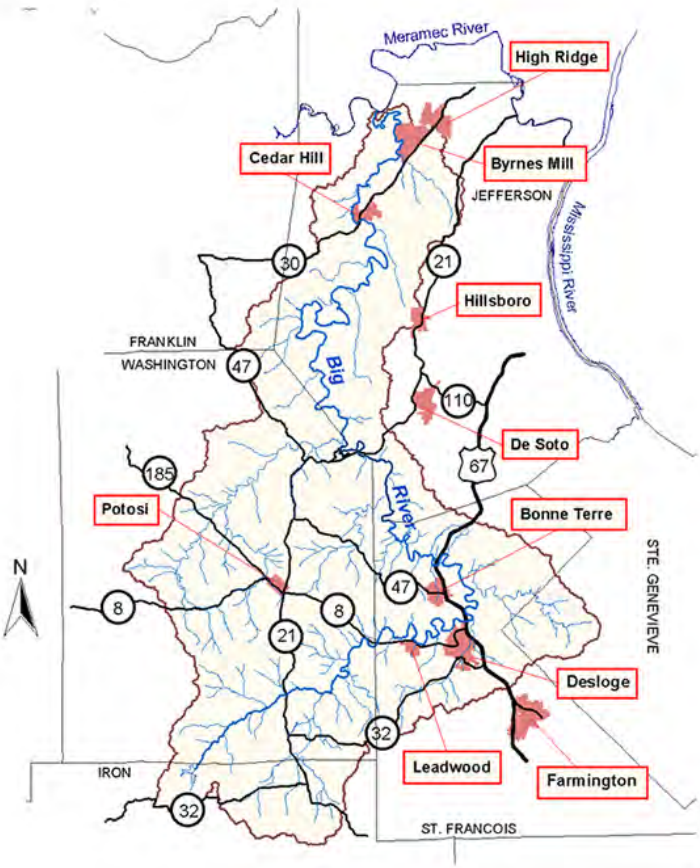

Big River

Watershed and Inventory Assessment, July 31, 1997

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Executive Summary

The Big River basin is located in east-central Missouri and drains 955 square miles of the Ozark plateau in portions of six counties. Big River has eight, order five tributaries and flows northward for 138 miles until it reaches the Meramec River.

The majority of basin land use is forest and pasture with some row cropping along stream bottoms. However, urbanization is rapidly increasing in the lower basin. Only 5% of the basin is owned by state and federal agencies. Surveys have found that local-users spend much time recreating (especially fishing) on and around Big River.

Basin streams exhibit typical Ozarkian characteristics: good water quality and fish habitat, and representative Ozark fish assemblages. Nineteen sensitive natural communities, including good examples of Ozark creeks and Ozark springs and spring branches are present. However, damage to some aquatic habitats and the potential for serious damage to several streams exists due to past lead and barite mining activity. Stabilization and reclamation projects are beginning to address some of these problems. Unsafe mine dams and poorly-stored mine waste continue to degrade habitat or biota in about 110 miles of basin streams. The United States Army Corps of Engineers predicts catastrophic results from 27 high-hazard, unsafe dams during a moderate earthquake or major flood.

Riparian corridor habitat is fair to good, with Big River having slightly better habitat than tributary streams. About 75% of basin streambanks have either minimal or no erosion and are protected by trees or shrubs. Riparian corridors are negatively affected by riparian land use, especially along tributary streams.

Overall, stream habitat is good with rock slides, boulders, gravel, water willow, downed logs, and rootwads. However, eroded mine waste has buried aquatic habitats in some basin streams, leading to extirpation of some benthic invertebrates. This sediment is associated with elevated levels of heavy metals. Habitat quality is threatened by potential releases of mine waste. A fish consumption advisory for some fish species is present on Big River due to lead contamination. The basin exhibits good aquatic biodiversity. One hundred fish species, 34 mussel species, eight crayfish species, and 107 aquatic insect taxa have been found within the basin. Four fish and three mussel species are either endangered, rare, or on the State watch list.

Maintaining and improving species diversity and habitat quality will be the main focus of management efforts. Increasing stream recreational opportunities and educating the public will be stressed. To be successful, cooperation of landowners, volunteer organizations, and other governmental agencies will be needed.

Location

The Big River is located in east-central Missouri and originates in northern Iron County. It flows 138 miles northward to its confluence with the Meramec River near Eureka, Missouri (Figure lo). Its watershed drains 955 square miles of the upper Mississippi River basin in portions of six Missouri counties. Big River has eight, order five tributaries, with Mineral Fork having the largest watershed.

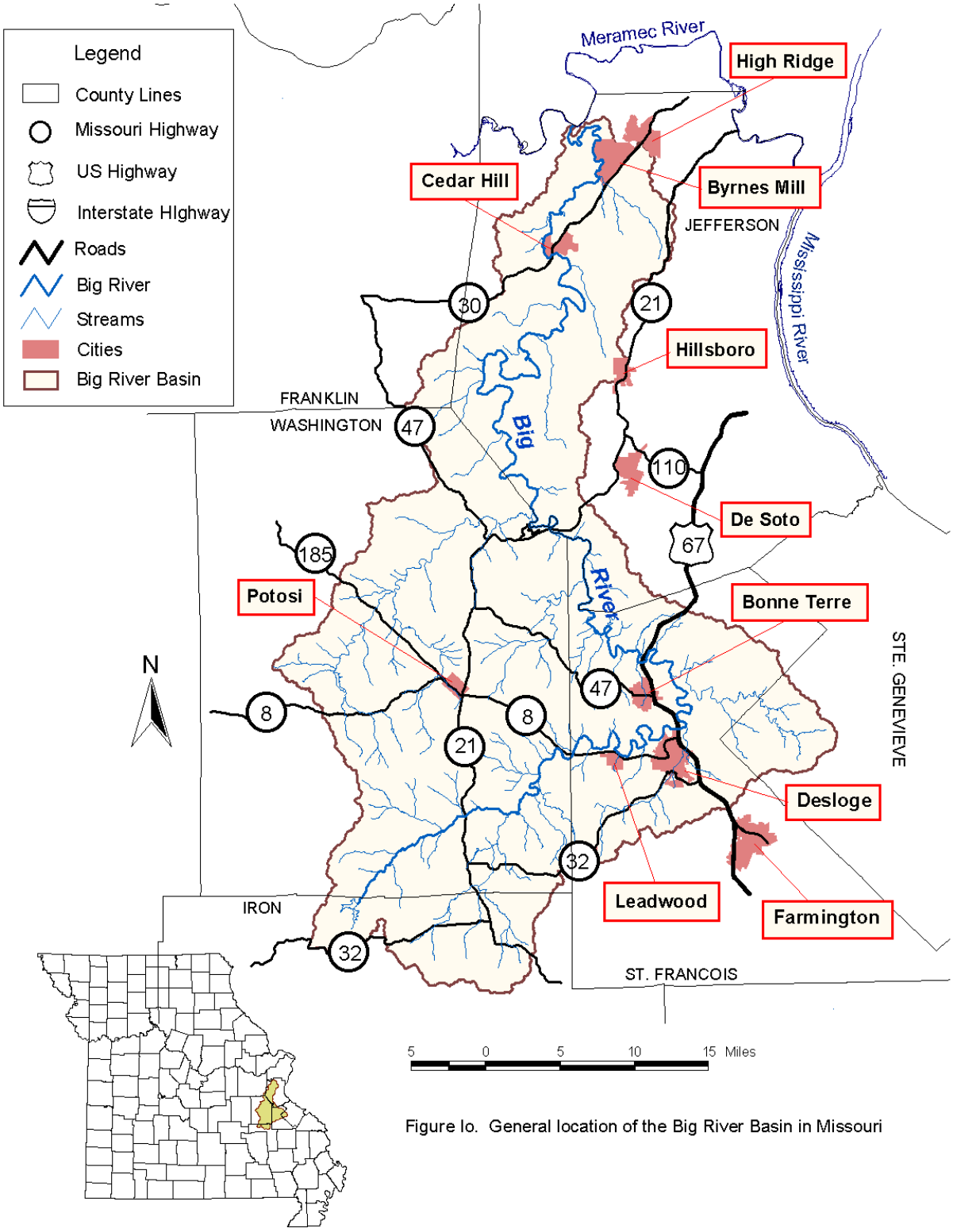


Figure lo. General location of the Big River Basin in Missouri

Geology

Physiographic Region

The Big River basin (Figure nd) lies within two subdivisions (Salem Plateau and St. Francois Mountains) of the Ozark Plateau physiographic region (MDNR 1986). Land elevations range from 435 feet above sea level at the mouth of Big River to 1,740 feet in the headwaters at Buford Mountain.

Geology

The Big River basin contains geologic formations (Figure ge) ranging in age from Mississippian to Precambrian. The majority of basin streams flow through the Salem Plateau, which is a dissected plateau of sedimentary rock topped by a thin layer of glacial loess. This plateau commonly forms rolling to narrowly-cut river valleys. As Big River flows northward, it cuts through progressively younger limestone and dolomite. Despite Karst topography being locally prominent, few springs are present. Sandstone is common in Jefferson County and shale becomes prominent in the lower basin.

Substantial deposits of lead, zinc, copper, magnesium, and barite have attracted mining operations to Jefferson, St. Francois, and Washington counties beginning over 200 years ago (MDNR 1984).

The southeastern portion of the basin drains the northern edge of the St. Francois Mountains which feature rugged, igneous peaks thought to be unaltered from their time of creation. Since these formations are highly-resistant to erosion, streams tend to be high gradient and form very narrow river valleys through thin residuum.

Soil types

Discussion of soil types is limited due to unavailability of soil surveys for Jefferson and Washington counties (68% of watershed). Primary soil series in the upper watershed include: Crider, Fourche, and Hildebrecht on ridge tops; Gasconade, Goss, and Irondale on slopes; and Haymond and Midco in the bottoms (USDA 1981, 1985, 1989, 1991). Soils on ridgetops and slopes are highly erodible, especially when disturbed.

Upper basin soils are typical for the Ozark Dome region, while lower basin soils reflect the Ozark border region (MDNR 1986). Upland soils are moderately shallow and consist of a combination of loess and residuum derived from in-place weathering of dolomite. These soils are silty, moderately well drained, highly susceptible to erosion, and suitable for pasture, forest, and limited row cropping (USDA 1981, 1985, 1989, 1991). However, much of the loess and residuum has been eroded from the slopes, exposing much chert and frequent bedrock outcrops.

The lower elevations of these soils tend to be clayey with high chert content, thin, draughty, infertile, and stony, best suited for grasslands and forest (USDA 1981, 1985, 1989, 1991). Very fertile silt-loam, developed from alluvium, has been deposited over cherty gravel in river valley bottoms and is suitable for row crops, bottomland forest, and pasture.

Stream Order

Big River becomes a sixth order stream at its confluence with Cedar Creek at river mile (RM) 118 in Washington County. A total of 86 streams (>order 3) were identified, ordered, and measured (Appendix 1) from USGS 7.5-minute topographic maps (Appendix 2).

There are 129 miles of permanent streams and 220 miles of intermittent streams in the basin (Funk 1968).

Watershed Area

The Big River watershed encompasses 955 square miles. Main sub-basins (Order 5) range from 26 to 189

square miles, with the largest being Mineral Fork (Table 1).

Channel Gradient

Big River's average gradient is 6.6 ft/mile and ranges from 1.3 (RM 34) to 200 (RM 137). Generally, stream gradient is steepest in the St. Francois Mountain area and more gradual beginning at RM 85 to the confluence with the Meramec River.

Appendix 1: Stream information for all third order and larger streams in the Big River basin.

Stream Name	Max. Order	Watershed Area (sq.Mi)	Length (miles)
Big River	6	955	1.38
Heads Creek	5	52	7.7
Dulin Creek	4		2.4
Bear Creek	3		2.3
Bourne Creek	3		3.4
Sand Creek	4		2
Buck Creek	4		2.9
Dutch Creek	3		1.4
Wine Creek	3		0.7
Skullbones Creek	3		2.2
Isum Creek	3		0.5
Belew Creek	5	73.2	6.9
Galligher Creek	3		1.1
Jones Creek	3		4.8
Dry Creek	5	54	9.6
Kruze Creek	3		0.7
Maupin Creek	3		2.1
Ditch Creek	3		3.3
Cedar Hollow Cr.	3		0.8
Calico Creek	3		1.5
Mammoth Creek	3		1.3
Mineral Fork	5	189	15.4
Old Mines Creek	3		7.7
Rocky Branch	3		3
Simpson Branch	3		3.4
Mine a Breton Cr.	4		13.3
Swan Branch	3		4.6
Bates Creek	4		8.5
Fourche a Renault Cr.	4		11.6
Puckett Branch	4		3.8
Ebo Creek	3		4.1

Stream Name	Max. Order	Watershed Area (sq.Mi)	Length (miles)
Scott Branch	3		4.4
Mill Branch	3		4
Montgomery Creek	3		3.8
North Fork	3		4
North Fork - Fourche a Renault	3		4.4
Allen Branch	3		4.9
Andrews Branch	3		2.6
Middle Fork-Fourcha Renault	3		4.5
Maddin Creek	3		0.7
Tiff Creek	3		2.9
Mill Creek	5	51.7	13.3
Three Hill Creek	4	6.5	83
Primrose Creek	3		3.6
Pond Creek	3		5.3
Cabanne Course	3		6
Shibboleth Branch	3		4.9
Turkey Creek	3		3.3
Coonville Creek	4		3.7
Bee Run	3		4.8
Terre Bleue	5	66.8	21.7
Dry Branch	3		4.5
Hazel Run	3		5.3
Salem Creek	4		5.6
Three Rivers Cr.	3		5
Bear Creek	3	40	4.2
Flat River	5	53	14.9
Koen Creek	4		6
Bannister Branch	3		2.7
Owl Creek	3		3.8
Hayden Creek	3		3.9
Hopewell Creek	3		4
Wallen Creek	3		6.3

Stream Name	Max. Order	Watershed Area (sq.Mi)	Length (miles)
Dry Creek	3		8.3
Mill Creek	3		6
Cedar Creek	5	79.2	14.1
Lost Creek	3		7
Goose Creek	3		4.1
Bellview Branch	4		5
Logan Creek	3		4.3
Townsen Creek	3		3.9
Saline Creek	4	* 19.5	3.8
Reid Creek	3		6.3
Coon Hollow	3		4.5
Furnace Creek	3		4.4
Clear Creek	4		7.3
Brock Creek	3		5.8
Janes Creek	3		5.1
Telleck Branch	3		3.5
Fountain Farm Branch	3		4.8

* = NRCS, pers. comm.

Appendix 2. United States Geological Survey Topographic maps (scale 1:24,000) used for determining watershed areas, river mileage, and stream order.

- Banner, MO – 1968
- Belgrade, MO – 1958
- Cedar Hill, MO - 1974
- Ebo, MO - 1981
- Flat Creek, MO - 1982
- French Village, MO - 1964
- Halifax, MO - 1982
- Irondale, MO - 1982
- Lawrenceton, MO – 1982
- Belew Creek, MO - 1974
- Bonne Terre, MO - 1982
- DeSoto, MO - 1981
- Farmington, MO – 1982
- Fletcher, MO – 1981
- Old Mines, MO - 1981
- Potosi, MO 1982
- Tiff, MO – 1981
- Graniteville, MO - 1968
- House Springs, MO - 1982
- Johnson Mtn., MO - 1968
- Mineral Point, MO - 1982

Table 1. Watershed area of Big River's major tributaries.

Stream	(sq. Mi)	(acres)
Mineral Fork	189	120,960
Cedar Cr.	79	50,666
Terre Bleue Cr.	67	42,755
Flat River	53	33,920
Mill Cr.	52	33,080
Heads Cr.	30	19,440
Dry Cr.	30	18,930
Belew Cr.	26	16,620

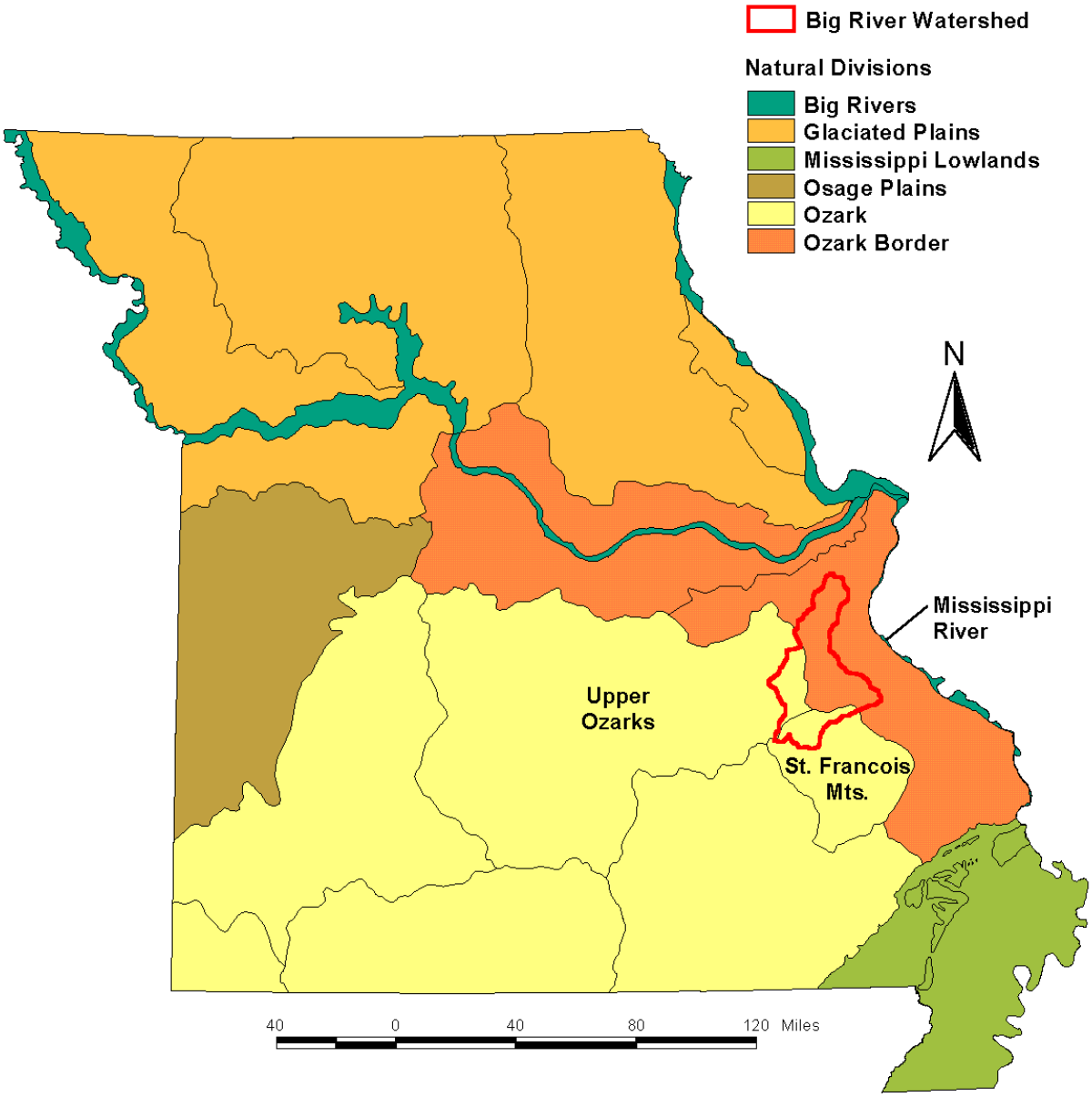


Figure nd. Natural divisions of the Big River basin in Missouri.

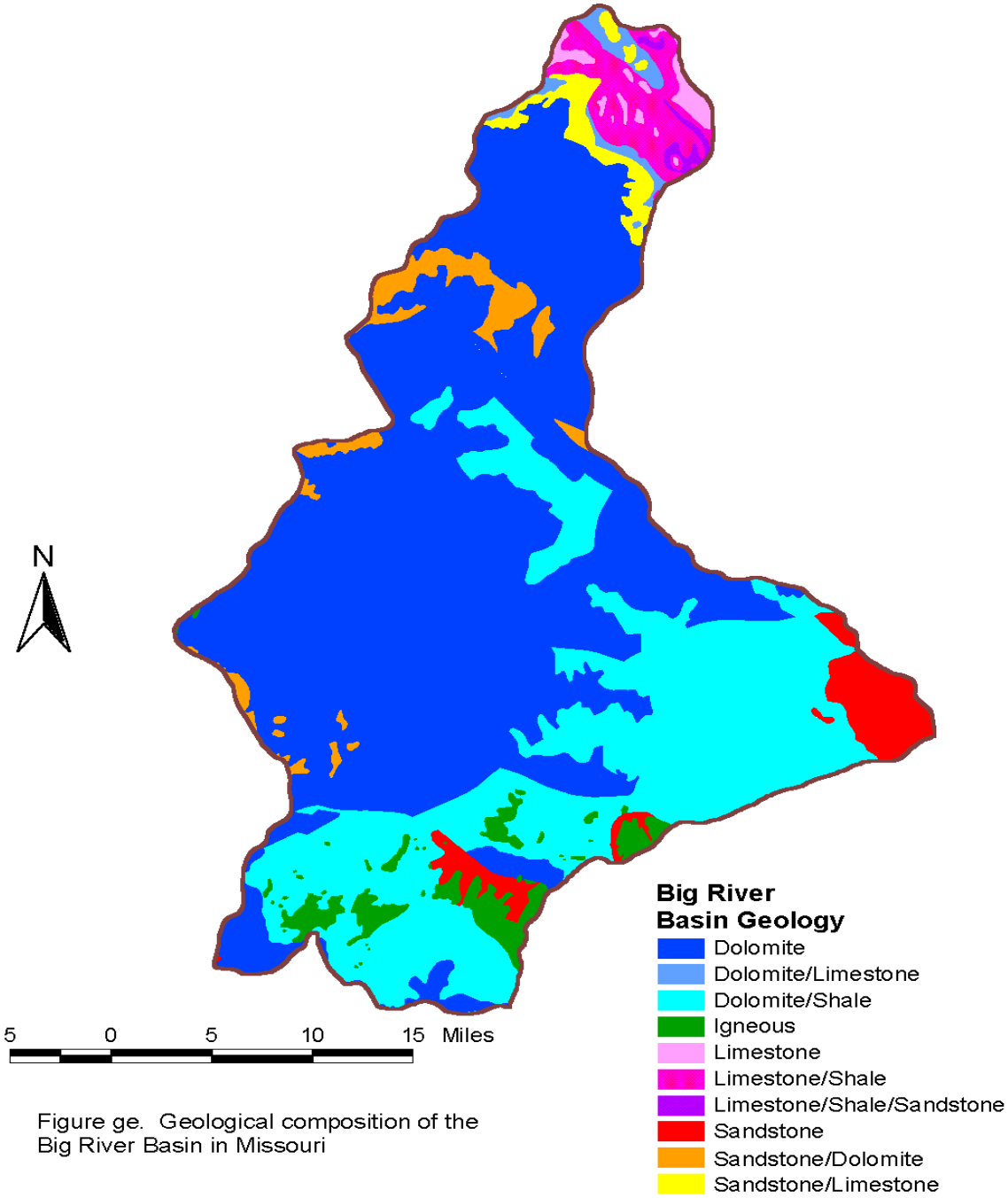


Figure ge. Geological composition of the Big River Basin in Missouri

Land Use

Historic Land Use

Pre-settlement conditions indicate that Ozark uplands were mostly prairie and oak savannah, while steep valley slopes and bottoms were dominated by thick deciduous and pine forests. Early settlers cleared trees off valley bottoms and uplands for pasture and row crops. From 1880 to 1920, the Ozarks were subject to heavy timber cutting, leaving large expanses of eroding uplands and valley slopes. This was followed by increased pasture grazing and row cropping. Woodland grazing and seasonal burning became popular, further increasing soil erosion and suppressing young trees. Cutting of the second growth forest began in the mid-1950s (Jacobson and Primm 1994).

Lead was initially discovered in the upper Big River Basin in the early 1700s (Jennet et al. 1981) with the discovery of the Old Lead Belt in St. Francois, Madison, Washington, and Jefferson counties (Figure me). Minimal surface mining began shortly thereafter and continued until 1864 when St. Joseph Lead Company (now St. Joe Minerals Corp.) began advanced lead mining and milling. Since 1920, Missouri has been a leading producer of lead for the United States. Lead mining in the Old Lead Belt ceased in 1972 after over 8 million tons of lead were mined (Kramer 1976). In the early 1970s, barite mining began, primarily in Washington County. By 1978, over 20,000 acres (3%) of Big River watershed was affected by mining (USDA 1980).

Beginning in the 1940s, clusters of cottages and club houses were built on the lower 70 miles of Big River. Most were constructed on top of stilts to avoid flooding. Many of these riverfront dwellings began as vacation cabins, but were transformed into full-time residences in the 1960s and 1970s.

Recent Land Use

Big River basin land uses (Figure lu) are currently dominated by forest (48%) and pastures (26%), with lesser amounts of urban areas (9%), row crops (7%), old fields (3%), roads (1%), reservoirs and streams (1%), and other (5%) (USDA 1992).

All counties within the basin are experiencing population growth, which is especially rapid in Jefferson and Franklin counties (Figure pc). Populations within basin counties are expected to increase by as much as 44% by 2020 (Missouri Office of Administration 1994). Urbanization of the watershed (home building, paving, etc.) will increase with population growth, which will reduce forest and agricultural use. This land use change is already happening. In just 10 years, urban land use has increased by 117%, while row crop land has dropped by 320% (USDA 1992).

