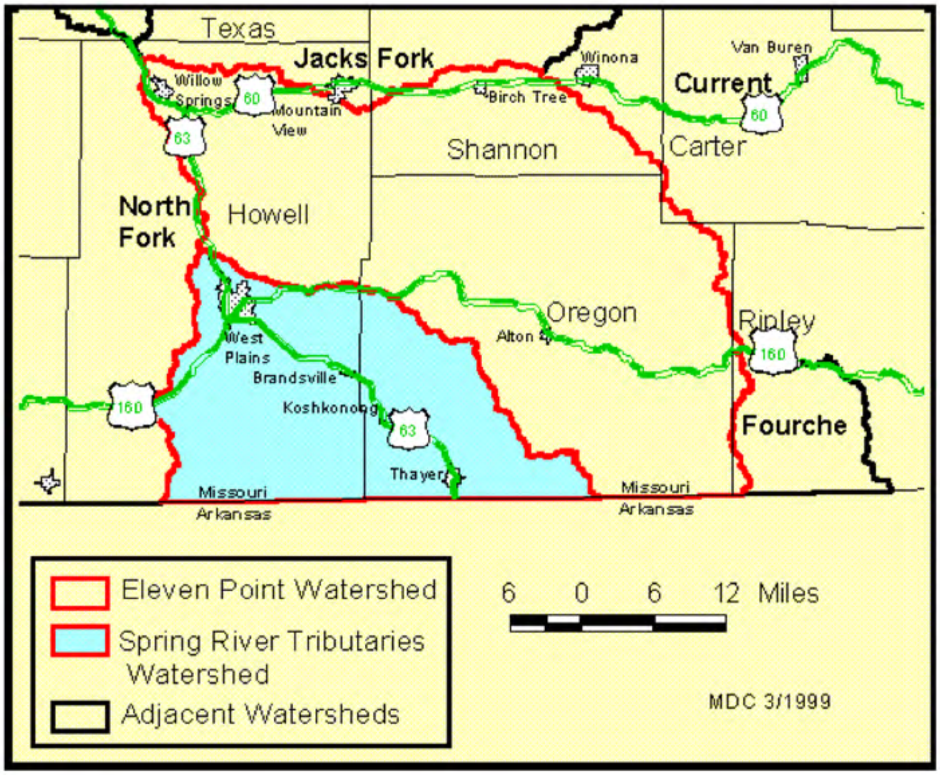

Spring River

Watershed and Inventory Assessment, March 2000
Prepared by Thomas Wilkerson Jr., Fisheries Biologist
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Table of Contents

Executive Summary

The Spring River Tributaries Watershed is located southwest of the Eleven Point Watershed and is bounded to the west by the North Fork of the White River Watershed. For the purposes of this report, the Missouri/Arkansas state line represents the southern boundary of the watershed in Missouri. The Spring River Tributaries Watershed in Missouri occupies 480.3 square miles of the Salem Plateau Subdivision of the Ozark Plateau Physiographic Region. It constitutes approximately 39% of the total area of the Spring River Watershed with the remainder in Arkansas and of which the Eleven Point River is also a tributary. The watershed occupies parts of Howell and Oregon Counties in Missouri. Caves, springs, losing streams, and sinkholes are common in the watershed. This is due to the highly karst nature of its topography. The watershed consists of three major streams which generally flow in a south to southeast direction and cross the Missouri/Arkansas border to join the Spring River in Arkansas. These streams include the South Fork of the Spring River, Myatt Creek, and the Warm Fork of the Spring River. The longest of these tributaries in Missouri is the Warm Fork of the Spring River which originates in the headwaters as Howell Creek within the city limits of West Plains, Missouri. From there, it generally flows in a southeast direction for approximately 28 miles where it then turns in a general southern direction and flows for another 10 miles before crossing the Missouri/Arkansas border. The Warm Fork becomes the Spring River at the confluence of Mammoth Spring at Mammoth Spring, AR.

Land use/land cover within the Spring River Tributaries Watershed primarily consists of grassland/cropland (49.1%) and forest/woodland (48.3%). Urban areas make up 2.4% of the watershed. The watershed has two urban areas with a population of over 1,000 persons. These are Thayer, Missouri (population 1,996) and West Plains, Missouri (population 8,913). West Plains is the largest population center in South Central Missouri. It is also a hub of transportation. Two U.S. highways and one rail line intersect the city of West Plains and thus the watershed. The population density of the watershed is approximately 43 persons per square mile. Approximately 2% of the watershed is in public ownership, nearly all of which is managed by the Missouri Department of Conservation.

Little water quality or hydrologic data exists for the Spring River Tributaries Watershed. However existing data indicate that high fecal coliform levels, nutrient loading, and the potential disturbance of sediment and gravel budgets are the most severe threats to surface water quality. Ground water has also experienced water quality problems relating to turbidity and high bacteria counts. It is from the ground water system that nearly all water for domestic use is obtained within the watershed. Poor land use practices, gravel dredging, large numbers of cattle, and runoff as well as sewage effluent associated with developed and urbanized areas all contribute to water quality problems of both surface water and ground water. There are two municipal wastewater discharges within the watershed. Nine additional National Pollution Elimination System discharges are also located within the watershed.

Riparian corridor land cover/land use was used as an indicator of stream habitat condition within the Spring River Tributaries Watershed. Riparian corridor land cover/land use within the watershed consists of slightly more forest/woodland (49.8%) than grassland/cropland (48.1%). The Upper Howell Creek 14 Digit Hydrologic Unit has the highest percentages of grassland/cropland and urban land use at 60.1% and 11.4% respectively. For the most part, there have been no significant channel alterations within the watershed.

Some channel alterations undoubtedly have occurred in areas of the upper portion of Howell Creek and some of its tributaries in and around West Plains due to urban expansion and

development. However, it is difficult to determine the time and extent of these alterations. Small channel alterations have probably occurred on private property and also from road and bridge construction. Since 1995 there have been fourteen 404 permitted operations within the watershed. Seven of these have involved bridge work.

The biotic community of the Spring River Tributaries Watershed is diverse. Since 1963 forty six species of fish have been collected within the watershed. In addition, 5 species of mussels and 8 species of crayfish have been collected within the watershed. Several species of sport fish occur within the watershed including shadow bass, smallmouth bass, and largemouth bass. In addition, a total of 39 "species of conservation concern" are known to occur within the watershed. These include two fish species, one mussel species, and three crayfish species.

The management goals, objectives, and strategies for the Spring River Tributaries Watershed were developed using information collected from the Spring River Tributaries Watershed Assessment and Inventory (WAI) and direction provided by the MDC Strategic Plan, and the Fisheries Division Five Year Strategic Plan (1995-2000). Objectives and strategies were written for in-stream and riparian habitat, water quality, aquatic biota, and recreational use. All goals are of equal importance. These goals include:

1. Improve riparian and aquatic habitats in the Spring River Tributaries Watershed,
2. Improve surface and ground water quality and quantity in the Spring River Tributaries Watershed,
3. Maintain the abundance, diversity, and distribution of aquatic biota at or above current levels while improving the quality of the sport fishery in the Spring River Tributaries Watershed,
4. Increase public awareness and promote wise use of aquatic resources in the Spring River Tributaries Watershed.

The attainment of these goals will require cooperation with private landowners, other divisions within the Missouri Department of Conservation, as well as other state and federal agencies.

Location

The Spring River Tributaries Watershed is located southwest of the Eleven Point Watershed and is bounded to the west by the North Fork of the White River Watershed. For the purposes of this report, the Missouri/Arkansas state line represents the southern boundary of the watershed in Missouri.

The Spring River Tributaries Watershed in Missouri occupies 480.3 square miles. It constitutes approximately 39% of the total area of the Spring River Watershed http://www.epa.gov/surf/hucinfo/110100010 with the remainder in Arkansas and of which the Eleven Point River is also a tributary. The watershed occupies parts of Howell and Oregon counties in Missouri. It consists of three major streams which generally flow in a south to southeast direction and cross the Missouri/Arkansas border to join the Spring River in Arkansas. These streams include the South Fork of the Spring River, Myatt Creek, and the Warm Fork of the Spring River (Figure Bk01). The longest of these tributaries in Missouri is the Warm Fork of the Spring River which originates in the headwaters as Howell Creek within the city limits of West Plains, Missouri. From there, it generally flows in a southeast direction for approximately 28 miles where it then turns in a general southern direction and flows for another 10 miles before crossing the Missouri/Arkansas border. The Warm Fork becomes the Spring River at the confluence of Mammoth Spring at Mammoth Spring, AR.

The Spring River Tributaries Watershed has two cities with a population of over 1,000 persons. These are Thayer, Missouri (population 1,996) and West Plains, Missouri (population 8,913) (MSCDC 1997). West Plains is the largest population center within a 100 mile radius in Missouri. It is also a hub of transportation. Two U.S. highways and one rail line intersect the city of West Plains and thus the watershed (Figure Bk02).

Unless otherwise noted, the information presented in this document refers only to the Spring River Tributaries Watershed in Missouri.

Figure Bk01.

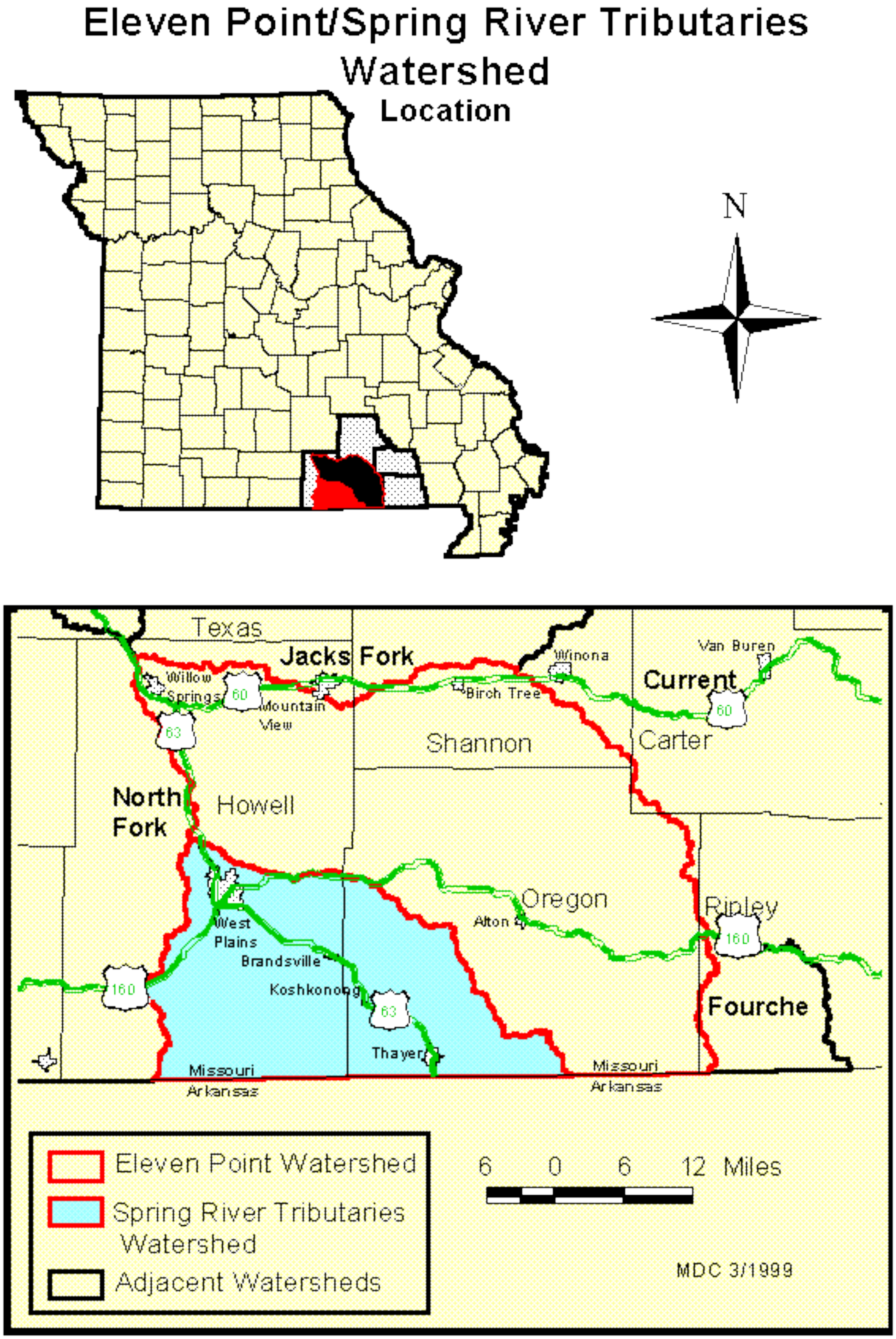
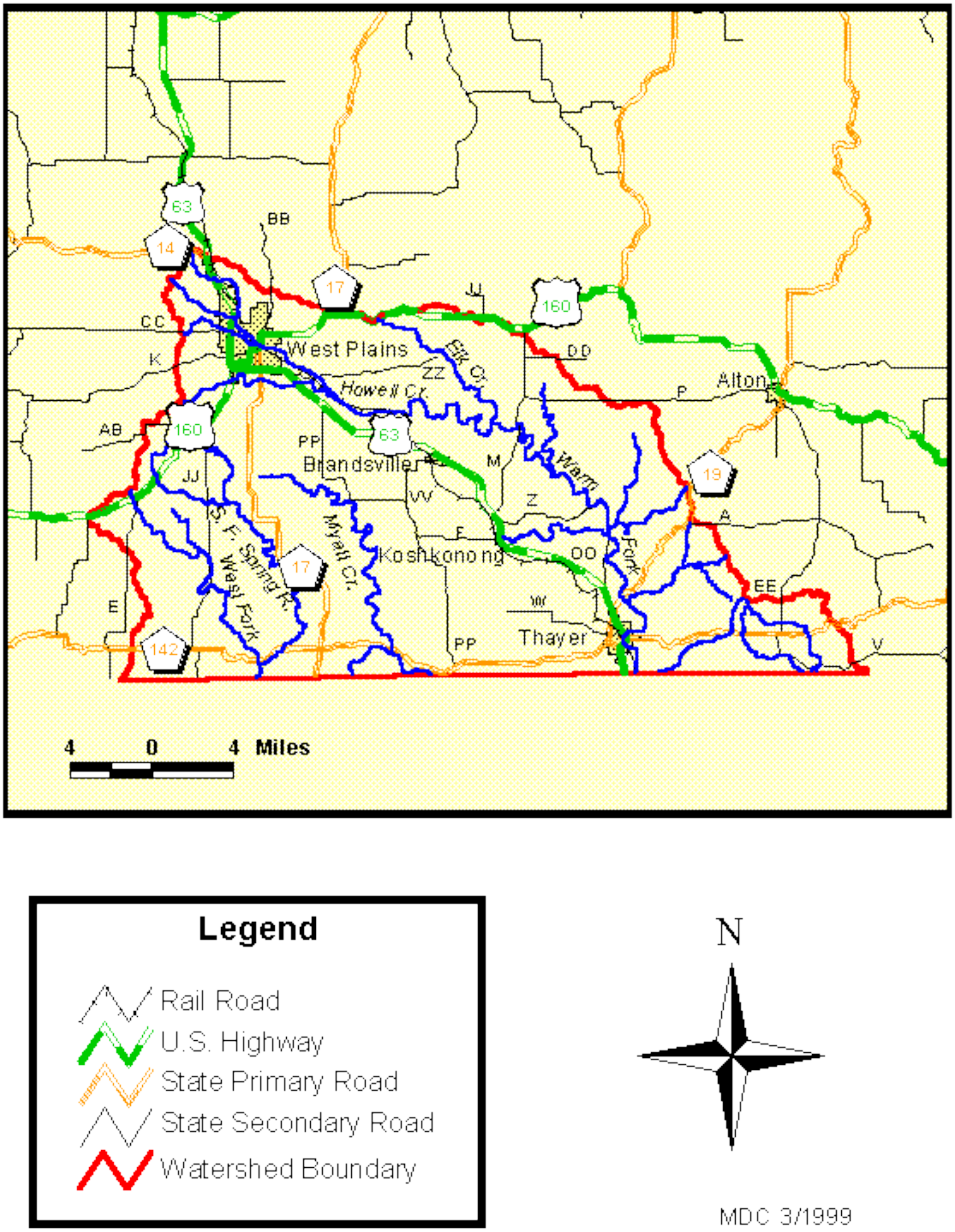

Eleven Point/Spring River Tributaries
Watershed
Location
N
Texas
Jacks Fork
Winona
Van Buren
Willow Springs
60
Mountain View
Birch Tree
Current
60
63
Shannon
Carter
North Fork
Howell
Oregon
Ripley
Alton
160
West Plains
Brandsville
Koshkonong
160
63
Fourche
Thayer
Missouri
Arkansas
Missouri
Arkansas
Eleven Point Watershed
Spring River Tributaries Watershed
Adjacent Watersheds
6 0 6 12 Miles
MDC 3/1999

Figure Bk02.

