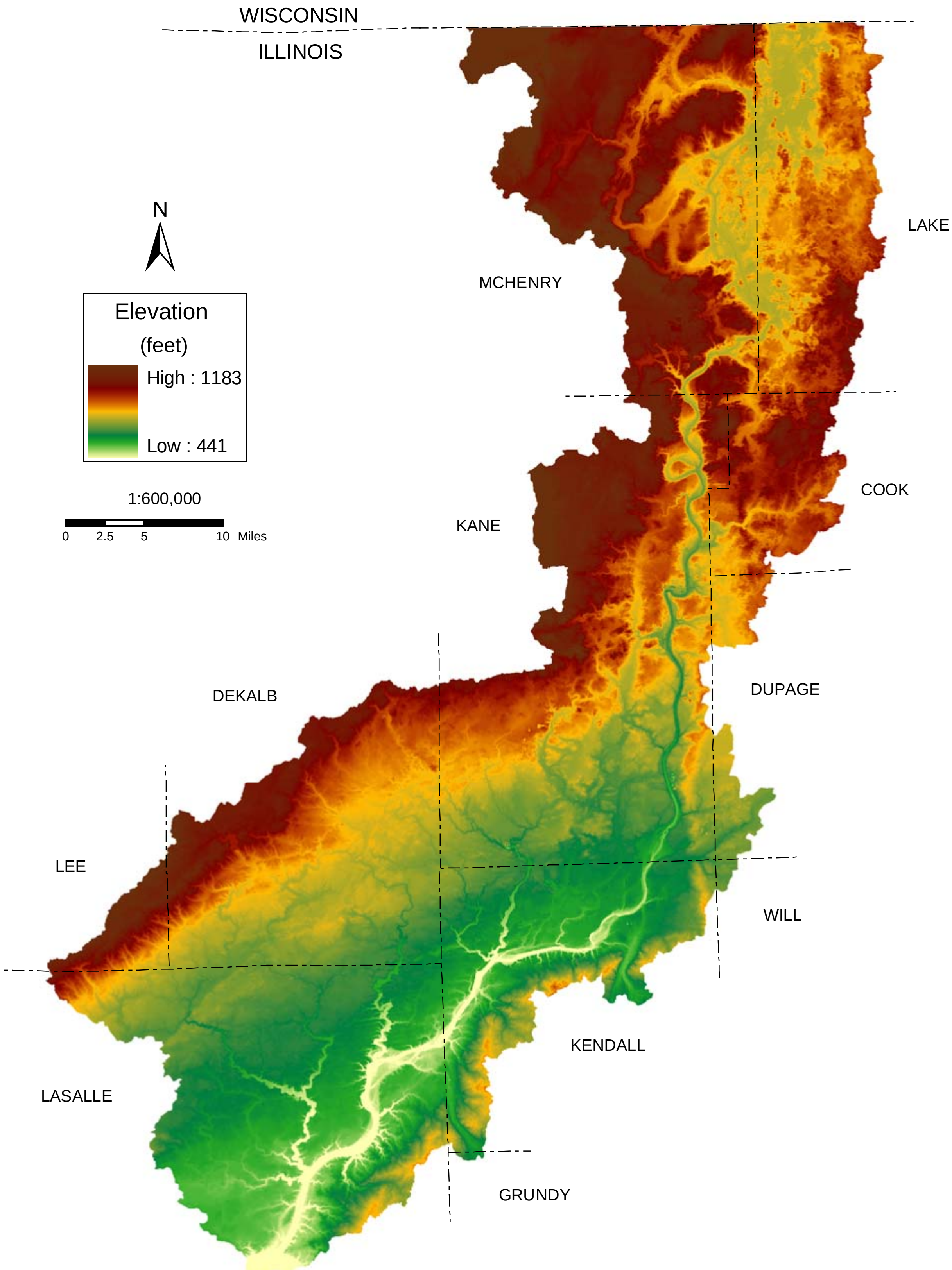

Figure 2.15. Fox River watershed elevations

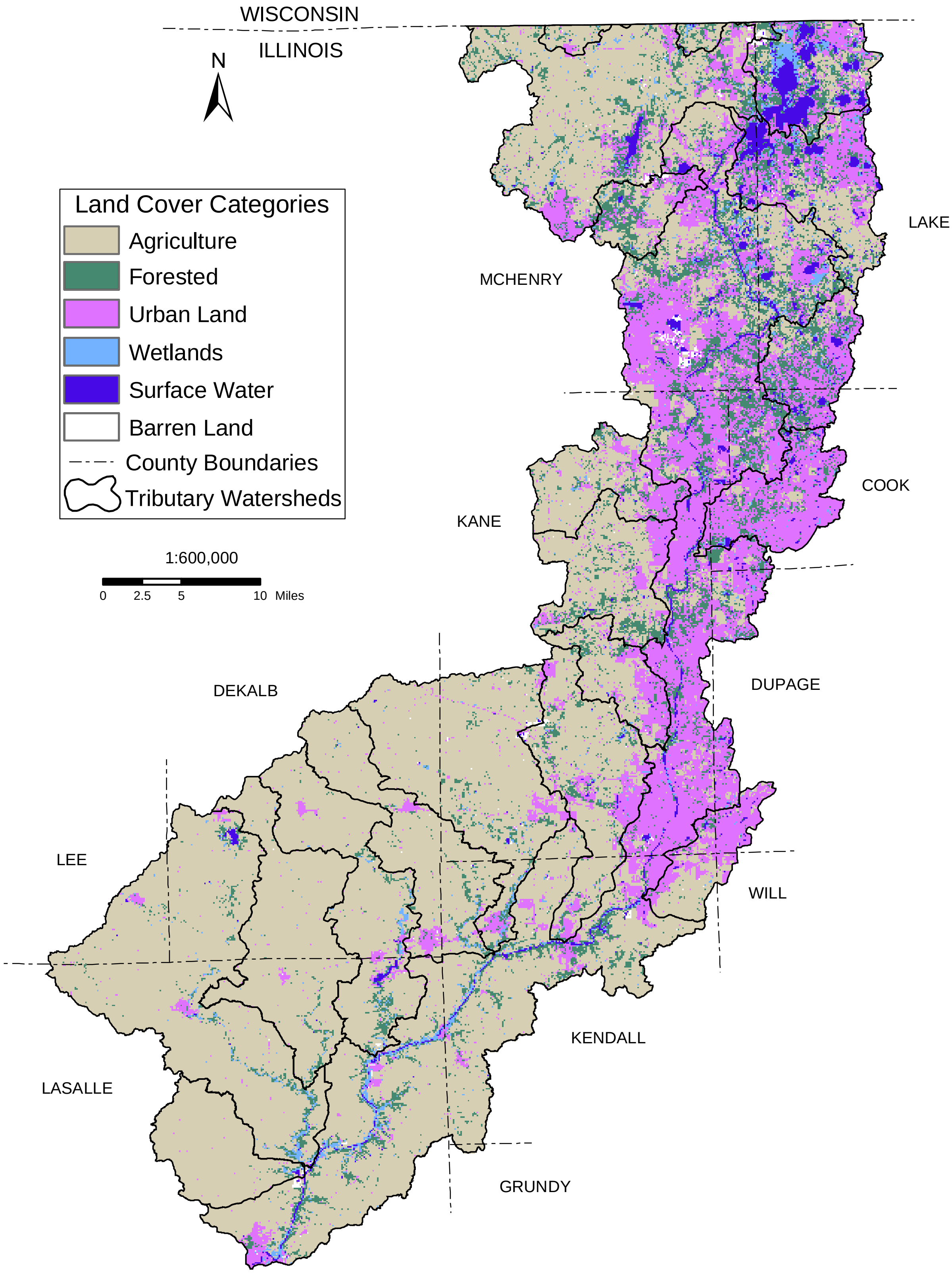

Figure 2.16. Fox River watershed land cover

Table 2.5. Land Cover as a Percentage of Total County and State Area

Land cover category	*McHenry*	*Lake*	*DeKalb*	*Kane*	*DuPage*	*Cook*	*LaSalle*	*Kendall*	*State*
Agricultural land	66.4	19.3	92.1	64.9	7.2	3.8	86.3	86.8	76.4
Corn	22.5	5.6	45.8	25.4	1.4	1.1	38.8	39.6	31.6
Soybeans	20.2	3.8	37	22.2	1.8	1.1	37.1	33.6	29.1
Winter Wheat	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.2	1
Other small grains and hay	2.1	0.8	0.9	1.1	0.1	<0.1	0.8	1	0.9
Winter Wheat/soybeans, double cropped	-	-	-	-	-	-	-	-	1.7
Other agriculture	<0.1	-	0.1	0.1	-	<0.1	0.1	0.6	0.4
Rural grassland	21.5	9.1	8.3	16	3.9	1.5	9.4	11.8	11.6
Forested land	12.4	22.9	1.7	8.2	14.1	12.8	5.4	4.9	11.5
Upland	7.9	14.5	1.3	5.7	10.3	8.9	4	3.2	9.6
Partial forest/savanna upland	4.5	8.4	0.4	2.5	3.6	3.8	1.4	1.7	1.7
Coniferous	0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	-	0.2
Urban and built-up land	16.9	47.4	4.8	24.6	75	79.6	4.3	6	6.4
High density	1.2	4.7	0.5	2.9	10.9	19.7	0.8	0.7	1.7
Low/medium density	6.4	21.2	2.5	11.8	38.1	42.9	2.4	3	2.8
Urban open space	9.3	21.4	1.7	9.9	26.1	17	1.1	2.3	1.8
Wetland	2.1	4.3	0.9	1	2	1.4	2.2	1.4	3.9
Shallow marsh	1.3	2.1	0.1	0.6	1.1	0.8	0.1	0.1	0.3
Deep marsh	0.2	1.9	<0.1	0.1	0.2	0.2	<0.1	<0.1	0.1
Seasonally/temporarily flooded	-	-	<0.1	<0.1	-	-	0.4	0.2	0.3
