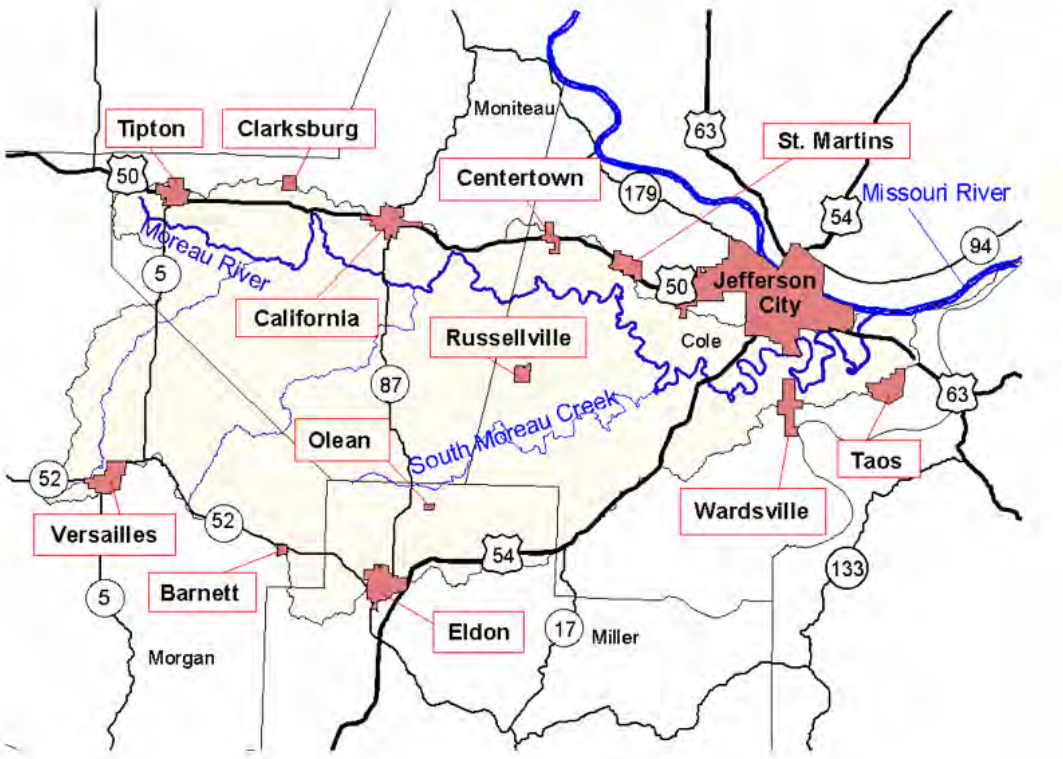

Moreau River Watershed

Watershed and Inventory Assessment, July 31, 2002

Prepared by Devona Weirich

Missouri Department of Conservation, Central Region

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Executive Summary

The Moreau River basin, a sub basin of the Missouri River, lies in the central Missouri counties of Cole, Miller, Moniteau, and Morgan. The Moreau River is formed by the union of North Moreau Creek and South Moreau Creek, and empties into the Missouri River just south of Jefferson City, MO. The watershed is approximately 584 square miles. The Moreau River has an average discharge of 381 cubic feet/second. It is an order 6 stream with an average gradient of 1.6 feet per mile.

The basin is underlain with Ordovician age cherty dolomite, thin beds of shale and minor deposits of sandstone. The surface has a stony red clay residuum and pockets of loess.

Water penetration to the subsurface is poor and most runs off to surface streams. Stream base flows are poorly sustained (MDNR 1984).

Early settlement of the Moreau River basin began about 1812-1816 when settlers from Kentucky and Tennessee moved into the area. At the time of settlement, prairie occurred in the central and northern parts of Morgan County, the south and western parts of Moniteau County, and the northwest part of Miller County. Today, only two examples of prairie land remain (Hite Prairie C.A. and Newcomb Prairie).

Current land use in the basin is 2.6% urban, 5.8% woodland, 18.4% forest, 32.4% grassland, and 40.5% cropland. The cities of Jefferson City, California, Versailles, Tipton, Eldon, and Wardsville ring the perimeter of the basin. Cropland and grassland uses predominate in the western portion of the basin whereas forest, grassland and woodland predominate in the eastern half of the basin. In 1992, livestock sales accounted for greater than 75% of the total agricultural sales in Cole, Miller, Moniteau and Morgan counties (DuCharme and Miller 1996). In 1997, the combined production of beef, dairy, swine, and poultry animals was 237,247,000 pounds of live weight (Barney 2002, personal communication). Soils support cultivation of corn, soybeans, grain sorghum, and hay crops (Allgood and Persinger 1979).

Public boat ramps on the Moreau River are available at the Moreau 50 and Honey Creek accesses. Bank fishing access is available at Scrivner Road C.A. on South Moreau Creek and at Stringtown Bridge Access on North Moreau Creek. Major streams support fishing for largemouth bass, smallmouth bass, spotted bass, channel catfish, flathead catfish, bluegill, longear sunfish, crappie, white bass, sauger and walleye. All stream fishing is regulated under statewide fishing regulations.

A total of 71 fish species have been collected in this basin since 1940. The fauna is a blending of the Ozark-Missouri and Prairie-Lower Missouri faunal types. Aquatic biota also includes three species of crayfish and 25 species of mussels. Noted changes in the fish fauna during the 1990's included the expansion in range of spotted bass and western mosquitofish, a decline in the abundance of common shiners and smallmouth bass, and absence of ghost shiners (a species once abundant in this watershed but which has become imperiled statewide) in fish collections. The decline of common and ghost shiners suggests some perturbation has occurred to their habitat in recent years.

Overall, fish species diversity is good and numerous intolerant species of fish (18) were widely distributed among streams. Based on this information, the Moreau basin fish communities appear to be in generally good condition at sites that were sampled.

Streams worthy of further evaluation due to species present historically (Topeka shiner, common shiner, blacknose shiner, plains topminnow) or currently unique species (Ozark sculpin, southern redbelly dace) include Straight and Clark forks.

Fifty-five reaches of stream are designated for fish, wildlife and livestock watering, and aquatic life protections. All of the Moreau River and portions of the North Moreau, South Moreau, Smith Creek, Straight Fork and Willow Fork are satisfactory for whole body contact. In 2000, 61 municipal, industrial, and agricultural sites required National Pollution Discharge Elimination System outfall permits. All of these outfalls are potential sources of point-source pollution; however, relatively few problem areas exist. The two most serious impairments to streams occur downstream of the California South and Versailles

waste-water treatment plants. Reaches of Straight Fork and North Moreau Creek downstream from these treatment plants are listed as EPA CWA Section 303(d) impaired waterbodies (EPA 1998). Renovations at the California plant are underway and improvement in water quality is expected in the near future. Illegal spillage of hog manure into waterways has been documented three times since 1995 resulting in high ammonia and BOD levels but no fish kills resulted. Waste spillage into receiving streams from confined animal feeding operations (CAFOs) in the basin is a potentially serious pollution problem. In 2002, there were 19 active swine, 16 poultry, one dairy, and one kennel facility in the watershed (MDNR 2002). As the number of CAFOs increase more animal related pollution problems may be expected to occur.

Non-point pollution in 1997 included soil erosion of 5.619 tons per acre per year from cropland and 1.322 tons per acre per year from pastureland (Barney 2002, personal communication). Other sources of pollution include in-stream erosion and nutrient-loaded runoff from crop fields, livestock pastures, and residential septic fields.

The clearing of riparian corridors contributes to streambank instability and allows sediment laden runoff to reach streams. Inspection of aerial photos of the mainstem Moreau River indicated 16% of streambanks had virtually no tree corridor and 40% had 1 row to 25 meters of continuous tree coverage. Forty- four percent had a tree corridor at least 26 meters wide. An appropriate goal for a wooded riparian border is 100-300 feet (33-99 meters) wide.

The most serious pollution threats to streams in the basin are due to contamination by human and animal wastes, soil erosion, and in-stream erosion. Agricultural and livestock interests are very high in this basin so their needs must be considered in management decisions. Efforts to improve water quality and maintain the quality of aquatic habitats and fauna in this basin center on improving riparian habitat, agricultural practices, livestock pasture and waste management techniques, and increasing citizen involvement. The close proximity of the Moreau River to Jefferson City makes it a potentially valuable recreational resource. The addition of more public accesses to major streams, improved management of the sport fishery and increased public awareness of this river could help boost its value.

Location

The Moreau River basin, a sub basin of the Missouri River, lies in the central Missouri counties of Cole, Miller, Moniteau and Morgan (Figure lo). The river is formed by the confluence of North Moreau and South Moreau creeks approximately 4 miles north of Brazito in Cole County. North Moreau Creek originates near Fortuna in Moniteau County and flows to the east. South Moreau Creek originates near Eldon in Miller County and flows to the northeast. The Moreau River, draining 584 square miles of land, then empties into the Missouri River near Jefferson City in Cole County. Hereafter, the term “basin” will refer to the entire Moreau River basin.

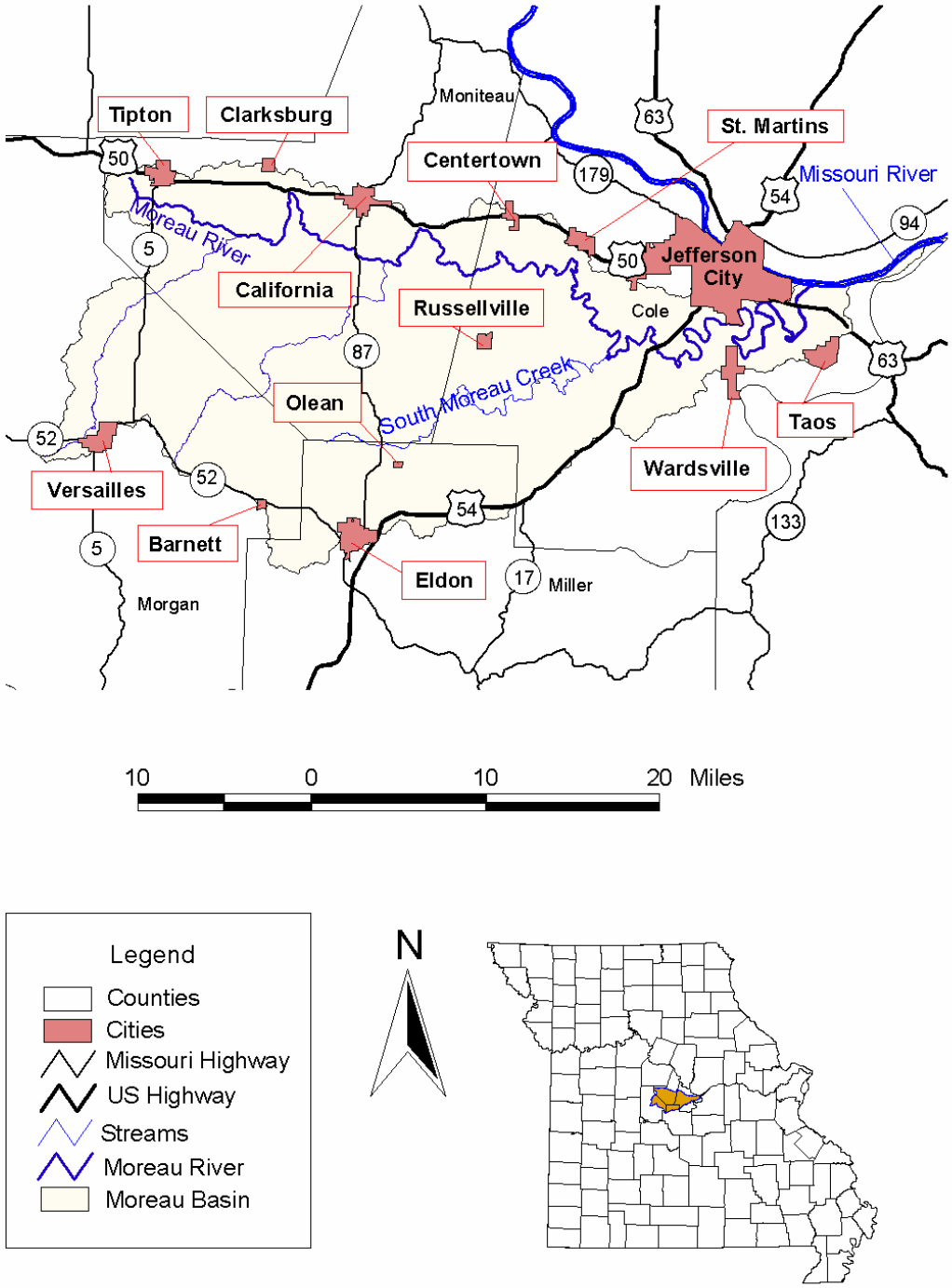


Figure lo. General location of the Moreau River Watershed, in Missouri.

Geomorphology

Physiographic region and Geology

The Moreau basin lies in the physiographic province of the United States known as the Interior Highlands. It is part of the northern Salem Plateau, a subdivision of the Ozark Plateau (Figure nd). This landform is characterized by rolling upland topography with local relief of 100-200 feet along major drainage divides (MDNR 1986). Gently sloping prairie is evident near Tipton, Latham and High Point (USDA 1964). In areas, rugged hills with deeply carved river valleys can be found. The highest elevation (1100 feet) in the watershed is located along the western border of the basin near Versailles. Water flows toward the east and empties into the Missouri River at an elevation of 523 feet. At one time geologists believe the Moreau River may have emptied into the Osage River near Osage City rather than flowing directly into the Missouri River. The theory is that the Moreau shortened itself by meandering too close to the Missouri River where it became captured (Beveridge 1978).

The predominant rock type includes Ordovician age cherty dolomite, thin beds of shale, and minor deposits of sandstone (Figure ge). The surface contains a stony red clay residuum of the Jefferson City-Cotter formation and some pockets of loess on the tops of high ground (Figure gs) (MDNR 1984). Penetration of water to the subsurface is poor so most water runs off to streams and stream base flows are poorly sustained (MDNR 1984). Minor deposits of lead, iron, germanium, zinc, coal and barite are found in basin counties (USFS 2001). Mining was especially active in Moniteau county near California, Tipton, and High Point in the early 1870's (Campbell's Gazetteer of Missouri 1874).

These mines are now closed and current mining efforts are directed at sand and gravel, and limestone.

There are two springs, Steenbargen (SE SW 25, R14W, T43N) and Strobel (SW SW 35, R14W, T44N), located near Russellville in Cole county. Neither spring has significant discharge (Vineyard and Feder 1974).

Soils

The soils of the basin are classified as Ozark Border. The upland plateau is characterized by narrow ridgetops and valleys. Thin loess deposits occur on the ridgetops. Some soils contain fragipans, a loamy or sandy subsurface horizon of low organic content that can form a cement-like layer that impedes water and the growth of roots. Steep slopes contain deep cherty clayey reddish colored soils over dolomite or limestone. Sandy, loamy and gravelly alluvial soils are in the bottom lands. The predominant soil series are Seymour- Glensted-Creldon-Eldon ("deep, nearly level to steep, poorly drained to well drained, clayey and loamy and cherty upland soils") derived from loess, limestone, sandstone and shale, and Union-Goss-Gasconade-Peridge ("deep and shallow, nearly level to very steep, moderately well drained to excessively drained, loamy and clayey upland soils") derived from loess and limestone (Allgood and Persinger 1979).

These soils support cultivation of corn, soybeans, grain sorghum and hay crops (Allgood and Persinger 1979).

In the 1997 National Resource Inventory, soil erosion losses for lands in the larger 8-digit hydrologic unit (10300102), which includes the Moreau subbasin, were estimated for cropland, pastureland, and non-cultivated cropland. These erosion rates were estimated at 5.619, 1.322, and 0.651 tons of soil per acre annually, respectively, for each land type (Barney 2002, personal communication).

Watershed Area

The watershed or drainage area of the Moreau River is 584 square miles. It is located in the southern portion of the Missouri River mainstem-Glasgow to Hermann 8-digit hydrologic unit (10300102)(Figure

wa). This watershed is further divided into three hydrologic units: the North Moreau (10300102200), the South Moreau (10300102210), and the mainstem Moreau (10300102220) (Figure wa). Interestingly, the North Moreau hydrologic unit only includes the North Moreau watershed upstream from Burris Fork. The lower portion is included in the Moreau hydrologic unit. Therefore, the watershed areas of these two hydrologic units do not equal the watershed areas for these subbasins (Table 1).

The watershed areas of the three major subbasins are: South Moreau Creek 174 square miles, North Moreau Creek 347 square miles, and mainstem Moreau River 63 square miles (Table 1). The largest proportion of the watershed (59%) lies in the North Moreau subbasin.

Stream Order

Stream ordination is a method used to describe the branching geomorphologic nature of streams. A 1st order stream is unbranched. A 2nd order stream is formed when two 1storder streams join. A higher ordination can only be formed when two streams of the same order join. In this manner, 71 streams, 3rd order or greater, were identified, ordered, and measured using USGS 7.5 minute topographic maps (Appendix 1). They provide a total of 424 miles of stream frontage. The highest order streams are: mainstem Moreau river and South Moreau Creek, 6th order; and North Moreau Creek, Brush Creek and Burris Fork, 5th order.

Stream Gradient

On the mainstem Moreau, the river drops an average 1.6 feet per mile. The 5th order and larger reaches of North (first 47 miles) and South Moreau (first 29 miles) creeks drop 3.6 ft/mi and 6.6 ft/mi, respectively (Figure sg). Additional gradient information for other streams in this basin can be obtained from the Missouri Department of Conservation Central Region office in Columbia (Address: 1907 Hillcrest Drive, Columbia, MO 65201; phone: 573/ 884-6861).

Figure nd. Natural divisions of the Moreau River Watershed, in Missouri.

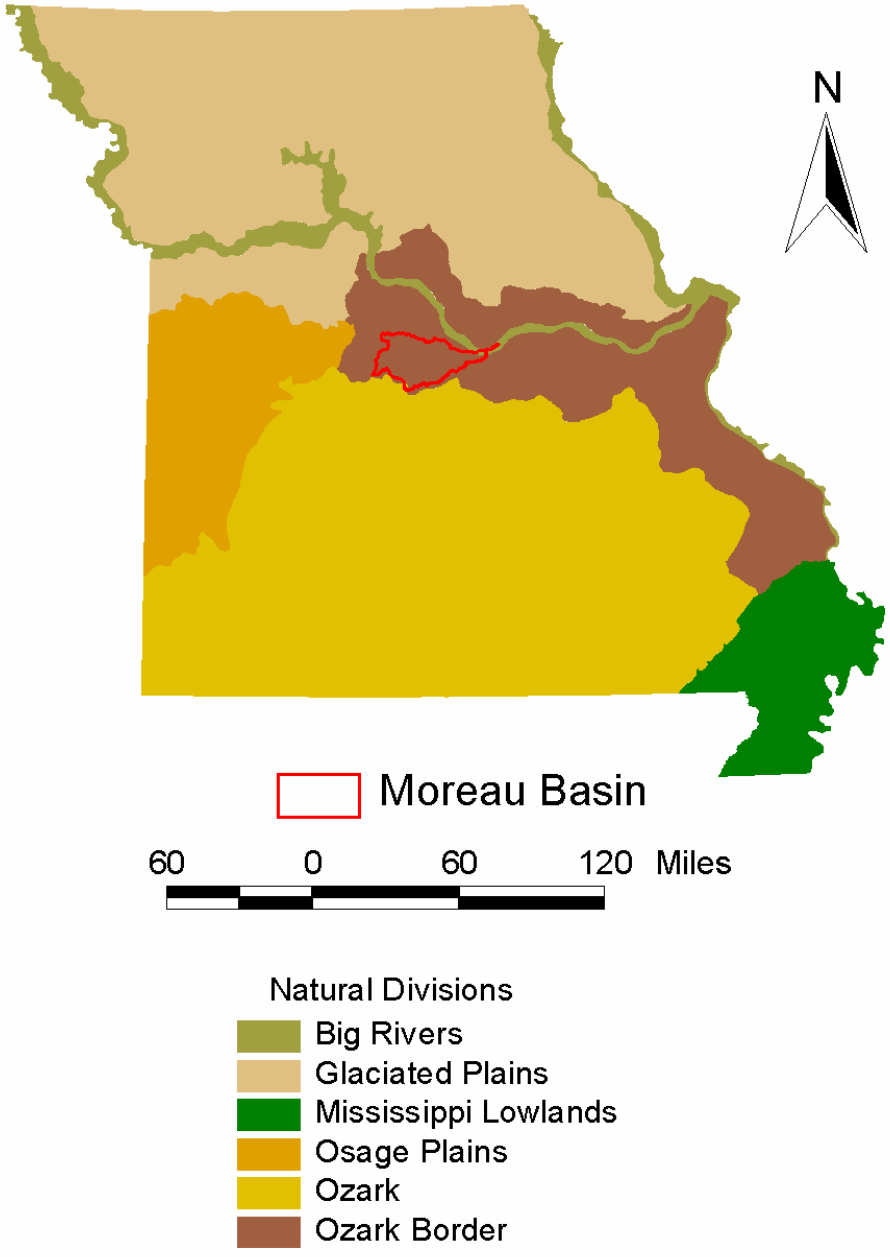


Figure ge. Bed geology in the Moreau River watershed.

