USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Lower Missouri River Sub-basin

HUC # 10300200

R A P I D W A T E R S H E D A S S E S S M E N T

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A rapid watershed assessment (RWA) evaluates resource conditions and needs on an 8-digit hydrologic unit (HU) basis. The assessment identifies the primary resource concerns for the watershed being profiled and provides estimate as to where conservation investments would best address the concerns of landowners, conservation districts, stakeholders, and others. The RWA provides information on which to base decisions about conservation priorities, allocation of resources, and funding for implementation.

Introduction[1]

Rapid watershed assessments (RWAs) provide initial estimates of where conservation investments would best address the concerns of land owners, conservation districts and other stakeholders within drainage sub-basins. These assessments are designed as quick looks over large drainage areas to provide a starting point for area-wide, watershed or site-specific planning. Missouri has 66 sub-basins averaging 628,000 acres in size.

RWAs contain two parts: a resource profile based on readily available resource information and an assessment matrix of current and future resource conditions and related installation and maintenance costs. The resource profiles provide a general description of the location and primary physical attributes of the sub-basin; known resource concerns; and selected agricultural and socio-economic characteristics. The assessment matrices contain condition tables detailing the current level of conservation in the sub-basin; future considerations tables identifying appropriate suites of conservation practices needed to deal with the primary resource concerns for each major land use; and summary tables that summarize the various costs associated with the Resource Management Systems (RMS) identified in the future considerations tables.

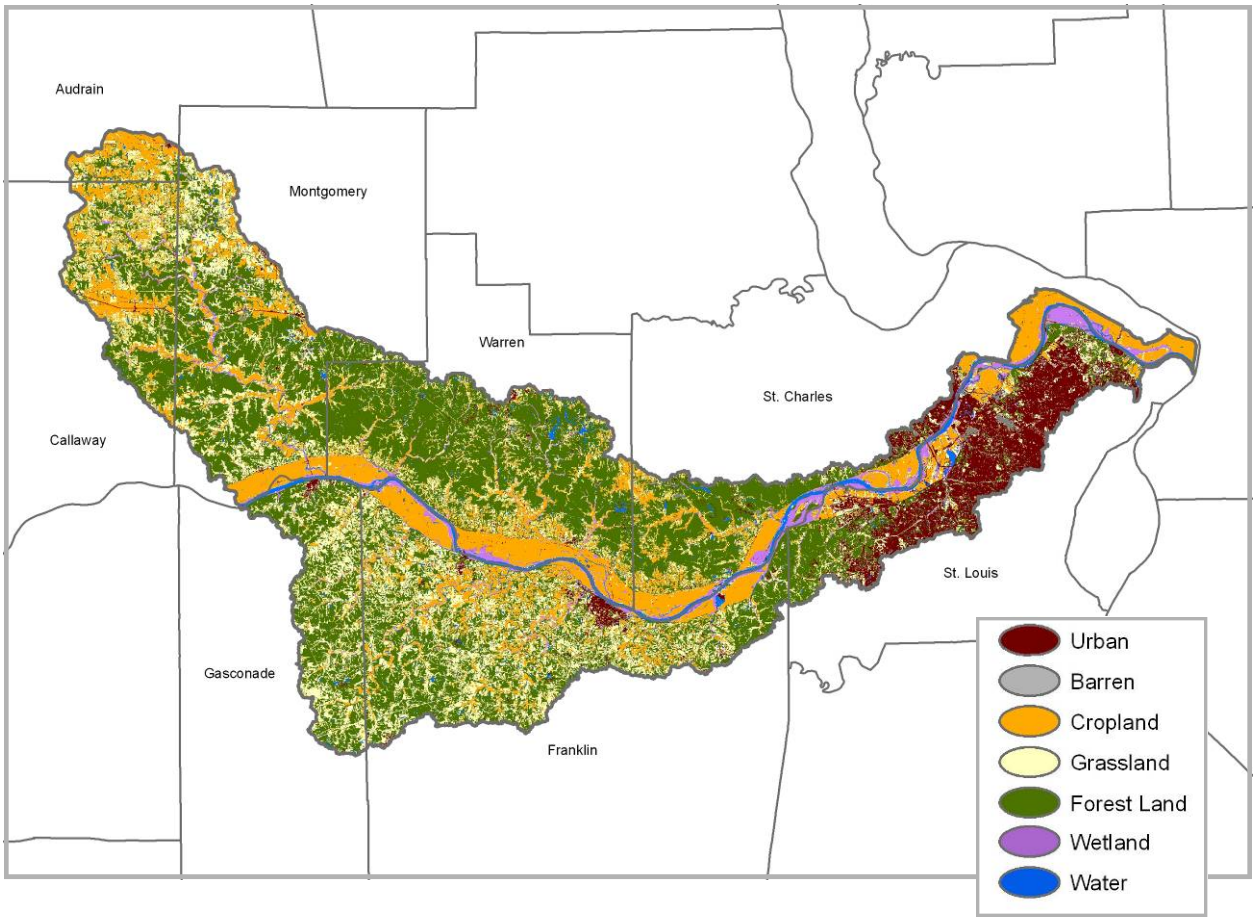
Located in east central Missouri, the Lower Missouri River sub-basin extends eastward from the confluence of the Missouri and Gasconade Rivers, across portions of eight counties, to the confluence of the Missouri and Mississippi Rivers just north of St. Louis, Missouri. This 1,590 square mile drainage area divides into three distinct physiographic parts; a central corridor composed of the Missouri River alluvial plain and two flanking bands of deeply dissected hills and bluff lands. The alluvial plain reflects the narrowed channel and floodplain typical of the Missouri River as it flows through the northern edge of the Ozark Highlands. The predominant loamy, well drained alluvial soils are heavily row cropped and protected with an extensive levee network. Over the past four decades, the lower reaches approaching the St. Louis metropolitan area have experienced increasingly strong urban development pressures. Below St. Charles, Missouri, the alluvial plain widens as it merges with the Mississippi River alluvial plain. The land area north of the alluvial plains is dominated by narrow, loess covered limestone ridges with steep side slopes and narrow, deeply entrenched valleys cut in sandstone and dolomite. Moving northward away from the Missouri River alluvial plain, the rugged, heavily forested hills give way to flat glacial till plains to the west and more gently rolling loess and till cover hills to the east with local relief dropping from 250 feet on the Missouri River bluffs to 150 feet on the sub-basin's northern boundary with the Cuivre River drainage system. The small amount of row cropping is limited to the larger stream valleys with most open ridge tops and valley bottom areas dedicated to pasture. The band of hills on the south side of the Missouri River alluvial plain is underlain by dolomite and covered with loess that thins as one moves south, away from the Missouri River and into the limestone formations drained by the Bourbeuse and Meramec Rivers. The topography is more rolling with local relief ranging from 100 to 200 feet. The extensive pre-settlement woodlands and forests have given way to an open mix of cool-season pastures, row cropped valleys and flat uplands and small, scattered forested tracts.

Despite strong development pressures from the St. Louis metropolitan area in the lower end of the sub-basin, a majority of the land use/land cover (83%) is agricultural. Cultivated cropland accounts for 21 percent of the sub-basin's land area, lead by soybean acreage and followed by corn, wheat and sorghum. Forage crops are predominantly cool season pastures and hayland covering 17 percent of the sub-basin. Forest land, much of it second growth, covers 41 percent of the drainage area. Fourteen percent of the sub-basin's land area has been developed. Hogs and pigs lead livestock production followed by cattle and poultry.

Physical Description

A. Land Use/ Land Cover[2]

Figure 1



Land Use/ Land Cover NRI	Urban	Cultivated cropland	Conservation Reserve Program	Non-cultivated cropland	Pastureland	Forest land	Minor land cover/uses	Water
1982 Acres	114,200	259,200	NA	40,400	174,000	384,800	15,100	30,600
1987 Acres	120,600	239,200	1,800	38,400	176,900	403,600	15,100	31,200
1992 Acres	131,300	224,900	20,800	44,000	142,800	407,200	15,000	31,800
1997 Acres	145,500	215,800	19,800	70,800	103,300	415,300	15,200	32,100
Five Year trend 92-97	**Up 11%**	**Down 4%**	**Down 5%**	**Up 61%**	**Down 28%**	**Up 2%**	**Up 1%**	**Up 1%**
Ten year trend 87-97	**Up 21%**	**Down 10%**	**Up 1000%**	**Up 84%**	**Down 42%**	**Up 3%**	**Up 1%**	**Up 3%**
Fifteen year trend 82–97	**Up 27%**	**Down 17%**	**NA**	**Up 75%**	**Down 41%**	**Up 8%**	**Up 1%**	**Up 5%**

Land Cover / Land Use Definitions

- Urban – This map category corresponds to the tabled category called Developed Land. Developed Land is a combination of the NRI land cover/use categories large urban and built-up areas, small lbuilt-up areas and rural transportation land. Rural transportation land consists of all highways, roads, railroads and associated right-of-ways outside urban and built-up areas and also includes private roads to farmsteads, logging roads and other private roads.

- Barren – This map category is typically, the surface of sand, rock or exposed soil with less than 5 percent vegetative cover. Barren land acreage is included in the tabled NRI Minor Land category. Minor land is a miscellaneous grouping of land covers and uses that includes farmsteads and farm structures, field windbreaks, and barren land.

- Cropland – This map category most closely corresponds to the tabled category called Cultivated Cropland. Cultivated Cropland comprises land in row crops, close-grown crops and hayland or pastureland in rotation with row or close-grown crops.

- Grassland – This map category includes 4 tabled NRI land cover/use categories:
  Non-cultivated cropland; Conservation Reserve Program (CRP) lands; Pastureland; Rangland. on-cultivated cropland includes permanent hayland and horticultural cropland. The CRP is a federal program established under the 1985 Food Security Act to convert highly erodible cropland to vegetative cover (primarily grass) under 10 year contracts. Pastureland is land managed primarily for the production of introduced forage plants for livestock grazing. Rangeland is land on which the climax or potential plant cover is composed principally of native grasses, grass-like plants, forbs or shrubs suitable for grazing and browsing and introduced forage species that are managed like rangeland.

- Forestland and Woodland – A majority of the acreage for these map categories is captured by the tabled NRI Forestland category, defined as land that is at least 10 percent stocked by single-stemmed woody species of any size that will be at least 4 meters tall a maturity. Ten percent stocked, equates to an areal canopy cover of 25 percent or greater.

- Wetlands – Acreage for this mapped category is not reflected in any of the NRI tabled acreage estimates. The wetland map category is a combination of satellite derived wetland classes, National Wetland Inventory (NWI) acres and Wetland Reserve Program (WRP) acres. (See Wetlands Section for NWI acreage estimates)

- Water – This map category closely corresponds to the NRI table acreage estimate representing water bodies and streams that are permanent open water.

B. Grassland[2]

	Rangeland (acres)			Pastureland (acres)			Grazed Forest Land (acres)		
Year	Total Sub-basin	Percent of sub-basin	Percent of state land use total	Total Sub-basin	Percent of sub-basin	Percent of state land use total	Total Sub-basin	Percent of sub-basin	Percent of state land use total
1997	0	0	0%	103,300	10%	1%	81,100	18%	1%

C. Crop History[2]

	Close Grown Crops (acres)	Row Crops (acres)			Hayland (acres)		
Year	Wheat	Corn	Sorghum	Soybeans	Grass	Legume	Grass-Legume
1997	40,500	59,100	4,200	90,300	53,600	12,000	16,100

D. Public Land[3]

About 51,613 acres or 5.1% of the sub-basin are in public ownership. These public lands include 25 conservation or wildlife management areas, 7 river accesses, 3 lakes, 3 state parks, 2 state historic sites, 2 natural areas and 1 county park. Public ownership in this region is near Missouri's state average of 6.7%.

Figure 2

Public Land Ownership (acres)			
	Missouri Department of Conservation	Missouri Department of Natural Resources	Other
Total Acres	45,937	3,796	1,880

E. Soil Capability

Land Capability[2]

Land Capability is a classification system used to identify the erosion potential of farmland. For over forty years the USDA has used land capability classification as a planning tool in laying out conservation measures and practices to farm without serious deterioration from erosion or other causes. The current system includes eight classes of land designated by Roman numerals I through VIII. The first four classes are arable land--suitable for cropland--in which the limitations and the need for conservation measures and management increase from I through IV. The remaining four classes, V through VIII, are not to be used for cropland, but may have uses for pasture, range, woodland, grazing, wildlife, recreation, and aesthetic purposes.

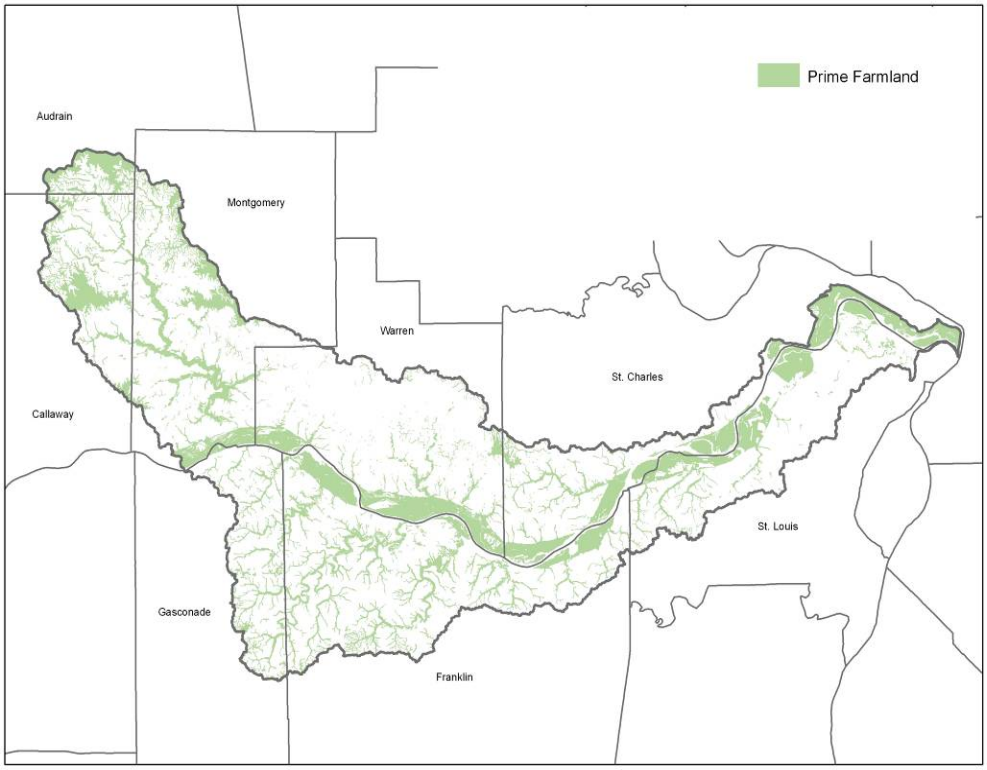
Figure 3

Land Capability Class	Cultivated cropland (acres)	Non-cultivated cropland (acres)	Pastureland (acres)
I - slight limitations	50,600	11,600	500
II - moderate limitations	65,000	10,900	3,900
III - severe limitations	88,500	13,500	64,700
IV - very severe limitations	6,200	2,700	30,700
V - no erosion hazard, but other limitations	1,400	1,400	-
VI - severe limitations, unsuited for cultivation, limited to pasture, range, forest	2,600	2,600	3,500
VII - very severe limitations, unsuited for cultivation, limited to grazing, forest, wildlife	1,500	1,500	-
VIII - misc. areas have limitations, limited to recreation, wildlife and water supply	-	-	-
Total	**215,800 acres**	**70,800 acres**	**103,300 acres**

Prime Farmland[4,5]

Prime Farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses. It has the soil quality, growing season, and moisture supply needed to produce economically sustained high yields of crops when treated and managed according to acceptable farming methods, including water management. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding.

