CHARITON RIVER
WATERSHED
INVENTORY AND ASSESSMENT

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EXECUTIVE SUMMARY

The Missouri Department of Conservation (MDC) is responsible for managing the forests, fish, and wildlife of the State of Missouri. The water, fish, and other animals inhabiting our streams are a public resource, but the quality of stream fishing and overall stream health is almost entirely dependent upon land management decisions made by private citizens who own more than 93% of the State, including the corridors and beds of our streams.

Since the mid 1980s, MDC biologists have provided on-site stream habitat evaluation and planning services to landowners, usually in response to geographically random streambank erosion problems. Local attempts at spot-treatment, while instructive, have done little to address the watershed-wide problems that affect our streams. Clearly, any substantial progress toward improving our stream fisheries will occur only if a significant number of people from all walks of life acquire an understanding of the physical, chemical and biological character of these resources and their values to society. Only from such a common understanding may there arise a shared vision and science-based plan for watershed conservation that incorporates the perspectives and reflects the needs of all stakeholders.

The main objectives of this report are: 1) to summarize the widely scattered physical, chemical, and biological information most relevant to the stream fishery of the Chariton River watershed; and 2) to identify opportunities for conserving (wisely managing) Chariton River basin streams on a watershed scale. In addition to providing guidance for MDC operations, we hope this document will facilitate citizen-led initiatives to manage the watershed in a way that will benefit our fisheries, our rural economy in general, and future generations who will inherit our legacy.

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LOCATION

The Chariton River originates in Iowa in southeastern Clarke County. It flows eastward and southward until it is dammed to form 11,000-acre Rathbun Reservoir in Appanoose County, Iowa. After flowing southward for approximately 30 miles the Chariton River enters Missouri, forming the boundary between Putnam and Schuyler counties. It continues to flow to the south through Adair and Macon counties. Upon entering the northeastern corner of Chariton County, the river takes a southwesterly route to its confluence with the Missouri River. The basin's eastern boundary is known as the "Grand Divide". All streams to the east flow to the Mississippi River, all streams to the west are tributaries of the Missouri River.

Major tributaries of the Chariton River include Mussel Fork Creek, which reaches its confluence in southeastern Chariton County, and Shoal Creek, which meets the Chariton in the middle of Putnam and Schuyler counties. The Little Chariton River, formerly a tributary of the Chariton, now flows into the Missouri River in the southeastern corner of Chariton County. For practical reasons, the Little Chariton River is included in this inventory of the Chariton River basin. Major tributaries to the Little Chariton are Middle Fork and East Fork (Figure 1).

Stream Orders and Mileages

Streams were identified on USGS 7.5-minute topographic maps and ordered according to Strahler (1957). There are 158 third-order and larger streams in the basin (Appendix A). The Chariton River is the longest (209 miles) and largest (sixth order). Mussel Fork (100 miles long) and Shoal Creek (60 miles long) are major fifth order tributaries. Short fifth-order streams include Walnut Creek (17 miles), Blackbird Creek (26 miles), and Elm Creek (9 miles). A 7-mile reach of Little Chariton River is sixth order, but its Middle Fork (63 miles) and East Fork (100 miles) tributaries are fifth order streams. All other streams in the basin are fourth-order or smaller.

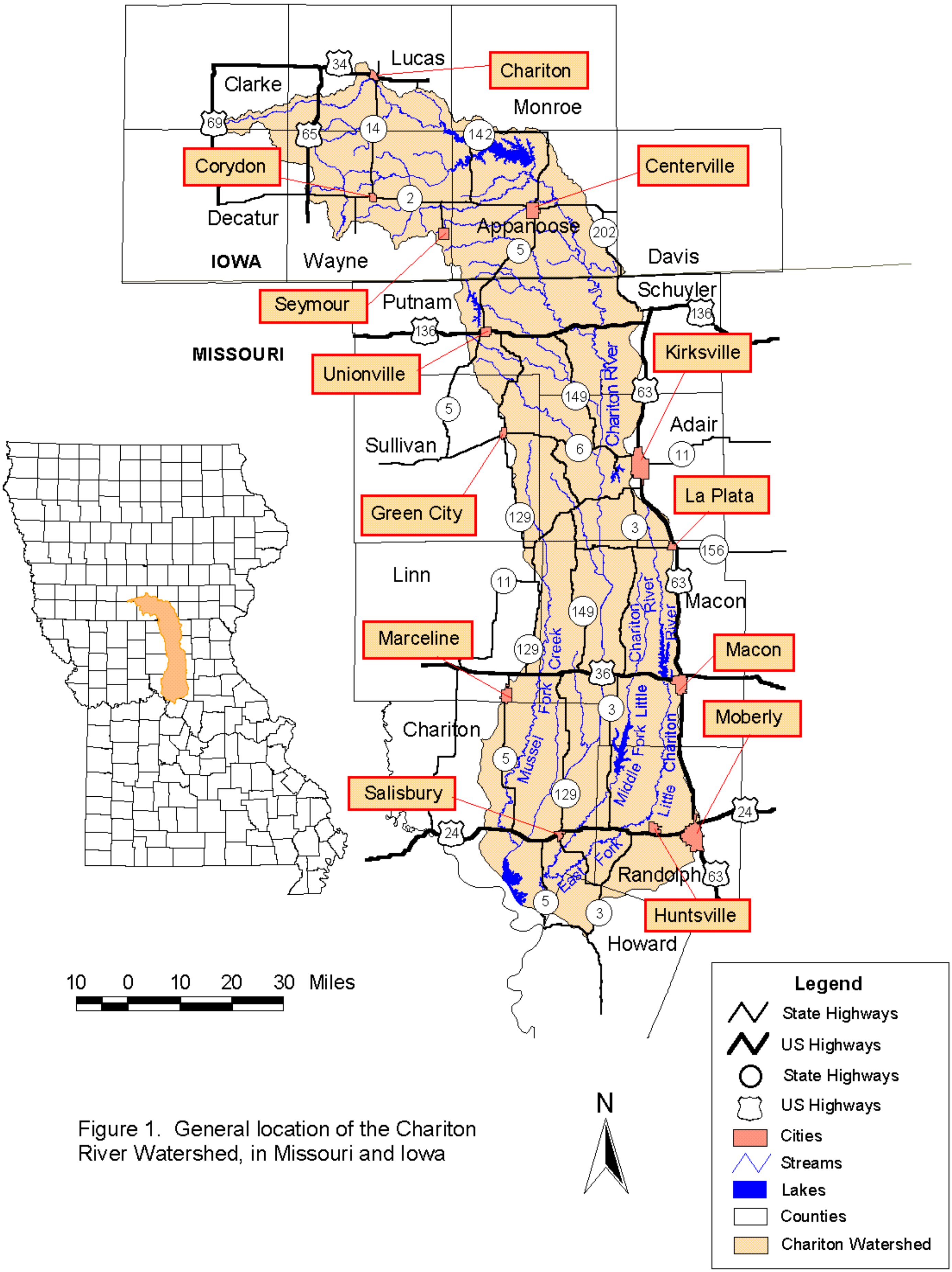

Figure 1. General location of the Chariton River Watershed, in Missouri and Iowa

GEOLOGY/GEOMORPHOLOGY

Physiographic Region/Geology/Soils

The Chariton River basin is within the Glaciated Plains region of Missouri and Iowa (Unklesbay and Vineyard 1992), also known as the Dissected Till Plains (COE 1963, Figure 2). In describing the geological origins of the basin, we start at the bottom of a stratum that exists 350 to 600 feet into the earth. Up to 250 feet of limestone was deposited in the Mississippian age (MDNR unpublished). Above the limestone are deposits of Pennsylvanian-age sedimentary rock in layers up to 170 feet thick. These were formed under rapidly changing conditions that caused sediments to be deposited in alternating sequences (e.g., shale, coal, limestone etc., Figure 3) (Unklesbay and Vineyard 1992).

The basin contains coal deposits of the Pennsylvanian age (MDNR unpublished), yet not all of it has commercial value. Of the five minable coal fields in Missouri, two lie partially within the boundaries of the Chariton River basin (Unklesbay and Vineyard 1992). The "Plains" of the Glaciated Plains are the deposits that were left on top of the Pennsylvanian strata by glaciers--a level expanse of till or drift up to 200 feet deep composed of mostly clay with rock fragments and sand lenses (MDNR unpublished). Erosional forces cut steep relief into this landscape prior to it being covered by wind deposited loess (Unklesbay and Vinyard 1992), which varies in thickness to eight feet. Soils of loessal origin are found primarily on the tops of ridges (SCS 1995, 1994, 1991, 1989).

The prevalent soil types that developed from this loess and till parent material are classified as loams with differing clay and silt content. Soils with silt content are predominantly alluvial in origin. The relatively low permeability of the soil and till coupled with the presence of shale and coal greatly inhibits the percolation of surface water to ground water sources. Because of this, most water movement occurs through the stream network.

Of the mappable soil units in Putnam, Adair and Macon counties, 57% to 71% were classified as "eroded" or "severely eroded" (SCS 1995, 1994, 1991). The streams of the basin have served as depositories for these eroded soils. The bed of the Chariton River mainstem is comprised almost exclusively of unconsolidated sand.

Though the stream resource remains very degraded, soil erosion has been reduced significantly in the past ten years. In a 1982 report it was noted that 56% of land in the Chariton River basin was losing 8, 15 or 22 tons of soil per acre annually depending upon soil type (USDA 1982). An inventory by the Soil Conservation Service revealed that mean soil loss rate per acre of Missouri farmland dropped from 9.4 tons in 1982 to 5.5 tons in 1992 (SCS 1995). Ninety percent of the reduction occurred on cropland. Breaking this figure down, 47% was attributable to implementation of conservation practices on highly erodible cropland, 35% was due to cropland going into the Conservation Reserve Program (CRP), 10% was attributable to soil loss reductions on lands not classified as highly erodible, and 9% was attributed to other sources. In a watershed where the majority of land is in some type of commodity production, wise land management is crucial to the quality of stream habitat and health of the aquatic communities they support.

Stream Channel Gradients

Channel gradients (slopes) were determined for all third-order and larger streams by using USGS 7.5-minute topographic maps and digitizing software (Appendix A). Gradient is very low (2.2-3.1 feet/mile) in the mainstem Chariton River; and it is equally low (1.0-3.3 feet/mile) in the lowermost reaches (orders 4-5) of major basin tributaries – Middle Fork Little Chariton River, East Fork Little Chariton River, and Mussel Fork Creek. Gradients in fourth-order reaches of other basin streams range from 1.4 to 10.4 feet/mile. Such low gradients lend themselves to deposition of sediments transported from the watershed.

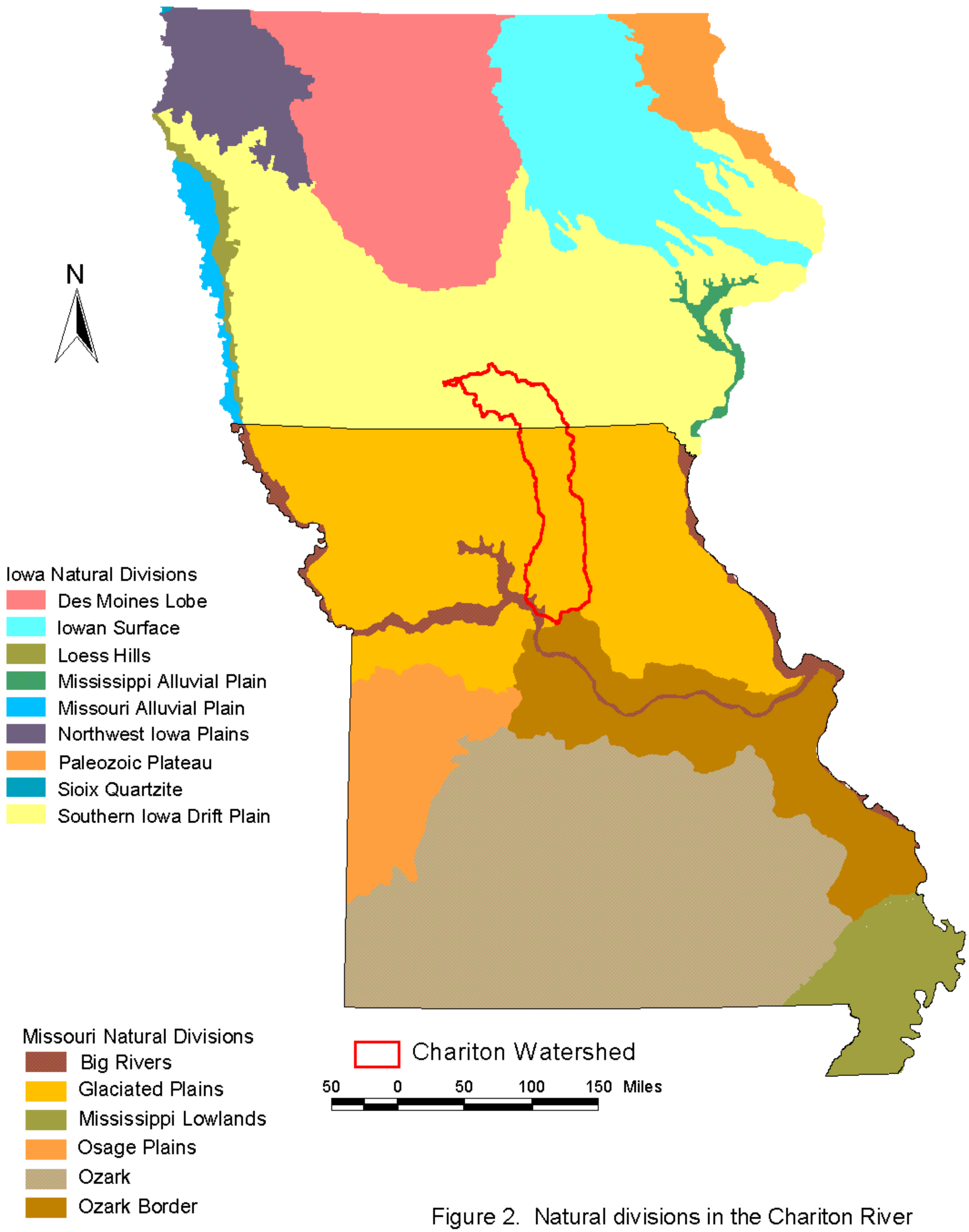

Figure 2. Natural divisions in the Chariton River watershed, in Missouri and Iowa.