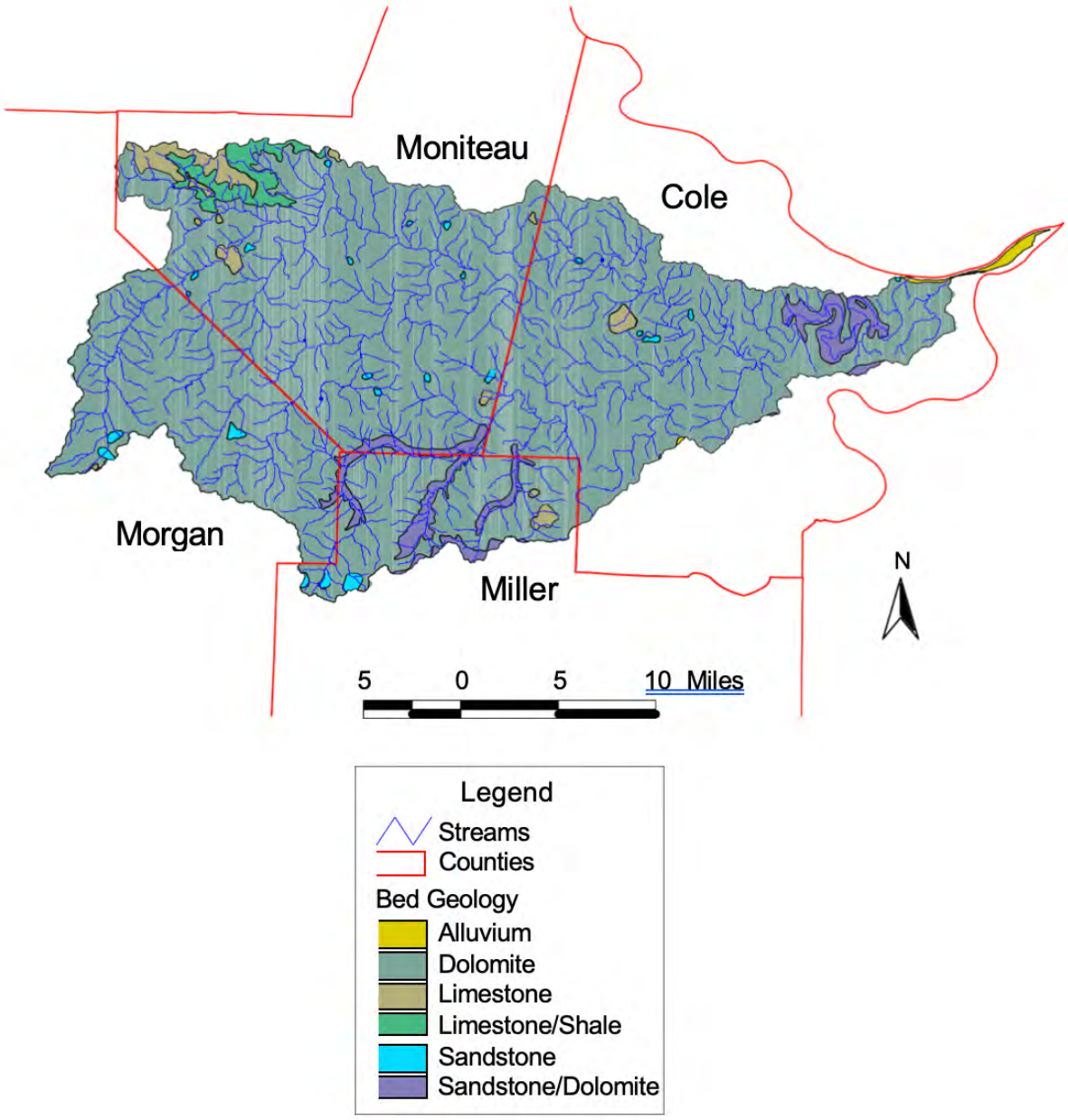
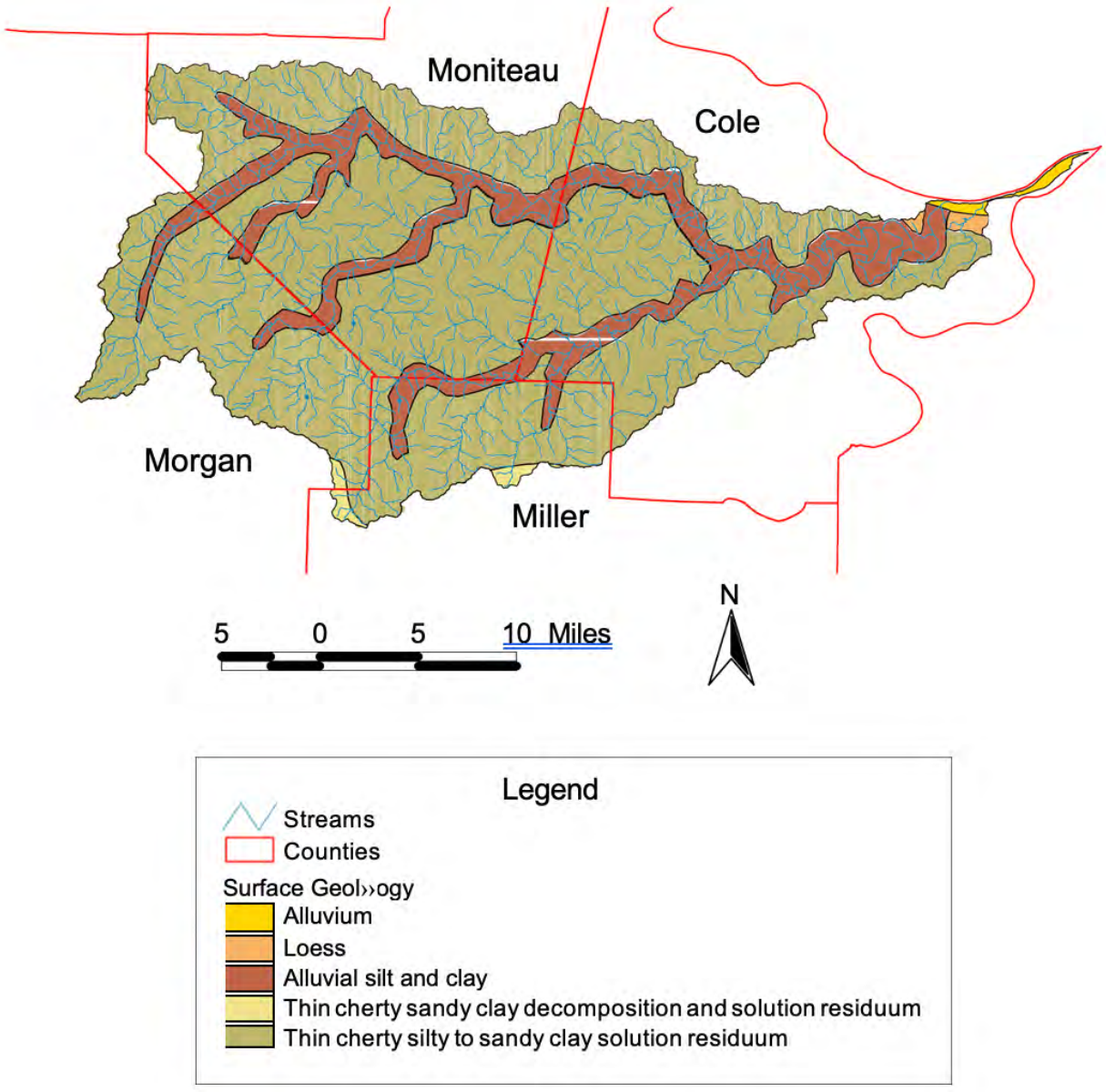


Figure gs. Surface geology of the Moreau River watershed.



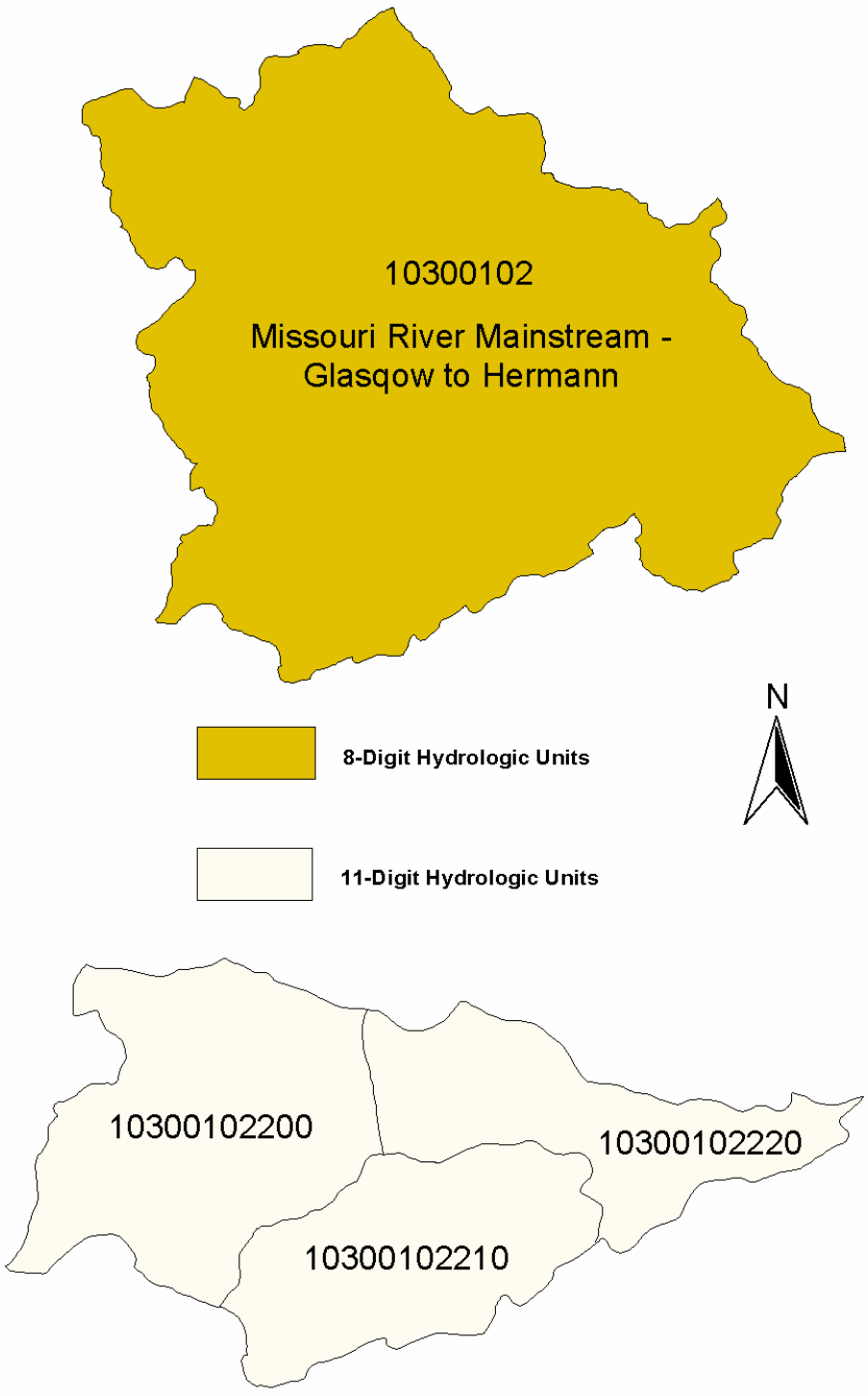


Figure wa. Hydrological units of the Moreau River Watershed.

Table 1. Watershed size and stream order of sub-basins in the Moreau River basin.

Stream Hydrologic Units	Stream Order	Unit area (sq miles)	Watershed area (sq miles)	% of Entire Watershed
North Moreau 10300102200	5	252	-	43
South Moreau 10300102210	6	174	-	30
Moreau mainstem 10300102220	6	158	-	27
Watershed sub-basin				
North Moreau	5	-	347	59
South Moreau	6	-	174	30
Moreau mainstem	6	-	63	11
Total		584	584	100

Appendix 1. Table 1. Stream lengths and order for tributaries of the Moreau River.

River Name	Stream Order	Length in miles	River mouth located on topo map named
Moreau River	6	35.2	Osage City
Coon Creek	3	3.3	Osage City
Honey Creek	3	6.5	Wardsville
UN trib-1 to Moreau R	3	2.4	Brazito
North Moreau Creek	5	47.2	Brazito/Lohman
Kautsch Branch	3	3.5	Lohman
UN trib-1 to N. Moreau Cr	3	1.6	Lohman
UN trib-2 to N. Moreau Cr	3	3.2	Lohman
Logan Creek	3	6.2	Lohman
UN trib-3 to N. Moreau Cr	3	1.2	Russellville/Lohman
Strobel Branch-1	3	4.1	Russellville
Strobel Branch-2	3	4.5	Russellville
Wieneke Branch	4	5.4	Russellville
Westing Branch	3	2.7	Russellville
Burger Creek	3	3.6	California South
Burris Fork	5	22.7	California South
Marney Branch	3	6.4	California South
Bear Branch	3	5.7	California South
Medlen Creek	4	6.1	California South
Colburn Branch	3	4.1	Olean
UN trib-1 to Burris Fk	3	1.6	California South
UN trib-2 to Burris Fk	3	2	Latham
Rocky Branch	3	2.7	Barnett
Jones Creek	4	6.7	Barnett
Gracey Creek	3	4.1	Barnett
Scott Branch	3	3.7	California South
Dry Fork	3	6.7	Clarksburg
Smith Creek	4	16.6	Latham

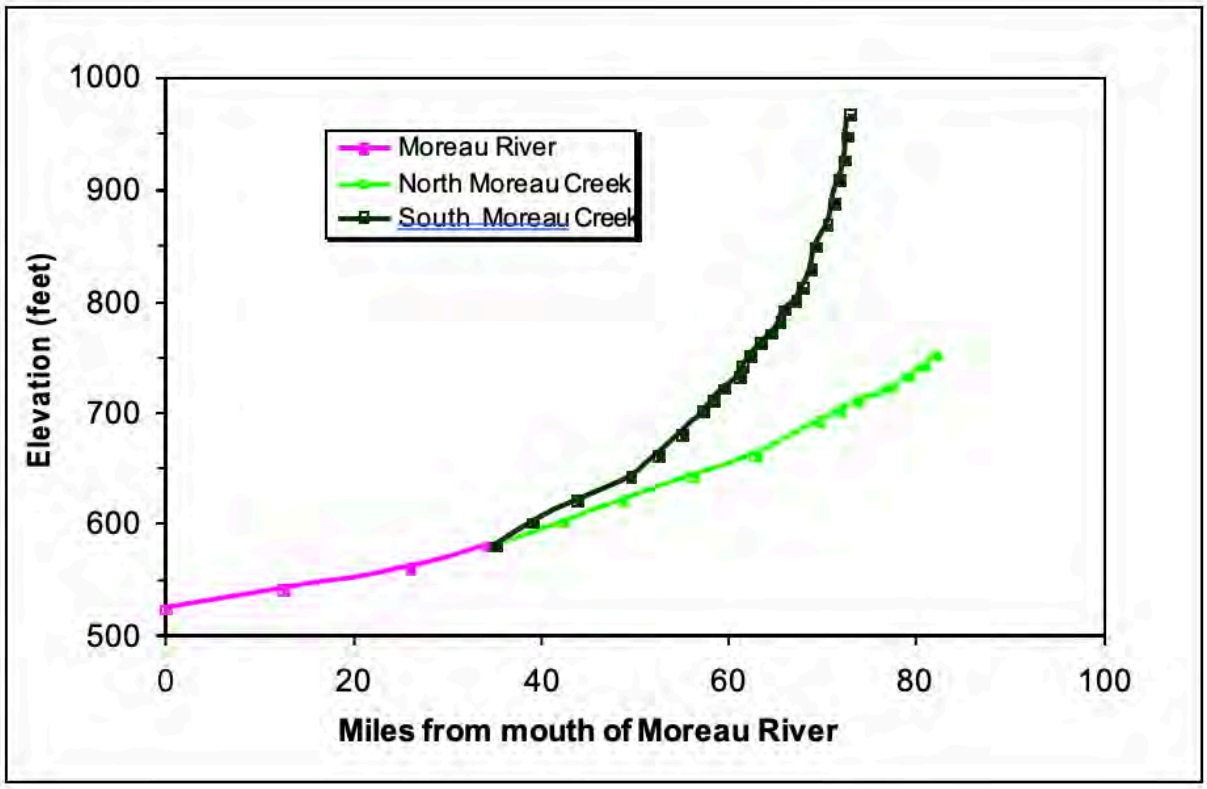
River Name	Stream Order	Length in miles	River mouth located on topo map named
Pilot Branch	3	3.5	Latham
Lick Creek	3	6.7	Latham
UN trib-1 to Smith Cr	3	5.2	Fortuna
Straight Fork	4	21.2	Latham
UN trib-1 to Straight Fk	3	2.5	Fortuna
Willow Fork	4	10	Latham
Kelly Branch	3	4.3	Latham
UN trib-1 to Willow Fk	3	1.7	Latham
UN trib-2 to Willow Fk	3	3.1	Tipton
South Moreau Creek	6	37.8	Brazito
Clark Fork	4	14.2	Brazito
UN trib-1 to Clark Fk	3	1.9	Brazito
Russellville Branch	4	5.7	Brazito
Millbrook Branch	3	2.8	Brazito
UN trib-1 to S. Moreau Ck	4	2.2	Enon
UN trib-1 to UN trib-1 to S. Moreau Ck	3	1	Enon
Roark Branch	4	4	Enon
UN trib-1 to Roark Br	3	1.7	Enon
UN trib-2 to S. Moreau Cr	4	3	Enon
UN trib-1 to UN trib-2 to S. Moreau Ck	3	1.7	Enon
UN trib-3 to S. Moreau Ck	3	1.4	Enon
Brush Creek	5	9.6	Enon
UN trib-1 to Brush Cr	3	2.1	Enon
UN trib-2 to Brush Cr	3	1.7	Enon
UN trib-3 to Brush Cr	4	3.3	Enon
UN trib-1 to UN trib-3 to Brush Cr	3	1.9	Enon
UN trib-4 to Brush Cr	3	2	Enon

River Name	Stream Order	Length in miles	River mouth located on topo map named
UN trib-5 to Brush Cr	4	4.6	Enon
UN trib-1 to UN trib-5 to Brush Cr	3	2.5	Enon
UN trub-2 to UN trib-5 to Brush Cr	3	2.1	Enon
UN trib-4 to S. Moreau Cr	3	1.7	Enon
Morgan Branch	4	3.7	Enon
UN trib-1 to Morgan Br	3	1.5	Enon
UN trib-2 to Morgan Br	4	1.9	Enon
UN trib-1 to UN trib-2 to Morgan Br	3	1.4	Enon
Rock Enon Creek	4	5.6	Enon
UN trib-1 to Rock Enon Cr	3	2	Olean
Blythe's Creek	4	8.3	Enon
UN trib-1 to Blythe's Cr	3	1.1	Enon
UN trib-5 to S. Moreau Cr	3	2.2	Olean
Beard Creek	4	3.7	Olean
UN trib-1 to Beard Cr	3	1.6	Barnett
Wilkes Creek	3	4.2	Barnett

Appendix 1. Table 2. Summary of miles of stream frontage in the Moreau River watershed by steam order.