Floodplain forest	0.6	0.4	0.7	0.3	0.6	0.3	1.7	1.1	3.1
Swamp	-	-	-	-	-	-	-	-	0.1
Shallow water	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1
Other	2.2	6.1	0.5	1.2	1.7	2.4	1.9	0.9	1.8
Surface water	1.7	5.8	0.3	1	1.6	2.1	1.5	0.7	1.7
Barren and exposed land	0.6	0.3	0.2	0.2	0.1	0.3	0.4	0.2	0.1
Clouds	-	-	-	-	-	-	-	-	<0.1
Cloud shadows	-	-	-	-	-	-	-	-	<0.1

Source: Illinois IDOA (2003).

and the percent area in the Illinois portion of the Fox River watershed for each category are listed in Table 2.6 for 1991-1995 and 1999-2000. The values for land cover categories Wetland and Other Land are combined in Table 2.6 as there seem to be differences in how these categories were interpreted for the two datasets. The percent change between the two time periods also is listed in the table. Land in agricultural use is still dominant in the Illinois part of the watershed although it has decreased, while urban areas, the second largest land cover identified in the watershed, increased.

Table 2.6. Land Cover as a Percentage of Total Fox River Watershed Area in Illinois

Time period	*Agriculture*	*Forest*	*Urban and built-up*	*Wetland and other*
1991-1995	66.2	9.2	17.7	6.9
1999-2000	63.8	10.4	20.8	5.0
Percent change	-2.4	1.2	3.1	-1.9

These same datasets were used to compare land cover changes in the watersheds of major tributaries to the Fox River below Stratton Dam. The tributaries and statistics for land cover categories for 1999-2000 data and the percent change as compared to the 1991-1995 data are listed in Table 2.7, if data were available. A positive value for the percentage change indicates an increase in the land cover type since the 1991-1995 time period, a negative value indicates a decrease in the given land cover. A less than one percent change is shown in the table when the change was less than plus or minus one percent. Poplar Creek and` Wabaunsee Creek watersheds have experienced the greatest increase in urban land cover. The data for Ferson Creek watershed is suspect as it shows a significant decrease in urban land cover (6.5 square miles about 0.4 percent of the Illinois portion of the Fox River watershed). This appears to be a consequence of a difference in the assignment of open space, grassed areas, classified as "urban" in the summary of 1991-1995 data and "rural" in the 1999-2000 data. The Mill Creek watershed data likewise shows a decrease in urban area. Anomalies such as these are expected, given the difference in the satellite imagery data, interpretation of those data, and slight differences between the watershed boundaries used to develop two sets of statistics. Wetland and other areas are a small percentage of the total land area; thus the small percentage changes listed may likewise be a consequence of the data resolution and imagery interpretation. This comparison provides guidance for interpretation of trends in water quality data collected between 1991 and 2000.

