

GEOLOGY

Physiography

The basin lies entirely within the Salem Plateau section of the Ozark Plateau, a portion of the larger Interior Highlands physiographic province. The Salem Plateau is a dissected plateau largely on Cambrian and Ordovician carbonate rocks with streams dissecting it in varying degrees. Along the drainage divides, the plateau has been best preserved as a rolling upland surface with a local relief of 100-200 feet. Karst features such as sinkholes, springs, and caves are locally prominent within the Salem Plateau (MDNR 1986).

The basin includes portions of four of Missouri's natural divisions (listed in descending order based on estimated basin percentages): Ozark division (85%), Ozark Border division (11%), Osage Plains division (3%), and Big River division (1%) (Figure 4) (Thom and Wilson 1980).

Geology

The majority of the basin's surface is covered in dolomites and sandstones of Ordovician and Cambrian age (Figure 5). The basin boundaries lie in Jefferson City-Cotter dolomite and the streams incise progressively older Roubidoux and Gasconade formations. Eminence dolomite is exposed in the Osage River valley near the Morgan-Camden county line. The Osage River and all of its major tributaries incise the Gasconade Formation. There are a few scattered exposures of Eminence dolomite along the Osage River and Tavern Creek in Miller County.

The geology of the basin creates conditions for a considerable amount of subsurface water movement. This subsurface water movement coupled with the presence of carbonate bedrock from the Paleozoic period provides an ideal environment for the development of karst topography. Caves, underground streams, and sinkholes are relatively abundant within the basin.

Dry Auglaize and Wet Glaize subbasins have unique geological and hydrological attributes. Both subbasins are underlain by numerous large faults, allowing a considerable amount of surface water to move underground within each subbasin as well as to adjacent subbasins. A good portion of the water in the Dry Auglaize Subbasin flows underground in a northwesterly direction crossing the subbasin divide to emerge in springs of the Niangua River Subbasin along the Niangua River or the Niangua Arm of Lake of the Ozarks. The Dry Auglaize Subbasin has no notable springs, while the Wet Glaize Subbasin has six. Four of these have discharges greater than 2 cubic feet per second (cfs). Four of the six, including the three largest, emerge from the Gasconade Formation (MDNR 1995).

Soil Types

Soils of the basin vary widely in character (Figure 6). Some soils are infertile stony-clay type soils, while

others are fertile loess-capped types. Some soils are stone-free, while others may have a stone content exceeding 50 percent, and other areas may have no soil, exhibiting only exposed bedrock (STATSGO 1998).

The majority of the basin is dominated by stony, cherty soils found on steep slopes while soils of lower stone content are found on more level areas. Soils formed in the residuum from cherty limestone or dolomite, range from deep to shallow and contain a high percentage of chert in most places. Soils formed in a thin mantle of loess are found on the ridges and have fragipans, which restrict root penetration. Soils formed in loamy, sandy, and cherty alluvium are found in narrow bottomland areas, and are the most fertile soils in the basin (Allgood and Persinger 1979).

Soils in the basin are generally acidic and of moderate-to-low fertility. Productivity of the soils in the basin varies widely, with forest and grassland being the dominant land cover. A typical landscape of this basin consists of broad forested areas on moderately steep to very steep slopes and small pastures and cultivated fields on smoother ridge tops and valleys. The moisture holding capacity of most soil in the basin is limited, making many areas unsuitable for crop production.

Overall, erosion rates in the basin are relatively low as compared to those in the West Osage River Basin. The majority of the basin has annual erosion rates between 0-100 tons of sediment/mi.². Higher erosion rates (100-300 tons/year/mi.²) may occur along the southeastern and western borders of the basin (USDA-SCS 1970). Heavy spring rains of three to eight inches, corresponding with poor land cover conditions, have the potential to cause severe erosion problems on sloping lands. Most erosion damage occurs in the form of sheet and rill erosion. Locally intensive land use practices may contribute to higher erosion rates. New housing developments, road construction, and overgrazing by livestock, may denude land causing increased erosion and sediment pollution (USDA-SCS 1970).