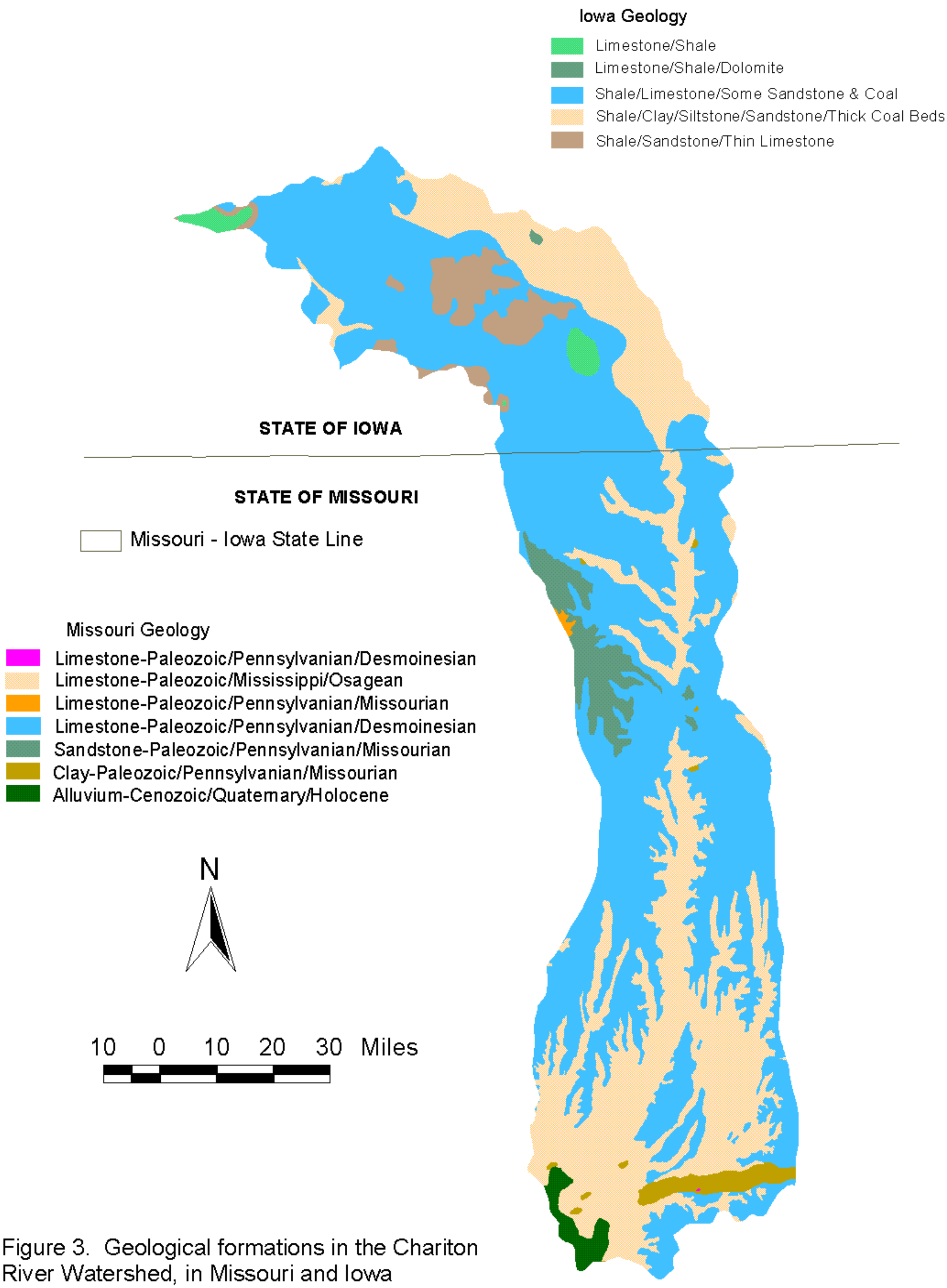

Figure 3. Geological formations in the Chariton River Watershed, in Missouri and Iowa

Appendix A1 and A2: General location, mileage, and habitat information for all third order and larger streams within the Chariton River basin. The legal description is of the mouth of each respective stream. All mileages and gradients were determined from measurements on 1:24,000 topographic maps by using a Houston Instrument digitizer. The first gradient figure presented is a mean for the entire stream from its uppermost third order point to its mouth. The gradient of reaches of different orders are denoted by a superscripted number; the superscript refers to the stream order. "NM" = not measurable. "Chan" = channelized. "% Perm Flow" = percent of stream channel length represented by a solid blue line on 1:24,000 topographic maps.

Appendix A1 – Stream Mileage and Habitat Information

Stream Code	Stream Name	County	Order	Miles Total	Miles Chan	% Chan	% Perm Flow
LITTLE CHARITON RIVER SUBBASIN							
80000000	Old Channel Chariton	Chariton	3	19.4	0	0	100
51110000	Young Creek	Chariton	3	1.9	0	0	0
46580000	Little Chariton River	Chariton	6	7.1	2.9	40	100
46581100	Doxies Creek	Chariton	4	12.7	3.8	30	100
46581110	Batts Creek	Chariton	4	5.8	1.9	33	100
*46581111	Unnamed	Chariton	3	.2	.2	100	0
*46581112	North Fork Batts Creek	Chariton	3	2.5	.4	16	100
46581120	Doxies Fork	Howard	3	1.3	0	0	100
46581200	Unnamed	Chariton	3	1.1	0	0	0
46582000	Middle Fork Little Chariton	Chariton	5	63.1	31.3	50	100
46582120	Lake Branch	Chariton	3	.8	.3	38	0
46582130	Muncas Creek	Chariton	3	4.3	1.5	35	100
46582140	Bee Creek	Chariton	3	1.3	.3	23	100
46582150	Unnamed	Randolph	3	1.2	0	0	0
*46582210	Unnamed (Brush Creek Tributary)	Randolph	3	.2	0	0	0
46582230	North Fork Claybank Creek	Macon	4	6.7	2.2	33	100
*46582231	Tributary of North Fork Claybank Creek	Macon	3	.2	0	0	0
*46582300	Stinking Creek	Macon	3	7	4.6	66	100
46582410	Unnamed	Macon	3	.2	0	0	0
46582420	Sweezer Creek	Macon	3	6.4	1.6	25	100
46582430	Town Creek	Macon	3	.2	0	0	100
*46582440	Unnamed	Macon	3	2	0	0	100

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46583000	East Fork Little Chariton River	Chariton	5	99.8	23.5	24	100
99999991	Unnamed	Chariton	3	6.8	0	0	0
46583110	Barber Branch	Howard	3	2.3	0	0	89
46583120	Mott Creek	Chariton	4	2.2	.3	14	0
*46583121	Tributary of Mott Creek	Chariton	3	.3	0	0	0
46583130	Silver Creek	Chariton	4	17.4	4	25	100
*46583131	Tributary of Silver Creek	Randolph	3	2.3	.3	13	0
*46583132	Bagby Branch	Randolph	3	2	0	0	100
*46583133	Turner Fork	Randolph	3	4.4	0	0	100
99999992	Unnamed	Randolph	3	.4	.4	100	100
46583140	Sweet Spring Creek	Randolph	4	17.4	3.7	25	100
*46583141	Tributary of Sweet Springs	Randolph	3	9.2	0	0	0
*46583142	Collier Branch	Randolph	3	1.2	0	0	100
*46583143	Trib. of Sweet Springs	Randolph	3	1.3	.3	23	100
*46583144	Trib. of Sweet Springs	Randolph	3	.9	0	0	0
46583150	Dark Creek	Randolph	3	10.9	4.7	43	100
46583160	Sugar Creek	Randolph	4	7.3	2.3	32	100
*46583161	Tributary of Sugar Creek	Randolph	3	1.2	0	0	0
46583170	Sinking Creek	Randolph	3	3	1.3	43	100
46583210	Walnut Creek	Randolph	4	3.1	2	65	100
*46583211	East Fork Walnut	Randolph	3	3.4	0	0	100
*46583212	North Fork Walnut	Randolph	3	.6	.2	33	100
99999993	Unnamed	Randolph	3	.99	0	0	0
46583220	Unnamed	Randolph	3	2.6	1.4	54	0
46583230	Unnamed	Macon	3	1.2	0	0	0
46583240	Unnamed	Macon	3	.9	.4	44	100
46583250	Duck Creek	Macon	3	1.8	0	0	0
46583260	Long Branch	Macon	4	27.5	11.7	43	100
*46583261	Tributary to Long Branch	Adair	3	.9	0	0	0
46583270	Lick Creek	Macon	3	2.8	0	0	100
46583280	Richland Creek	Macon	3	7.2	0	0	100

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46583290	Tributary of East Fork Little Chariton	Adair	3	.2	0	0	0
MUSSEL FORK SUBBASIN							
51130000	Mussel Fork Creek	Chariton	5	100.3	24.3	24	100
51131100	Unnamed	Chariton	3	1.3	1.3	100	0
51131200	Unnamed	Chariton	3	.6	.6	100	0
51131300	Long Branch	Chariton	4	11.6	4.9	43	100
51131310	Unnamed	Chariton	3	1	0	0	100
51131320	Skunk Creek	Chariton	3	1.3	.2	17	100
51131330	Hurricane Creek	Chariton	3	.7	.7	100	100
51131400	Cottonwood Creek	Chariton	3	7.3	3.6	49	76
51131500	Clarks Creek	Chariton	4	11.4	6.9	60	100
51131510	Unnamed	Chariton	3	.2	.2	100	0
51131520	Locust Branch	Chariton	3	4.2	3.7	89	100
51131600	Unnamed	Chariton	3	.4	0	0	0
51131700	Van Dorsen	Chariton	3	.1	0	0	100
51131800	Unnamed	Chariton	3	.6	.6	100	0
51132100	Brush Creek	Chariton	3	17.1	11.3	66	100
51132400	Unnamed	Macon	3	2.7	0	0	0
51132500	Badger Creek	Macon	3	2.4	0	0	100
51132600	Little Mussel	Adair	3	2.7	.4	16	100
51132700	Unnamed	Sullivan	3	.7	.6	82	0
51132800	Unnamed	Sullivan	3	2.9	.3	11	0
CHARITON RIVER MAIN STEM SUBBASIN							
51200000	Chariton River	Chariton	6	208.6	114.1	55	100
51200001	Unnamed	Chariton	3	1.5	.5	33	0
51200002	Unnamed	Chariton	3	3.0	3.0	100	0
51200003	Unnamed	Chariton	3	2.5	2.5	100	100
51210000	Puzzle Creek	Chariton	4	5.2	4.4	85	100
51211000	Unnamed	Chariton	3	1.1	.6	52	0
51220000	Long Creek	Chariton	3	6.0	2.5	41	0
51230000	Jones Branch	Chariton	4	10.6	5.3	43	100
51231000	Unnamed	Chariton	3	1.2	0	0	0
51240000	Bee Branch	Chariton	4	13.2	7.5	56	100
51241000	Unnamed	Chariton	3	1.0	.6	54	0

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51242000	East Bee Branch	Chariton	3	8.6	3.9	45	100
51270000	Elm Branch	Chariton	3	1.6	1.6	100	100
51280000	Kelly Branch	Chariton	3	11.0	1.9	17	100
51300004	Old Channel Chariton River	Macon	4	13.5	1.9	14	25
51300005	Branch of Old Channel Chariton River – Mile 32	Macon	3	1.5	.4	26	0
51300006	Sand Creek	Macon	3	2.4	1.3	54	100
51300007	Ward Branch	Macon	3	2.1	0	0	0
51300008	Branch of Old Channel Chariton River – Mile 45	Macon	3	2.5	.8	34	0
51300009	Huckleberry Creek	Macon	3	1.6	0	0	0
51310000	Puzzle Creek	Chariton	4	15.9	6.3	40	100
5131000	Unnamed	Chariton	3	.8	0	0	0
51312000	Unnamed	Chariton	3	.7	0	0	0
51330000	Painter Creek	Macon	3	4.9	1.8	35	100
51340000	Elam Creek	Macon	3	1.3	0	0	0
51350000	White Oak Creek	Macon	3	3.5	0	0	0
51360000	Little Turkey Creek	Macon	3	3.2	2.5	78	100
51370000	Turkey Creek	Macon	4	7.1	3.4	48	100
51371000	Unnamed	Macon	3	3.1	.8	26	43
51380000	Rock Creek	Macon	3	6.5	0	0	0
51410000	Walnut Creek	Macon	5	16.9	8.7	52	100
51411000	Little Walnut Creek	Macon	4	4.5	2.5	56	41
51411100	Unnamed	Macon	3	2.8	.7	23	0
51411200	Unnamed	Macon	3	2.2	.6	25	0
51412000	Little Walnut Creek	Macon	3	6.0	1.5	24	0
51413000	Unnamed	Macon	3	2.9	0	0	0
51420000	Sand Creek	Macon	4	4.9	0	0	100
51421000	Unnamed	Macon	3	2.2	0	0	0
51430000	Cottonwood Creek	Macon	3	6.3	2.6	42	0
51440000	Sugar Creek	Adair	4	7.6	0	0	100
51441000	Unnamed	Adair	3	.6	0	0	0
51442000	Turkey Run	Adair	3	2.6	0	0	0
51460000	Goose Creek	Adair	3	4.6	3.9	85	0