Spring River Tributaries Watershed

Infrastructure



Geology/Geomorphology

Physiographic Region

The Spring River Tributaries Watershed lies within the Salem Plateau Subdivision of the Ozark Plateau. The Salem Plateau is a heavily dissected plateau with upland elevations of between 1,000 and 1,400 feet (MDNR 1986). Local relief on the uplands is between 100 to 200 feet. In areas of deeply intrenched valleys, local relief ranges between 200 to 500 feet. Elevations within the Spring River Tributaries Watershed range between 1,200 feet above sea level in the uplands to less than 500 feet above sea level in the lower portions of the watershed within Missouri, specifically the Warm Fork of the Spring River at the state line.

Geology

The surface of the Spring River Tributaries Watershed occurs almost entirely within Jefferson City Dolomite. The only exception to this is a two mile section of the Warm Fork occurring within the sandstone and cherty dolomite of the Roubidoux Formation which underlies the Jefferson City Formation (Figure Ge01) (MSDIS 1998 and MDNR 1994). Due to the nature of the surface geology of the watershed as well as climatic conditions, there are many karst features present here including sink holes, losing streams, and springs (MDNR 1986 and MDNR 1994). The two most prominent karst features within the watershed are the Grand Gulf (Missouri), and Mammoth Spring (Arkansas). The Grand Gulf, part of Grand Gulf State Park, is a large sinkhole into which Bussel Branch, a third order stream, drains. Successful dye traces have shown that much of this flow resurfaces at Mammoth Spring in Arkansas which has an average discharge of 300 cfs making it the 2nd largest spring in the Ozarks (MDNR 1994). This is despite the fact that streams of the watershed do not incise the Gasconade Dolomite Formation which is the top formation of the three formations in which most of the largest springs in Missouri occur (MDNR 1994; Vineyard and Feder 1974).

Soils

The Spring River Tributaries Watershed occurs within the Ozark Soils Region. Allgood and Persinger (1979) describe the Ozark Soils Region as "cherty limestone ridges that break sharply to steep side slopes of narrow valleys. Loess occurs in a thin mantle or is absent. Soils formed in the residuum from cherty limestone or dolomite range from deep to shallow and contain a high percentage of chert in most places. Some of the soils formed in a thin mantle of loess are on the ridges and have fragipans, which restrict root penetration. Soil mostly formed under forest vegetation with native, mid-tall and tall grasses common in open or glade area."
The following is a list of soil associations found in the Spring River Tributaries Watershed in Missouri: Lebanon-Hobson-Clarksville, Captina-Macedonia-Doniphan-Poynor, Captina-Clarksville-Doniphan, Wilderness-Clarksville-Coulstone, Hartville-Ashton-Cedargap-Nolin (alluvial), (Allgood and Persinger 1979).

Stream Mileage, Order and Permanency, Springs

Using United States Geological Survey (USGS) 7.5 minute topographic maps, a total of 77 third order and larger streams were identified within the Spring River Tributaries Watershed within Missouri (Table Ge01, Figures Ge02, and Ge03). These streams account for approximately 392 stream miles. Of the 77 third order and larger tributaries within the watershed, 54 are third order, 16 are fourth order, 5 are fifth order, and 2 are sixth order. Table Ge02 shows length of stream per order for fourth order and larger streams within the watershed.

Drainage areas have been determined from digital raster graphic (drg) versions of USGS 1:100,000 and 1;24,000 scale topographic maps. The drainage area of the Spring River Tributaries Watershed in Missouri is 307,200 acres or 480 square miles. The watershed has been divided into six subwatersheds (not to be confused with the 14 digit hydrologic units or the drainage sections which are used in this document for display purposes) based on drainage areas accounting for > 5% of the total drainage area of the Spring River Tributaries Watershed (Figure Ge04). The Warm Fork Subwatershed is the largest subwatershed within the Spring River Tributaries Watershed. It encompasses a total of 265 square miles and includes most of the major populated places within the watershed including the cities of West Plains and Thayer, Missouri.

Using United States Geological Survey (USGS) 7.5 minute topographical maps, the extent of permanent and intermittent flow has been determined for third order and larger streams within the Spring River Tributaries Watershed. (Table Ge03, Figure Ge02, and Ge03). Of the 392 miles of third order and larger streams, 99.8 miles (25%) have permanent flow. The Warm Fork of the Spring River has the longest length of permanent stream at 22.6 miles. Spring Creek below Arrowhead lake has the highest percentage of permanent stream versus total length at 100 percent.

In an effort to further delineate stream flow as well as the cold water resource within the watershed, stream crossing temperature checks were performed during the summers of 1996, 1997, and 1998 by Missouri Department of Conservation Ozark Region Fisheries personnel. Results from this study generally corresponded with the USGS 7.5 minute topographical maps with a few exceptions. One site on Howell Creek below Big Grassy Creek went completely dry in 1997. However, a site above and below had permanent pools for all years. Another notable exception is the fact that permanent water appears to exist in some headwater streams within the watershed which were previously shown to be intermittent on USGS maps. Two examples of this are the North Fork of Howell Creek and Galloway Creek (Legler, personal communication). Flows from both streams are eventually lost to the groundwater system. These represent somewhat unique features given their headwater characteristics in addition to the fact that they exist in an area highly influenced by karst topography. In order to fully appreciate the significance of these small reaches of permanent headwater streams further study will be required. Figure Ge05 shows the remaining flow data including other additional sites with permanent flow. It is important to note that sites which were found to be dry in a single year were not checked in proceeding years. Additionally, sites found to be dry the first year are not included in Figure Ge05.

The karst nature of the Spring River Tributaries Watershed is evident in the amount of losing streams within the watershed. There are 78.5 miles of stream within the watershed which are designated as losing streams by MDNR (1996) (Table Ge04). This is important to note when considering potential point and nonpoint pollution effects not only within the immediate watershed, but also on the groundwater system and thus well systems as well as other watersheds. Dye traces conducted within the watershed and adjoining watersheds by various state and federal agencies as well as one private individual have shown that much of the water lost to the ground water network in the watershed resurfaces at Mammoth Spring at the head of the Spring River in Arkansas (MDNR 1995, 1996). Two dye traces which had injection points outside the watershed also were recovered at Mammoth Spring (Figure Ge06). This illustrates the point that surface ground water system boundaries do not always coincide with surface watershed and subwatershed boundaries.

There are 17 named springs within the Spring River Tributaries Watershed as determined by data obtained from United States Geological Survey (USGS) Geographic Names Information System (GIS) Database (Table Ge05 and Figure Ge07). The only springs within the watershed listed by Vineyard and Feder (1974) are Lost Spring and Mammoth Spring in Arkansas. Lost Spring has a discharge of .02 cfs (13,000 gallons/day), while Mammoth Spring, the second largest spring in the Ozarks has a discharge of 240 cfs (155,000,000 gallons/day). Little information regarding flow rates, chemical characteristics, or recharge area appears to be available relating to the remaining springs. However, some of these springs within the watershed are believed to have significant flow. The Warm Fork receives enough spring influence below Warm Fork Spring to be designated for Cold-Water Sport Fishery by the Missouri Department of Natural Resources (MDNR 1996). Data from long term temperature recorders (thermographs) indicate significant spring influence in other stream reaches as well (Figure Hc02 and Hc03). Given the influence on aquatic habitat demonstrated by some springs as well as the karst nature of this watershed, these springs represent a significant characteristic of the subwatershed and should be studied in more depth.

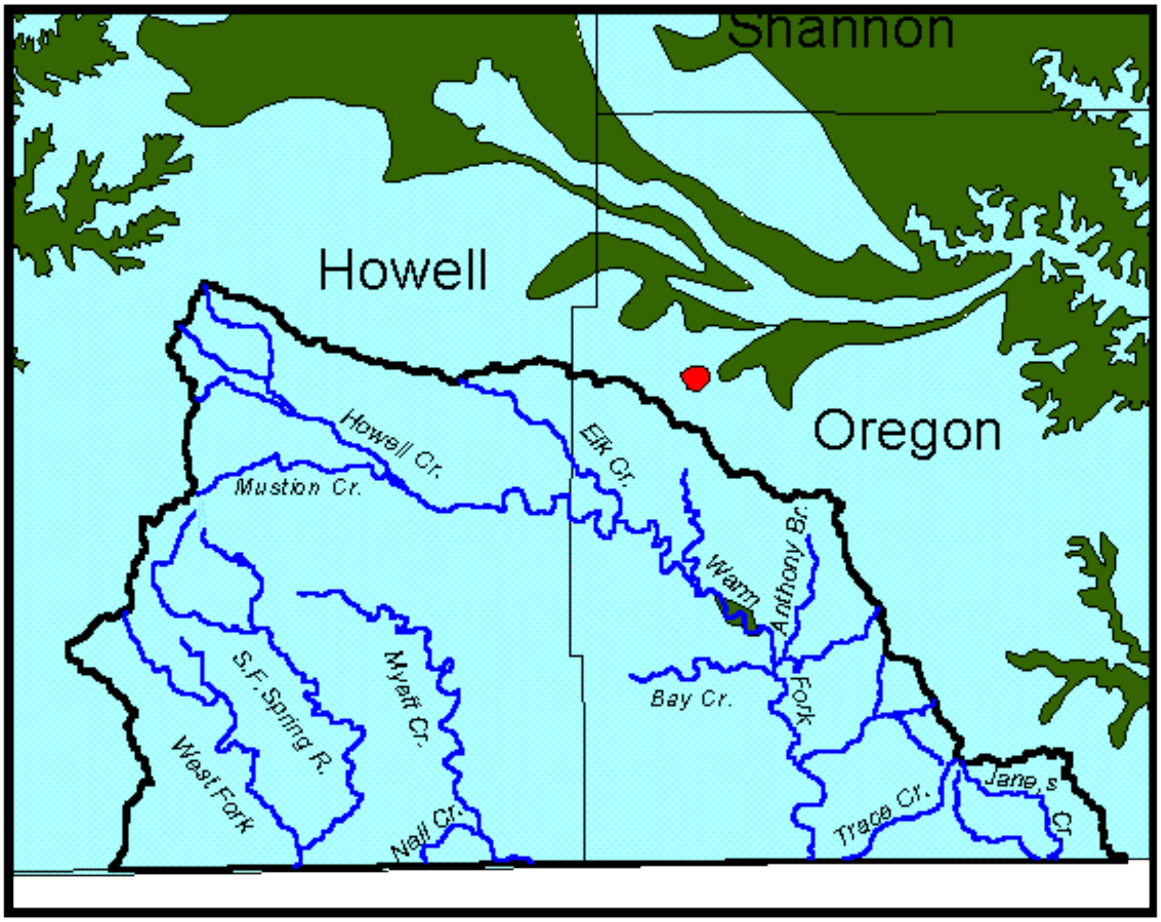
Channel Gradient

Gradient Plots were digitized from 7.5 minute USGS topographical maps for all fourth order and larger streams within the Spring River Tributaries Watershed in Missouri (Table Ge06). Composite gradient graphs were generated for fifth order and larger streams within the watershed. The Warm Fork of the Spring River/Howell Creek (6th order) have the lowest overall stream gradient at approximately 11 feet/mile; while stream EPW070 (4th order) has the highest overall stream gradient at approximately 79 feet/mile.

Figure Ge01.

Spring River Tributaries Watershed

Geology



Legend

Watershed Boundary

County Boundary

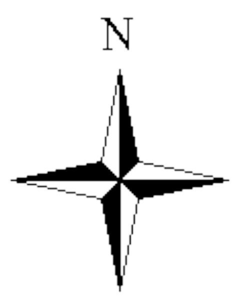
Geology*

Ordovician Dolomite

Mississippian Limestone

Ordovician Sandston/Dolomite

*Based on digitized version of 1979 1:500,000 scale state geologic map Missouri Spatial Data Information Service (MSDIS 1998).

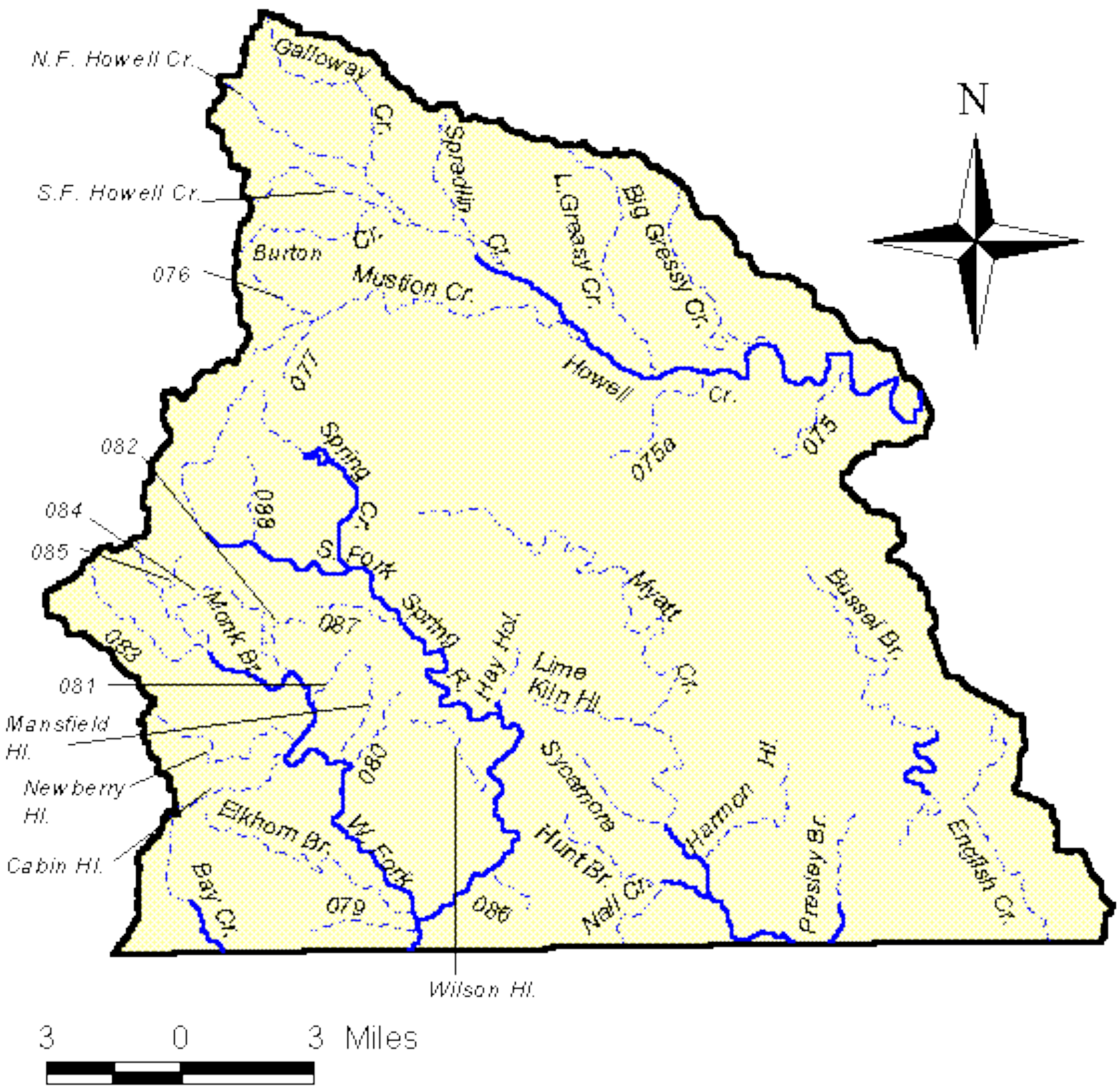


MDC 3/1999

Figure Ge02.