Figure 4. Common Resource Areas



Prime Farmland[2]—Change in Acres from 1982 to 1997	
1982	250,600 acres
1997	244,800 acres
Difference	**(5,800) acres**

F. Common Resource Areas[6]

NRCS has divided the Nation into ecological type land regions called Major Land Resource Areas (MLRA). MLRAs are defined by their agricultural potential and soils capabilities and provide a spatial framework for addressing national and regional agricultural issues. A Common Resource Area (CRA) is a geographic and ecologic subdivision of an MLRA within which there are similar resource concerns and treatment requirements.

Each Missouri CRA is a grouping of Land Type Associations (LTA) taken directly from the state's ecological classification system (ECS). Missouri's LTAs are primarily differentiated on the basis of local climate, landforms and topography, geologic parent materials, soil types and potential vegetation.

The Pomme de Terre Sub-basin occupies portions of MLRA 113.1, 115B.1, 115B.2, 115B.3, 115C.2 and 116A.3.

113.1 – Clay Pan Till Plains

Nearly level and gently sloping, well-developed claypan soils on a flat glacial till plain. Light to mod-

erately dark colored, poorly drained and somewhat poorly drained soils formed primarily in loess. Loess thickness generally ranges from greater than 6 feet in the western part to about 3 feet in the eastern part. The low clay surface soil changes abruptly to the high clay subsoil. The area is intensively cropped with row crops and small grain. Sodium affected soils are throughout the area and occur in an intricate pattern with soils not affected by sodium. The more sloping areas adjacent to the streams are more commonly used for pasture or remain in woodland. Postglacial stream erosion has made little progress and most of the surface is flat or gently rolling with local relief less than 100 feet. Bedrock exposures are rare.

115B.1 – Outer Ozark Border

The Outer Ozark Border CRA consists of a belt of deeply dissected hills and bluffs and several relatively smooth karst plains. Relief in the river hills is 200-350 feet. Slopes are steep and bedrock exposures are common. Loess, occasionally very thick, mantles the uplands of the entire CRA. Land use is extremely varied, including row crops, improved pasture, and densely wooded valleys.

115B.2 – Northern Inner Ozark Border

The Northern Inner Ozark Border CRA consists of dissected plains and hills with various expressions of local relief with a range of 150-300 feet. The CRA is defined largely by its association with the dolomites and loess-mantled ridges. Land use is extremely varied, from row crops and improved pasture to overgrown glades and dense second-growth oak forests.

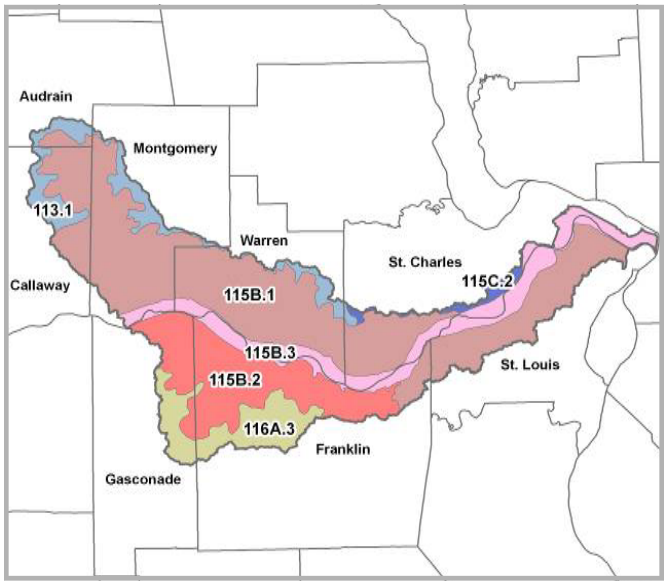
115B.3 – Missouri River Alluvial Plain

The Missouri River Alluvial Plain CRA consists of the Missouri River channel and its adjoining alluvial plain across the northern Ozarks. Formerly the channel contained numerous islands and bars, but in the last half century it has been narrowed, its islands virtually eliminated, and its banks stabilized. Soils are deep and loamy. The alluvial plain is subject to flooding. Land use is chiefly row crops.

115C.2 – Mississippi River Hills

The Mississippi River Hills CRA consists of a broad belt of hills, valleys, and bluffs. Topography ranges from moderately rolling to steep and rugged; local relief averages 150-250 feet. Loess mantles the entire subsection. Carbonate bedrock is exposed on steeper slopes and locally creates karst tracts. Most of the subsection is in farms, mainly livestock, with crops on better soils.

Figure 5



116A.3 – Central Plateau

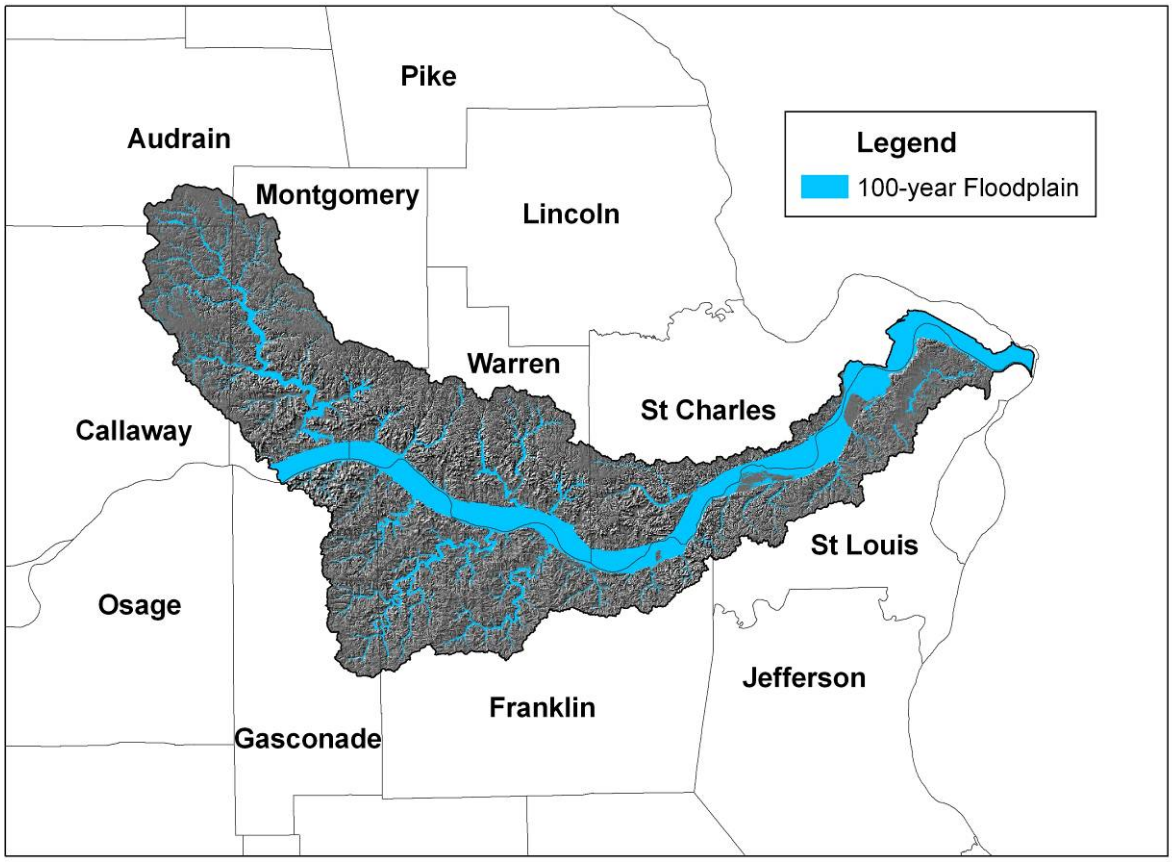
The Central Plateau CRA consists of some of the least dissected portions of the alluvial plain and channel of the Mississippi River. The alluvial plain has very deep loamy and clayey soils of variable drainage capacity. Many islands are timbered. The main bottoms are artificially drained and in cropland, but some oxbow wetlands remain.

G. Streams

Floodplains[7]

The Federal Emergency Management Agency (FEMA) maps areas of flood vulnerability. FEMA has produced maps for 8 of the 9 counties in this sub-basin. For the remaining county (Audrain), the SSURGO soil attribute 'flooding frequency' was used. Flooding frequency documented as rare, occasional, frequent and very frequent cumulatively represent the 1% annual chance of flooding, or 100-year floodplain, as shown from the FEMA data. Using these combined methods, 192,456 acres (19%) of the sub-basin are in the 100-year floodplain.

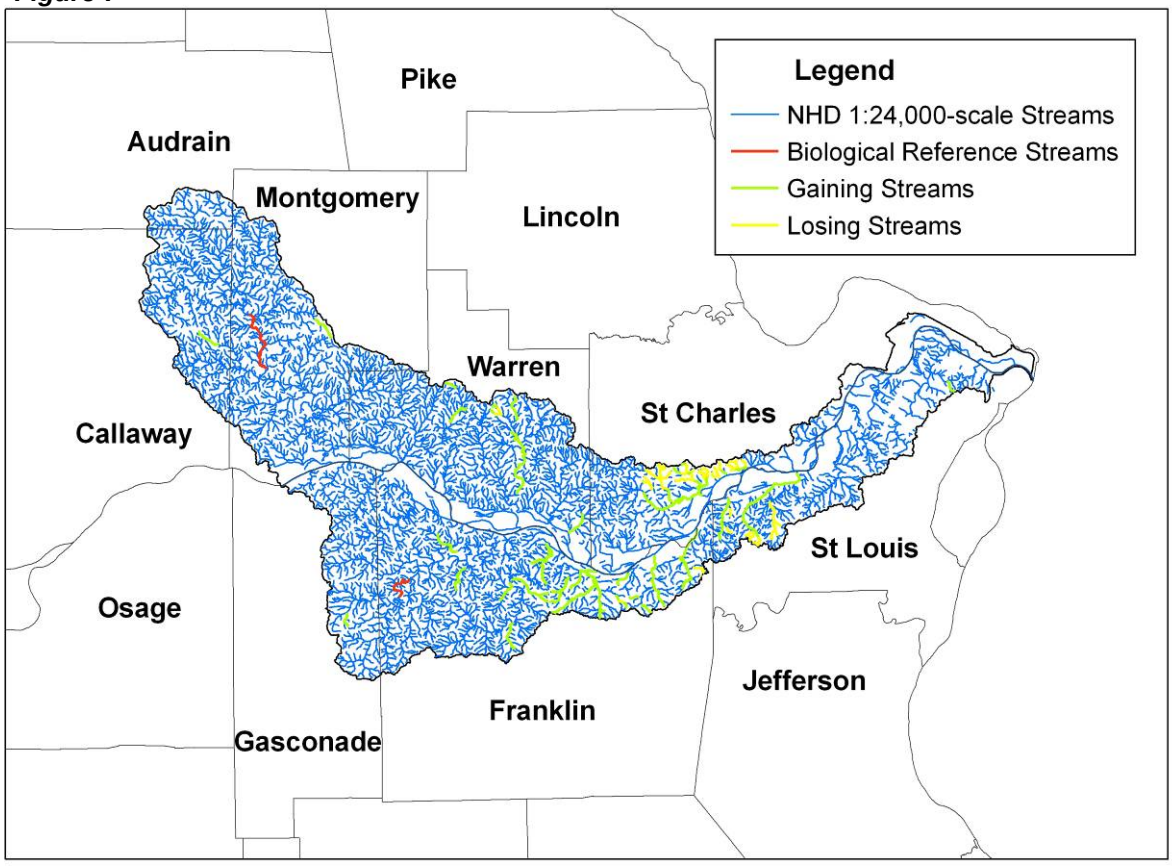
Figure 6



National Hydrography Dataset (NHD) with Gaining Streams and Biological Reference Streams [8 & 15]

High-resolution (1:24,000-scale) streams from the National Hydrography Dataset total 2,119 miles of intermittent and perennial streams in this watershed. Sixty-six (66) miles of streams are considered gaining streams while 7 miles are designated losing streams. Stream segments are classified 'gaining' or 'losing' by the Missouri Department of Natural Resources (MoDNR), Division of Geology and Land Survey (DGLS). The classification depicts sections of streams which are either losing water flow to the subsurface or gaining water flow from the subsurface, based on change in flow rate over a set distance. MoDNR also designates biological reference streams for watersheds. Biological reference streams are segments of streams that represent the best stream conditions to support aquatic life for a given area. A 4.2-mile stretch of Boeuf Creek and a 9.1-mile segment of the Loutre River are biological reference streams in this sub-basin.