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51470000	Hog Creek	Adair	3	16.7	6.3	38	100
51480000	Billy's Creek	Adair	3	14.7	7.8	53	100
51510000	Big Creek	Adair	4	3.6	3.4	94	100
51520000	Dave Branch	Adair	3	2.6	1.1	42	100
51530000	Spring Creek	Adair	4	24.6	14.5	59	100
51531000	Jobs Creek	Adair	3	.7	0	0	0
51532000	Dry Branch	Sullivan	3	1.8	.9	46	100
51533000	North Spring Creek	Sullivan	3	8.8	.4	3	100
51540000	Rye Creek	Adair	3	1.8	1.8	99	100
51550000	Shuteye Creek	Adair	3	13.6	11.1	82	100
51560000	Hazel Creek	Adair	4	8.1	5.5	67	100
51561000	Little Hazel Creek	Adair	3	3.3	1.5	47	0
51570000	Blackbird Creek	Adair	5	25.9	19.7	76	100
51571000	South Blackbird Creek	Putnam	4	22.2	14.5	66	100
51571100	Kinny Creek	Putnam	3	4.0	.7	18	100
51571200	Unnamed	Putnam	3	1.9	.2	10	0
51573000	Lick Creek	Putnam	3	.82	.8	100	100
51574000	Unnamed	Putnam	3	.8	0	0	0
51575000	Unnamed	Putnam	3	.7	.7	100	0
51580000	Wildcat Creek	Putnam	3	7.3	5.9	82	100
51610000	Lost Creek	Schuyler	3	3.3	1.9	57	36
51620000	Sand Creek	Schuyler	3	2.3	2.1	89	100
51640000	Elm Creek	Schuyler	5	9.1	4.8	52	100
51641000	Winkler	Schuyler	4	5.0	2.1	41	100
51641100	Unnamed	Schuyler	3	1.4	0	0	0
51650000	Shoal Creek	Putnam	5	59.8	16.8	28	100
51651000	Brush Creek	Putnam	3	5.1	2.6	51	100
51652000	Sandy Creek	Putnam	4	6.8	4.4	64	100
51652100	Little Sandy Creek	Putnam	3	.9	.9	100	100
51653000	Unnamed	Putnam	4	11.5	2.3	20	53
51653100	Unnamed	Putnam	3	4.0	1.7	43	44
51653110	South Creek	Putnam	3	.9	0	0	48
51653200	Unnamed	Appanoose	3	3.3	.7	31	0
51654000	Unnamed	Appanoose	3	1.4	1.0	76	100
51655000	Unnamed	Appanoose	3	.2	0	0	0

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51656000	Unnamed	Appanoose	3	1.3	1.1	82	0
51657000	Unnamed	Appanoose	3	.5	0	0	0
51670000	Turkey Creek	Putnam	3	6.4	.5	7	0
Stream Code	Stream Name	County	Order	Miles Total	Miles Chan	% Chan	% Perm Flow
51671000	Unnamed	Putnam	3	.9	0	0	0
51511000	Unnamed	Adair	3	1.3	.35	27	100

Appendix A2 – General Location

Stream Code	Stream Name	County	Sec	Town-ship	Range	Gradient (feet/mile) (Mean & By Order)
LITTLE CHARITON RIVER SUBBASIN						
80000000	Old Channel Chariton	Chariton	06	51	17	NM
51110000	Young Creek	Chariton	03	52	18	15.8
46580000	Little Chariton River	Chariton	08	51	17	2.8
46581100	Doxies Creek	Chariton	32	52	17	7.0 [4]5.6 [3]15.0
46581110	Batts Creek	Chariton	21	52	17	10.3 [4]9.7 [3]46.1
*46581111	Unnamed	Chariton	22	52	17	NM
*46581112	North Fork Batts Creek	Chariton	19	52	17	8.1
46581120	Doxies Fork	Howard	06	51	17	NM
46581200	Unnamed	Chariton	07	52	17	NM
46582000	Middle Fork Little Chariton	Chariton	05	52	17	2.5 [5]2.9 [4]2.0 [3]4.2
46582120	Lake Branch	Chariton	11	53	17	12.5
46582130	Muncas Creek	Chariton	06	53	16	5.9
46582140	Bee Creek	Chariton	31	54	16	15.6
46582150	Unnamed	Randolph	02	54	16	NM
*46582210	Unnamed (Brush Creek Tributary)	Randolph	08	55	15	NM
46582230	North Fork Claybank Creek	Macon	20	56	15	8.9 [4]6.1 [3]11.8
*46582231	Tributary of North Fork Claybank Creek	Macon	4	56	15	NM
*46582300	Stinking Creek	Macon	24	56	16	7.2
46582410	Unnamed	Macon	06	56	15	NM

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46582420	Sweezer Creek	Macon	4	57	15	3.2
46582430	Town Creek	Macon	34	58	15	NM
*46582440	Unnamed	Macon	15	58	15	NM
46583000	East Fork Little Chariton River	Chariton	05	52	17	2.9 [5]1.0 [4]3.3 [3]8.0
99999991	Unnamed	Chariton	04	52	17	NM
46583110	Barber Branch	Howard	02	52	17	12.9
46583120	Mott Creek	Chariton	30	53	16	9 [4]NM [3]9.6
*46583121	Tributary of Mott Creek	Chariton	32	53	16	NM
46583130	Silver Creek	Chariton	21	53	16	8.3 [4]6.5 [3]12.2
*46583131	Tributary of Silver Creek	Randolph	26	53	16	17.7
*46583132	Bagby Branch	Randolph	36	53	16	10.5
*46583133	Turner Fork	Randolph	28	53	15	13.5
99999992	Unnamed	Randolph	10	53	16	NM
46583140	Sweet Spring Creek	Randolph	12	53	16	6.9 [4]6.7 [3]10
*46583141	Tributary of Sweet Springs	Randolph	16	53	15	NM
*46583142	Collier Branch	Randolph	02	53	15	8.6
*46583143	Trib. of Sweet Springs	Randolph	18	53	14	7.8
*46583144	Trib. of Sweet Springs	Randolph	10	53	14	NM
46583150	Dark Creek	Randolph	31	54	15	7.3
46583160	Sugar Creek	Randolph	23	54	15	10.4 [4]10.4 [3]NM
*46583161	Tributary of Sugar Creek	Randolph	30	54	14	8.2
46583170	Sinking Creek	Randolph	24	54	14	6.6
46583210	Walnut Creek	Randolph	36	55	15	6.6
*46583211	East Fork Walnut	Randolph	20	55	14	8.7
*46583212	North Fork Walnut	Randolph	20	55	14	15.6
99999993	Unnamed	Randolph	36	55	15	20
46583220	Unnamed	Randolph	18	55	14	15.4
46583230	Unnamed	Macon	31	56	14	24.6
46583240	Unnamed	Macon	29	57	14	10.9
46583250	Duck Creek	Macon	19	57	14	22.9
46583260	Long Branch	Macon	31	58	14	2.9 [4]3.8 [3]1.6
*46583261	Tributary to Long Branch	Adair	31	61	14	NM

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46583270	Lick Creek	Macon	36	59	15	3.5
46583280	Richland Creek	Macon	01	59	15	2.8
46583290	Tributary of East Fork Little Chariton	Adair	15	61	15	NM
MUSSEL FORK SUBBASIN						
51130000	Mussel Fork Creek	Chariton	15	53	18	3.7 [5]3.7 [4]NM [3]6.4
51131100	Unnamed	Chariton	5	53	18	NM
51131200	Unnamed	Chariton	31	54	18	NM
51131300	Long Branch	Chariton	17	54	18	6.2 [4]4.7 [3]3.9
51131310	Unnamed	Chariton	6	54	18	NM
51131320	Skunk Creek	Chariton	6	54	18	7.9
51131330	Hurricane Creek	Chariton	18	55	18	NM
51131400	Cottonwood Creek	Chariton	9	54	18	8.4
51131500	Clarks Creek	Chariton	29	55	18	6.2 [4]4.1 [3]6.6
51131510	Unnamed	Chariton	20	55	18	NM
51131520	Locust Branch	Chariton	29	56	18	7.3
51131600	Unnamed	Chariton	11	55	18	NM
51131700	Van Dorsen	Chariton	23	56	18	NM
51131800	Unnamed	Chariton	24	56	18	10.3
51132100	Brush Creek	Chariton	13	56	18	8.1
51132400	Unnamed	Macon	6	59	17	NM
51132500	Badger Creek	Macon	6	59	17	8.3
51132600	Little Mussel	Adair	31	61	17	12.8
51132700	Unnamed	Sullivan	23	62	18	NM
51132800	Unnamed	Sullivan	2	62	18	NM
CHARITON RIVER MAIN STEM SUBBASIN						
51200000	Chariton River	Chariton	15	53	18	2.1 [6]2.2 [5]NM [4]2.7 [3]3.1
51200001	Unnamed	Chariton	1	53	18	6.5
51200002	Unnamed	Chariton	18	54	17	6.6
51200003	Unnamed	Chariton	4	54	17	8.2
51210000	Puzzle Creek	Chariton	11	53	18	5.8 [4]NM [3]7.4
51211000	Unnamed	Chariton	12	53	18	18.7
51220000	Long Creek	Chariton	2	53	18	3.3
51230000	Jones Branch	Chariton	7	54	17	10.3 [4]NM [3]12.3

Appendix A2 continued

51231000	Unnamed	Chariton	31	55	17	16.7
51240000	Bee Branch	Chariton	4	54	17	8.3 [4]2.0 [3]12.2
51241000	Unnamed	Chariton	28	55	17	9.8
51242000	East Bee Branch	Chariton	10	55	17	12.7
51270000	Elm Branch	Chariton	13	55	17	6.4
51280000	Kelly Branch	Chariton	8	55	16	3.6
51300004	Old Channel Chariton River	Macon	3	59	16	2.2 [4]2.5 [3]NM
51300005	Branch of Old Channel Chariton River – Mile 32	Macon	32	58	16	13.4
51300006	Sand Creek	Macon	9	57	16	21.1
51300007	Ward Branch	Macon	15	58	16	19.4
51300008	Branch of Old Channel Chariton River – Mile 45	Macon	33	59	16	8.1
51300009	Huckleberry Creek	Macon	11	59	16	18.9
51310000	Puzzle Creek	Chariton	31	56	16	6.3 [4]4.2 [3]12.1
5131000	Unnamed	Chariton	19	56	16	12.8
51312000	Unnamed	Chariton	25	57	17	NM
51330000	Painter Creek	Macon	17	58	16	6.7
51340000	Elam Creek	Macon	27	58	16	22.4
51350000	White Oak Creek	Macon	8	58	16	NM
51360000	Little Turkey Creek	Macon	33	57	16	12.5
51370000	Turkey Creek	Macon	28	59	16	15.4 [4]4.2 [3]19.1
51371000	Unnamed	Macon	17	59	16	15.9
51380000	Rock Creek	Macon	23	59	16	3.1
51410000	Walnut Creek	Macon	34	60	16	8.2 [5]2.0 [4]10.4 [3]14.6
51411000	Little Walnut Creek	Macon	18	60	16	8.9 [4]7.7 [3]17.2
51411100	Unnamed	Macon	14	60	17	13.9
51411200	Unnamed	Macon	14	60	17	18
51412000	Little Walnut Creek	Macon	31	61	16	11.6
51413000	Unnamed	Macon	35	62	17	16.7
51420000	Sand Creek	Macon	35	60	16	12.1 [4]7.6 [3]17.4
51421000	Unnamed	Macon	36	60	16	13.6
51430000	Cottonwood Creek	Macon	26	60	16	12.7

Appendix A2 continued

51440000	Sugar Creek	Adair	16	61	16	10.5 [4]9.9 [3]13.1
51441000	Unnamed	Adair	14	61	16	31.3
51442000	Turkey Run	Adair	18	61	15	15.3
51460000	Goose Creek	Adair	5	61	16	19.8
51470000	Hog Creek	Adair	4	61	16	11.4
51480000	Billy's Creek	Adair	21	62	16	11.5
51510000	Big Creek	Adair	15	62	16	17.6 [4]12.7 [3]21.2
51520000	Dave Branch	Adair	16	62	16	15.9
51530000	Spring Creek	Adair	33	63	16	7.8 [4]4.9 [3]4.0
51531000	Jobs Creek	Adair	25	63	17	30.7
51532000	Dry Branch	Sullivan	7	64	18	21.7
51533000	North Spring Creek	Sullivan	27	64	18	11.3
51540000	Rye Creek	Adair	22	63	16	16.4
51550000	Shuteye Creek	Adair	9	63	16	10.3
51560000	Hazel Creek	Adair	3	63	16	9.8 [4]4.1 [3]12.4
51561000	Little Hazel Creek	Adair	36	64	16	12.3
51570000	Blackbird Creek	Adair	3	63	16	7.3 [5]2.7 [4]1.4 [3]12.2
51571000	South Blackbird Creek	Putnam	2	64	17	6.3 [4]5.5 [3]8.9
51571100	Kinny Creek	Putnam	22	65	18	15
51571200	Unnamed	Putnam	13	65	19	10.2
51573000	Lick Creek	Putnam	21	65	17	15.2
51574000	Unnamed	Putnam	28	66	18	NM
51575000	Unnamed	Putnam	19	66	18	30.3
51580000	Wildcat Creek	Putnam	16	64	16	13.7
51610000	Lost Creek	Schuyler	10	64	16	18
51620000	Sand Creek	Schuyler	34	65	16	8.6
51640000	Elm Creek	Schuyler	22	65	16	8.8 [5]5.0 [4]9.1 [3]6.9
51641000	Winkler	Schuyler	11	65	16	16
51641100	Unnamed	Schuyler	12	65	16	14.1
51650000	Shoal Creek	Putnam	4	65	16	4.0 [5]2.3 [4]4.5 [3]12.9
51651000	Brush Creek	Putnam	31	66	16	15.7
51652000	Sandy Creek	Putnam	31	66	17	12.3 [4]NM [3]13.4
51652100	Little Sandy Creek	Putnam	28	66	17	21.5