Spring River Tributaries Watershed

West Drainage Section
Third Order and Larger Streams



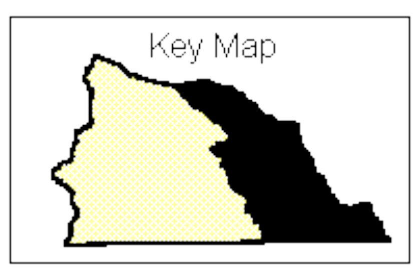
Legend

Permanent Stream*

Intermittent Stream*

Label: Br.=Branch, Cr.=Creek, Hl.=Hollow

*Based on USGS 7.5 minute topographical maps.



MDC 3/1999

Figure Ge03.

Spring River Tributaries Watershed
East Drainage Section
Third Order and Larger Streams

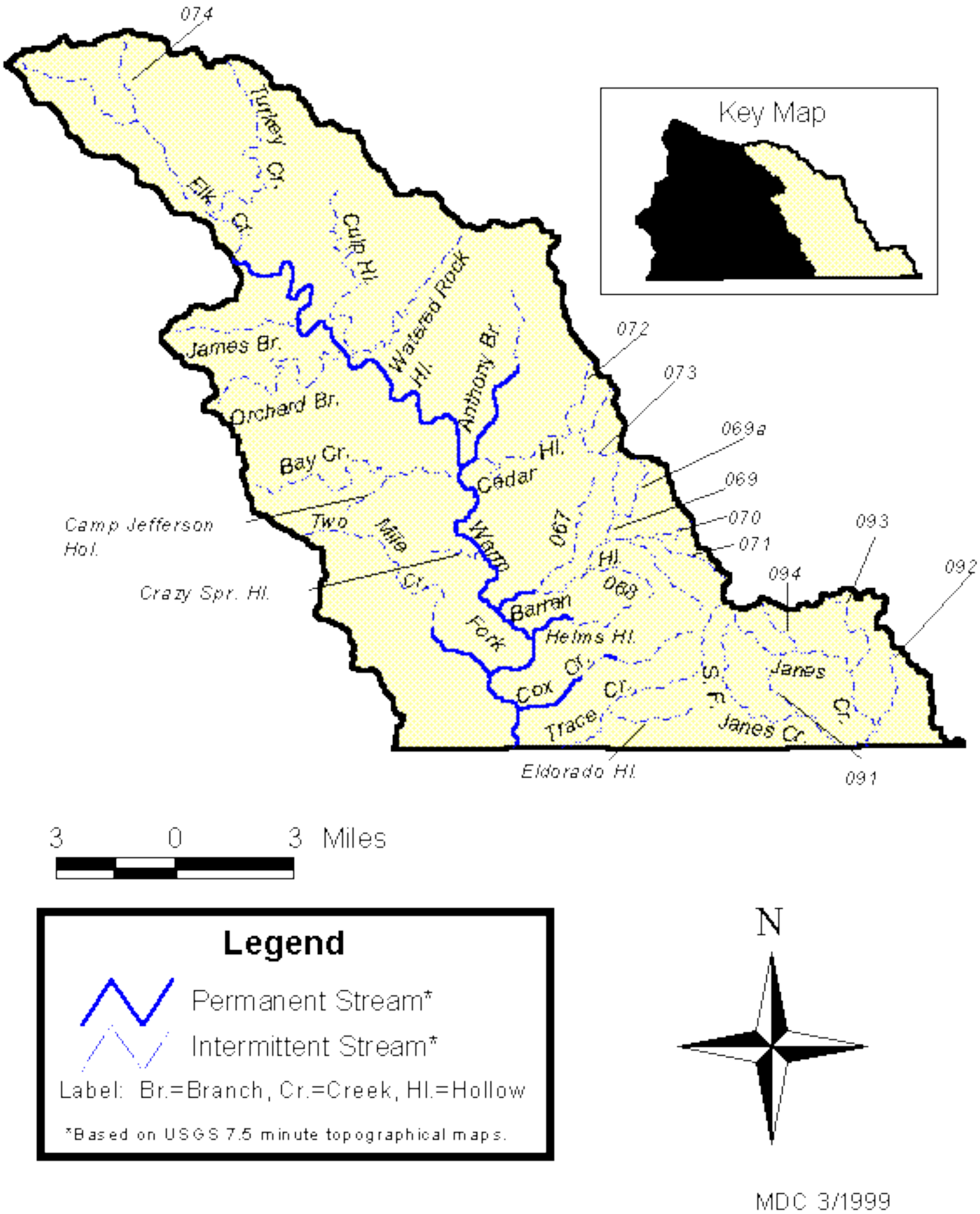
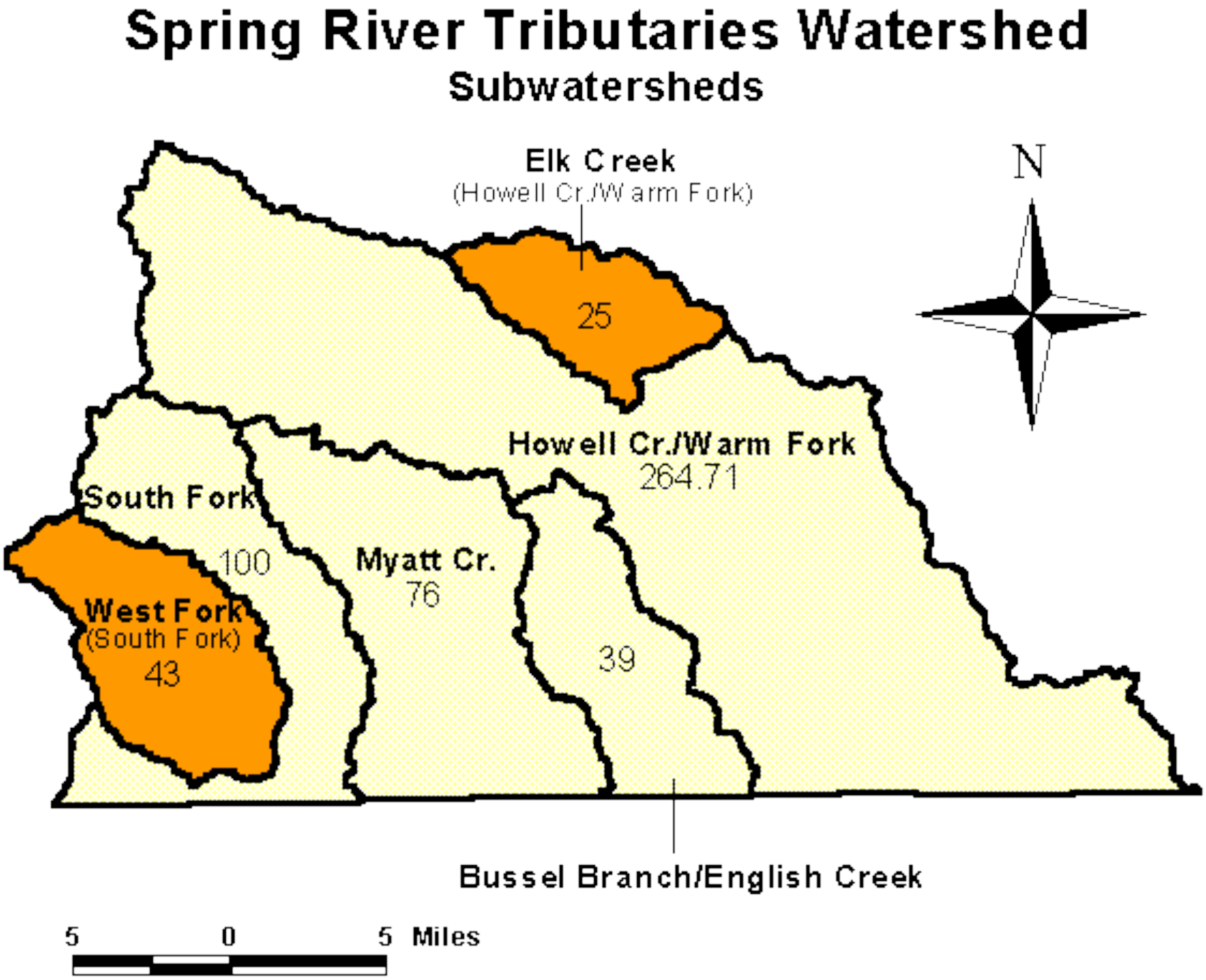


Figure Ge04.



Shaded areas indicate that subwatershed is a part of larger subwatershed (indicated in parenthesis) and included in estimated drainage area of larger subwatershed. Drainage area given in square miles.

MDC 3/1999

Figure Ge05.

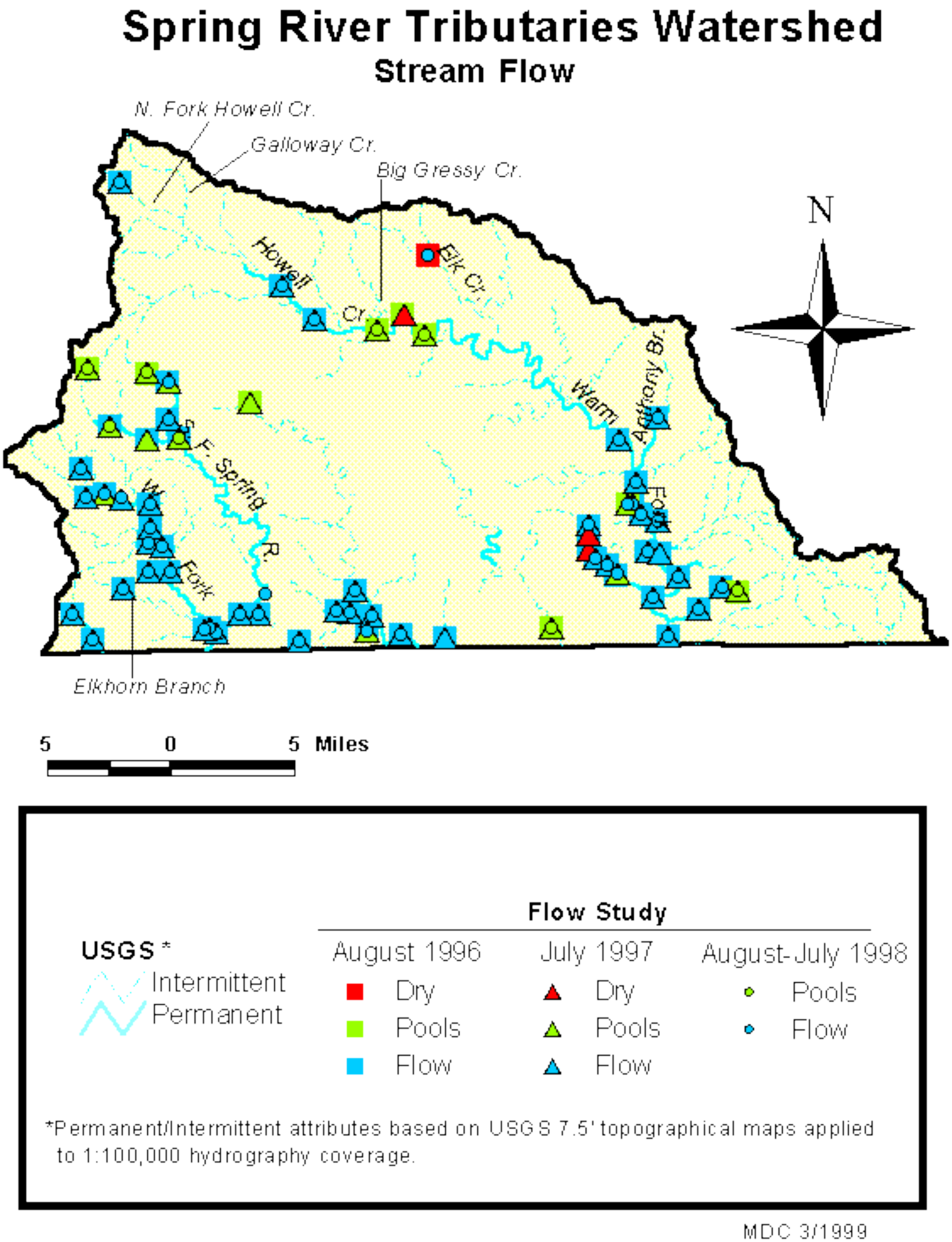
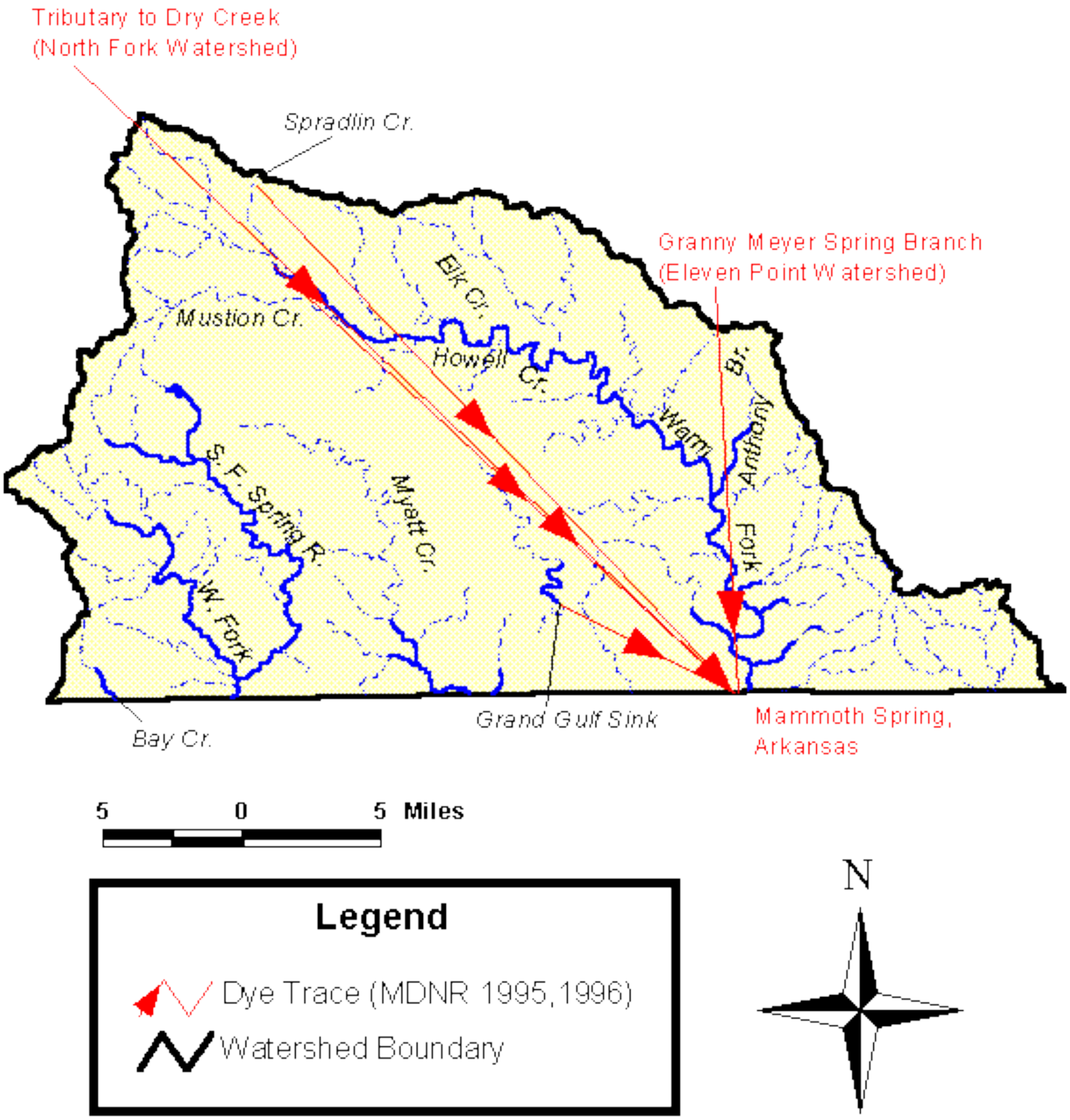

Spring River Tributaries Watershed
Stream Flow
N. Fork Howell Cr.
Galloway Cr.
Big Gressy Cr.
Elk Cr.
Howell
Cr.
Warm
Anthony Br.
S. F. Spring
R.
W. Fork
Fork
Elkhorn Branch
N
5
0
5 Miles
USGS *
Intermittent
Permanent
Flow Study
August 1996
July 1997
August-July 1998
Dry
Pools
Flow
Dry
Pools
Flow
Pools
Flow
*Permanent/Intermittent attributes based on USGS 7.5' topographical maps applied to 1:100,000 hydrography coverage.
MDC 3/1999

Figure Ge06.