Order	Number of streams	Stream frontage (miles)
3	48	145
4	18	126
5	3	80
6	2	73

Figure sg. Stream gradient for the North and South Forks of the Moreau River.



Land Use

Historical Development

The first inhabitants of the basin were ancient “mound building” people. Evidence including burial mounds, skeletal remains and artifacts of their occupation was found near the mouth of the Missouri and Osage rivers and along the Moreau River. At the time of westward expansion, the land was occupied by Osage Indians. In the late 1700's, French hunters and trappers sought the resources of the Moreau and Osage rivers. During 1812-1816, they were followed by white settlers coming primarily from Kentucky and Tennessee. Large-scale immigration followed in the 1820's. Cole County organized in 1820. It was followed by Morgan (1833), Miller (1837), and Moniteau (1845) counties (Conard 1901).

Early settlers found prairie in the central and northern parts of Morgan County, the south and western parts of Moniteau County and northwest part of Miller County. The central and eastern parts of Moniteau County were woodlands (Conard 1901). Timber consisted of various oaks, white and black walnut, hickory, elm, maple and sycamore. Several fine springs were reported in the southeastern part of Moniteau County (Campbell’s Gazetter of Missouri 1874). Around the turn of the twentieth century, most of Cole County was untillable with only 70,000 A cultivated (30% of the land). Forty percent of Morgan and 85% of Moniteau counties were cultivated (Conard 1901).

The most profitable businesses in Morgan County were raising stock and mining. Moniteau County residents profited most in farming and livestock (Conard 1901). Major crops included corn, wheat, oats, flax, tobacco and potatoes. Hay was widely cultivated. In 1898, surplus livestock products shipped from Moniteau County included cattle (4,279); hogs (25,511); sheep (3,983); horses and mules (703); poultry (721,575 pounds); and game and fish (32,335 pounds) (Conard 1901). Deposits of coal, lead and barites were also found. Lead and coal were mined close to Burris Fork near High Point around 1855 and also near the Moniteau/Cole county line in 1857. Smelters were also open near California. Coal was mined 2.5 miles southeast of Tipton and in the vicinity of California. Good potters’ clay was found 3 miles west of California. (Campbell’s Gazetter of Missouri 1874, Conard 1901).

Recent Land Use

The total human population of counties encompassing this basin was 112,151 in the 1990 U.S. population census. Of this population, an estimated 39,000 people reside in the basin based on township population estimates and estimation of the percentage of each township located in the watershed. The cities of Jefferson City, California, Tipton, Versailles, and Eldon, ring the border of the watershed but only portions of these towns have drainage into the Moreau watershed. A total of 2.6% of the land coverage in the basin is urban.

Grassland and cropland comprise 72.8% of the land use in the basin (MoRAP 1997). Grassland and cropland predominate in the western half of the basin whereas forest, grassland and woodland predominate in the eastern half of the Basin (Figure lu).

As in the past, raising livestock and farming remain important businesses in the basin. In Cole, Miller, Moniteau, and Morgan counties, livestock sales accounted for greater than 75% of total agricultural sales in 1992 (DuCharme and Miller 1996). In 1997, there were 3,287 livestock operations in these counties which produced 237,247 animal units (animal unit=1000 pounds live weight) (Table 1; Barney 2002, personal communication).

Hay, soy beans, corn and wheat are the primary crops grown in the basin. The Missouri Agricultural Statistics Service (2002) reported a total production of 315,000 tons of hay, 3,473,000 bu corn, 401,200 bu wheat, and 1,372,000 bu soybeans for the four counties encompassing the basin in 2000.

The old coal and lead mines near California, Tipton and High Point are now closed. Currently, there are 3 active limestone quarries in Cole County near Jefferson City and 7 sand and gravel removal operations on streams (MDNR 2002b).

Soil Conservation Projects

There is one completed and two active soil conservation projects underway in the basin. A 5-year Special Areas Land Treatment Project (SALT) was completed in FY 1996 in the Honey Creek watershed, Cole County. Of this 6,337 acre watershed, 2,206 acres received soil erosion control treatments. The two ongoing projects are an Environmental Quality Incentive Program (EQIP) project covering the entire Moreau watershed and an Agricultural Non-Point Source Special Area Land Treatment (AGNPS SALT) project encompassing the upper portion of the North Moreau Creek, and its tributaries Willow Fork Creek, Straight Fork Creek, Smith Branch, Kelly Branch, and Willow Branch. The EQIP project is 10 years in length (FY 99-2009). Its focus is primarily water quality improvement through improved animal waste management. It provides cost-share for items like stackhouses, management intensive grazing systems, and woodland protection through livestock exclusion.

The AGNPS SALT project is funded for 7 years. Its goals are similar to that of an EQIP project but it focuses on a smaller geographical area and includes streambank stabilization, filter strips, and soil erosion control measures for cropland as well as planned grazing systems and nutrient management.

For more information on AGNPS SALT and EQIP projects in Morgan and Moniteau counties, contact your local Soil and Water Conservation District (Table 2).

Public Areas

There are no federal lands or state parks located in the watershed. However, there are 7 areas either owned or managed by cooperative agreement with the Missouri Department of Conservation which are open to the public (Table 3; Figure pa). Moreau 50, Honey Creek, Stringtown Bridge, and Scrivner Road CA provide access to the Moreau River, North Moreau and South Moreau creeks (Figure pa). The Honey Creek and Moreau 50 accesses have concrete boat ramps. Recreational opportunities for lake fishing, bird watching, nature viewing, or hiking can be found at Hough Park, Proctor Park, Scrivner Road CA and Hite Prairie CA. Prairie flowers can be viewed at Hite Prairie CA located on the watershed divide near the southwest edge of Versailles in Morgan County. For more information or maps for these areas visit the MDC website (2002) at http://www.conservation.state.mo.us/atlas or consult a Missouri's Conservation Atlas A Guide to Exploring Your Conservation Lands (1995) published by the MDC, Jefferson City, MO.

Floating by small john boat or canoe on the Moreau River, North Moreau and South Moreau creeks is enjoyed from the vicinity of Russellville downstream to the confluence of the Moreau and Missouri rivers. Rockhouse Bridge, 5.5 miles south of McGirk off Hwy K and Decatur Bridge on Hwy AA south of Russellville are the uppermost put-in points (Figure pa). Floating is best during the springtime when water levels are high. Later in the year, portage over shallow riffles becomes necessary.

U.S. Army Corps of Engineers Jurisdiction

The U.S. Army Corps of Engineers Jurisdiction Corps regulates the construction of structures, and the excavation and filling of wetlands, rivers, streams and lakes. Some examples of regulated activities include but are not limited to placement of riprap, gravel excavation, bridge, dam and levee construction, land-filling, and creation of borrow pits in wetlands. For this basin, regulatory jurisdictions for alterations are with the Missouri State Regulatory Office (Cole and Moniteau counties) and Truman Satellite Office (Morgan and Miller counties) of the U.S. Army Corps of Engineers (Table 4).

Table 1. Livestock population estimated from U.S. Census of Agriculture, 1997 (Barney 2002, personal communication).

County	Total number livestock operations	Total AU on livestock farms	Number of confined operations	Total AU on confined operations
Cole	844	35,678	424	8,284
Moniteau	841	56,801	533	17,864
Morgan	708	67,619	478	36,745
Miller	894	77,149	561	37,445
Total	3,287	237,247	1,996	100,338

AU=animal unit=1000 pounds live animal weight; Livestock=beef, dairy, swine and poultry; Confined operation= livestock held in a feedlot or other facility such that accumulated manure needs to be removed on a regular basis

Table 2. Address information for Morgan and Moniteau Soil and Water Conservation District offices.

Morgan Co. SWCD	Moniteau Co. SWCD
100 S. Burke St.	410 W. Buchanan St.
Versailles, MO 65084-1004	California, MO 65018-1223
Phone: 573-378-4589 Ext 3	Phone: 573-796-2010 Ext 3
FAX: 573-378-6163	FAX: 573-796-4520

CAP-Community Assistance Program. Local entities and MDC have a partnership whereby the MDC provides management of a lake for public use.

Table 3. State managed public areas in the Moreau River basin (MDC 1995, MDC 2002).

County	Area Name (Management)	Total acres	Ponded acres	Stream Frontage Facilities	Access to Stream
Cole	Hough Park Lake (Jefferson City CAP)	153	7	0	-
	Honey Creek Access (MDC)	85	0	0.3 mi, boat ramp 0.4 mi	Moreau R. Honey Cr
	Moreau 50 Access (MDC)	10	0	0.25 mi, boat ramp	Moreau R.
	Scrivner Road CA (MDC)	919	8	1.7 mi	S. Moreau Cr
	Stringtown Bridge (MDC)	50	0	1.0 mi	N. Moreau Cr
Moniteau	Proctor Park Lake (California CAP)	38	7	0	-
Morgan	Hite Prairie CA (MDC)	103	0	0	-

CAP-Community Assistance Program. Local entities and MDC have a partnership whereby the MDC provides management of a lake for public use.

Table 4. Field office addresses for U.S. Army Corps of Engineer offices have jurisdiction for the Moreau basin.

Missouri State Regulatory Office	Truman Satellite Office
221 Bolivar Street, #103 **Jefferson City, MO 65101** **Tel: 573-634-4788** **FAX: 573-634-4895**	Route 2, Box 29-C Warsaw, MO 65355 Tel: 660-438-6697 FAX: 660-438-6909

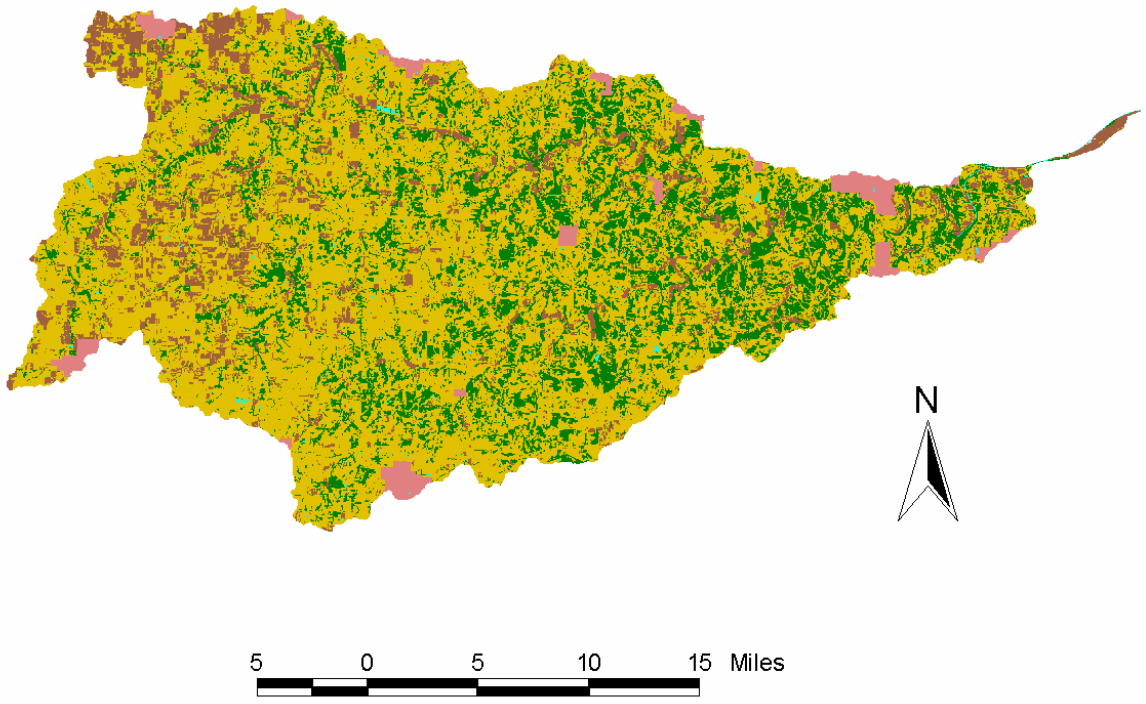


Figure lu. Land use in the Moreau River Watershed, in Missouri.

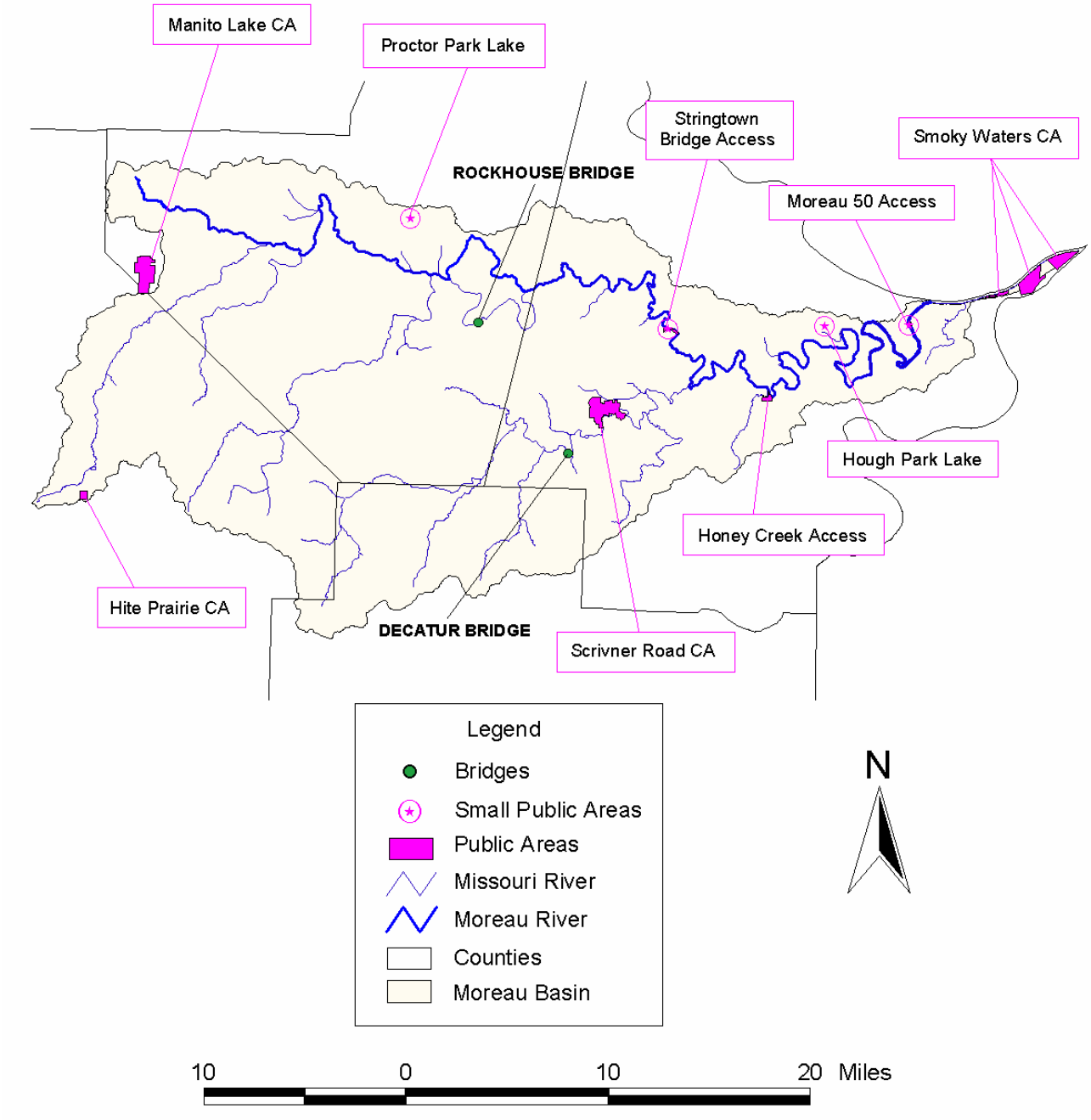


Figure pa. Public areas within the Moreau River watershed.
CA = Conservation Area

Hydrology

Precipitation and Temperature

The mean precipitation in the basin ranges from 38.4 inches near Jefferson City to 41.6 inches at Versailles in the southwestern portion of the basin (Table 1). May, June, September and October are the months with highest precipitation. January and February are the driest months. July is the hottest month, a temperature near 90°F can be expected. January is the coldest month with the average minimum in the upper teens. Climate statistics for the three National Weather Service sites, Jefferson City water plant, Eldon, and Versailles, in the basin are summarized in Table 1.

Additional information can be found on the internet at the Midwestern Regional Climate Center's web site: http://mcc.sws.uiuc.edu/.

USGS Gaging Stations

The one active USGS gage station in the basin is on the Moreau River near Jefferson City (station number 6910750) (USGS 2002). This station was active 1947-74, 1975-79, and reactivated in 2000. There are four stations: (North Moreau Creek near California, Hazel Branch tributary near Wardsville, Burris Fork, and South Moreau Creek near Russellville) which have partial records for years between 1957-1979 (Table 2; USGS 1971, USGS 1980). Base low flows recorded for North Moreau Creek on 8-25-70 was 1.4 cfs; Burris Fork on 9-23-71 was 1.88 cfs; and South Moreau Creek on 9-23-71 was 8.29 cfs. For additional information visit the USGS web site at http://water.usgs.gov/nwis/.

Hydrologic Data

The average 25-year discharge of the Moreau River at the 06910500 USGS gaging station near Jefferson City was 381 ft3/sec (USGS 2002). For the period of record, Dec 1947-Sep 1974, the maximum discharge occurred on October 14, 1969 where a discharge of 24,400 ft3/sec was recorded. The lowest discharge, 0.1 ft3/sec, was observed on September 30, 1956. Peaks in average annual monthly discharge occur in March and June and minimums occur in August (Figure hd).

In 1970, Skelton analyzed base-flow data for many streams in Missouri. He estimated flows by regression analysis of base- flow recession characteristics to determine the amount of water that could be expected to flow in a stream during rainless periods of 30 days or less. For the Moreau River, gage 069105, the 7-day low flow for a recurrence interval of 2 years (Q2) is 6.5 cubic feet per second (cfs) (Skelton 1970). This means the minimum 7-day average flow will be less than 6.5 cfs at intervals averaging 2 years; or, the probability is 50% that the minimum 7 day flow will average less than 6.5 cfs in a given year. Table 3 summarizes low-flow data for gage stations on the Moreau River near Jefferson City and the North Moreau Creek near California.

Dam and Hydropower Influences

There are no hydroelectric generators nor major dams in the basin. However, there is a series of wood pilings crossing the North Moreau Creek (T44N, R16W, S3) about 1.5 miles downstream from the mouth of Straight Fork where a mill once operated. Small impoundments are located on small tributary streams. In 1986, the number of dams 6 feet or higher impounding at least 50- acre feet or 25 foot high and impounding at least 15 acre- feet inventoried by the Department of Natural Resources numbered 73 in Cole, Miller, Moniteau, and Morgan counties (MDNR 1986). This is a relatively low number of lakes compared to other areas of the state.

Table 1. Climatology report of National Weather Service stations in the Moreau basin, 1961- 1990 (Midwestern Regional Climate Center, Champaign, IL 2000).

Month	Average Minimum Temperature °F			Average Mean Temperature °F			Average Maximum Temperature °F			Mean Total Precipitation (inches)		
	Jef	Eld	Ver	Jef	Eld	Ver	Jef	Eld	Ver	Jef	Eld	Ver
Jan	15	18	19	27	29	30	40	40	40	1.38	1.54	1.57
Feb	19	22	23	32	33	34	44	45	45	1.73	1.84	1.89
Mar	30	33	33	43	45	45	56	56	57	3.28	3.44	3.56
Apr	41	44	44	54	56	56	68	68	68	3.55	3.89	3.95
May	51	54	53	63	65	64	76	76	75	4.94	5.01	5.03
Jun	60	62	62	72	73	72	84	84	83	4.41	4.4	4.23
Jul	65	67	67	77	79	78	90	90	88	3.04	3.33	3.5
Aug	62	65	65	75	77	76	88	88	87	3.14	3.42	3.87
Sep	54	57	57	67	69	68	81	80	79	3.97	4.7	4.24
Oct	42	46	45	56	58	57	70	70	69	3.49	3.6	4.03
Nov	31	34	35	44	45	45	56	56	56	2.88	3.13	3.05
Dec	21	23	24	32	33	34	43	43	43	2.62	2.54	2.66
Annual Average	41	44	44	54	55	55	66	66	66	38.4	40.8	41.6

Jef=Jefferson City water plant, MO 1961-1990; Eld=Eldon 1961-1990; Ver=Versailles, MO 1961-1990

Table 2. USGS gage stations located in the Moreau watershed (USGS 1971, USGS 1980, USGS 2002).