Figure 7

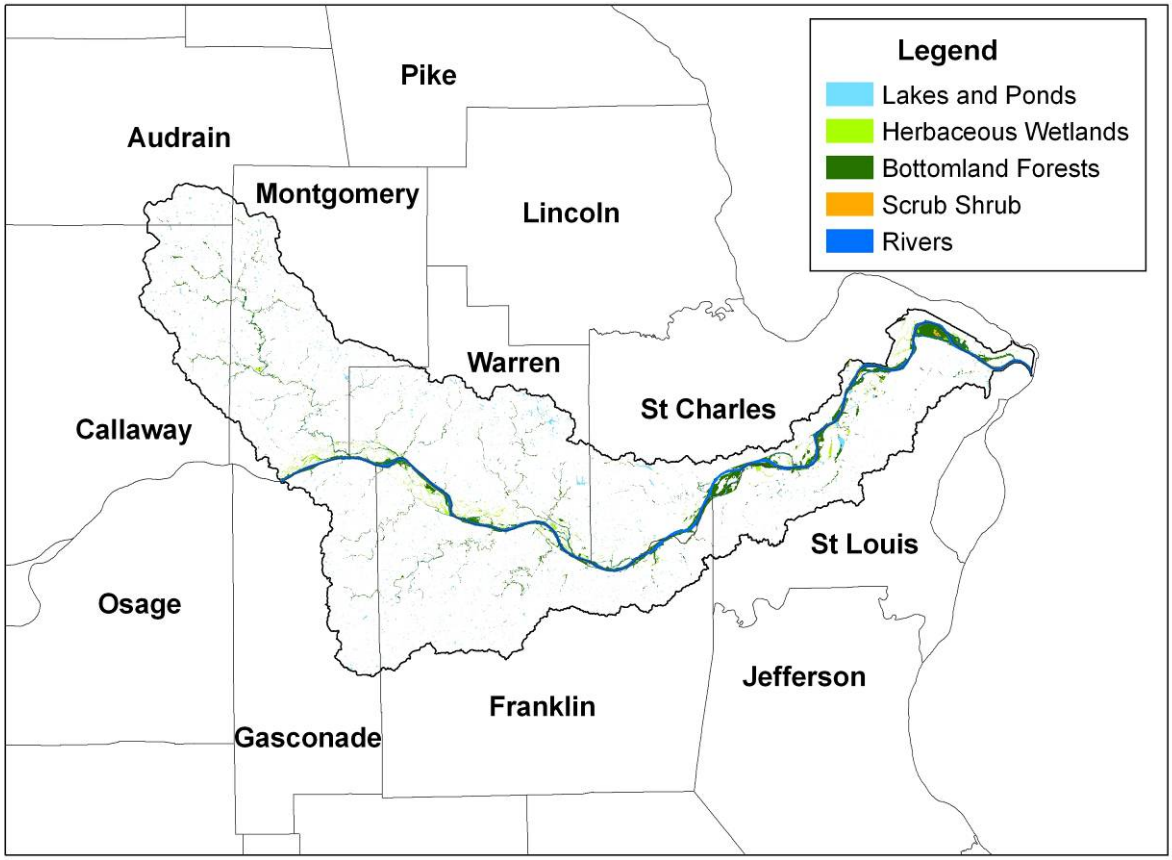


H. Wetlands[9,10]

Wetlands consist of land areas that are flooded or saturated by surface or ground water often enough to support plant and animal lifeforms that are adapted to wet environments.

The National Wetland Inventory (NWI) delineated wetlands from early 1980s aerial photography and classified wetlands using a wetland classification scheme developed by Cowardin, et al. The inventory identifies 64,258 acres of various wetland types within the Lower Missouri sub-basin.

Figure 8



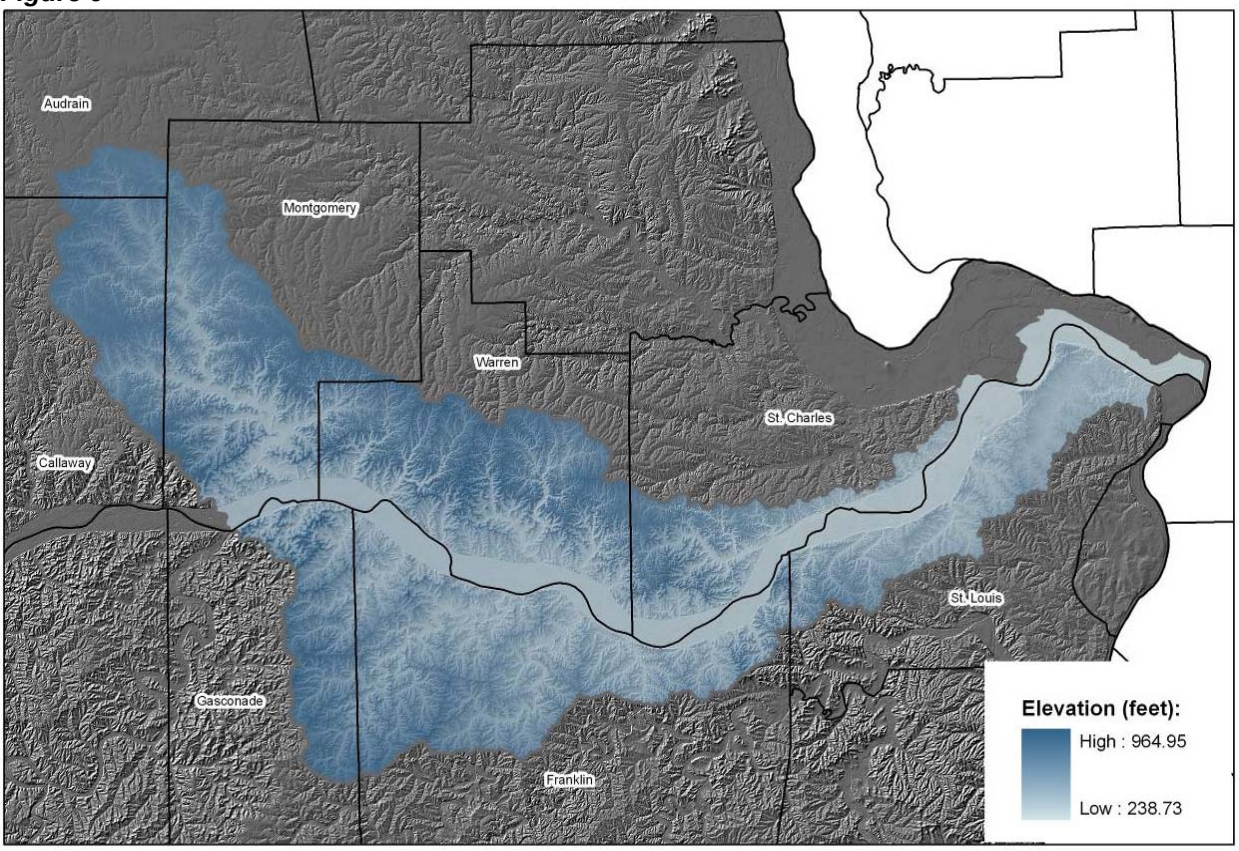
General Wetland Type	Acres	Percent of Sub-basin
Lakes and Ponds	9,883	1%
Herbaceous Wetlands	6,110	0.6%
Bottomland Forests	26,616	2.6%
Scrub Shrub	910	0.09%
Rivers	20,739	2%
Total	**64,258**	**6.29%**

I. Relief Map[1,11,12]

The shaded relief map of the Lower Missouri River sub-basin depicts elevations above sea level. The shaded relief and elevation values were derived from digital elevation models generated from U.S. Geological Survey 7.5 minute elevation contours.

The sub-basin consists primarily of deeply dissected hills and blufflands, as well as dissected plains. The landscape has rolling narrow ridgetops and hilly to steep ridge slopes and valley sides. Streams are often deeply entrenched due to their close proximity to the Missouri River. Elevations range from 300 feet to about 1,000 feet with local relief of 100 to 300 feet.

Figure 9



J. Geology[1,13,14,34]

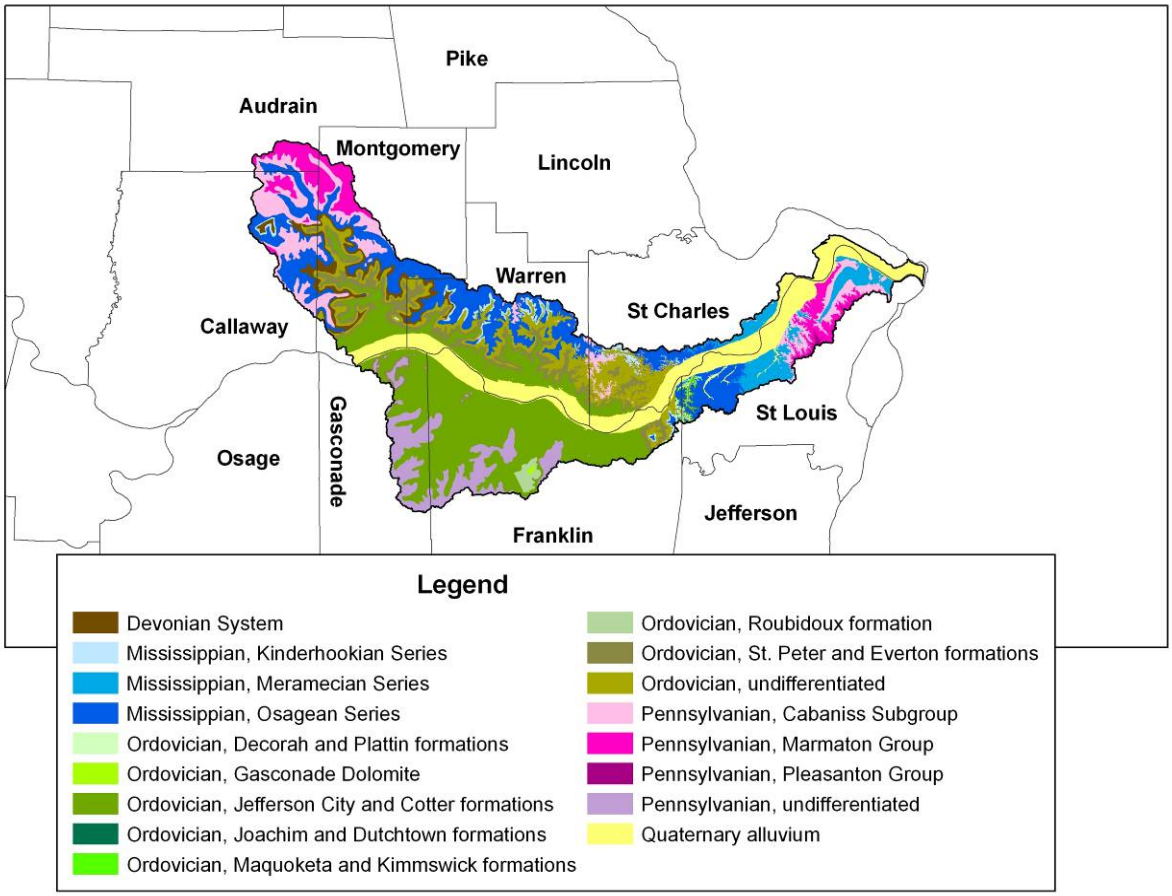
Geology Map

This bedrock geology map is derived from the Geologic Map of Missouri. The Pomme de Terre sub-basin is dominated by Mississippian-age limestones and Ordovician-age dolomites. To the north, bedrock units lie on the flank of the Ozark uplift and dip to the northwest. The sub-basin is underlain by cherty dolomites and sandstones with lesser amounts of shaley dolomites, shales, and limestones. Many areas are covered with thick residuum and rock outcrops can be common. A moderately significant number of springs, sinkholes, caves, and losing streams, associated with a karst terrain, are found within the sub-basin.

Significant numbers of springs, sinkholes, caves, and losing streams, associated with a karst terrain, are found within the sub-basin.

Bedrock units in the Lower Missouri River sub-basin can be further divided into the following stratigraphic groups in descending order:

Figure 10



Pennsylvanian Sub-System

- Pleasanton group – Consists predominantly of clastic materials which have formed sandstones and shales. Thin beds of coal and conglomerate are sometimes present. The Pleasanton is quite limited in the sub-basin and occurs only in the far eastern portion.
- Marmaton group – Consists of a succession of shales, escarpment-forming limestones, sandstones, clays, and coal beds.
- Cherokee group (Cabaniss Subgroup) – Consists of cyclic deposits of sandstone, siltstone, shale, underclay, limestone and coal beds.
- Undifferentiated Pennsylvanian - These units also occur and are found primarily in Franklin and Gasconade counties.

Mississippian System

- Meramecian, Osagean and Kinderhookian Series—Characteristically composed of fossiliferous and crystalline limestones. The units can be cherty, dolomitic and/or siliceous.

Devonian System—Small areas of Devonian-age bedrock occur in the western portion of the sub-basin. These generally consist of limestone and dolomite and may contain lesser amounts of shale, sandstone and chert.

Ordovician System—The sedimentary strata of this system are comprised primarily of dolomites and limestones. However, numerous sandstone and shale formations and members can also be present. The following stratagraphic units comprise the Ordovician System in the Lower Missouri sub-basin: Maquoketa Group, Kimmswick Limestone, Decorah Group, Plattin Group, Joachim Dolomite, Dutchtown Formation, St. Peter Sandstone, Everton Formation, Cotter Dolomite, Jefferson City Dolomite, Roubidoux Formation, and the Gasconade Dolomite. The sub-basin also contains some undifferentiated Ordivician strata.

Karst features[15]

Karst topography is generally formed over carbonate bedrock such as limestone and dolomite by dissolving or solution. It is often characterized by sinkholes, caves, underground drainage and losing streams. Twenty-one (21) named and fifty-two (52) unnamed springs are located in this sub-basin, a well-developed karst region. The 6 largest springs have flows up to 1 cubic feet per second (cfs), while the remaining springs have flows of less than 0.2 cfs or unmeasured flow. Five hundred thirty-nine (539) sinkholes are mapped in the area. One hundred thirteen (113) caves are also documented. Twenty-eight dye tracings have been completed by Missouri Department of Natural Resources (MoDNR) Division of Geology and Land Survey (DGLS). These established flow paths of up to 10 miles between a losing streams and springs in the sub-basin. As noted in section 2.5, 166 miles of streams are considered gaining streams while 53 miles are designated losing streams.