Buildings in the lower Big River floodplain (RM 0-29) are susceptible to flood damage, especially in the Morse Mill, Cedar Hill, and House Springs areas. "The Great Flood of '93" damaged 102 properties, of which 47 were approved for a flood buy-out program offered by the

Federal Emergency Management Agency (FEMA). Most of the damaged dwellings have been removed and current land use consists of park-like developments or have been allowed to revegetate. However, many club houses still persist along the lower 70 miles of Big River.

All lead and most barite mining activities within the basin have ceased, but 45 mine dams and numerous piles of mine waste (Figure md) remain. Despite the cessation of mining activity, lead contamination of the Big River basin continues (Czarnezki 1987; MDNR 1994; Missouri Department of Health 1999). The most significant lead source is a 500-acre lead tailings pile, at Desloge, which is bordered on three sides by Big River (Figure lt). Progress on stabilizing the Desloge pile was recently made with the announcement of an estimated $12.1 million plan to stabilize the dam and mine waste. Doe Run Company began work in November, 1995 and is financing the 3-year project to stabilize the base with rock rip-rap, as well as grade and plant the pile slopes. In addition, the Leadwood tailings pond dam was stabilized with rip-rap and had its spillway upgraded in 1996 (J. Czarnezki, personal communication).

Also, a plan for stabilization of the St. Joe State Park dam has been approved. Stabilization of its lead tailings began in 1997.

Recent attempts have been made to obtain approval for landfills in the Washington County portion of the basin. Some applications have been for land within 700 feet of Big River. Intense public opposition and potentially unsuitable geology have led to denial of all applications.

Soil Conservation Projects

There is one on-going Special Area Land Treatment (SALT) project within the 12,463-acre Saline Creek watershed (Iron County). One thousand acres out of the 3,780-acre Bellview Valley SALT Project area have been treated (NRCS, personal communication). There are no completed, ongoing, or scheduled Public Law 566 or EARTH watershed projects in the Big River Basin.

Only 782 acres (0.1% of the basin) are enrolled in the Conservation Reserve Program (NRCS, personal communication).

Public Areas

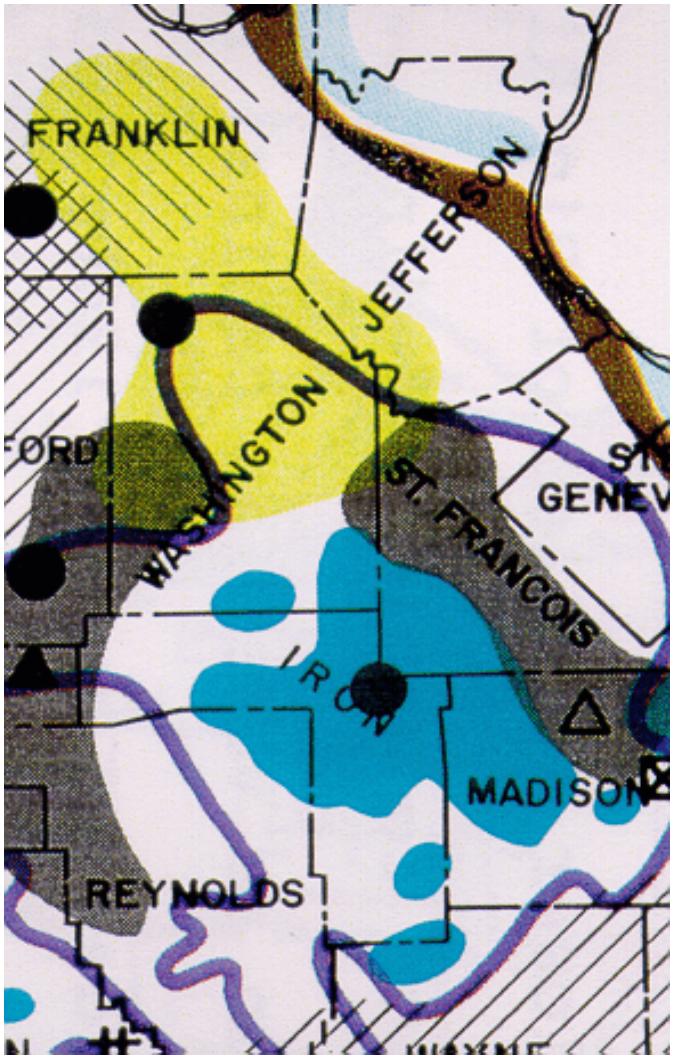
The Big River basin contains 20 areas owned by governmental agencies (Figure pa) equaling 5% (32,339 acres) of all basin land. The largest tract is a 17,742-acre portion of the Mark Twain National Forest in Iron and Washington counties. Eighteen areas offer a combined 15.5 miles of stream frontage (74% on Big River), including 14 access areas on floatable streams and four boat ramps (Table 2). About 75% of this stream frontage is along streams with permanent flow.

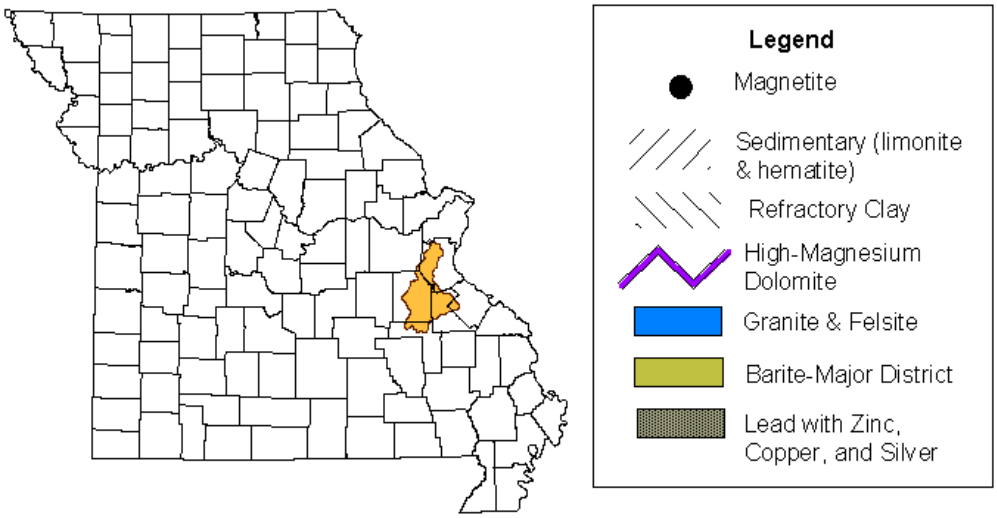
Additional access to basin streams is needed and more is planned along Big River, Mineral Fork, and Fourche a Renault Creek (McPherson 1994). Trailered-boat access at Cedar Hill, Morse Mill, House Springs, Washington State Park, and St. Francois State Park is poor or non-existent. Blackwell Access has a vertical 12-foot-tall streambank which does not allow for bank angling or canoe/boat launching. In addition, wade and bank fishing access is somewhat limited, especially along larger tributary streams and Big River (above RM 63). Missouri STREAM TEAMs have helped improve bank access along Big River frontage in Washington State Park.

Corps of Engineers 404 Jurisdiction

The Big River basin is under the jurisdiction of the United States Army Corps of Engineers-St. Louis District. Applications or inquiries regarding 404 permits should be directed to the St. Louis office: 1222 Spruce St., St. Louis, MO 63103-2833; (314) 331-8141.

Figure me. Various mineral and energy locations within the Big River Basin. Portion taken from "Mineral and Energy Resources in Missouri", compiled by Ardel W. Rueff, Missouri Department of Natural Resources, Division of Geology and Land Survey.





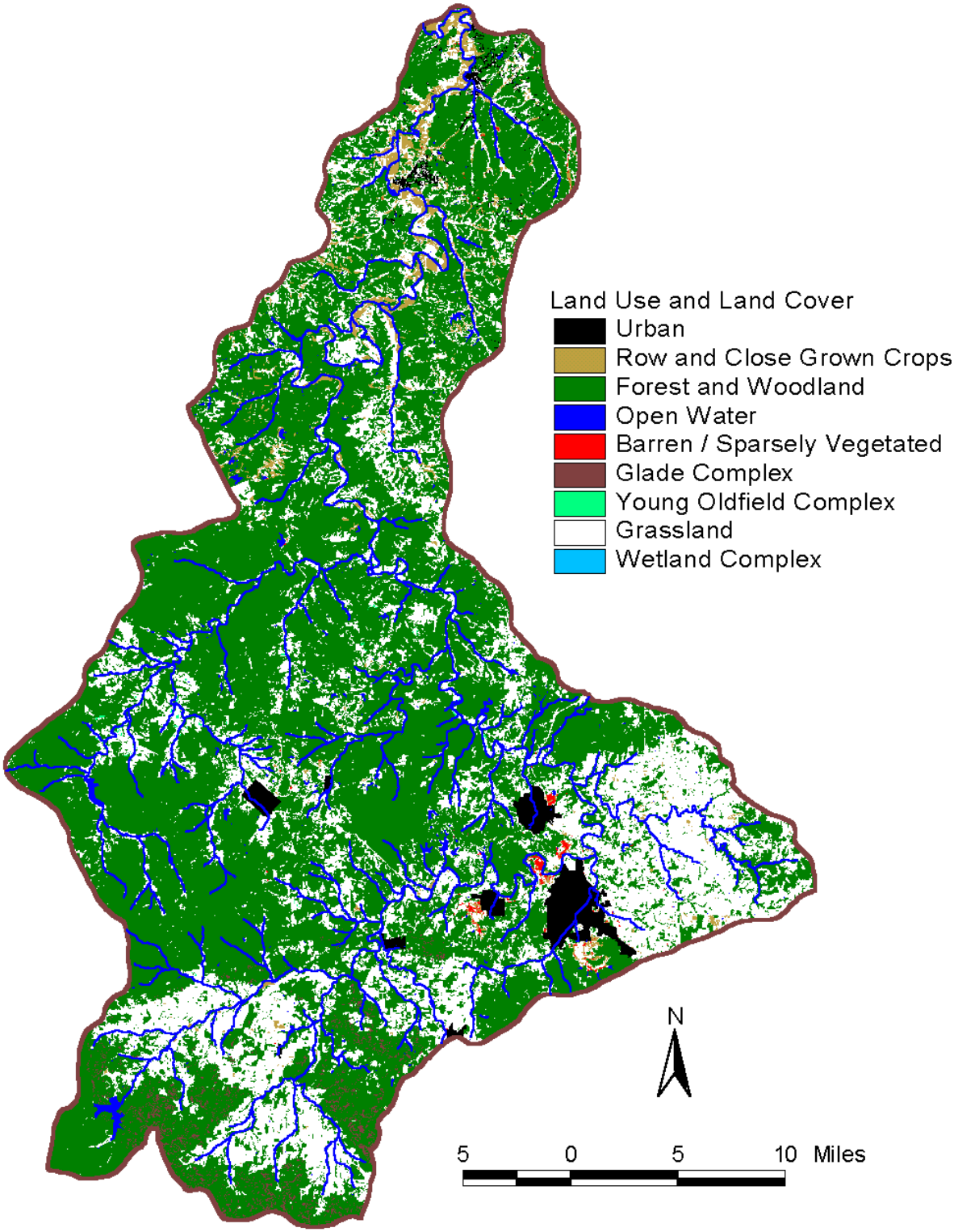
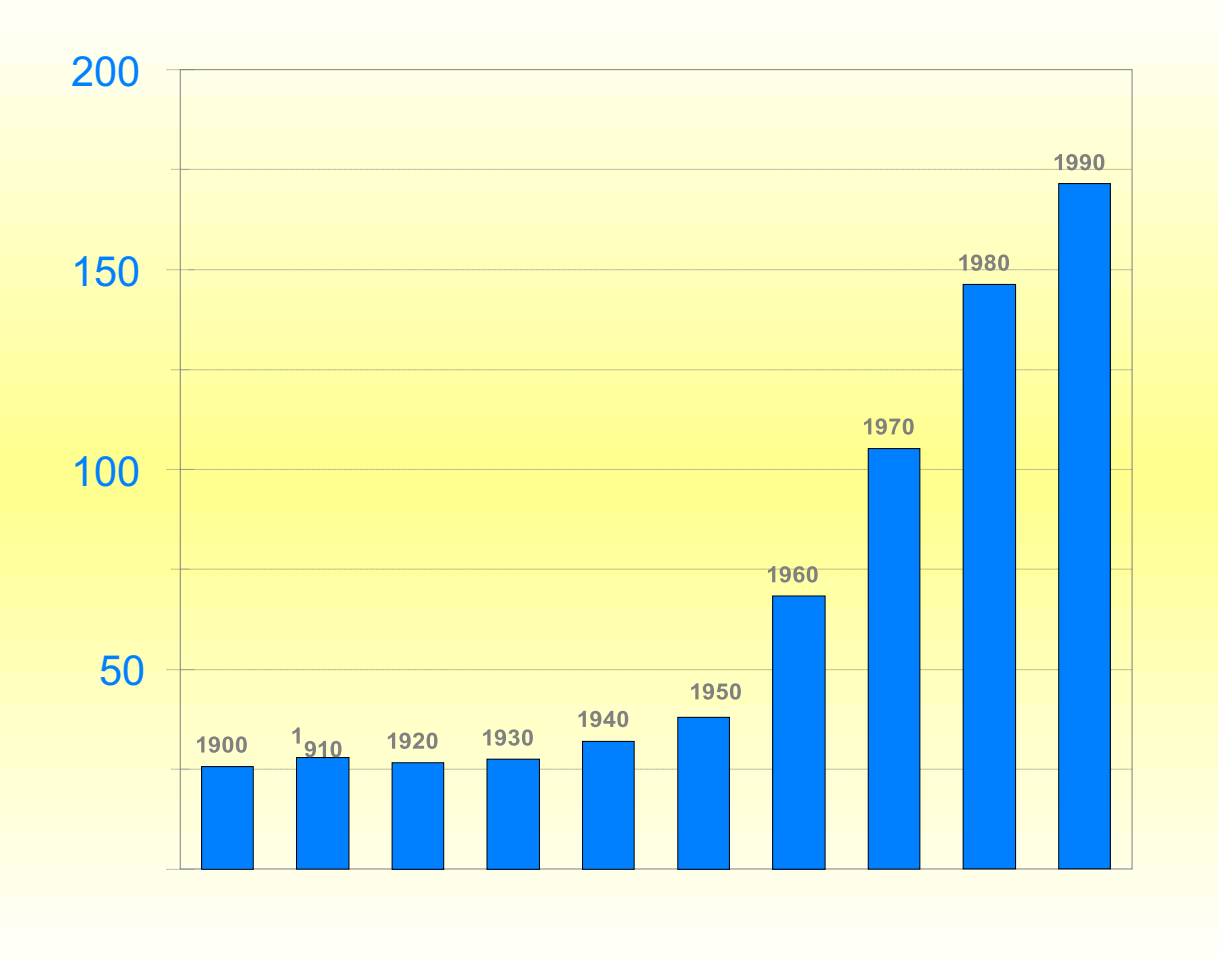


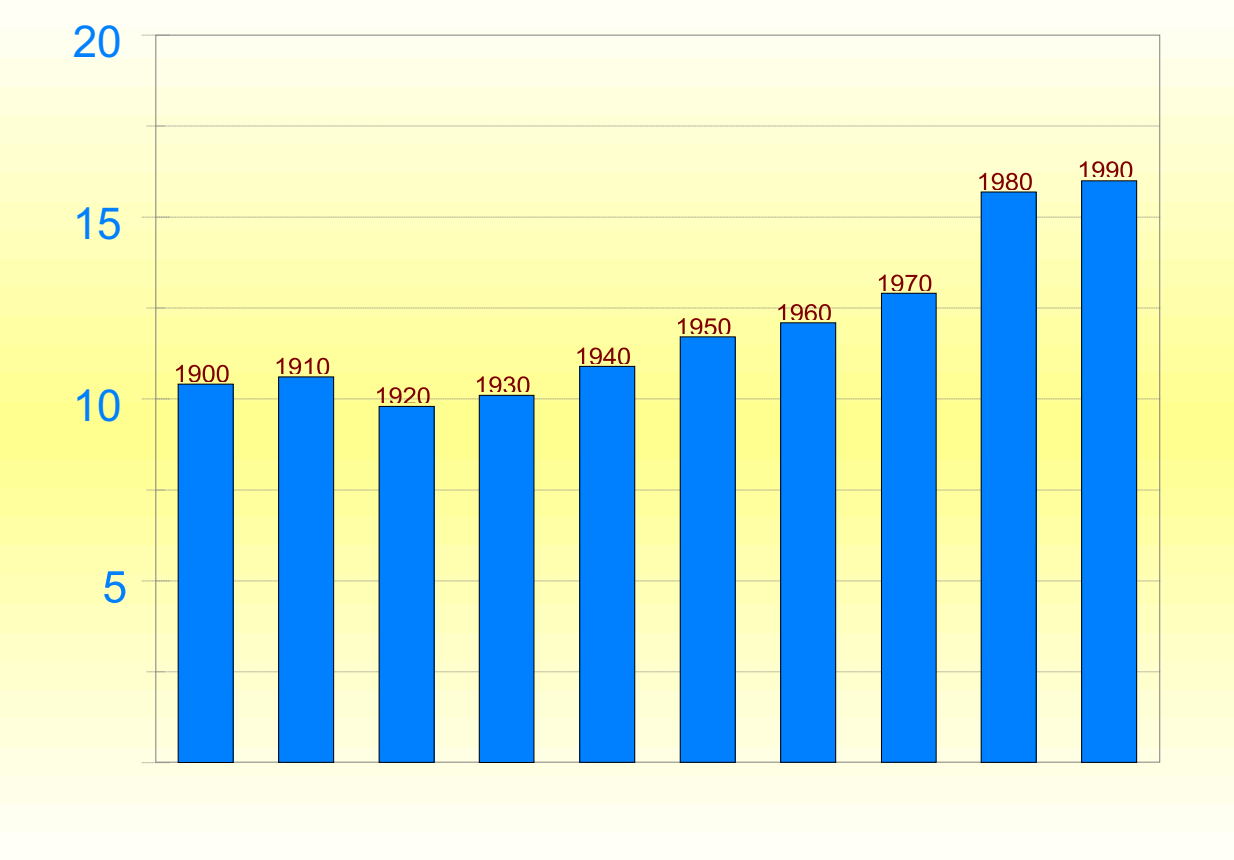
Figure lu. Land use in the Big River basin, Missouri

Figure pc. County populations from 1900 to 1990. Numbers are in thousands.



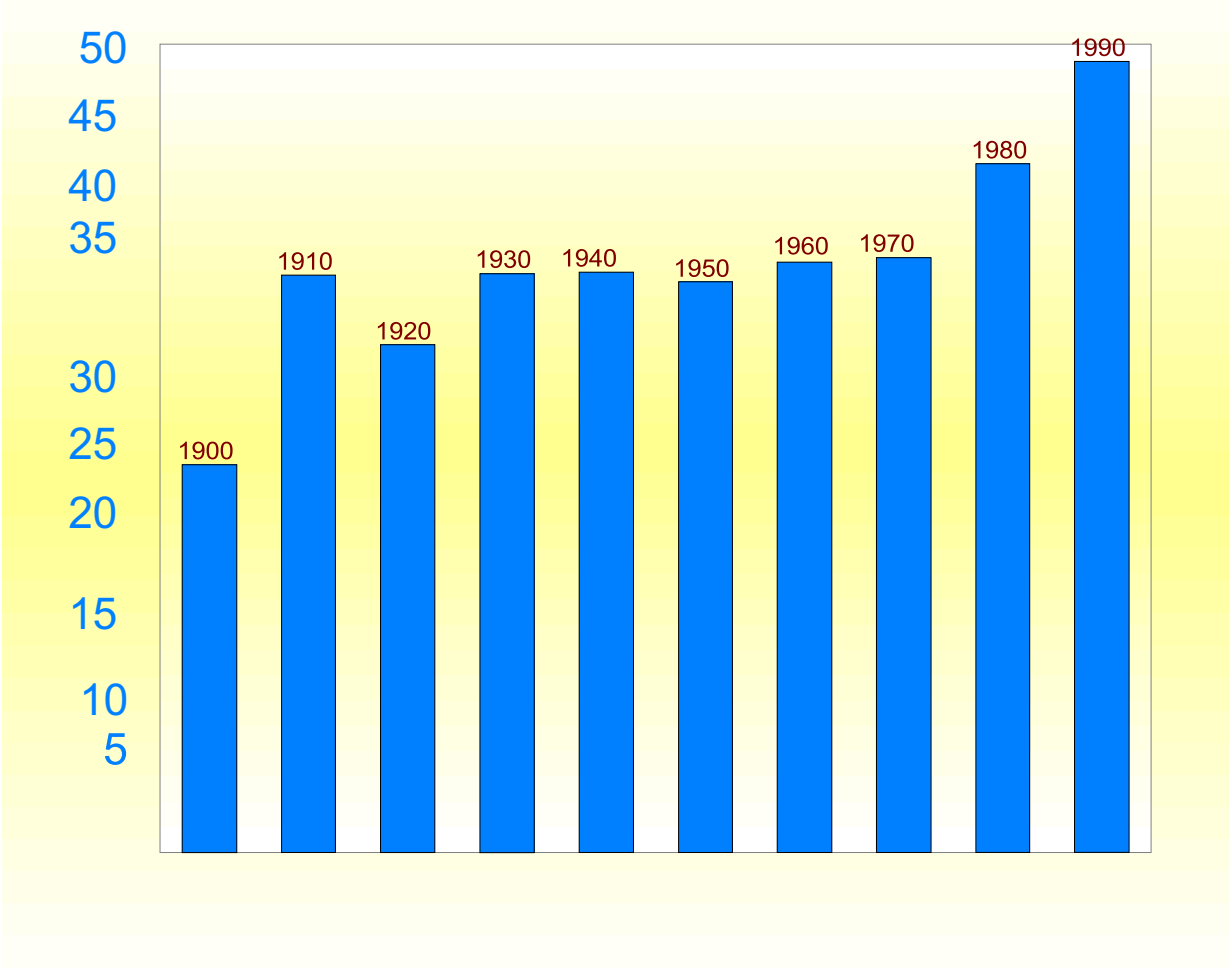
Jefferson County

Figure pc continued.



Ste. Genevieve County

Figure pc continued.