Spring River Tributaries
Ground Water Movement



MDC 3/1999

Figure Ge07.

Spring River Tributaries Watershed
Springs

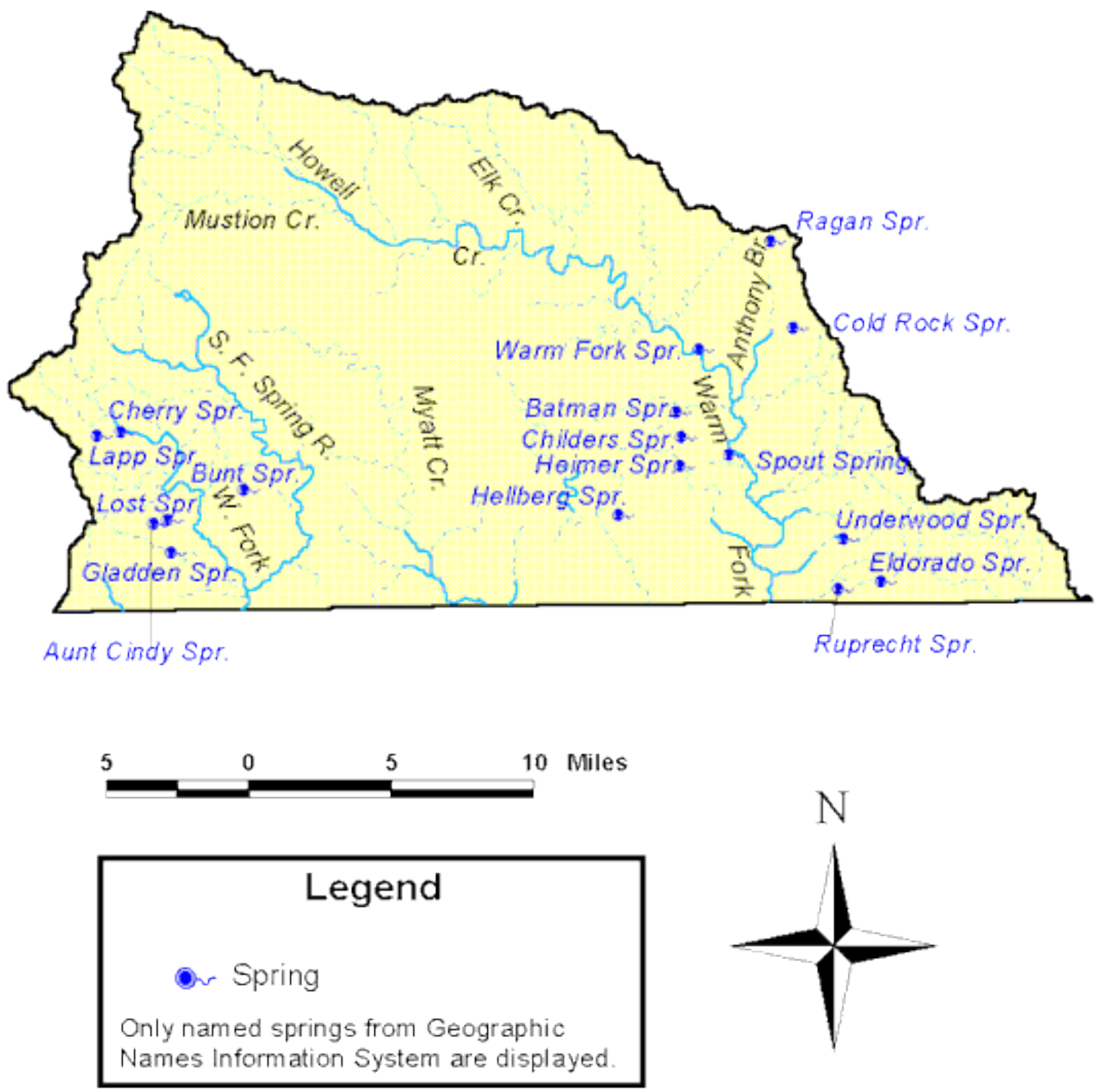


Figure GE08. Gradient Plot for Barren Hollow and major tributaries.

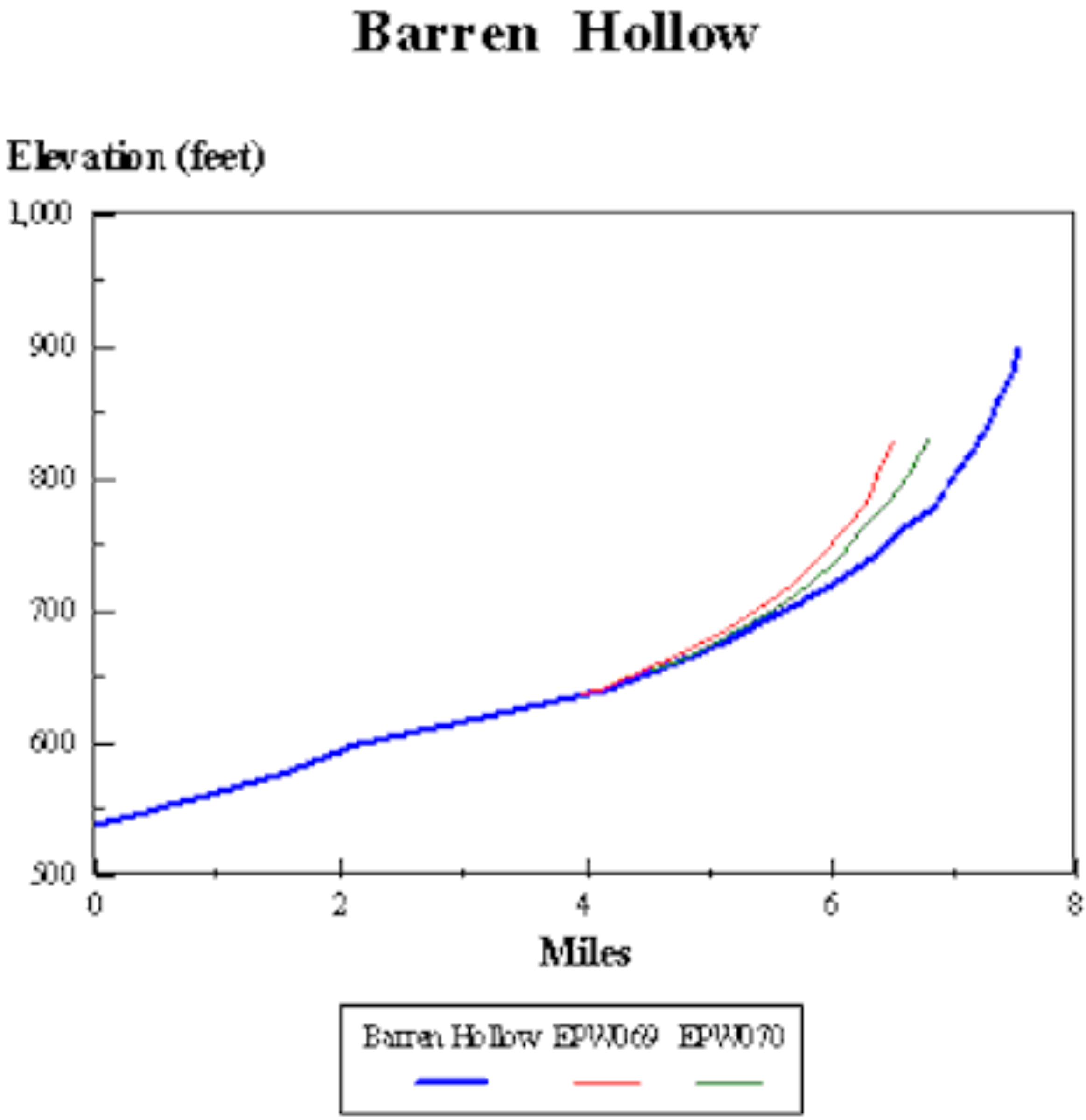


Figure GE09. Gradient plot for Howell Creek and major tributaries.

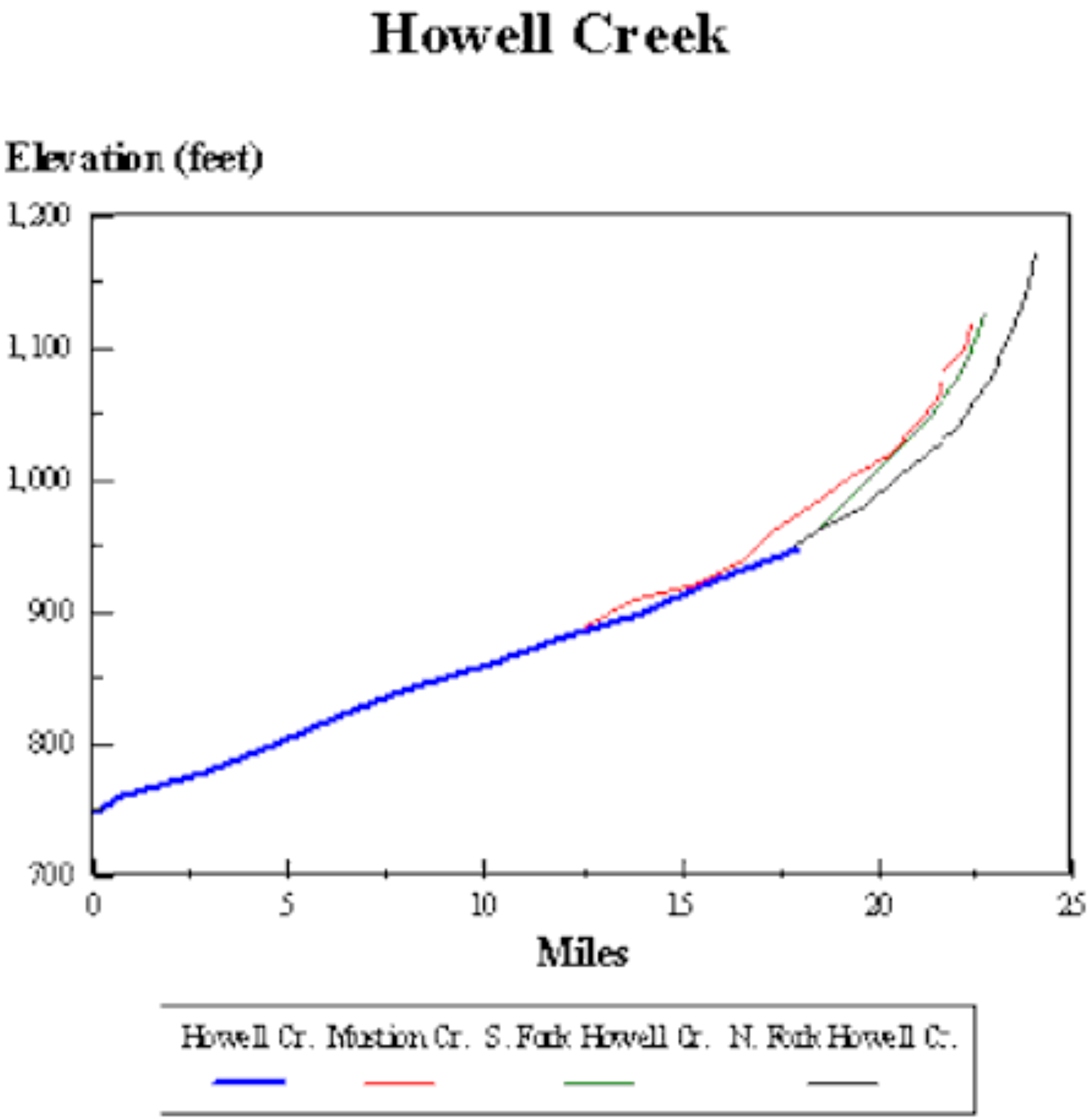


Figure GE 10. Gradient plot for Janes Creek and major tributary.

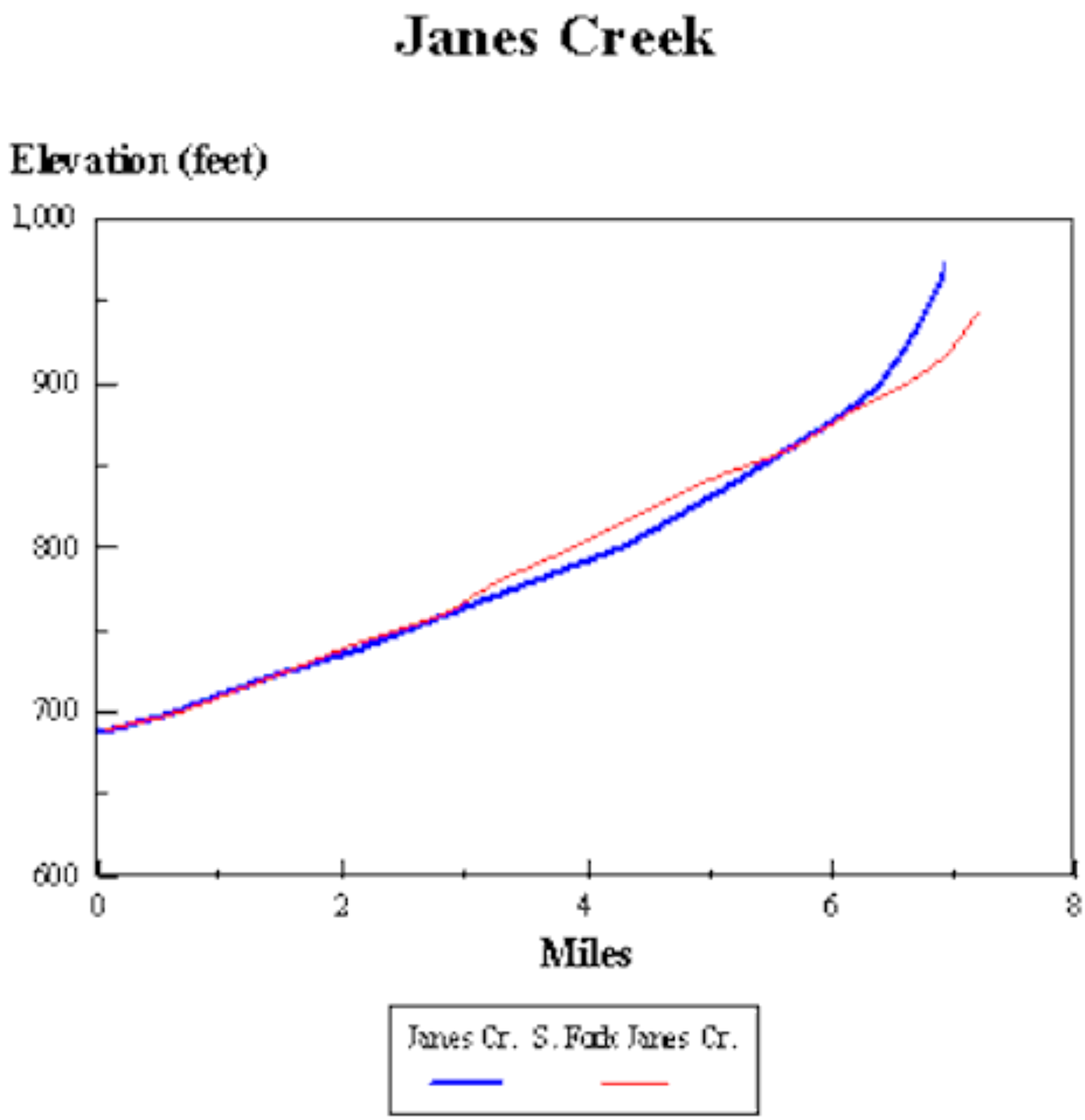


Figure GE 11. Gradient plot for Myatt Creek and major tributary.