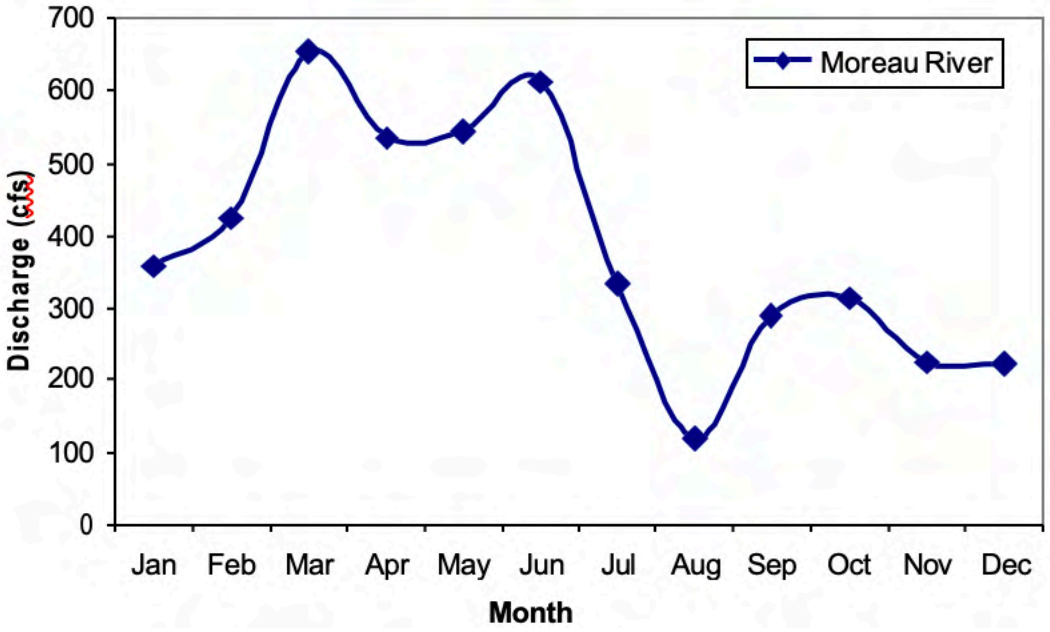
Station Name	Station Number	Latitude	Longitude	Elevation above mean sea level	Period of Record	County
Moreau River near Jefferson City[wsr]	6910500 6910750	38E30’25” 38? 31'44"	092E15’20” 092? 11'31"	562.73 ft	1947-74; 1975-79, 2000-01	Cole Cole
North Moreau Creek near California[pr]	6910420	38E35’13”	092E34’25”		1962-65, 1967, 1970	Moniteau
Burris Fork[pr]	6914850	38E32’58”	093E34’15”		1961, 1971	Moniteau
South Moreau Creek near Russellville[epr]	6910480	38E29’43”	092E20’40”		1971	Cole
Hazel Branch trib near Wardsville[cp]	6910700	38? 28'15"	092? 12'35"		1957-79	Cole

[wsr] water stage recorder, pr partial record, low flow, cp crest stage partial record

Table 3. Low flow 7-day discharge for various recurrence intervals (Skelton 1970).

Gage Station	Station Name	Period used in analysis	7-day Low flow in cubic feet per second for recurrence interval			
			2 year	5 year	10 year	20 year
6910420	North Moreau Creek near California	1962-65, 1967	0.7	-	0.1	-
6910500	Moreau River near Jefferson City	1948-65	6.5	1.6	0.8	0.4

Figure hd. Mean annual hydrograph for the Moreau River gaging station, 6910500, for the period of record 1947-1974.



Water Quality and Use

Beneficial Use Attainment

Fifty-five reaches of stream in the basin are designated for fish, wildlife and livestock watering, and aquatic life protection (Table 1) (MDNR 1994). In addition, all of the Moreau River, 50.0 miles of the North Moreau, 29.5 miles of the South Moreau, 10.5 miles of Smith Creek, 12.0 miles of Straight Fork and 3.0 miles of Willow Fork are also satisfactory for whole body contact. Boating and canoeing are designated uses on the Moreau, South and North Moreau rivers. No streams are designated for irrigation or drinking water uses.

Water Quality

State water quality standards were not met for two streams in the basin. A portion of North Moreau Creek and Straight Fork are identified as EPA CWA Section 303(d) impaired waterbodies (Figure wq). They exceeded standards for non- filterable residue (suspended solids). The two problem areas identified included the California S. Waste Water Treatment Plant (WWTP) and Versailles lagoon (EPA 1998). The California S. WWTP is in the process of upgrading its lagoons.

One reach of stream on Burris Fork is designated a “reference reach” for study in the Missouri Resource Assessment Monitoring Project (Fischer 2002, personal communication). This is a project aimed at identifying the health of Missouri streams on a statewide basis through random sampling of stream sites. Biomonitoring will be conducted on fish populations, aquatic habitat, water quality and aquatic invertebrates every 6 years.

Fish Kills

Only one fish kill was documented in basin streams since 1995 (MDC 2002b). This kill occurred in October 1997 on Straight Fork, a tributary to North Moreau Creek, at 43N 18W 36NE, just downstream from the Versailles waste water treatment plant. Insufficiently treated plant effluent caused the death of approximately 3,512 fish. Three quarters of a mile of stream were affected.

Water Use

Surface waters are not used for human consumption and crop irrigation is uncommon in this part of the state (DuCharme and Miller 1996). However, surface water is an important necessity for the livestock industry. For the counties in this basin, the estimated water consumption by livestock ranges from 101-225 million gallons per year per county (DuCharme and Miller 1996).

Point Source Pollution

In 2000, 61 municipal, industrial, and agricultural sites requiring National Pollution Discharge Elimination System (NPDES) outfall permits were identified as potential point-sources of pollution. Despite the number of permits, serious point source pollution problems in the basin are relatively few in number. They relate mostly to impaired municipal waste water treatment facilities and illegal spillage of hog manure into waterways. The California S. WWTP and Versailles WWTP have had the most serious problems with pollution. One incident at the Versailles WWTP involved a fish kill and excessive nutrient enrichment was associated with the California plant (MDC 2002b).

The spillage of hog manure into waterways has been documented (three times) periodically since 1995, however, no fish kills have resulted from the se spills. Excessively high BOD and ammonia levels resulted from one hog manure spill on Beard Creek, a tributary to South Moreau Creek, in 1996 (MDC 2002b). This type of acute problem is associated with confined, high density livestock operations. In

2002, there were 19 confined swine, 16 poultry and 1 active dairy facility permits issued by the state of Missouri for containing animal wastes (MDNR 2002; Figure ps). High concentrations of operations occurred in the watersheds of Willow Fork, Burris Fork, Wilkes Creek and Blythe's Creek.

Non-point Source Pollution

Soil erosion rates from cropland in the basin have declined steadily from 10.868 to 5.619 tons of soil lost per acre per year from 1982 to 1997, respectively (Barney 2002, personal communication). Erosion rates for pastureland have followed a similar but less dramatic trend, declining from 1.948 in 1982 to 1.322 tons per acre per year in 1997. Soil entering streams degrades aquatic habitat by increasing turbidity, water temperatures, and depositing excessive amounts of unconsolidated sand, silt and clay on the stream bottom to decrease diversity and destabilize in-stream aquatic habitats.

In addition to sediment laden runoff from fields, the clearing of riparian corridors and the trampling of streambanks by livestock also contribute to problems with sedimentation. The clearing of riparian areas diminishes the filtering function of the corridor and allows increased amounts of sediment to enter streams. This same vegetation also serves to strengthen streambanks. When trees are removed, the streambanks, particularly along outside bends, become weak and are prone to bank caving. This instability is particularly striking on aerial photos.

Nutrient-loaded runoff from pastures, feedlots, septic drainage fields, and direct contamination to streams by free livestock contributes to increasing in-stream biological oxygen demand (BOD), suspended solids, fecal coliform counts, and algae growth. Depletion of oxygen in the water for aquatic life is most serious during periods of low stream flow when water temperatures are elevated and the biological oxygen demand from organic rich nutrients is high.

Littering along streams at access points, bridges, and public areas is a problem throughout this basin (as well as throughout the state).

Community Involvement

Activity of local citizens in the Missouri STREAM TEAM program, a citizen network sponsored by the Conservation Federation of Missouri, the Missouri Department of Conservation, and Missouri Department of Natural Resources for individuals interested in stream conservation and protection, is one gauge of community involvement in local stream issues. As of March 2002, there are eight STREAM TEAMS in the watershed. Five teams adopted portions of the Moreau River, and other individual groups adopted Roark Creek, Honey Creek and Logan Creek.

Examples of activities which these teams have participated in include: water quality and invertebrate monitoring projects, litter pick-ups, forestkeeper monitoring, or attendance at crayfish or water quality monitoring workshops. For 2001, seven of the eight teams reported no activity. This suggests community involvement in these streams is low.

Table 1. Beneficial use classifications for streams in the Moreau River Watershed (MDNR 1994).

Stream	Miles	From (Township, Range, Section)	To (Township, Range, Section)	County	Beneficial Use*
Bear Branch	2	Mouth	44N 15W 19	Moniteau	LWW, AQL
Blythe's Creek	6.5	Mouth	Bus Hwy 54	Moniteau	LWW, AQL
Brush Creek	5.5	Mouth	42N 14W 16	Cole	LWW, AQL
Trib. to Brush Creek	1	Mouth	43N 14W 34	Cole	LWW, AQL
Burris Fork	8	43N 16W 10	43N 17W 25	Moniteau	LWW, AQL
Trib.to Burris Fork	0.5	Mouth	43N 16W 3	Moniteau	LWW, AQL
Trib. to Burris Fork	0.5	Mouth	44N 16W 34	Moniteau	LWW, AQL
Clark Fork	7	Mouth	43N 13W 34	Cole	LWW, AQL
Cliffty Branch	2	Mouth	44N 15W 36	Moniteau	LWW, AQL
Dry Fork	3	Mouth	45N 16W 28	Moniteau	LWW, AQL
Gracey Creek	2	Mouth	42N 16W 5	Morgan	LWW, AQL
Honey Creek	4	Mouth	43N 12W 29	Cole	LWW, AQL
Jones Creek	4	Mouth	42N 16W 4	Morgan	LWW, AQL
Kelley Branch	0.5	Mouth	44N 17W 1	Moniteau	LWW, AQL
Logan Creek	3	Mouth	44N 13W 19	Cole	LWW, AQL
Marney Branch	5	Mouth	43N 15W 3	Moniteau	LWW, AQL
Medlen Creek	1	Mouth	43N 15W 6	Moniteau	LWW, AQL
Mineral Branch	2	Mouth	44N 15W 17	Moniteau	LWW, AQL

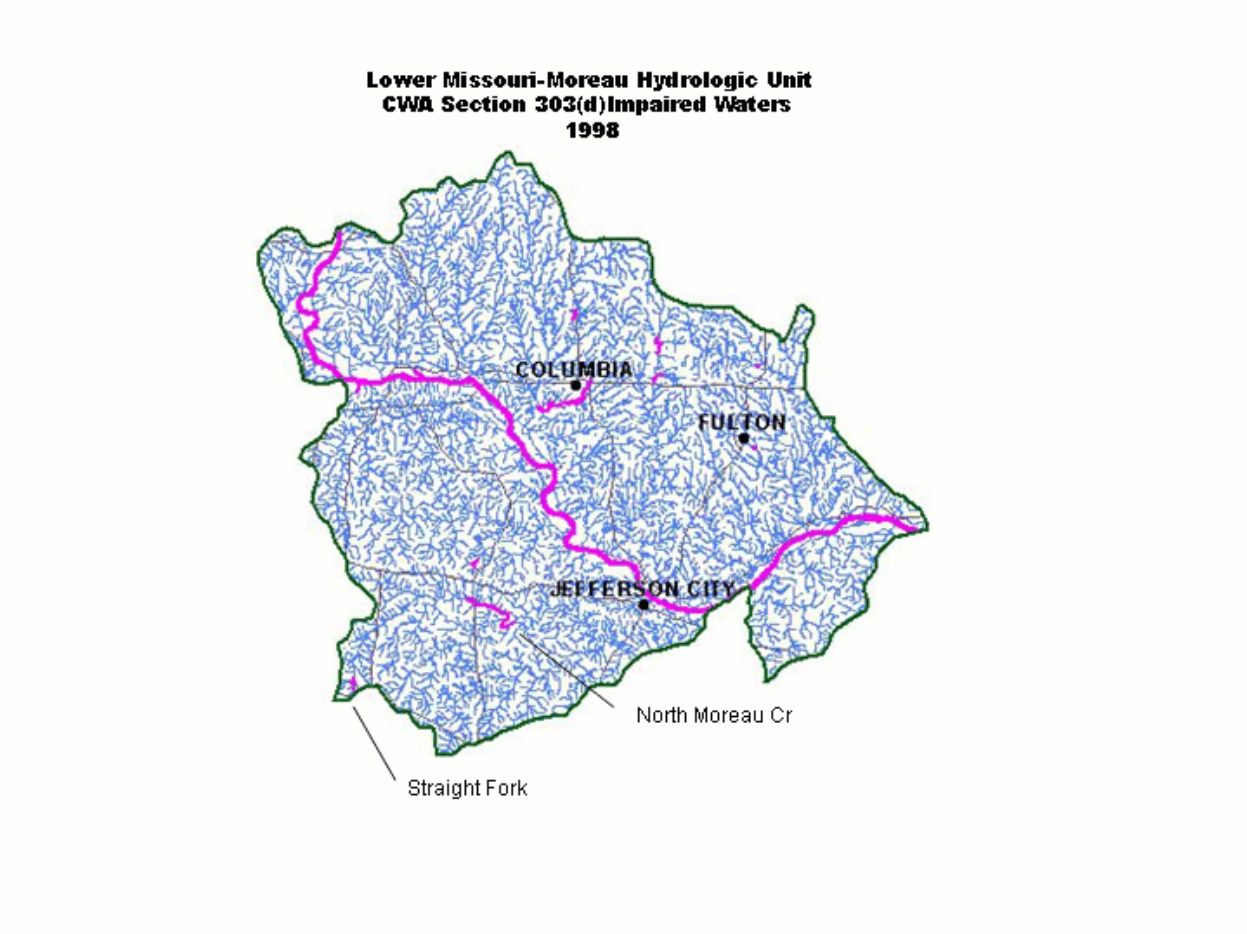
Stream	Miles	From (Township, Range, Section)	To (Township, Range, Section)	County	Beneficial Use*
Morgan Branch	1.5	Mouth	43N 14W 17	Cole	LWW, AQL
Moreau River	33	Mouth	43N 14W 1	Cole	LWW,AQL, WBC,BTG
Trib. to Moreau River	0.5	Mouth	43N 12W 6	Cole	LWW, AQL
North Moreau Creek	50	43N 13W 1	44N 16W 4	Cole	LWW,AQL, WBC,BTG
Trib. to N. Moreau Creek	0.5	Mouth	44N 13W 23	Cole	LWW, AQL
Trib. To N. Moreau Creek	1	Mouth	44N 14W 9	Moniteau	LWW, AQL
Trib. to N. Moreau Creek	0.5	Mouth	44N 13W 9	Cole	LWW, AQL
Trib. to N. Moreau Creek	2	Mouth	45N 15W 33	Moniteau	LWW, AQL
Trib. to N. Moreau Creek	2	Mouth	44N 15W 18	Moniteau	LWW, AQL
Trib. to N. Moreau Creek	2	Mouth	44N 16W 12	Moniteau	LWW, AQL
Trib. to N. Moreau Creek	2	Mouth	44N 16W 2	Moniteau	LWW, AQL
Trib. to N. Moreau Creek	0.5	Mouth	44N 15W 4	Moniteau	LWW, AQL
Pilot Branch	1	Mouth	44N 16W 10	Moniteau	LWW, AQL
Roark Branch	1	Mouth	43N 14W 23	Cole	LWW, AQL

Stream	Miles	From (Township, Range, Section)	To (Township, Range, Section)	County	Beneficial Use*
Rock Enon Creek	4	Mouth	43N 15W 14	Moniteau	LWW, AQL
Rocky Branch	2	Mouth	43N 16W 16	Moniteau	LWW, AQL
South Moreau Creek	20.5	43N 13W 1	43N 14W 29	Cole	LWW,AQL, WBC,BTG
South Moreau Creek	9	43N 14W 29	42N 15W 7	Moniteau	LWW, AQL,WBC, BTG
South Moreau Creek	6.5	42N 15W 7	42N 15W 31	Miller	LWW, AQL
Trib. to S. Moreau Creek	0.5	Mouth	43N 14W 25	Cole	LWW, AQL
Trib. to S. Moreau Creek	0.5	Mouth	43N 13W 19	Cole	LWW, AQL
Trib. to S. Moreau Creek	1.5	Mouth	43N 15W 28	Moniteau	LWW, AQL
Trib. to S. Moreau Creek	1	Mouth	43N 15W 31	Moniteau	LWW, AQL
Trib. to S. Moreau Creek	1	43N 15W 31	43N 16W 25	Moniteau	LWW, AQL
Trib. to S. Moreau Creek	1.5	Mouth	42N 15W 29	Miller	LWW, AQL
Trib. to S. Moreau Creek	1	Mouth	43N 15W 30	Moniteau	LWW, AQL
Scott Branch	0.5	Mouth	44N 15W 5	Moniteau	LWW, AQL
Smith Creek	10.5	Mouth	43N 17W 2	Moniteau	LWW, AQL, WBC

Stream	Miles	From (Township, Range, Section)	To (Township, Range, Section)	County	Beneficial Use*
Straight Fork	12	44N 16W 4	43N 17W 6	Moniteau	LWW, AQL, WBC
Straight Fork	6	43N 17W 6	43N 18W 36	Morgan	LWW, AQL
Strobel Branch (1)	2	Mouth	44N 14W 24	Cole	LWW, AQL
Strobel Branch (2)	2.5	Mouth	45N 14W 35	Cole	LWW, AQL
Trib. to Strobel Branch (2)	0.5	Mouth	45N 14W 36**	Cole	LWW, AQL
Trib. to Strobel Branch (2)	0.5	Mouth	44N 14W 1	Cole	LWW, AQL
Willow Fork	3	44N 16W 4	45N 17W 36	Moniteau	LWW, AQL, WBC
Willow Fork	6.5	45N 17W 36	45N 17W 29	Moniteau	LWW, AQL
Trib. to Willow Fork	0.5	Mouth	45N 17W 27	Moniteau	LWW, AQL

*Beneficial use= LWW=livestock and wildlife watering, AQL=protection of warmwater aquatic life and human health fish consumption, WBC=whole body contact, BTG=boating and canoeing.
**Trib. to Strobel Br. is reported as from Mouth to T45N, R13W, S36 in MDNR 1992 source, however, R13W, appears incorrect; R14W makes more sense.

Figure wq. CWA Section 303(d) impaired waterways identified by the EPA which are associated with the California and Versailles, MO waster treatment facilities.