St. Francois County

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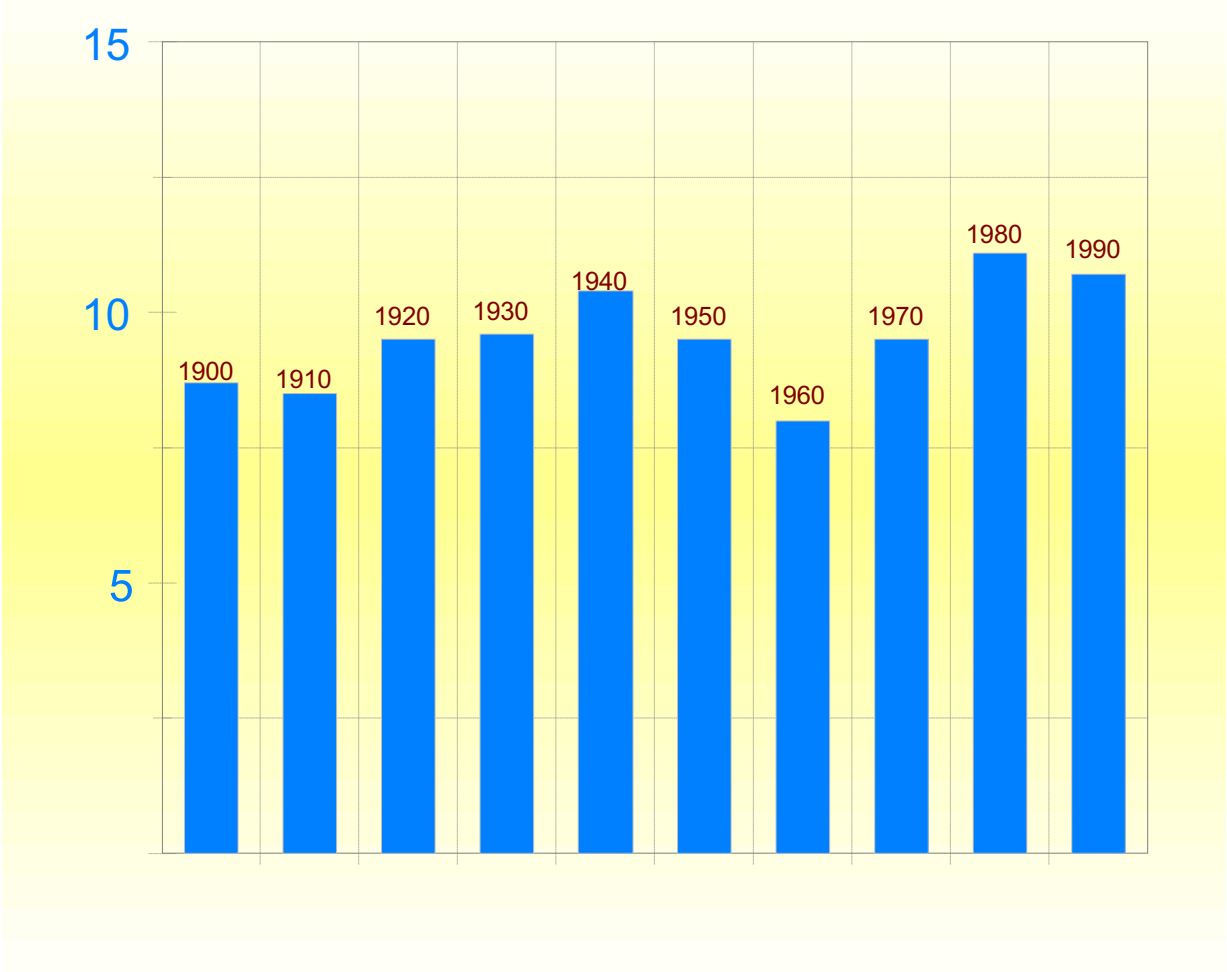
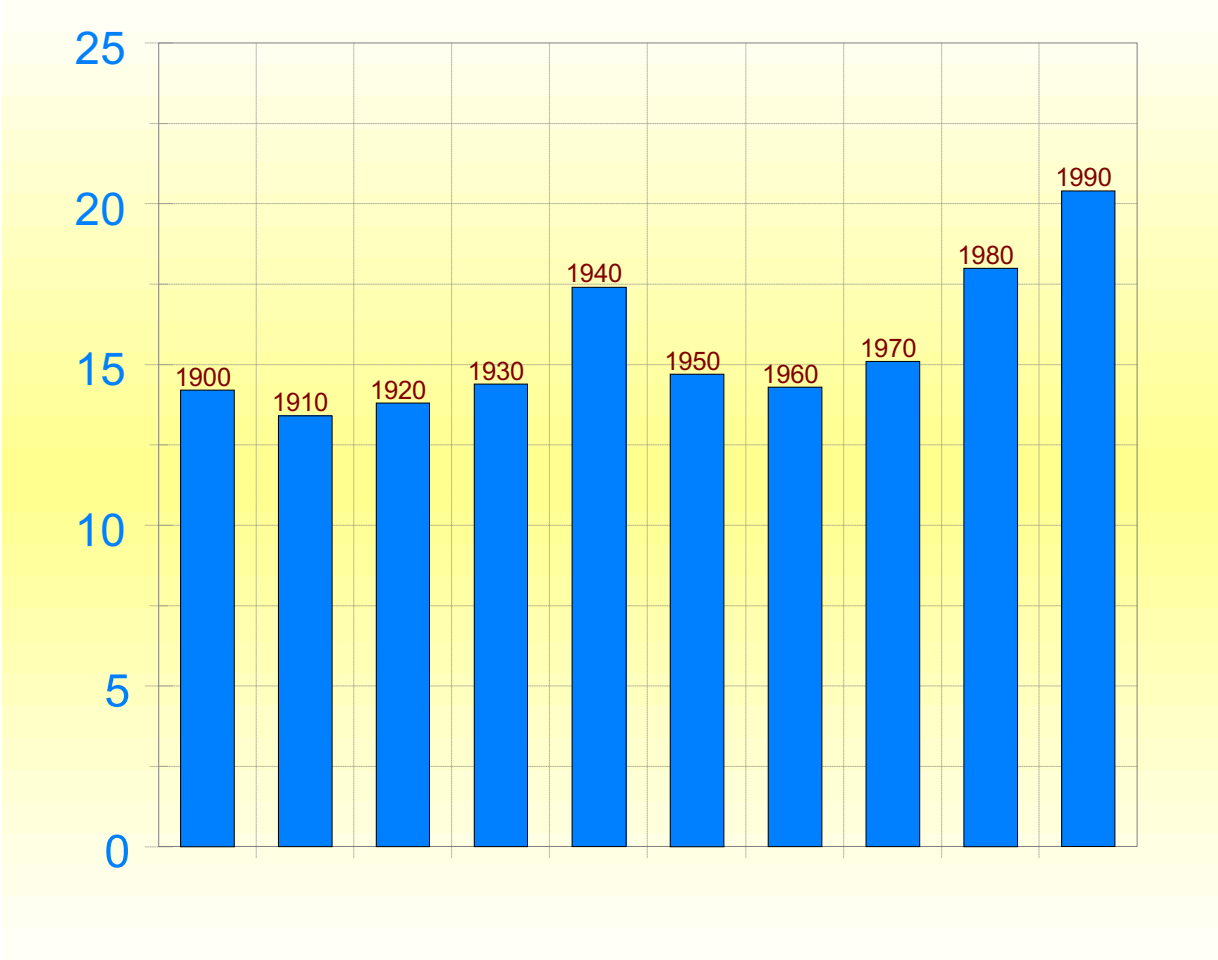


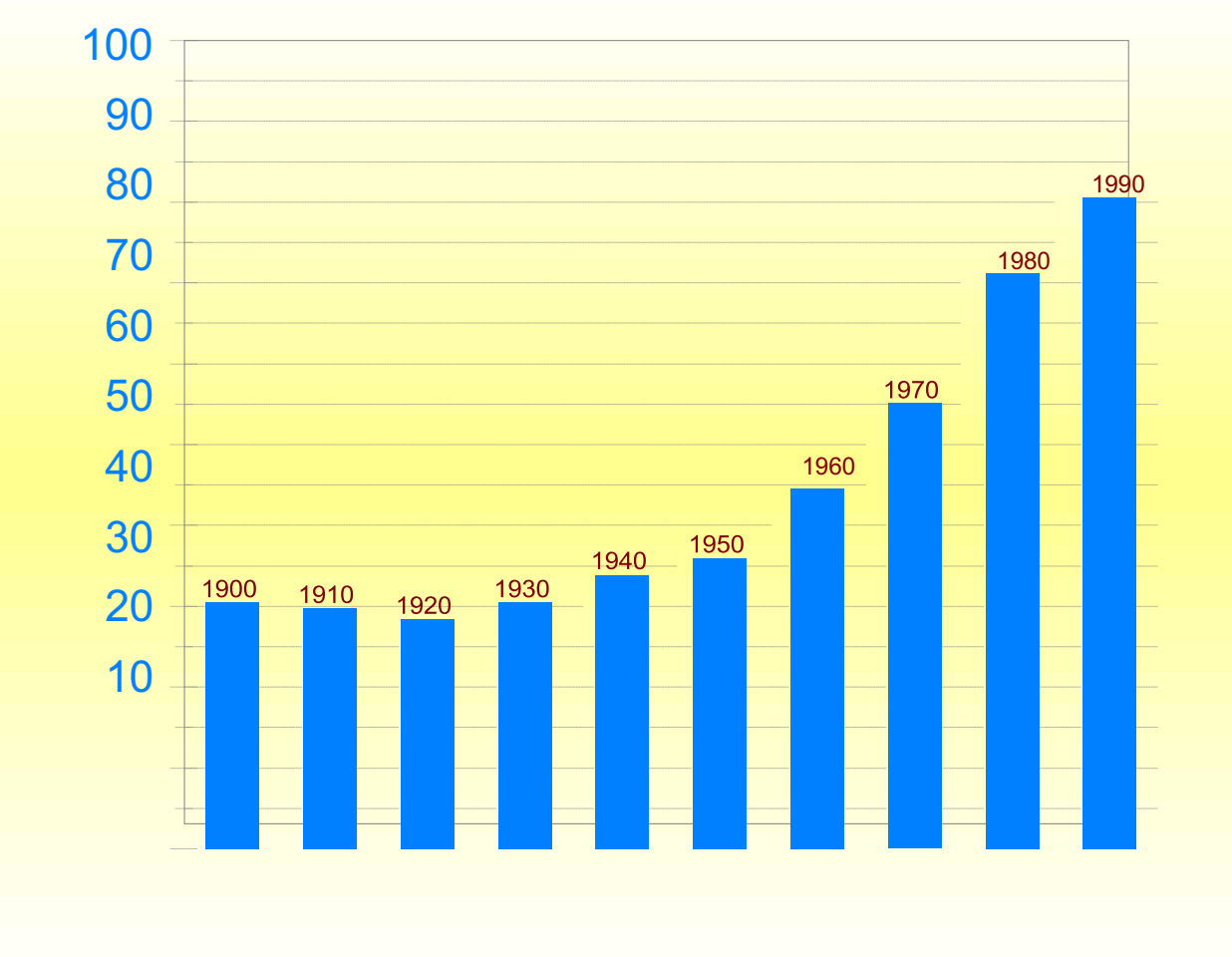
Iron County

Figure pc continued.



Washington County

Figure pc continued.



Franklin County

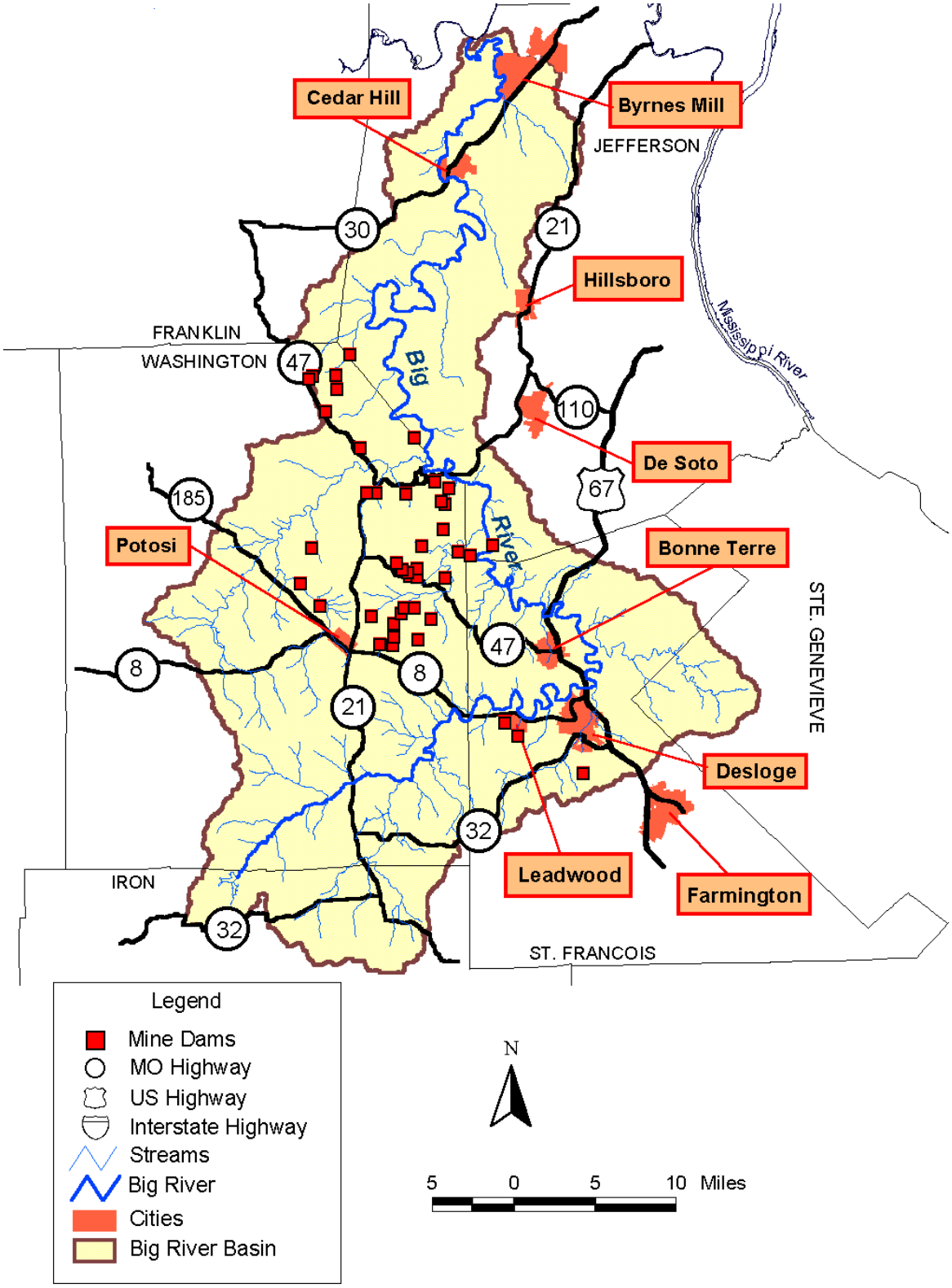


Figure md. Mine dams within the Big River basin, Missouri.

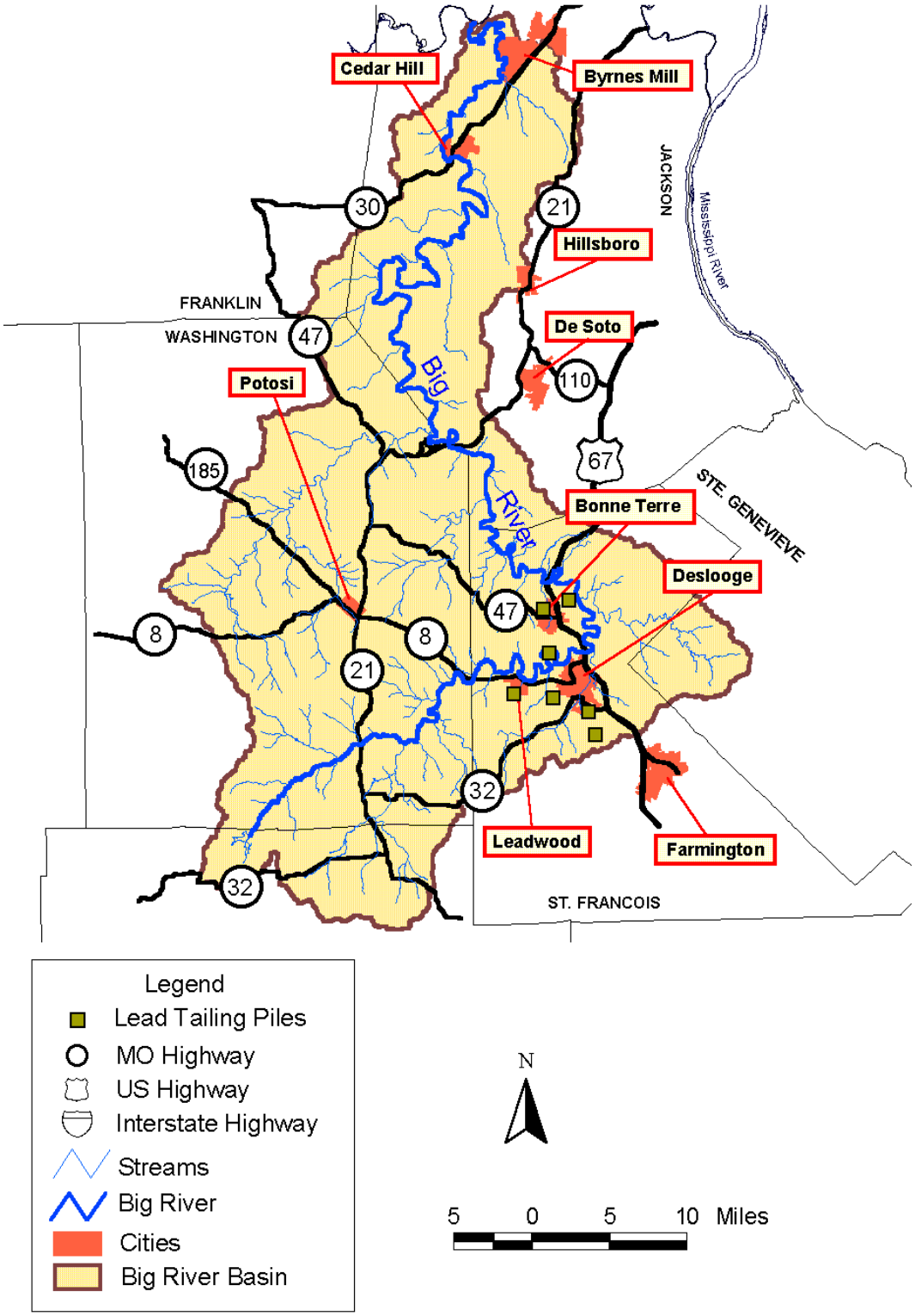


Figure lt. Lead tailing piles within the Big River basin, Missouri.

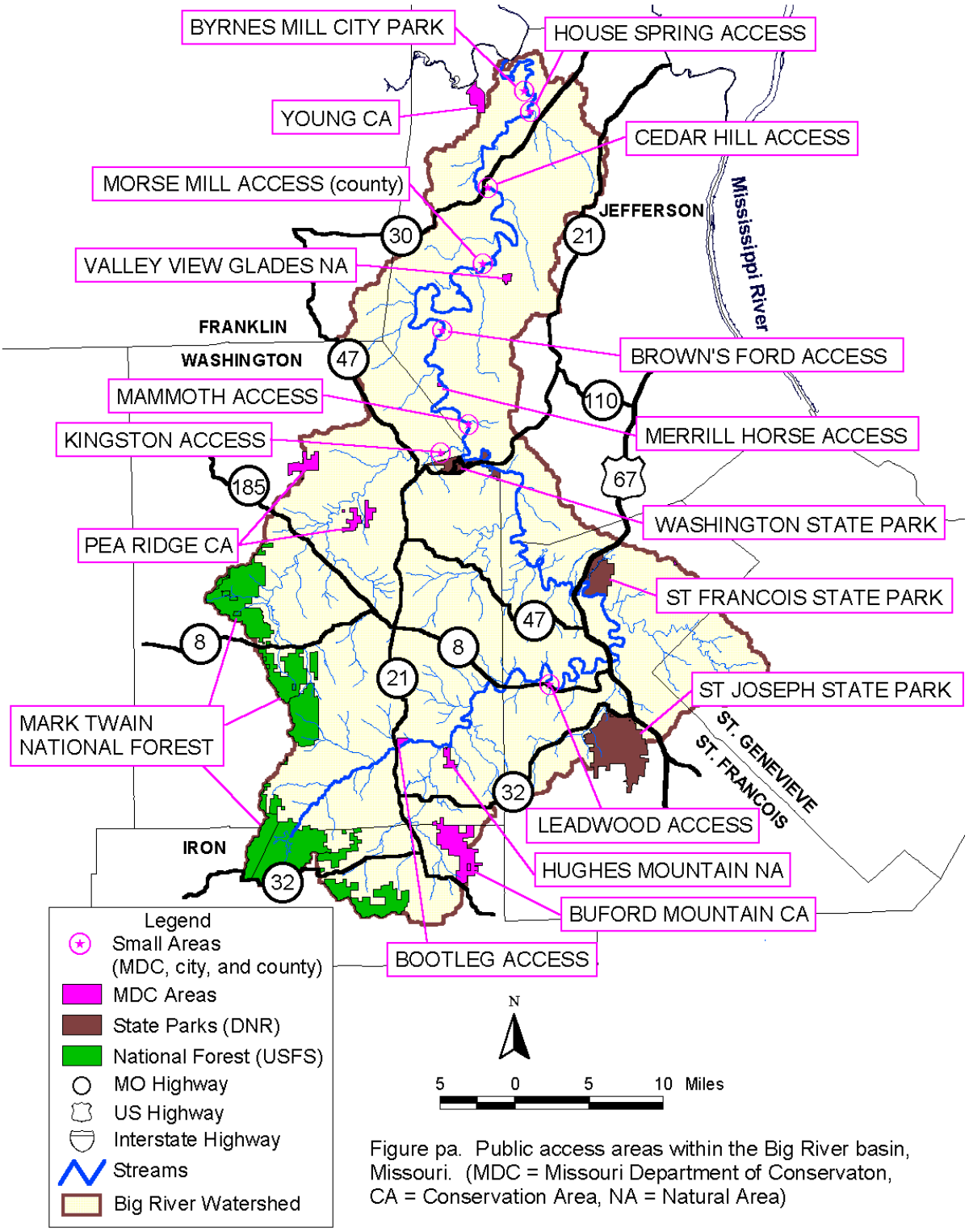


Figure pa. Public access areas within the Big River basin, Missouri. (MDC = Missouri Department of Conservaton, CA = Conservation Area, NA = Natural Area)

Table 2. Public areas in the Big River basin.

County	Area Name (Onwership)	Acres	Frontage (Miles)	Stream	Boat Ramp
Jefferson	Brown's Ford Access (MDC)	1.5	0.05	Big River	X
	Byrnesmill City Park (City)	28	0.1	Big River	-
	Byrnesmill City Park (City)	7	0.2	Big River	-
	Cedar Hill Access (County)	8	0.22	Big River	X
	House Springs Access (County)	4.8	0.2	Big River	X
	Mammoth Access (MDC)	74.0	0.3	Big River	X
	Merrill Horse Access (MDC)	10	0.3	Big River	-
	Morse Mill Access (County)	227.2	-	-	-
	Valley View Glades CA (MDC)	2248.3	0.7	Chambers Cr.	-
Iron	Mark Twain NF (USFS)	15784.4	1.1	Big River	-
St. Francois	Leadwood Access (MDC)	6.3	0.2	Big River	-
	St. Francois SP (DNR)	2458.0	3.2	Big River	-
	St. Joseph SP (DNR)	5606.8	2.9	Harris Branch	-
Washington	Bootleg Access (MDC)	303.2	1.2	Big River	-
	Buford Mountain CA (MDC)	230.5	-	-	-
	Hughes Mountian NA	330.0	0.2	Wallen Cr. Trib.	-

County	Area Name (Onwership)	Acres	Frontage (Miles)	Stream	Boat Ramp
	(MDC)				
	Kingston Access (MDC)	58.5	1	Mineral Fork	-
	Mark Twain NF (USFS)	1957.9	-	-	-
	Washington SP (DNR)	1359	3.1	Big River	-
	Pea Ridge CA (MDC)	1595.0	-	-	-

Hydrology

Precipitation

The average annual precipitation for the Big River basin is 41 inches/year, with 29 inches being rainfall (MDNR 1986). Precipitation usually peaks in May (13") and is lowest in February (6"). Average annual runoff is 12.8 inches.

U.S. Geological Survey Gaging Stations

Three U.S. Geological Survey (USGS) gaging stations (numbers 07017200-Irondale, 07018100-Richwoods, and 07018500-Byrnesville), all on Big River, are active within the basin (Figure gs). The Irondale station (RM 115) measures flow from 175 square miles of watershed, and its period of record is July 1985 to present (Appendix 4). Some water quality data were collected during 1986 (Appendix 5).

- The Richwoods (formerly DeSoto) station (RM 53.7) measures flow from 735 square miles of watershed, and its period of record is October 1942 to present (Appendix 4). Sporadic water quality sampling has taken place since 1963, but only 1986 to present is summarized (Appendix 5).
- The Byrnesville station (RM 14.1) measures flow from 917 square miles of watershed, and its period of record is October 1921 to present (Appendix 4).
- Instantaneous discharge (Appendix 4) and some water quality data (Appendix 5) have been taken on Coonville Creek at St. Francois State Park since 1992.

Five other low-flow, partial-recording gaging stations were operated on Big River, Dry Branch, Hopewell Spring, Mineral Fork, and Old Mines Creek until the early 1970s. They are currently inactive.

Streamflow Characteristics

Big River's average annual discharge is 862 cubic feet per second (cfs) at Byrnesville (USGS 1994). Mean streamflow is lowest in August and highest in April (Figure ms). The lowest and highest instantaneous flows recorded, 25 cfs (August 30, 1936) and 63,600 cfs (September 25, 1993), occurred at the Byrnesville gaging station (Table 3; USGS 1994). However, an estimated discharge (from high-water marks) of 80,000 cfs, at Byrnesville on August 21, 1915, may have been the highest instantaneous flow (USGS 1994). Flows of 116 cfs, 337 cfs, and 1,720 cfs were exceeded 90%, 50%, and 10% of the time, respectively, at the Byrnesville gaging station (Table 3).

Data from Big River's Byrnesville gaging station were used to construct a flow duration curve (Figure fd) and a 90:10 ratio. The 90:10 ratio of 15 to 1 indicates stable, high flow (Miller et al. 1974).

Frequency of 7-day Q values (low-flow discharges; Table 4) and low slope index of 2.3 represent well sustained base flows (Miller et al. 1974), despite only 5 springs of note (6.6 cfs combined, Figure sp) being present (Vineyard 1982). Base flows are aided by ample precipitation, numerous small springs and seeps located in fractured limestone and subsurface chert, and artesian flow from old exploratory bore holes in the Old Lead Belt. During lead mining activities, base flow in the upper Big River at Leadington and Flat River was increased by 100-200% by lead mine discharges (Missouri Water Pollution Board 1964).

Flood magnitude for Big River (Table 5) is somewhat low for a basin of its size (Hauth 1974). However, increasing urbanization of the watershed and subsequent increased stormwater could increase flood magnitudes. A flood, which on average would happen once/100 years, would generate flows of 40,500 cfs (Table 5). The "Great Flood of '93" (63,600 cfs) was well above the 100-year flood level.

Dam and Hydropower Influences

One mainstem dam (RM 132) forms 440-acre Council Bluff Lake along the Washington-Iron County line. The lake was completed in 1981 for flood control and recreation. Five old mill dams, all in Jefferson County, affect Big River (Figure mld). The dams at Byrnesmill (RM 7.9), Cedar Hill (RM 18.8), and Morse Mill (RM 29) have been breached and are in varying degrees of disrepair. The dams at House Springs (RM 9.4) and Byrnesville (RM 13.8) remain intact, impounding over 2 miles of river. All these dams can be barriers to fish movement during normal flows.

In 1974, Congress authorized the United States Army Corps of Engineers (USCOE) to proceed with the Meramec Basin flood control project by constructing 5 impoundments on the Big, Bourbuese, and Meramec rivers (USCOE 1982). Two impoundments, 3,700-acre Pine Ford (RM 41) and 4,600-acre Irondale (RM 118) were designed for mainstem Big River. Intense public opposition forced deauthorization of these projects in 1982.

The Big River watershed contains many large (impounding >50 acre-feet of water with a dam height > 25'), privately-owned dams, with Jefferson, Franklin, and Washington counties each containing over 100 (MDNR 1986). The largest, 360-acre Sunnen Lake in Washington County, impounds a portion of Fourche a Renault Creek.

Jefferson, St. Francois, and Washington counties contain 45 dams which retain finely-ground (tailings) and coarsely-ground (chat) lead and barite mine waste (Appendix 6). Most of these dams were improperly constructed or maintained, which has led to erosion of mine waste or dam collapse and large influxes of mine waste.