Stream channel erosion downstream of Bagnell Dam has been significant and has led to a number of studies. Erosion is greater near Bagnell Dam and decreases downstream (Belt 1983). UEC (1983) concluded that since Bagnell Dam was closed, the Osage River has caused approximately 10 acres of erosion per year and the average width of the Osage River channel has increased approximately 1 foot per year. Bank recession is occurring in varying degrees all along the Osage River below Bagnell Dam. The instream islands are also subject to erosive processes.

Below Bagnell Dam, the Osage River channel has experienced an increase in cross-sectional area caused by degradation, channel widening and base level lowering (Germanoski and Ritter 1988). Degradation appears to be the most important cause of tributary incision. Since the closure of Bagnell Dam in 1931, tributary streams have incised an average of 2.2 m and widened approximately 1.2 m at their mouths (Germanoski and Ritter 1988). Bank failure along the Osage River channel has occurred by two main processes, block gliding and slab failure. Block gliding is a slip process which involves large volumes of material moving on a planar surface as a single discrete block during periods of instability. Along the lower Osage River, sliding of this type involves portions of banks exceeding 5 feet in thickness and 20 feet in length. Block gliding results when high flows are followed by rapid drops of river stage to a level below the intermediate zone of the bank stratigraphy, and maintenance of that river level for several days. Slab failure is produced by lateral cutting at the surface of the Osage River into the bank materials. This incision engenders an overhanging slab which eventually falls when the overlying mass can no longer be supported. Slab failure is also significant because it is responsible for removal of the tree growth along the Osage River (Ritter 1983).

Stream Order and Gradient

Fourth order and larger streams and their respective subbasins are listed in Table 2.

Subbasin Descriptions

Lower Osage River Subbasin (HUC 10290111060)

This subbasin is located in eastern Cole, and extreme northeastern Miller counties. Major streams of this subbasin include the Osage River, Brule Creek, Profits Creek, and Sugar Creek. This subbasin contains portions of the Upper Ozarks, Missouri River, and Lower Missouri River physiographic regions. The Lower Osage River Subbasin covers the region from the Osage River/Tavern Creek confluence downstream to the Osage River/Missouri River confluence. The HUC drains 218 sq. mi².

Lower Maries River Subbasin (HUC 10290111050)

This subbasin is located in east central Osage County with a small portion of the headwaters located in northeastern Maries County. Major streams of the Lower Maries River Subbasin include the Maries River, Loose Creek, Little Maries Creek, Bear Creek, Brush Creek, Indian Creek, and a few unnamed creeks. The entire subbasin is located in the Missouri River physiographic section. The Lower Maries Subbasin originates 0.4 miles above the confluence of the Little Maries and Maries Rivers. The Maries River empties into the Osage River approximately 10 miles above the Osage River's confluence with the Missouri River. The Lower Maries River Subbasin drains 133 sq. mi².

Upper Maries River Subbasin (HUC 10290111040)

The Upper Maries River Subbasin is located in central Maries County with a very small portion of the headwaters in northeastern Pulaski County. The Maries River flows through the center of this subbasin. Major creeks of this subbasin include Rogers Creek, Prairie Creek, Mag Creek, and Fly Creek. These creeks are all major tributaries to the Maries River. The majority (about 95%) of this subbasin is in the Upper Ozarks physiographic section with a smaller part in the Missouri River physiographic section. The Maries River originates in the town of Dixon, MO in northeastern Pulaski County and joins with the Little Maries River in northern Maries County, 2 miles southeast of Argyle, MO. The Upper Maries River Subbasin drains an area of 92 sq. mi².

Little Maries River Subbasin (HUC 10200111030)

This subbasin covers a small portion of north central Pulaski County with the remainder found in western Maries County. The Little Maries River is the only major stream in this subbasin. The majority (about

95%) of this subbasin is in the Upper Ozarks physiographic section with a smaller part in the Missouri River physiographic section. The Little Maries River originates about 2.5 miles west of Dixon, MO in Pulaski County. This subbasin drains 60 sq. mi².

Tavern Creek Subbasin (HUC 10290111010)

The subbasin surrounding Tavern Creek covers portions of eastern Miller, western Maries, and northwestern Pulaski Counties. Major streams of this subbasin include Tavern Creek, Little Tavern Creek, Wiemer Creek, Barren Fork, and Brushy Fork. The Tavern Creek Subbasin is located entirely within the Upper Ozarks physiographic section. Tavern Creek originates about 6 miles west-southwest of Crocker, MO in Pulaski County and drains to the Osage River 31.0 miles below Bagnell Dam. The Tavern Creek Subbasin drains an area of 314 sq. mi².