Resource Concerns

Resource concerns are issues related to the natural environment. Natural resources include soil, water, air, plants, animals, and humans. Field office personnel of the USDA-Natural Resources Conservation Service were asked to complete inventory sheets in order to identify the 4 primary resource concerns for 5 landuse categories within the Lower Missouri River Watershed (Hydrologic Unit 10300200). The identified concerns are: PASTURELAND - (1) soil erosion-classic gully; (2) plant condition-productivity, health, and vigor; (3) plant condition-forage quality and palatability; (4) domestic animals-inadequate stock water. CULTIVATED CROPLAND - (1) soil erosion-sheet and rill; (2) soil erosion-streambank; (3) soil condition-compaction; (4) water quantity-excessive runoff, flooding, or ponding. DEVELOPED LAND - (1) water quantity-excessive seepage; (2) water quantity-excessive runoff, flooding, or ponding. FORESTLAND - (1) soil erosion-classic gully; (2) soil erosion-streambank; (3) soil erosion-road, roadsides, and construction sites; (4) plant condition-productivity, health, and vigor. NON-CULTIVATED CROPLAND - (1) soil erosion-sheet and rill; (2) plant condition-productivity, health, and vigor; (3) plant condition-noxious and invasive plants; (4) plant condition-forage quality and palatability.

Figure 11

Resource Concerns/Issues by Land Use

Soil, Water, Air, Plant, Animal, plus Human (SWAPA+H) Concerns	Specific Resource Concern/Issue	Pasture/Grass	Cropland	Non-Cultivated Cropland	Forestland	Urban	Floodplain	Developed Land	Water
Soil Erosion	37% of all cultivated cropland eroding at levels above “T”		X						
	Erosion on streambanks and streambeds	X	X		X		X		
	Erosion and runoff from construction sites					X			
	Erosion from ephemeral gullies		X						
	Erosion from classical gullies	X	X	X	X				
Sedimentation	Damage to waterbodies, increased flooding						X		X
Prime Farmland	5,800 acres lost between 1982 and 1997	X	X		X		X		
Water Quantity	Excessive seepage, runoff, flooding or ponding							X	
Water Quality	Cultivated cropland primary nonpoint source of pollutants		X						X
	Watkins Cr. (St. Louis Co.) not meeting water quality standards								X
Floodplains	Nearly 192,500 acres fall within the 100-year flood area						X		
Riparian Corridors	Certain riparian zones unprotected or vulnerable	X	X			X	X		

Soil Erosion

- Streambank, streambed, and classical gully erosion occurs in pasture/grassland, cropland, forestland, and urban areas. However, due to a lack of reliable data at the sub-basin (8-digit hydrologic unit) level, the degree and amount of soil loss from these sources is not known.
- Ephemeral gully erosion occurs primarily on cultivated cropland eroding at levels above the tolerable limit ("T"). No sub-basin level data are available to determine the degree and extent.
- An estimated 37 percent (80,500 acres) of all cultivated cropland is eroding at levels above "T".
- The estimated USLE soil loss on highly erodible, cultivated cropland (eroding above "T") is 15.4 tons/acre/year

Sedimentation

- Sedimentation can reduce the useful life of ponds, lakes, reservoirs, and wetlands and can increase the severity and frequency of flooding by reducing the water carrying capacity of streams and rivers.**Soil Quality**

Soil Quality

- Soil erosion is a primary contributor to soil quality degradation. This limits the productivity and sustainability of the soil resource.

Water Quality

- Highly erodible and cultivated cropland with USLE soil losses above tolerable limits ("T") are a primary non-point source of sediment, nitrogen, and phosphorus pollutants that enter the stream system.
- One sub-basin waterbody in St. Louis County (Watkins Creek) appears on the 303(d) list and is not meeting water quality standards. The pollutant listed is bacteria.

Floodplains

- An estimated 192,456 acres fall within the 100-year return period flood area. This can result in damages to crops, pastures, and other resources, as well as damages to roads, bridges, and buildings.

Riparian Corridors

- The data suggest that about 33 percent of the riparian corridors, primarily in cropland, pasture/grass, and urban areas, are unprotected or vulnerable. Protected riparian corridors can act as filters to trap nutrients, sediment, and other pollutants.

A. Soils

The soils of this sub-basin vary widely, depending on their parent materials and location on the landscape. Most of the upland soils formed in loess (silty wind blown material). The loess deposits are thickest in the upland areas adjacent to the Missouri River. Soils on the steep slopes further away from the Missouri River formed in residuum or colluvium weathered predominantly from cherty limestone, dolomite, or sandstone.

Soils in the deep loess deposits near the Missouri River formed under forest vegetation. As a result they have thin, silt loam surface texture. The subsoil is typically silty clay loam or silty clay which is underlain by several feet of relatively unweathered silt loam. These soils are very deep and range from well drained to somewhat poorly drained.

Soils formed from material weathered from the Mississippian or Ordovician age geology are variable in depth, ranging from shallow to very deep. The less sloping areas have a mantle of loess, while the steeper back slope areas formed entirely in residuum or colluvium. These soils typically formed under forest or savanna type vegetation and have relatively thin surface layers. The subsoils are variable in texture. These soils are typically somewhat excessively drained to moderately well drained.

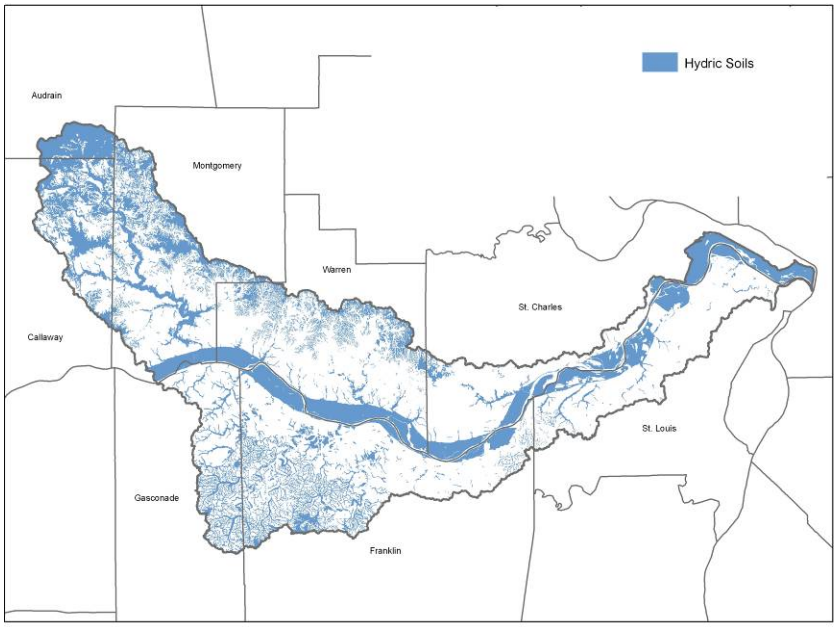
A few upland soils in the north part of this sub-basin formed in glacial till overlain by loess. These soils formed under prairie or savanna type vegetation and have moderately thick silt loam surface layers. The subsoil is clay loam or silty clay. Drainage is moderately well to somewhat poorly.

The floodplain and terrace soils along the Missouri River and its tributaries form in alluvium. They are very deep and are highly variable in texture and drainage. Texture ranges from sand to clay, and drainage from excessive to poorly. The soils along the Missouri River are relatively gravel free, while the soils along the tributary streams range from non-gravelly to very gravelly.

Hydric Soils[5]

Hydric soils are those that developed under sufficiently wet conditions (saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions) to support the growth and regeneration of hydrophytic (water-loving) vegetation. Soils that are sufficiently wet because of artificial measures are included in hydric soils.

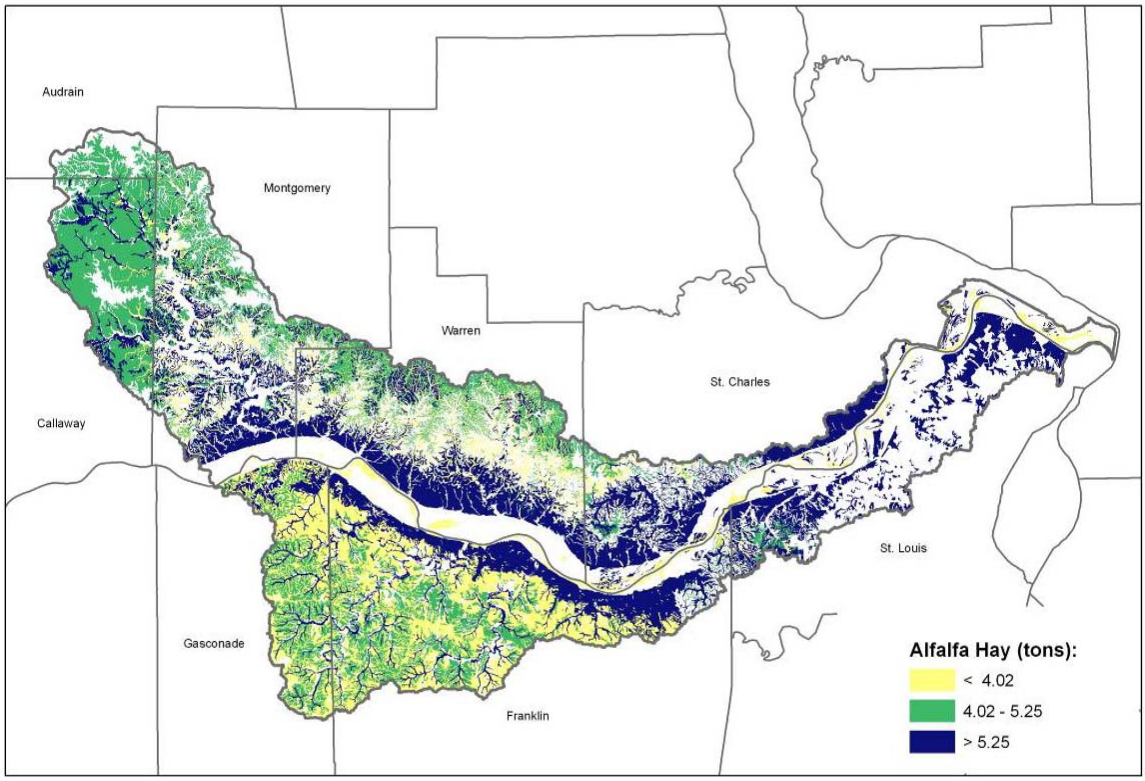
Figure 12



Pasture Productivity[5,35]

“Alfalfa is the most productive legume for Missouri, with potential yields exceeding six tons of hay per acre on good soils. Unlike red or white clover, established alfalfa is productive during midsummer except during extreme drought. Alfalfa is a tap-rooted crop and can last five years and longer under proper management. Whether grazed or fed as hay, alfalfa is an excellent forage for cattle and horses. Alfalfa is best adapted to deep, fertile, well-drained soils with a salt pH of 6.0 to 6.5, but it can be grown with conservative management on more marginal soils.”

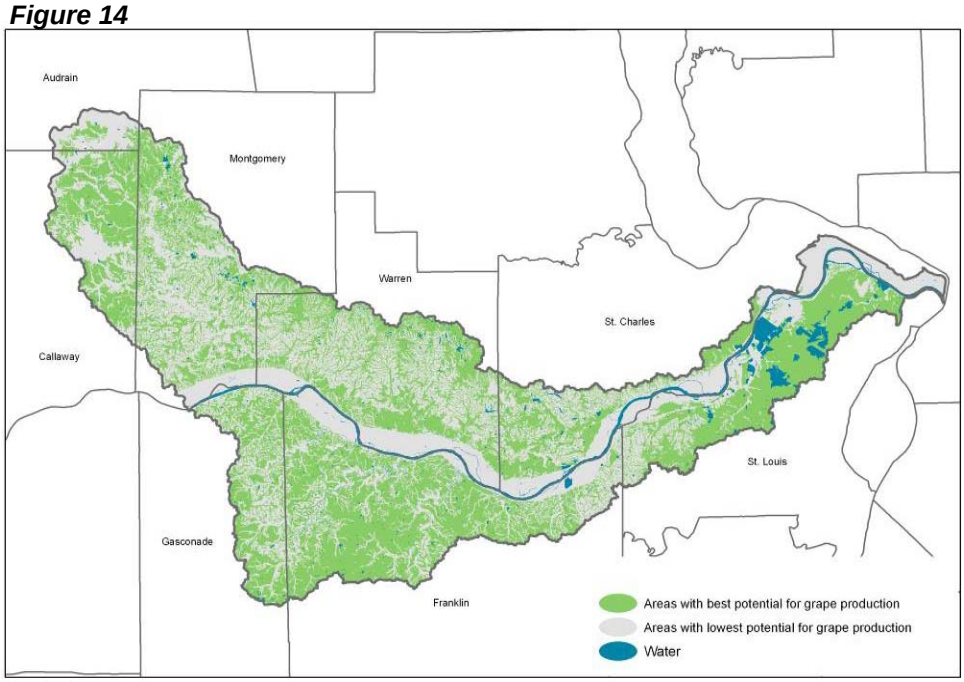
Figure 13—Alfalfa Hay Yield Estimate



Grape Production[5]

There are many soils that have a good potential for grape production. Limiting factors include site and soil properties such as clayey subsoil, low available water capacity, high seasonal water tables, low organic matter, flooding and ponding. Most of the limitations can be overcome with some type of corrective management measure.

Figure 14



B. Soil Erosion[16]

The objectives of this section are to profile cropland erosion rates and identify cropland areas within the Lower Missouri River sub-basin that would benefit the most from the application of conservation practices to limit sediment loss.

"**The production practices and inputs used by agriculture can result in a number of pollutants entering water resources, including sediment, nutrients, pathogens, pesticides and salts." (USDA-Economic Research Service).**

"Sediment is the largest contaminant of surface water in the United States by weight and volume (Koltun et al., 1997) and the second leading pollution problem in rivers and streams and third leading problem in lakes" (USEPA, 2002).

Sediment losses from soil erosion on cropland, streambanks and streambeds and runoff from construction sites and developed land are an ongoing resource concern throughout the Lower Missouri River sub-basin. Cropland and pastureland are the primary nonpoint source of sediment loss in this heavily forested sub-basin and together account for 38 percent of the sub-basin's total surface area. In sub-basins like the Lower Missouri River, the acres most in need of conservation treatment are those with waterborne sediment, nitrogen and phosphorus losses.