In a 1992 study, USCOE found that only one of the 45 Big River basin mine dams was safe and 27 received the worst possible rating—high-hazard, unsafe—and could fail during a severe flood or earthquake (Appendix 7). Perhaps the greatest danger to humans is from the St. Joe State Park dam which could bury Park Hills, Missouri, under 10 to 30 feet of mining waste and inject millions of tons of mine waste into Big River if it should fail. The USCOE study concluded that the Federal government should help stabilize 17 of the high-hazard, unsafe dams based on threat to human life, property loss, extreme long-term environmental damage, and magnitude of the problem (USCOE 1992).

Three lead tailings dams (Leadwood, Eaton, and St. Joe State Park) and tailings piles (including sites at National, Bonne Terre, and Elvins) in St. Francois County are being studied by Missouri Department of Natural Resources (MDNR) and the United States Environmental Protection Agency (USEPA) to determine the proper method of remediation. The Leadwood tailings pond dam was stabilized and spillway enlarged in 1996 (J. Czarnezki, personal communication). A plan for stabilization of the St. Joe State Park dam has been approved. Stabilization of lead tailings began in 1997. Appendix 4. Active USGS gaging, discharge, and water quality data gathering stations within the Big River basin (USGS 1993).

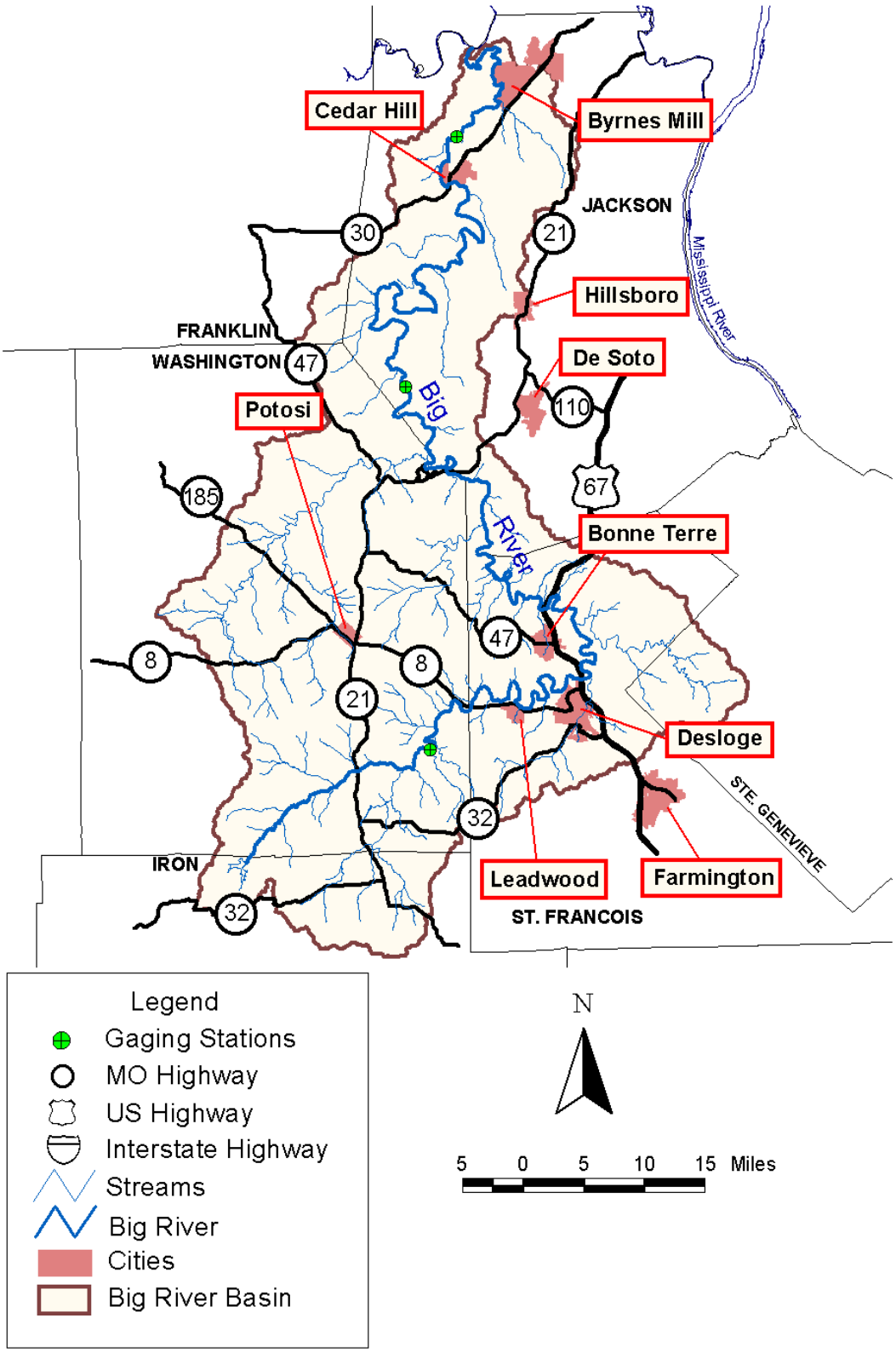


Figure gs. Gaging station locations within the Big River Basin

Appendix 4. Active USGS gaging, discharge, and water quality data gathering stations within the Big River basin (USGS 1993).

Station Number	Station Name	Location	Type	Record
717200	Big River at Irondale, Washington County	SE1/4, SW1/4, sec.15, T36N, R3E; on the right bank, 50' upstream State Highway U bridge, 0.2 miles upstream from Mill Creek, 0.8 miles west of Irondale	D/C/Q	1965-present
7018100	Big River at Richwoods, Jefferson County	Sec.33, T40N, R3E; on left downstream bank side of the State Highway H bridge, 1.8 miles east of Fletcher and 6.8 miles east of Richwoods.	D/Q	1942-present
7018500	Big River at Byrnesville, Jefferson County	SE1/4, Sec.12, T42N, R3E; on right downstream bank side of a pier of a privately-owned bridge at Byrnesville, 4.0 miles upstream from Heads Creek.	D	1921-present
7017605	Coonville Creek at St. Francois State Park St. Francois County;	Sec.25, T38N, R4E; at first culvert on park road off U.S. Route 67.	Q	1992-present

C = Crest-gage station

D = Continuous counting record gaging station L = Low-flow station

Q = Water quality station

Appendix 5. Water quality data for Big River basin streams taken from USGS gaging stations (USGS,1993).

Station	Parameter	Sample Size	Max	Min	Mean
RICHWOODS at Big River (1986 to present)	Specific conductance (us/cm)	51	598	194	419
	pH	51	8.5	7.3	8
	Oxygen, dissolved (mg/l)	44	17	5.6	10
	COD (mg/l)	42	126	63	91
	Fecal coliform (c/100ml)	43	5500	1	412
	Total hardness (mg/l)	22	310	170	247
	NO2+NO3, total (mg/l)	43	0.9	—	0.3
	Nitrogen, ammonia (mg/l)	42	0.11	—	0.03
	Phosphorus, total (mg/l)	43	0.18	0.01	0.04
	Copper, total (ug/l)	22	4	—	2
	Copper, dissolved (ug/l)	10	6	1	2.7
	Iron, total (ug/l)	15	790	30	255
	Iron, dissolved (ug/l)	10	100	4	23
	Lead, total (ug/l)	15	89	8	31
	Lead, dissolved (ug/l)	32	9	—	3.7
	Zinc, dissolved (ug/l)	10	47	4	20
	Specific conductance (us/cm)	7	378	245	305
IRONDALE at Big River (1986)	pH	7	8.1	6.3	7.5
	Hardness, total (mg/l)	7	210	130	167
	Alkalinity (mg/l)	7	209	109	152
	Copper, dissolved (ug/l)	7	—	—	—
	Iron, dissolved (ug/l)	7	12	4	7.4
	Lead dissolved , (ug/l)	7	—	—	—

Station	Parameter	Sample Size	Max	Min	Mean
	Specific conductance (us/cm)	6	420	155	344
St. Francois State Park at Coonville Creek (1992 to present)	pH	6	8.1	7.3	7.9
	Oxygen , dissolved	6	13.8	8.4	10.9
	COD (mg/l)	6	36	—	<10
	Fecal coliform (c/100ml)	6	3600	34	861
	Hardness, total (mg.l)	3	270	190	233
	NO2+NO3, total (mg/l)	6	0.13	0.04	0.07
	Nitrogen, ammonia (mg/l)	6	0.03	<0.01	0.02
	Phosphorus, total (mg/l)	6	0.04	<0.01	0.02
	Copper, total (ug/l)	3	1	<1.0	<1.0
	Copper, dissolved (ug/l)	7	1	1	1
	Iron, total (ug/l)	3	39	7	20
	Iron, dissloved (ug/l)	7	93	7	26
	Lead, total (ug/l)	3	27	5	15
	Lead, dissolved (ug/l)	3	3	3	3
	Zinc, dissolved (ug/l)	7	110	70	93

—below detection

Figure ms. Monthly maximum, minimum, and mean streamflow at the Big River Byrnesville gaging station for the period of record (1921-1993).

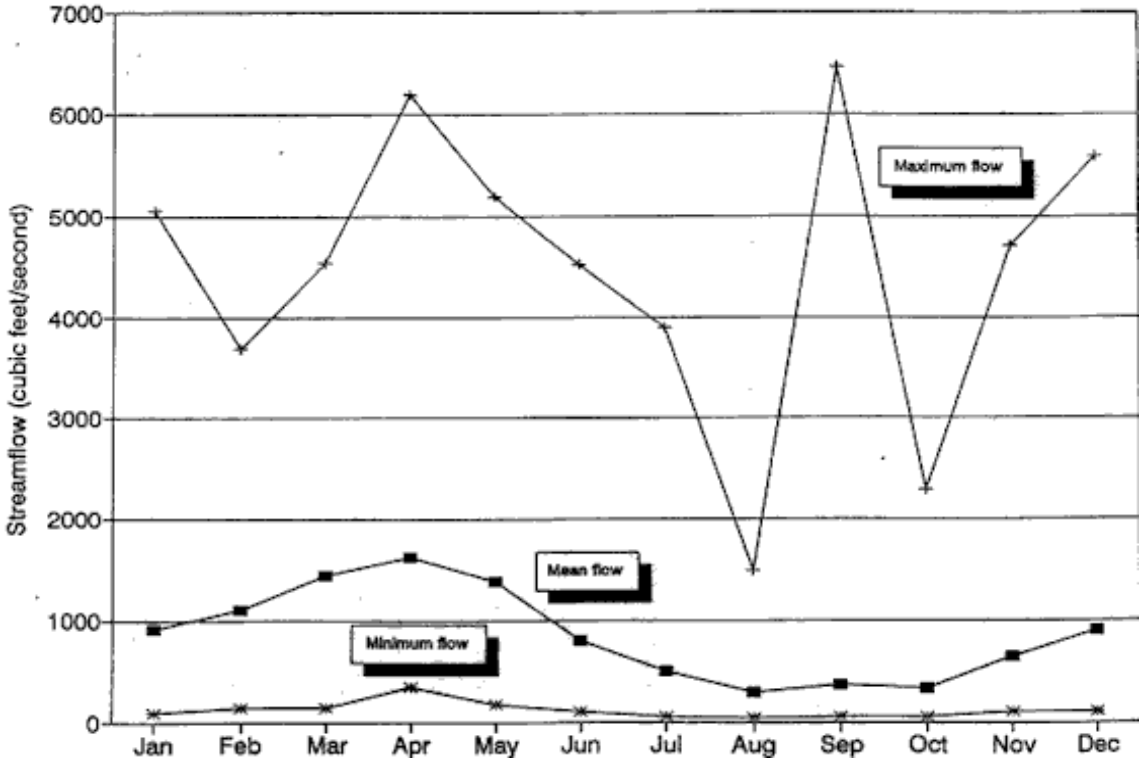


Table 3. Discharge data (cfs) for Big River at Irondale, Richwoods, and Byrnesville gaging stations (USGS 1994).

Location	Maximum	Minimum	0.1 Exceeds	0.5 Exceeds	0.9 Exceeds
Irondale	43200	2.2	363	59	10
Richwoods	59800	20	1310	280	99
Byrnesville	63600	25	1720	337	116

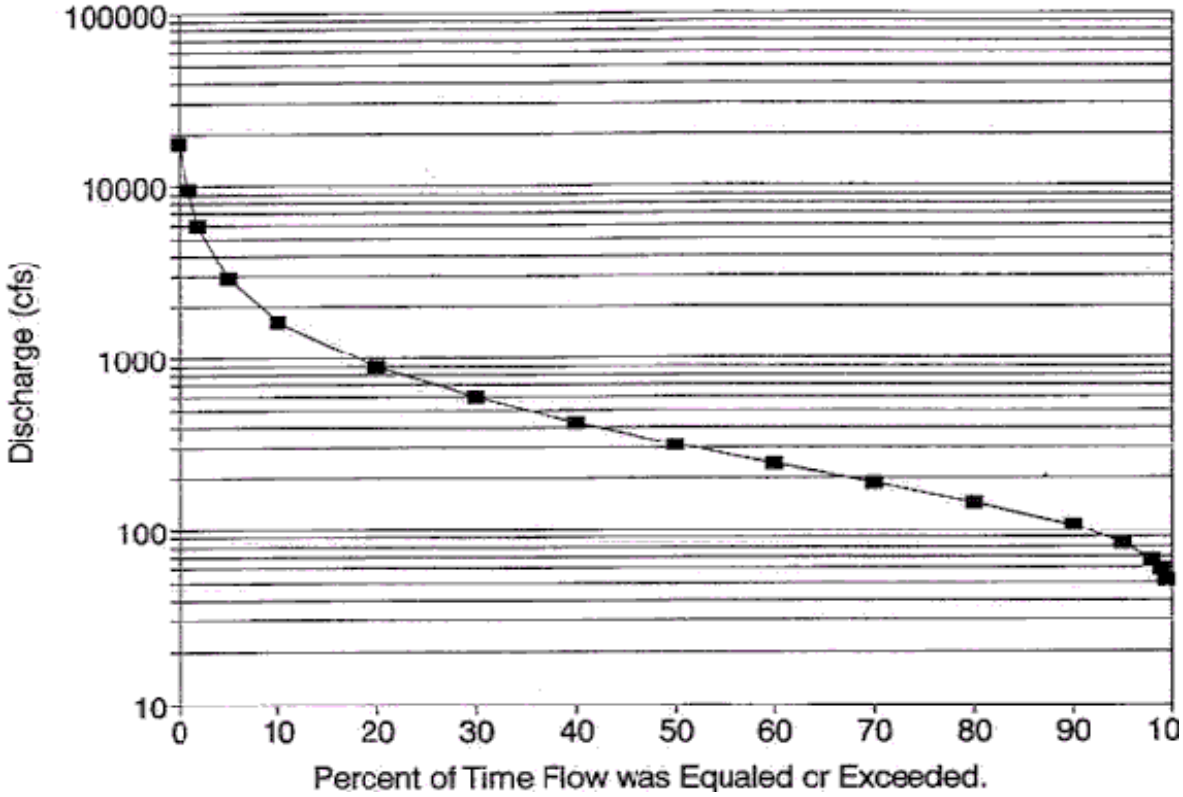
Table 4. Seven-day low-flow frequency data for the Big River, Richwoods and Byrnesville gaging stations (Miller et al. 1974).

Location	Period of Record	Drainage Area (sq. Mi)	Seven-day low-flow (cfs) for recurrence interval (years)				
			2	5	10	20	50
Richwoods	1942-69	735	89	60	44	34	**27**
Byrnesville	1921-69	917	96	62	50	41	32

Table 5. Flood frequency data for Big River, Byrnesville gaging station (Hauth 1974). Flood Frequency (years)

	2	5	10	25	50	100
Magnitude of flood (cfs)	14,900	22,500	27,300	32,900	36,800	40,500

Figure fd. Flow duration curve for the Big River at the Byrnesville gage (USGS, 1994).



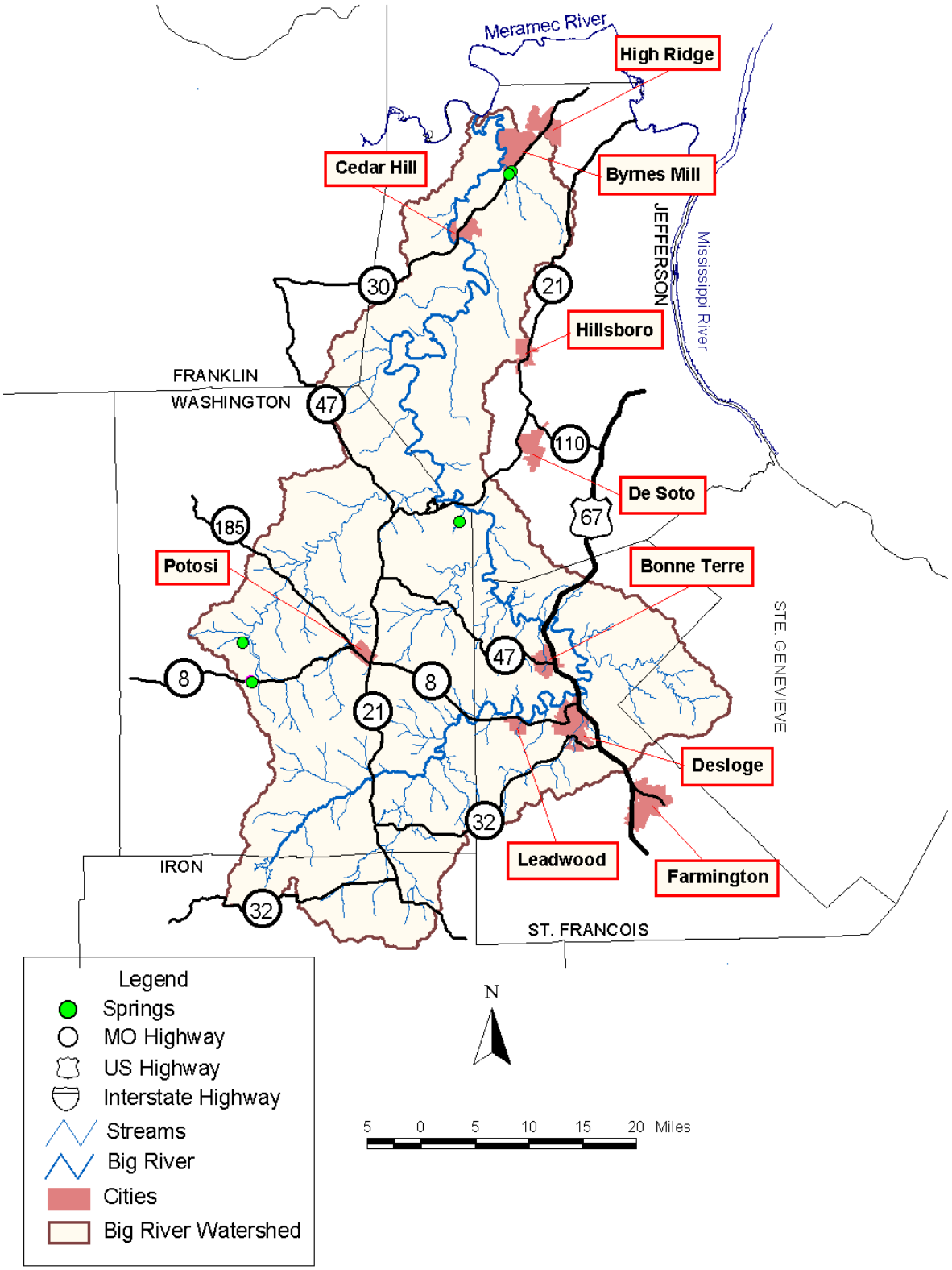


Figure sp. Springs within the Big River Basin

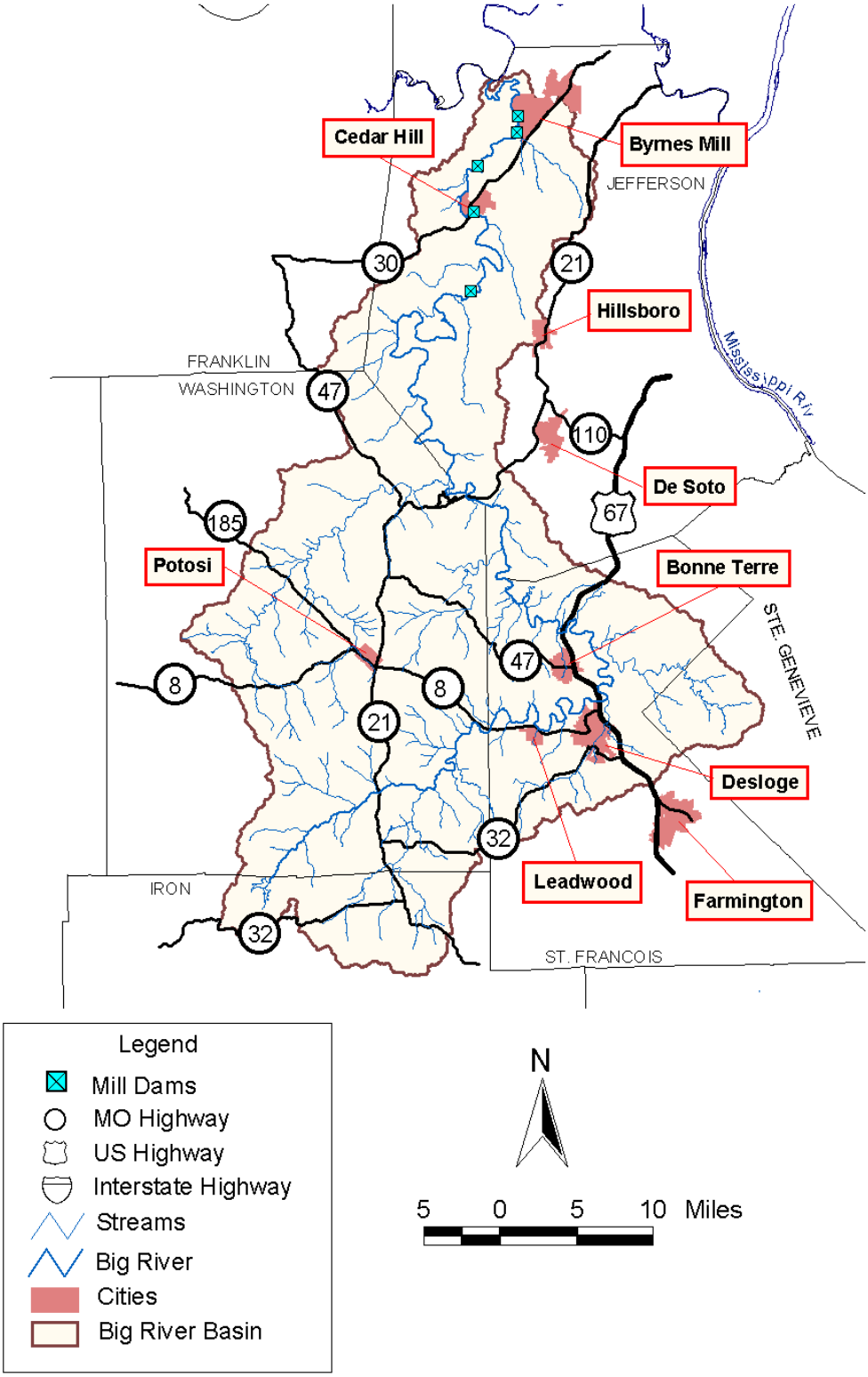


Figure mld. Mill dams in the Big River Basin.

Appendix 6. Hazard rating of lead and barite tailings dams and piles in the Big River basin (USCOE and MDNR 1980).

GP—COE 404 General Permit; LR—DNR Land Reclamation Permit; IP-Individual Permit.

ID	Name	County	Material	Rating
DAMS				
1	Richwoods "WW" Dam	Jefferson	barite	high
2	Dresser #11 Dam	Jefferson	barite	low
3	Desoto B Dam	Washington	barite	high*
4	Richwoods Mine B Dam	Washington	barite	high*
5	Richwoods Pond Dam	Washington	barite	high*
6	Ditch Creek Dam	Washington	barite	high*
7	Big Four Mine Dam	Washington	barite	high*
8	Desoto Mining Co. A Dam	Washington	barite	high*
9	Kingston #1 Dam	Washington	barite	high*
10	Star Mine Dam	Washington	barite	high*
11	P&P Gravel Co.	Washington	barite	high*
12	Dorlac Lake Dam	Washington	barite	high*
13	Eshbaugh_M artin Dam	Washington	barite	high*
14	Carter Lake Dam	Washington	barite	high*
15	Sun Mine Dam	Washington	barite	high*
16	Blackwell Mine Dam	Washington	barite	high*
17	New Dresser No.4 Dam	Washington	barite	high*
18	NL Industries Tiff Dam	Washington	barite	high*
19	Dresser No.4 Dam (failed)	Washington	barite	high*
20	Bottom Diggins Dam	Washington	barite	high*
21	Cadet #2 Dam	Washington	barite	low
22	Cadet No.1 Dam	Washington	barite	sign
23	Old Wolf Dam	Washington	barite	high*
24	Cadet Mine Tailings Dam	Washington	barite	high*
25	Racola Tailings Dam	Washington	barite	high*
26	Old Mines Tailings Dam	Washington	barite	sign
27	Arnault Branch Mine Dam	Washington	barite	high*
28	Lutrell Lake Dam Upper	Washington	barite	high*
29	Moeckel Dam	Washington	barite	high*

ID	Name	County	Material	Rating
30	Keyes Branch Mine Dam	Washington	barite	high*
31	Mineral Point No.2 Dam	Washington	barite	high
32	Mineral Point #1 Dam	Washington	barite	high
33	Dresser Minerals #7 Dam	Washington	barite	low
34	Dresser Mineral #7 Dam South	Washington	barite	sign
35	Old Washer #1 Dam	Washington	barite	high*
36	Black Tailings Dam	Washington	barite	high*
37	Pond Creek Tailings Dam	Washington	barite	high*
38	Cadet #3 Dam	Washington	barite	high*
39	Dresser Indust. Old #1 Dam	Washington	barite	high*
40	Dresser #1 D	Washington	barite	high*
41	Blackwell Pond Dam	St. Francois	barite	high*
42	Dresser #10 Dam	Jefferson	barite	–*
43	Eaton Dam	St. Francois	lead	–*
44	Leadwood Tailings Dam	St. Francois	lead	high*
45	St. Joe State Park Dam	St. Francois	lead	high*
TAILINGS PILES				
A	Bonne Terre Lead Tailings	St. Francois	lead	
B	East Bonne Terre Tailings	St. Francois	lead	
C	Desloge Lead Tailings Pile	St. Francois	lead	
D	National Lead Tailings Pile	St. Francois	lead	
E	Elvins Lead Tailings Pile	St. Francois	lead	
F	Federal Lead Tailings Pile	St. Francois	lead	
G	Leadwood/Eaton Lead Tailings	St. Francois	lead	

_ unknown DNR

Hazard Ratings

low = no permanent structures downstream of dam sign = 1_9 permanent structures downstream of dam
high = 10+ permanent structures downstream of dam

* USCOE "unsafe" designation

Appendix 7. Repair costs of high-hazard, unsafe mine dams located within the Big River basin USCOE, 1992).