Appendix A2 continued

51653000	Unnamed	Putnam	34	67	18	7.0 ^{4}4.8 ^{3}8.2
51653100	Unnamed	Putnam	5	66	18	5.0 ^{4}NM ^{3}6.9
51653110	South Creek	Putnam	16	67	18	NM
51653200	Unnamed	Appanoose	16	67	18	18.2
51654000	Unnamed	Appanoose	19	67	17	14.6
51655000	Unnamed	Appanoose	6	67	17	NM
51656000	Unnamed	Appanoose	36	68	18	15.5
51657000	Unnamed	Appanoose	26	68	19	NM
51670000	Turkey Creek	Putnam	5	66	16	12.4
Stream Code	Stream Name	County	Sec	Town-ship	Range	Gradient (feet/mile) (Mean & By Order)
51671000	Unnamed	Putnam	6	66	16	0
51511000	Unnamed	Adair	7	62	15	15.3

LAND USE

Historical Land Use

The basin's first inhabitants, Native Americans of the Fox, Sac, Illinois, Missouri and Iowa tribes, and white explorers, exerted little pressure on the land and its natural resources. Intensive land use came to the basin after it was settled by European immigrants in the early to mid 1800s. The first homesteader arrived in Randolph County at the southern end of the basin in 1818. Settlers that followed moved slowly northward to settle Putnam County by 1845. The first immigrants in any area of the basin settled on the hillsides where timber was easily accessible. The grasslands were used for open range (SCS 1995, 1994, 1989).

Prior to settlement, it was reported that as much as 70% of the basin was forested (St. Louis Historical Co. 1884). Railroads were built shortly after the organized settlement of the basin in the mid 1800s. This stimulated the commercial sale of many of the basin's natural resources. Coal mining began at this time, but did not peak as an industry until 1900 through 1925 in Randolph, Macon, Adair and Putnam counties (SCS 1995, 1989; Kirksville-Adair Co. Bicentennial Committee 1976; History of Adair, Sullivan, Putnam and Schuyler counties 1888). Railroads and coal mines produced a great demand for timber in the form of ties, pillars and props. By the end of World War I there were no extensive stands of virgin timber left in Adair County (Kirksville-Adair Co. Bicentennial Committee 1976).

Modern Land Use

Over 80% of the land in the Chariton River basin is used for commodity production (Figure 4).

At the turn of the Millennium, 43% of the basin was in hay or pasture, including lands enrolled in the Conservation Reserve Program (only 21% hay/pasture in 1982; USDA), 38% was in cropland (53% in 1982), 15% was forested, including grazed woodlands (17% in 1982), and 4% was used for other purposes (municipalities, roads, impounded water etc.) (NRCS district conservationists in Putnam, Adair, Macon, Chariton and Randolph counties, pers. comm.). Changes over the past two decades likely reflect some conversion of highly erodible cropland to CRP or idle ground, and would support the recent reduced soil erosion findings.

In general, the level ridge tops and floodplains are used to grow crops. Hayland and pasture occur on the hillsides as well as the ridgetops. Forested land can be found along small and larger streams, on hillsides and ridges, but is not a predictable part of any landform. The Mussel Fork Creek subbasin is more heavily forested than the remainder of the Chariton River Basin.

The predominant type of farming changes from hay and livestock production in the northern Missouri portion of the basin to grain crop production in the basin's southern reaches, and is reflected in the annual production record for each county. Putnam, Adair and Macon counties are among the top hay-producing counties in the state (Reddick 1992). Beef cattle numbers are also highest in the northern reaches of the basin; Putnam County supports over 25,000 head.

Row crop production predominates in the southern reaches of the basin; Macon and Chariton counties are among the top soybean producers in the state, and Chariton county is among the top ten producing counties for soybeans as well as corn and wheat (Reddick 1992).

Corporate hog farms now dwarf the production of private hog farmers. Prior to the development of corporate farms, there were roughly 56,000 hogs produced annually basin-wide. Though there are fewer small family hog farms today, corporate farmers alone have boosted this annual production figure by approximately 270,000 head, to a herd size of 326,000 in the late 1990s – roughly equivalent to a human population of 1.2 million (calculations based on 250-pound average finished hog, and 15 people equivalent to 1000 pounds of swine, T. Chockley, DNR, pers. comm.).

PSF-ContiGroup (formerly Premium Standard Farms) has three large farms and an increasing number of consignment farms within the basin. Each PSF-owned farm has a number of lagoons which hold the excrement from up to 8,800 hogs. Average drawdown on each lagoon is approximately 4.2 million gallons; the finished effluent from one lagoon is applied to a 110-acre field. Whitetail Farm, located in north central Putnam County, has the capacity to raise 105,600 head to marketable size, and produces up to 50.4 million gallons of waste annually in 12 lagoons. In the event of a spill, the receiving stream would be a third- or fourth-order tributary to fifth-order Little Shoal Creek, or first- through third-order tributaries to fourth-order North Blackbird Creek. The Valley View Farm in eastern Sullivan County can raise up to 88,000 head and produce up to 42 million gallons of waste annually in 10 lagoons. These facilities drain into either first- through third-order tributaries to, or directly to, fourth-order Mussel Fork Creek. Green Hills Farm, in northeastern Sullivan County, has 9 lagoons which treat 37.8 million gallons of waste from 79,200 head annually. The receiving stream is second- or third-order Spring Creek just upstream of Union Ridge Conservation Area.

The majority of the basin's forest resources are of poor quality and generally are not valued enough to be managed to their full potential (USDA 1982). Though inventories show 15% of the basin is forested, as much as 66% of this is grazed – one reason for the poor quality of forested lands. From the mid 1950s through the mid 1980s, clearing of forested land by bulldozer was common enough that forest cover was reduced significantly in the lower Chariton River basin (G. Crowder, District Conservationist, Chariton County, pers. comm.) Though not a common practice for the past 15 years, one large area in southeastern Putnam County (Gillum Ranch) was cleared significantly in order to create pasture. The drainages affected were Kinney Creek, South Blackbird Creek and the upper reaches of Shuteye Creek (L. Sell, MDC, pers. comm.).

Soil Conservation Projects

Publically financed soil conservation projects are occurring on less than 3 percent of basin lands (Table 6).

Public Areas

There is a wide variety of public land within the Chariton River basin. Several areas offer access to major basin streams. Concrete boat ramps have been built at two locations on the unchannelized Chariton River within Rebel's Cove Conservation Area (CA), at Archangel Access on the lower end of the unchannelized Chariton at U.S. Highway 136, at Mullanix Ford Access in southeastern Putnam County on the channelized Chariton, and at Dodd Access in Macon County, also on the channelized Chariton. Two areas await further development on the channelized Chariton River (Truitt Access and Elmer A. Cook Memorial Access in Adair County), and two areas remain completely undeveloped (Keytesville Access and Price Bridge Access in Chariton County). There is a concrete boat ramp at Lewis Mill Access on the Little Chariton River. Mussel Fork CA offers access to Mussel Fork Creek via a nearby parking lot. Bee Hollow CA on East Fork Little Chariton River has no stream access developments planned.

Table 6. Ongoing and proposed soil conservation projects within the Chariton River basin. Earth projects are funded by local Soil and Water Conservation Districts.

County	Salt Project	PL-566 Project	Earth and Other Type Projects
Chariton	Jones Branch (5,000 A)	--	Bee Branch (20,000 A)
Macon	Painter Creek (3,500 A)	Middle Fork Little Chariton[a] (9,500 A)	--
Putnam	Turkey Creek (3,070 A)	Blackbird/Wildcat creeks[i] (101,200 A)	--
Randolph	Silver Creek[a] (30,000 A)	Middle Fork Little Chariton[a] (95,500 A)	Sugar Creek Lake[P] (8,000 A)

[a]Active application awaiting priority
[i]Inactive application
[P]319 Water Quality Project

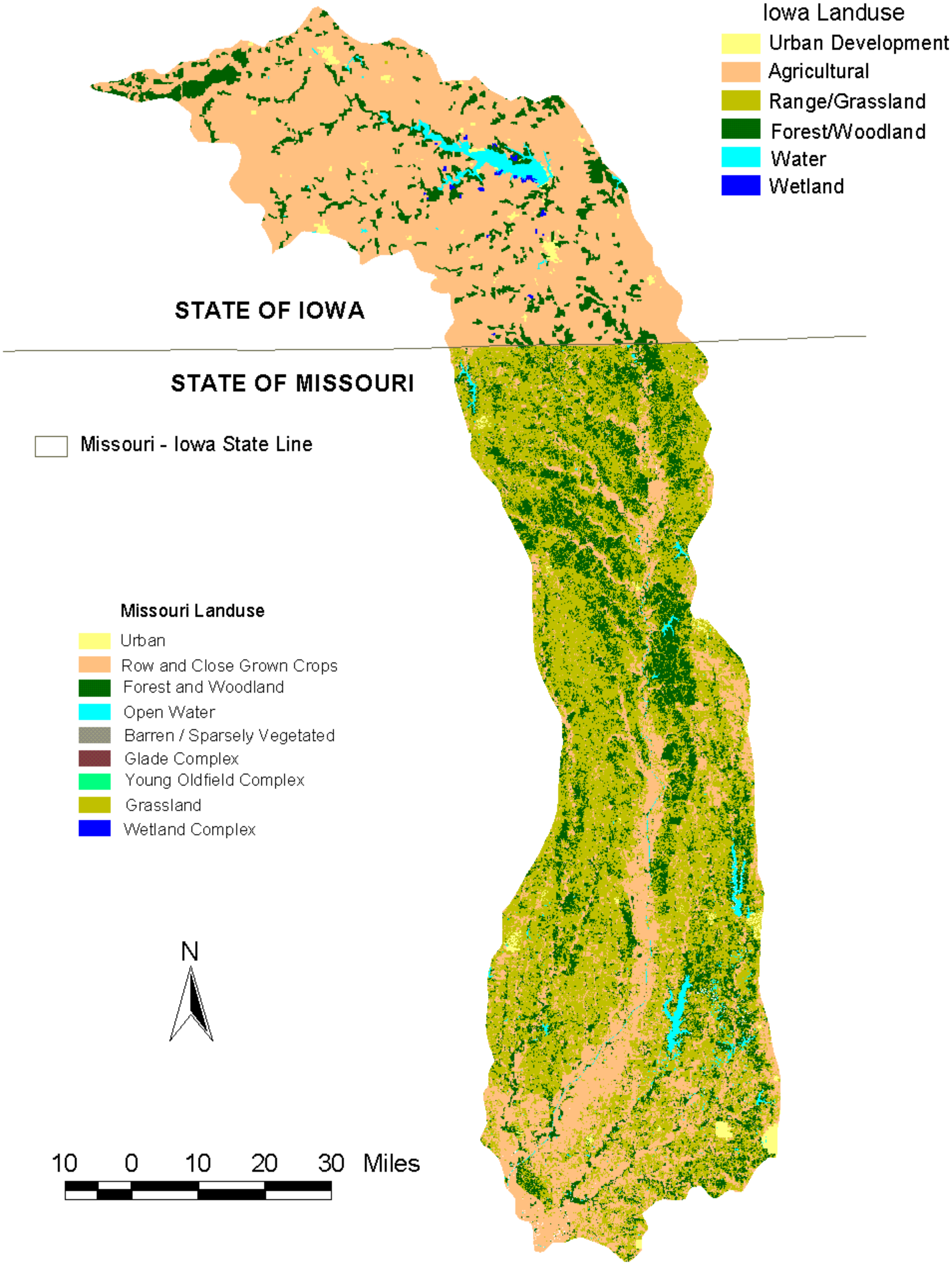

Figure 4. Land use in the Chariton River Watershed, in Missouri and Iowa

HYDROLOGY

Precipitation

Though the basin has experienced periods of extreme drought and extraordinary precipitation, average annual precipitation in the Chariton River watershed ranges from 34 inches in the north to 36 inches in its southern reaches (USDA 1982).

USGS Gaging Stations

There are seven active gaging stations in the Chariton River basin (Table 1). Several gaging stations have been discontinued. The gaging station near Prairie Hill is the only locality where water quality parameters continue to be monitored. Suspended solids are monitored at the Long Branch Creek station.

Permanence of Flow and Average Annual Discharge

With the exception of the Chariton River, which receives discharge from Lake Rathbun and has some recharge from a large flood plain in its lower reaches, all streams within the basin experience periods of no discharge (Table 2). Intermittent flowing streams – those experiencing complete desiccation or extended periods of holding water in pool habitat only – are found primarily in streams third-order and lower (Appendix A).

Base and Low-flow Frequency Data

With the exception of the lower reaches of the Chariton River, base flows are not sustained by groundwater inflow during droughts due to the low hydraulic conductivity of the basin's clay soils and underlying shales (DeTroy and Skelton 1983, Skelton 1976). This effect is intensified by highly altered stream channels and intense agricultural land use. Hence, man-made ponds and reservoirs are relied upon for water supply. A compilation of low-flow statistics for Missouri streams is contained in Skelton (1976); select data were summarized for readers who have access to this inventory only (Table 3). These data, however, must be qualified.