Table 2.7. 1999-2000 Land Cover as a Percentage of Tributary Watershed Area and Percent Change between 1991-1995 Imagery and 1999-2000 Imagery

Tributary watershed	*Agriculture*	*Change*	*Forest*	*Change*	*Urban and built-up*	*Change*	*Wetland and other*	*Change*
Big Rock Creek	89.5	-1	4.3	1	4.6	<1	1.6	<1
Blackberry Creek	72.6	-1	7.8	2	17.3	2	2.3	-3
Buck Creek	97.7	<1	0.9	<1	0.5	<1	0.9	<1
Ferson Creek	69.4	14	13.1	2	16.2	-12	1.4	-4
Flint Creek	6.6	-4	30.2	1	53.8	6	9.4	-4
Indian Creek	93.4	<1	3.3	<1	1.4	<1	1.9	<1
Little Indian Creek	96.9	<1	1.7	<1	1.0	<1	0.4	<1
Little Rock Creek	90.8	<1	3.2	1	5.0	<1	1.0	<1
Mill Creek	62.6	1	8.1	2	27.8	-2	1.6	-2
Poplar Creek	6.2	-20	13.6	2	74.5	21	5.8	-3
Somonauk Creek	89.5	<1	4.4	1	3.5	<1	2.6	<1
Tyler Creek	68.0	<1	9.2	2	21.0	3	1.8	-4
Wabaunsee Creek	42.6	-15	3.4	1	52.1	16	2.0	-3

2.5. Population

The Fox River watershed is one of the most populous watersheds in the state and is home to about 11 percent of the state's population. Lake, Kane, and McHenry Counties all rank among the top ten counties in population. According to the 1990 U.S. Census, the population within the Illinois portion of the Fox River watershed was 767,552 persons, and the 2000 census shows 1,010,106 persons in the Illinois portion of the watershed (588 persons per square mile), an increase of 242,554 persons, or 32 percent. The 2000 Census shows that the Wisconsin part of the watershed has 330,287 persons (353 persons per square mile), an increase of 11 percent (32,388 persons) from the 1990 population of 297,899. Between 1990 and 2000, the population of the six-county region of Northeastern Illinois (Lake, McHenry, Cook, DuPage, Kane, and Will Counties) grew to 8,091.720, an increase of 11.4 percent (NIPC, 2001). The Northeastern Illinois Planning Commission (NIPC) has developed population projections for 2020 for the six-county region, which includes McHenry, Lake, Kane, DuPage and Cook counties within the Fox River watershed. NIPC has developed population projections for two different scenarios for the location of a regional airport (NIPC, 2000). One scenario is based upon expansion of existing airports, the other is based upon the construction of a new airport south of Chicago. NIPC's projections for the six-county region are listed in Table 2.8.

Population density of each subwatershed (HUC-12) within Illinois was computed using the U.S. Census data for 1990 and 2000 (IDNR, 1991; U.S. Census Bureau, 2000). The population density of each subwatershed was computed as an area-weighted average using the area of each census block intersecting the subwatershed and the population density of the census block for the given year. The population density by subwatershed in 1990 and in 2000 is shown in Figures 2.17 and 2.18, respectively. In 1990 a population density of 3001 or more persons per square mile existed along the much of the mainstem of the Fox River in Kane County, Poplar Creek watershed, primarily in Cook County, Crystal Creek watershed in McHenry and Kane Counties, and Squaw Creek watershed in Lake County. By 2000, the entire corridor along the mainstem of the Fox River in Kane County had reached 3001 or more persons per square mile. The 2000 population density in the Waubansee Creek and Tyler Creek watersheds now ranks among those subwatersheds having the highest population density. The subwatershed containing Aurora had the highest density population in both 1990 and 2000.