Dam Name	Dam Height (ft.)	Storage (acre-feet)	Mine Waste	Renovation Cost ($)*
St. Joe	134	6,100	lead	14,000,000
Leadwood	60	1,000	lead	1,500,000
Desloge	40	3,000	lead	12,400,000
Eaton	30	4,500	lead	1,300,000
EastBonne Terre	40	3,000	lead	4,300,000
Blackwell Mine	87	4,000	barite	10,300,000
Dresser #10	107	1,100	barite	2,700,000
Old Mines	61	1,200	barite	1,800,000
Cadet #2	77	650	barite	6,000,000
Richwoods B	48	1,750	barite	2,600,000
Cadet Mine	96	950	barite	600,000
Esbaugh-Martin	115	650	barite	-
DeSoto Mine A	76	3,700	barite	5,800,000
Kingston #1 (Pfizer)	85	1,700	barite	-
Moeckel	85	2,400	barite	-
Dresser #11	100	600	barite	3,900,000
Big Four Mine	71	2,000	barite	600,000

* USCOE estimates, 1981

Water Quality and Use

Beneficial Use Attainment

Most permanently-flowing basin streams are suitable for: aquatic life protection and fishing, livestock and wildlife watering (MDNR 1996). However, due to the fish consumption advisory on Big River fish, MDNR classifies the lower 93 miles of Big River as not suitable for aquatic life protection and fishing or livestock and wildlife watering (J. Madras, personal communication). Lower Flat River (lead and zinc from mine waste and low dissolved oxygen and high ammonia from waste water discharge) is classified as non-attainment waters. Outside of these areas all of Big River and Sunnen Lake, and portions of Mineral Fork, Terre Bleue Creek, and Old Mines Creek are designated for whole body contact (MDNR 1986). Recreation and irrigation is approved on Big River (RM 0-52). No basin streams are designated for drinking water.

Recreational Use and Citizen Involvement

Despite its lack of statewide notoriety, Big River is a popular resource. Bachant et al. (1982) found Missourians ranked Big River fifth out of 38 major Missouri watersheds in recreational value. Bachant et al. (1982) noted that few people are familiar with Big River on a statewide basis, but local users highly value it and that many Missourians perceive Big River to be polluted (i.e. lead) and highly urbanized (i.e. club houses). A 1983-85 telephone survey found that recreational use on Big River ranked 10th out of 46 watersheds (Weithman 1987). Anglers annually spent an average of 36,602 days fishing Big River from 1983-88 (Weithman 1991).

Fleener (1988) found that Missourians spent over 1.6 million hours recreating on and around Big River (including 129,000 hours fishing) in 1980. In 1996, anglers spent 13,571 hours fishing Big River from RM 40 to RM 59, with over 70% of angling effort coming from Jefferson County residents (unpublished data, K. Meneau, MDC).

Boating is popular on Big River, especially with anglers below RM 60. During 1992 and 1993, 61% of anglers fishing from RM 40 to RM 59 used a boat or canoe (unpublished data, K. Meneau, MDC). About 75% of boat anglers used outboard motors. Canoeing's popularity is demonstrated by the presence of six canoe liveries (mostly in Jefferson County) that currently serve Big River. Mineral Fork supports spring and early summer canoeing. Bank and wade fishing are popular where access is good. Bank fishing takes place at boat ramps and below mill dams. Wade fishing is popular in upper Big River (above RM 93) and tributary streams like Mineral Fork, but little public bank fishing access exists.

The STREAM TEAM program is well represented within the basin with portions of five streams being adopted by 18 TEAMs. A STREAM TEAM association was formed by Big River TEAMS, in 1996, to improve communication. Basin STREAM TEAMs are active in tree planting, water quality monitoring, and trash pickup. In 1992, STREAM TEAMs incorporated Big River into Operation Clean Stream (annual Meramec River basin trash pick-up). In 1995, Big River STREAM TEAMs removed 6,180 pounds of trash and 1,033 tires during Operation Clean Stream (J. Wacker, personal communication).

In 1995, a 30-minute film documenting Big River's lead pollution problems was produced by two TEAMs. This was the second film made by these TEAMs to educate and urge action on Big River lead issues.

In 1998, Big River TEAMs constructed 1.5-miles of trails along Big River in Washington State Park (B. Stewart, personal communication). These included spur trails to gravel bars to improve fishing access.

Water Quality

Water chemistry and benthos samples indicate that Big River basin streams generally have good water quality (Missouri Water Pollution Board 1964; Ryck 1973; Miller et al. 1974; Mills et al.1978; MDC

1995d). Data collected from USGS gaging stations also indicate good water quality (Appendix 5). However, some localized problems exist. About eight miles of basin streams are chronically impacted (excessive algal growth, low oxygen, odor) by discharges from sewage treatment facilities (MDNR 1994a). Ryck (1974a) found depressed aquatic invertebrate populations and listed 1.5 miles of Spring Branch (near Bonne Terre) as seriously polluted from municipal sewage effluent. Recent facility upgrades have greatly reduced these impacts (MDNR 1994a).

In addition to affecting aquatic habitat, mine waste affects the water quality of some basin streams. Ryck (1974b) categorized 10.5 miles of Mill Creek and four miles of Flat River as seriously polluted from mine waste and listed four other basin streams that were affected. Kramer (1976) found elevated levels of lead, zinc, cadmium, and copper in Flat River water. Zachritz (1978) and Czarnezki (1987) found elevated lead and zinc concentrations in Big River water samples taken below the Leadwood and Desloge tailings piles and the confluence of Flat River. Schmitt and Finger (1982) found elevated copper, iron, lead, and zinc levels in Big River, especially during periods of high flow. They felt the majority of copper, lead, and iron was tied to sediment movement, while zinc was transported in liquid form. USGS has detected copper, iron, lead, and zinc from samples of Big River (Richwoods) water (Appendix 5). However, copper, iron, and lead levels were below those observed by Schmitt and Finger (1982) and Missouri State Water Quality Standards (MDNR 1994).

Cattle watering is a common practice in basin streams, though not intensive enough to present significant problems. Cattle activity increases organic pollution, bank erosion and subsequent sedimentation within the basin. Also, trampling and grazing by cattle destroys riparian vegetation.

Fish Kills, Contaminant Levels, and Consumption Advisories

Fishkill data (Table 6) indicate localized, but recurring problems with livestock manure and liquid fertilizer spills, as well as lead and barite mine waste erosion (MDC 1995a). Since 1966,

20 fishkills have involved releases of livestock manure from farms or liquid fertilizer leaks from the Williams Brothers pipeline in Jefferson County. The worst documented event occurred in Calico Creek (Washington County) on 9/6/77, when an ammonium nitrate (liquid fertilizer) pipeline leaked, killing 62,589 fish.

Lead and barite mine waste releases have negatively affected the biota of many basin streams. Some mine waste releases occur daily; 16 major releases have been documented since 1966. Fishkills have occurred with many of these. Depression or extirpation of invertebrate populations and loss of habitat have also occurred (Ryck 1974; Duchrow 1976; Kramer 1976; Zachritz 1978; Buchanan 1980; Jennett et al. 1981; MDNR 1984).

In 1975, a barite pond dam failed near Blackwell, sending an undetermined amount of clay into Mill Creek and causing an extensive fishkill in the 11.5 miles of Mill Creek and Big River immediately below the dam (Duchrow 1976). The red-colored runoff increased turbidity of Big River for 73 miles to its confluence with the Meramec River and depressed invertebrate populations for up to 264 days in Mill Creek.

Though the most dramatic results of mine waste releases are felt locally, the effects are often seen far downstream. Elevated lead levels have been found in fish (Kramer 1976; Czarnezki 1985; Schmitt and Finger 1982; Missouri Department of Health 1999), mussels (Schmitt and Finger 1982; Czarnezki 1987), plants, and crayfish (Schmitt and Finger 1982) up to 75 miles downstream from mine waste releases.

Lead concentrations in Big River fish have been monitored since 1979 (Table 7). Lead levels in fish tissue were high enough (> 300 ppb) to issue a consumption advisory against eating carp, redhorse, and suckers from Desloge to Washington State Park in 1980 (Missouri Department of Health 1999). In 1992, the advisory was updated to include catfish and the remaining 58 miles of Big River (93 miles total) to the Meramec River. Re-analysis of the data caused catfish to be removed from the advisory in 1993. Sunfish (longear, green, and bluegill) were added to the advisory in 1994. Subsequent testing (unpublished data, K, Meneau, MDC) showed Big River black bass (spotted, smallmouth, and largemouth bass), rock bass,

and catfish lead levels to be safe for human consumption. Mill Creek bleeding shiners and rainbow darters showed high lead levels in 1996 tests, but sunfish suckers, and rock bass levels were well below Federal standards (unpublished data, K. Meneau, MDC).

The fish consumption advisory prevents beneficial use classification of aquatic life from MDNR, negatively affects some anglers' fishing enjoyment, and causes some Missourians to doubt Big River's value. This advisory is likely to continue as lead-ladened sediment (from previous mine waste releases) continues its way through Big River.

Water Use

Only one public water supply withdrawal (Jefferson County PWSD No. 2 on Big River, RM 8) uses significant amounts (0.75 million gallons/day) of basin surface water (MDNR 1984 and 1986). Additionally, 10 wells with a maximum pumping capacity of 24.5 million gallons/day operate within the basin (MDNR 1994a).

Point Source Pollution

The basin contains 102 point sources of pollution (Figure ps), including five stormwater sources from landfills and quarries and 16 mining sources (MDNR 1994a).

About eight miles of basin streams are impacted (excessive algal growth, low oxygen, odor) by discharges from municipal sewage facilities (primarily lagoons). There are no permitted discharges of heavy metals or toxic organic materials.

Non-point Source Pollution

The Big River basin receives non-point source pollution from 65 documented sites, mainly runoff from intensive poultry farms or mines which affect 188 miles of basin streams. Mining (mostly near Big River) is responsible for 98% of the basin's non-point source pollution, primarily sediment influx (MDNR 1994a).

Chat and tailings piles are difficult to stabilize and subject to wind and water erosion. At times, this erosion can be very serious. The worst case happened in 1977, when a lead tailings pile near Desloge (RM 105.6) collapsed and discharged about 50,000 cubic yards of tailings into Big River. Runoff and erosion from barite processing ponds and dams affect nine basin streams, but this could be corrected by enlarging and rock lining emergency spillways and stabilizing dams (MDNR 1994a).

Sediment and water samples showed negative effects of mining activity. Zachritz (1978) and Czarnezki (1987) found high lead and zinc concentrations in Big River sediment and water samples. Elevated zinc, sulfate, cobalt, lead, and nickel were found in Big and Flat river water and sediment (MDNR 1994a). Kramer (1976) found elevated levels of lead, zinc, cadmium, and copper levels in Flat River sediment, water, and biota (minnows and crayfish). In 1980, due to sedimentation from mine waste, 15 miles of Big River (from Desloge to Bonne Terre) was the only segment in the entire Meramec River system found to be devoid of mussels (MDNR 1984).

Sheet erosion on watershed lands is responsible for about 3 tons of eroded soil/acre/year (Anderson 1980). Gully erosion is considered moderate, 0.16-0.32 tons of soil/acre/year (Anderson 1980). Runoff from sheet, gully, streambank, and urban erosion contribute 77%, 15%, 3%, and 3% of annual streams sediment yield, respectively (Anderson 1980). Localized erosion (especially around tailings and chat piles) has greatly reduced the quality of some aquatic habitat.

Livestock is not heavily concentrated within the basin (MDNR 1984). The total number of hogs and cattle in the basin was estimated to be equal to 512,100 PE (human population equivalents). However, during summer, cattle spend much time near or in streams, which results in increased organic and bacterial loads, bank erosion, turbidity, trampling of the riparian corridor, and locally-high concentrations of algae. Though not a basin-wide problem, livestock activity has decreased the quality of some local habitat.

In 1983, 15 confined animal farming operations (mostly poultry) generated about 42,100 PE of waste, which were stored in "no discharge" lagoons (MDNR 1984). In 1994, MDNR (1994a) listed 18 operations existed within the basin.

Appendix 5. Water quality data for Big River basin streams taken from USGS gaging stations (USGS,1993).

Station	Parameter	Sample Size	Max	Min	Mean
RICHWOODS at Big River (1986 to present)	Specific conductance (us/cm)	51	598	194	419
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	Fecal coliform (c/100ml)	43	5500	1	412
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	NO2+NO3, total (mg/l)	43	0.9	—	0.3
	Nitrogen, ammonia (mg/l)	42	0.11	—	0.03
	Phosphorus, total (mg/l)	43	0.18	0.01	0.04
	Copper, total (ug/l)	22	4	—	2
	Copper, dissolved (ug/l)	10	6	1	2.7
	Iron, total (ug/l)	15	790	30	255
	Iron, dissolved (ug/l)	10	100	4	23
	Lead, total (ug/l)	15	89	8	31
	Lead, dissolved (ug/l)	32	9	—	3.7
	Zinc, dissolved (ug/l)	10	47	4	20
IRONDALE at Big River (1986)	Specific conductance (us/cm)	7	378	245	305
	pH	7	8.1	6.3	7.5
	Hardness, total (mg/l)	7	210	130	167
	Alkalinity (mg/l)	7	209	109	152
	Copper, dissolved (ug/l)	7	—	—	—

Station	Parameter	Sample Size	Max	Min	Mean
	Iron, dissolved (ug/l)	7	12	4	7.4
	Lead dissolved , (ug/l)	7	—	—	—
St. Francois State Park at Coonville Creek (1992 to present)	Specific conductance (us/cm)	6	420	155	344
	pH	6	8.1	7.3	7.9
	Oxygen , dissolved	6	13.8	8.4	10.9
	COD (mg/l)	6	36	—	<10
	Fecal coliform (c/100ml)	6	3600	34	861
	Hardness, total (mg.l)	3	270	190	233
	NO2+NO3, total (mg/l)	6	0.13	0.04	0.07
	Nitrogen, ammonia (mg/l)	6	0.03	<0.01	0.02
	Phosphorus, total (mg/l)	6	0.04	<0.01	0.02
	Copper, total (ug/l)	3	1	<1.0	<1.0
	Copper, dissolved (ug/l)	7	1	1	1
	Iron, total (ug/l)	3	39	7	20
	Iron, dissloved (ug/l)	7	93	7	26
	Lead, total (ug/l)	3	27	5	15
	Lead, dissolved (ug/l)	3	3	3	3
	Zinc, dissolved (ug/l)	7	110	70	93

—below detection

Table 6. Fishkills reported in the Big River basin, 1966-94 (MDC 1995a).

			No. of Fish Est.		
Date	**Stream**	**County**	**Killed**	**Value**	**Cause/Source**
8/7/66	Big River	St. Francois	NA	NA	Gravel Washing/A. M. Mount Gravel
6/8/68	Mill Cr.	Washington	U	U	Diesel Fuel/Buckman Labs
5/5/70	Belew Cr.	Jefferson	U	U	Hog Lagoon
8/28/70	Mill Cr.	Washington	200	U	Farm/Hog Manure Lollar
3/10/71	Fountain Farm Cr.	Washington	NA	NA	Turbid water/Dresser Minerals
5/24/71	Flat River	St. Francois	NA	NA	Sewage/Bismark STP
5/25/71	Fountain Farm Cr.	Washington	NA	NA	Turbid water/Pfizer & Co.
7/13/71	Mine a Breton Cr.	Washington	U	U	Road Oil/County Hwy. Dept
9/28/71	Mineral Fork Cr.	Washington	NA	NA	Gravel Washing/ Concrete Aggregate
4/30/72	Reid Cr.	Iron	NA	NA	Acid Spill/Truck Accident
8/8/72	Big River	Washington	NA	NA	Gravel Washing/Mount S&G Co.
3/25/74	Bass Cr.	Washington	U	U	Fuel oil/St. Joe Lead Co.
12/11/74	Big River Trib.	Jefferson	NA	NA	Turbid Discharge/ Dresser Minerals
2/6/75	Flat River	St. Francois	NA	NA	Sewage Solids/Flat River STP
3/2/75	Mine a Breton Cr.	Washington	2,230	195.00+	Fuel Oil/Purcell Tire
8/15/75	Mill Cr.	Washington	U	U	Tailings Discharge/ Dresser Min
8/15/75	Big River	Washington	824+	U	Tailings Discharge/ Dresser Min.
8/18/76	Big River	St. Francois	NA	NA	Tailings/Valley Mineral
10/29/76	Mine a Breton Cr.	Washington	7,988	742.4	Gasoline/Transport Del. Co.
8/5/77	Big River	St. Francois	NA	NA	Lead Tailings/City of Desloge
9/6/77	Calico Cr.	Jefferson	62,589	5790	Ammonium Nitrate/

No. of Fish Est.					
Date	**Stream**	**County**	**Killed**	**Value**	**Cause/Source**
					Williams Pipe
5/18/78	Terre Bl. Trib.	St. Francois	NA	NA	Chicken Manure/ Gremminger Farm
7/26/78	Big River	St. Francois	7,820	3390	Unknown
9/14/78	Keesling Cr.	Iron	10,904	1207	Chicken Manure/ Atchison Farm
4/10/79	Trib. Cedar Cr.	Iron	320	30	Chicken Manure
7/3/79	Dry Cr.	St. Francois	NA	NA	Chicken Manure/ Thompson Farm
11/27/79	Old Mines Cr.	Washington	NA	NA	Barite Tailings/General Barite
1/12/80	Big River	Jefferson	NA	NA	Dresser Plant/Leak-Red Clay
5/22/80	Cedar Cr.	Washington	NA	NA	Red Paint/MO Hwy. Dept
7/17/80	Terre Bl. Trib.	St. Francois	9,520	992.99	Chicken Manure/ Gremminger Farm
2/15/82	Mine a Breton Cr.	Washington	NA	NA	Gasoline/Hoskcer Oil
2/23/82	Shaw Branch	St. Francois	NA	NA	Lead Tailings/St. Joe SP
3/12/82	Mine a Breton Cr.	Washington	NA	NA	Oil & Trans. Fluid/Borer Auto
4/24/82	Heads Cr.	Jefferson	NA	NA	Asphalt/Pruitt & Campbell
5/28/82	Big River	Jefferson	NA	NA	Barite Tailings/Dresser Minerals
7/3/82	Big River	St. Francois	1,150	990.5	Unknown
7/31/82	Turkey Cr.	St. Francois	104	76.06	Sewage/Bonne Terre STP
8/13/82	Cedar Cr.	Iron	578	82.56	Chicken Manure/Byerley Farm
10/30/82	Hazel Run Cr.	St. Francois	1,062	121.2	Chicken Manure/Yeager Farm
2/9/83	Cedar Cr.	Iron	NA	NA	Chicken Manure/Byerley Farm
7/12/83	Pond Cr.	Washington	U	U	Red Clay/IMCO Services
8/25/83	Mine a Breton Cr.	Washington	2,397	157.31	Diesel Fuel/Purcell Tire

No. of Fish Est.					
Date	**Stream**	**County**	**Killed**	**Value**	**Cause/Source**
3/11/84	Coonville Cr.	St. Francois	NA	NA	Oil/Bonne Terre Sunoco
5/3/84	Turkey Cr.	St. Francois	NA	NA	Sewage/Bonne Terre STP
10/5/84	Small Cr.	Washington	NA	NA	Hog Manure/Jim Dicus Farm
3/8/85	Cedar Cr.	Iron	NA	NA	Chicken Manure/Byerley Farm
4/5/85	Big River	St. Francois	NA	NA	Lead Tailings/St. Joe Minerals
8/13/85	Wallen Cr.	Washington	33,642	3815	Chicken Manure/Silvey Farm
9/6/85	Big River	Washington	NA	NA	Dredging Silt/Politte Ready Mix
10/7/85	Ditch Trib. to Big River	Jefferson	NA	NA	Diesel Fuel/U-Gas Station
1/3/86	Dry Cr.	St. Francois	NA	NA	Chicken Manure/Unknown
1/16/86	Terre Bl. Trib.	St. Francois	100	U	Chicken Manure/Robert Hoehn Farm
2/4/86	Big River	Jefferson	NA	NA	Lqd. Fertilizer/Williams Bros
3/3/86	Trib Big River	Jefferson	NA	NA	Fuel Oil/Speigel Oil Co.
3/18/86	Terre Bl. Trib.	St. Francois	300	U	Chicken Manure/Robert Hoehn Farm
5/7/86	Big River	St. Francois	NA	NA	Sewage Sludge/Bonne Terre STP
11/15/86	Cadet Cr.	Washington	NA	NA	Indust. Chemicals/ Buckman Labs
7/6/87	Big River	St. Francois	NA	NA	Lead Tailings/St. Joe Minerals
3/30/88	Big River	St. Francois	NA	NA	Lead Tailings/St. Joe Minerals
6/24/89	Mine a Breton Cr.	Washington	NA	NA	Gasoline Pump Handle
6/30/89	Skullbones Cr.	Jefferson	NA	NA	Waste Oil/Jeff. Co. Hwy. Dept.
8/16/89	Shaw Branch	St. Francois	NA	NA	Lead Tailings MHTD
4/24/90	Flat River	St. Francois	211	21.53	Sewage/Flat River STP

No. of Fish Est.					
Date	**Stream**	**County**	**Killed**	**Value**	**Cause/Source**
5/2/90	Mine a Breton Cr.	Washington	NA	NA	Hydraulic Fluid/Purcell Tire
7/25/90	Turkey Cr.	St. Francois	NA	NA	Sodium Fluorocein Dye
12/1/90	Big River	Jefferson	NA	NA	Suspended Sed./ Norman Goad
3/14/91	Big River	St. Francois	1	0.08	Hydraulic Fluid/Resco Products
4/25/91	Mill Cr. Trib	Washington	NA	NA	Chicken Manure/Silvey Farm
5/19/91	Trib Terre Bl	St. Francois	8,919	1438	Chicken Manure/Robert Hoehn Farm
11/29/93	Big River	St. Francois	NA	NA	Lead Tailings/St. Joe Minerals
3/10/94	Mine a Breton Cr.	Washington	NA	NA	Gasoline/Wallis Oil Company
3/14/94	Mine a Breton Cr.	Washington	374	33.62	Gasoline/CooperOil Company
6/9/94	Big River	Washington	NA	NA	Land Clearing/Richard Dix
8/1/94	Big River	Washington	NA	NA	Diesel/Politte Ready Mix

Total Number of Fish Killed - 151,233+

Total Estimated Value: $19,083.25+

U - Undetermined NA - Not available

Table 7. Lead levels in fish from Big River, MDC Mammoth Access, Jefferson County, 1979-1994 (unpublished data, J. Czarnezki, MDC).