The regulation of streamflow by the impoundment of large reservoirs is one limitation to quantification of base-flow and low-flow statistics for streams in the Chariton River watershed (Skelton 1976, 1970). Three of the largest streams in the basin, the Chariton River, East Fork Little Chariton and Middle Fork Little Chariton, all have become regulated by reservoirs within the last 20 to 30 years. The gage records used to infer low-flow data are either outdated (i.e., pre-impoundment), or calculations are inaccurate due to inclusion of pre- and post-impoundment data. A long period of consistently regulated flows and detailed study are necessary before accurate low-flow frequency data can be calculated. However, it is possible to use drainage basin area to estimate low-flow frequency for smaller unregulated streams for which low-flow data have never been collected (Skelton 1976).

Flow Duration

These statistics are based upon measured discharge for a specified period of record and represent the flow that is exceeded for a given proportion of time. The magnitude of the ratio of the flow that is exceeded 90% of the time to the flow that is exceeded 10% of the time (90:10 ratio) can be used as an indicator of the flashiness or variability of streamflow for streams with similar drainage areas. Chariton River basin soils, landscape and channel modifications work together to create flashy flows in all basin streams (Table 4). Due to the speed that the water comes off the land, streams rise and fall quickly with each precipitation event. Additionally, perennial flow cannot be sustained even minimally because the subsurface clay soil resists water infiltration, forcing most water to run off after each precipitation event.

Flood Frequency

Flood frequency data for basin streams are limited (Table 5). Multiple regression techniques revealed that drainage area and main-channel slope can be used to predict return period flows for streams that lack gage data within the plains physiographic region of Missouri (Alexander and Wilson 1995). Given that: Q_t = estimated flood discharge in cubic feet per second for a t-year recurrence interval; A = drainage area in square miles; S = main channel slope in feet per mile, the generalized least squares regression equations are as follows:

$$Q_2 = 69.4A^{0.703}S^{0.373}$$
$$Q_5 = 123A^{0.690}S^{0.383}$$
$$Q_{10} = 170A^{0.680}S^{0.378}$$
$$Q_{25} = 243A^{0.668}S^{0.366}$$
$$Q_{50} = 305A^{0.660}S^{0.356}$$
$$Q_{100} = 376A^{0.652}S^{0.346}$$
$$Q_{500} = 569A^{0.636}S^{0.321}$$

Dam and Hydropower Influences

The dams of large reservoirs influence three of the largest streams in the basin. Lake Rathbun is an 11,000-acre Corps of Engineers reservoir on the Chariton River in the Iowa portion of the basin. It functions primarily for flood control, and as such dampens the extremes of low and high flow. Due to the dam's presence, there can be lengthy periods of moderate flow. A minimum downstream release of 11 cubic feet per second (cfs) maintains the Chariton River as a permanent stream during periods of drought. Below the dam, Rathbun Fish Hatchery (Iowa DNR) releases a constant flow of 10 cfs, and Rathbun Regional Water withdraws between 4 and 6 cfs (P. Egeland pers. comm.). Planned discharge ranges from 800 cfs in mid summer and fall, to 1200 cfs in late summer and 1500 cfs through the winter.

The Middle Fork Little Chariton River flows into 4,950-acre Thomas Hill Reservoir north of Moberly, Missouri. The reservoir was impounded in 1965. Prior to December 1991 the reservoir covered 4,400 acres and the mean pool elevation was 710 m.s.l. Current pool elevation is 712 m.s.l. Thomas Hill Reservoir is the property of Associated Electric Cooperative, Inc., which uses the water for cooling its three-unit coal-fired electrical power plant. There is also a contract which allots a portion of the water to nearby municipalities. These withdrawals are not strictly monitored. To maintain downstream water quality, Associated Electric maintains a minimum downstream flow of 5 cfs, though they rarely release less than 10 cfs (J. Bindel, pers. comm.).

The East Fork Little Chariton River was dammed near Macon, Missouri by the Corps of Engineers in 1978 to form 2,430-acre Long Branch Lake. The primary project purpose is flood control. Secondarily, Long Branch Lake serves as a water supply for much of the surrounding area and provides recreation and fish and wildlife benefits. To maintain downstream water quality, the Corps of Engineers releases a minimum of 7 cfs. In extreme drought this can be reduced to 3.5 cfs (H. Diesel, pers comm.). Above an elevation of 791 m.s.l. there is uncontrolled discharge into East Fork, below this level maximum discharge varies with the surface elevation of the lake from approximately 68 cfs at 791 m.s.l. to 35 cfs at 775 m.s.l. (H. Diesel, pers. comm.).

Major Water Users

Surface water withdrawals comprise the majority of public water supply in the basin (MDNR 1986). Most sources are from reservoirs of various sizes which are on small order tributary streams (MDNR unpublished). The only stream withdrawal is operated by the City of Bucklin, which uses Mussel Fork Creek as an auxiliary water supply.

Water use for irrigation is minimal throughout the basin. The only irrigated lands are in the basin's southern half; fewer than 2,500 acres are irrigated in Macon, Randolph and Chariton counties (MDNR 1986). The only major industrial use is of Thomas Hill Reservoir by Associated Electric Cooperative, Inc. Depending upon time of year and the number of units operational, AECI will use for cooling as little as 144 million gallons per day and as much as 1 billion gallons per day (B. Johnson, AECI, pers. comm.).

Table 1. Location of active and discontinued stream gaging stations within the Missouri portion of the Chariton River basin.

Gage Station Location	Type of Record	Period of Record
Chariton River @ Livonia	d	5/74-CY
Chariton River @ Novinger	d	1930-1952, 1954-CY
Chariton River @ Prairie Hill	d c	1928-CY 1962-1963, 1967-1975, 1978-1986, 1992-CY
East Fork Little Chariton @ Macon	d	1971-CY
East Fork Little Chariton @ Huntsville	d	1962-CY
Long Branch Creek @ Atlanta CA	d	7/95-CY
Long Branch Reservoir	e	1978-CY
Middle Fork Little Chariton @ Salisbury	d c	1964-1970 1983-1986
Mussel Fork Creek @ Mussel Fork	d	1948-1951, 1962-1990
Thomas Hill Lake	e	1966-1974

Type of record: c=chemical quality, d=discharge, e=elevation. CY = Current Year (as of 1994).

Table 2. Discharge (cubic feet per second) for the period of record at gage locations within the Chariton River basin (USGS 1994).

Location	Instantaneous Peak Flow	Instantaneous Low Flow	Mean Flow	10% Exceeds	50% Exceeds	90% Exceeds	Drainage Area (Square Miles)
Chariton River Livonia, MO (1974-1994)	9200	13	697	1650	415	33	864
Chariton River Novinger, MO (1970-1994)	21500[a]	11	1131	2420	589	40	1370
Chariton River Prairie Hill, MO (1929-1994)	31900	4.6 (1934)	1243	3200	350	37	1870

East Fork Little Chariton Macon, MO (1979-1994)	13900	0	92.8	284	48	5.5	112
East Fork Little Chariton Huntsville, MO (1979-1994)	10400	0	182	393	68	6.7	220
Mussel Fork Creek Mussel Fork, MO (1979-1994)	18300	0	234	517	28	0.8[b]	267
[a] - 1993 record [b] - 95% exceeds							

Table 3. Seven-day low-flow discharges at various recurrence intervals for streams in the Chariton River basin. Discharge is presented in cubic feet per second (Skelton 1976).

STREAM NAME AND LOCATION	DRAINAGE AREA (square miles)	RECURRENCE INTERVAL (years)			
		2	5	10	20
Chariton River near Chariton, IA	182	0.6	---	0.2	---
S. Fork Chariton River near Cambria, IA	59	<0.1	---	0	0
S. Fork Chariton River near Corydon, IA	69	<0.1	---	0	0
S. Fork Chariton River near Promise City, IA	168	0.3	---	<0.1	0
Chariton River near Rathbun, IA[1]	549	1.7	0.5	0.2	0.1
Chariton River near Centerville, IA	708	1.7	---	0.3	---
Chariton River at Livonia, MO[1]	864	6.0	---	1.0	---
Shoal Creek near Cincinnatti, IA	68	0	0	0	0
Shoal Creek at Glendale, MO	154	0	0	0	0
North Blackbird Creek near Unionville, MO	---	0	0	0	0
Chariton River at Novinger, MO[1]	1,370	9.5	3.0	1.3	0.6
Chariton River near Callao, MO[1]	—	22	—	6.0	---

Chariton River near Prairie Hill, MO[1]	1,870	24	12	8.6	6.2
Mussel Fork near Musselfork, MO	267	0.4	---	0	0
Mussel Fork at Keytesville, MO	---	0.4	---	0	0
E.F. Little Chariton River near Macon, MO	112	0	0	0	0
E.F. Little Chariton River near Huntsville	220	0.1	---	0	0

[1]Flow partially regulated by Rathbun Reservoir since 1969. Low-flow frequency data represent natural conditions prior to regulation.

Table 4. Flow-duration discharge and 90:10 ratio for three locations in the Missouri portion of the Chariton River basin. Discharge is presented in cubic feet per second.

Stream Name and Location (assumed period of record)	**Drainage Area (sq. miles)**	**Flow (cfs) that was exceeded for indicated proportion of time**					**90:10 Ratio**
		95%	**90%**	**70%**	**50%**	**10%**	
Chariton River at Novinger, MO (1931-1952, 1955-1982)	1,370	5.4	10	38	110	2,000	1:200
Chariton River at Prairie Hill, MO (1929-1982)	1,870	17	24	80	200	2,800	1:117
East Fork Little Chariton River at Huntsville, MO (1963-1982)	220	0.3	1.2	10	28	510	1:425

Table 5. Flood discharges for 2- to 500-year intervals at selected streamflow gaging stations within the Missouri portion of the Chariton River basin (Alexander and Wilson 1995).

Stream/ Location	Period of Record (water year used)	Drainage Area (mi^2)	Main-Channel Gradient (ft/mi)	Flood Discharge (cfs) for Indicated Recurrence Interval (years)						
				2-					100-	500-
Chariton River at Novinger MO	1917, 1931-52, 1955-69	1,370	2.63	9,590	14,700	18,100	22,300	25,200	28,100	34,400
Strop Branch near Novinger MO	1955-79	0.96	94.7	514	1,150	1,670	2,410	3,000	3,610	5,070
Chariton River at Elmer, MO	1917, 1922-30, 1961-69	1,660	2.40	12,500	18,500	22,400	27,300	30,800	34,300	42,200
Chariton River near Prairie Hill, MO	1929-69, 1993	1,870	2.25	13,200	18,800	22,300	26,400	29,300	32,00	38,000
Puzzle Creek near Salisbury MO	1955-79	.80	55.6	156	301	428	626	803	1,010	1,600
Mussel Fork near Musselfork MO	1963-89	267	2.70	5,400	10,700	15,300	22,700	29,300	36,900	59,300
East Fork Little Chariton River near Huntsville MO	1963-76	220	3.50	3,360	6,950	10,400	16,200	21,800	28,600	50,700

WATER QUALITY

Designated Beneficial Uses

The main stem of the Chariton River is the only stream in this basin classified for whole-body contact recreation and boating. Water quality, per se, does not impede recreational activity on the Chariton River. It is the sediment-choked and therefore shallow condition of the channelized portion that restricts boating and canoeing during times of low flow. The unchannelized portion of the Chariton River has a narrower, deeper channel, and due to releases from Lake Rathbun will support boat and canoe traffic in all but the winter months (ice cover). Occasional large log jams deter recreational use of this section.

Chemical Quality of Stream Flow

General water quality data have been collected intermittently on the Chariton River since 1962 at the gage station near Prairie Hill. An "average" water year (1986) and a flood year (1993) were chosen for comparison (Table 7). Both iron and manganese can exceed secondary drinking water standards in the Chariton River and the alluvial aquifer (MDNR unpublished). Occasionally high concentrations of phosphorus are most likely attributable to agricultural runoff.

Non-Point Source Pollution

The primary pollutant in Chariton River basin streams is sediment delivered by the processes of sheet, rill, gully and stream bank erosion throughout the watershed. Average sheet erosion rate was estimated to be 10.3 tons of soil per acre of watershed per year (tons/A/yr) in 1978, at which time it was estimated that 2.7 tons/A/yr were actually yielded to basin streams. Of that total sediment yield, sheet and rill erosion were estimated to be responsible for 71%, gully erosion for 11% and stream bank erosion for 16% of the sediment delivered to streams in this basin (Anderson 1980). Though erosion on agricultural lands has been greatly reduced in the last 15 years, severe sedimentation problems continue to plague basin streams. Active head-cutting associated with channelization performed decades ago continues to create deep gullies, even on completely forested slopes approaching the highest elevations in the watershed.

Uncontrolled or poorly controlled sheet and rill erosion from road construction, road maintenance, and other large construction projects yield unknown amounts of fine sediment and suspended clay particles to receiving streams and subsequently turbid reservoirs. Those projects that fail to incorporate adequate erosion control and re-vegetation practices (true of many county road and right-of-way projects) yield much more than the average 10.3 tons/A/yr of sediment.

Nutrient enrichment from livestock (mostly cattle grazing near or in streams) is most noticeable during the summer at times of low flow. At such times, excessive animal waste and algal growth can cause locally high ammonia and low dissolved oxygen concentrations in headwater streams (MDNR unpublished). These conditions have not been recorded to cause fish kills, though they likely restrict the distribution of pollution-sensitive aquatic species.