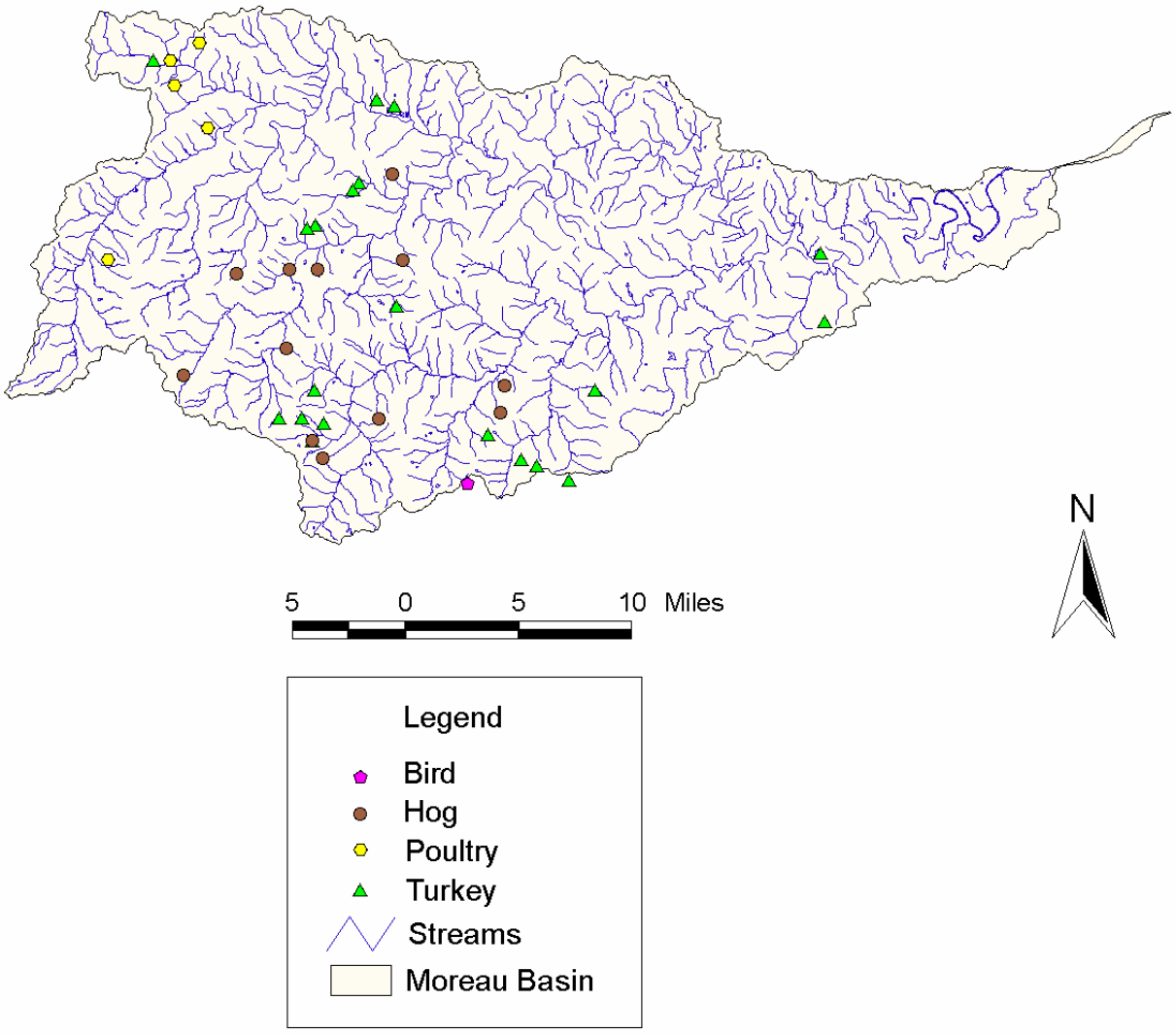


Figure ps. CAFO point source discharge locations within the Moreau River Watershed.

Stream Habitat

Instream Habitat Assessment

The lower Moreau River is a slow moving, turbid river with steep, silty streambanks. The channel is “U” shaped. The substrate is rich in silt, organic matter, gravel, and cobble. The lower reaches of the North Moreau and South Moreau creeks resemble the sluggish Moreau River but farther upstream they become more Ozark-like. They run more swiftly, are clearer and have more gravel, cobble and boulder substrates. Because the Moreau River has a very low gradient (1.6 feet/mile) and it empties into the Missouri River, its water level is greatly influenced by the stage of the Missouri River. For example, if the Missouri River is at flood stage then flooding is likely to occur on the Moreau River as well.

Inspection of aerial photos covering major streams indicate numerous areas of streambank sloughing on outside bends of the channel where the riparian trees have been cleared. These areas are sources of sediment that can fill pools and cause the channel to become shallower and wider.

During periods of severe drought, fish and other aquatic life require either sufficient water flow to sustain life or pools that can provide refuge. A survey to examine these conditions in many major Missouri streams was conducted in 1941-43 by A. H. Denny (Project Leader of P-R 1-5R) and rechecked and tabulated by John Funk in 1968. He reported that during periods of severe drought in the 1930- 1950's, 34 miles of Moreau River, 26.5 miles of South Moreau, 42 miles of North Moreau, 11 miles of Burris Fork and 13 miles of Straight Fork creeks maintained flows capable of supporting fish populations (Funk 1968). An additional 4 miles of South Moreau, 8 miles of Burris Fork and 6 miles of Straight Fork maintained permanent pools when water flow became intermittent (Funk 1968).

Streamside Forest Condition

Aerial photographs (1995) covering the mainstem Moreau River (35.2 miles) were examined for width of continuous wooded riparian corridor. A template was used to characterize the condition of the streamside corridor. One hundred and twenty four segments, 300-1200 meters in length, were inspected and each 100 meter section of bank was categorized into one of 6 groupings: 0-scattered trees, 1 row of trees-25 m of continuous tree cover, and continuous tree coverage of 26-50m, 51- 75m,75-100m or =100 meters (Table 1). The results of this analysis indicated 16% (mean of both banks) of 35.2 miles of river had virtually no wooded corridor and 40% (mean) had a corridor consisting of at least 1 row of trees to 25 meters (82 feet) in width. Eighteen percent of streambanks had tree corridors over 100 meters in width. An appropriate goal for a tree corridor width on an order 6 stream like the Moreau River is at least 100 feet (33 meters) wide on each river bank. An adequate tree corridor will foster infiltration of water into the ground, slow velocity of flood and overland runoff waters, trap sediments, provide a source of nutrients for the stream ecosystem, and moderate stream water temperature by providing shade.

Another way to identify potential stream problem areas is to examine land use patterns along streams. For example, where large wooded areas exist we may anticipate fewer streambank erosion and pollution problems and where high cropland and grassland use exists we may expect more problems with siltation, streambank erosion or nutrient enrichment. We obtained basin-wide estimates of land use patterns along basin streams using GIS technology. A computer program, the riparian estimator, developed in 2001 by Mark Caldwell, a MDC fisheries researcher, derived land use adjacent to streams using Landsat 30 meter resolution satellite imagery from 1993-1995 (MoRAP 1997). The program divided streams into 400 meter segments then characterized land use within a 90 meter swath (3 pixel width) centered on the main creek channel. Its accuracy is estimated to be from 15-60 meters. These data suggest 51-54% forest cover along streams in the eastern part of the basin with a gradual decrease to 29% in the western part of the basin. Grassland use exceeded 34% in all areas of the basin and peaked around 56% in the southwest region. Cropland was lowest in the southcentral part of the basin (3-5%) and highest in the western portion (15%). Urban and wetland uses in the stream corridor were insignificant. Figures sf1 and sf2 summarize

the sub-basin localities and land use patterns.

Channel Alterations

The mainstem Moreau is a low gradient stream which gently meanders across its flood plain. Its channel has been modified in places to create more cropland and to facilitate road crossings. An exact estimate of the proportion of its length that has been channelized (straightened) is difficult to determine because channel alterations done 50-150 years ago may not be detected without on-site inspection and use of historical notations. Especially straight reaches of stream are highly suspect for past channel alteration activities. The overall effect of channel straightening is a shortening of the overall stream length which decreases storage capacity and increases water velocity and thus erosive forces.

Small impoundments occur on the upper reaches of many small streams but none of the major streams are impounded at this time. There are remnants of an old mill dam at T44N, R16W, S3 on North Moreau Creek near California in Moniteau county.

In 2002, there were 7 permitted sand and gravel removal operations in the basin. They are located on Straight Fork Creek (2), Burris Fork Creek (1), Neighorn Branch (1), Russellville Branch (2) and South Moreau Creek (1) (MDNR 2002b; Figure gs). Extraction activities have the potential to increase channel instability which leads to channel down-cutting and widening, increase streambank erosion, increase turbidity, and increase sedimentation of downstream aquatic habitat. Consequences of these alterations include threatening fisheries productivity, biodiversity, recreational potential, public infrastructure (bridges, oil, gas, sewer pipelines, utility lines), streamside land use and aesthetics, and real estate values.

Unique Habitat

The Missouri Department of Conservation tracks six high quality natural communities in the Moreau watershed through the Missouri Natural Heritage database (2002). They include Baker Bluff, a mesic limestone/dolomite forest in Moniteau county; Hite Prairie, a dry-mesic chert prairie, which is also an

MDC conservation area in Morgan County; Newcomb Prairie, a dry-mesic prairie in Moniteau county; Straight Fork Forest, a 20-acre dry-mesic limestone/dolomite forest in Moniteau County; North Moreau Creek Forest, a mesic bottomland forest in Cole County; and the mainstem Moreau River in Cole County (Figure uh). The Moreau River is recognized as a good example of a Missouri Ozark Division stream.

There are no natural areas in the basin.

Improvement Projects

MDC staff have been available since 1986 to provide technical assistance to landowners with streambank erosion problems. Advice regarding appropriate streambank stabilization techniques, tree species for riparian plantings and information on various cost share programs sponsored by MDC, DNR, NRCS, and county soil and water conservation districts was made available. Twenty-two contacts involving site visits were made to problem areas on Burris Fork (4), North Moreau Creek (5), South Moreau Creek (5), Straight Fork (3), Smiths Creek (1), Roark Branch (3), and Honey Creek

(1) since 1986. Five major stream habitat improvement projects were implemented with government assistance in 1999-2002 (Table 2).

Table 1. Condition of the riparian corridor of the mainstem Moreau River (35.2 miles) by inspection of 1995 aerial photographs.

Tree Corridor width	Percent wooded riparian corridor		
	Left streambank	Right streambank	Mean both banks
0-scattered trees	17%	14%	16%
1 row of trees-25 meters	34%	46%	40%
26-50 meters	15%	10%	12%
51-75 meters	7%	8%	8%
76-100 meters	6%	7%	7%
=100 meters	20%	16%	18%

Table 2. Stream habitat improvement projects implemented in 1999-2002.

Stream	County	Project practices
Roark Branch	Cole	Livestock exclusion from riparian corridor, fencing, well, solar-powered water pump
Tributary to Roark Branch	Cole	Livestock exclusion from riparian corridor, fencing, rock stream crossing
North Moreau Creek	Cole	CRP filter strip, rock stream crossing, rock jetty
North Moreau Creek	Moniteau	Willow stake streambank
Straight Fork	Moniteau	Rock jetties (3), trees for planting

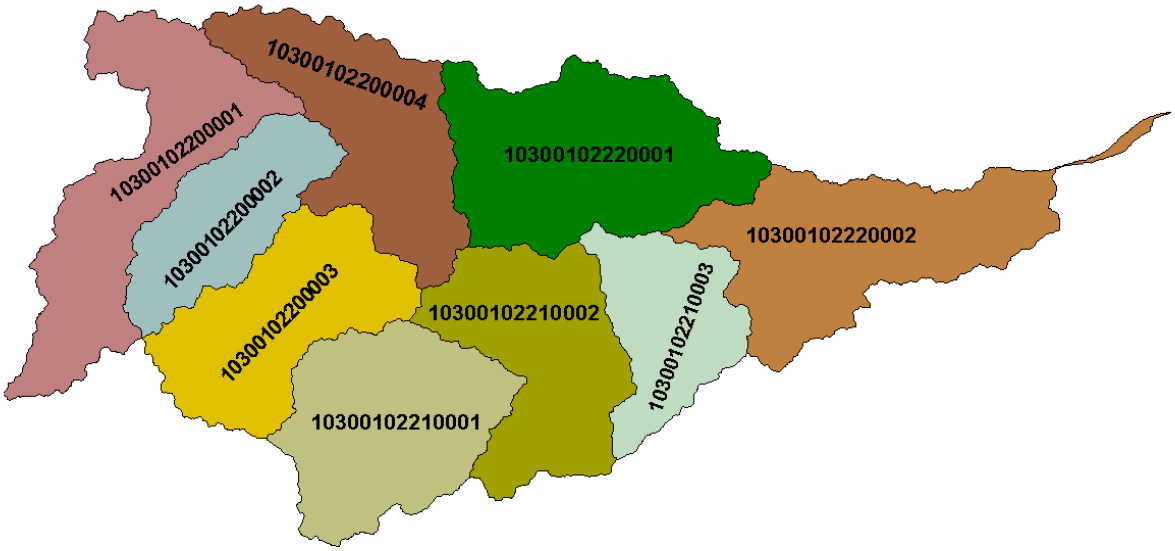


Figure sf1. Subbasins of the Moreau River Watershed in Missouri.

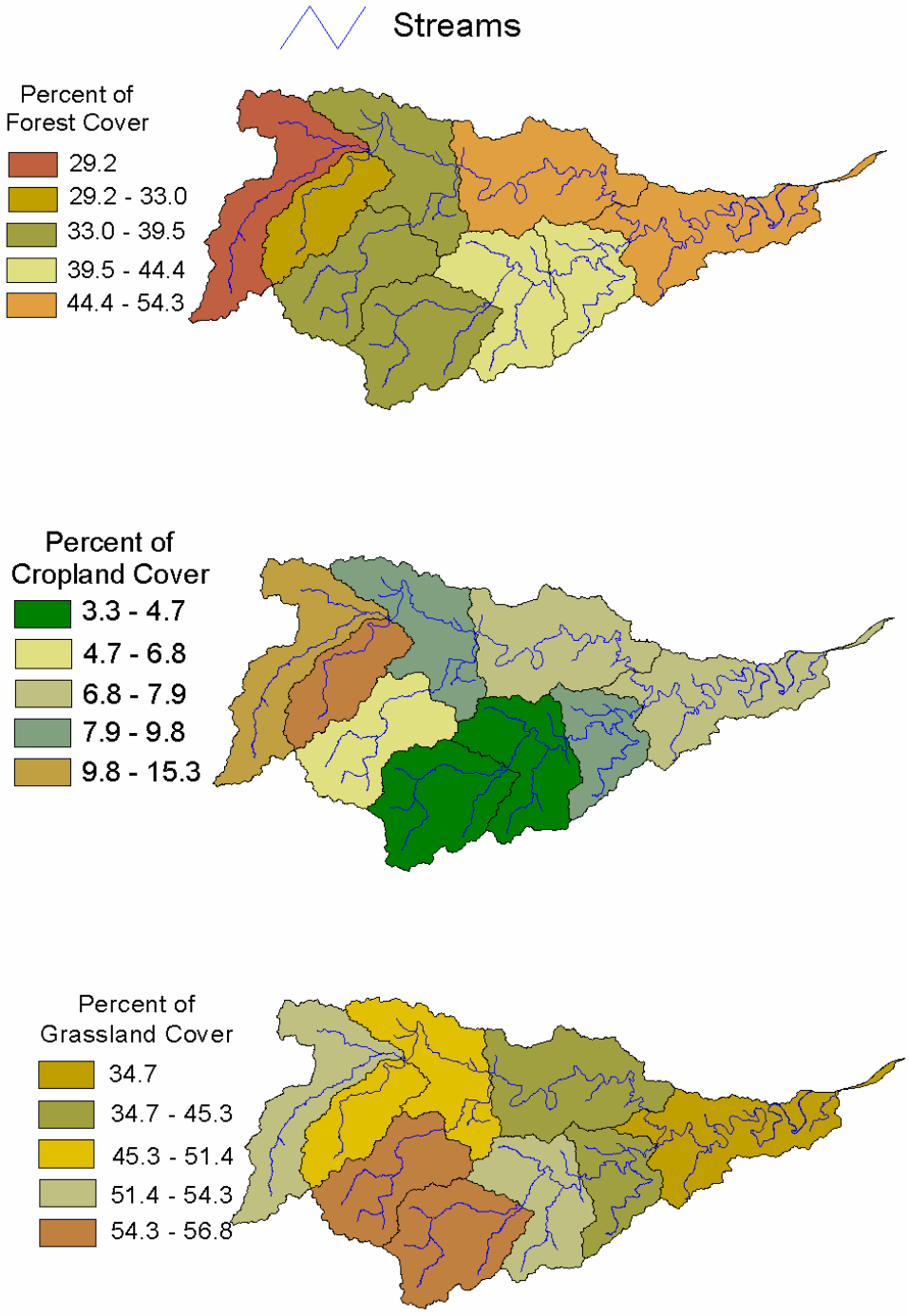


Figure sf2. Riparian 90-foot wide land use in the Moreau River sub-basins, 1993-1995.

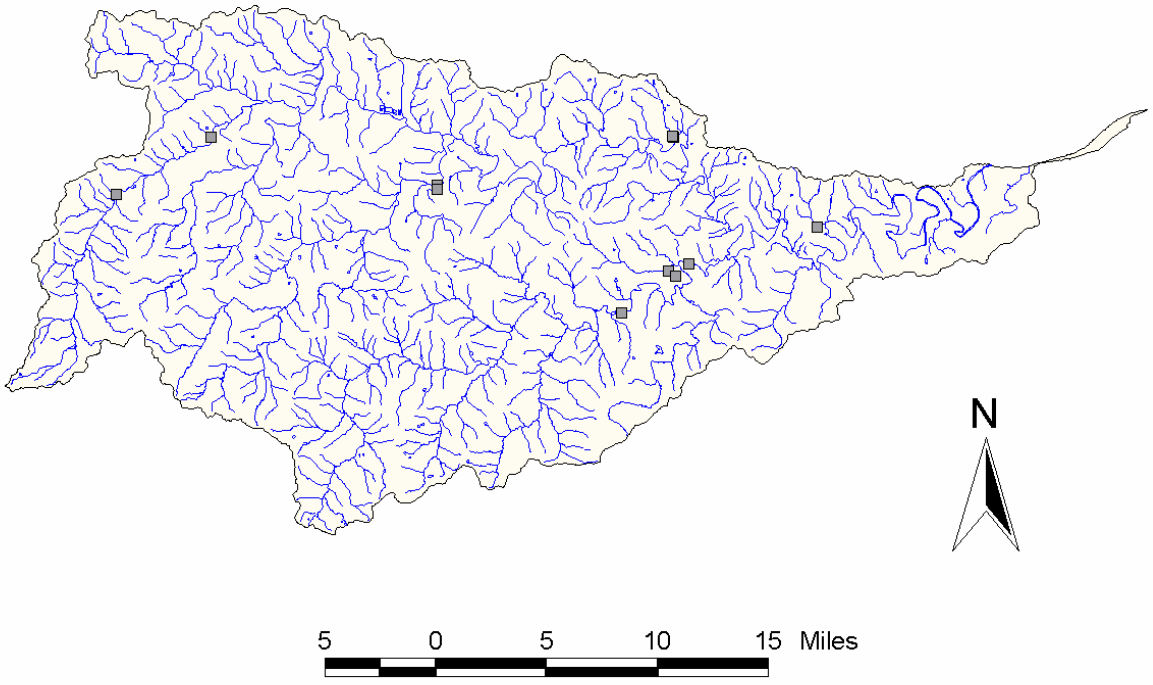


Figure gs. 2002 gravel removal sites in the Moreau River Watershed, in Missouri.