Wet Glaize Creek Subbasin (HUC 10290109070)

This subbasin is located in southeast Camden County. Major streams of this subbasin include Grand Auglaize Creek, Wet Glaize Creek, Deane Creek, Murphy's Creek, Conn's Creek, Sellars Creek, and Mill Creek. This subbasin is located entirely within the Upper Ozarks physiographic section. Wet Glaize Creek originates northeast of Stoutland, MO in Laclede County and joins Dry Auglaize Creek near the Camden/Miller County line to form Grand Auglaize Creek. There are no inundated river miles in this subbasin. The Wet Glaize Creek Subbasin drains 180 sq. mi².

Dry Auglaize Creek Subbasin (HUC 102901090600)

The Dry Auglaize Creek Subbasin is located in north central Laclede County and southeast Morgan County. This subbasin is located entirely within the Upper Ozarks physiographic section. The subbasin's namesake creek originates in the eastern edge of Lebanon, MO. Goodwin Hollow, Dry Auglaize Creek's principle tributary, originates about 4 miles southwest of Lebanon, MO and is the southernmost stream in the basin. The Dry Auglaize Creek Subbasin drains 205 sq. mi².

Lower Lake of the Ozarks Hills Subbasin (HUC 10290109080)

This large subbasin is located in northeast Camden, southeast Morgan, and southwest Miller Counties. Major streams of this subbasin include Linn and Bollinger Creeks. This subbasin lies completely within the Upper Ozarks physiographic section. The Lower Lake of the Ozarks Hills Subbasin contains the lower half of the impounded portion of the Osage River (from the 48.5 mile marker to Bagnell Dam), the impounded length (15.5mi) of Grand Auglaize Creek and Linn Creek. Linn Creek has about 3.5 RMs impounded by Lake of the Ozarks. This subbasin drains 265 sq. mi².

Deer Creek Subbasin (HUC 10290109030)

The Deer Creek Subbasin lies mainly in southeastern Benton County. A small portion of the subbasin's headwaters are located in extreme northwestern Hickory County and extreme west central Camden County. The major streams of this subbasin include Deer Creek and Little Deer Creek. The majority of this subbasin lies in the Springfield Plateau physiographic section with about five percent in the Upper Ozarks physiographic section. Deer Creek and Little Deer Creek both originate in extreme northwestern Hickory County. Deer Creek flows into Lake of the Ozarks 19.1 miles below Truman Dam. The Deer Creek Subbasin covers 70 sq. mi². About 2.9 RMs of Deer Creek have been inundated by Lake of the Ozarks.

Turkey Creek Subbasin (HUC 10290109010)

The Turkey Creek Subbasin covers portions of south central Benton County and north central Hickory County. The only major stream of this subbasin is Turkey Creek. The Turkey Creek Subbasin is completely contained in the Springfield Plateau physiographic section. Turkey Creek originates near the town of Cross Timbers, MO and enters Lake of the Ozarks 12.5 miles below Truman Dam. The Turkey Creek Subbasin drains 72 sq. mi². About 2.4 RMs of Turkey Creek are inundated by Lake of the Ozarks.

Cole Camp Creek Subbasin (HUC 10290109020)

This subbasin lies in northeastern Benton County. The major streams of this subbasin include Cole Camp Creek, Williams Creek, Duran Creek, Bauer Creek, and Indian Creek. The upper reaches lie in the Osage Plains with a small northeast corner in the Missouri River and the majority in the Springfield Plateau. Cole Camp Creek has its headwaters due north of Cole Camp, MO. Cole Camp Subbasin drains 147 sq. mi² and drains into Lake of the Ozarks 13.7 miles below Truman Dam. About 4.8 RMs of Cole Camp Creek have been inundated due to the impoundment of the Osage River at Bagnell Dam.