Acid mine drainage affects several streams within the Chariton River basin. Drainage from abandoned strip mines and gob piles from old shaft mines causes the waters of receiving streams to become "mineralized". Mineralization generally refers to an increase in one or more of the following parameters: total dissolved solids, specific conductance, total recoverable iron (>500 µg/L), manganese (>500 µg/L), and sulfate concentration (>75 µg/L); and mineralization is sometimes accompanied by a drop in pH, or acidity being greater than alkalinity (DeTroy and Skelton 1983). Several miles of Shoal, Sandy and Little Sandy creeks in eastern Putnam County are mineralized. In western Adair County, approximately 0.9 mile of Billy Creek receives acid mine drainage from a gob pile. There are several thousand acres of strip-mined lands within the basins of East Fork and Middle Fork Little Chariton rivers. Heavily impacted tributaries of East Fork include Sinking, Sugar, Dark and North Fork Claybank creeks (MDNR unpublished, USGS 1986). Reclamation is either underway or planned for most of these areas (MDNR unpublished, MDNR 1990).

Point Source Pollution

Oil and petroleum product pipelines belonging to Amoco, Arco and Mapco companies cross the basin from east to west for its entire length. An Amoco pipeline break in 1990 spilled 86,000 gallons of crude oil and impacted over 35 miles of Little Turkey Creek and the Chariton River. Though devastating to aquatic invertebrates and mammals, very few dead fish were found in this isolated incident.

Two wastewater treatment facilities present problems regularly – the City of Salisbury's discharge to Puzzle Creek in Chariton County, and effluent from Moberly West's wastewater plant, which impacts at least 2.5 miles of an unclassified tributary to East Fork Little Chariton River (MDNR unpublished).

MDNR has identified acid mine drainage to Sandy Creek in Putnam County from Missouri Mining Company's coal preparation plant near Hartford. However, it is unclear whether the mineralization and depressed pH are due to point source drainage or non-point sources from other mined lands (MDNR unpublished). The Thomas Hill power plant ash pond discharges into Middle Fork Little Chariton River, and during drought these discharges can exceed that of the reservoir. Though the effluent tested as nontoxic in 1991, Associated Electric Cooperative, Inc. is conducting a three-year study to assess the impact of that effluent on heavy metals in the river (MDNR unpublished).

Concentrated Animal Feeding Operations

Large corporate hog farms pose a potential threat to aquatic life at times of system failure. PSF-ContiGroup is the only corporate farm venture in the Missouri portion of the basin. In the latter half of 1995, manure spills by then Premium Standard Farms resulted in three fish kills – one on the headwaters of Mussel Fork Creek (T62N R18W Sec 2), impacting nine miles of stream; one on a 0.4-mile reach of a tributary to Spring Creek (T64N R19W Sec 13); and a third killing all fish in a 1.0-mile portion of North Blackbird Creek (T66N R18W Sec 21). Public outcry and a federal pollution lawsuit filed by the Citizens Legal Environmental Action Network (CLEAN), along with stricter DNR enforcement of engineering standards, seem to have reduced the probability of recurrence of events of such magnitude that would create fish kills.

If not carefully monitored and regulated, large corporate hog farms also have potential to develop into a source of nutrient enrichment and perhaps heavy metal contamination due to the approved surface disposal of liquid manure (lagoon effluent) onto fields. In the late 1990s, PSF-ContiGroup "land applied" effluent from each lagoon at a rate of 4.2 million gallons per 110 acres of field annually. It is unknown whether these fields will retain and recycle applied nutrients long enough to prevent runoff, percolation, and ultimate release of nutrients at pollutant levels into receiving waters. As of November 2001, alternative methods of waste treatment and disposal, including nutrient recycling, were being explored by PSF-ContiGroup under terms of a proposed settlement of the aforementioned federal lawsuit.

Table 7. Selected water quality data for the Chariton River near Prairie Hill, MO at gage station 06905500 during water years 1986 and 1993 (USGS 1986, 1993; Code of State Regulations 10 CSR 20.7). Protection Class Codes: I = Aquatic Life; III = Drinking Water Supply; VI = Whole-Body-Contact Recreation; VII = Ground Water.

Parameter	State Standard				Water Year	
	I	III	VI	VII	1986	1993
Temperature (F°)	90° max				32-79	32-78
Specific Conductance (µmhos/cm)					190-389	144-345[a]
pH		6.5 - 9.0			7.3-8.1	7.4-8.0
Turbidity (NTU)					37-430	-
Oxygen, Dissolved (mg/L)	5				6.3-15.6	4.7-15.6
Coliform, Fecal (cols/100ml)				200 non-storm runoff	34-11,000[b]	34-14,000[b]
Streptococci, Fecal (cols/100ml)					24-20,000[b]	36-25,000[b]
Total Hardness (mg/L $CaCO_3$)					91-200	61-140
Alkalinity, Total (mg/L as $CaCO_3$)					73-130	58-116
Nitrogen, Total Ammonia (mg/L as N)	Depends on temp & pH				0.04-0.28	0.02-0.11
Phosphorus, Total (mg/L as P)					0.14-0.39	0.09-0.62
Manganese, Dissolved (µg/L as Mn)		50		50	<1-80	3-80
Iron, Dissolved (µg/L as Fe)	1,000	300		300	7-2,900	78-190
Sulfate, Dissolved (mg/L as SO_4)		20% increase from background levels			23-77	11-43
Atrazine, Dissolved (µg/L)		3		3	-	0.16-0.49

[a] Laboratory value replacing missing field value
[b] Non-ideal count of colonies (e.g., sample was not diluted enough, colonies merged)

HABITAT CONDITIONS

Channel Alterations and Habitat Problems

The entire Chariton River basin has been altered and degraded by stream channelization. Among the three subbasins, the degree of channelization in third-order and greater streams is least in the Little Chariton and greatest in the Chariton River mainstem. The fraction of total stream mileage channelized, as interpreted from 1:24,000 topographic maps, is 28%, 35% and 47% in the Little Chariton, Mussel Fork, and Chariton River subbasins, respectively.

The Chariton River itself is channelized in Missouri from Highway 136 in Putnam County to its confluence with the Missouri River in Chariton County. All channelization did not occur at the same time. The lower Chariton was straightened in the early 1900s under the auspices of drainage districts in both Macon and Chariton counties (L. and C. Dunham, pers. comm.). Channelization in Macon County from the Burlington Railroad line to just south of the Chariton County line was finished in 1907. Most work in Chariton County occurred at the same time, because residents of Chariton County did not wish to be flooded downstream of Macon County's new “ditch” (L. and C. Dunham, pers. comm.). The river was straightened north of the Burlington Railroad line to near the Adair County line beginning in 1922, and that channelization was completed in 1923. In Adair County, channelization efforts were made as early as 1912 when landowners taxed themselves to operate a dredge boat to create a ditch to replace the natural channel. These efforts were not successful until sometime between 1930 and 1935 (Otten 1976).

The Corps of Engineers (COE) is responsible for channelizing or rechannelizing approximately 35 miles of the river from 1948 through 1952. At that time, the lowermost 13.6-mile segment of the Chariton was re-aligned, causing the Little Chariton River to cease being a tributary to the Chariton and flow directly into the Missouri River. A federal levee project undertaken by COE from 1965 to 1972 keeps these two drainages completely separate. COE also assisted in the channelization of a 4-mile segment beginning just north of the Adair/Schuyler county line, and a 17.5-mile segment from the Chicago/Quincy/Burlington railroad bridge at Novinger to South Gifford just south of the Macon County line (G. Covington, COE, pers. comm.)

Widespread channelization has led to deeply incised, wide, shallow and characteristically unstable channels that typify shortened streams with unstable gradients. This is particularly true of most tributaries to the Chariton River. Whether straightened or not, most tributary streams have been impacted by head cuts originating from the Chariton River. Though the gradient in most streams is no longer changing rapidly, the equilibrium characteristic of an unaltered stream does not exist (Figure 8).

Perhaps just as pervasive as the channel alterations and associated instability are the homogeneous, fine channel substrates that form an excessive bedload. It is not uncommon to sink up to one's knees in soft sandy or silty substrates in non-riffle reaches of streams of any order. Insufficiently forested riparian corridors further add to habitat problems. Even on rare reaches of stream not impacted by channelization, streambanks fail where trees are absent from the corridor. The resultant 10- to 30-foot vertical streambanks are a common sight. Instability of the outer bends precludes the development of good pool habitat for aquatic organisms.

Unique Riparian Habitats

Two areas may be appropriately classified as unique habitat. First is the unchannelized portion of the Chariton River that forms the border between Putnam and Schuyler counties. A natural rock formation in the channel north of Highway 136 has prevented the headcutting as a result of downstream channelization. Second is the confluence of the East Fork and Middle Fork of the Little Chariton River (T. Grace, pers. comm.). The swamp, oxbow and bottomland forest which exists in the floodplain of the East Fork Little Chariton River has been identified as rare habitat in MDC's Natural Heritage Database. This land is in the ownership of one individual who has been a conscientious steward of the stream resource.

Corps of Engineers Jurisdiction

The entire Chariton River basin is under the jurisdiction of the Kansas City District of the U.S. Army, Corps of Engineers. Applications for permits to dredge and fill in or near stream channels and associated wetlands, required under Section 404 of the Federal Clean Water Act, should be sent to the Glasgow field office.

BIOTIC COMMUNITY

Fish Community

The most recent fish community data were collected by seine between late July and late September in 1990, 1992, 1993 and 1994. Sample sites were chosen on most fourth-order and larger streams, and on some streams of smaller order. Site selection was based upon access, and was generally conducted upstream or downstream of bridge crossings (Figures 1-4).

We identified 51 species of fish (and several hybrids) in the most recent basin surveys (Table 8). Minnows species such as bigmouth shiners, sand shiners, and red shiners that are tolerant of shallow, sediment-filled channels occurred at over 80% of all sample sites. Other cyprinids occurring at over half of the sites seined were central stoneroller, bluntnose minnow, fathead minnow, and creek chub. Sunfishes were surprisingly prevalent; green sunfish, bluegill, and largemouth bass occurred at 68%, 50%, and 46% of all sample sites, respectively.

Four species collected historically but absent in recent samples were ghost shiner (Notropis buchanani) – last collected from the Chariton River in 1941; plains minnow (Hybognathus placitus) – last collected in 1941 from the Chariton River and Spring Creek; western silvery minnow (Hybognathus argyritis) – last collected from the Chariton River in 1967; and black buffalo (Ictiobus niger) – last collected from the Chariton River in 1966 (W. Pflieger, unpublished data).

Three species collected historically but represented by only one or two individuals in recent samples were Topeka shiner (Notropis topeka), trout-perch (Percopsis omiscomaycus) and stonecat (Noturus flavus). One specimen of Topeka shiner and one hybrid (N. topeka X dorsalis) were collected from Dog Branch Creek in eastern Putnam County (site 27, Figure 2) (R. Haydon, pers. comm.). The only recent records of trout-perch were individual fish captured in Blackbird Creek in Putnam County (1990) and in Mussel Fork Creek on the conservation area (1987). Only two specimens of stonecat were collected in the basin, both on the unchannelized portion of the Chariton River in 1994. We did not find any stonecat in Mussel Fork Creek where they were commonly found in the 1960s, nor in Shoal Creek where they were abundant in the late 1970s (W. Pflieger, unpublished data). Fish species collected throughout the basin, yet considered indicators of good habitat, include the blackside darter (Percina maculata) and brassy minnow (Hybognathus hankinsoni).

Several species have not been documented in the Chariton River basin until recently. Most noteworthy was the capture of a bullhead minnow (Pimephales vigilax) in 1994 from the Chariton River, thus extending the known range of this species (S. Bruenderman, pers. comm.). Other relatively recent records for the basin include largemouth bass (Micropterus salmoides) and bluegill (Lepomis macrochirus), which were first sampled in the mid sixties (W. Pflieger, unpublished data). Their steady increase in occurrence is likely due to emigration of juvenile sunfishes from an ever-increasing number of small impoundments in the watershed. Another recent stream invader, the mosquitofish (Gambusia affinis), was collected in samples of tributaries to Thomas Hill Reservoir in 1992 (D. Weirich, unpublished data) and in several other streams in the southern reaches of the basin in 1994. To date, mosquitofish have not been collected north of Macon and Chariton counties. In East Fork of Little Chariton River, bighead carp (Hypophthalmichthys nobilis) have been captured during stilling basin inspections below Long Branch Lake. The first specimen captured in 1987 was 27 inches long. In 1994, bighead carp comprised nearly half of all fish captured below Long Branch Dam. Total length ranged between 12 and 18 inches. In 1996, dozens of bighead carp of all sizes were observed far upstream in the North Blackbird Creek tailwater area of privately owned Lake Thunderhead in Putnam County (M. Anderson, pers. comm.).

Large fishes are under-represented in all recent samples due to seine selectivity. Yet, when electrofishing and hoopnetting surveys have been conducted, very few adult specimens of these species have been collected. Top predators such as the flathead catfish have been scarce in all samples. Some large flathead catfish and channel catfish are reported by anglers whenever flows are high.

Intentional Introductions

Spotted bass were introduced into Mussel Fork Creek by Otto Fajen of the Department of Conservation in 1968. An electrofishing survey in 1987 in Mussel Fork Conservation Area and several miles upstream near Hart, Missouri produced 17 spotted bass, ranging in size from 15-inch adults to young-of-the-year. Adults seemed oriented to submersed root wads.