Table 2.8. NIPC Population Projections for Six-County Region of Northeastern Illinois

County	*1990 Census*	*2000 Census*	*2020 ORD*	*2020 SSA*
Cook	5,105,067	5,376,741	5,615,278	5,565,154
DuPage	781,666	904,161	985,704	985,812
Kane	317,471	404,119	552,034	548,965
Lake	516,418	644,356	806,779	782,544
McHenry	183,241	260,077	347,159	339,782
Will	357,313	502,266	738,046	822,743
Total	7,261,176	8,091,720	9,045,000	9,045,000

Notes: ORD = existing, improved airports alternative; SSA = south suburban airport alternative.
Source: NIPC (2000).

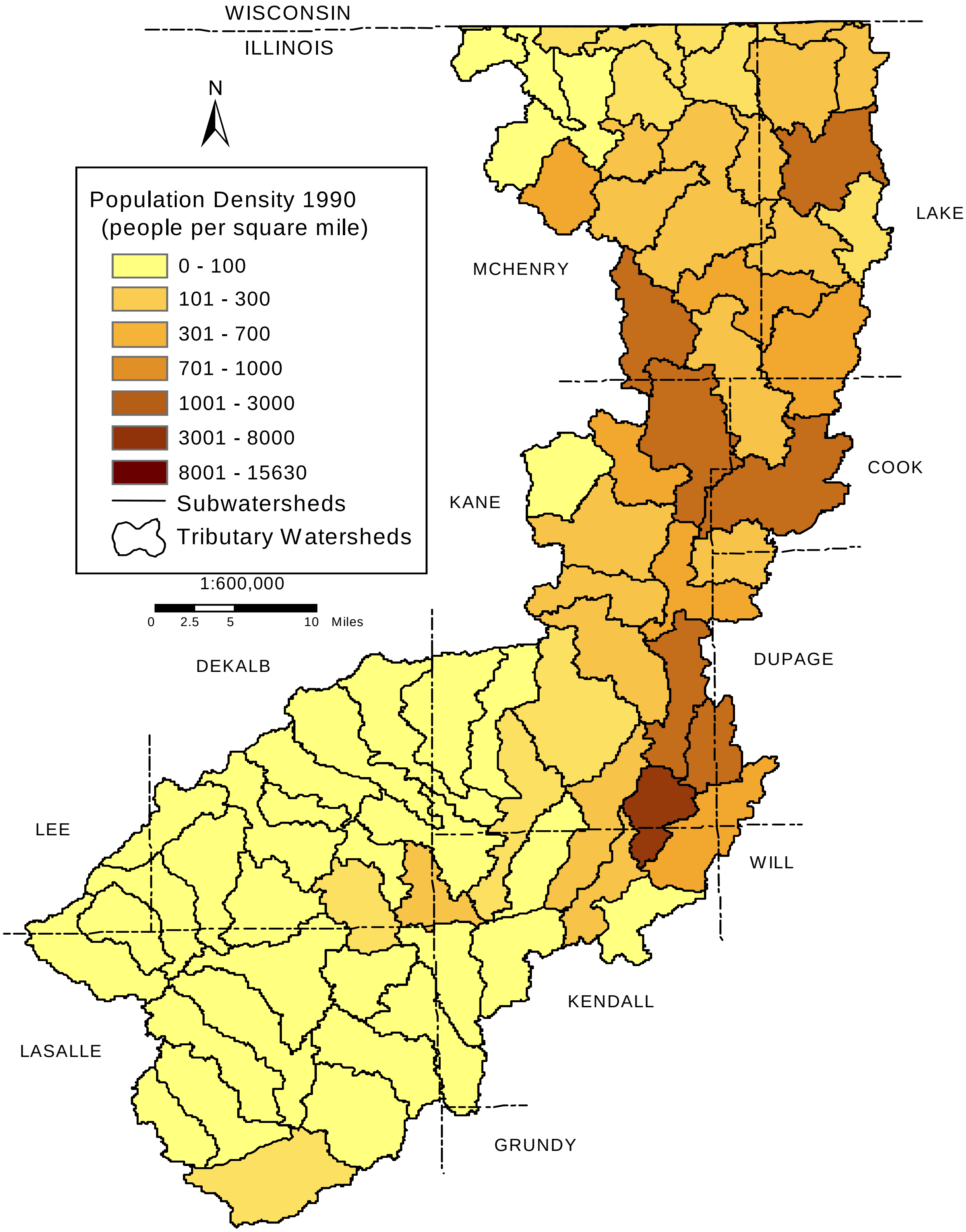

Figure 2.17. Fox River watershed population density 1990

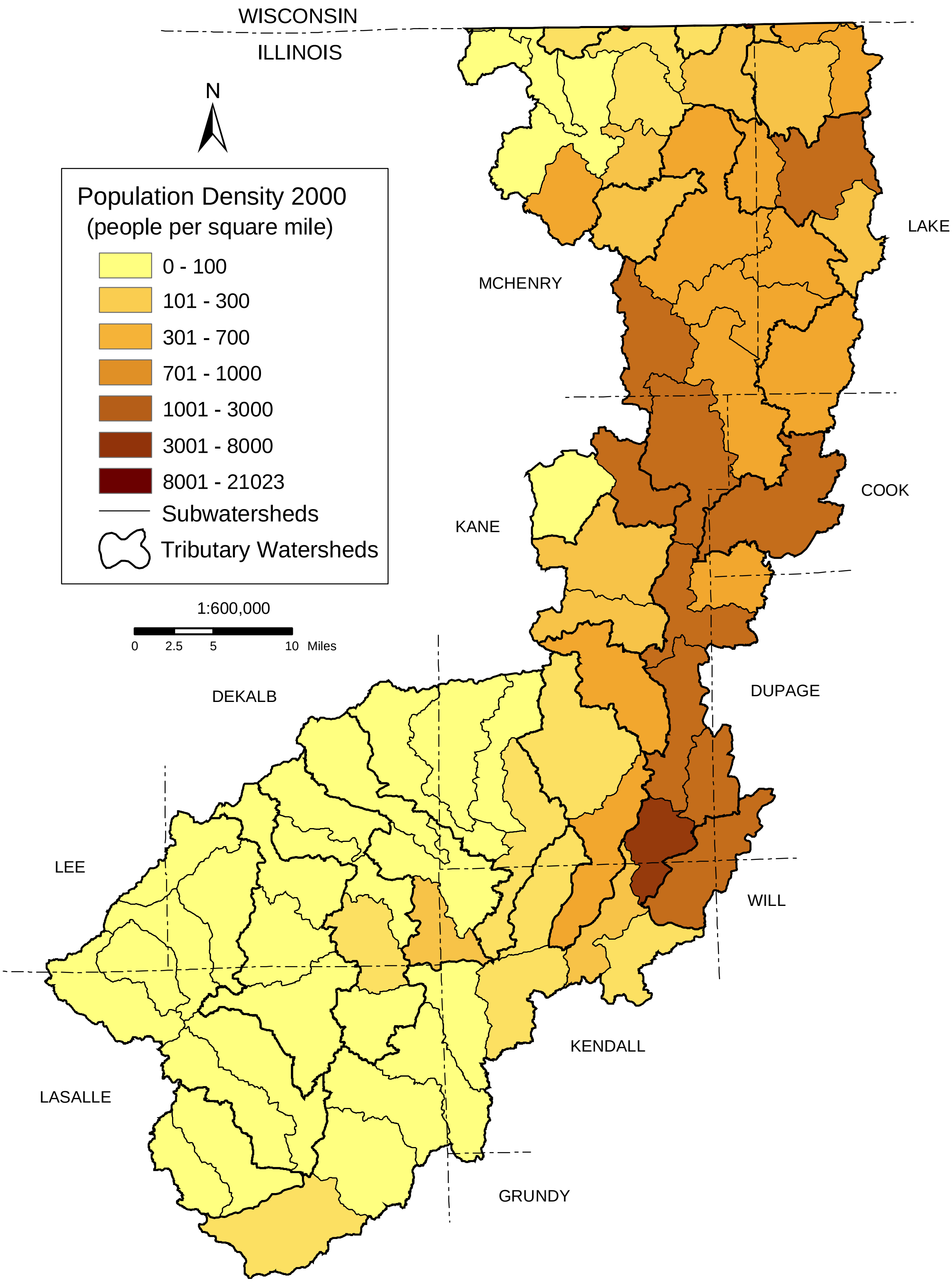

Figure 2.18. Fox River watershed population density, 2000

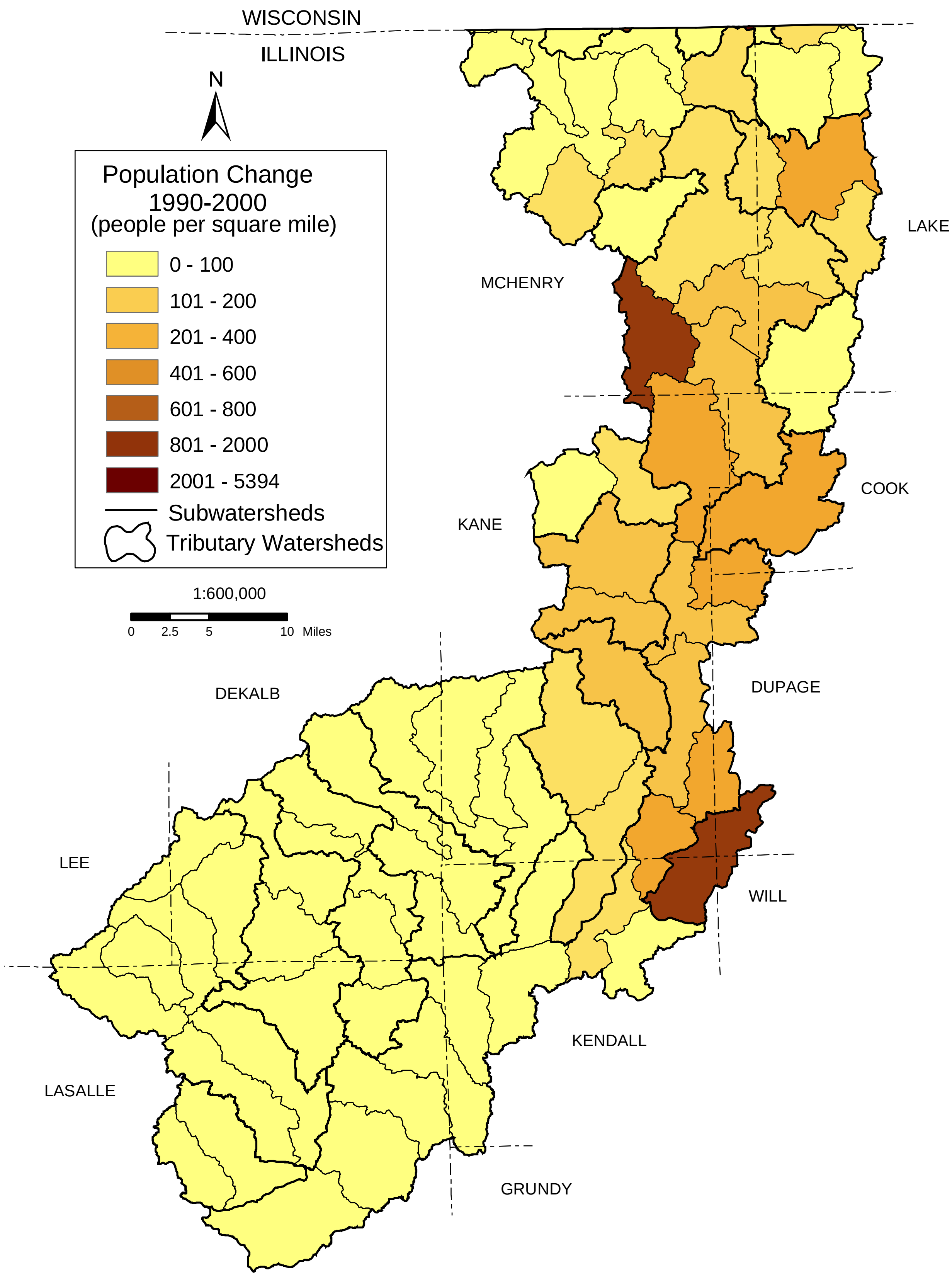

Figure 2.19. Fox River watershed population density change, 1990 - 2000

The change in population density between 1990 and 2000 is illustrated in Figure 2.19. Crystal Creek and Waubansee Creek watersheds experienced the greatest population growth in terms of increasing population density. Inspection of Figure 2.19 shows little population change in the southwest part of the watershed that lies in western Kane and Kendall Counties, and DeKalb, Lee, LaSalle and Grundy Counties. The greatest increase in population density in Illinois is along the mainstem of the Fox River from southern McHenry County to northern Kendall County.