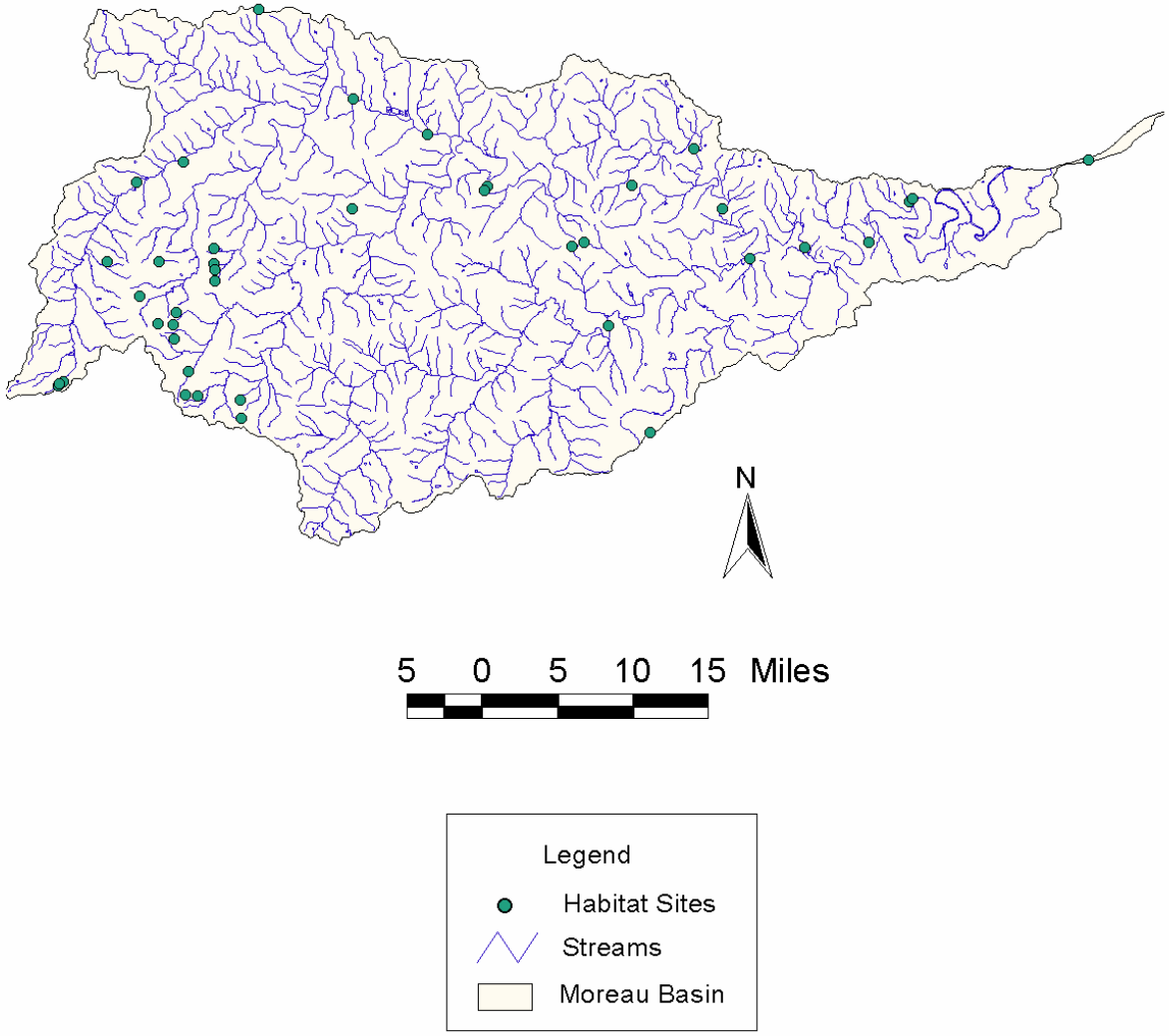


Figure uh. Uniqu habitat areas tracked in the Natural Heritage Database (2002).

Biotic Community

Fish Community

Twenty-six fish sampling stations are present among 9 streams in the basin (Figure fc1). Fish collections were made at 4 sites in 1940, 10 sites in 1961-66, 10 sites in 1977-79, and 21 sites in 1995-98 using drag and kick seines, or backpack electrofishing equipment.

A total of 71 fish species were collected basin wide since 1940. Sixty-six species were represented in the three largest streams, the Moreau, North and South Moreau creeks, and 44 species were represented in the six smaller streams (Burris Fork, Straight Fork, Brush Creek, Clark Fork, Willow Fork, and unnamed tributary) in the basin (Tables 1 and 2). Most streams had appropriately diverse fish fauna, however, some changes in fish species abundance and distribution have occurred in recent years and are discussed below.

The fish fauna of the Moreau basin reflects a blending of Ozark-Missouri and Prairie-Lower Missouri aquatic fauna. In the two most recent collection periods, 1977-79 and 1995-98, across all sizes of streams, approximately 56% of the fauna was Ozark in character, 21% were species of broad adaptability and wide range, 15% were typical prairie species and 5% were lowland species (Figure fc2). Big river fauna (4%) was concentrated in the Moreau River.

Three species (Missouri saddled darter, emerald shiner, and gravel chub) were only found in large river habitats. The Missouri saddled darter was present in the Moreau River, lower South Moreau (RM 5) and lower North Moreau (<= RM 16) creeks. The emerald shiner, a species preferring open channels of large rivers with moderate to low gradient, only occurred in the Moreau River. The gravel chub inhabited the lower North Moreau Creek (RM <=16) and middle to upper Moreau River (RM >=18).

The common carp, the only exotic species found in the basin, was last collected in 1977 in the Moreau River at RM 3. Despite few capture records, carp from the Missouri River probably frequent the lower reaches of the Moreau on a regular basis.

Spotted bass and western mosquitofish have become more widespread in the Moreau, South and North Moreau creeks, and Burris Fork drainages in the last 40 years. Neither species were collected in these rivers in 1940. However, the proportions of sites where spotted bass were collected has increased from 10% to 64% from the 60's to the 90's and the sites having mosquitofish increased from 0 to 36% during this same time period (Table 3). Our findings are consistent with Pflieger's (1997) observation that the range of the mosquitofish has been naturally expanding over the last 50 years. The expansion of spotted bass into the Moreau system is believed to be associated with an undocumented stocking into the Osage drainage sometime prior to the 1940's.

At the same time that the range of the spotted bass has been expanding, the range of smallmouth bass has been shrinking in this watershed. In the 1990's, smallmouth bass were collected at one site on Burris Fork and at one site on the upper Moreau River. At seven other sites (on Straight Fork, North Moreau Creek, South Moreau Creek) where they had previously been collected, no fish were taken during recent sampling. Pflieger (1997) partly attributes this decline in

abundance from hybridization with spotted bass, increased siltation, and poorer base water flows.

Two species, southern redbelly dace and Ozark sculpin, were collected at the fringe or outside of their normal distribution. One southern redbelly dace was collected in 1996 in the small fourth order Clark Fork, a tributary to South Moreau Creek. This locality is along the northern fringe of its normal range. The dace typically inhabits permanently flowing small creeks and spring branches with clear, cool water and sand or gravel substrates. In 1995, one Ozark sculpin was taken at RM 8 on Straight Fork. This sculpin was taken farther north than its typical distribution in the central and southern Ozarks, however, isolated populations do occur in the Osage and Gasconade drainages. In the Ozarks, it is abundant in spring- fed streams. These species suggest the possibility of finding some areas of unique habitat on Straight Fork and Clark Fork.

There were seven species only taken in 1940-1966 surveys. They included the chestnut lamprey, Topeka shiner, white bass, walleye, plains topminnow, common shiner, and blacknose shiner.

Four of these seven species (Topeka shiner, walleye, common shiner, blacknose shiner) are considered intolerant of habitat perturbations and are often the first species to decline following changes to their environment. Populations of chestnut lamprey, white bass and walleye are secure in Missouri. Our inability to recapture these species could have been due to sampling method rather than changes in abundance because these are large fish and they are not as susceptible to seining as the smaller-sized species. The plains topminnow, blacknose shiner, and Topeka shiner are imperiled statewide. The abundance of common shiners, although not dangerously low in numbers statewide, has been declining in some central Missouri streams (Pflieger 1997). They were last collected in upper North Moreau Creek (RM 45) and Straight Fork in 1966.

The plains topminnow, common shiner, Topeka shiner, and blacknose shiner were all collected in 1940. Their combined presence suggests that at one time Straight Fork had very high quality habitat and this habitat has subsequently degraded significantly.

The final species that might be declining in this drainage is the blackside darter. These darters generally occur in medium to large-size rivers at low population densities. They are found in pockets in the Prairie and Lowland regions of the state. In 1964 and 1979, one blackside darter was taken on the lower North Moreau Creek and on the lower South Moreau Creek. In collections made in the 1990's, no blackside darters were collected. Because abundance was very low in the past, it is difficult to determine if this change is significant or due to inadequate sampling for a rare species.

Since 1940, 22 intolerant species, those considered highly sensitive to perturbations, have been identified in basin streams (Tables 1 and 2). Four of these species were only observed before 1970. The remaining 18 intolerant species were widely distributed among streams. The great variety of fish species found in this basin as well as the abundance of intolerant species suggests that overall, the fish communities are in good condition. Streams worthy of further evaluation due to species present historically (Topeka shiner, common shiner, blacknose shiner, plains topminnow) or currently unique species (Ozark sculpin, southern redbelly dace) include

Straight and Clark forks. Smith Creek would also be a good candidate for further sampling efforts (it has not been sampled to date) due to its size and close proximity to Straight Fork.

Species of Concern

"Species of concern" are species of special interest because their population is declining, they are extremely rare, or they are particularly vulnerable to extinction. Four fish species, the plains topminnow, blacknose shiner, ghost shiner and Topeka shiner, on this list, once occurred in the basin but were not been observed in the 1990's (Figure sc). The plains topminnow, blacknose shiner, and federally endangered Topeka shiner, were last collected in Straight Fork in 1940. It is doubtful that populations of these species remain in the basin. Low numbers of ghost shiners were observed in North Moreau Creek in 1940 and in the Moreau River in 1962 and 1979.

However, when these same localities were resampled in 1995 or 1998, no ghost shiners were collected. This species is imperiled in the state because of rarity but is secure globally. It prefers low-gradient reaches of large, moderately clear creeks with permanent flow.

Non-fish species of concern that have occurred in the basin are as follows: the Northern crawfish frog *(Rana Areolata circulosa),* a Meropid scorpionfly *(Merope tuber),* three Great blue heron rookeries *(Ardea herodias),* Henslow's sparrow *(Ammodramus henslowii),* Upland sandpiper *(Bartramia longicauda),* Northern harrier *(Circus cyaneus),* Cooper's hawk *(Accipiter cooperii),* Greater prairie-chicken *(Tympanuchus cupido),* Running buffalo clover *(Trifolium stoloniferum),* False mermaid *(Floerkea proserpinacoides),* Amethyst shooting star *(Dodecatheon amethystinum),* Wolf's spike rush *(Eoleocharis wolfii),* and Columbia water- meal *(Wolffia columbiana)* (Figure sc). Four of the species

listed above (Henslow's sparrow, Northern harrier, Wolf's spike rush and Northern crawfish frog) were observed on prairie habitat at Hite Prairie CA near Versailles. The Greater prairie-chicken, Northern harrier, and Running buffalo clover are endangered in the state.

Concentrations of prairie-chickens were last found northeast of Versailles and in the vicinity of Tipton to the north in 1993 (Figure sc). In 1996, a few prairie-chickens were sighted in the vicinity of Tipton and Clarksburg along the divide between the Moniteau and Moreau drainages but none have been sighted on booming grounds in the vicinity of Versailles. It is doubtful that any viable population of prairie-chickens remains in this watershed (Mechlin 2002, personal communication). The conversion of vast grasslands to pasture is believed to be contributing to their decline throughout Missouri.

One exotic plant, purple loosestrife *(Lythrum salicaria),* is monitored in the database because it is a noxious exotic wetland plant that is displacing native plants (Missouri Natural Heritage database 2002; Figure sc).

Sport Fishing

Numerous sport fishing opportunities, especially wade fishing, abound in the Moreau basin. Largemouth bass, spotted bass, bluegill, and longear sunfish are found in all major streams. Channel catfish appear most abundant in the North Moreau, Moreau and South Moreau rivers.

Angling for smallmouth bass is less predictable. Their abundance and distribution has declined since the appearance of spotted bass in the 1950's. Smallmouth bass occurred in recent fish collections made in the Moreau River, South Moreau Creek and Burris Fork but not in North Moreau Creek. Hybridization with spotted bass, increased siltation, and lowered base flows (i.e. greater intermittent conditions) are believed to have contributed to their decline along the Ozark border and northeastern prairies (Pflieger 1997).

Over the years a few white bass, white crappie, walleye, flathead catfish, and sauger have been taken in fish collections in the Moreau, South Moreau or North Moreau rivers. Local anglers catch these fish seasonally.

Gigging, a popular Ozark sport, is possible in the larger rivers but is challenging due to frequent low water conditions which make boating difficult and poor water clarity. Golden and shorthead redhorse, favorite targets of giggers in the late fall and early winter, are abundant in the larger streams. "Suckers" as they are called, are scored and deep- fat fried.

Public fishing accesses are available at the Moreau 50 access near the Hwy 50-63 bridge in Cole County, at the mouth of Honey Creek, at Stringtown bridge 2 miles east of Lohman, and at Scrivner Road Conservation Area 3 miles southeast of Russellville (Figure pa).

Fishing Regulations

Statewide stream fishing regulations apply to all streams.

Macroinvertebrates

Crayfish

The golden, *Orconectes luteus,* and Northern, *Orconectes virilis,* crayfishes are widely distributed throughout the basin (Pflieger 1996). The golden crayfish prefers rocky and gravelly substrates and permanent water. The Northern crayfish is most at home in fertile, warm, moderately turbid water without strong base flows. They prefer to hide among slab rock, logs, and organic debris. The papershell crayfish, *Orconectes immunis,* is found extensively in the Prairie faunal region and in the floodplain of the Missouri River (Pflieger 1996). Because the Moreau River is a major tributary of the Missouri, it is likely that some papershell crayfish also inhabit the lower reaches of the Moreau. The grassland crayfish, *Procambarus gracilis,* a crayfish that burrows up to 6 feet underground and lives long distances from

permanent water, is found in eastern Moniteau County (Pflieger 1996). As its name implies, this crayfish inhabits grassland or prairie areas, a habitat type found in eastern Moniteau County.

Naiades

The Moreau River has a diverse fauna of aquatic mussels. Twenty-five species of naiades have been collected from this watershed since 1965 (Table 4; Figure ms). None are threatened or endangered, however, one species, the black sandshell *(Ligumia recta),* collected by Oesch (1984) is locally imperiled. Although the commercial harvest of mussels is not permitted in the Moreau River, it does contain a number of mussels of commercial value for the pearl, button and polished chip industries.

Aquatic Insects

The aquatic insect fauna of the Moreau basin is not well known. MDC has no current collection data available for benthic aquatic insect samples in this watershed, however, some macroinvertebrate sampling will be collected from Burris Fork for the Missouri Resource Assessment Monitoring Project (Fischer 2002, personal communication). Informal collection information gathered by private citizens participating in the Missouri STREAM TEAM program is available for selected sites on Logan Creek, Honey Creek, South Moreau Creek, North Moreau Creek and Medlin Creek (Tables 5 and 6). These specimens were broadly categorized into taxa intolerant, somewhat tolerant, and tolerant to pollution. This method provides a general impression of the water quality at these sites ranging from poor to good.

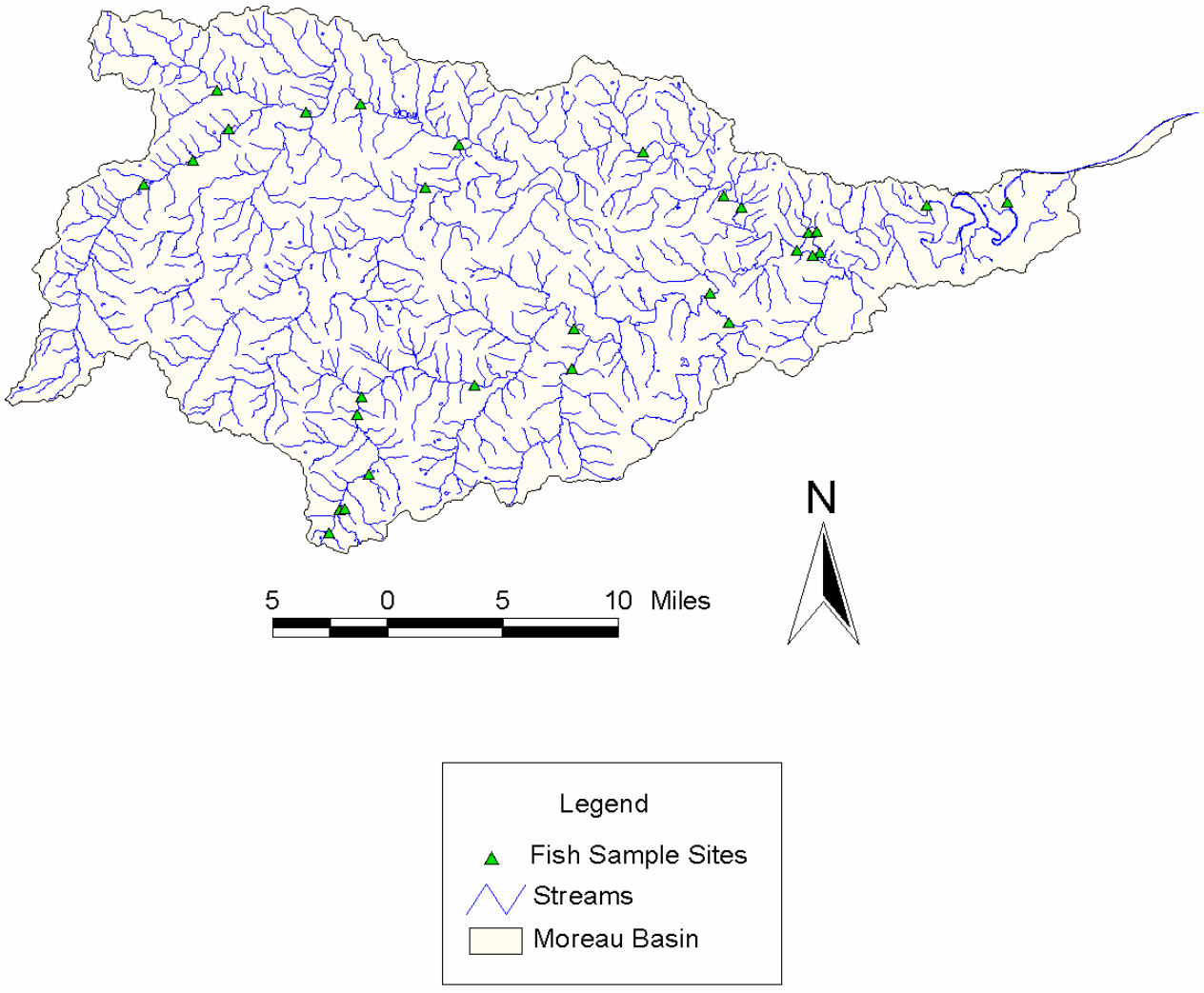


Figure fc1. MDC fish sample sites in the Moreau River basin, 1940-1998.