Fish Contamination Levels and Health Advisories

There is no specific cause for concern regarding contamination of fish in the Chariton River watershed (Missouri Department of Conservation, unpublished data). Statewide chlordane advisories have been lifted due to steadily decreasing concentrations of this banned insecticide in fish flesh. In 2001, statewide concerns developed regarding the potential for accumulation of mercury in the flesh of fish-eating predators such as largemouth bass. The only significant piscivore harvested by anglers in the Chariton River watershed is the flathead catfish, which have not yet been examined for mercury levels.

Aquatic Invertebrate Community

Suitable mussel habitat is generally lacking throughout the basin. As of 2001, the only qualitative survey to assess the mussel fauna was conducted on Mussel Fork Creek in Chariton County in 1994. The most common species collected were *Quadrula quadrula* (mapleleaf), *Lasmigona complanata* (white heelsplitter) and *Leptodea fragilis* (fragile papershell). Less common species included *Amblema plicata* (threeridge), *Lampsilis teres* (yellow sandshell), *Pyganodon* = (*Anodonta*) *grandis* (giant floater), *Potamilus ohioensis* (pink papershell), *Truncilla truncata* (deer-toe, only one specimen), *Utterbackia* (=*Anodonta*) *imbecillis* (paper pondshell, shell only) and *Ligumia subrostrata* (pond mussel, shell only) (D. Figg and B. Sietman, unpublished data).

Table 8. List of fish species captured by seine by the Missouri Department of Conservation at 80 sample sites in the Chariton River basin (between 1987 and 1994). Asterisks (*) denote species not collected in recent samples but previously documented as occuring in the watershed (year of last collection in parentheses). Frequency of occurrence was calculated as the proportion of all samples in which a species appeared.

LARGE FISH	**FREQUENCY (%)**
Gizzard shad (Dorosoma cepedianum)	10
Goldeneye (Hiodon alosoides)	4
Common carp (Cyprinus carpio)	19
Bighead carp (Hypophthalmichthys nobilis)	1
River carpsucker (Carpiodes carpio)	29
Quillback (Carpiodes cyprinus)	26
White sucker (Catostomus commersoni)	20
Smallmouth buffalo (Ictiobus bubalus)	4
Bigmouth buffalo (Ictobius cyprinellus)	4
Black buffalo (Ictiobus niger)	* (1966)
Shorthead redhorse (Moxostoma macrolepidotum)	5
Blue catfish (Ictalurus furcatus)	1
Black bullhead (Ictalurus melas)	20
Yellow bullhead (Ictalurus natalis)	14
Channel catfish (Ictalurus punctatus)	38
Flathead catfish (Pylodictus olivaris)	10
White bass (Morone chrysops)	2
Green sunfish (Lepomis cyanellus)	68
Orangespotted sunfish (Lepomis humilis)	64
Bluegill (Lepomis macrochirus)	50
Bluegill X green sunfish hybrid	3
Spotted bass (Micropterus punctatus)	1
Largemouth bass (Micropterus salmoides)	46

Table 8 continued

White crappie (Pomoxis annularis)	14
Black crappie (Poxomis nigromaculatus)	4
Sauger (Stizostedion canadense)	1
Walleye (Stizostedion vitreum)	1
Freshwater drum (Aplodinotus grunniens)	8
NEKTONIC FISHES	**FREQUENCY (%)**
Central stoneroller (Campostoma anomalum)	63
Western silvery minnow (Hybognathus argyritis)	* (1967)
Brassy minnow (Hybognathus hankinsoni)	35
Plains minnow (Hybognathus placitus)	* (1941)
Golden shiner (Notemigonus crysoleucas)	15
Emerald shiner (Notropis atherinoides)	5
Ghost shiner (Notropis buchanani)	* (1941)
Bigmouth shiner (Notropis dorsalis)	80
Sand shiner (Notropis stramineus)	83
Topeka shiner (Notropis topeka)	1
Red shiner (Cyprinella lutrensis)	83
Redfin shiner (Lythrurus umbratilis)	13
Common shiner (Luxilus cornutus)	29
Bluntnose minnow (Pimephales notatus)	68
Fathead minnow (Pimephales promelas)	58
Bullhead minnow (Pimephales vigilax)	1
Creek chub (Semotilus atromaculatus)	79
Trout-perch (Percopsis omiscomaycus)	3
Mosquitofish (Gambusia affinis)	9
BENTHIC FISHES	
Speckled chub (Hybopsis aestivalis)	4
Silver chub (Hybopsis storieana)	4

Table 8 continued

Suckermouth minnow (Phenacobius mirabilis)	38
Stonecat (Noturus flavus)	1
Tadpole madtom (Noturus gyrinus)	* (1979)
Johnny darter (Etheostoma nigrum)	39
Blackside darter (Percina maculata)	18

OPPORTUNITIES FOR STREAM FISHERY CONSERVATION IN THE CHARITON RIVER WATERSHED

The following perspectives on problems and opportunities for watershed management will guide MDC management priorities and activities for the foreseeable future. We realize we are only one of many partners whose joint efforts will be needed to protect and restore stream ecosystem integrity in the Chariton River watershed.

MANAGING MDC RIPARIAN OWNERSHIPS

Stream Access Acquisition

MDC has purchased small tracts of land along streams in order to provide public access for recreation and to establish an ownership stake which may strengthen our position in resisting system-wide threats to riparian habitat integrity. Several opportunities exist to improve the stream access network within the Chariton River basin.

Particularly high quality riparian habitat exists near the confluence of the East Fork and Middle Fork of the Little Chariton River in southeastern Chariton County. Acquisition would conserve this rare habitat, and development would enable a 12-mile float of the Little Chariton from the confluence downstream to Lewis Mill Access.

Mussel Fork Creek in its unaltered lower reaches has excellent instream and riparian habitat, but access is limited to walk-in fishing at Mussel Fork Conservation Area. It would be desirable to have small craft access at river mile 30 and walk-in access near river mile 12.

Shoal Creek in eastern Putnam County contains several reaches of exceptional instream and riparian habitat, but there is no public access. It would be desirable to acquire an ownership stake on this stream and provide limited walk-in fishing access somewhere between river mile 13 and U.S. Highway 136.

Recreational potential is limited on the channelized portion of the Chariton River, but there is a gap in small craft access between Dodd Access (river mile 43) and Price Bridge Access (river mile 7). If canoeing and other small craft navigation becomes more popular on such water, intermediate points of access would be desirable.

Stream Access Development

Because of fiscal constraints, planned developments have not been completed on all existing stream access areas. Developments should be completed so citizens can experience the recreational opportunities that will build their individual commitment to helping preserve and restore streams in this watershed. As a matter of strategic priority, MDC should complete planned developments on the following areas (year of acquisition in parentheses) before acquiring additional areas:

Access Area Name	Stream	Development Need
Truitt (1972)	Chariton	Concrete boat ramp
Elmer Cook Memorial (1995)	Chariton	Concrete boat ramp
Keytesville (1993)	Chariton	Entrance road, 10-car parking area, concrete boat ramp
Price Bridge (1988)	Chariton	Entrance road, 10-car parking area, concrete boat ramp

<u>Site-Specific Stream Habitat Restoration</u>

Although stream ecosystem health is almost entirely dependent upon processes occurring upstream and downstream of any given ownership, Department of Conservation riparian areas should serve as models of good stream stewardship. In the Chariton River watershed, forested corridor deficiencies have been corrected at Rebel's Cove and Mussel Fork conservation areas. MDC has a unique opportunity to restore approximately one mile of original channel adjacent to a channelized reach of Mussel Fork Creek on the Mussel Fork Conservation Area, pending cooperation by a neighboring landowner and funding for equipment work and rock.

<u>Public Use Information</u>

Public use of Chariton River watershed streams is very low, largely because instream habitat has been so adversely affected by channelization and sedimentation. Still, there are remnant reaches that are scenic, support diverse aquatic communities, and have fair fishing.

MDC could increase public use and appreciation of Chariton River watershed streams by developing a brochure describing stream recreational opportunities. Such a brochure would include colored pictures, simple stream maps with mileages, access sites, and camping areas clearly marked, descriptions of other local attractions, and fishing opportunities/regulations. Statewide news releases and an article in the *Conservationist* magazine might also help to inform potential users of the opportunities awaiting them in the Chariton River watershed.

CONSERVATION OF AQUATIC COMMUNITIES

Statewide, the Department of Conservation is developing a long-term Resource Assessment and Monitoring program (RAM). The objective is to establish standardized sampling methods for several stream ecosystem attributes, especially biotic communities, that will allow scientists to provide an accurate, legally defensible portrayal of conditions and trends. Sampling will occur at random and fixed sites to allow statewide or individual watershed assessments. Information gathered from this effort may be used to prioritize watersheds for conservation.

Long-Term Fish Community Monitoring

Long-term monitoring to assess stream fish community trends has not been conducted in the Chariton River watershed. Extensive sampling within the RAM framework is not likely to occur for several years. Baseline fish data are absent for the Little Chariton River basin. In order to monitor trends in fish community composition and population levels, the Department of Conservation should conduct an initial fish community survey of the Little Chariton River basin, and perform follow-up surveys on approximate ten-year intervals of the Chariton River basin at a subset of sites randomly selected from among those surveyed during 1987-1994 (Table 8).

Fishery Management and Research Needs

Stream fish communities in the Chariton River watershed seem to be imbalanced. Surveys and angler reports reveal the existence of relatively few fish-eating predators (flathead catfish or walleye) but large numbers of insect-eating bottom feeders (channel catfish, river carpsuckers, common carp, and a variety of native minnow species). Non-game fishes are represented mostly by species tolerant of the shallow depths and shifting substrates caused by excessive watershed erosion and subsequent stream channel sedimentation. Shifting substrates dramatically reduce biological productivity, so in channelized streams the large populations of insect-eating fish are almost entirely dependent upon terrestrial inputs or whatever invertebrate production occurs on in-channel woody debris. There are not enough predatory fish to control the abundant insect-eating fish. Degraded habitat may be the main factor limiting predator abundance and thereby preventing ecosystem balance.

We know very little about the migration patterns and minimum habitat requirements of the key predator--flathead catfish. Also, we do not know if the relative scarcity of flathead catfish is due to overharvest under liberal regulations, illegal harvest, habitat deficiencies, or some combination of factors. We need basic research, starting with studies of flathead catfish movement and exploitation rate, in order to begin developing a broad range of strategies for effectively managing sport fishes in streams (e.g., regulation, stocking, and information/education in addition to habitat protection/restoration).

Monitoring Contaminants in Fish

Fish contaminant monitoring has been conducted every three years within the Chariton River watershed at Long Branch and Thomas Hill lakes (Little Chariton watershed) and at Prairie Hill on the Chariton River mainstem. Such monitoring should continue. Additionally, the Department of Conservation should work with the Department of Health to monitor mercury levels in flathead catfish – the only significantly harvested piscivore in basin streams.

Long-Term Mussel Community Monitoring

Most basin streams have an excessive bedload of shifting sand that is not conducive to the existence of a healthy mussel fauna. The only qualitative mussel survey conducted in the basin to date was on Mussel Fork Conservation Area in 1994. The Department of Conservation should assess mussel species diversity and abundance in streams on major conservation areas in the watershed, such as Rebel's Cove and Union Ridge.

SUPPORTING OTHER AGENCIES AND ORGANIZATIONS

The Missouri Department of Conservation works with many other governmental agencies and private conservation organizations in the process of managing stream resources. The following formal or traditional interactions are among the most significant in frequency and scope, and they should be continued:

Missouri Department of Natural Resources (DNR)

MDC assists DNR by periodically nominating pristine or otherwise valuable stream reaches for "Outstanding State Resource Water" status; recommending water quality standard classifications for stream reaches of special concern; and assisting in water pollution investigations whenever an event results in the loss of aquatic life. In such cases, MDC's role is to document the number of dead fish and other aquatic organisms and report to DNR the estimated value of animals lost according to formulas established by the American Fisheries Society. MDC should continue coordination with DNR in order to ensure efficient use of state government resources in the conservation of streams in the Chariton River watershed. In particular, MDC should sample stream fish communities in conjunction with DNR invertebrate monitoring at specific sites in sub-basin streams that may be impacted by the corporate hog producer, PSF-Contigroup.

Missouri Department of Health (DOH)

MDC assists DOH by periodically collecting fish from select streams and preparing tissue samples for analysis of pesticide and heavy metal contaminants. We cooperate with DOH in advising anglers about fish consumption. MDC should continue collecting tissue samples triennially from carp and bass in Little Chariton River reservoirs – Long Branch and Thomas Hill lakes – and from carp and flathead catfish in the Chariton River mainstem at Prairie Hill.

U.S. Army Corps of Engineers (COE)

MDC joins several other agencies in commenting to COE and DNR about activities in streams that require permit under Sections 404 and 401, respectively, of the federal Clean Water Act. COE requires a Section 404 permit for operators who propose to deposit or stockpile material in stream channels; and DNR requires a Section 401 permit for any activity that could significantly degrade water quality. MDC biologists help to disseminate information about stream-friendly sand and gravel removal practices to county commissions, contractors, and landowners.

MDC personnel are often the first agency representatives contacted by neighbors when individuals or public entities engage in what appear to be unpermitted and destructive practices in and along streams. Several incidents of Section 404 violation occur annually in the Chariton River watershed, prompting MDC biologists to assess impacts and recommend potentially acceptable terms of mitigation or restoration. However, only the COE or EPA (Environmental Protection Agency) can impose such requirements. MDC biologists should remain vigilant advocates for the interests of all riparian residents, upstream and downstream, who may be adversely affected by the activities of those few who knowingly violate Sections 404 or 401 of the Clean Water Act.

MDC recognizes that regulations are necessary to protect streams and their watersheds. Previous hopes that voluntary efforts alone would afford reasonable protection were unrealistic. Watershed management must be approached in a balanced, market-based manner that falls somewhere in the continuum between regulatory protection and voluntary conservation efforts.