The increase in population density implies increased development and attendant increases in impervious areas and urban pollution. Considering the population projects for 2020 for Kane, McHenry, and Lake Counties, population density will continue to increase over time. Using population growth as a predictor of increased pollution, this would imply increased loading of pollutants in the Fox River watershed. When there are significant changes, then pollutant loading may change, and contemporary water quality sampling is needed. Where population and land use have not changed dramatically, water quality data collected in prior years still may be reasonably representative for the watershed.

2.6. Summary

Standard data inputs needed to model water quality in a watershed include: elevation data, stream locations, soil types and properties, land cover, stream channel geometry, and flow data and climate data (precipitation and temperature). A summary of available data and recommendations for additional data acquisition follow. Given the costs and time to develop large spatial datasets, the following georeferenced data generally are considered appropriate for watershed modeling. Gaps in these regional datasets are noted in italics.

- Elevation data in the form of 30-meter resolution DEMs are available for the entire study area and should be adequate for the watershed scale models, but data needs may change, depending on the resolution desired for individual tributaries.
- The National Hydrography Dataset (NHD) is state-of-the-art georeferenced river/stream data. The 1:24,000 scale high-resolution data (which should be adequate for modeling) is nearly completed for the lower Fox River watershed, but only low-resolution data are available for the upper Fox River watershed. *Cost sharing with the USGS is a viable option to finalize the high-resolution data for the entire watershed in a timely manner*.
- The SSURGO database has high-resolution soils information, but only for selected counties in the Fox River watershed: Kane, McHenry, DuPage, DeKalb, and Will Counties. The STATSGO database is available for the entire Fox River watershed at a scale of 1:250,000 but, in most cases, does not provide sufficient detail at the tributary level for detailed modeling. *Counties are encouraged to work with the U.S. Department of Agriculture, Natural Resources Conservation Service to develop the SSURGO data.*
- Land cover data have been compiled using aerial photography from 1999-2000. This will be adequate for initial modeling efforts but, should be updated frequently, given the population projections for the region.

- Stream channel geometry and information on dams along the Fox River are adequate for initial modeling needs. Information on tributary impoundments may be needed, depending on the resolution of tributary modeling.
- Flow monitoring on the Fox River recently has been enhanced by improvement of reporting at Montgomery, but compromised by loss of information at South Elgin due to the downgrading of the station from a continuous recording to a stage-only gage. Recent modifications to the dam at Algonquin have changed flow relationships. *It is strongly recommended that the South Elgin gage (05551000) be reinstated as a continuous recording gage.* The lack of flow data for many tributaries also will limit model capabilities, and *establishing continuous recording gages is encouraged, particularly for those ungaged tributaries recommended for additional water quality sampling above.*
- Precipitation data requirements depend on the model resolution (extent of aggregated land area and whether yearly, daily, or hourly simulations are desired). At a minimum, precipitation data should be collected for every gaged watershed with at least daily totals, and preferably hourly data should be collected. Precipitation data are lacking in the lower part of the watershed. Hourly data will provide the best resolution, but daily data are needed at a minimum.