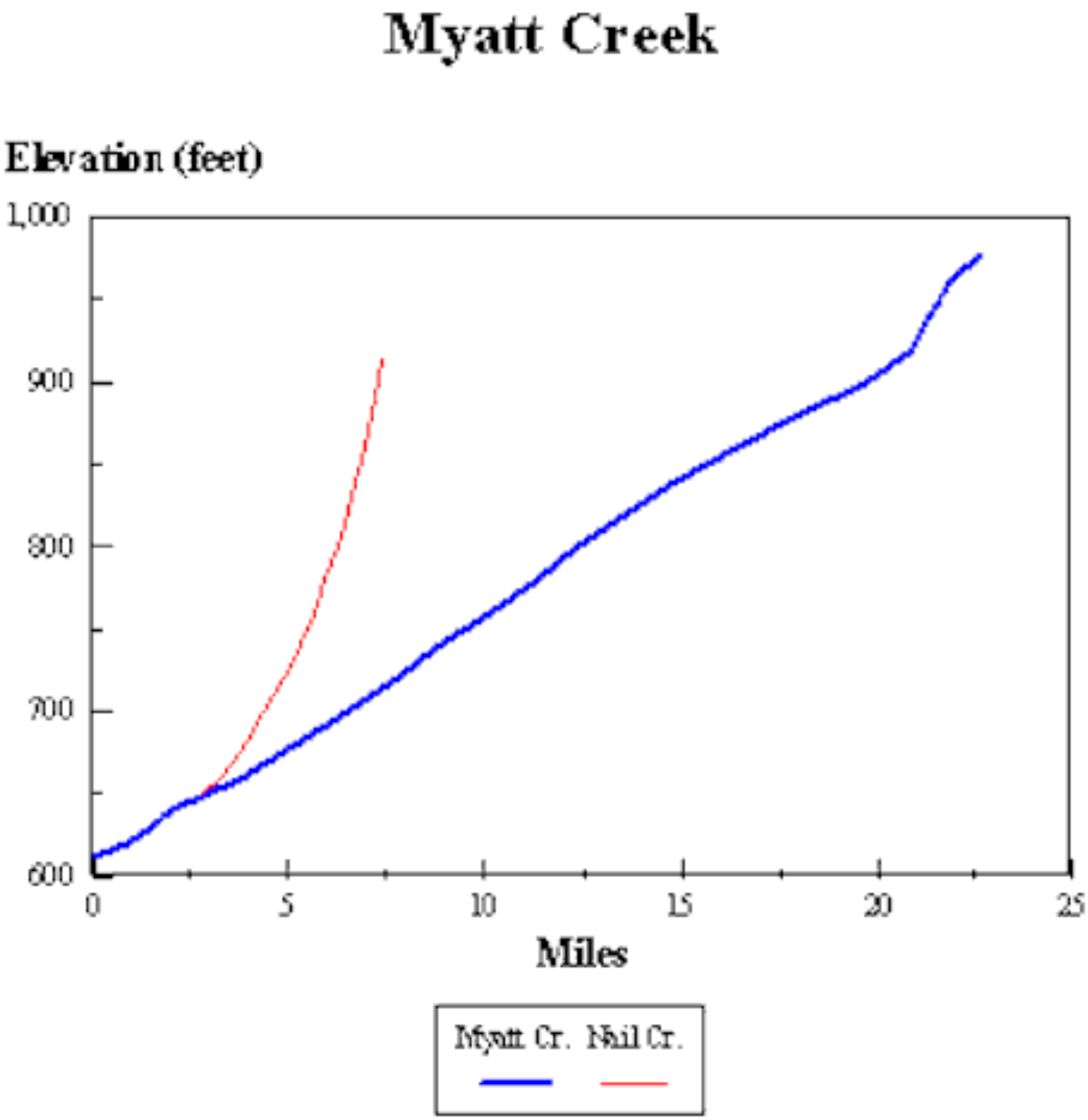


Figure GE 12. Gradient plot for South Fork and major tributaries.

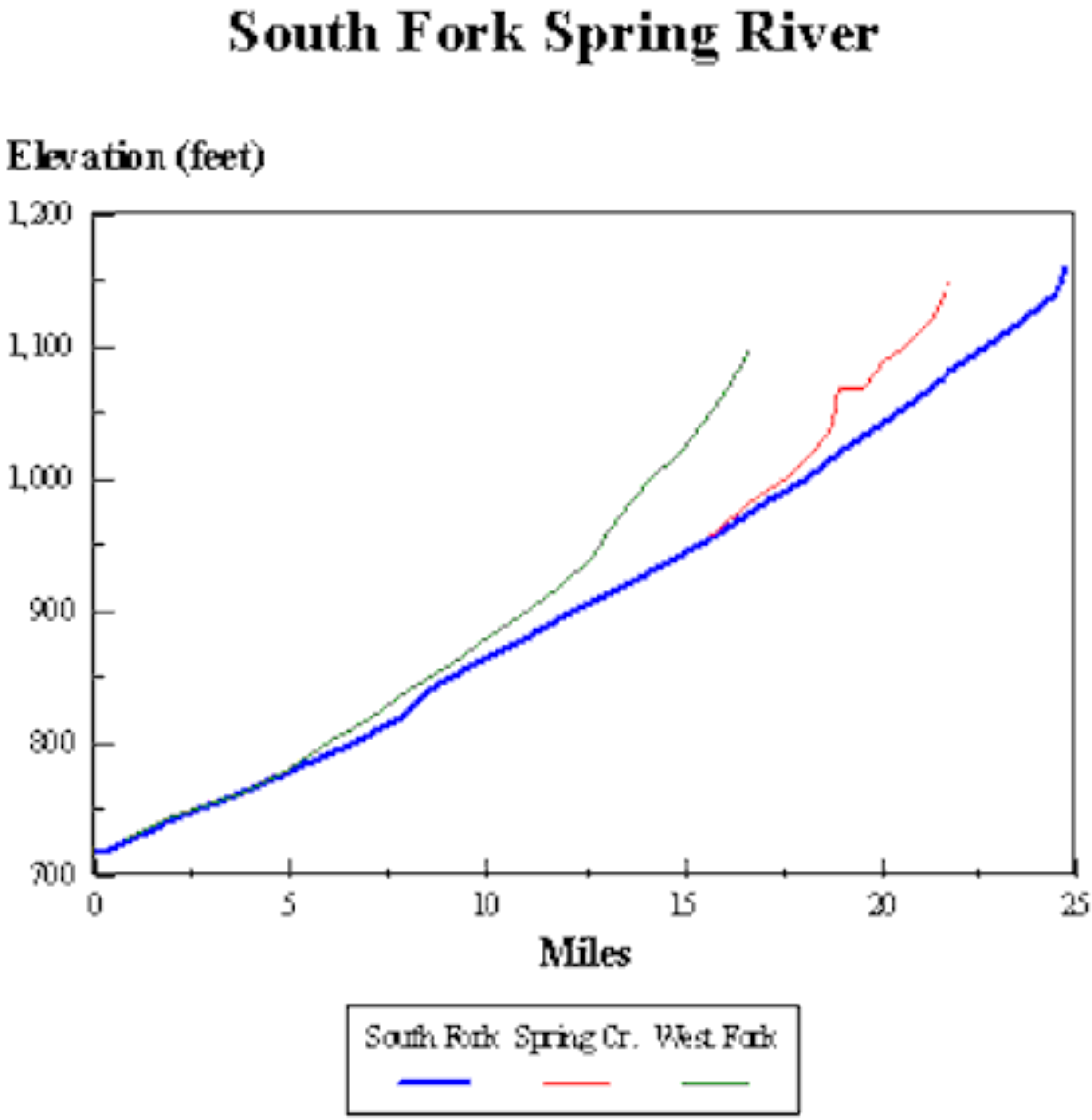


Figure GE 13. Gradient plot for Warm Fork and major tributaries.

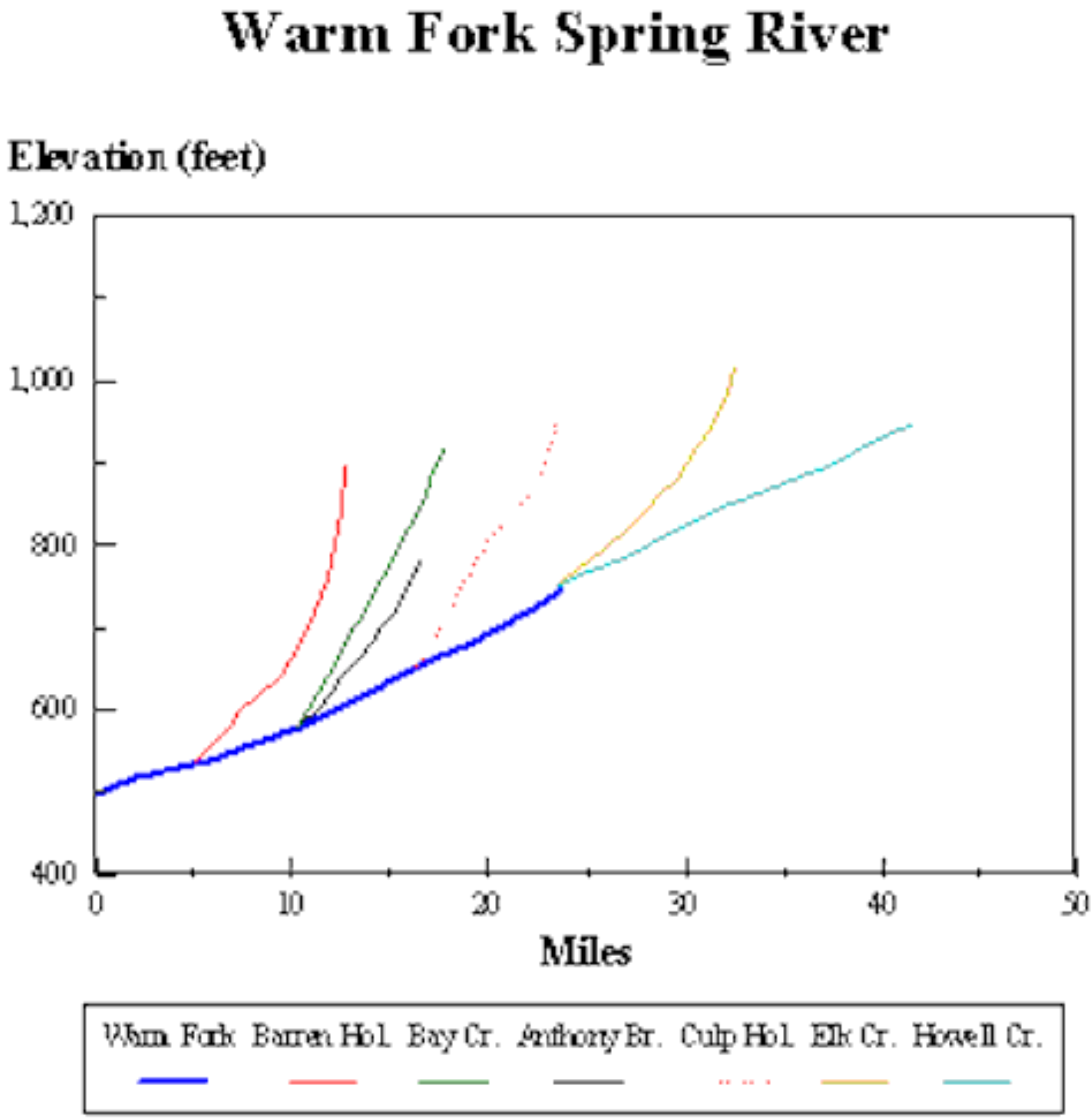


Figure GE 14. Gradient plot for West Fork and major tributary.

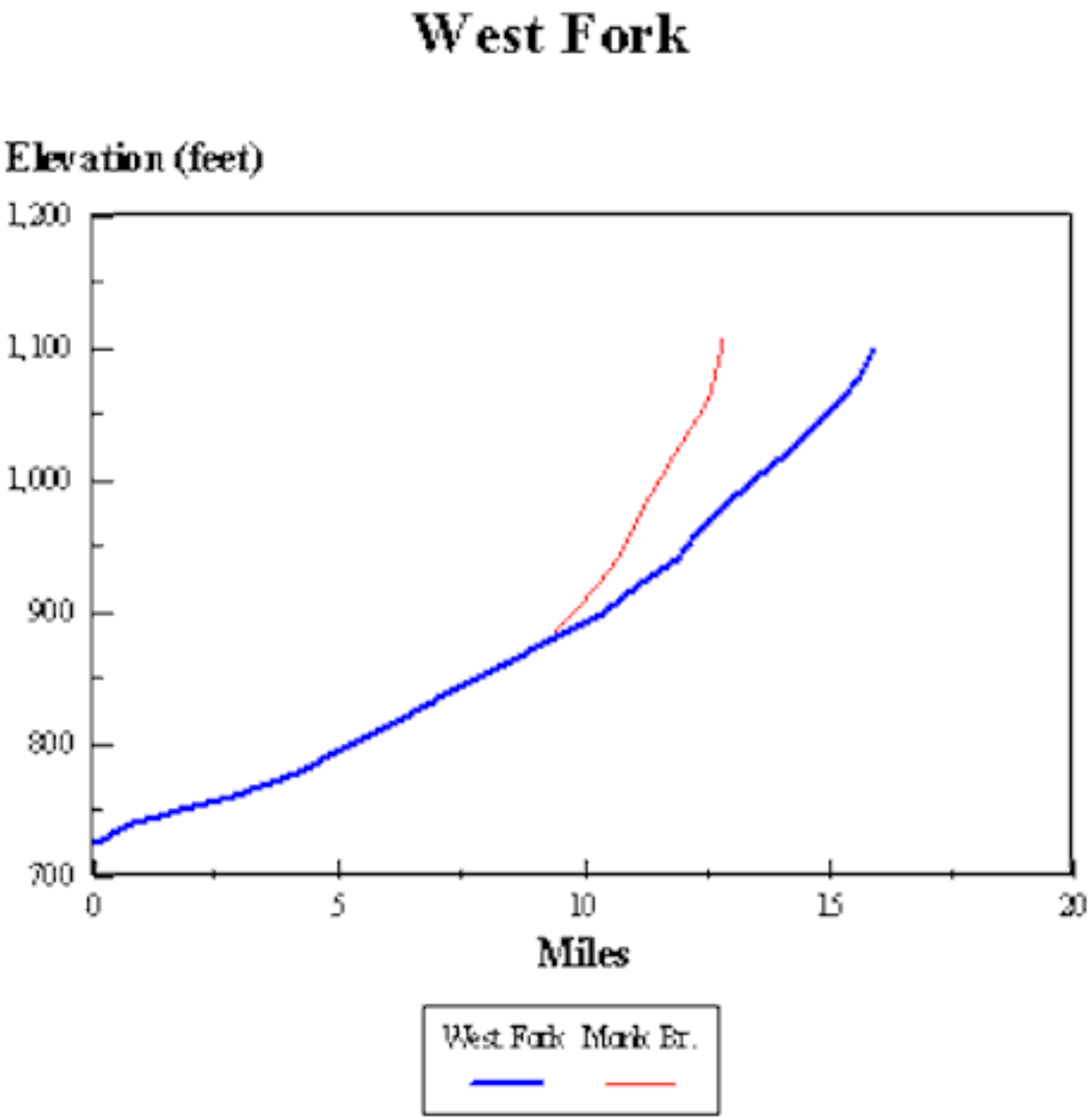


Table Ge01. Third order and larger streams of the Spring River Tributaries Watershed in Missouri as determined from 1:24,000 USGS topographical maps.