Upper Lake of the Ozarks Hills Subbasin (HUC 10290109040)

The Upper Lake of the Ozarks Hills Subbasin is located in east central Benton, southwest Morgan, and northwest Camden Counties. The major water bodies found in this subbasin include Lake of the Ozarks, Big Buffalo Creek, Archer Creek, Little Buffalo Creek, Little Proctor Creek, Feaster Creek, and Knobby Creek. The western portion of this subbasin lies in the Springfield Plateau physiographic section. The eastern portion is in the Upper Ozarks physiographic section. A small northeastern section of this subbasin is in the Missouri River physiographic section. Approximately 11.3 miles of 4th and 5th order streams in this subbasin have been inundated by Lake of the Ozarks. The Upper Lake of the Ozarks Subbasin drains 265 sq. mi².

Gravois Arm Subbasin (HUC 10290109050)

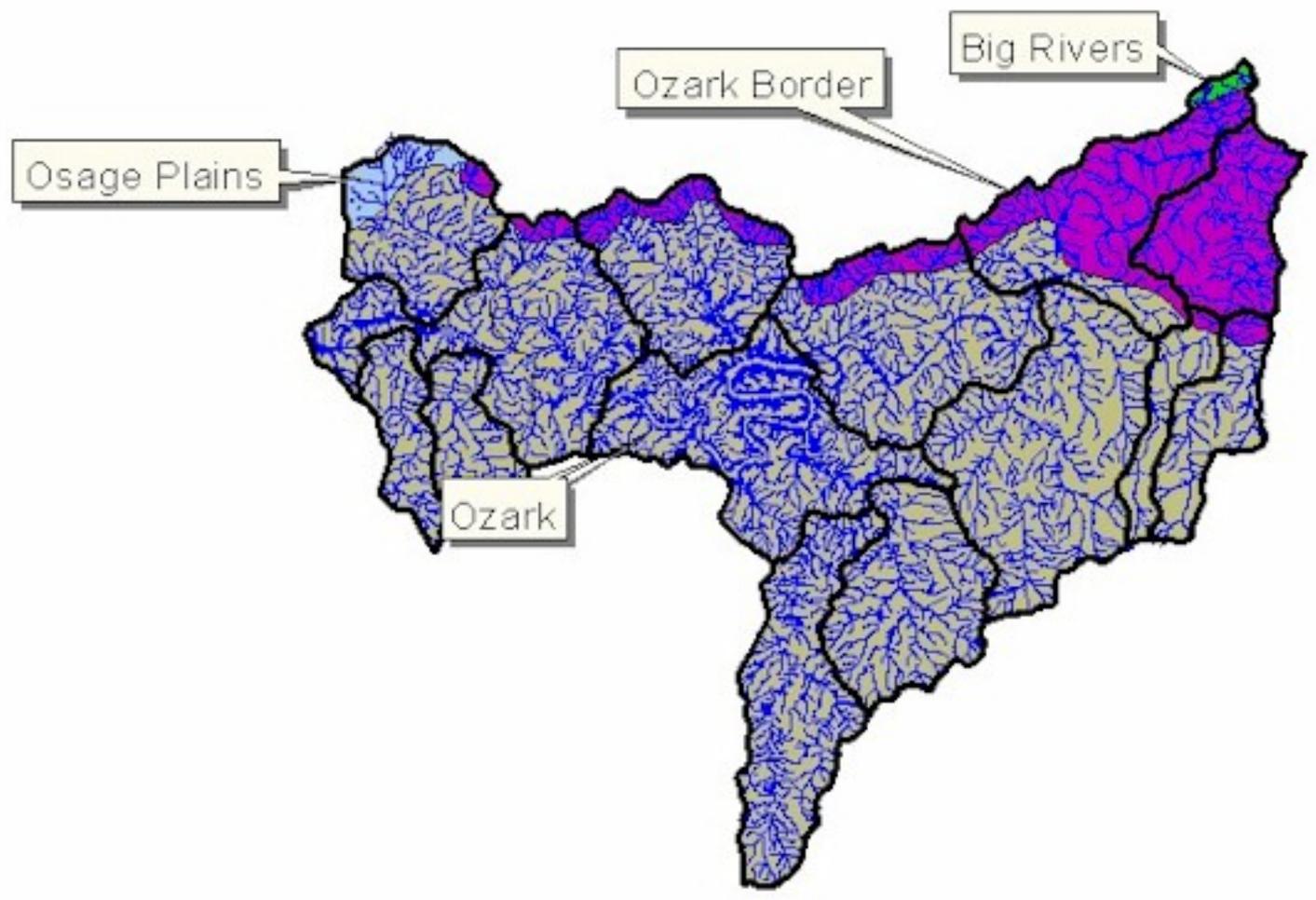
This subbasin is located in southeastern Morgan County with a small section going into the western portion of Miller County. The major streams of this subbasin include Big Gravois Creek, the Little Gravois Creek, Indian Creek, and Mill Creek. The majority of this subbasin is in the Upper Ozarks