Table 1. Fish list of Moreau River, North Moreau Creek, and South Moreau Creek, 1940- 1998

Common Name (intolerant species bolded)[a]	Scientific Name	Collection Period			
		Primary Rangeb	North Moreau Creek	South Moreau Creek	Moreau River
Black Bullhead	*Ameiurus melas*	Wide	A	C	
Yellow Bullhead	*Ameiurus natalis*	Wide	A	C,D	
Freshwater Drum	*Aplodinotus grunniens*	Big River	B	B	C,D
River Carpsucker	*Carpiodes carpio*	Prairie	B		
Quillback	*Carpiodes cyprinus*	Prairie	D		C,D
White Sucker	*Catostomus commersonni*	Oz-Pr	A,B	B,C,D	
Common Carp	*Cyprinus carpio*	Wide	B		C
Gizzard Shad	*Dorosoma cepedianum*	Wide	B,D		C,D
Goldeye	*Hiodon alosoides*	Big River			D
Northern Hog Sucker	*Hypentelium nigricans*	Ozark	B,D	B,C,D	D
Chestnut Lamprey	*Ichthyomyzon castaneus*	Wide		B	B
Channel Catfish	*Ictalurus punctatus*	Wide	A,B,D	D	D
Smallmouth Buffalo	*Ictiobus bubalus*	Wide	B		D
Bigmouth Buffalo	*Ictiobus cyprinellus*	Wide	B		C
Longnose Gar	*Lepisosteus osseus*	Wide	B	B, C	B,C
Shortnose Gar	*Lepisosteus platostomus*	Big River		B,D	C,D

Common Name (intolerant species bolded)[a]	Scientific Name	Collection Period			
		Primary Rangeb	North Moreau Creek	South Moreau Creek	Moreau River
Green Sunfish	*Lepomis cyanellus*	Wide	A,B,D	B,C,D	B,C
Orange Spotted Sunfish	*Lepomis humilis*	Prairie	A,B,D	B,C,D	B,C,D
Bluegill	*Lepomis macrochirus*	Wide	A,B,D	B,C,D	B,C,D
Longear Sunfish	*Lepomis megalotis*	Oz-Low	B,D	B,C,D	B,C,D
Smallmouth Bass	*Micropterus dolomieu*	Ozark	B	B,C,D	D
Spotted Bass	*Micropterus punctulatus*	Oz-Low	D	B,C,D	C,D
Largemouth Bass	*Micropterus salmiodes*	Wide	A,B,D	B,C,D	B,C,D
Spotted Sucker	*Minytrema melanops*	Lowland		B,C	
White Bass	*Morone chrysops*	Big River		B	
Silver Redhorse	*Moxostoma anisurum*	Ozark	B,D	B,C	C
Black Redhorse	*Moxostoma duquesnei*	Ozark	B	B,C,D	C
Golden Redhorse	*Moxostoma erythrurum*	Ozark	A,B,D	B,C,D	C,D
Shorthead Redhorse	*Moxostoma macrolepidotum*	Oz-Pr	B,D	B,C,D	B,C,D
White Crappie	*Pomoxis annularis*	Wide	A,B,D	B,C	B
Flathead Catfish	*Pylodictis olivaris*	Wide	B	C	
Sauger	*Stizostedion canadense*	Big River			C

Common Name (intolerant species bolded)[a]	Scientific Name	Collection Period			
		Primary Rangeb	North Moreau Creek	South Moreau Creek	Moreau River
Walleye	*Stizostedion vitreum*	Wide		B	
Largescale Stoneroller	*Campostoma oligolepis*	Ozark	B,D	B,C,D	B,C,D
Central Stoneroller	*Campostoma pullum*	Oz-Pr	A,B,D	B,C,D	B,C,D
Red Shiner	*Cyprinella lutrensis*	Prairie	A,B,D	B,C,D	B,C,D
Northern Studfish	*Fundulus catenatus*	Ozark	B,D	B,C,D	B,D
Blackspotted Topminnow	*Fundulus olivaceous*	Oz-Low	A,B,D	B,C,D	B,C,D
Western Mosquitofish	*Gambusia affinis*	Lowland	D	D	C,D
Brook Silverside	*Labidesthes sicculus*	Oz-Low	D	C,D	C,D
Common Shiner	*Luxilus cornutus*	Prairie	B		
Western Redfin Shiner	*Lythurus u. umbratilis*	Wide	A,B,D	B,C,D	B,C,D
Hornyhead Chub	*Nocomis biguttatus*	Ozark	A,B,D	C,D	D
Golden Shiner	*Notemigonus crysoleucas*	Wide		C	C,D
Emerald Shiner	*Notropis atherinoides*	Big River			C,D
Ghost Shiner	*Notropis buchanani*	Prairie	A		B,C
Ozark Minnow	*Notropis nubilus*	Ozark		C,D	C,D
Rosyface Shiner	*Notropis rubellus*	Ozark	A,B,D	B,C,D	B,C,D
Sand shiner	*Notropis stamineus*	Prairie	A,B,D	B,C,D	B,C,D

Common Name (intolerant species bolded)[a]	Scientific Name	Collection Period			
		Primary Rangeb	North Moreau Creek	South Moreau Creek	Moreau River
Bluntnose Minnow	*Pimephales notatus*	Wide	A,B,D	B,C,D	B,C,D
Fathead Minnow	*Pimephales promelas*	Prairie	D	B,C,D	
Creek Chub	*Semotilus astromaculatus*	Oz-Pr	A,B,D	B,C,D	C,D
Gravel Chub	*Erimystax x-punctatus*	Ozark	A,B,D		B,C,D
Greenside Darter	*Etheostoma blennioides*	Ozark	B,D	B,C,D	C,D
Striped Fantail Darter	*Etheostoma f. lineolatum*	Ozark	A,B,D	B,C,D	B,C,D
Johnny Darter	*Etheostoma nigrum*	Oz-Pr	A,B,D	B,C,D	B,C,D
Northern Orangethroat Darter	*Etheostoma s. spectabile*	Ozark	A,B,D	B,C,D	B,C,D
Missouri Saddled Darter	*Etheostoma tetrazonum*	Ozark	A,B,D	C,D	B,C,D
Speckled Chub	*Machrybopsis aestivalis*	Big River			D
Slender Madtom	*Noturus exilis*	Ozark	A,D	B,C,D	C
Stonecat	*Noturus flavus*	Prairie	A,D	D	D
Tadpole Madtom	*Noturus gyrinus*	Lowland	D	B,D	B,C
Ozark Logperch	*Percina c. fulvitaenia*	Ozark	A,B,D	B,C,D	B,C,D
Blackside Darter	*Percina maculata*	Prairie	B	C	
Slenderhead	*Perinca*	Oz-Pr	A,B,D	C,D	B,C,D

Common Name (intolerant species bolded)[a]	Scientific Name	Collection Period			
		Primary Rangeb	North Moreau Creek	South Moreau Creek	Moreau River
Darter	*phoxocephala*				
Suckermouth Minnow	*Phenacobius mirabilis*	Prairie	A,B,D	B,C,D	C,D

[a] Pflieger, personal communication
[b]Pflieger, 1971 A= 1940; B=1961-66; C=1977-79; D=1995-98

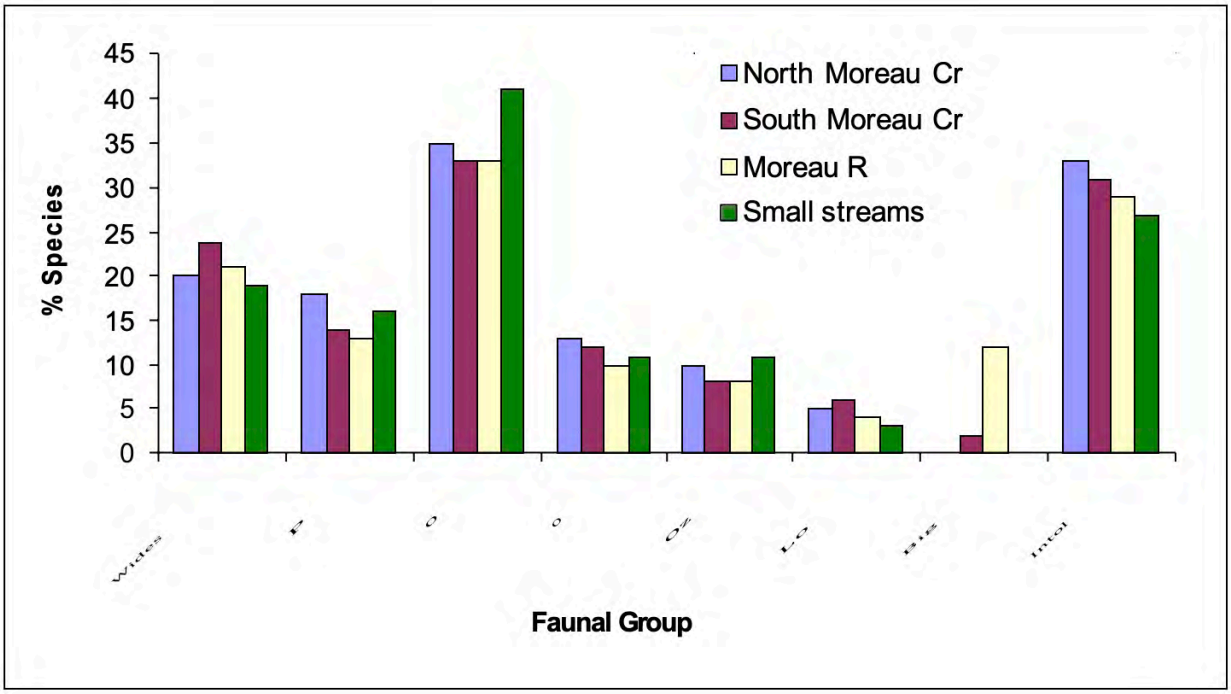
Table 2. Fish list for smaller streams in Moreau Basin sampled 1940-98.

Common Name (intolerant species in bold)a	Presence in A=1940; B=1961-66; C=none; D=1995-98					
	Straight Fork	Burris Fork	Brush Creek	Willow Fork	Clark Fork	Trib 1st order
Black bullhead	B	A				
Yellow Bullhead	A,D	B	D	B,D		
River Carpsucker	D					
Quillback	D					
White Sucker	A,B,D	A	D			
Northern Hog Sucker		A,D				
Green Sunfish	A,B,D	A,B,D	D	B,D	D	D
Orange Spotted Sunfish	A	A,D	D			
Bluegill	B,D	B,D		B,D	D	D
Longear Sunfish	B,D	D	D	D	D	
Smallmouth Bass	B	A,D				
Spotted Bass		D				
Largemouth Bass	A,B,D	A,B,D			D	
Black Redhorse	B					
Golden Redhorse	A,B,D	A,D				
Largescale Stoneroller	B,D	D		B,D	D	
Central Stoneroller	A,B,D	A,B,D	D	B,D	D	
Red Shiner	A,B,D	A,B,D		B,D		
Northern Studfish	D	D	D		D	
Blackspotted Topminnow	B,D	B,D	D	B		
Plains Topminnow	A					
Western Mosquitofish		D				
Brook Silverside	A,D	D				
Common Shiner	A,B					

Common Name (intolerant species in bold)a	Presence in A=1940; B=1961-66; C=none; D=1995-98					
	Straight Fork	Burris Fork	Brush Creek	Willow Fork	Clark Fork	Trib 1st order
Western Redfin Shiner	A,B,D	A,D		B,D		
Hornyhead Chub	A,B,D	A		D		
Golden Shiner	D				D	
Blacknose shiner	A					
Ozark Minnow			D		D	
Rosyface Shiner	A,B,D	A,B,D	D	B,D		
Sand Shiner	A,D	A,B,D	D	B,D		
Topeka Shiner						
Southern Redbelly Dace					D	
Bluntnose Minnow	A,B,D	A,B,D		B,D	D	
Fathead Minnow		B	D			
Creek Chub	A,B,D	A,B,D	D	B,D	D	D
Ozark Sculpin	D					
Greenside Darter	B,D	B,D	D			
Striped Fantail Darter	B,D	A,B,D	D	B,D	D	
Johnny Darter	A,B,D	A,B,D		B,D		
Northern Orangethroat Darter	A,B,D	A,B,D	D	B,D	D	
Slender Madtom	B,D	D	D		D	
Ozark Logperch	B,D	A,D				
Suckermouth Minnow	A,B			B		

[a]Pflieger, personal communication

Figure fc2. Fish faunal groups in the Moreau River Watershed, 1977-1998.



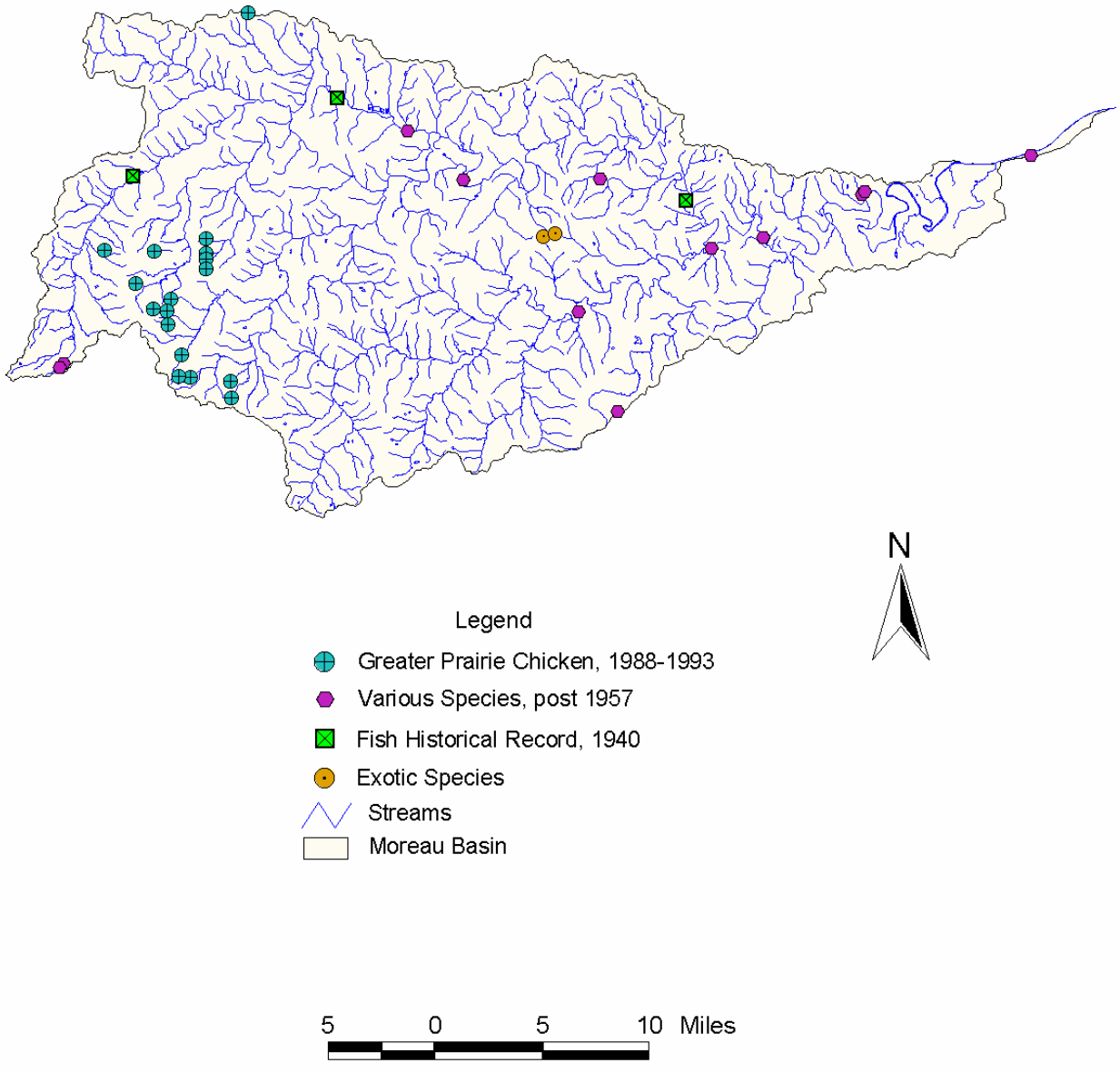


Figure sc. Species of concern tracked in the Natural Heritage Database (2002).

Table 3. Prevalence of spotted bass and western mosquitofish in the Moreau watershed, 1940-1998.

Species	Percent of sites where collected			
	1940's (4 sites)	1960's (10 sites)	1970's (10 sites)	1990's (22 sites)
Spotted bass	0	10	50	64
Western mosquitofish	0	0	10	36

Table 4. Mussel fauna of Moreau basin (Oesch 1984, Missouri natural heritage database1999, MDC 2002c).

Common Name (Status)	Scientific Name	Habitat type	Sample site
Three-Ridge	*Amblema plicata*	gravel, gravel- mud, tolerant of polluted water	95111
Paper floater	*Anodonta imbecilis*	ponds, lakes, rivers, quiet backwaters, eddies, sandy to muddy substrate	-
Asiatic clam	*Corbicula fluminea*	any habitat, small- medium rivers, lakes, stable gravel in swift water	96089
Wabash Pig-toe	*Fusconaia flava*	gravel and sand with moderate current	96089
Pocketbook	*Lampsilis cardium*	quiet-swift water, any substrate except sand	79076, 79079
Fat mucket	*Lampsilis siliquoidea*	any substrate, moderate-slow moving water, soft mud of lakes	95111
Yellow sandshell	*Lampsilis teres*	large, warm, turbid rivers	96089, 95111
White heel-splitter	*Lasmigona c. complanata*	rivers assoc. with large rivers, sluggish, turbid with mud, mud-gravel substrate	96089
Fragile papershell	*Leptodea fragilis*	small- large streams, mud, mud-gravel, gravel, clear or murky water	79076, 79079, 96089
Black sandshell (S1, S2, G5)*	*Ligumia recta*	small- large size gravel, good current	lower Moreau
Pond mussel	*Ligumia subrostrata*	quiet river pools, sloughs, shallow ponds	96089, 95111, 80074
Threehorn wartyback	*Obliquaria reflexa*	medium- large rivers, moderate current, gravel, gravel-sand, gravel- mud	79076
Pink heel-splitter	*Potamilus alatus*	slow-swift water, lake, lake- like river, any habitat	79076, 79079
Giant floater	*Pyganodon grandis grandis*	quiet water with mud or mud-gravel substrate, lakes	96089
Pimple-back	*Quadrula pustulosa*	small- large streams, any substrate except shifting sand	79076
Maple leaf	*Quadrula quadrula*	clear or turbid, small- medium gravel or rocks with or without	79076, 96089

Common Name (Status)	Scientific Name	Habitat type	Sample site
		mud interspersed, large rivers	
Peaclam	*Sphaerid sp.*	-	96089, 95111
Squaw foot	*Strophitus undulatus*	gravel to gravel- mud, flowing water	79076, 95111
Liliput shell	*Toxolasma parvus*	quiet waters, lake, mud, mud-sand	80074
Pistol- grip	*Tritogonia verrucosa*	any substrate	79076, 96089
Fawn's Foot	*Truncilla donaciformis*	small & large rivers	79076, 79079
Deer-toe	*Truncilla truncata*	mud- gravel to larger rocks, moderately swift water	79076
Pondhorn	*Uniomerus tetralasmus*	mud bottom lakes, pools, oxbows, sloughs	80074
Paper pondshell	*Utterbackia imbecillis*	ponds or lakes, small- large rivers in backwaters and eddies with sand to mud substrate	96089, 80074
Ellipse	*Venustaconcha ellipsiformis*	small- medium steams, stable gravel bottom	96089

*S1=critically imperiled in the state because of extreme rarity or because of some factor(s) making it vulnerable to extirpation from the state (typically 5 or fewer occurrences or very few remaining individuals).
*S2=imperiled in the state because of rarity because of some factor(s) making it vulnerable to extirpation from the state (typically 6-20 occurrences or few remaining individuals or acres).
*G5=Demonstrably widespread, abundant, and secure globally, although it may be rare in parts of its range, especially at the periphery.

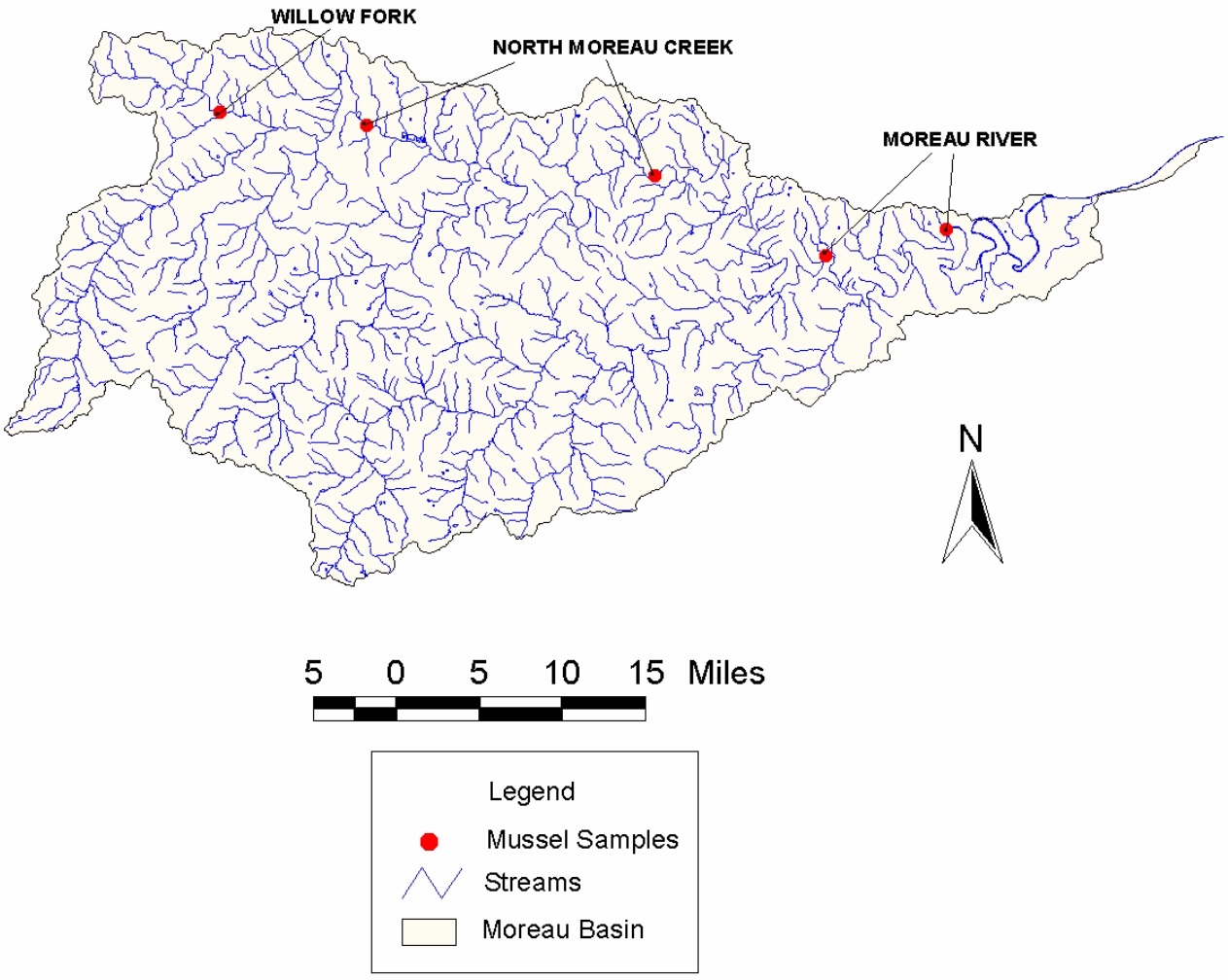


Figure ms. MDC mussel sampling sites in the Moreau River basin, 1979-1996.