Species	Lead Level (ppb)	Year
Redhorse species	450	1994
	670	1993
	550	1992
	870	1991
	400	1990
	43	1987
	440	1986
	280	1984
	320	1983
	270	1982
	415	1980
	395	1979
Channel catfish	74	1994
	51	1993
	150	1992
	160	1991
	66	1990
	225	1980
	216	1979
Flathead catfish	30	1992
	1700	1993
Sunfish species	340	1994
	440	1987
	170	1986
	180	1980
	174	1979
Rock bass	360	1994
Largemouth bass	160	1994
Smallmouth bass	40	1987
	91	1986
	150	1980

Species	Lead Level (ppb)	Year
	138	1979
Carp	440	1991
	380	1987
	370	1986
	520	1980

* FDA action level = 300 parts per billion

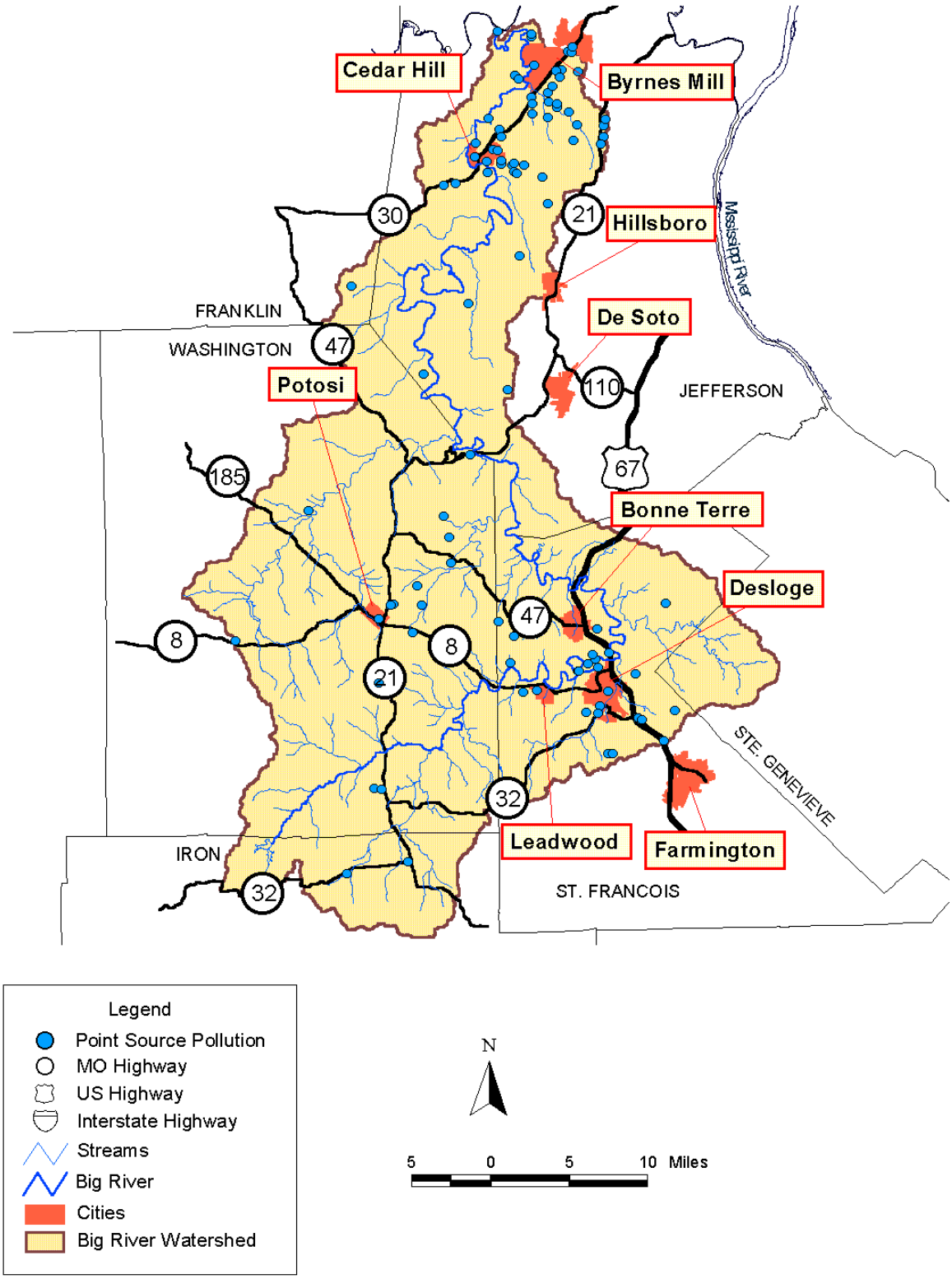

Figure ps. Point source pollution sites in the Big River basin, Missouri.

Habitat Conditions

Channel Alterations

No large channel alteration projects have taken place within the basin (MDNR 1986). However, small sections of many streams have been straightened for bridge construction; gravel pushing is commonly practiced in misguided attempts at streambank stabilization.

Sedimentation from erosion of mine waste is extensive in portions of Big and Flat rivers (MDNR 1984 1986 1994a, Buchanan 1980, Kramer 1976, Ryck 1974b, Zachritz 1978) and other basin

streams (Duchrow 1976, Jennett et al. 1981, MDNR 1984 1986 1994a, Ryck 1974b). Shaw (2.0 miles), Shibboleth (0.5 miles), and Fountain Farm (0.2 miles) branches continue to be affected by barite mining sediment (MDNR 1994a). Mine waste sedimentation has smothered aquatic habitats within these streams; making them inhabitable for some invertebrates.

Three instream sand and gravel mining operations are permitted by MDNR—in Big River (Washington County), Mineral Fork (Washington County) and lower Dry Creek (Jefferson County; MDNR 1994b), while two illegal Washington County operations (Big River and Cedar Creek) have been stopped.

The Washington County operations negatively affect adjacent stream reaches through increased channel instability (downcutting and channel widening), streambank erosion, increased turbidity, and loss of aquatic habitat.

The lower 1.5 miles of Dry Creek is mined, but has a bedrock bottom which prevents upstream downcutting. However, past gravel removal from Big River near the Dry Creek confluence may have caused lower Dry Creek to downcut to bedrock and has caused the Big River channel to become unstable and streambank erosion to occur. Gravel is periodically removed from many basin streams by unpermitted and undocumented small operators.

Two floodplain sand and gravel operations are permitted near Big River in Jefferson County (MDNR 1994b). Other unpermitted floodplain operations exist near Big River and Mineral Fork in Washington County.

Watershed urbanization has decreased wooded riparian corridors and increased stormwater runoff, thereby increasing channel instability.

Unique Habitats

Nineteen sensitive natural communities have been documented within the basin (MDC 1995b). Included in these communities are two examples of Ozark creeks and four examples of Ozark springs and spring branches (Appendix 8).

Stream Improvement Projects

In October, 1991, a cedar tree revetment and corridor planting project was installed on Cedar Hill Access (RM 18.5). Forty cedar trees (20-45 ft.) were anchored along a 525-foot long, 14-foot tall, vertical eroding streambank immediately downstream from a breached mill dam. The revetment consisted of a 180-foot triple and 345-foot single rows of cedar trees. Seventy-five hardwood trees (6-8 ft.) were planted in April, 1992 and a 100-foot "no mowing zone" was marked to help re-establish the riparian corridor.

Although no cedar trees were lost and bank toe remains stable, natural backsloping and capture of sediment haven't occurred in adequate amounts to stabilize the streambank. Mechanical backsloping and immediate willow planting may have improved results. Planted corridor trees continue to survive; however, dense ragweed growth is greatly inhibiting natural regeneration of trees.

In April 1995, with the help of 38 STREAM TEAM volunteers, 5,000 tree seedlings were planted on Mr. Tim Smith's property along Big River (RM 58.4-59.0) and Mineral Fork (RM

0-0.4). This frontage was planted with sweetgum, pin oak, tulip popular, silver maple, and green ash at four sites. Trees were planted on 6 x 6 ft. spacing to create a corridor that ranged from 60 to 120 ft. wide.

Despite well-marked planting sites and Mr. Smith's assurances of good stewardship, 75% of the planted seedlings were mowed or plowed under by Mr. Smith's lessee farmer. The remainder of trees are doing well.

In April 1997, 18 STREAM TEAM volunteers planted 1,800 tree seedlings on private property along Sandy Creek (Jefferson County). Sweetgum, pin oak, and green ash were planted on 6- x 6-foot spacing. Survival was estimated to be about 60%.

Stream Habitat Assessments

Stream habitat quality was evaluated by using MDC's Stream Habitat Assessment Device (SHAD Version II) and aerial video tape (Big River only). SHAD was utilized at 113 sites on 49 streams (Figure hb).

Overall, SHAD surveys revealed streambanks were in good condition. Most Big River and tributary streambanks showed minimal (74%) or no (79%) bank erosion. Trees and shrubs were the dominant types of streambank protection.

Riparian corridor condition was fair to poor. Generally, Big River's corridors were in better condition than its tributaries. Sixty percent of Big River sites exhibited a timbered stream corridor > 75 ft., versus 44% for tributary stream sites. Timbered corridor was absent on 24% of Big River and 44% of tributary streams' SHAD sites. Twenty-one percent of tributary SHAD sites had corridors that consisted mainly of grasses, compared to only 6% for Big River. Cattle

grazing and hay production were more prevalent land uses around tributaries than around Big River. Row cropping and hay production took place near Big River, but generally comprised a smaller portion of the riparian corridor. Corridor width is being reduced along streams with increasing amounts of urbanization.

Results from SHAD surveys suggest that the potential for soil erosion and non-point source pollution may be greater from tributary streams than from Big River, due to heavier riparian corridor land use and poor vegetative quality (narrow corridor and prevalence of grasses). Cattle grazing increases erosion and greatly limits the development of wooded corridors. Row cropping and hay production eliminates wooded corridors through constant plowing or mowing. Generally, intensive riparian corridor land use and poor vegetative quality increased as the size of stream decreased.

Big River basin's instream habitat is typical of Ozark streams with gravel present at 89% of the SHAD sites. Water willow bordering pools and boulder slides from bluffs was common. The percentage of SHAD sites with downed logs or rootwads was high, with 74% in tributary streams and 88% in Big River.

Appendix 8. Sensitive natural communities within the Big River basin (MDC 1995b).

∫	Location
Ozark creek	Cedar Creek shut-ins, Washington Co., sec. 18, T35N, R3E and sec. 13, T35N, R2E. West of Highway 21 bridge, 6.5 miles NE of Banner.
Ozark creek	Mineral Fork, Washington Co., sec. 8, T38N, R2E to sec. 15, T39N, R3E. Confluence with Big River, upstream to Highway F, near Aptus.
Gravel wash	Cedar Creek, Washington Co., sec. 18, T35N, R3E. Along Cedar Creek east of Highway 21 bridge, about 6.5 miles NE of Banner.
Ozark spring & spring branches	Mammoth Creek, Jefferson Co., sec. 11&12, T39N, R3E.
Ozark spring & spring branches	Coonville Creek, St. Francois Co., sec.19 & 30, T38N, R5E and sec. 25, T36N, R2E.Coonville Creek Natural Area, St. Francois State Park.
Ozark spring & spring branches	Clear Creek, Washington Co., sec. 23 & 24, T36N, R1E and sec. 19, T36N, R2E. Mark Twain National Forest.
Ozark spring & spring branches	North Fork Creek, Washington Co., sec.9, 16, & 17, T36N, R2E. Tributary to Cedar Creek about 3 miles north of Belgrade.
Dry igneous forest	Round Mountain, Washington Co., sec. 34, T36N, R3E. Two and one half miles SSW of Irondale.
Fen	St. Francois Co., sec. 19 & 30, T38N, R3E & sec 25, T38N, R4E. Coonville Creek Conservation Area and St. Francois State Park.
Fen	Appleberry Meadows, St. Francois Co., sec. 19 & 20, T38N, R5E. On NNE boundary of St. Francois State Park near Appleberry Cemetery.
Fen	Cruise Meadow, Washington Co., sec. 30, T39N, R3E. West of Washington State Park, along Old Mines Creek, at junction of highways 47 and 21.
Igneous glade	Buford Mountain Glades, Iron Co., sec. 16, 17, 21, 22, 27, 34, and 35, T35N, R3E. Buford Mountain Conservation Area.
Igneous glade	Hanson Hill, Washington Co., sec. 17 & 18, T35N, R2E. Three miles NW of Banner.
Igneous glade	Unnamed, Washington Co., sec. 17 & 18, T35N, R3E. Three miles NW of Banner.
Igneous glade	Hughes Mill Glade, Washington Co., sec. 21, 22, 27, and 28, T36N, R3E.
Igneous glade	Round Mountain Glade, Washington Co., sec. 33 & 34, T36N, R3E. Round Mountain.

∫	Location
Mesic Limestone/dolomite forest	Washington State Park Hardwoods Natural Area, Washington Co., sec. 22 & 23, T39N, R3E. Washington State Park.
Xeric igneous forest	Unnamed, Washington Co., sec 21, 22, 27, and 28, T36N, R3E. Hughes Mill Glade.
Xeric igneous forest	Unnamed, Washington Co., sec. 28, T36N, R3E. Hughes Mountain.

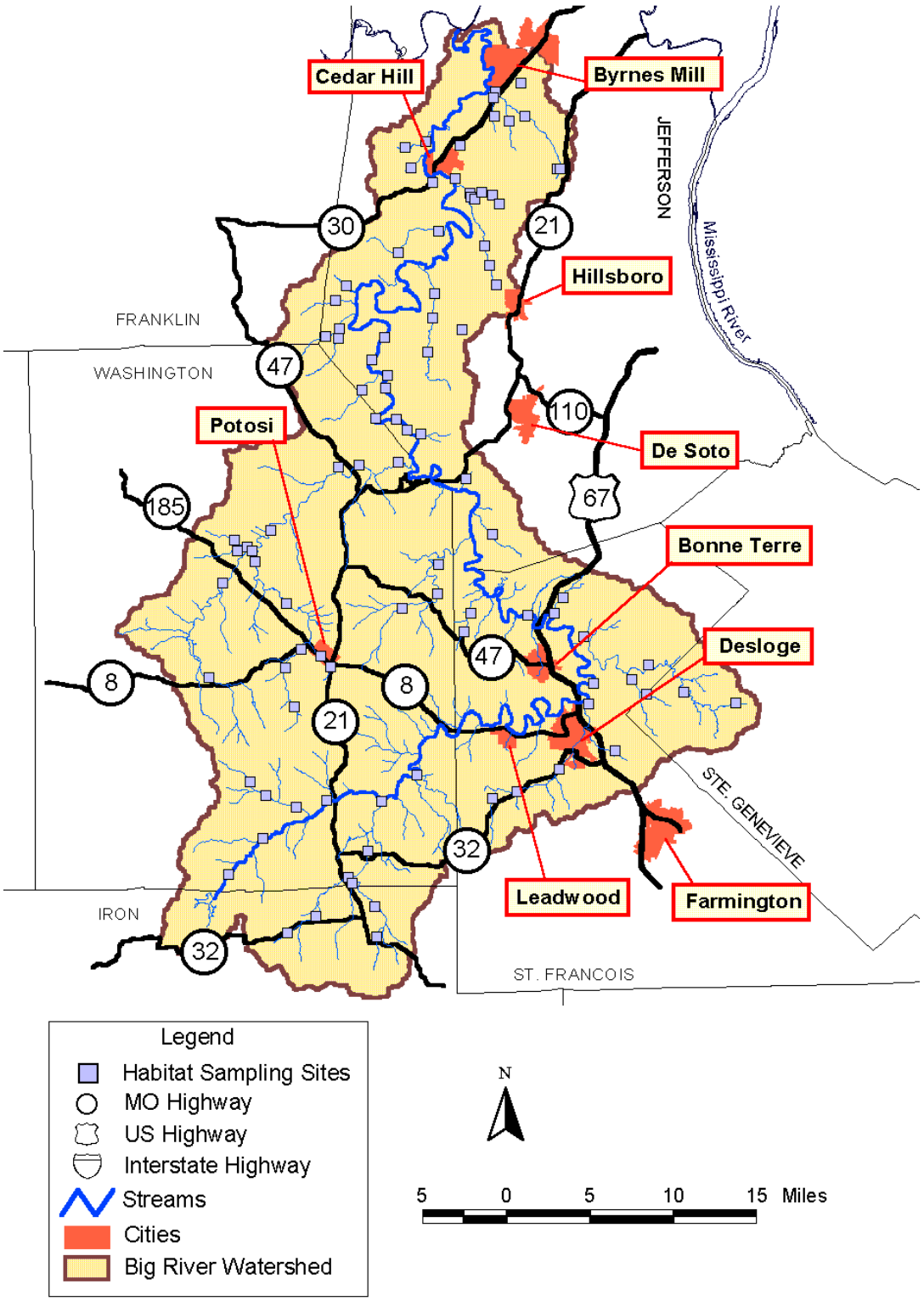

Figure hb. Habitat sampling locations within the Big River basin, Missouri.

Biotic Communitty

Fish Community

During 1992-95, fish were sampled at 70 sites on 38 basin streams using seines and backpack and boat electrofishing methods (Figure fs). Sixty-one species were collected. Thirty-nine additional species have been collected during other surveys for a total of 100 species (Table 8; MDC 1995c). Grass carp (Ctenopharyngodon idella), creek chubsucker (Erimyszon oblongus), spottedbass (Micropterus punctulatus), warmouth (Lepomis gulosus), and redear sunfish (Lepomis microlophus) (Table 8) were collected outside of the range described by Pflieger (1975). Seven other species have distributions that overlap a portion of the basin (Pflieger 1975) but were not collected.

The entire basin lies within the Ozark Faunal Region (Pflieger 1989). During 1992-95, some of the most frequently collected fishes were typical Ozark species, such as smallmouth bass (Micropterus dolomieui), rock bass (Amploplites rupestris), longear sunfish (Lepomis megalotis), northern hogsucker (Hypentelium nigricans), black redhorse (Moxostoma duquesnei), greenside darter (Etheostoma blennioides), rainbow darter (Etheostoma caeruleum), Ozark minnow (Notropis nubilus), and striped shiner (Luxilus chrysocephalus).

Species diversity and number of Ozark species were lowest in lower Big River basin. Number of species was 47, 53, and 36 for upper (Big River RM 93-134 and tributaries), middle (Big River RM 59-93 and tributaries), and lower (Big River RM 0-59 and tributaries) basin streams, respectively. Number of representative Ozark species was 24, 25, and 21 for upper, middle, and lower basin streams, respectively. Negative effects of increasing urbanization surrounding lower basin streams may be responsible for their lower diversity.

Threatened and Endangered Species

Four species of concern are found within the basin. The crystal darter (Ammocrypta asprella) is on the State endangered list and was found in lower Big River (RM 1-8), but only by Pflieger (1975). The Missouri status of the Alabama shad (Alos alabamae) is rare and was infrequently sampled in Big River (RM 1-4). The western sand darter (Ammocrypta clara) is on Missouri's watch list and was found in lower Big River (RM 1-10). Silverjaw minnow (Ericymba buccata) distribution was scattered throughout Big River and lower portions of Calico Creek, Terre Bleue Creek, Flat River, and Salem Creek. It is on the State watch list, but was common where sampled.

Fish Introductions and Stockings

Rainbow trout have been stocked in Mill Creek by a private business in Cadet, MO, but the numbers and stocking frequency are unknown. Grass carp (Ctenopharyngodon idella), redear sunfish (Lepomis microlophus), and hybrid sunfish (species undetermined) are occasionally taken during sampling (unpublished data, K. Meneau, MDC) and are suspected to originate from overflow of private ponds.

Spotted bass were first collected in Big River by Mills et al. (1978), which was the first report of spotted bass in the Meramec River basin. Spotted bass were not collected again until 1987 (unpublished data, K. Meneau, MDC). Since then, spotted bass have greatly increased their numbers below RM 20 (becoming the dominant black bass) and expanded their range above RM (unpublished data, K. Meneau, MDC). Also, genetic tests have revealed that some spotted bass/smallmouth bass hybridization has taken place (unpublished data, K. Meneau, MDC). Spotted bass may have entered the Meramec River basin as a result of stockings in the Osage River basin before 1940 or in Missouri River tributaries in the 1960s (Pflieger 1975).

Sport Fishing

Big River offers a variety of game fish, with the most popular being smallmouth bass. Big River is ranked third in Missouri for providing Master Angler smallmouth. In 1992, MDC established a Smallmouth Bass Special Management Area (SBBSMA; Figure fm) on Big River. During 1994 within the SBBSMA, electrofishing by MDC revealed good numbers of quality-sized fish (Figure sf). In MDC's 1995 creel survey, anglers reported catching 4,726 smallmouth bass including seven of Master Angler size, up to 24 inches.

Other popular Big River sportfish are: rock bass, channel and flathead catfish, sunfish, crappie, and suckers. Most rock bass and crappie are caught in spring. MDC sampling has shown good numbers of quality-sized rock bass (Figure rf). Though channel and flathead catfish angling effort is difficult to determine, catfishing peaks in summer with many anglers using set lines.

Several large (15-25 lbs) flatheads are reported each year. Sunfish (longear and green sunfish and bluegill) angling is best from May to September. Sucker gigging is popular in late fall and early winter, especially above RM 46, where boat access, water clarity, and sucker habitat is best.

Fleener (1988) estimated that 44,008 fish (63% gigged suckers) were caught from Big River and the lower five miles of the Mineral Fork in 1979-80. In April-October, 1995, anglers caught an estimated 11,718 fish within the SBBSMA (unpublished data, K. Meneau, MDC).

Other basin streams with significant sport fisheries that are accessible to wade-anglers include: Mineral Fork, Fourche a Renault, Terre Bleue, Cedar, Clear, and Mill creeks.

Present Regulations

Statewide fishing regulations apply to basin streams. The exceptions are black bass regulations within the Big River SBBSMA. The purpose of these regulations (listed below) are to produce more and bigger smallmouth bass, while attempting to reduce the number of slow-growing spotted bass.

Big River SMBSMA Black Bass Regulations

The SBBSMA consists of the Big River from the Hwy. 21 bridge (near Washington State Park) to its confluence with the Meramec River and Mineral Fork from the Hwy. F bridge (Washington County) to its confluence with the Big River. Within the SBBSMA the following regulations apply:

- Black Bass Daily Limit: six (6), only one (1) can be a smallmouth bass Black Bass Length Limit: Largemouth bass = 12" minimum
- Spotted bass = no length limit
- Smallmouth bass = 15" minimum

Big River anglers support these regulations. MDC creel results show that 21% of anglers fished the SBBSMA more because of the regulations (unpublished data, K. Meneau, MDC). Four percent fished less and fishing effort was unchanged for 75% (unpublished data, K. Meneau, MDC). Some anglers asked for expansion of the Big River SBBSMA boundaries.

To help further reduce the spotted bass population within the Big River a change in regulations will take effect on March 1, 2002. On March 1, 2002, the daily limit for spotted bass will be twelve (12). The daily limit for largemouth bass will remain six (6) fish, and the daily limit for smallmouth bass will remain one (1) fish. Size limits will remain the same.

Aquatic Invertebrates

Mussels

Big River has a diverse mussel community. Thirty-four species of mussels (Table 9) have been found within basin streams (Buchanan 1980; Ryckman et al. 1973). Three species are of special concern and

were sampled only in lower Big River. The pink mucket (Lampsilis abrupta) is Federally-endangered, while the scale shell (Leptodea leptodon) and spectacle case (Cumberlandia monodonta) are listed as rare in Missouri. Ryckman et al. (1973) and Buchanan (1980) found that Big River provided favorable mussel habitat throughout its length, except for a 46-mile section (RM 62.7-108.7) which is adversely affected by mine waste. River bed substrate has been covered with fine sediment, eliminating mussel habitat in this reach.

Crayfish

The Big River basin contains eight species of crayfish (Table 10; Pflieger), including the belted crayfish (Orconectes harrisoni), which is found only in Missouri and almost exclusively in the St. Francois and Big River basins (one isolated Meramec River sample at the mouth of Big River).

With the exceptions of the golden crayfish (Orconectes luteus) and the devil crayfish (Cambarus diogenes), all species are found only in Ozark streams.

Aquatic Insects

The Big River basin benthos communities can be quite diverse (Ryck 1973; Kramer 1976; Duchrow 1976; MDC 1995d). Twelve orders, 55 families and 107 taxa of aquatic insects have been collected since 1976 (Appendix 8). Mayfly and stonefly nymphs were especially prevalent (Ryck 1973; Duchrow 1976), generally indicating good water quality. In places, benthos populations are seriously affected by lead and barite mine waste (Ryck 1973; Duchrow 1976; Kramer 1976). Duchrow (1976) found that invertebrates with exposed gills like dobsonfly (Nigronis serricornis) larvae may become extirpated if mine waste is present.

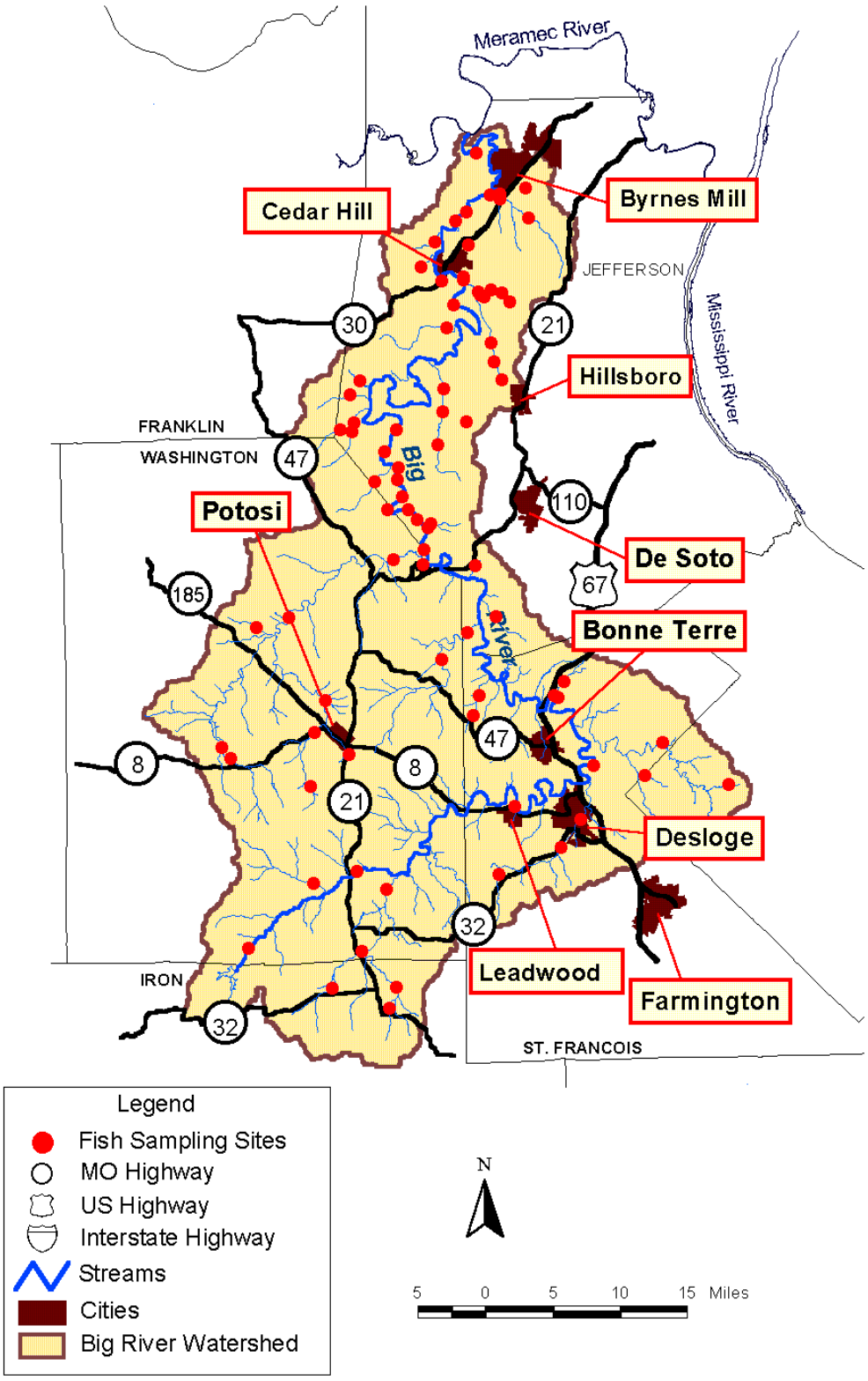

Figure fs. Fish samples within the Big River basin, Missouri.