Stream Name	Order	7.5' Quad (mouth)	Name and Order Downstream Link
Jane's Creek	5*	Myrtle*	Spring R. AR
South Fork Jane's Cr.	4	Myrtle	Jane's Cr. 5
EPW090	3	Couch	S.F. Jane's Cr. 4
EPW091	3	Couch	S.F. Jane's Cr. 4
EPW092	3	Myrtle	Jane's Cr. 4
EPW093	3	Couch	Jane's Cr. 4
EPW094	3	Couch	Jane's Cr. 3
Trace Creek	4*	Mammoth Springs, AR	Spring R. AR
Eldorado Hollow	3	Couch	Trace Cr. 4
EPW089	3	Couch	Trace Cr. 4
Warm Fork of Spring R.	6*	Thayer*	Spring R. AR
Cox Creek	3	Thayer	Warm Fork 6
Two Mile Creek	3	Thayer	Warm Fork 6
Helms Hollow	3	Thayer	Warm Fork 6
Barren Hollow	5	Thayer	Warm Fork 6
EPW067	3	Thayer	Barren Hollow 5
EPW068	3	Couch	Barren Hollow 5
EPW070	4	Couch	Barren Hollow 4
EPW071	3	Couch	EPW070 4
Crazy Spring Hollow	3	Thayer	Warm Fork 5
Bay Creek	4	Thayer	Warm Fork 5
Camp Jefferson Hollow	3	Thayer	Bay Cr. 4
Anthony Branch	4	Thayer	Warm Fork 5
Cedar Hollow	4	Thayer	Anthony Br. 4
EPW072	3	Couch	Cedar Hollow 4
EPW073	3	Couch	Cedar Hollow 4
Culp Hollow	4	Rover	Warm Fork 5
Watered Rock Hollow	3	Rover	Culp Hollow 4
Orchard Branch	3	Rover	Warm Fork 5
James Branch	3	Rover	Warm Fork 5
Elk Creek	4	Brandsville	Warm Fork 5
Turkey Creek	3	Brandsville	Elk Cr. 4
EPW074	3	Brandsville	Elk Cr. 4
Howell Creek	5	Brandsville	Warm Fork 5
EPW075	3	Brandsville	Howell Cr. 5
Big Gressy Creek	3	Brandsville	Howell Cr. 5
EPW075a	3	Brandsville	Howell Cr. 5
Little Greasy Creek	3	West Plains	Howell Cr. 5
Mustion Creek	4	West Plains	Howell Cr. 5
EPW076	3	South Fork	Mustion Cr. 4

Stream Name	Order	7.5' Quad (mouth)	Name and Order Downstream Link
EPW077	3	South Fork	Mustion Cr. 4
Spradlin Creek	3	West Plains	Howell Cr. 5
South Fork Howell Creek	4	West Plains	Howell Cr. 5
Burton Creek	3	West Plains	S. F. Howell Cr. 4
North Fork Howell Creek	4	West Plains	Howell Cr. 5
Galloway Creek	4	White Church	N.F. Howell Cr. 4
EPW078	3	Pomona	Galloway Cr. 4
English Creek(Bussel Br.)	3*	Thayer	Spring R. AR
Bussel Branch	3	Koshkonong	Grand Gulf Sink
Presley Branch	3	Koshkonong	Myatt Cr. AR
Myatt Creek	5*	Koshkonong	Spring R. AR
Nail Creek	4	Koshkonong	Myatt Cr. 5
Hunt Branch	3	Lanton	Nail Cr. 4
Harmon Hollow	3	Koshkonong	Myatt Cr. 5
Sycamore Hollow	3	Lanton	Myatt Cr. 4
EPW079	3	Lanton	S.F. Spring R. 6
West Fork	5	Lanton	S.F. Spring R. 6
Elkhorn Branch	3	Lanton	West Fork 5
EPW080	3	Moody	West Fork 5
Mansfield Hollow	3	Moody	West Fork 5
Cabin Hollow	3	Moody	West Fork 5
Newberry Hollow	3	Moody	West Fork 5
EPW081	3	Moody	West Fork 5
Monk Branch	4	Moody	West Fork 5
EPW082	3	Moody	Monk Br. 4
EPW083	3	Moody	West Fork 4
EPW084	3	Moody	West Fork 4
EPW085	3	Moody	West Fork4
EPW086	3	Lanton	S.F. Spring R. 5
Wilson Hollow	3	Lanton	S.F. Spring R. 5
Hay Hollow	3	Lanton	S.F. Spring R. 5
EPW087	3	Lanton	S.F. Spring R. 5
Spring Creek	4	Moody	S.F. Spring R. 5
EPW088	3	South Fork	S.F. Spring R. 4
Bay Creek	3	Moody*	S.F. Spring R. AR

* Order at State Line

T able Ge02. Length by order for fourth order and larger streams within the Spring River Tributaries Watershed.

Stream Name	Length by Order (miles)						
	6	5	4	3	2	1	Total Miles
Anthony Branch			0.5	5.3	-	-	5.8
Barren Hollow		4	0.6	2.2	0.3	0.5	7.5
Bay Creek			2.2	3.5	0.4	1.5	7.5
Cedar Hollow			3.9	0.7	0.5	0.2	5.2
Culp Hollow			0.4	5.5	0.7	0.5	7.2
Elk Creek			5.5	2.1	1	0.3	8.9
EPW069			0.8	0.8	0.6	0.3	2.5
EPW070			0.8	0.7	0.05	0.7	2.3
Galloway Creek			2.6	1.3	1.1	0.5	5.5
Howell Creek		18	-	-	-	-	18
Janes Creek		0.1	2.4	1.6	2.6	0.3	6.9
Monk Branch			1.1	0.9	0.7	0.6	3.4
Mustion Creek			8.1	1.2	0.7	-	9.9
Myatt Creek		2.9	6	11.4	0.6	1.8	22.7
Nail Creek			0.9	1.6	1.2	0.9	4.6
N.F. Howell Cr.			1.9	2.9	0.7	0.8	6.2
S.F. Howell Cr.			1	1.6	1.5	0.7	4.8
S.F. Janes Cr.			2.5	2.8	1.4	0.5	7.2
South Fork	0.8	14.9	2.8	3.4	2.4	0.5	24.7
Spring Creek			3.2	0.7	0.6	1.7	6.15
Trace Creek			4.2	0.6	1.7	0.4	6.9
Warm Fork.	5.4	18.3	-	-	-	-	23.6
West Fork		9.5	4.9	0.6	0.1	0.8	15.9
Total	6.2	67.7	56.3	51.4	18.9	13.5	213

Table Ge03. Estimated length of permanent flowing water of third order and larger streams within the Spring River Tributaries Watershed, Missouri based on USGS 7.5 minute topographical maps.

Stream Name	Order	Miles Permanent	Total Miles	% Permanent
Anthony Branch	4	3.2	5.8	55
Barren Hollow	5	1.1	7.5	15
Bay Creek	4	1.5	7.5	20
Bussell Branch	3	5.2	15	35
Cox Creek	3	2.2	5.3	41
Hay Hollow	3	0.3	1.6	19
Helms Hollow	3	1.3	3.1	42
Howell Creek	5	17.2	18	95
Myatt Creek	5	4.8	22.7	21
Nail Creek	4	1.1	4.6	24
Presley Branch	3	0.9	3.3	27
South Fork	4	18.9	24.7	77
Spring Creek	4	6.1	6.1	100
Two Mile Creek	3	2	7.8	26
Warm Fork.	6	22.6	23.6	96
West Fork	5	11.4	15.9	72
Total		99.8	173	-

Table Ge04. Spring River Tributaries Watershed stream reaches designated as losing by the Missouri Department of Natural Resources (MDNR 1996b).

Stream	Miles	From	To
Elk Cr.	4	sw,se,se,24,24n,07w	se,ne,nw,08,23n,06w
Big Greasy Cr.	3	sw,ne,sw,28,24n,07w	nw,nw,nw,02,23n,07 w
Mustion Cr.	3.5	ne,ne,se,32,24n,08w	sw,nw,se,36,24n,08w
Mustion Cr.	2	nw,ne,se,36,24n,09w	nw,se,ne,32,24n,083 w
Chapin Br.	3	sw,nw,nw,14,23n,08 w	ne,nw,se,06,23n,07w
Myatt Cr.	13	sw,se,nw,14,23n,08w	se,se,nw,33,22n,07w
L. Greasy Cr.	5	se,ne,13,24n,08w	nw,sw,se,05,23n07w
Bay Cr.	2.5	ne,sw,ne,32,22n,09w	se,sw,nw,10,21n,09w
Howell Cr.	16	ne,sw,nw,35,25n,09w	ne,ne,ne,12,23n,07w
Spradlin Cr.	3	ne,nw,nw,10,24n,08 w	se,ne,sw,26,24n,08w
Galloway Cr. and Trib.	0.5	sw,sw,04,24n,08w	sw,ne,08,24n,08w
Spring R.	2	sw,se,se,20,22n,05w	se,se,sw,29,22n,05w
Warm Fork	6	nw,nw,nw,07,23n,06 w	nw,ne,se,23,23n,06w
Water Br.	2	nw,ne,se,19,24n,06w	sw,sw,ne,31,24n,06w
English Cr.	2.5	sw,sw,sw,16,22n,06w	se,se,ne,33,22n,06w
Rover Br.	4	ne,27,24n,06w	se,se,se,31,24n,06w
Bussell Br.	5	nw,se,01,22n,07w	sw,sw,se,20,22n,06w
Trib to Bussell Cr.	1.5	nw,sw,05,22n,06w	nw,se,sw,07,22n,06w
Total	78.5		

Note: This table is not a final authority. Data subject to change.

Table Ge05. Named Springs of the Spring River Tributaries Watershed, Missouri. (Vineyard and Feder 1974; USGS Geographic Names Information System Data).

Name	County	USGS 7.5' Quad.	Discharge (cfs)
Aunt Cindy Spring	Howell	Moody	-
Batman Spring	Oregon	Thayer	-
Bunt Spring	Howell	Lanton	-
Cherry Spring	Howell	Moody	-
Childers Spring	Oregon	Thayer	-
Cold Rock Spring	Oregon	Rover	-
Eldorado Spring	Oregon	Couch	-
Gladden Spring	Howell	Moody	-
Heimer Spring	Oregon	Thayer	-
Hellberg Spring	Oregon	Thayer	-
Lapp Spring	Howell	Moody	-
Lost Spring	Howell	Moody	0.02
Ragan Spring	Oregon	Rover	-
Ruprecht Spring	Oregon	Couch	-
Spout Spring	Oregon	Thayer	-
Underwood Spring	Oregon	Couch	-
Warm Fork Spring	Oregon	River	-

Table Ge06. Stream gradient for order as well as average gradient for entire stream for fourth order and larger streams within the Spring River Tributaries Watershed. Streams highlighted are illustrated with composite gradient plots.

Stream Name	Gradient for Order (ft/mi)						Average Gradient (ft/mi)
	6	5	4	3	2	1	
Anthony Branch			23	35	Whiteoak/Ragan Hol.		33
Barren Hollow		25	27	56	114	193	48
Bay Creek			41	43	43	56	45
Cedar Hollow			37	54	110	202	52
Culp Hollow			26	37	40	98	41
Elk Creek			21	34	46	99	30
EPW069			38	59	96	200	77
EPW070			44	69	108	125	79
Galloway Creek			27	27	52	91	38
Howell Creek		11	N.F. Howell Cr. S.F. Howell Cr.				11
Janes Creek		14	25	29	52	149	41
Monk Branch			45	68	62	110	67
Mustion Creek			17	44	54	-	25
Myatt Creek		13	15	15	17	31	16
Nail Creek			22	50	49	133	60
N.F. Howell Cr.			18	28	62	89	37
S.F. Howell Cr.			26	31	33	74	37
S.F. Janes Cr.			22	36	39	75	35
South Fork	11	15	19	22	21	52	18
Spring Creek			33	7	25	38	31
Trace Creek			45	64	87	116	61
Warm Fork	8	Howell Cr./Elk Cr.					11
West Fork		17	30	36	38	53	23

Land Use

Historical Land Cover/Land Use

The Spring River Tributaries Watershed in Missouri essentially occupied the transition area between two contrasting areas of land cover. Nigh (1988) indicates that numerous written accounts of the Eleven Point Watershed describe it as being primarily forested while lacking the barrens country typical of the Northern and Western Ozarks. An independent account of Western Howell County by William monks as discussed by Ryan and Smith (1991) states that "The table-lands... had very little timber growing on them, but were not prairie. They were what were known as post oak runners and other brush growing on the table lands, but the grass turf was very heavy and in the spring of the year the grass would soon cover the sprouts and the stranger would have taken all of the table-lands, except where it was interspersed with groves, to have been prairie."

Unlike a large portion of the Eleven Point Watershed, the Spring River Tributaries Watershed did not have large tracts of continuous pine (MDC and Schroeder 1993). Open woodlands and oak savannas with occasional to common prairie and savanna openings was the principal vegetation type within the Spring River Tributaries Watershed. Post oak and black oak were the principal woodland tree species with scattered shortleaf pine in the northern portion of the watershed (MDC 1997). Fire likely played an important role in maintaining the open woodland and savanna flora. The more dissected lands within the watershed probably contained mixed oak woodland and forest. Unique sinkhole ponds, wet prairies and seeps were scattered throughout the watershed. A small portion (<250 acres) of presettlement prairie is believed to have existed in the watershed (MDC and Schroeder 1993).

The earliest inhabitants of the Ozarks, the Native American Indian, are thought to have existed in the Ozarks as semi-nomadic tribes living in small, transient camps and subsisting on hunting and foraging during much of the Archaic period (7000-1000 B.C.) (Jacobson and Primm 1994). Late in the Archaic period, tribes on the fringes of the Ozarks became less nomadic; existing in larger villages and increasingly depending on plants for food, while tribes in the interior retained their hunter-gatherer characteristics. Tribes within the interior began to construct more elaborate villages as well as incorporate more agriculture into their subsistence during the early Mississippian Period (A.D. 900-1200). By A.D. 1500 this culture had disappeared as large agricultural base villages began to grow along the eastern fringe of the Ozarks and the Mississippi River. During this period the interior of the Ozarks was used as a seasonal hunting ground as well as a source for flint and chalcedony for making tools. It is believed that a climatic shift to cooler, drier summers and the subsequent failure of maize crops on which early agriculture was based, may have caused an abrupt abandonment of these larger villages such as Cahokia Mounds in Illinois. Remnants of these villages and tribes reassembled to form the Osage Tribe which existed throughout much of the Ozarks and was present as European settlement of the area began to occur in the late 1700s and early 1800s (Jacobson and Primm 1994). Native American use of fire is believed to have been a large factor in the types of vegetation found by Schoolcraft and others as exploration of the Ozarks interior began to occur after the Louisiana Purchase of 1803. Fires, occurring naturally from lightning strikes or set for many reasons from harassment of enemies to aiding in hunting, also stimulated warm-season grasses such as bluestem and eliminated woody undergrowth thus creating open woodlands or savannas.

European settlement of the Ozark fringe began in the early 1700's under French and, later, Spanish political control (Jacobson and Primm 1994). After the Louisiana Purchase of 1803 American Settlers began settling the same areas earlier occupied by the Spanish and French. Settlement of the Ozarks Interior increased after the war of 1812. Many of the early settlers came from the Appalachian States such as Tennessee, Kentucky, and Virginia where they had learned the skills necessary for survival in land similar to the rugged Ozark wilderness (Nigh 1988). In addition to hunting and fishing, early settlers survived by using the valley bottom land for gardens and row crops, and the wooded side slopes and native grass of the uplands for grazing cattle, hogs, horses, and other livestock. This region remained isolated and only sparsely settled until the late 1800's (Nigh 1988). As the timber resource of the eastern states dwindled and an increasing number of settlers migrated onto the western plains, the demand for the timber of the Ozarks increased (Cunningham and Hauser 1989). Undoubtably, the cheap price of land having uncut timber was also very attractive to eastern speculators. Uncut timber land often sold for a $1.00 an acre (Cunningham and Hauser 1989). The coming of the railroad to the Ozarks interior during this time not only provided a means of transportation for lumber products, but also was a great consumer of this resource for railroad ties. With the extension of the railroads into the Ozarks came the large scale exploitation of the timber resource (Rafferty 1983).