Conservation Federation of Missouri (CFM)

MDC facilitates and promotes Stream Team, a program initiated by CFM that seeks to enlist volunteers in the stream conservation effort. As of October 2001, there were 28 Stream Teams registered in or bordering the Chariton River watershed. Of that total, 24 had not adopted a particular stream, but wanted to show their support in a variety of ways (8 from Kirksville, 6 from Macon, 4 from Moberly, and 6 from other rural communities).

Stream Teams who have adopted particular reaches of stream in the Chariton River watershed include the Truman State University Division of Science (Team #1780 - Chariton River and Big Creek); the Kirksville Alternative School (Team #1373 - Big Creek, Sugar Creek, and Hazel Creek); the Kirksville Tiger Cubs (Team #1588 - Sugar Creek); and Rick Gann of Callao (Team #1516 - Middle Fork Little Chariton River).

The most active Stream Team in the Chariton River watershed is the Family Farms Group (Team #714) based in Unionville. They have adopted various sections of Shoal Creek, Blackbird Creek, and Sandy Creek. Besides conducting extensive water quality monitoring in streams in the PSF-ContiGroup sub-basins, they have done riparian corridor tree plantings, stream bank stabilization, and litter pick-ups.

Greater citizen interest and volunteer effort will be needed for any significant stream improvements to occur within the Chariton River watershed.

ASSISTING CITIZEN-LED WATERSHED CONSERVATION EFFORTS

We are convinced that the watershed conservation approach will work only if there is widespread recognition that social, economic, and environmental values associated with streams are compatible. If that can be achieved, success will depend upon local initiatives to form diverse partnerships of committed groups and individuals under the leadership of landowners and other local interests.

Watershed restoration is essential to restoring the primary processes that create and maintain fish habitat in healthy stream ecosystems. The most critical and affordable first step in watershed restoration is *passive* restoration--the cessation of human activities that are causing degradation or preventing recovery (e.g., channelization, riparian corridor clearing, indiscriminate sand dredging, and streamside livestock grazing). *Active* restoration (e.g., tree revetments and riparian corridor tree plantings) should be considered only if recovery fails to occur over a reasonable period of time while using *passive* techniques (e.g., livestock exclusion and natural regeneration of woody plants). Because restoring degraded stream ecosystems is more costly and risky than simply protecting fully functional sites, we suggest that protecting and preserving intact riparian ecosystems be the highest priority of watershed-scale restoration efforts.

Protecting Healthy Riparian Corridors -- Stream Stewardship

A program aimed at conserving healthy forested stream corridors by placing them into permanent easements using Stream Stewardship Agreements (SSA) was piloted in Marion County between 1992 and 1995. That effort resulted in the permanent conservation of 88 acres of 100- to 200-foot-wide forested corridor on four ownerships along 2.4 miles of the South Fabius River. The infrastructure now exists for MDC to facilitate the permanent conservation of healthy stream corridors, but measurable impact will require funding from a variety of sources. Enrollment of streamside lands in continuous CRP (Conservation Reserve Program) will not substitute for enrollment in SSA or other permanent easement programs because healthy forested corridors cannot be enrolled in CRP, and land enrolled in CRP buffers may be converted back to crop production at the end of short-term contract periods (10 to 15 years). However, CRP may provide a viable first step for landowners on the long path toward converting eroding floodplain cropfields or pastures into functional riparian corridors.

Passively Restoring Mildly Degraded Riparian Corridors -- Livestock Exclusion

The activity of livestock can degrade physical aspects of water quality by causing streambank erosion, resulting in turbidity and stream channel sedimentation. Chemical aspects of water quality can be degraded by livestock waste products. In some situations, streambank healing, corridor reforestation, and improved water quality can be achieved simply by excluding livestock from stream corridors. For fencing to be attractive to landowners, an alternative source of livestock water must be available (e.g., upland ponds, or shallow floodplain wells tapped by nose pumps or solar-powered pumps). Some landowners may have potential alternative water sources on their property, but may not have the money or the technical support to adopt new technology. Cost-share money for fencing and alternative watering may be available through a variety of federal and state programs. Department of Conservation biologists are available to assist landowners in selecting a practical alternative to instream watering of livestock.

Actively Restoring Moderately to Severely Degraded Corridors

A 75% cost-share program for stream restoration practices (e.g., tree revetments and riparian corridor tree plantings) was piloted by MDC in Sullivan County between 1990 and 1993. The program had no participants, despite the fact that 41% of county landowners were aware of monetary incentives. The program lacked many elements critical to the adoption of innovation in agricultural communities, including relative economic advantage and value compatibility. The problems and their solutions were often complex, and MDC assistance had stipulations (ten-year forested corridors 50 to 100 feet wide) which many landowners were unwilling to accept. The lesson learned? Most rural northeastern Missouri landowners may not be prepared to make the personal sacrifices in time, money, and values needed to restore moderately to severely degraded stream habitats on their property. Available funds might be better spent first on protecting healthy riparian corridors and passively restoring those which are only mildly degraded.

<u>Educating Future Watershed Stewards</u>

Educating our youth about the complexities of watershed processes and problems will be critically important in advancing the science and art of watershed conservation. Today's youth are more technologically oriented and therefore more likely than their predecessors to embrace complex information systems. And because of changes in classroom teaching strategy, they are more likely to work effectively in problem-solving teams once they become adults.

MDC has found that students in and around the 6th grade are particularly receptive to messages about stream conservation because they can understand most concepts and evaluate new ideas with relatively little social or cultural bias. Classroom teachers may find helpful lesson-planning materials in Missouri's *Stream Team Curriculum*, a watershed-based curriculum developed by teachers, for teachers, that will help students to meet environmental education goals in the Missouri Performance Standards.

Junior high and high school students in vocational agricultural programs may also be prime candidates for watershed conservation education because they are more likely than others to become landowners and other important members of rural communities. Involving these students in hand-on stream conservation activities may contribute to the creation of a new generation of landowners committed to stream ecosystem integrity.

CITIZEN PRIMER TO LEADERSHIP IN WATERSHED CONSERVATION

This section is included as a starting point for citizens who wish to lead or contribute significantly to watershed-based stream conservation efforts. The proliferation of information about watershed planning can be intimidating to individuals or groups who have decided that they have a problem they wish to fix. To facilitate that process, we recommend that potential leaders and contributors to watershed conservation efforts first familiarize themselves with a summary of lessons learned over the past decade about what works and what does not. The list in Table 9 combines the *Top 10 Watershed Lessons Learned* published by the United States Environmental Protection Agency (1997) with the ten principles for effectively coordinating watershed-based programs listed by Turner (1997). These documents are highly recommended reading.

Citizens determined to develop and implement watershed conservation plans can also obtain critically important information about organizing and funding such projects by visiting the Internet websites listed in Table 10. These sites contain convenient links to many other sites that, in the aggregate, provide enough information about the watershed conservation process to help any individual or group get started in an informed and effective manner.

Table 9. Ten useful watershed conservation principles.*

1) For the watershed conservation approach to work, there must be widespread recognition that social, economic, and environmental values are compatible.

2) Successful watershed conservation requires the formation and support of diverse partnerships under the authority of landowners and other local interests.

3) Leadership is critical in the watershed approach to conservation.

4) A good coordinator is key to successful watershed conservation projects.

5) The best plans have clear visions, goals, and action items.

6) Good tools (planning guides, technical assistance, and funding sources) are available to help watershed groups achieve their goals.

7) It is important to start small and demonstrate success before working on larger scales, celebrating even minor success as it occurs.

8) Plans are most likely to succeed if implemented on a manageable scale.

9) Public awareness, education and involvement are keys to building and maintaining support for watershed conservation efforts.

10) Measuring and communicating progress is essential to the success of watershed conservation efforts.

* – For EPA Publication 840-F-97-001, call the National Center for Environmental Publications and Information at 1-800-490-9198.

Table 10. Internet websites containing important information for Missouri watershed planners.

Conservation Technology Information Center

http://www.ctic.purdue.edu/

CTIC is a non-profit, public-private partnership equipping agriculture with realistic, affordable, and integrated solutions to environmental concerns.

EPA Watersheds and Wetlands

http://www.epa.gov/OWOW/

This site, created and maintained by the federal Environmental Protection Agency, is a good starting point for information about watersheds and water quality.

Funding Sources for Watershed Conservation

http://www.epa.gov/OWOW/watershed/wacademy/fund.html#forword

This site contains a comprehensive listing of private and public sources of watershed project funding, with links to many individual sites and references to many useful publications.

Know Your Watershed

http://www.ctic.purdue.edu/KYW/KYW.html

This initiative works to encourage the formation of local, voluntary partnerships among all watershed stakeholders for the purpose of developing and implementing watershed plans based upon shared visions of the future.

Missouri Stream Team

http://www.rollanet.org/~streams/

This site provides specific information on activities, programs, and funding sources for volunteers who have adopted Missouri streams or otherwise committed themselves to conserving stream resources in Missouri.

Missouri Watershed Information Network

http://outreach.missouri.edu/mowin/

This site serves as a clearinghouse for information about Missouri watersheds.

River Network

http://www.rivernetwork.org/wag.htm

This organization supports development of local watershed partnerships through its Watershed Assistance Grants program. They seek to fund projects in diverse geographies that have demonstration value on a national scale.

FISHING AND FLOATING STREAMS IN THE CHARITON RIVER BASIN

Fish Species and Fishing Regulations

Fish species in streams of the Chariton River basin are those common to all of northern Missouri. The most commonly sought-after fish is undoubtedly the channel catfish. Flathead catfish are also popular. Other fish common to the basin and routinely caught by anglers include: drum, common carp, and gar. Walleye, spotted bass, and white crappie are less common but available in select locations.

Nothing could be more peaceful than floating or wading down a secluded stream, probing for a willing fish with pieces of worm, bits of liver or a frog. There is very little fishing pressure on any stream in the basin, so solitude is almost assured. The regulations chart below is specific to the streams in north Missouri, and should be helpful to all anglers.

The Chariton River

Because water level often is dependent upon releases from Lake Rathbun in Iowa, anyone planning an extended fishing trip will want to call Rathbun Dam for current water release information (641/647-2464 or http://www.nwk.usace.army.mil/rathbun/rathbun_home.htm and visit the Daily Lake Information section). It takes several days for the river in Missouri to change in response to changing releases at Rathbun, and one could be left with unexpected low or high flows. The river is navigable for its entire length in Missouri.

Fishing and floating on the Chariton River is best above Highway 136, where it has not been straightened. Deep water and woody cover is more common here. Channel catfish, flathead catfish, carp, drum, gar and the occasional walleye that has escaped from Lake Rathbun are caught here. Be prepared to drag a canoe or small jon boat over or around occasional piles of woody debris in the channel.

The river downstream of Highway 136 tends to be uniformly wide and shallow, without a lot of cover needed to hold fish. Relatively deep water may be found around bridge piers, piles of woody debris, or on the outside edge of a bend.

Mussel Fork

Though not immune from channelization, this stream has not been severely altered and has a good amount of woody cover, especially through the Mussel Fork Conservation Area. Spotted bass, stocked in the 1960's, are available but not abundant. Other species of fish common to the basin can also be found, but Mussel Fork is best known as a good stream for channel catfish.

Little Chariton

Though least impacted by channelization, the streams in this basin have been impacted by past coal mining operations and the impoundment of both Long Branch Lake (East Fork Little Chariton River) and Thomas Hill Reservoir (Middle Fork Little Chariton River). Fish common in other streams of the basin are also present here. The East Fork below Long Branch Lake occasionally yields nice catches of walleye which have escaped from the lake.

Tributary Streams

Smaller streams can be productive when fished “on the rise” at times when channel or flathead catfish are making migratory movements. Generally though, these streams are important to the basin fishery mostly as a fish nursery area.

STREAM FISHING REGULATIONS NORTH OF THE MISSOURI RIVER

FISH SPECIES	DAILY LIMIT	LENGTH LIMIT	FISHING SEASON
Channel and Blue Catfish (combined)	**10**	**None**	**All Year**
Flathead Catfish	**5**	**None**	**All Year**
Black Bass (largemouth, spotted, and smallmouth bass combined)	**6**	**12"**	**All Year**
White Bass and Hybrid Striped Bass (combined)	**15**	**No more than 4 over 18"**	**All Year**
Walleye and Sauger (combined)	**4**	**15"**	**(See Below [A])**
White and Black Crappie (combined)	**30**	**None**	**All Year**
Paddlefish (Spoonbill)	**2**	**24" [B]**	**3/15 to 4/30**
All other fish combined	**50 [C]**	**None**	**All Year**
Bullfrogs and Green Frogs (combined)	**8**	**None**	**Sunset 6/30 through 10/31**

[A] From February 20 through April 14, walleye and sauger on streams other than the Mississippi and Missouri rivers may be taken and possessed only between 6:30 a.m. and 6:30 p.m. CST.
[B] Paddlefish length is measured from the eye to the fork of the tail.
[C] Except daily limit is only 20 fish combined if taken by methods other than pole and line, trotline, throwline, limb line, or bank line.

POSSESSION LIMIT IS TWICE THE DAILY LIMIT. ONLY THE DAILY LIMIT MAY BE POSSESSED WHILE ON THE WATER OR STREAM BANKS. HEAD AND TAIL MUST REMAIN ATTACHED TO ALL FISH WITH LENGTH LIMITS WHILE ON THE WATER, OR UNTIL CHECKED BY A CONSERVATION AGENT.

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} Celcius 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 hierarchial 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.

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

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

<u>United States Geological Survey (USGS):</u> 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.

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

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

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