The consequences of excessive soil erosion are well known. Waterborne sediments are inextricably linked to degraded water quality through turbidity and loss of fertilizers and pesticides attached to soil particles. Suspended sediments degrade aquatic habitats, increase water treatment costs and marginalize water recreation. Sedimentation reduces the useful life of ponds, lakes and reservoirs; increases the probability and severity of flooding; and clogs drainage networks. Excessive soil erosion is a primary contributor to soil quality degradation, limiting the productivity and sustainability of the soil.

This assessment concentrates on sheet and rill erosion on cropland for which there are scientifically based soil erosion estimates for the entire sub-basin. This focus does not suggest that sedimentation related to urban stormwater runoff, stream bank erosion, classical gully erosion and ephemeral gully erosion on cropland is not significant in volume or impact. However, there is a lack of reliable data at the sub-basin level for these other sources of sediment. The erosion rate data have been extracted from the 1997 National Resources Inventory (NRI). Erosion rates and their relationship to "T" values are reported in tons/acre/year for cultivated cropland and non-cultivated cropland on highly erodible and non-highly erodible land. Also included are erosion rates and their relationship to "T" values for pastureland.

Universal Soil Loss Equation (USLE) Cropland Erosion Rates in Tons/Acre/Year[2]

USLE - This table reports estimated soil loss rates from the 1997 NRI based on the Universal Soil Loss Equation (USLE). USLE estimates average annual sheet and rill soil movement down a uniform slope using rainfall energy as the erosive force acting on the soil. Soil characteristics and slope for the fields in which the NRI sample points fall or those portions of the fields surrounding the points that would be considered in conservation planning are used in the NRI USLE calculations.

"T" FACTOR – This is the maximum rate of annual soil erosion that will still permit crop productivity to be sustained economically and indefinitely.

HEL – Highly erodible land (HEL) is land that has an erodiblity index (EI) value of 8 or more. The EI index provides a numerical expression of the potential for a soil to erode, considering the physical and chemical properties of the soil and climatic conditions where it occurs. The higher the index value, the greater the investment needed to maintain the sustainability of the soil if intensively cropped.

Figure 15

USLE Cropland Erosion Rates Tons/Acre/Year[2]

CROPLAND CATEGORY	CULTIVATED CROPLAND	NON-CULTIVATED CROPLAND
HIGHLY ERODIBLE LAND (HEL)		
HEL Eroding at or below "T"	2.04	1.17
HEL Eroding above "T"	15.4	0
All HEL	12.91	1.17
NON-HIGHLY ERODIBLE LAND (Non-HEL)		
Non-HEL Eroding at or below "T"	2.16	0.23
Non-HEL Eroding above "T"	5.21	0
All Non-HEL	2.5	0.23
ALL CROPLAND		
All Land Eroding at or below "T"	2.15	0.83
All Land Eroding above "T"	13.5	0
All Land	6.38	0.83

Cropland Erosion in Relationship to "T"[2]

This table reports acres and percentages of cultivated cropland, non-cultivated cropland and all cropland by HEL and "T" categories for the sub-basin.

Cultivated Cropland

CROPLAND CATEGORY	Total Acres	% of Cropland Category	% of all Cropland	% of Sub-basin
HEL				
Highly Erodible Cropland at or below "T"	15,100	19%	7%	1%
Highly Erodible Cropland above "T"	65,300	81%	30%	6%
TOTALS FOR HIGHLY ERODIBLE CROPLAND	**80,400**	**100%**	**37%**	**7%**
NON-HEL				
Non-Highly Erodible Cropland at or below "T"	120,200	89%	56%	12%
Non-Highly Erodible Cropland above "T"	15,200	11%	7%	1%
TOTALS FOR NON-HIGHLY ERODIBLE CROPLAND	**135,400**	**100%**	**63%**	**13%**
GRAND TOTALS	**215,800**	**100%**	**100%**	**20%**

Non-Cultivated Cropland

CROPLAND CATEGORY	Total Acres	% of Cropland Category	% of all Cropland	% of Sub-basin
HEL				
Highly Erodible Cropland at or below "T"	44,900	100%	63%	4%
Highly Erodible Cropland above "T"	0	0%	0%	0%
TOTALS FOR HIGHLY ERODIBLE CROPLAND	**44,900**	**100%**	**63%**	**4%**
NON-HEL				
Non-Highly Erodible Cropland at or below "T"	25,900	100%	37%	3%
Non-Highly Erodible Cropland above "T"	0	0%	0%	0%
TOTALS FOR NON-HIGHLY ERODIBLE CROPLAND	**25,900**	**100%**	**37%**	**3%**
GRAND TOTALS	**70,800**	**100%**	**100%**	**7%**

All Cropland

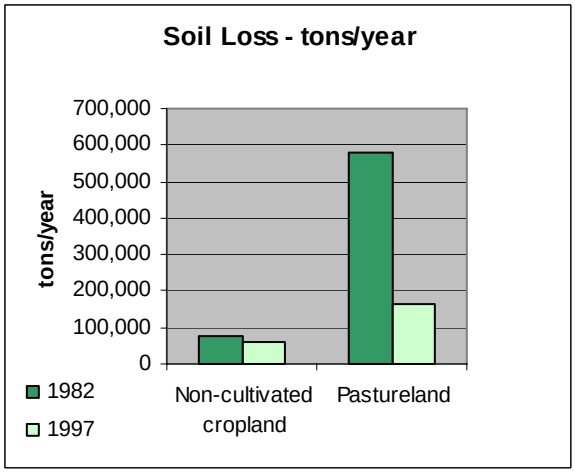
CROPLAND CATEGORY	Total Acres	% of Cropland Category	% of all Cropland	% of Sub-basin
HEL				
Highly Erodible Cropland at or below "T"	60,000	48%	21%	6%
Highly Erodible Cropland above "T"	65,300	52%	23%	6%
TOTALS FOR HIGHLY ERODIBLE CROPLAND	**125,300**	**100%**	**44%**	**12%**
NON-HEL				
Non-Highly Erodible Cropland at or below "T"	146,100	91%	51%	14%
Non-Highly Erodible Cropland above "T"	15,200	9%	5%	1%
TOTALS FOR NON-HIGHLY ERODIBLE CROPLAND	**161,300**	**100%**	**56%**	**15%**
GRAND TOTALS	**286,600**	**100%**	**100%**	**27%**

Pastureland Erosion[2]

This table reports USLE rates and acres in relationship to “T” for pastureland (tons/acre/year).

PASTURELAND CATEGORY	Total Acres	% of Category	USLE tons/acre/year	% of Sub-basin
HEL				
Highly Erodible Cropland at or below "T"	0	0%	0	0%
Highly Erodible Cropland above "T"	0	0%	0	0%
TOTALS FOR HIGHLY ERODIBLE CROPLAND	**0**	**0%**	**0**	**0%**
NON-HEL				
Non-Highly Erodible Cropland at or below "T"	98,300	95%	1.4	10%
Non-Highly Erodible Cropland above "T"	5,000	5%	4.96	0.004%
TOTALS FOR NON-HIGHLY ERODIBLE CROPLAND	**103,300**	**100%**	**1.57**	**10%**
GRAND TOTALS	**103,300**	**100%**	**1.57**	**10%**

USLE Soil Loss Rates (tons/year)[2]



Non-cultivated Cropland

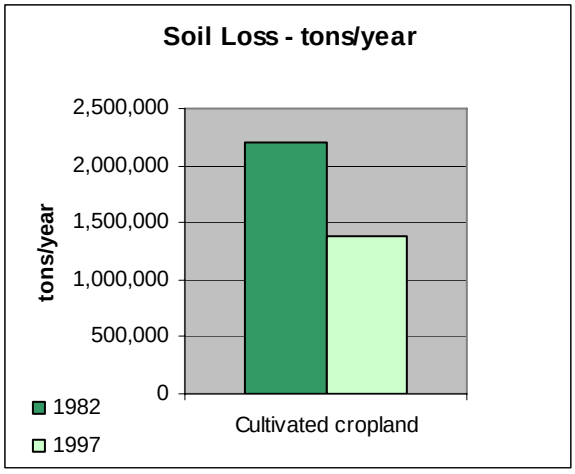
1982 78,200 tons per acre

1997 58,800 tons per acre

Pastureland

1982 582,000 tons per acre

1997 163,100 tons per acre



Cultivated Cropland

1982 2,207,100 tons per acre

1997 1,378,200 tons per acre

C. Water Quality

303d Listed Waters[17]

Section 303(d) of the federal Clean Water Act requires that each state identify waters that are not meeting water quality standards and for which adequate water pollution controls have not been required. Water quality standards protect such beneficial uses of water as whole body contact and secondary contact recreation, maintaining fish and other aquatic life, and providing drinking and processing water for people, wildlife, livestock and industry. The 303(d) list helps state and federal agencies keep track of waters that are impaired but not addressed by normal water pollution control programs.

Figure 16

Water Body	County	Pollutant	Impaired Use(s)*	Other Designated Uses*
Watkins Creek	St. Louis	Bacteria	AQL, WBC	FC, LWW

*** Impaired and Other Designated Uses:**

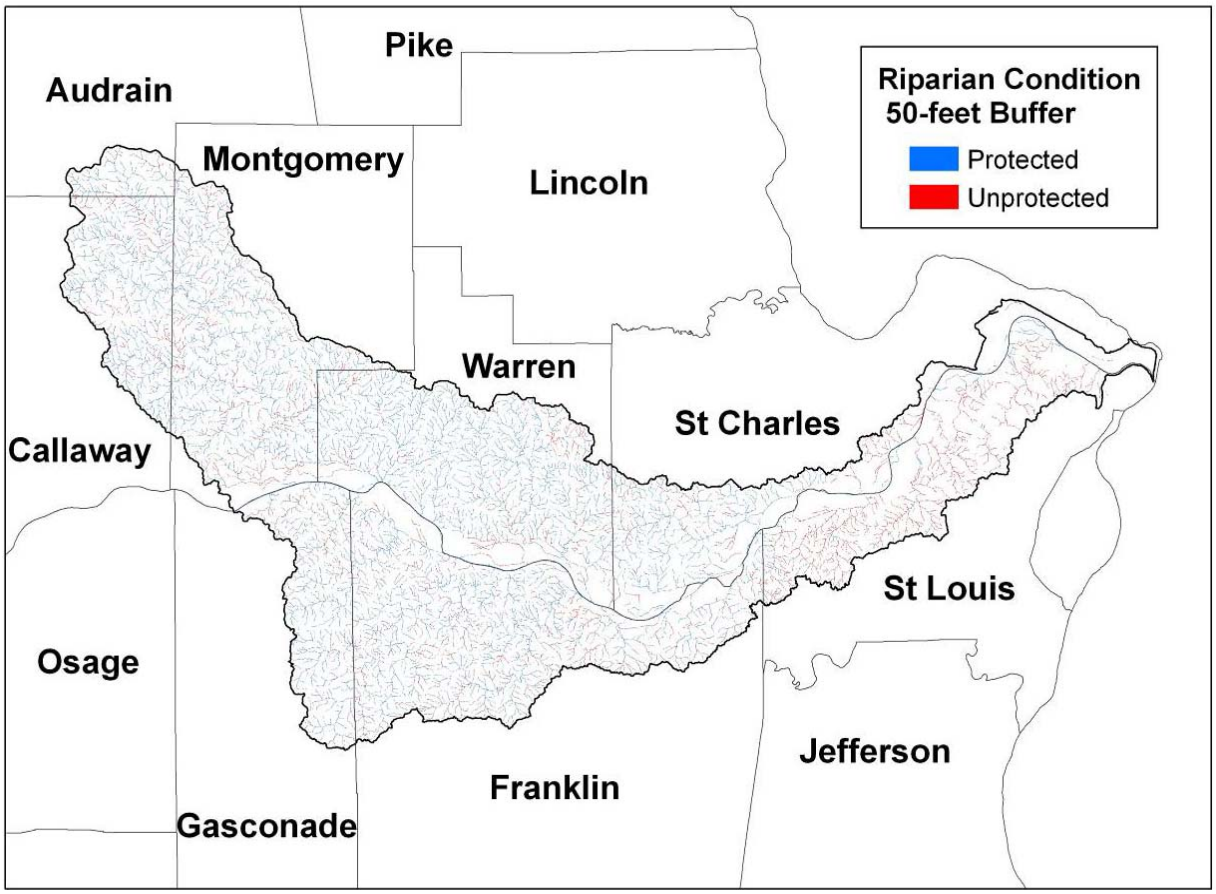
AQL Protection of Aquatic Life (Warm, Cool or Cold Water)
FC Fish Consumption
WBC Whole Body Contact
SCR Secondary Contact Reaction
DWS Drinking Water Supply
IRR Irrigation
LWW Livestock and Wildlife Watering
IND Industrial

Riparian Corridor Condition[8,18]

The condition of the riparian zone adjacent to streams has a critical impact on water quality. Permanent and deeply-rooted streambank vegetation slows run-off of nutrients and pollutants, and reduces sedimentation and solar heating. NRCS riparian practice standards specify 50-feet vegetated buffers along first and second order streams and 100-feet for third order and higher streams.

The 1:24,000 National Hydrologic Dataset (NHD) stream network is the highest resolution stream representation available consistently for the sub-basin states. Stream order is not an attribute of these data; therefore, the streams were all buffered by 50-feet to give the most conservative representation of riparian condition. Buffered streams were used to subset the common land unit (CLU) data, land parcel data developed and maintained by the USDA-Farm Service Agency. The land cover attribute in the CLU was used to characterize the vegetative condition of the buffers. Cropland (which includes pasture and hayland), urban, mined and barren cover types were considered “unprotected” or vulnerable riparian conditions, while forestland, rangeland and water were considered “protected”. Results are presented by county and sub-basin in the table and map below.