The Spring River Tributaries Watershed was an area lacking extensive tracts of shortleaf pine (MDC and Schroeder 1993). Instead much of the timber resource consisted of oak species; primarily post oak and black oak in open woodlands (MDC 1997). In areas such as this, hardwoods were used for a variety of products, primarily railroad ties, flooring, barrel staves, tool handles and fuel including the manufacture of charcoal (Rafferty 1983; Jacobson and Primm 1994). These products used a wide range of timber sizes.

As native timber within the Spring River Tributaries Watershed was being depleted, it was replaced by agriculture and horticulture. Approximately 153,000 of the 580,000 acres in Howell County were "under plow" in 1904 (Williams 1904). Estimates of 1902 cropland within Howell County indicate a total 47,686 acres planted in corn alone with Oregon County having 31,382 acres planted in corn (Table Lu01) (Williams 1904). This land use would have undoubtedly contributed significantly to erosion and thus sedimentation and an increase in gravel load in the streams of the watershed. In addition to cropland within the watershed, several large orchards existed. Williams (1904) proclaimed Howell County Missouri as "The largest peach growing county in Missouri. He also stated that the largest peach orchard in Missouri was in Oregon County with 102,400 trees. The orchard district in Oregon County was located along the Frisco Railroad in the southwest portion of the county (Williams 1904). These estimates paint a much different landscape than what exists within the watershed today.

Land Type Associations

Land Type Associations (LTAs) are units of land which are relatively similar in landform and in patterns of geologic parent material, aspect, soils and potential natural vegetation. Within the Spring River Tributaries Watershed, two LTAs have been identified (Figure Lu01 and Table Lu02). Each has a characteristic pattern of landform geology, soil and vegetation. These LTAs are the Howell/Oregon Oak Woodland Dissected Plain and West Plains Oak Savanna Woodland Plain. LTAs could prove to be a useful tool for planning and implementing management activities (ie. water quality and aquatic biodiversity).

Current Land Use

The Missouri Resource Assessment Partnership (MoRAP) Phase 1 Land Cover Classification (1997) (see page 12a) is currently the most recent compiled land cover/land use data available. This data, as analyzed by Caldwell (1998), indicates estimated forest/woodland cover within the watershed at 48.3% while grassland/cropland comprises 49.1% of the total land cover (Table Lu03, Figures Lu02, Lu03, and Lu04). Unlike its larger "sister" watershed, the Eleven Point, which has a land cover comprised of 65% forest/woodland, the Spring River Tributaries Watershed has a land cover comprised of slightly more grassland/cropland than forest/woodland. Reasons for this probably include, but are not limited to the following:

1. Local topographic relief is relatively less within the Spring River Tributaries Watershed than in the Eleven Point, thus the topography is generally more conducive to land clearing for pasture. Local relief data obtained for fish community sample sites within the Missouri Department of Conservation Fish Collection Database (1998) indicate mean local relief of sites within the Spring River Tributaries Watershed at 160 feet while mean local relief of sites within the Eleven Point is 256 feet.
2. The Spring River Tributaries Watershed is more densely populated than the Eleven Point. Estimates based on 1990 census data analysis using the MABLE/Geocorr Geographic Correspondence Engine Version 3.01 (Blodgett J. and CIESIN 1996) indicate that mean population density within the Spring River Tributaries Watershed is 43 persons per square mile as opposed to 14 persons per square mile within the Eleven Point Watershed.
3. Less public land exists within the Spring River Tributaries Watershed than in the Eleven Point. Public land within the Spring River Tributaries Watershed accounts for approximately 2% of the total area while it accounts for 22% within the Eleven Point.

Little cropland exists within the watershed today as compared to the turn of the century (1904). Nearly all of the non-forested areas are pasture or hay fields primarily composed of fescue and/or alfalfa and clover. Howell County ranks 2nd in Missouri (1997) in number of cattle and 18th in haycrop acres in the state (Table Lu01) (NASS 1997). Oregon County ranks 28th in Missouri in number of cattle and 64th in hay crop acres.

It should be noted that, at the time of this writing (1999), the MORAP Phase 1 Land Cover Data is currently considered a work in progress. A more accurate and detailed Phase 2 data compilation is planned.

The Natural Resource Conservation Service (NRCS) rates sheet erosion within the Spring River Tributaries Watershed as low at 2.5-5 tons per acre annually, which is considered an acceptable rate of soil loss. Gully erosion is only a slight problem at 0-0.16 tons per acre annually (MDNR 1994).

Soil Conservation Projects

The Spring River Tributaries Watershed has no completed, ongoing or planned Public Law 566 (PL-566) watershed projects. There is one Special Area Land Treatment (SALT) project within the watershed. This project occupies 3,541 acres of the Elkhorn Branch Drainage (Figure Lu05). The purpose of the project is to reduce soil loss and improve water quality by improving forest and grassland conditions within the drainage. At the beginning of the project, 2,782 acres within the project area were defined as needing treatment. Completion date for the project is July of 1999 (Cash, personal communication and Robbins, personal communication).

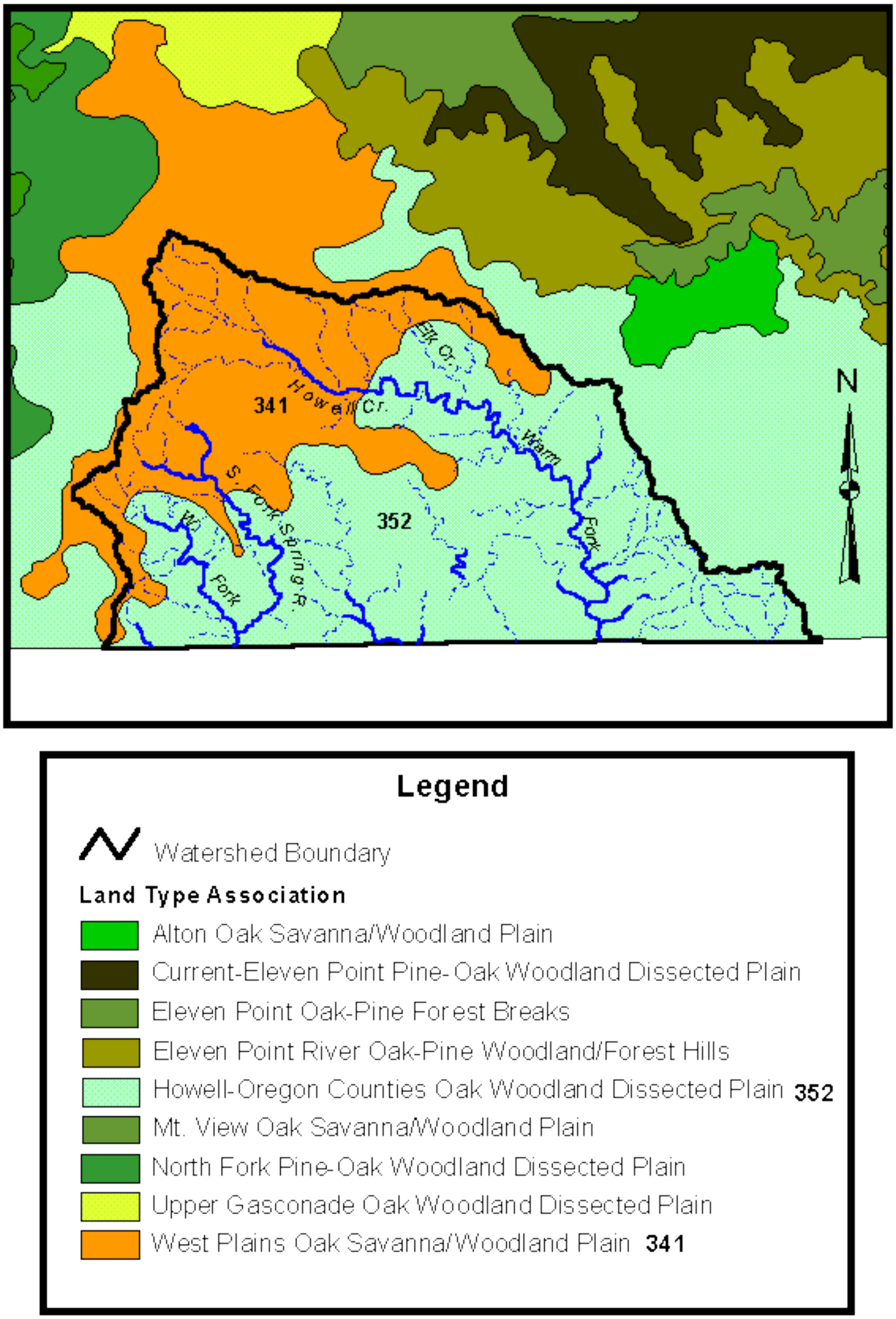
Public Areas

Approximately 7,405 acres, or 2% of the Spring River Tributaries Watershed is in public ownership. The largest public area is the 6,579 acre White Ranch Conservation Area owned by

the Missouri Department of Conservation. Approximately 3.8 miles of stream frontage exist on public lands within the watershed (Table Lu04 and Figure Lu06) (MDC 1995).
One public fishing area is located on the Warm Fork of the Spring River at Thayer, Missouri. This area is owned by the city of Thayer (Mayers, personal communication). An additional stream frontage area, known as Martin Access has been recently acquired however no development of facilities has occurred as of this writing (1999) (McPherson, personal communication and Mayers, personal communication).

Figure Lu01.

Spring River Tributaries Watershed
Land Type Associations



MDC 3/1999

Figure Bk02.

Spring River Tributaries Watershed
Infrastructure

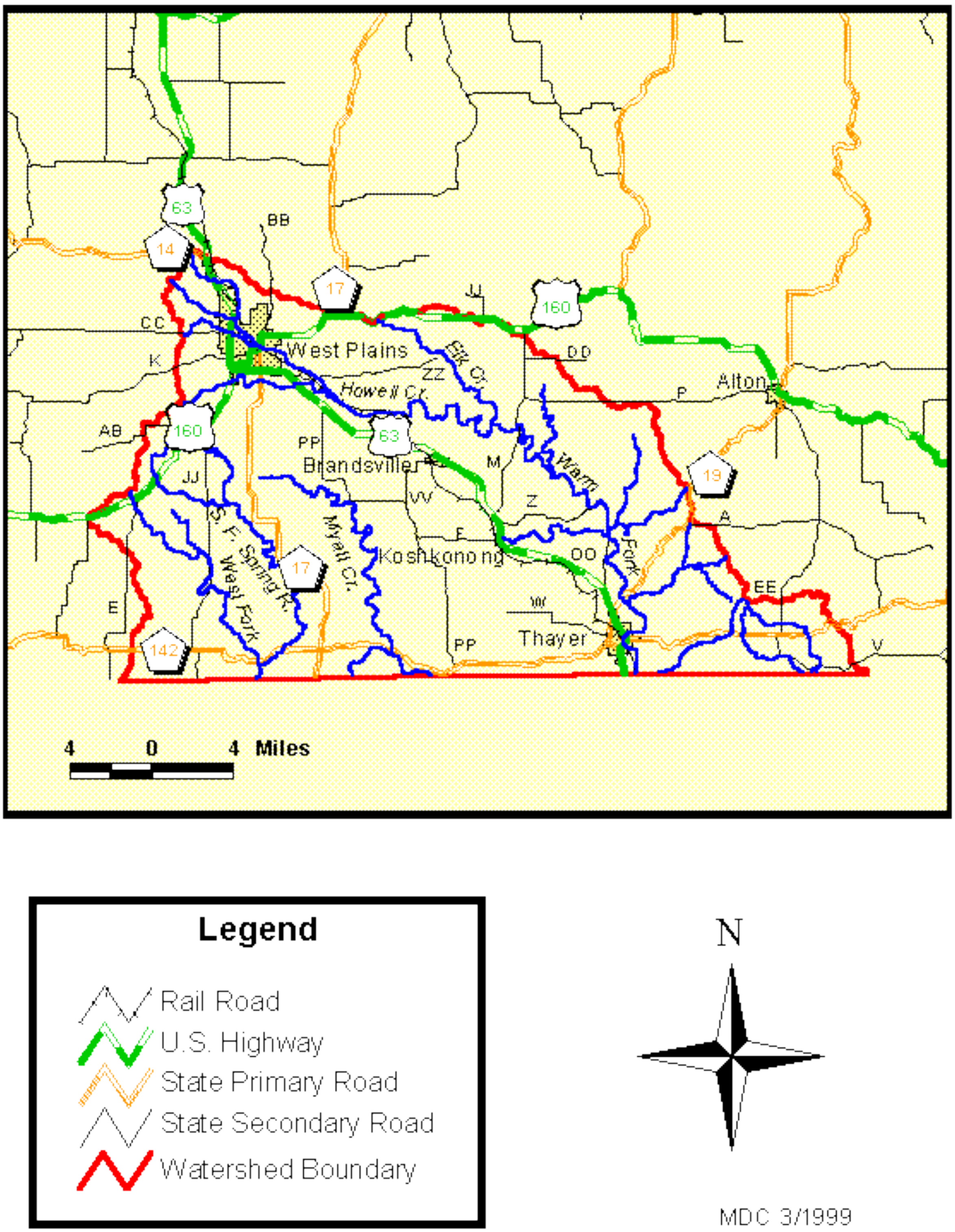
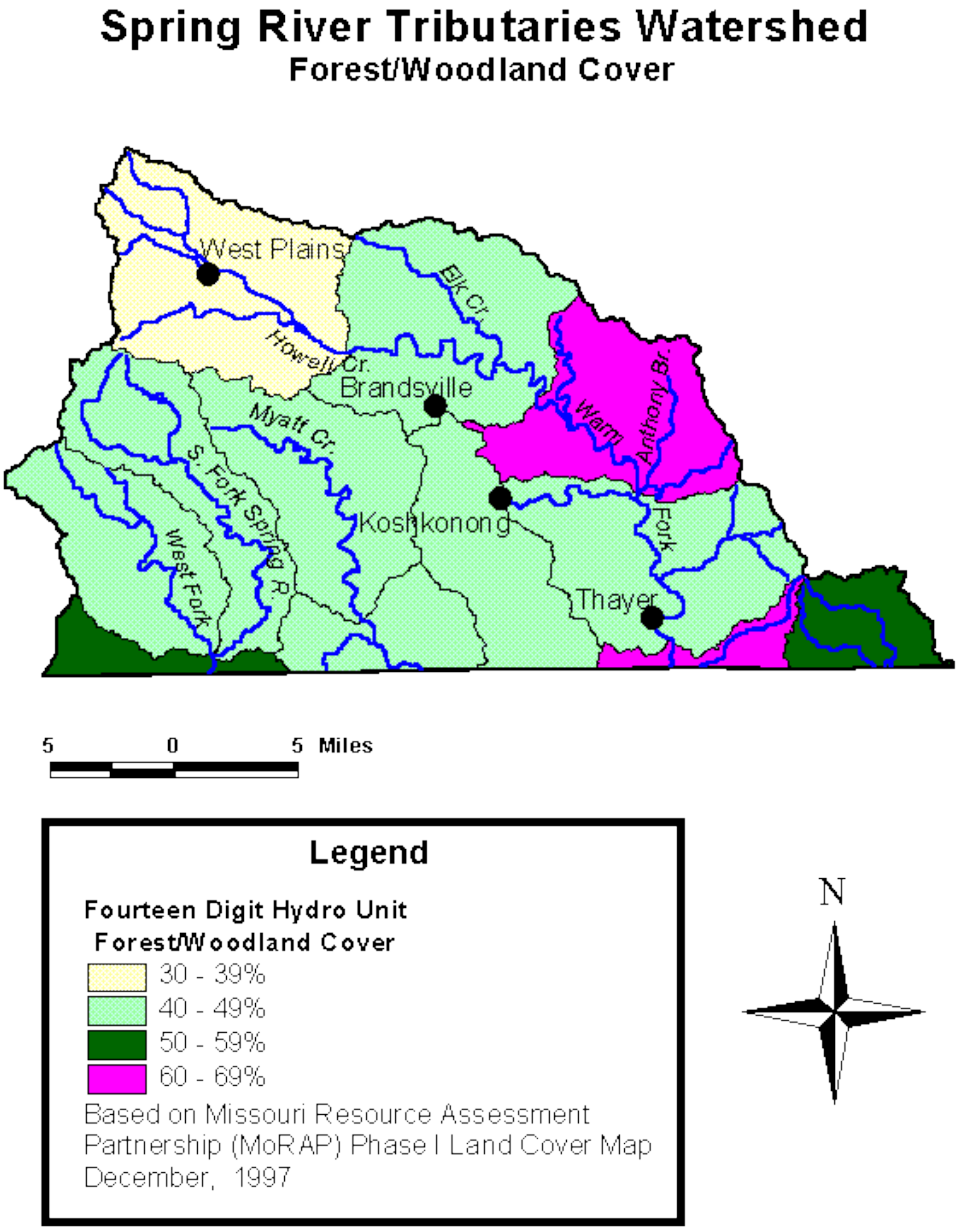


Figure Lu03.