Table 5. Aquatic benthic samples for the Moreau watershed collected by STREAM TEAMS.

Common Name	Taxa[1]	Number of organisms collected				
		3/11/01 Logan Creek[2] Hwy D BR	3/11/01 Logan Creek[3] E. Lohman Rd BR	6/1/95, 5/4/97 Honey Creek[4] DS Low water BR	4/17/94, 9/11/94, 4/8/1995 South Moreau[5] UP low water BR	9/13/95 South Moreau[6] Scrivner Rd CA
Pollution Sensitive						
Stonefly	*O. Plecoptera*	2,2,1	6,15,0	0,2	2,1,3	
Caddisfly	*O. Trichoptera*		0,1,0		2,0,2	44
Water penny	*O. Coleoptera*				0,1,0	
Riffle beetle	*O. Coleoptera*	2,1,0		1,1		
Other beetle	*O. Coleoptera*			2,0		1
Mayfly	*O. Ephemer-optera*	5,4,2	0,4,1	5,9	2,1,0	4
Gilled snail	*C. Gastropoda*				1,1,0	3
Dobsonfly Hellgrammite	*F. Corydalidae*				3,0,0	1
Somewhat Pollution Tolerant						
Crayfish	*O. Decapoda*	1,0,0			0,2,0	
Sowbug	*O. Isopoda*	5,2,1	2,4,7		2,0,0	
Scud	*O. Amphipoda*	40,20,6	50,60,60	1,3		
Fishfly	*F. Corydalidae*	0		50,0	0,1,0	
Damselfly	*S. Zygoptera*			0,1		4
Dragon fly	*S. Anisoptera*				0,2,0	
Crane fly	*S. Nematocera*	2,0,0	0,1,1	2,0		
Pollution Tolerant						
Aquatic worm	*C. Oligochaeta*		0,0,1	4,0	3,3,4	
Midge fly larva	*S. Nematocera*		0,1,0	0,73		3
Blackfly larva	*F. Simulidae*			0,4	0,0,1	

Common Name	Taxa[1]	Number of organisms collected				
		3/11/01 Logan Creek[2] Hwy D BR	3/11/01 Logan Creek[3] E. Lohman Rd BR	6/1/95, 5/4/97 Honey Creek[4] DS Low water BR	4/17/94, 9/11/94, 4/8/1995 South Moreau[5] UP low water BR	9/13/95 South Moreau[6] Scrivner Rd CA
Leech	*O. Hirudinea*	0,0,1		6,0	0,0,2	
Pouch and Pond snails	*C. Gastropoda*	1,0,3				
Pollution Sensitive		3	3	3,3	5,4,2	5
Semi-Pollution Tolerant		4	3	3,2	1,3,0	1
Pollution Tolerant		2	2	2,2	1,1,3	1
Total groups represented		9	8	8,7	7,8,5	7
Water quality assessment		Good	Good	Good, Fair	Good, Good, Poor	Good

[1]O=Order; F=Family; S=Suborder; C=Class
[2]Logan Creek, NW NE NW S28 T44N R13W
[3]Logan Creek, NW SW SW S22 T44N R13W
[4]Honey Creek, NW SE NW S10 T43N R12W
[5]South Moreau Creek, SW SW S30 T42N R15W
[6]South Moreau Creek, SE SE NW S17 T43N R13W

Table 6. Aquatic benthic samples for the Moreau watershed collected by STREAM TEAMS.

Common Name	Taxa1	Number of organisms collected			
		200' Upstream from mouth of Burris Fork	Scott's Ford at end of Stauffer's Rd		
Pollution Sensitive					
Stonefly	*O. Plecoptera*	22,0			
Caddisfly	*O. Trichoptera*	5,0	5,1,4	0,1,0	2,2,0
Water penny	*O. Coleoptera*	2,1			2,0,0
Riffle beetle	*O. Coleoptera*	3,2	10,10,10	10,10,4	
Other beetle	*O. Coleoptera*	0,4			
Mayfly	*O. Ephemer-optera*	15,14		0,0,8	5,0,5
Dobsonfly Hellgrammite	*F. Corydalidae*		1,0,0	0,0,1	
Somewhat Pollution Tolerant					
Sowbug	*O. Isopoda*				2,0,0
Fishfly	*F. Corydalidae*		50,10,10	10,10,0	4,5,5
Damselfly	*S. Zygoptera*	0,1		0,0,8	
Crane fly	*S. Nematocera*	0,1			
Dragon fly	*S. Anisoptera*		2,0,4		
Pollution Tolerant					
Aquatic worm	*C. Oligochaeta*	0,1		0,6,0	
Midge fly larva	*S. Nematocera*	3,3			4,5,4
Blackfly larva	*F. Simulidae*	4,2		10,0,0	
Leech	*O. Hirudinea*				3,0,1
Pouch and Pond snails	*C. Gastropoda*		50,1,0		3,0,0
Other snails	*C. Gastropoda*		1,0,0		
Pollution Sensitive		6	3	4	3
Semi-Pollution Tolerant		2	2	2	2
Pollution Tolerant		3	2	2	3

Common Name	Taxa1	Number of organisms collected			
		200' Upstream from mouth of Burris Fork	Scott's Ford at end of Stauffer's Rd		
Total groups represented		11	7	8	8
Water quality assessment		Excellent	Fair	Good	Fair

[1]C=Class; S=suborder; F=Family; O=Order
2Medlin Creek, NE SW NE S6 T43N R15W
[3]North Moreau Creek, SW SW S5 T44N R15W

Management Problems and Opportunities

The Missouri Department of Conservation (MDC) is charged with the '...control, management, restoration, conservation and regulation of the bird, fish, game, forestry and all wildlife resources of the state...' As stated in the MDC's recent Regional Management Guideline, 'The Conservation vision is to have healthy, sustainable plant and animal communities throughout the state of Missouri for future generations to use and enjoy, and that fish, forest, and wildlife resources are in appreciably better condition tomorrow than they are today.' In order to achieve this vision, efforts to better manage streams and their watersheds will be a continuing priority in the Moreau River watershed.

This section includes strategic guidelines for MDC Fisheries staff towards achieving this vision while dealing with the problems identified in this watershed which include:

- Insufficient wooded riparian corridors
- Declining aquatic biodiversity and aquatic habitats
- Failed EPA water quality standards
- A potential for agricultural or livestock-related erosion/pollution
- Soil erosion
- In-stream erosion
- Littering
- Limited public access to streams for recreation
- Undetermined management of the sport fish population
- Low community involvement

Goal I: Maintain or improve water quality in the Moreau River watershed so all streams are capable of supporting diverse native aquatic communities.

Objective 1.1: Meet state water quality standards in basin streams.

Guidelines

- Cooperate with state (Missouri Department of Natural Resources) and federal agencies (Environmental Protection Agency, U.S. Army Corps of Engineers) to review, monitor for compliance, and recommend requirements for NPDES, 404, 401 and other environmental permits.
- Conduct biological monitoring for fish and invertebrates to help identify stream reaches with poor or deteriorating water quality. This activity will include sampling reaches being studied for the Missouri Resource Assessment Monitoring (RAM) project. Other streams with
- high populations of livestock or humans will also be given high priority for sampling at strategic points.
- Conduct fish kill investigations to identify damage to biota and to identify pollutants violating Missouri Water Quality standards.
- Work with Missouri Department of Health officials and MDNR to monitor for and reduce contaminant levels in stream fishes.
- Support and train citizen and volunteer groups like STREAM TEAMS to monitor water quality and to be advocates for the resource.

Objective 1.2: Meet minimum low flow stream discharge requirements.

Guidelines

- Review and recommend minimum flow requirements for private, civic and industrial projects involving water diversion, storage or withdrawal.

Objective 1.3: Increase awareness of local government officials, business and residential developers of water quality conditions and problems in the Moreau River basin.

Guidelines

- Participate in local planning activities, public hearings, etc., at which activities impacting water quality are being discussed. Provide input which will help protect aquatic resources and water quality.
- Invite civic officials to workshops addressing water quality problems and best management practices.
- Create articles for or participate in T.V., newspaper, radio and magazine interviews concerning water quality issues and their solutions.

Objective 1.4: Improve citizen involvement in water quality and pollution issues.

- Support and train citizen and volunteer groups like STREAM TEAMS to monitor water quality and to be advocates for the resource.
- Promote annual stream clean-up and adopt-a-stream activities by citizen and school groups. Assist groups with equipment, litter bags, advertisement, or other special needs.
- Utilize local streams in teaching MDC Outreach and Education aquatic education modules so students can develop an awareness of local aquatic resources.

Goal II: Improve or maintain aquatic habitat conditions in the Moreau River watershed to meet the needs of native aquatic biota while providing for society's demands for water, agricultural, industrial and domestic uses.

Objective 2.1: Protect aquatic habitats from excessive siltation and nutrification.

Guidelines

- Provide at least 100- foot wide timbered riparian corridors and stabilize eroding streambanks on all MDC managed areas in the basin.
- Utilize good soil conservation practices on MDC lands to minimize soil erosion from cropland, building grounds, and parking lots.
- Increase landowner awareness of local stream resources and ways they can help protect these habitats. Information may be dispersed through cooperative interactions with Soil and Water Conservation Districts, Natural Resources Conservation Service and other farm organizations.
- Provide technical assistance to landowners requesting help with streambank erosion problems.
- Provide cost-share money to help fund streambank stabilization and riparian corridor restoration and protection projects (e.g. to cover costs for fencing material to exclude livestock from riparian areas, alternative watering sources, tree seedlings, tree revetments, hard points, etc.) on private lands.
- Develop a list of imperiled watersheds within the basin on which restoration efforts can be focused. Consideration should be given to aquatic as well as prairie/grassland areas due to the

number of prairie/grassland dependent species of concern present in this watershed. The Straight Fork watershed should be evaluated further for restoration potential.
- Actively cooperate with other agencies on watershed-based projects (e.g. EQIP, AgNPS, etc.).
- Promote good stream stewardship through public workshops and stream demonstration site tours.
- Facilitate satisfactory animal and human waste management by reporting violations to Missouri Department of Natural Resources and keeping informed about cost-share programs sponsored by other agencies that can help waste producers improve their facilities and management of wastes.

Objective 2.2: Identify and protect unique aquatic habitats from development or degradation.

Guidelines

- Identify unique habitats during habitat and biotic surveys performed in the basin. A more detailed inventory of the Straight Fork and Clark Fork drainages may yield important habitat features worthy of protection. Submit outstanding resources to the Natural Heritage Database for future monitoring and protection.
- Acquire, protect and enhance critical, unique or otherwise high quality aquatic and riparian habitats.

Goal III: Maintain diverse, stable and abundant populations of native aquatic fauna while providing quality sport fishing.

Objective 3.1: Maintain the diversity, abundance and distribution of native non-sport fish and aquatic invertebrates at or above current levels.

Guidelines

- Continue to inventory biotic assemblages (fish, mussels, and invertebrates) throughout the basin to obtain baseline population information on all 4th order and larger streams with at least 5 miles of stream length. Smith Creek would be an appropriate stream to inventory in the future given its size and close proximity to Straight Fork. Streams having confined animal feeding operations and point source discharge sources should also be inventoried at strategic points so potential threats to community stability and diversity can be identified and corrective actions can be taken. Sampling of these fish and invertebrate communities may involve cooperative projects utilizing staff from MDC Research and Management, University of Missouri, and other groups.
- Monitor the condition of the fish populations at established fish sampling sites at 10- year intervals.
- Assist with recovery efforts for “species of concern” within the watershed.
- If significant aquatic faunal changes are observed, recommend research projects in cooperation with MDC Research staff to investigate reasons and solutions for community alterations.
- Utilize GIS technology to document population sampling, species distribution, unique habitats, and the location of potential threats to water quality and aquatic biota.

Objective 3.2: Maintain or improve sport fishing opportunities and fish-size quality for anglers without detrimentally impacting non-sport fish populations.

Guidelines

- Intensively sample sportfish populations on the Moreau, North Moreau, and South Moreau rivers to assess the status of the sportfish populations (including age and growth, population size structure, etc.) in these streams.

- Set management objectives for the sportfish populations and recommend appropriate fishing regulations once adequate data have been collected.
- Complete fish habitat improvement projects on MDC areas where fish habitat is limited.
- Increase angler awareness of the fisheries in the basin by writing magazine and internet articles, and making photo displays for public events which highlight the basin and its fishing resources and access points.
- Improve the fishing experience for anglers by providing litter- free MDC access sites with well maintained functional facilities.
- Develop a new stream access site to the Moreau River in the vicinity of Highway B or Tanner Bridge Road in Cole County. This would provide an access 8-10 miles downstream from the Honey Creek Access and about 16-19 miles upstream of the Moreau 50 Access.

Objective 3.3: Prevent detrimental impacts on native fauna in the Moreau River basin by exotic aquatic species.

Guidelines

- Keep tight regulatory control over the introduction of exotic species into state waters.
- Participate on the Missouri Aquaculture Advisory Council (MAAC) and with other organizations to curb the introduction of new exotic species into Missouri.
- Monitor for potentially harmful exotic species, like zebra mussels and bighead carp, in basin streams. This can be done during routine fish and invertebrate surveys.
- Provide flyers at public accesses to inform users about the harmful effects of zebra mussels, certain noxious plants, and the introduction of undesirable species through contamination of boats, trailers, and bait buckets.

Goal IV: Improve public appreciation and awareness of basin stream resources and recreational uses.

Objective 4.1: Provide information to interested parties on basin stream resources such as public access points, and the flora, fish, crayfish, mussel, bird, and wildlife found in and alongside local streams.

Guidelines

- Create a basin stream oriented forest, fish, and wildlife guide for distribution on the internet, at nature centers, department offices, and at public events.
- Create a “Moreau River basin” calendar which features the natural resources of this watershed.
- Utilize local streams in teaching MDC Outreach and Education aquatic education modules so students can develop an awareness of local aquatic resources.
- Publicize the acquisition, development and opening of new public access and or stream frontage sites.
- Maintain a statewide emphasis on stream ecology and good stream stewardship in public presentations and publications.

Angler Guide

Rivers and Streams

Anglers in the Moreau watershed streams primarily pursue largemouth bass, spotted bass, bluegill, longear sunfish, and channel catfish. Largemouth and spotted bass, bluegill, and longear sunfish are abundant in all of the major streams. Channel catfish are most abundant in the North Moreau, South Moreau, and Moreau River. Smallmouth bass are less common, but anglers may catch one in the South Moreau, Burris Fork, and Moreau River.

Anglers catch white bass, white crappie, walleye, sauger, and flathead catfish seasonally in the North Moreau, South Moreau, and Moreau River. These species are not very abundant. Gigging for suckers is possible in the major streams but it is limited due to poor water clarity and frequent low water.

There are public concrete ramps on the Moreau River at the Moreau Access and Honey Creek Access. The Moreau 50 Access is one mile east of Jefferson City. The entrance road is just east of the Moreau River and just north of Highway 50/63. Honey Creek Access is three miles southwest of Jefferson City on Highway 54, and two and a quarter miles southeast of the highway on Buffalo Road. Public bank access is available on South Moreau Creek at Scrivner Road Conservation Area and on North Moreau Creek at Stringtown Bridge Access. Scrivner Road Conservation Area can be reached from Russellville by going 2.1 miles south on AA, then 1.6 miles southeast on Scrivner Road, then 0.7 miles northeast on Scott Road to the area. Stringtown Bridge Access is five miles west of Jefferson City on Highway C, then one mile west on Hemstreet Road.

Anglers fish from the bank, by wading in shallows, and floating the larger streams in a small johnboat or canoe. The upper put-in points are Rockhouse Bridge on North Moreau Creek (5.5 miles south of McGirk off Highway K) and Decatur Bridge on South Moreau Creek (four miles south of Russellville on Highway AA). During low water periods, portage over riffles is often necessary.

Statewide stream fishing regulations apply to all streams in the watershed.

Fishing Tips

- **Largemouth, spotted and smallmouth bass:** All three of these species of black bass can be caught on a large variety of lures. Spinner baits, crank baits, plastic worms, and jigs are commonly used artificial lures. Live bait (night crawlers, crayfish, minnows, etc.) is also very effective. The largemouth bass prefers the quieter pools while spotted bass and smallmouth bass like reaches with more current. All of these species relate to cover (fallen trees, root wads, boulders, steep banks, etc.). Artificial lures are usually retrieved through or near the cover while live bait is more often still fished in or near the cover.
- **Bluegill and longear sunfish:** Live bait like crickets and pieces of night crawlers are a good choice for catching bluegill and longear. Artificial lures will also work but these fish have small mouths and your lure will need to be small as well. Most sunfish anglers still fish or allow the current to move their bait slowly by the cover. Floats are often used to suspend the bait at the level of the fish.
- **Channel catfish:** Channel catfish are equipped with a sense of smell that allows them to find food in very low visibility situations. Often bait that has a strong odor will be most effective. There are many commercial stink baits available. Chicken livers, shrimp heads, dead minnows, and cut shad are also good choices. Night crawlers will work for channel catfish too. Fish for channels on the bottom, either still fishing or drifting in the current. Many anglers use limb lines and trotlines for catfish.
- **Other Fishes:** White bass and crappie are usually caught on minnows or artificial lures that imitate small minnows. Flathead catfish prefer live baitfish. Walleye and sauger can be caught by

drifting jigs tipped with night crawlers or minnows along the bottom in late winter and early spring.

Public Lakes

Scrivner Road Conservation Area, Proctor Park in California, and Hough Park in Jefferson City provide public lake fishing in the Moreau watershed. All of these lakes have populations of largemouth bass and bluegill and the Department of Conservation stocks these lakes with channel catfish regularly. Winegar Lake, on Scrivner Road Conservation Area, is eight acres. This lake also has a population of redear sunfish. Directions to the area are written above. Proctor Park in California is four-tenths of a mile south of Highway 50 on Highway 87, and just east of Highway 87 on Parkway Drive. The lake is seven acres and it has a handicapped accessible fishing dock.

Hough Park, also a seven-acre lake, can be reached by going south from Ellis Boulevard in Jefferson City on Route B for 1.1 miles, then east (left turn) one block on Tanner Bridge Raod, then continue east (right turn) on Hoffman Drive three blocks to Iven Drive, then north one block to the lake.

Fishing Tips

Anglers can catch redear sunfish by tight-lining with pieces of night crawler on small hooks on the bottom. Largemouth bass, bluegill, and channel catfish tips are listed in the above section.

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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^{o} 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.