Table 8. List of fish reported in Big River Basin, 1975-95.

SPECIES		A	B	C	D	E	F
Brook Lamprey	*Ichthyomyzon fossor*			X			X
Chestnut lamprey	*Ichthyomyzon castaneus*	X					
Longnose gar	*Lepisosteus osseus*	X	X			X	
Shortnose gar	*Lepisosteus platostomus*		X			X	
American eel	*Anguilla rostrata*	X		X		X	X
Gizzard shad	*Dorosoma cepedianum*	X	X			X	
Alabama shad	*Alosa alabamae*		X				
Mooneye	*Hiodon tergisus*	X					
Rainbow trout	*Oncorhynchus mykiss*	X					X
Grass pickerel	*Esox americanus*	X					X
Common carp	*Cyprinus carpio*	X	X	X	X	X	X
Grass carp	*Ctenopharyngodon idella*					X	
Golden shiner	*Notemigonus crysoleucas*	X	X				
Southern redbelly dace	*Phoxinus erythrogaster*	X	X				X
Southern redbelly dace x creek chub	*P. erythrogaster x S. atromaculatus*	X					
Bullhead minnow	*Pimephales vigilax*	X	X				
Bluntnose minnow	*P. notatus*	X	X				X
Fathead minnow	*P. promelas*	X	X				X
Hornyhead chub	*Nocomis biguttatus*	X	X				X
Hornyhead chub x striped shiner	*N. biguttatus x L chrysocephalus*	X					
Bigeye chub	*Notropis amblops*	X	X				X
Silver chub	*Macrhybopsis storeriana*		X				
Speckled chub	*M. aestivalis*		X				
Gravel chub	*Erimystax x-punctata*	X	X				X
Stoneroller spp.	*Campostoma spp.*		X	X			X
Central stoneroller	*Campostoma anomalum*	X					
Largescale stoneroller	*C. oligolepis*	X		X			X
Ozark minnow	*Notropis nubilus*	X	X				X
Suckermouth minnow	*Phenacobius mirabilis*	X	X				

SPECIES		A	B	C	D	E	F
Creek chub	*Semotilus atromaculatus*	X	X				X
Silverjaw minnow	*Notropis buccata*	X	X				X
Redfin shiner	*Lythrurus umbratilis*	X	X				X
Spotfin shiner	*Cyprinella spilopterus*	X	X				X
Steelcolor shiner	*Cyprinella whipplei*	X	X				X
Rosyface shiner	*Notropis rubellus*	X	X				X
Emerald shiner	*Notropis atherinoides*		X	X			X
Bleeding shiner	*Luxilus zonatus*	X	X	X			X
Striped shiner	*L. chrysocephalus*	X	X	X			X
Bigmouth shiner	*Notropis dorsalis*		X				
Sand shiner	*N. stramineus*	X	X				X
Bigeye shiner	*N. boops*	X	X	X			X
Wedgespot shiner	*N. greenei*	X	X				
Mimic shiner	*N. volucellus*	X	X				X
Smallmouth buffalo	*Ictiobus bubalus*	X	X				
Quillback	*Carpiodes cyprinus*	X	X	X		X	
Highfin carpsucker	*Carpiodes velifer*	X	X	X		X	
River carpsucker	*Carpiodes carpio*	X	X	X		X	
Northern hogsucker	*Hypentelium nigricans*	X	X	X	X	X	X
White sucker	*Catostomus commersoni*	X	X				X
Silver redhorse	*Moxostoma anisurum*	X				X	
Shorthead redhorse	*M. macrolepidotum*	X	X	X		X	
River redhorse	*M. carinatum*	X	X	X		X	
Black redhorse	*M. duquesnei*	X	X	X		X	X
Golden redhorse	*M. erythrurum*	X	X	X		X	X
Spotted sucker	*Minytrema melanops*	X					
Creek chubsucker	*Erimyzon oblongus*						X
Channel catfish	*Ictalurus punctatus*	X	X	X	X	X	
Flathead catfish	*Pylodictis olivaris*	X	X	X		X	
Yellow bullhead	*Ameiurus natalis*	X	X	X	X	X	X
Black bullhead	*Ameiurus melas*	X		X		X	X
Slender madtom	*Noturus exilis*	X	X				X

SPECIES		A	B	C	D	E	F
Stonecat	*N. flavus*	X	X				
Freckled madtom	*N. nocturnus*	X	X				X
Northern studfish	*Fundulus catenatus*	X	X				X
Blackspotted topminnow	*F. olivaceus*	X	X				X
Blackstripe topminnow	*F. notatus*	X		X			X
Mosquitofish	*Gambusia affinis*		X				X
Brook silverside	*Labidesthes sicculus*	X	X				X
Banded sculpin	*Cottus carolinae*	X	X				X
Ozark sculpin	*C. hypselurus*	X	X				X
Largemouth bass	*Micropterus salmoides*	X	X	X	X	X	X
Spotted bass	*M. punctulatus*		X			X	
Smallmouth bass	*M. dolomieui*	X	X	X	X	X	X
Warmouth	*Lepomis gulosus*					X	X
Green sunfish	*L. cyanellus*	X	X	X		X	X
Orangespotted sunfish	*L. humilis*	X	X		X	X	X
Longear sunfish	*L. megalotis*	X	X	X	X	X	X
Bluegill	*L. macrochirus*	X	X	X	X	X	X
Redear sunfish	*L. microlophus*				X	X	
Hybrid sunfish	*species undetermined*	X				X	X
Green sunfish x Bluegill	*L. cyanellus x L. macrochirus*	X					
Rock bass	*Ambloplites rupestris*	X	X	X	X	X	X
Black crappie	*Pomoxis nigromaculatus*		X				
White crappie	*P. annularis*	X	X			X	X
Walleye	*Stizostedion vitreum*	X	X			X	
Sauger	*S. canadense*	X	X				
Crystal darter	*Ammocrypta asprella*	X					
Western sand darter	*Ammocrypta clara*		X				
Logperch	*Percina caprodes*	X	X			X	X
Slenderhead darter	*P. phoxocephala*	X	X				
Gilt darter	*P. evides*	X	X				X

SPECIES		A	B	C	D	E	F
River darter	*P. shumardi*		X				
Johnny darter	*Etheostoma nigrum*	X	X				X
Greenside darter	*E. blennioides*	X	X				X
Missouri saddled darter	*E. tetrazonum*	X	X				X
Banded darter	*E. zonale*	X	X				X
Fantail darter	*E. flabellare*	X	X				X
Rainbow darter	*E. caeruleum*	X	X				X
Orangethroat darter	*E. spectabile*	X	X				X
Freshwater drum	*Aplodinotus grunniens*	X	X			X	
White sucker	*Catostomus commersoni*	X	X				X
Silver redhorse	*Moxostoma anisurum*	X				X	
Shorthead redhorse	*M. macrolepidotum*	X	X	X		X	
River redhorse	*M. carinatum*	X	X	X		X	
Black redhorse	*M. duquesnei*	X	X	X		X	X
Golden redhorse	*M. erythrurum*	X	X	X		X	X
Spotted sucker	*Minytrema melanops*	X					
Creek chubsucker	*Erimyzon oblongus*						X
Channel catfish	*Ictalurus punctatus*	X	X	X	X	X	
Flathead catfish	*Pylodictis olivaris*	X	X	X		X	
Yellow bullhead	*Ameiurus natalis*	X	X	X	X	X	X
Black bullhead	*Ameiurus melas*	X		X		X	X
Slender madtom	*Noturus exilis*	X	X				X
Stonecat	*N. flavus*	X	X				
Freckled madtom	*N. nocturnus*	X	X				X
Northern studfish	*Fundulus catenatus*	X	X				X
Blackspotted topminnow	*F. olivaceus*	X	X				X
Blackstripe topminnow	*F. notatus*	X		X			X
Mosquitofish	*Gambusia affinis*		X				X
Brook silverside	*Labidesthes sicculus*	X	X				X
Banded sculpin	*Cottus carolinae*	X	X				X

SPECIES		A	B	C	D	E	F
Ozark sculpin	*C. hypselurus*	X	X				X
Largemouth bass	*Micropterus salmoides*	X	X	X	X	X	X
Spotted bass	*M. punctulatus*		X			X	
Smallmouth bass	*M. dolomieui*	X	X	X	X	X	X
Warmouth	*Lepomis gulosus*					X	X
Green sunfish	*L. cyanellus*	X	X	X		X	X
Orangespotted sunfish	*L. humilis*	X	X		X	X	X
Longear sunfish	*L. megalotis*	X	X	X	X	X	X
Bluegill	*L. macrochirus*	X	X	X	X	X	X
Redear sunfish	*L. microlophus*				X	X	
Hybrid sunfish	*species undetermined*	X				X	X
Green sunfish x Bluegill	*L. cyanellus x L. macrochirus*	X					
Rock bass	*Ambloplites rupestris*	X	X	X	X	X	X
Black crappie	*Pomoxis nigromaculatus*		X				
White crappie	*P. annularis*	X	X			X	X
Walleye	*Stizostedion vitreum*	X	X			X	
Sauger	*S. canadense*	X	X				
Crystal darter	*Ammocrypta asprella*	X					
Western sand darter	*Ammocrypta clara*		X				
Logperch	*Percina caprodes*	X	X			X	X
Slenderhead darter	*P. phoxocephala*	X	X				
Gilt darter	*P. evides*	X	X				X
River darter	*P. shumardi*		X				
Johnny darter	*Etheostoma nigrum*	X	X				X
Greenside darter	*E. blennioides*	X	X				X
Missouri saddled darter	*E. tetrazonum*	X	X				X
Banded darter	*E. zonale*	X	X				X
Fantail darter	*E. flabellare*	X	X				X
Rainbow darter	*E. caeruleum*	X	X				X
Orangethroat darter	*E. spectabile*	X	X				X

SPECIES		A	B	C	D	E	F
Freshwater drum	*Aplodinotus grunniens*	X	X			X	

Collectors:

A) Pfleiger (1975)
B) Mills et al. (1978)
C) G. Kromrey, 1978-79,81, MDC, unpublished data
D) S. Alcorn, 1980, MDC, unpublished data
E)) K. Meneau, 1987-95, MDC, unpublished data
F) K. Meneau and A. Austin, et al., 1992-95, MDC, unpublished data

Outside range of distribution (as described by Plfeiger, 1975).

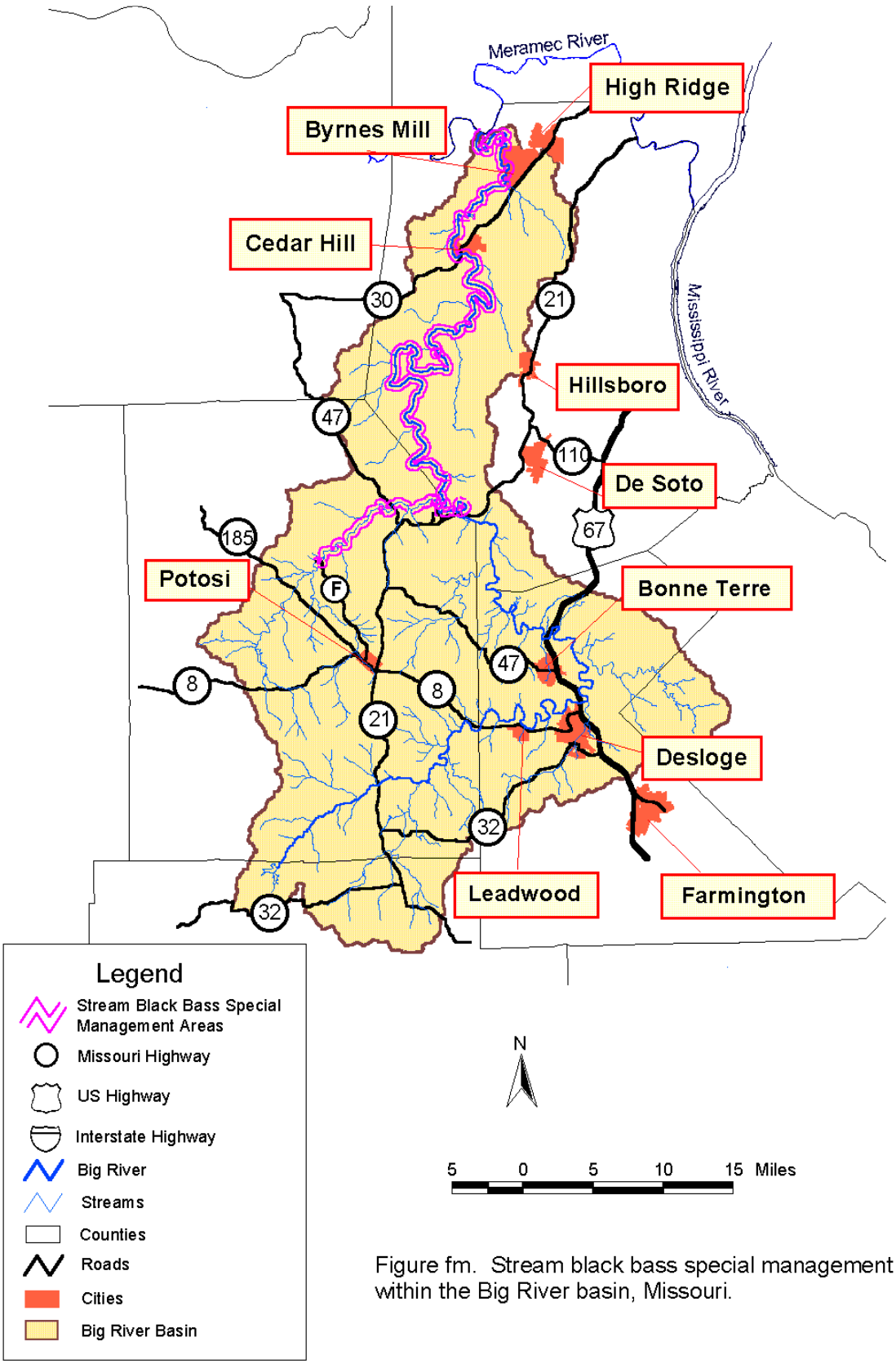

Figure fm. Stream black bass special management areas within the Big River basin, Missouri.

Figure sf. Big River SMBSMA smallmouth bass length frequency from electrofishing.

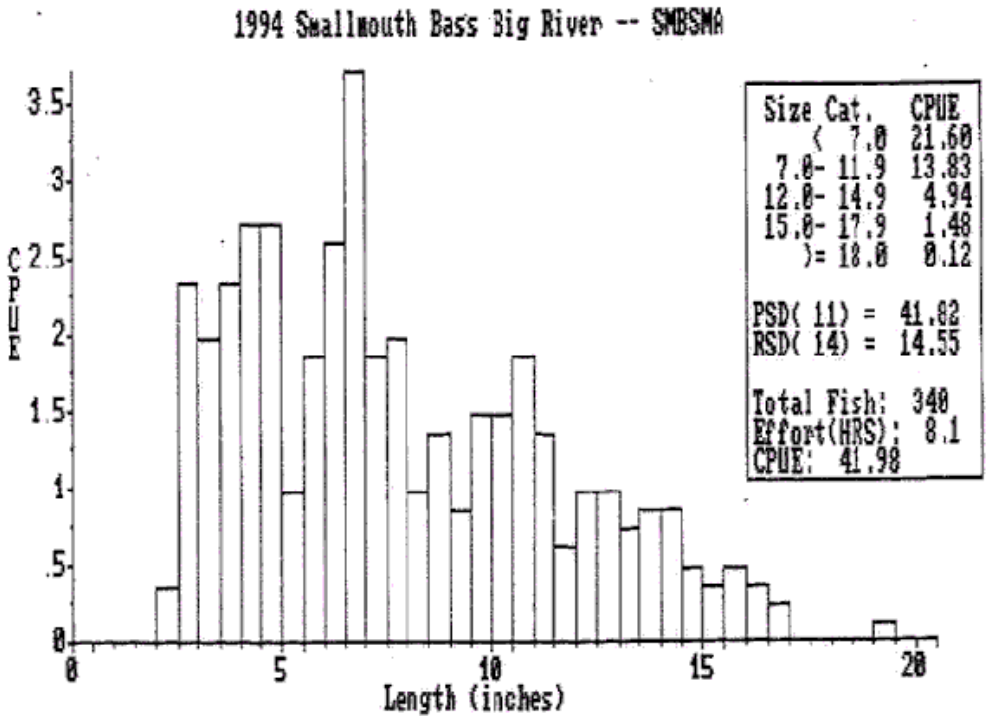

Figure rf. Big River SMBSMA rock bass length frequency from electrofishing.

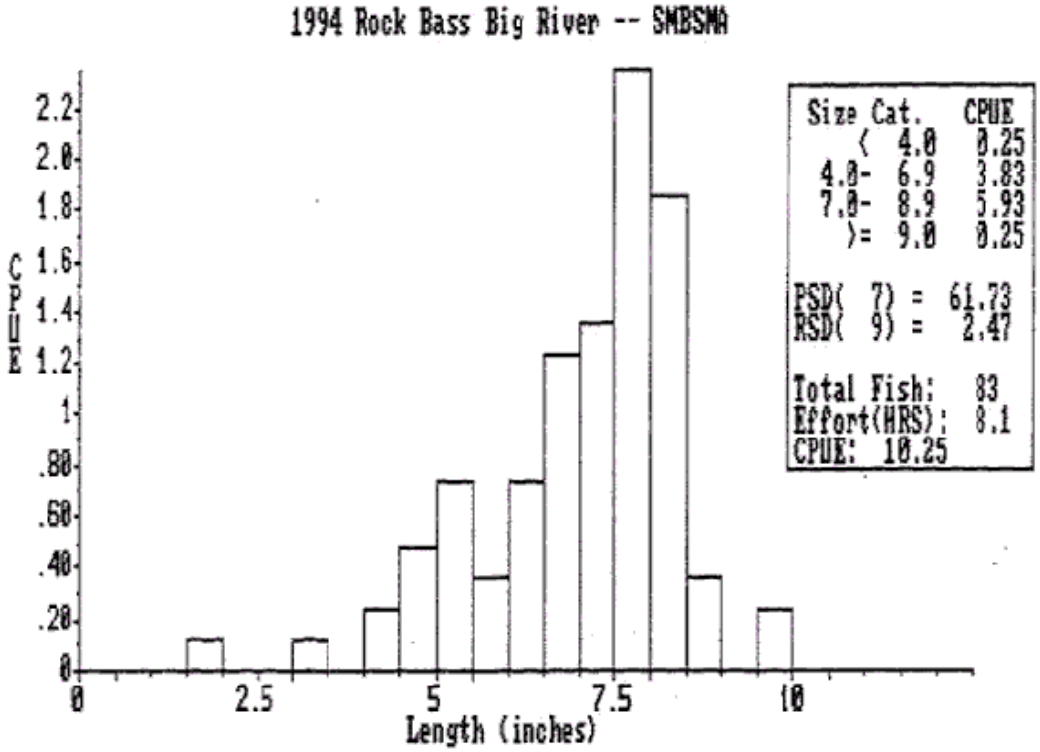

Table 9. Mussels found within the Big River Basin (Buchanan 1980, Ryckman et al. 1973)

Common Name	Scientific Name
Spectacle case	*Cumberlandia monodonta*
Paper floater	*Anodonta imbecilus*
Giant floater	*Anodonta grandis grandis*
Squaw foot	*Strophitus undulatus undulatus*
Elk toe	*Alasmidonta marginata*
Slipper shell	*Alasmidonta viridis*
White heel-splitter	*Lasmigona complanata*
Fluted shell	*Lasmigona costata*
Washboard	*Megalonaias nervosa*
Pistol-grip	*Tritigonia verrucosa*
Monkey-face	*Quadrula metanevra*
Pimple-back	*Quadrula pustulosa*
Three-ridge	*Amblema plicata*
Wabash pig-toe	*Fusconaia flava*
Round pig-toe	*Pleurobema sintoxia*
Lady-finger	*Elliptio dilatata*
Three-horned warty-back	*Obliquaria reflexa*
Mucket	*Actinonaias ligamentina carinata*
Ellipse	*Venustaconcha ellipsiformis ellipsiformis*
Butterfly	*Ellipsaria lineolata*
Deer-toe	*Truncilla truncata*
Fawn's foot	*Truncilla donaciformis*
Scale shell	*Leptodea leptodon*
Fragile paper shell	*Leptodea fragilis*
Pink heel-splitter	*Potamilis alatus*
Pink paper shell	*Potamilus ohioensis*
Liliput shell	*Toxolasma parvus*
Black sand shell	*Ligumia recta*
Slough sand shell	*Lampsilis teres teres*
Yellow sand shell	*Lampsilis teres anodontoides*
Fat mucket	*Lampsilis radiata luteola*

Common Name	Scientific Name
Pink mucket	*Lampsilis abrupta*
Pocketbook	*Lampsilis ventricosa*
Britt's mussel	*Lampsilis reeviana brittsi*

Table 10. Crayfish present in Big River basin (Pflieger 1996).

Common Name	Scientific Name
Freckled crayfish	*C. maculatus*
Belted crayfish	*Orconectes harrisoni*
Woodland crayfish	*O. hylas*
Golden crayfish	*O. luteus*
Spothanded crayfish	*O. punctimanus*
Northern crayfish	*O. virilis*
Saddledback Crayfish	*O. medius*
Devil crayfish	*Cambarus diogenes*

Appendix 9. Aquatic invertebrates of the Big River basin.

EPHEMEROPTERA (Mayflies)	
Baetiscidae	*Baetisca bajkovi*
Potamanthidae	*Potamanthus*
Polymitarcyidae	*Ephoron album*
Ephemeridae	*Ephemera*
	Ephemera guttulata
	Hexagenia limbata
	Ephemera simulans
Tricorythidae	*Tricorythodes*
Caenidae	*Caenis*
Ephemerellidae	*Ephemerella*
	Ephemerella invaria
	Ephemerella bicolor
	Ephemerella serrata
Heptageniidae	*Heptagenia*
	Heptagenia lucidipennis
	Heptagenia maculipennis
	Rhithrogena
	Stenonema pulchellum
	S. nepotellum
	S. ares
	S. bipunctatum
	S. tripunctatum
	S. interpunctatum
	S. integrum
	S. lutem
	Stenocron
Leptophlebiidae	*Choroterpes basalis*
	Leptophlebia
	Paraleptophlebia
	Paraleptophlebia praepedita
Oligoneuriidae	*Isonychia*
Siphonuridae	*Siphlonurus marshalli*
Baetidae	*Baetis amplus*
	Baetis
	Centroptilum
	Psuedocloeon

ODONATA (dragonflies and damsmselflies)	
Calopterygidae	*Hetaerina americana*
Coenagrionidae	*Argia*
Gomphidae	*Gomphus*
	Lanthus
	Progomphus

PLECOPTERA (stoneflies)	
Pteronarcyidae	*Pteronarcys*
	Pteronarcys dorsata
Nemouridae	*Brachyptera faciata*
	Leuctra
	Nemoura
	Patacapnia
	Taeniopteryx
	T. nivalis
	T. maura
Perlidae	*Acronueria*
	Agnetina capitata
	Neoperla clymeme
	Paragnetina
	Paraperla
	Perlesta
	Perlesta placida
	Perlinella
	Perlinella ehyre
Perlodidae	*Hydroperla crosbyi*
	H. natala

PLECOPTERA (stoneflies)	
	Isogenus
	Isoperla bilineata
	I. richardsoni
	I. clio
	I. duplicata
	I. marlynia
	I. mohri
Capniidae	*Allocapnia*

HEMIPTERA (true bugs)	
Corixidae	*Trichocorixa*
Veliidae	*Microvelia*
	Rhagovelia
Gerridae	*Gerris*

MEGALOPTERA (alderflies, dobsonflies)	
Sialidae	*Sialis*
Corydalidae	*Corydalus cornutus*
	Nigronia serricornis

LEPIDOPTERA (moths)	
Pyralidae	*Paragyractis*

TRICHOPTERA (caddisflies)	
Helicopsychidae	*Helicopsyche*
Hydropsychidae	*Cheumatopysche*
	Hydropsyche bifida
	H. cuanis
	H. betteni
Hydroptilidae	*Agraylea*
	Ithytrichia
	Ochrotrichia
	Oxyethira
Leptoceridae	*Athripsodes flavus*
	Oecetis

AMPHIPODA	
Gammaridae	*Gammarus*
Talitridae	*Hyalella azteca*

ISOPODA	
Asellidae	*Asellus*

COLEOPTERA (beetles)	
Elmidae	*Ancyronyx variegata*
	Dubiraphia
	Macronychus glabratus
	Optioservus ozarkensis
	Stenelmis
Curculionidae	*Onychylis*
Haliplidae	*Peltodytes*
Hydrophilidae	*Berosus*
Limnichidae	*Lutrochus laticeps*
Gyrinidae	*Dineutus*
Dytiscidae	*Hydroporus undulatus*
Psephenidae	*Ectopria nervosa*
	Psephenus herricki
Dryopidae	*Dryops*
	Helichus lithophilus

DIPTERA (true flies)	
Chironomidae	*Chironomus*
Simuliidae	*Simulium*
Empididae	
Stratiomyiidae	
Muscidae	
Chaoboridae	
Dolichopodidae	
Dixidae	*Dixa*
Tipulidae	*Antocha*
	Eriocera
	Tipula
Tabanidae	*Chysops*
Rhagionidae	*Atherix variegata*
Ceratopogonidae	*Bezzia*
	Forcipomyia
	Pericoma

Management Problems and Opportunities

Goal I: Maintain or improve the water quality of the Big River basin.