physiographic section with the northern boundary in the Missouri River physiographic section. The headwaters of Big Gravois Creek originate about three miles due east of Versailles, MO, while Little Gravois Creek, the largest tributary to Big Gravois Creek, originates within the city limits of Versailles. This subbasin drains an area of 179 sq. mi². Approximately 10.4 RMs of Big Gravois Creek have been inundated by Lake of the Ozarks. An additional 8.6 RMs of 4th order streams of this basin have been inundated in this subbasin as well.

Miller County Osage River Hills Subbasin (HUC 10290111020)

This river hills subbasin is located in central Miller County with small portions (<5% total) located in Morgan and Cole Counties. Major streams of this subbasin include the Osage River, Little Gravois Creek, Big Saline Creek, Blue Springs Creek, East Fork Little Gravois Creek, Little Saline Creek, Dog Creek, Cub Creek, Jack Buster Creek, Cattail Creek, Bear Creek, East Fork Creek, Coon Creek, and Wright's Creek. This subbasin covers a stretch of the Osage River (about 31 RMs) and all tributary streams from Bagnell Dam to the Osage River's confluence with Tavern Creek. The majority of this subbasin is located in the Upper Ozarks physiographic section with a narrow strip along the northern border located in the Missouri River physiographic section. This subbasin drains 252 sq. mi².

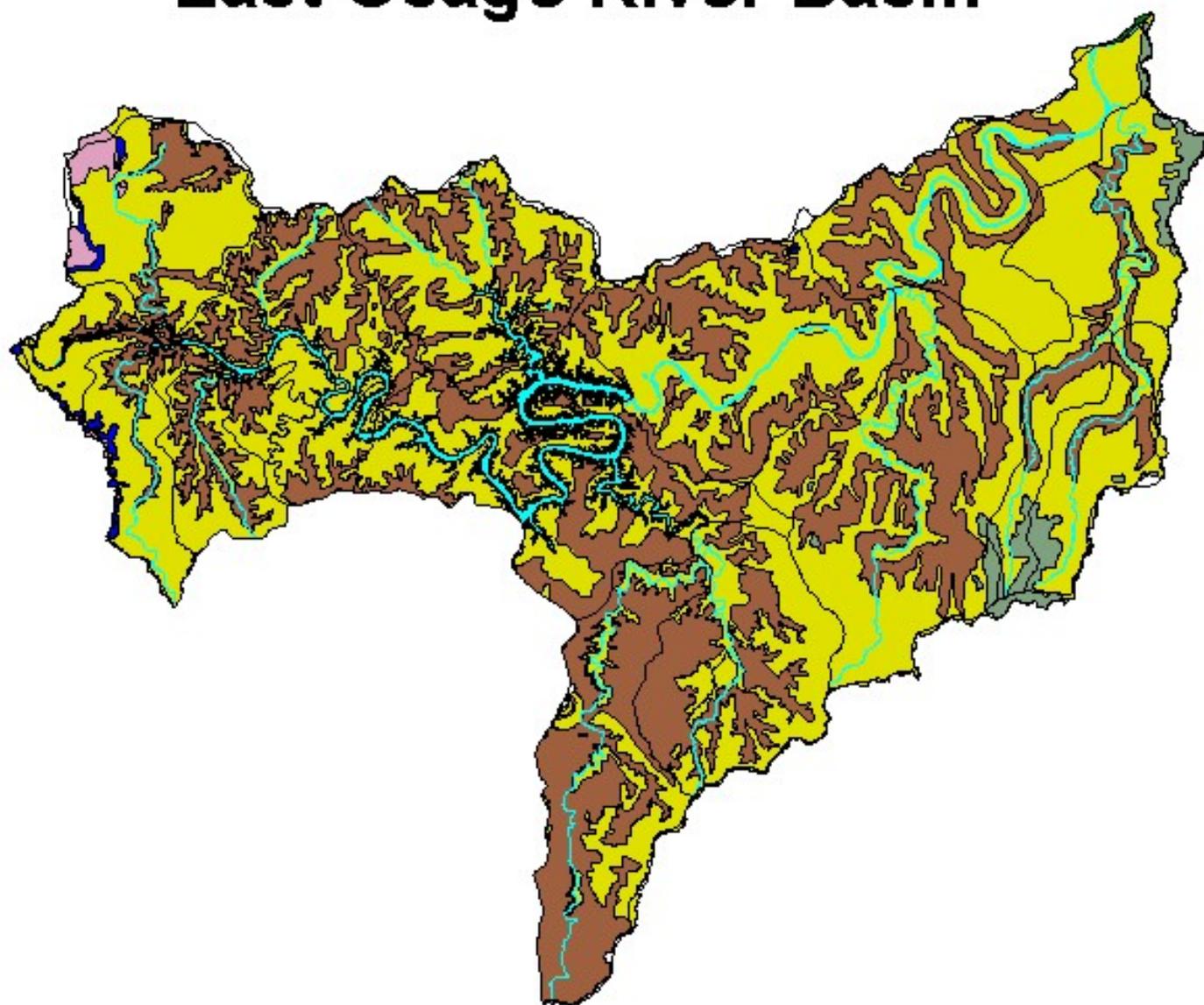
Figure 4. Natural Divisions of the East Osage River Basin