Figure 17



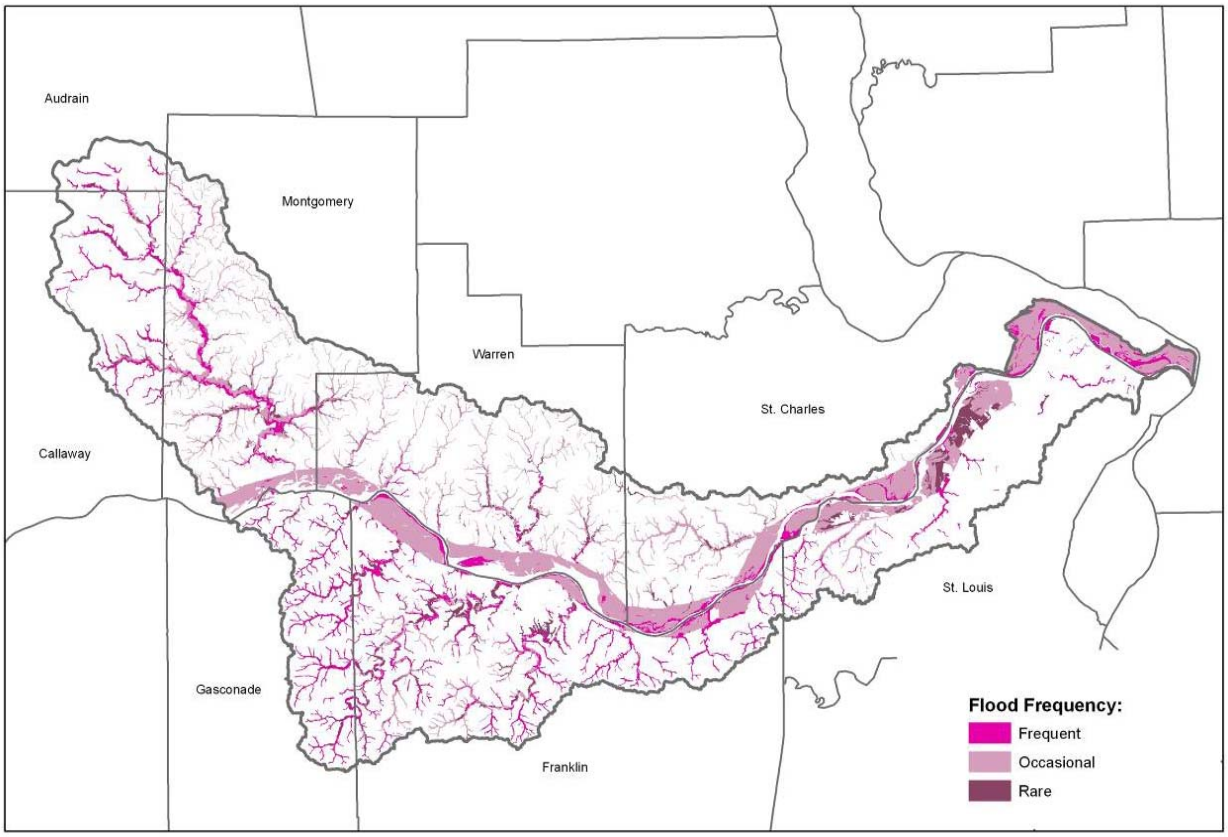
County	Stream Miles (in sub-basin)	50-ft. Stream Buffer (in acres)	Percent Protected
Audrain	71	854	63%
Callaway	359	4,288	71%
Gasconade	292	3,507	76%
Franklin	942	11,289	70%
Montgomery	659	7,917	72%
St. Charles	368	3,877	66%
St. Louis	445	5,333	20%
Warren	783	9,396	81%
Total in Sub-basin	**3,919**	**46,461**	**67%**

Flooding Frequency[5]

Flooding frequencies are defined by the number of times flooding occurs over a period of time and expressed as a class. The classes of flooding are defined as follows:

- Rare—Flooding unlikely but possible under unusual weather conditions; 1 to 5 percent chance of flooding in any year or nearly 1 to 5 times in 100 years
- Occasional—Flooding is expected infrequently under usual weather conditions; 5 to 50 percent chance of flooding in any year or 5 to 50 times in 100 years.
- Frequent—Flooding is likely to occur often under usual weather conditions; more than a 50 percent chance of flooding in any year or more than 50 times in 100 years, but less than a 50 percent chance of flooding in all months in any year.

Figure 18—Flooding Frequency in the Lower Missouri River Sub-basin



D. Water Quantity

Public Water Supply[20,21,22,23]

Missouri's 5.8 million residents draw their water supplies from ground and surface sources that vary tremendously in both quality and quantity. These variations are, to a large extent, controlled by geology and land use. North of the Missouri River, herbicides, sediments, and nutrients are the primary concerns in surface water sources while well sources contend with heavy mineralization, nitrates, and pesticides. In the Ozark Highlands, ground water, the primary water supply source, is vulnerable to aquifer degradation from contaminated surface runoff and leachates through highly permeable soils and bedrock. Missouri's alluvial aquifers supply large quantities of high quality water, primarily to population centers located near the larger rivers and the Mississippi embayment covering most of the southeastern corner of the state. Shallow wells are vulnerable to nitrate and pesticide contamination and the deeper wills in highly urbanized areas are at risk from a wide variety of chemical pollutants.

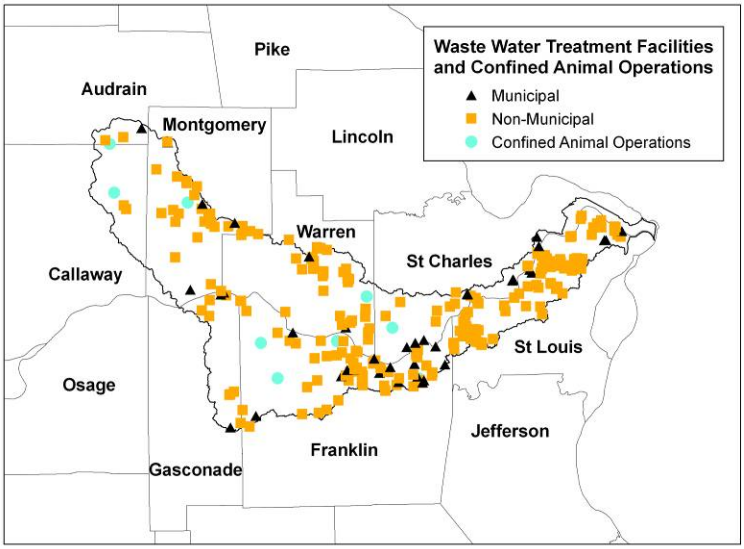
Detailed information is available for individual public drinking supply systems and the spatial distribution of other drinking water supply features (wells, intakes, tanks, treatment plants, pumping stations, springs, and lakes) from MDNR. The 2006 Missouri Water Quality Report provides current water quality assessments and summarizes water quality issues around the state. The 2007 Census of Missouri Public Water Systems is a comprehensive description of city, water district, subdivision, and non-community water systems including type of treatment processes and chemical analyses of community water systems. The 2005 Missouri Water Supply Study provides detailed technical hydrologic and water resource engineering data for drought planning for 34 community water systems in north and west central Missouri.

Waste Water Treatment Facilities and Concentrated Animal Feeding Operations[19]

The National Pollutant Discharge Eliminations System (NPDES) facilities database is a point data set depicting outfall locations of waste water facilities requiring and holding NPDES operating permits. One type of NDPES facility is a concentrated animal feeding operation, or CAFO. A CAFO is defined as having more than 7000 animal units confined in an area with less than 50% vegetation ground cover. Smaller animal unit operations may be designated a CAFO if they discharge directly into waters of the State or have a post history of discharge violations. The animal unit is a unit of measurement to compare waste produced by various animal types, using one beef feeder as a reference.

The Lower Missouri sub-basin has 11 hog and 1 dairy CAFO. It has 46 municipal and 259 non-municipal waste water facilities. The municipal sites are for sewage treatment while the non-municipal sites are industry, services, schools and sewage treatment for unincorporated developed areas.

Figure 19



E. Forestry

Forests cover about a third of Missouri - forests containing some of the finest oak, walnut, and red cedar found anywhere. Forests are Missouri's greatest renewable resource, providing many economic, environmental and social benefits. They protect hillsides from erosion, keeping streams and rivers clean. They filter the air, soften the extremes of the weather, and add beauty to cities and towns. Much of Missouri's recreation and tourism industry is centered in the forested regions of the state. And forests are a diverse resource of plants, animals, birds, and other life forms. Annual growth of forests in Missouri far exceeds the amount harvested, ensuring ample forests for future generations. The majority of tree species are hardwoods with softwoods locally important in certain regions of the state. Forest products are also important to Missouri. Harvesting and processing trees into wood products gives thousands of people jobs and contributes about $3 billion each year to Missouri's economy. Private landowners control 85 percent of the forest land in Missouri. Most of these private forested acres in Missouri are not following a management plan.

The following tables for this sub-basin are based on data compiled from The Forest Inventory and Analysis (FIA) Program of the U.S. Department of Agriculture (USDA) Forest Service. Information from USDA-Forest Service, National Forest Inventory and Analysis Database, 2005 is available at www.fia.fs.fed.us/tools-data/default.asp.

Area of Forestland by Ownership in Sub-Basin

Private	162,629 acres
Federal	21,214 acres
State	0 acres
County and municipal	0 acres
Other	0 acres
Total	183,843 acres

Area of Forestland by Stocking Class in Sub-Basin

Overstocked	1,669 acres
Fully stocked	54,659 acres
Medium stocked	77,259 acres
Poorly stocked	46,499 acres
Non-stocked	3,757 acres
Total Growing Stock	183,843 acres

Area of Forestland by Productivity Site Class in Sub-Basin

165-224	0 acres
120-164	0 acres
85-119	14,523 acres
50-84	63,832 acres
0-49	105,488 acres
Total	183,843 acres

Net Volume of Growing Stock on Forestland by Species Type in Sub-Basin

Softwoods	12,854,346 cubic feet
Hardwoods	143,794,684 cubic feet
Other	0 cubic feet
Total	156,649,030 cubic feet

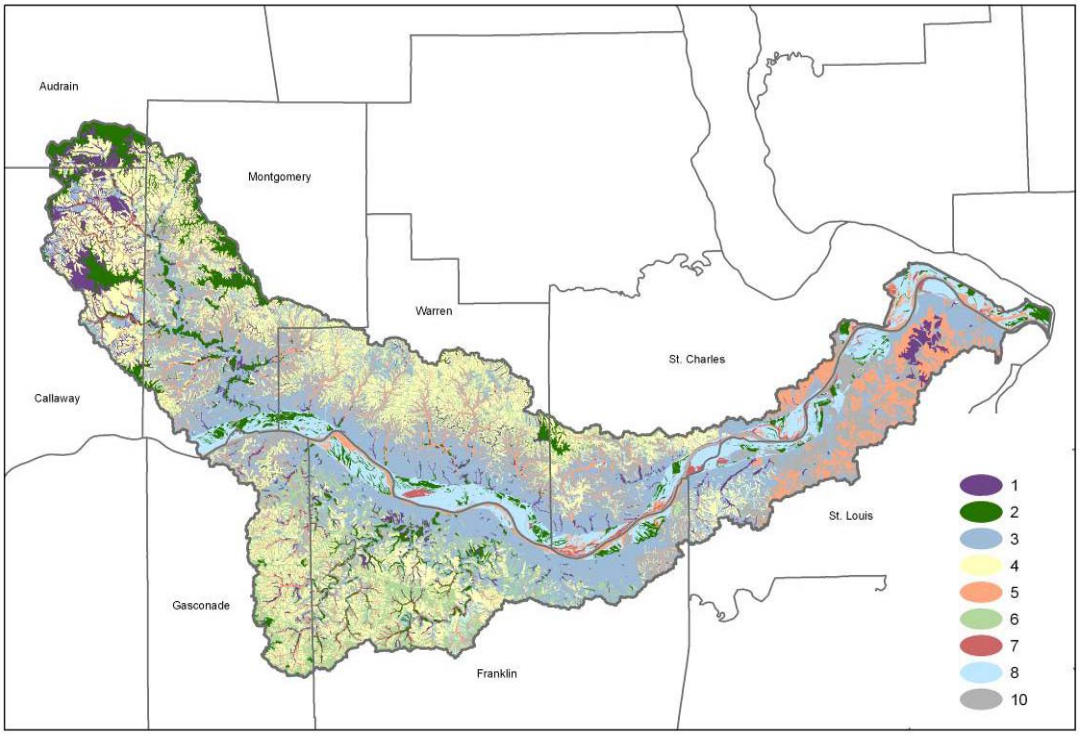
Forest Productivity[5]

This information can help forestland owners or managers plan the use of soils for wood crops. It shows the potential productivity of the soils for wood crops by Conservation Tree and Shrub Groups (CTSG).

The CTSGs were developed by foresters and soil scientists from soil properties stored in USDA's National Soils Information System (NASIS). A report build in NASIS "automatically" evaluates specific soil properties directly related to growth. The properties include: depth to limiting layer (water table, limiting layer, bedrock, etc.), available water capacity, calcium carbonates, pH, flooding frequency and duration.

Vegetation examples are commonly grown trees that forestland managers prefer for planting, seeding, or natural regeneration and those that remain in the stand after thinning or partial harvest.

Figure 20



CSTG Definitions:

- **Group 1 - 5% of sub-basin**
  Soils in CTSG-1 are somewhat poorly drained to moderately well-drained and at least moderately deep. They receive beneficial moisture or have a **seasonable high water table from .5-1.5 feet** during the growing season. Flooding frequency ranges from none to rare. The **available water capacity is at least 3 inches.** Sodium adsorption rates are less than 1. Subgroups may be acid, clayey, shallow, flooded, calcareous, strongly contrasting horizon, or sandy.

  Vegetation examples: Shumard Oak, Red Maple, Shingle Oak, Bur Oak, Pecan, American Sycamore, Shellbark Hickory, American Basswood, Musclewood, Eastern Cottonwood

- **Group 2 – 7% of sub-basin**
  Soils in CTSG-2 are poorly drained or very poorly drained and at least moderately deep. They have a

seasonal high water table from 0-.5 feet during the growing season. Flooding frequency ranges from none to rare. Available water capacity is greater than 3 inches. This group also **includes peat, muck, or muck-peat soils**. Sodium adsorption rates are less than 1. Subgroups may be acid, clayey, shallow, flooded, organic, calcareous, or sandy.

Vegetation Examples: Green Ash, Red Maple, Black Willow, Pecan, Silver Maple, River Birch, Swamp White Oak, Pin Oak, Green Hawthorn, Pecan

- **Group 3 – 24% of sub-basin**
  Soils in CTSG-3 are deep loamy, moderately well drained to well drained soils. The **depth to a water table during the growing season is greater than 1.5 feet.** Flooding frequency ranges from none to rare. The **available water capacity is at least 9 inches**. **Soil depth is greater than 40 inches to a restrictive layer.** Sodium adsorption rates are less than 1. Subgroups may be acid, flooded, or calcareous.