Status: Currently, basin water quality is good in most streams. Most basin streams support diverse aquatic communities and are designated for recreation and irrigation. However, localized problems do exist; and water quality of many basin streams is at serious risk from a number of threats related to past mining.

Failure of poorly-constructed mine waste dams and erosion of unstable mine waste could damage water quality in many streams. Water quality in some streams was severely altered during past mine waste releases, which induced fishkills and extirpation of some benthic invertebrates.

Twenty-seven mine dams have been rated as high-hazard, unsafe, and in jeopardy of failing during a large flood or earthquake. Elevated lead levels in fish flesh have necessitated a fish consumption advisory on Big River.

Increasing urbanization of the watershed could negatively impact water quality in the lower basin. Inadequate sewage treatment could pollute surface water and reduce numbers of aquatic animals. Increased stormwater runoff would destabilize stream channels and increase soil erosion. Water quality throughout the basin is somewhat impacted by cattle grazing and other farming activities in riparian corridors.

Objective 1.1: Reduce or eliminate the threat of mine waste contamination of Big River basin streams.

- Encourage Federal agencies to help stabilize mine dams and stabilize or remove mine waste from basin floodplains.
- Provide USEPA and MDNR with comments on basin remediation plans and recommendations to protect or improve aquatic biodiversity and habitat.
- Encourage MDNR to implement best reclamation techniques for tailings dams, ponds, and piles.
- Inform STREAM TEAMs (Big and Meramec rivers) and the general public of the mine waste threat, encourage them to ask elected officials for action, and support their efforts, when possible.
- Continue to help the Missouri Department of Health in monitoring fish contaminant levels and publicizing fish consumption advisories.

Objective 1.2: Ensure that basin streams meet state water quality standards.

- Work with DNR and USCOE to review 404 and other permits, assist with the enforcement of existing water quality laws, and recommend measures to protect aquatic communities.
- Encourage soil and water conservation districts to include fencing, cattle watering pumps, and pond construction in cost-share programs.
- Oppose the establishment of landfills in areas that may contaminate basin streams.
- Continue to assist the Missouri Department of Health in monitoring fish contaminant levels.
- Work with county authorities to discourage unwise floodplain development.
- Encourage basin STREAM TEAMs to become certified as water quality monitors and to report illegal trash dumping to the proper authorities.
- Encourage and assist STREAM TEAMs and Operation Clean Stream in removing trash from all major basin streams.
- Work with basin STREAM TEAMs to develop an education program to help reduce amount of trash entering basin streams.
- Educate public about basin water quality problems, create a list of public agency contacts

responsible for protecting basin streams, and encourage the public to contact agencies for action on environmental problems within the basin.

Objective 1.3 Reduce negative effects of urbanization.

- Present workshops for land developers and local government agencies on the benefits of stormwater retention and stream greenways.
- Develop and advertise incentive packages and recognition programs for land developers that includes technical assistance and stream greenway, tree, and retention basin incentives.
- Encourage county authorities to establish adequate stormwater retention guidelines for residential and commercial developments.
- Encourage counties to purchase and remove flood-prone dwellings, from willing sellers, and convert properties into greenspace.

Goal II: Maintain or improve riparian and aquatic habitats of the Big River Basin

Status: Most sections of larger basin streams have good aquatic and riparian habitat. However, habitat in many basin streams are at serious risk from a number of threats related to past mining. Failure of poorly constructed mine waste dams and unstable mine waste could seriously damage habitats in several basin streams. On some stream reaches, chronic and acute contamination from mine waste has greatly altered habitat, increased sedimentation, and reduced benthic populations. Streambank erosion causes some habitat degradation, especially in tributary streams where land use encroaches upon the riparian corridor. Cattle grazing and hay and row crop production negatively affect riparian corridors. Increasing urbanization of lower basin streams reduces corridor width. Instream gravel dredging has caused instability in some streams.

Objective 2.1: Reduce stream channel instability, soil erosion, and sedimentation as well as maintain and improve riparian corridors.

- Encourage Federal agencies to help stabilize mine dams and stabilize or remove mine waste from basin floodplains.
- Encourage MDNR to implement best reclamation techniques for tailings dams, ponds, and piles.
- Provide technical assistance and recommendations about streams to all landowners, public agencies, and private contractors that request it.
- Establish a Stream Landowner Management Area (SLMA) within the Big River basin and design special voluntary management strategies and volunteer landowner incentive packages for stream frontage landowners.
- Obtain Jefferson County's permission to allow installation of tree revetments and other streambank erosion control techniques without expensive engineering studies.
- Oppose construction of dams on any basin stream that would threaten sensitive aquatic species or significant aquatic habitat.
- Work with DNR and USCOE to review 404 and other permits, assist with the enforcement of existing water quality laws, and recommend measures to protect aquatic communities.
- Contact, in-person when possible, all Big River SMBSMA landowners with inadequate riparian corridors and offer voluntary incentive packages.
- Present workshops to educate land developers and local government officials about stream dynamics and the importance of healthy riparian corridors.
- Encourage county authorities to establish adequate stormwater retention for residential and commercial developments.
- Encourage soil and water conservation districts to include fencing, corridor tree planting, cattle watering pumps, and pond construction in cost-share programs.

- Develop and advertise incentive packages and recognition program for land developers that includes technical assistance and stream greenway, tree, and retention basin incentives.
- Work with county authorities to discourage unwise floodplain development.
- Encourage counties to purchase and remove flood-prone dwellings, from willing sellers, and convert properties into greenspace.
- Inform STREAM TEAMs (Big and Meramec rivers) and the general public of lead mine waste and gravel dredging threats and encourage them to ask elected officials for action.
- Identify high priority stream areas for personal contacts to offer MDC assistance to landowners.
- Where possible, ensure all MDC areas have >100-foot riparian corridors and assist other government agencies in establishing >100-foot riparian corridors on their lands.
- Prioritize Big River sub-basins for voluntarily, targeted riparian landowners' incentive efforts which go beyond providing only technical assistance.
- Monitor corridor width along representative streams every 5 years.
- Establish at least one Stream Demonstration Area/county within the Big River basin.
- Enlist STREAM TEAMs to help plant riparian trees on private property.
- Investigate the possibility to provide sapling-size trees to city and county agencies wishing to improve riparian corridors and enlist STREAM TEAMs to aid in planting.

Goal III: Maintain aquatic biodiversity in the Big River basin.

Status: Aquatic biological diversity within most of the Big River basin is relatively stable and typical of the Ozark Faunal Region. The basin contains several sensitive species that may need additional protection. Mine wastes negatively affect aquatic habitat and animals and threaten human health. Diversity of lower Big River and its Jefferson County tributaries may be depressed and will be challenged by increasing urbanization. Non-indigenous spotted bass continue to thrive in Big River and compete with indigenous fishes in lower Big River.

Objective 3.1: Monitor and assess aquatic populations and communities for biodiversity.

- Sample representative sections of Big and Flat rivers, Mineral Fork, and Belew Creek, every 5 years, to monitor fish species diversity.
- Periodically monitor mussel populations, especially rare and endangered species, in basin streams.
- Determine status of belted crayfish populations and take steps to protect them, if necessary.
- Enlist help of STREAM TEAMs in aquatic invertebrate sampling and identification.
- Continue to monitor reaction of black bass populations to special regulations.

Objective 3.2: Improve aquatic habitat to maintain or improve aquatic biodiversity.

- Develop and implement voluntary programs for riparian landowners and developers, volunteer groups, and governmental agencies that aid in rehabilitation or improvement of land uses that affect stream habitat.
- Work with DNR and USCOE to review 404 and other permits, assist with the enforcement of existing water quality laws, and recommend measures to protect aquatic communities.
- Monitor representative sections of Big and Flat rivers, Mineral Fork, and Belew Creek, every 5 years, for changes in habitat quality.
- Encourage soil and water conservation districts to include fencing, cattle watering pumps, and pond construction in cost share programs.
- Oppose the establishment of landfills in areas that may contaminate basin streams.
- Inform the public of mine waste, gravel dredging, and other threats to basin streams and encourage them to ask elected officials for action.
- Oppose construction of dams on any basin stream that would threaten sensitive aquatic species or

significant aquatic habitat.

Goal IV: Improve recreational opportunities on Big River basin streams.

Status: Fishing access in the Big River basin is fair. However, boat launch facilities are poor at some existing accesses. Bank/wade fishing frontage is limited. Fish consumption advisories limit some anglers' enjoyment. Angler acceptance of special smallmouth bass regulations has been good; some anglers are calling for their expansion.

Objective 4.1: Improve access to basin streams.

- Assist in improving boating access at MDC's Cedar Hill, House Springs, and Morse Mill accesses.
- Assist in relocating and/or improving an MDC access in the Blackwell area (Jefferson-St. Francois counties).
- Encourage MDNR to improve boat/canoe and angler access on Big River at St. Francois and Washington State Parks.
- Work with local governments to purchase flood-prone property, from willing sellers, and establish greenways.
- Investigate the possibility of creating greenways along portions of basin streams.
- Investigate the possibility of increasing bank/wade fishing opportunities along the Mineral Fork, Fourche a Renault, Mine a Breton, Mill Creek, Terre Bleue Creek, Clear Creek, Cedar Creek, and Big River, in addition to those outlined in the Stream Areas Program Strategic Plan.

Objective 4.2: Improve or maintain sportfish populations.

- Monitor results of special black bass regulations on Big River through creel and electrofishing surveys.
- Increase the harvest of Big River spotted bass through angler education.
- Assist in rehabilitation or improvement of land uses that limit sportfish habitat.
- Assist in monitoring contaminant levels of Big River fish.
- Assess status of flathead catfish population in Big River.
- Assess status of channel catfish population in Big River after current catfish research determines effective sampling techniques.

Goal V: Increase public awareness and appreciation of Big River basin streams.

Status: The Big River basin is a very valuable recreational resource. People use basin streams for fishing, boating, canoeing, swimming, and a variety of other activities. Basin streams contain high-quality aquatic communities that include populations of several sensitive species. Some basin streams are threatened by the remains of past mining activity or unwise land development. Habitat in all basin streams has suffered somewhat from unwise riparian corridor use. Despite its close proximity to St. Louis, the Big River basin is often unknown or not appreciated by those living outside the basin. Misunderstanding of lead problems has probably tainted some Missourians' views of the basin's value.

Objective 5.1: Inform the public about the types, amounts and quality of recreation available on Big River and tributary streams.

- Prepare and distribute a "Big River Basin Floater's Guide" brochure describing access, fishing opportunities, canoe liveries, and other recreational opportunities on major basin streams.
- Work with MDC interpretive staff to develop a Big River basin display, that includes

representative flora and fauna, recreational opportunities available, basin lead problems, and visual presentations. This temporary display could be used at nature centers, zoos, etc. within the basin.

- Ensure annual reprinting of the "Fish St. Louis" brochure, which includes information on Big River.
- Develop a tri-fold, velcro-board display featuring recreational opportunities on major basin streams and encourage MDC employees to use it.
- Encourage and assist MDNR personnel at Washington and St. Francois State Parks in dissemination of fishing information to anglers.
- Continue to supply bait shops and canoe liveries with Big River fishing information.
- Promote Big River fisheries in the media and MDC's annual FishingProspects.
- Inform MDNR personnel at Washington and St. Francois State Parks of Big River basin displays and make them available for loan.
- Encourage Public Affairs Division to film an SMBSMA video, featuring Big River, for the "Missouri Outdoors" television series.
- Encourage St. Louis area media to join MDC on river surveys and organize a media float trip/educational event on Big River.
- Emphasize Big River in St. Louis County's "Gone Fishin'" series' Ozark Float Fishing program and in MDC's "Fishing Opportunities Within an Hour of the Arch" presentations.
- Encourage St. Louis County to add a "Fishing the Big River Basin" slide presentation to their "Gone Fishin'" series.
- Encourage St. Louis County to add a catfish fishing seminar geared to Ozark streams to their "Gone Fishin'" series.

Objective 5.2: Educate the public on the value of healthy stream ecosystems and encourage advocacy on behalf of basin streams.

- Promote the establishment of a Big River Basin STREAM TEAM Association by holding an organizational workshop and periodic association meetings, as needed.
- Establish an annual Big River Days educational event for basin's school children.
- Encourage formation of additional STREAM TEAMs within the basin.
- Encourage and assist in expansion of Operation Clean Stream to major basin tributaries.
- Provide basin canoe liveries with MDC litter bags and other stream conservation information.
- Mail riparian landowners informational letters offering stream management services, followed by a telephone survey to obtain additional data on landowners' level of interest.
- Construct Stream Demonstration Area and Streams For The Future posters for Big River basin and distribute to farm supply stores, rural hardware stores, county and state agency offices.

Objective 5.3: Provide stream-oriented activities.

- Investigate the possibility of a festival on Big River, similar to Day on the River, that includes outdoor skills, food, and natural resource interpretation.
- Develop a cooperative program, sponsored by STREAM TEAMs, canoe liveries, and public agencies, to sponsor "first-time" canoe trips on Big River for urban families and other groups.
- Assist Operation Clean Stream in removing trash and encourage its expansion to major basin streams.
- Encourage St. Louis County's "Gone Fishin" program to conduct an annual float fishing trip on Big River.
- Involve public, especially STREAM TEAMs, in tree planting projects.

Angler Guide

Fishing in the Big River basin is primarily limited to Big River and sections of the Mineral Fork, Fourche a Renault, Terre Bleue, Cedar, Clear, and Mill creeks and numerous private ponds and lakes. Although the lower portion of Big River is accessed by propeller- and jet-powered boats, anglers are mostly limited to fishing from the bank, wading, or canoeing.

All three species of black bass (largemouth, smallmouth, and spotted) can be caught in Big River. Though smallmouth continue to be the dominant black bass in Big River, spotted (Kentucky) bass continue to increase their numbers and range. The largemouth bass population has remained stable. Big River is home to a newly-expanded Stream Black Bass Special Management Area from the Hwy. 21 bridge (near Washington State Park) on Big River and the Hwy. F bridge (Washington County) on the Mineral Fork, to the Meramec River confluence.

Special fishing regulations apply:

- **Black Bass Daily Limit:** six (6), only one (1) can be a smallmouth bass.
- **Black Bass Length Limit:** Largemouth bass = 12" Spotted bass = no length limit Smallmouth bass = 15"

Smallmouth bass angling continues to be very good to excellent. Fisheries surveys annually find good numbers of 12- to 15-inch smallies, with fish up to 20"+. Anglers will find their best chances of catching more smallmouth bass in June, while a high percentage of large fish (17"+) are caught in April and September/October. Many of the larger smallmouth bass are caught near large woody cover or rock if they are in some current with at least 3 feet of water depth. Favorite baits include, jig N' pig, jig N' craw, buzzbaits, and small crayfish and minnow imitators.

Spotted bass angling quality continues to change as they become more established in Big River. Prior to 1989, spots were relatively uncommon. Since then, they have become the dominant black bass in the lower 25 miles of Big River. Though most spotted bass are less than 11", some over 15" have been observed. Spotted bass prefer habitats and foods similar to smallmouth bass. However, they usually do not like swifter water. So, look for spotted bass around rocks with some depth and a little current. Anglers using live minnows or crayfish, or imitators of either should do well.

The largemouth bass population has always been low density, but high quality. Largemouths up to 20" are routinely surveyed and anglers have caught fish up to 24". Big River's ample supply of downed logs, out of the current, supply largemouths with great habitat. Buzz baits, spinner baits, and jig N' pig are good baits to use.

Rock bass (goggle-eye) fishing can vary between fair and good, depending upon water conditions. High water in spring, usually means poor fishing. But, stable water conditions can yield some good rock bass fishing, with fish up to 10". Fish near root wads or rock slides with minnows, crayfish, or small jigs for best success.

Longear sunfish and bluegill fishing is normally very good. High numbers of these colorful fish can mean fast action for everyone, even beginners. Look for root wads, brush, and weed edges and use live worms or crickets, small jigs, or spinners for fast action.

Channel catfish and flathead catfish are mostly confined to Big River. The large supply of logs, root wads, and downed trees provide very good habitat. Channel cat fishing can be good using worms or dough bait. While, flatheads prefer live fish, like sunfish. Limb lining is a popular technique. Please remember to label your lines.

Six species of redhorse suckers are relatively common in the larger basin streams, which makes spring fishing and fall/winter gigging good. Look for fast water to find suckers. Anglers can use worms or Asiatic clams fished on the bottom. Giggers usually find the clear water they need above RM 46 on Big River.

Glossary

Alluvial soil: Soil deposits resulting directly or indirectly from the sediment transport of streams, deposited in river beds, flood plains, and lakes.

Aquifer: An underground layer of porous, water-bearing rock, gravel, or sand.

Benthic: Bottom-dwelling; describes organisms which reside in or on any substrate.

Benthic macroinvertebrate: Bottom-dwelling (benthic) animals without backbones (invertebrate) that are visible with the naked eye (macro).

Biota: The animal and plant life of a region.

Biocriteria monitoring: The use of organisms to assess or monitor environmental conditions.

Channelization: The mechanical alteration of a stream which includes straightening or dredging of the existing channel, or creating a new channel to which the stream is diverted.

Concentrated animal feeding operation (CAFO): Large livestock (ie. cattle, chickens, turkeys, or hogs) production facilities that are considered a point source pollution, larger operations are regulated by the MDNR. Most CAFOs confine animals in large enclosed buildings, or feedlots and store liquid waste in closed lagoons or pits, or store dry manure in sheds. In many cases manure, both wet and dry, is broadcast overland.

Confining rock layer: A geologic layer through which water cannot easily move.

Chert: Hard sedimentary rock composed of microcrystalline quartz, usually light in color, common in the Springfield Plateau in gravel deposits. Resistance to chemical decay enables it to survive rough treatment from streams and other erosive forces.

Cubic feet per second (cfs): A measure of the amount of water (cubic feet) traveling past a known point for a given amount of time (one second), used to determine discharge.

Discharge: Volume of water flowing in a given stream at a given place and within a given period of time, usually expressed as cubic feet per second.

Disjunct: Separated or disjoined populations of organisms. Populations are said to be disjunct when they are geographically isolated from their main range.

Dissolved oxygen: The concentration of oxygen dissolved in water, expressed in milligrams per liter or as percent.

Dolomite: A magnesium rich, carbonate, sedimentary rock consisting mainly (more than 50% by weight) of the mineral dolomite($CaMg(CO_3)_2$).

Endangered: In danger of becoming extinct.

Endemic: Found only in, or limited to, a particular geographic region or locality.

Environmental Protection Agency (EPA): A Federal organization, housed under the Executive branch, charged with protecting human health and safeguarding the natural environment — air, water, and land — upon which life depends.

Epilimnion: The upper layer of water in a lake that is characterized by a temperature gradient of less than 1° Celsius per meter of depth.

Eutrophication: The nutrient (nitrogen and phosphorus) enrichment of an aquatic ecosystem that promotes biological productivity.

Extirpated: Exterminated on a local basis, political or geographic portion of the range.

Faunal: The animals of a specified region or time.

Fecal coliform: A type of bacterium occurring in the guts of mammals. The degree of its presence in a lake or stream is used as an index of contamination from human or livestock waste.

Flow duration curve: A graphic representation of the number of times given quantities of flow are

equaled or exceeded during a certain period of record.

Fragipans: A natural subsurface soil horizon seemingly cemented when dry, but when moist showing moderate to weak brittleness, usually low in organic matter, and very slow to permeate water.

Gage stations: The site on a stream or lake where hydrologic data is collected.

Gradient plots: A graph representing the gradient of a specified reach of stream. Elevation is represented on the Y-axis and length of channel is represented on the X- axis.

Hydropeaking: Rapid and frequent fluctuations in flow resulting from power generation by a hydroelectric dam's need to meet peak electrical demands.

Hydrologic unit (HUC): A subdivision of watersheds, generally 40,000-50,000 acres or less, created by the USGS. Hydrologic units do not represent true subwatersheds.

Hypolimnion: The region of a body of water that extends from the thermocline to the bottom and is essentially removed from major surface influences during periods of thermal stratification.

Incised: Deep, well defined channel with narrow width to depth ration, and limited or no lateral movement. Often newly formed, and as a result of rapid down-cutting in the substrate

Intermittent stream: One that has intervals of flow interspersed with intervals of no flow. A stream that ceases to flow for a time.

Karst topography: An area of limestone formations marked by sinkholes, caves, springs, and underground streams.

Loess: Loamy soils deposited by wind, often quite erodible.

Low flow: The lowest discharge recorded over a specified period of time.

Missouri Department of Conservation (MDC): Missouri agency charged with: protecting and managing the fish, forest, and wildlife resources of the state; serving the public and facilitating their participation in resource management activities; and providing opportunity for all citizens to use, enjoy, and learn about fish, forest, and wildlife resources.

Missouri Department of Natural Resources (MDNR): Missouri agency charged with preserving and protecting the state's natural, cultural, and energy resources and inspiring their enjoyment and responsible use for present and future generations.

Mean monthly flow: Arithmetic mean of the individual daily mean discharge of a stream for the given month.

Mean sea level (MSL): A measure of the surface of the Earth, usually represented in feet above mean sea level. MSL for conservation pool at Pomme de Terre Lake is 839 ft. MSL and Truman Lake conservation pool is 706 ft. MSL.

Necktonic: Organisms that live in the open water areas (mid and upper) of waterbodies and streams.

Non-point source: Source of pollution in which wastes are not released at a specific, identifiable point, but from numerous points that are spread out and difficult to identify and control, as compared to point sources.

National Pollution Discharge Elimination System (NPDES): Permits required under The Federal Clean Water Act authorizing point source discharges into waters of the United States in an effort to protect public health and the nation's waters.

Nutrification: Increased inputs, viewed as a pollutant, such as phosphorous or nitrogen, that fuel abnormally high organic growth in aquatic systems.

Optimal flow: Flow regime designed to maximize fishery potential.

Perennial streams: Streams fed continuously by a shallow water table an flowing year-round.

pH : Numeric value that describes the intensity of the acid or basic (alkaline) conditions of a solution. The pH scale is from 0 to 14, with the neutral point at 7.0. Values lower than 7 indicate the presence of acids and greater than 7.0 the presence of alkalis (bases).

Point source: Source of pollution that involves discharge of wastes from an identifiable point, such as a smokestack or sewage treatment plant.

Recurrence interval: The inverse probability that a certain flow will occur. It represents a mean time interval based on the distribution of flows over a period of record. A 2-year recurrence interval means that the flow event is expected, on average, once every two years.

Residuum: Unconsolidated and partially weathered mineral materials accumulated by disintegration of consolidated rock in place.

Riparian: Pertaining to, situated, or dwelling on the margin of a river or other body of water.

Riparian corridor: The parcel of land that includes the channel and an adjoining strip of the floodplain, generally considered to be 100 feet on each side of the channel.

7-day $Q^{10:}$: Lowest 7-day flow that occurs an average of every ten years.

7-day Q^{2}: Lowest 7-day flow that occurs an average of every two years.

Solum: The upper and most weathered portion of the soil profile.

Special Area Land Treatment project (SALT): Small, state funded watershed programs overseen by MDNR and administered by local Soil and Water Conservation Districts. Salt projects are implemented in an attempt to slow or stop soil erosion.

Stream Habitat Annotation Device (SHAD): Qualitative method of describing stream corridor and instream habitat using a set of selected parameters and descriptors.

Stream gradient: The change of a stream in vertical elevation per unit of horizontal distance.

Stream order: A hierarchical ordering of streams based on the degree of branching. A first order stream is an unbranched or unforked stream. Two first order streams flow together to make a second order stream; two second order streams combine to make a third order stream. Stream order is often determined from 7.5 minute topographic maps.

Substrate: The mineral and/or organic material forming the bottom of a waterway or waterbody.

Thermocline: The plane or surface of maximum rate of decrease of temperature with respect to depth in a waterbody.

Threatened: A species likely to become endangered within the foreseeable future if certain conditions continue to deteriorate.

United States Army Corps of Engineers (USCOE) and now (USACE): Federal agency under control of the Army, responsible for certain regulation of water courses, some dams, wetlands, and flood control projects.

United States Geological Survey (USGS): Federal agency charged with providing reliable information to: describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect the quality of life.

Watershed: The total land area that water runs over or under when draining to a stream, river, pond, or lake.

Waste water treatment facility (WWTF): Facilities that store and process municipal sewage, before release. These facilities are under the regulation of the Missouri Department of Natural Resources.

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