30 0 30 Miles



Figure 5. Geology of the East Osage River Basin



20 0 20 Miles

- Alluvium
- Dolomite
- Dolomite/Shale
- Igneous
- Limestone
- Limestone/Shale
- Sandstone
- Sandstone/Dolomite

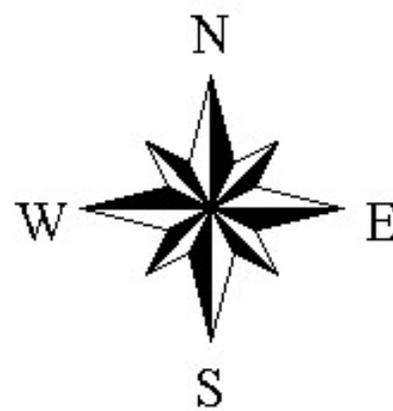


Figure 6. Soils of the East Osage River Basin

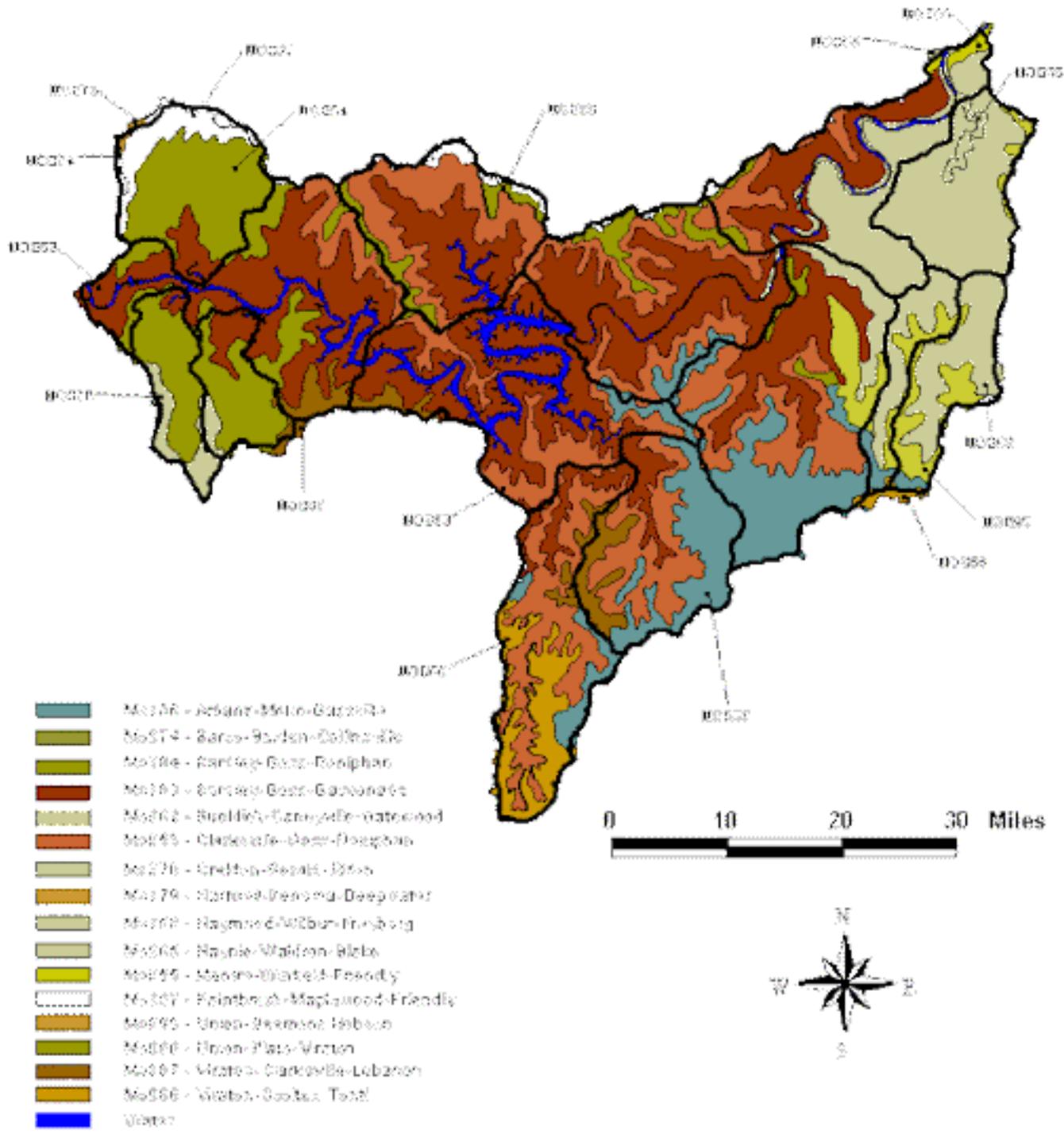


Table 2. Stream name, order, unimpounded length, impounded length, length influenced by Bagnell Dam discharge, and confluence for fourth-order and larger streams in the East Osage River Basin.

Name	Order	Unimpounded* Length (mi)	Length impounded by Lake of the Ozarks (mi)	Length ** influenced by Bagnell Dam Discharge (mi)	Confluence
Osage River	8	82	93	82	Missouri River
<u>LOWER OSAGE RIVER SUBBASIN</u>					
Sugar Creek	4	12.8	0	0	Osage River
Profits Creek	4	5.5	0	0	Osage River
<u>LOWER MARIES RIVER SUBBASIN</u>					
Maries River	6	37.5	0	0	Osage River
Little Maries Creek	5	13.7	0	0	Maries River
Loose Creek	4	5.6	0	0	Maries River
Unnamed Creek	4	4.9	0	0	Little Maries Creek
Unnamed Creek	4	3.7	0	0	Little Maries Creek
<u>UPPER MARIES RIVER SUBBASIN</u>					
Maries River	5	28.2	0	0	Maries River
Mag Creek	4	4.7	0	0	Maries River
Prairie Creek	4	3.6	0	0	Maries River

Rodgers Creek	4	5.6	0	0	Maries River
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LITTLE MARIES RIVER SUBBASIN

Little Maries River	4	25.5	0	0	Maries River
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TAVERN CREEK SUBBASIN

Tavern Creek	5	55.4	0	0	Osage River
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Little Tavern Creek	5	17.9	0	0	Big Tavern Creek
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Little Tavern Creek	4	10.5	0	0	Big Tavern Creek
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Clinkingbeard Creek	4	5.8	0	0	Big Tavern Creek
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Kenser Creek	4	6.8	0	0	Big Tavern Creek
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Barren Fork	4	13.3	0	0	Big Tavern Creek
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Table 2. Stream name, order, unimpounded length, impounded length, length influenced by Bagnell Dam discharge and confluence for fourth-order and larger streams in the East Osage River Basin.