  Vegetation examples: Blackgum, Tuliptree, Scarlet Oak, Cucumber-tree, Shumard Oak, White Ash, Black Cherry, Eastern Redbud, Flowering Dogwood, Serviceberry, Kentucky Coffeetree

- **Group 4 – 22% of sub-basin**
  Soils in CTSG-4 are moderately well to well drained with **some or all horizons that are clayey or clayey skeletal or fine and very fine.** The depth to a water table during the growing season is at least 1.5 feet. Flooding frequency ranges from none to rare. The available water capacity is at least 6 inches. Soil depth is at least 40 inches to a restrictive layer. Sodium adsorption rates are less than 1. Subgroups may be acid, clayey, flooded, calcareous, or dry.

  Vegetation examples: Pignut Hickory, Black Hickory, Blue Ash, Shortleaf Pine, Southern Red Oak, Mockernut Hickory, Persimmon, White Oak, Black Oak, Flowering Dogwood

- **Group 5 – 8% of sub-basin**
  Soils in CTSG-5 are deep **loamy moderately well to well drained with moderate AWC**. Depth to the water table is at least 1.5 feet. Flooding frequency ranges from none to rare. The **available water capacity is between 6 and 9 inches.** Sodium adsorption rates are less than 1. Subgroups may be acid or flooded.

  Vegetation examples: Shortleaf Pine, Sassafras, Northern Red Oak, Shagbark Hickory, Red Mulberry, Post Oak, Bur Oak, Eastern Redcedar, American Sycamore, American Cottonwood

- **Group 6 – 10% of sub-basin**
  Soils in CTSG-6 are moderately well to well drained with a **root restrictive zone (bedrock, fragipan, sand and gravel) at 20-40 inches**. Flooding frequency ranges from none to rare. The depth to a water table during the growing season is at least 1.5 feet. The available water capacity is 6 inches or less. Sodium adsorption rates are less than 1. Subgroups may be acid, calcareous, or strongly contrasting horizon.

  Vegetation examples: Sweet Crabapple, Big Tree Plum, Blackgum, Pignut Hickory, Sassafras, Scarlet Oak, Shortleaf Pine, Slippery Elm, Blackjack Oak, Cockspur Hawthorn

- **Group 7 – 1% of sub-basin**

Soils in CTSG-7 **have a sandy texture for all horizons**. Soil depth is at least 40 inches. The available water capacity is at least 3 inches. Depth to water table during the growing season is greater than 6.5 feet. Flooding frequency ranges from none to rare. Sodium adsorption rates are less than 1. Subgroups may be wet.

Vegetation examples: Rock Elm, Black Hickory, Pignut Hickory, Slippery Elm, Black Oak, Chinkapin Oak, Blue Ash, Blackjack Oak, Persimmon, Post Oak

- **Group 8 – 7% of sub-basin**
  Soils in CTSG-8 are calcareous, **moderately deep to deep** and poorly drained to well-drained. Calcium carbonate percentages are greater than 15% but less than 40%. The depth to a water table during the growing season is greater than 1.5 feet. Flooding frequency ranges from none to rare. The available water capacity is at least 6 inches. Subgroups are clayey or wet.

  Vegetation examples: Northern Catalpa, Honeylocust, Black Willow, Bitternut hickory, Bur Oak, Shingle Oak, Hackberry, Eastern Cottonwood, Black Walnut

- **Group 10 – 14% of sub-basin**
  Soils in CTSG-10 have **one or more characteristics that are severely limiting to the planting and growth of trees and shrubs**. Soil depth is less than 20 inches; available water capacity is less than 3 inches; depth to a water table during the growing season is less than 0.5 feet; pH is less than 4.0 or greater than 8.5, sodium adsorption rate is greater than 25; flooding duration is very long. This group also includes urban land and water.

  Vegetation examples: none

F. Threatened and Endangered Species[24]

The Missouri Natural Heritage databases store locations, population status and habitat information about species and communities of conservation concern. The table below is a subset of the Heritage records that occur in the Lower Missouri sub-basin, restricted to federally threatened, endangered or candidate and state threatened or endangered species. While Heritage data can not prove the absence of a species in an area, it is the best collection available of known locations of sensitive species and is used to assess potential impacts of various land management activities in the region.

Figure 21

Species Common Name	Scientific Name	Threatened, Endangered, or Candidate	Federal or State Listing
Amphibians/Reptiles			
Blanding's Turtle	Emydoidea blandingii	Endangered	State
Birds			
American Bittern	Botaurus lentiginosus	Endangered	State
Bald Eagle	Haliaeetus leucocephalus	Threatened/ Endangered	Federal/ State
Barn Owl	Tyto alba	Endangered	State
King Rail	Rallus elegans	Endangered	State
Peregrine Falcon	Falco peregrinus	Endangered	State
Fish/Mollusks/Crustaceans			
Scaleshell	Leptodea leptodon	Endangered/ Endangered	Federal/ State
Sheepnose	Plethobasus cyphyus	Endangered	State
Mammals			
Gray Bat	Myotis grisescens	Endangered/ Endangered	Federal/ State
Indiana Bat	Myotis sodalis	Endangered/ Endangered	Federal/ State
Plants			
Decurrent False Aster	Boltonia decurrens	Threatened/ Endangered	Federal/ State
Running Buffalo Clover	Trifolium stoloniferum	Endangered/ Endangered	Federal/ State

Census and Social Data

A. Census Bureau[25]

Block group-level GIS data files from the 2000 Census were used to illustrate population, income and the agricultural cohort for the sub-basin. Spatial files were clipped by the sub-basin boundary. The percent of the block group falling in the watershed was calculated, and population figures were prorated by this value. Although this technique erroneously assumes even spatial distribution of population, it is a more accurate population count for the sub-basin than including the entire block group population.

Figure 22a. 1990 Population—The 1990 estimated population of the sub-basin was 414,190.

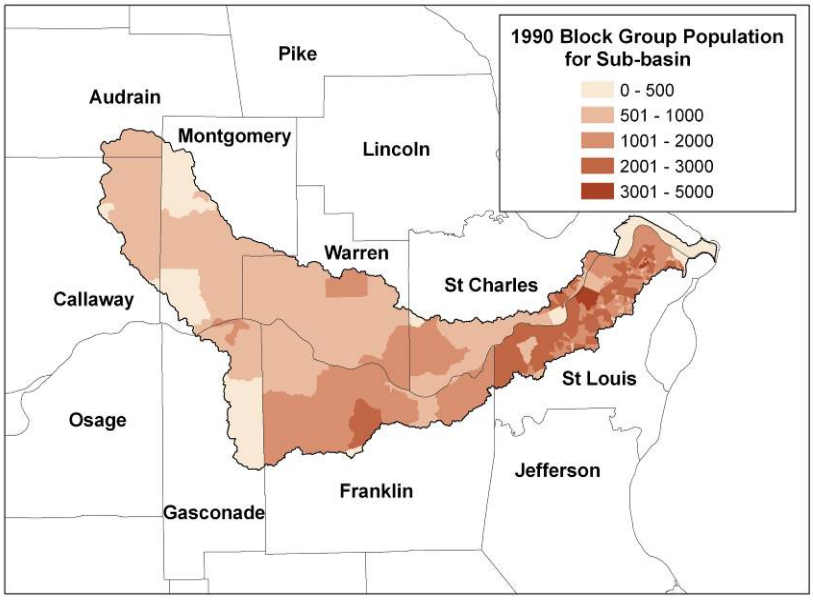
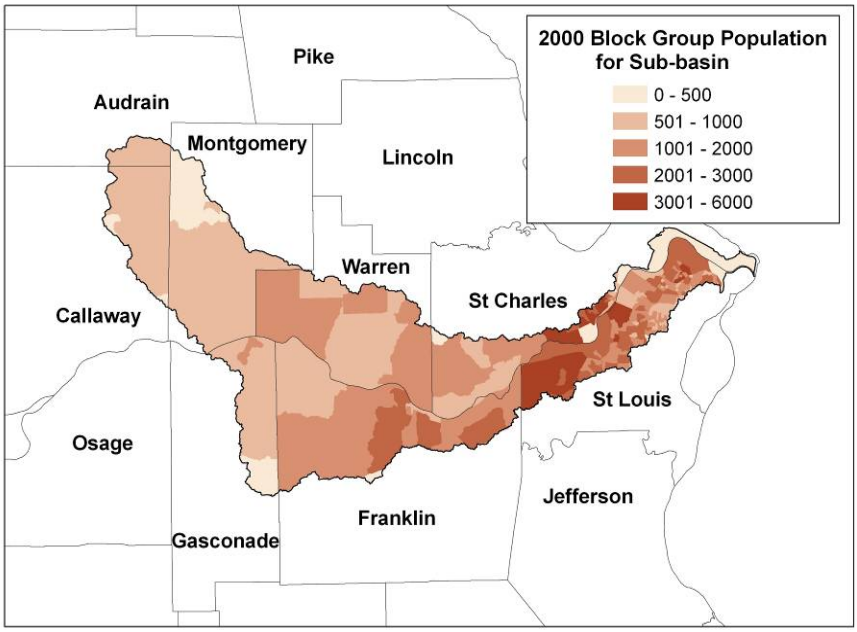


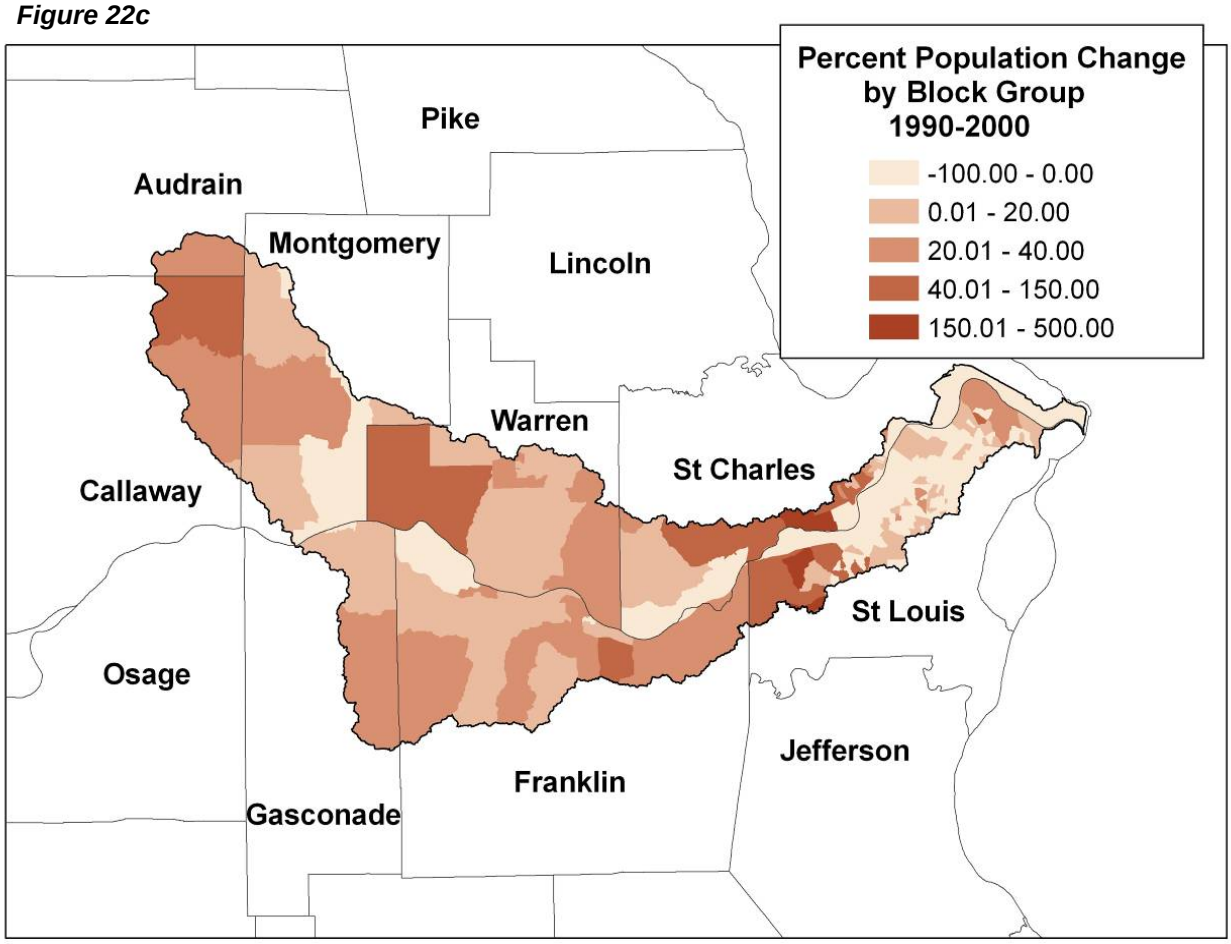
Figure 22b. 2000 Population—The 2000 estimated population of the sub-basin was 442,599.



Change in Population

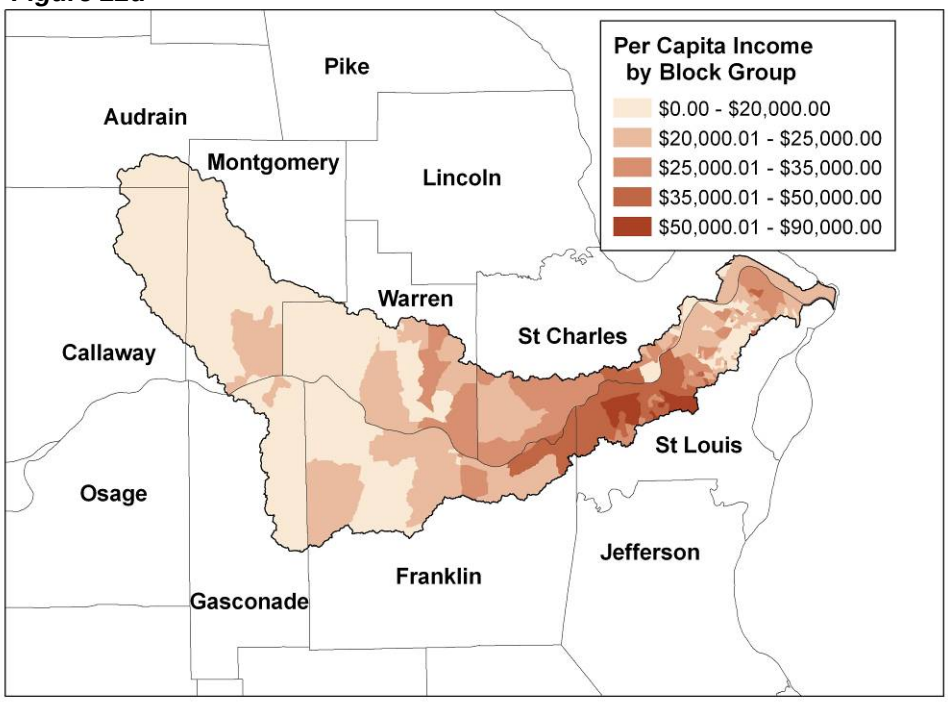
The 1990 estimated population of the sub-basin was 414,190 and grew to 442,599 by 2000, representing a 28,409 person increase or about 7 per cent. With a total of 340 block groups in the sub-basin, 171 showed a gain in population while 169 lost population.