Name	Order	Unimpounded* Length (mi)	Length impounded by Lake of the Ozarks (mi)	Length ** influenced by Bagnell Dam Discharge (mi)	Confluence
<u>DRY AUGLAIZE CREEK SUBBASIN</u>					
Dry Auglaize Creek	5	44.7	0	0	Grand Glaize Creek
Goodwin Hollow	4	26.4	0	0	Dry Auglaize Creek
<u>WET GLAIZE CREEK SUBBASIN</u>					
Grand Auglaize Creek (unimpounded section)	6	7.8	0	0	Lake of the Ozarks
Wet Glaize Creek	5	11.7	0	0	Grand Auglaize Creek
Deane Creek	4	11.9	0	0	Grand Auglaize Creek
Murphy's Creek	4	8.8	0	0	Wet Glaize Creek
Conn's Creek	4	4.7	0	0	Wet Glaize Creek
Sellars Creek	5	9.0	0	0	Wet Glaize Creek
Mill Creek	4	5.5	0	0	Sellars Creek
<u>LOWER LAKE OF THE OZARK HILLS SUBBASIN</u>					

Grand Auglaize Creek (impounded section)	6	0	15.5	0	Lake of the Ozarks
Linn Creek	4	6.9	3.5	0	Lake of the Ozarks
<u>DEER CREEK SUBBASIN</u>					
Deer Creek	4	13.6	2.9	0	Lake of the Ozarks
Little Deer Creek	4	10.4	0	0	Deer Creek
<u>TURKEY CREEK SUBBASIN</u>					
Turkey Creek	4	24.2	2.4	0	Lake of the Ozarks
<u>COLE CAMP CREEK</u>					
Cole Camp Creek	5	23.5	4.8	0	Lake of the Ozarks
Williams Creek	4	11.2	0	0	Cole Camp Creek
Duran Creek	4	10.0	0	0	Cole Camp Creek
Bauer Branch	4	6.2	0	0	Cole Camp Creek
Indian Creek	4	10.1	0	0	Cole Camp Creek

Table 2. Stream name, order, unimpounded length, impounded length, length influenced by Bagnell Dam discharge and confluence for fourth-order and larger streams in the East Osage River Basin.

Name	Order	Unimpounded* Length (mi)	Length impounded by Lake of the Ozarks (mi)	Length** influenced by Bagnell Dam Discharge (mi)	Confluence
<u>UPPER LAKE OF THE OZARK HILLS SUBBASIN</u>					
Big Buffalo Creek	5	11.1	2.5	0	Lake of the Ozarks
Little Buffalo Creek	4	7.6	2.1	0	Lake of the Ozarks
Proctor Creek	4	4.5	1.7	0	Lake of the Ozarks
Feaster Creek	4	3.4	1	0	Lake of the Ozarks
Knobby Creek	4	7.0	1.5	0	Lake of the Ozarks
Rainy Creek	4	6.9	2.5	0	Lake of the Ozarks
<u>GRAVOIS ARM SUBBASIN</u>					
Big Gravois Creek	4	12.4	10.4	0	Lake of the Ozarks
Little Gravois Creek	4	8.3	1.8	0	Lake of the Ozarks
Indian Creek	4	8.1	4.2	0	Lake of the Ozarks
Mill Creek	4	5.5	2.6	0	Lake of the Ozarks
<u>MILLER COUNTY OSAGE RIVER HILLS SUBBASIN</u>					

Little Gravois Creek	5	7.6	0	1.1	Osage River
East Fork Little Gravois Creek	4	7.4	0	0	Little Gravois Creek
Big Saline Creek	6	16.0	0	1	Osage River
Little Saline Creek	4	10.0	0	0	Big Saline Creek
Dog Creek	4	12.8	0	0	Osage River
Cub Creek	4	6.0	0	0	Osage River
Jack Buster Creek	5	7.0	0	0	Big Saline Creek
Cattail Creek	4	4.2	0	0	Osage River
Bear Creek	4	9	0	0.1	Osage River
Unnamed Creek	4	2.7	0	0	Jack Buster Creek
Unnamed Creek	4	3	0	0	Big Saline Creek

* unimpounded stream length above Lake of the Ozarks normal pool (660" elevation)

** distances taken from 7.5 minute topographic maps at 12-15,000 cfs approximate discharge