Figure 22c



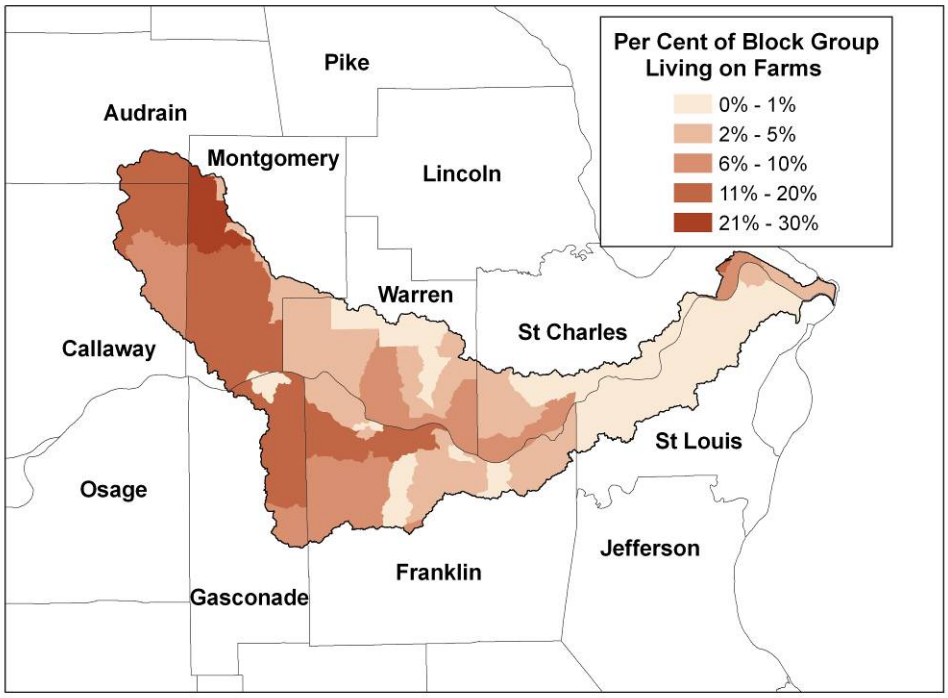
Income

Figure 22d



Farms

Figure 22e



B. Agricultural Census[27]

The data shown in the table are totals for complete counties. County land area acreages and percentages are supplied to assist the user in calculating sub-county estimates. Grazing livestock includes cattle, sheep, horses and ponies and goats.

Figure 23

COUNTY SUMMARY HIGHLIGHTS, 2002				
	Audrain	**Callaway**	**Franklin**	**Gasconade**
Farms	1,089	1,494	1,833	877
Land in Farms	415,192	357,517	300,212	222,214
Hogs & Pigs	32,471	49,501	56,903	15,639
Poultry	8,145	3,184	3,644	1,406
Cattle	47,630	55,761	46,846	36,508
Sheep	1,546	676	1,073	252
Horses & Ponies	2,125	2,463	2,591	975
Goats	180	851	698	449
Cropland Used only for Pasture or Grazing	24,797 acres	46,584 acres	46,906 acres	33,673 acres
Woodland pastured	9,797	23,924 acres	23,418 acres	27,938 acres
Permanent Pastureland and Rangeland	24,793 acres	55,158 acres	34,292 acres	26,712 acres
Pastureland, All Types	59,115 acres	125,666 acres	104,616 acres	88,323 acres
Percent Pastureland to All Land in Farms	14.2 %	35.1%	34.8%	39.7%
Sum of All Grazing Livestock	51,481	59,751	51,208	38,184
Pastureland per Animal	1.1 acres	2.1 acres	2 acres	2.3 acres

County Summary Highlights continued

COUNTY SUMMARY HIGHLIGHTS, 2002				
	Montgomery	**St. Charles**	**St. Louis**	**Warren**
Farms	761	739	328	670
Land in Farms	258,679	184,753	39,395	141,665
Hogs & Pigs	27,018	15,915	unavailable	18,712
Poultry	1,036	675	82	1,490
Cattle	761	8,390	1,194	11,617
Sheep	1,763	416	unavailable	560
Horses & Ponies	511	1,200	838	945
Goats	670	67	242	271
Cropland Used only for Pasture or Grazing	18,785	7,143 acres	2,090 acres	10,968 acres
Woodland pastured	16,267 acres	4,006 acres	1,311 acres	8,115 acres
Permanent Pastureland and Rangeland	22,661 acres	7,311 acres	1,924 acres	9,509 acres
Pastureland, All Types	57,713 acres	18,460 acres	5,325 acres	28,592 acres
Percent Pastureland to All Land in Farms	22.3%	10%	13.5%	20.2%
Sum of All Grazing Livestock	25,982	10,073	2,274	13,393
Pastureland per Animal	2.2 acres	1.8 acres	2.3 acres	2.1 acres

Status of Resources

A. PRS[28]

NRCS' Performance Results System (PRS) is a consolidated reporting system of conservation activities. The following tables summarize conservation systems and practices planned and applied in the sub-basin for the designated time periods. PRS data, in conjunction with other information, are used to assess the current state of the resources in the sub-basin and past efforts to address resource concerns.

FY = Fiscal Year

PRS Data	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	Average per Year
Total Acres Conservation Systems Applied	9,509	14,248	13,312	11,723	Not reported by Hydrologic Unit (HU)	9,626	10,523	18,424	12,858

Figure 24. Conservation Practices Applied

Summary Conservation Practices (PRS Number)	FY 05	FY 06	FY 07
Brush Management (314)			145 acres
Composting Facility (31)			1
Comprehensive Nutrient Management Plan (100)		2	1
Conservation Cover (327)	215 acres	1,690 acres	673 acres
Conservation Crop Rotation (328)	6,341 acres	4,255 acres	4,821 acres
Contour Farming (330)	448 acres	695 acres	1,513 acres
Cover Crop (340)	19 acres	17 acres	112 acres
Critical Area Planting (342)	8 acres	38 acres	27 acres
Dike (356)		2,550 feet	
Diversion (362)	1,600 feet	1,490 feet	2,371 feet
Early Successional Habitat Development/Management (647)	46 acres	58 acres	365 acres
Fence (382)	25,490 feet	113,747 feet	99,725 feet
Field Border (386)	600 feet	58,014 feet	8,916 feet
Filter Strip (393)	4 acres	101 acres	38 acres
Forage Harvest Management (511)	913 acres	583 acres	476 acres
Forest Stand Improvement (666)		99 acres	242 acres
Grade Stabilization Structure (410)	7	25	13
Grassed Waterway (412)	10 acres	501 acres	16 acres
Heavy Use Area Protection (561)			2 acres
Manure Transfer (634)	1	320	3

Conservation Practices Applied (continued)

Summary Conservation Practices	FY 05	FY 06	FY 07
Nutrient Management (590)	425 acres	828 acres	8,349 acres
Pasture and Hay Planting (512)	442 acres	774 acres	832 acres
Pest Management (595)	40 acres	557 acres	8,480 acres
Pipeline (516)	11,702 feet	32,260 feet	28,137 feet
Pond (378)	2	2	2
Prescribed Burning (338)		38 acres	
Prescribed Grazing (528)	111 acres	640 acres	913 acres
Prescribed Grazing (528A)	1,340 acres	146 acres	761 acres
Residue and Tillage Management, Mulch Till (345)		2,837 acres	1,314 acres
Residue and Tillage Management, No-Till/Strip Till/ Direct Seed (329)		1,253 acres	1,430 acres
Residue Management, Mulch Till (329B)	4,962 acres	534 acres	613 acres
Residue Management, No-Till/Strip Till (329A)	1,105 acres	142 acres	157 acres
Residue Management, Seasonal (344)	378 acres	147 acres	454 acres
Restoration and Management of Declining Habitats (643)	5 acres		
Riparian Forest Buffer (391)		26 acres	24 acres
Structure for Water Control (587)		2	
TA Design (911)		4	1
Terrace (600)	13,420 feet	17,380 feet	27,444 feet
Tree/Shrub Establishment (612)		11 acres	
Tree/Shrub Pruning (660)		2,000 acres	
Tree/Shrub Site Preparation (490)		13 acres	
Underground Outlet (620)	8,861 feet	7,406 feet	11,419 feet
Upland Wildlife Habitat Management (645)	123 acres	472 acres	1,108 acres
Use Exclusion (472)	510 acres	1,984 acres	1,128 acres
Waste Storage Facility (313)			4
Water and Sediment Control Basin (638)	1	5	2
Water Well (642)	1	1	2
Watering Facility (614)	23	47	37
Wetland Enhancement (659)			39 acres
Wetland Restoration (657)		62 acres	
Wetland Wildlife Habitat Management (644)		61 acrs	
Wildlife Watering Facility (648)		1	

B. Watershed Projects

In addition to conservation activities itemized for individual land units, state and Federal watershed programs contribute to the current state of resources. Past and current activities within this sub-basin are summarized in the table below.

Figure 25

319 Project Name[36]	Status
Fee Fee Creek Watershed Vegetative Bank	Closed
Riverfront Rendezvous	Closed
Soils & Urban Conservation Tour	Closed
Stream Care Guide for Urban Areas	Closed
Urban Erosion and Water Management Conference	Closed

PL-566 Project Name[32]	Acres	Status
Town Branch (Marthasville)	1,903	Operational

AgNPS SALT Project Name[29]	Acres	Status
Charette Creek	90,562	Active

C. Farm Bill Program Lands[30]

USDA programs involving long-term contracts or long-term to permanent easements on land units allow for sustained conservation and restoration goals. In this sub-basin, the Conservation Reserve and Wetlands Reserve programs have considerable participation, as summarized in the table below.

Figure 26

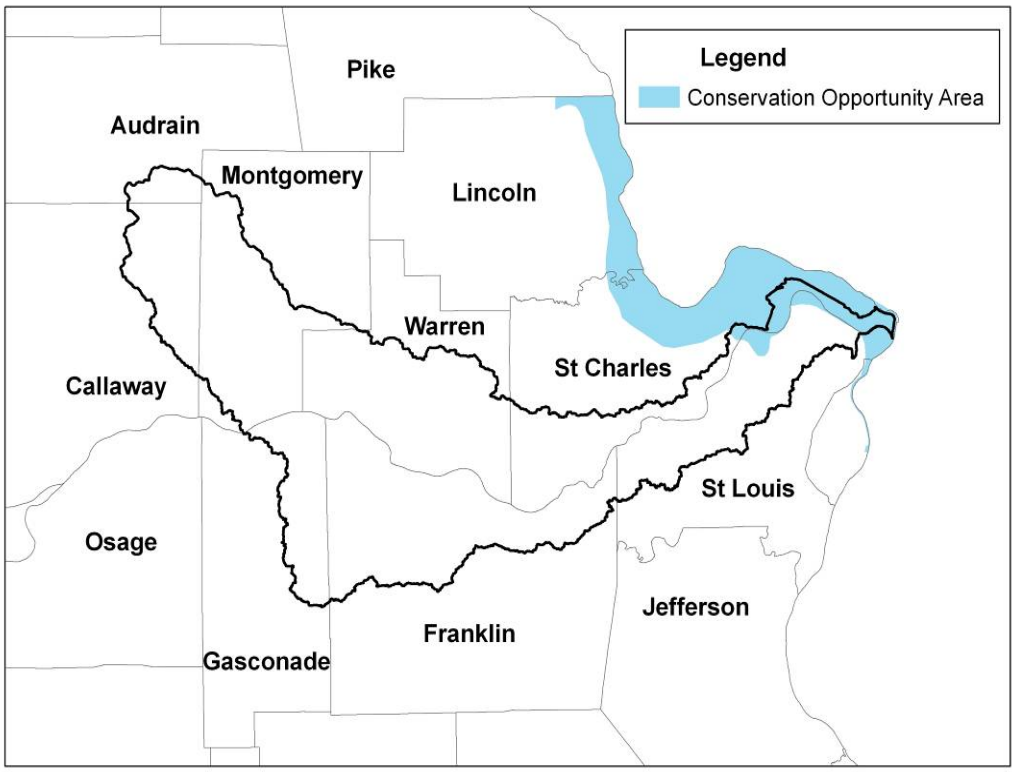
Program	Number of Acres	Number of Contracts or Easements
Conservation Reserve Program (CRP)	16,406	497 contracts
Wetland Reserve Program (WRP)	1,538	11 easements

D. Conservation Opportunity Areas[31]

The Missouri Department of Conservation joined with resource partners to take an "all conservation" approach via a framework referred to as Conservation Opportunity Areas (COAs). COAs identify the best places where partners can combine technology, expertise and resources for all conservation, with such focused efforts providing enhanced results. Various future funding opportunities for resource projects will give priority to work addressing the conservation goals within COAs.

Stakeholder groups have been formed and resources profiles developed for thirty-three of the highest priority COAs in Missouri. The Lower Missouri River sub-basin contains a small portion of the Missouri/ Mississippi River Confluence COA, a large floodplain complex that is a vital corridor for bird migration.

Figure 27



E. Environmental Protection Agency Priority Watersheds[32,33]

The Environmental Protection Agency (EPA) has worked in conjunction with Kansas Department of Health and Environment and Missouri Departments of Natural Resources to identify priority watersheds in each state. The prioritization process paid particular attention to those watersheds where there is a high potential to accomplish measurable water quality improvements in a relatively short time. The target watersheds are used to target requests for Clean Water Act 319 funds. No EPA target watersheds are in the Lower Missouri sub-basin.

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