Spring River Tributaries Watershed
Forest/Woodland Cover
West Plains
Elk Cr.
Howell Cr.
Brandsville
Myatt Cr.
Warm
Anthony Br.
S. Fork Spring R.
West Fork
Koshkonong
Fork
Thayer
5 0 5 Miles
Legend
Fourteen Digit Hydro Unit
Forest/Woodland Cover
30 - 39%
40 - 49%
50 - 59%
60 - 69%
Based on Missouri Resource Assessment Partnership (MoRAP) Phase I Land Cover Map December, 1997
N
MDC 3/1999

Figure Lu04.

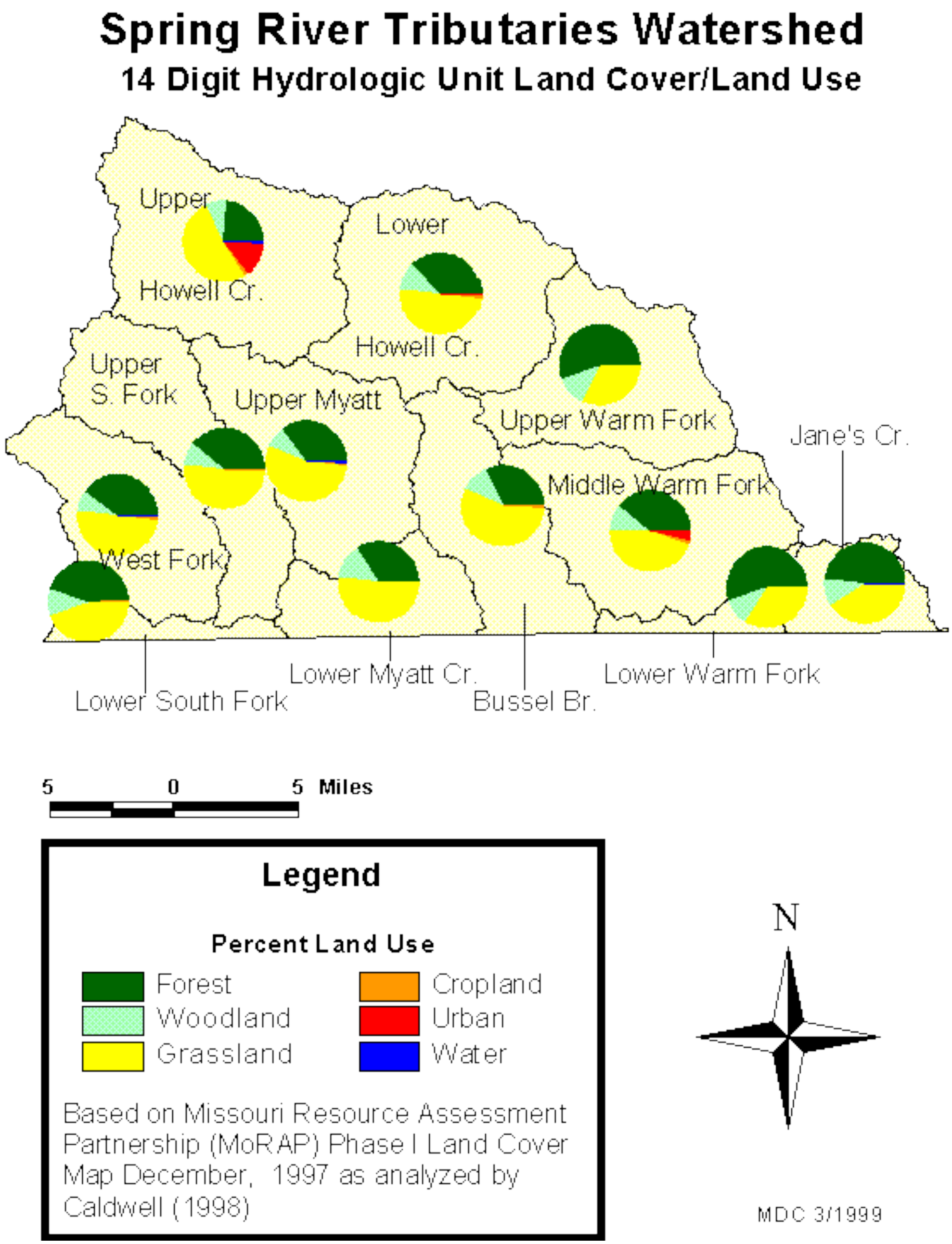
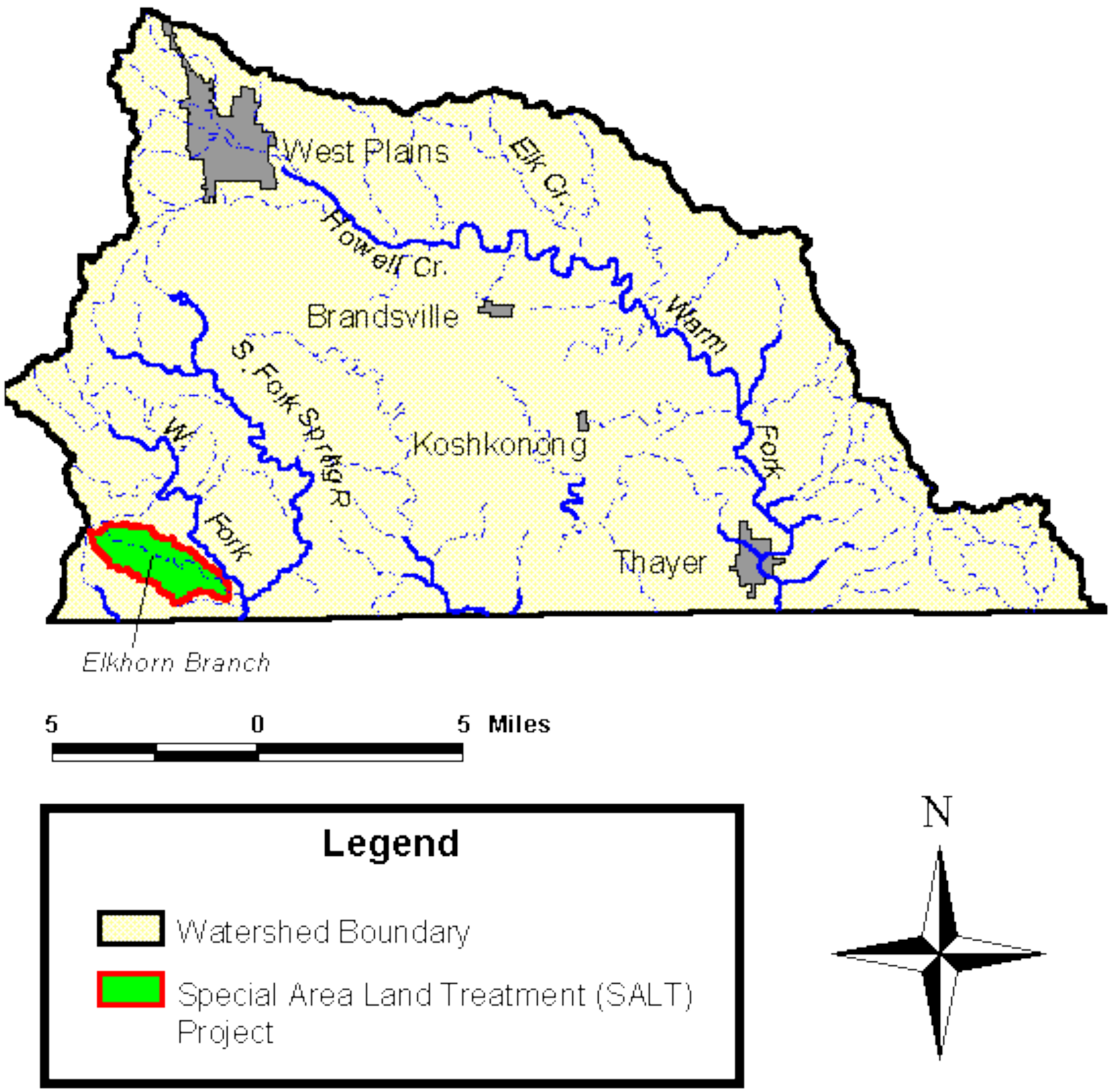

Spring River Tributaries Watershed
14 Digit Hydrologic Unit Land Cover/Land Use
Upper Howell Cr.
Lower Howell Cr.
Upper S. Fork
Upper Myatt
Upper Warm Fork
Jane's Cr.
Middle Warm Fork
West Fork
Lower South Fork
Lower Myatt Cr.
Bussel Br.
Lower Warm Fork
5 0 5 Miles
Legend
Percent Land Use
Forest
Woodland
Grassland
Cropland
Urban
Water
Based on Missouri Resource Assessment Partnership (MoRAP) Phase I Land Cover Map December, 1997 as analyzed by Caldwell (1998)
N
MDC 3/1999

Figure Lu05.

Spring River Tributaries Watershed

Watershed and Stream Projects



MDC 3/1999

Figure Lu06.

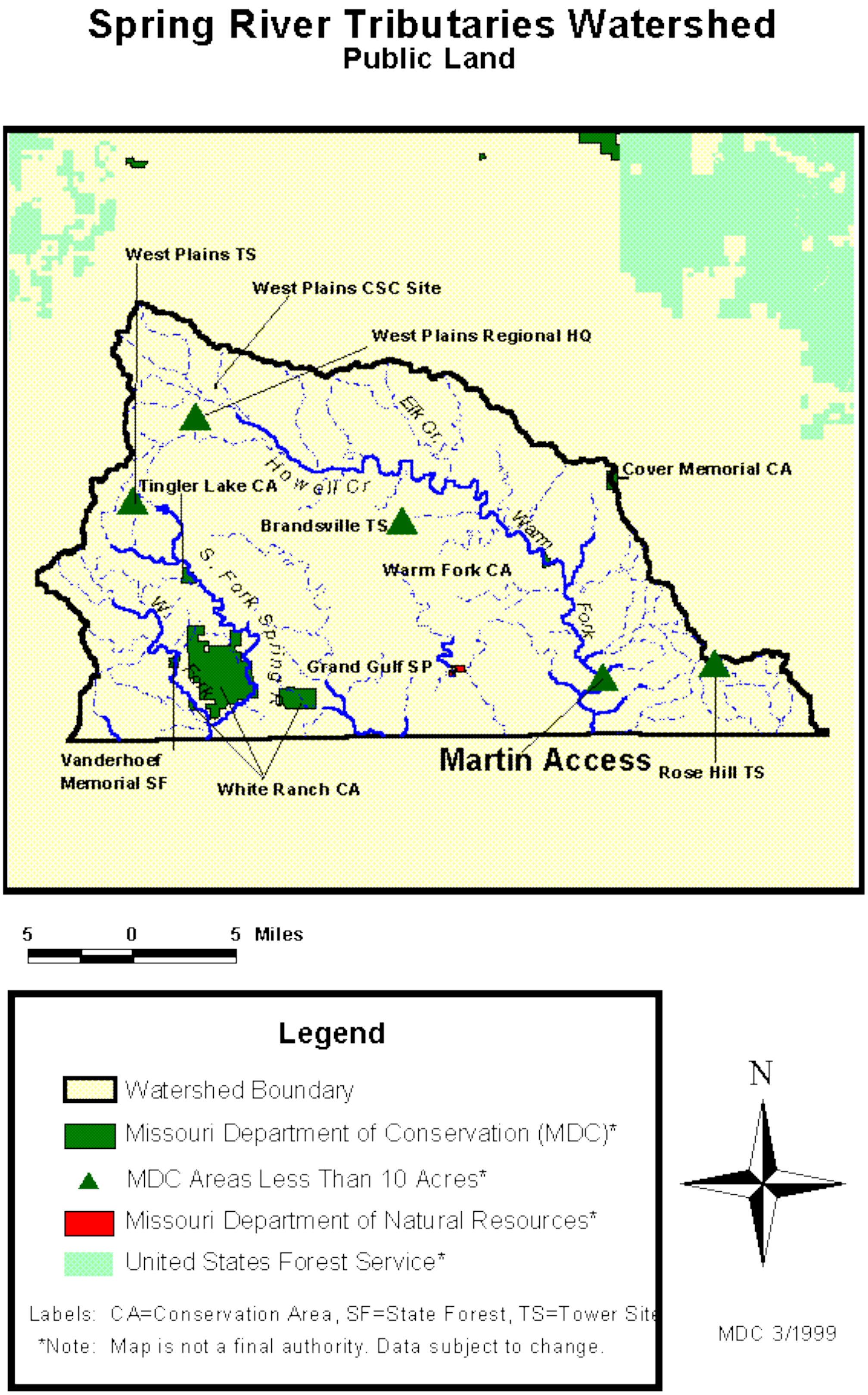

Spring River Tributaries Watershed
Public Land
West Plains TS
West Plains CSC Site
West Plains Regional HQ
Elk Cr
Howell Cr
Cover Memorial CA
Tingler Lake CA
Brandsville TS
Warm
Warm Fork CA
S. Fork Spring R
Fork
Grand Gulf SP
Vanderhoef
Memorial SF
White Ranch CA
Martin Access
Rose Hill TS
5 0 5 Miles
Legend
Watershed Boundary
Missouri Department of Conservation (MDC)*
MDC Areas Less Than 10 Acres*
Missouri Department of Natural Resources*
United States Forest Service*
Labels: CA=Conservation Area, SF=State Forest, TS=Tower Site
*Note: Map is not a final authority. Data subject to change.
N
MDC 3/1999

Table Lu01. Estimated acres of selected cultivated crops in Howell and Oregon Counties in 1902 versus 1997 (Williams 1904 and MASS 1999).

Crop	Howell County		Oregon County	
	1902 Acres	1997 Acres	1902 Acres	1997 Acres
Corn	47,686	IA	31,382	IA
Wheat	36,605	700	15,821	800
Oats	4,322	NO DATA	3,287	NO DATA
Hay	11,822	47,800	6,485	22,900
Forage	1,125	NO DATA	845	NO DATA
Broom Corn	26	NO DATA	5	NO DATA
Cotton	520	IA	895	IA
Tobacco	102	IA	50	IA
Potatoes	733	NO DATA	307	NO DATA
Vegetables	855	NO DATA	785	NO DATA

IA= insignificant amountTable Lu02. Descriptions of land type association (LTAs) groups as well as a condensed description of the two LTAs within the Spring River Tributaries Watershed, Missouri. Descriptions are quoted in part or whole from MDC (1997).

Oak Woodland Dissected Plains and Hills Group

- Landform: Distinguished by rolling to moderately dissected topography. Local relief is 75-150 feet. Very broad, flat ridges give way to gentle sideslopes and broad stream valleys. Karst plains with frequent shallow sinkhole depressions are common. Broad stream valleys most often occupied by losing streams, however occasional seeps do occur and can spread across substantial portions of a valley.
- **Geology:** Commonly underlain by Jefferson City-Cotter dolomites with a common loess cap. Some minor areas underlain by Roubidoux sandstones.
- **Soils:** Soils are variable, ranging from shallow to bedrock and fragipan soils, to deep, cherty and well-drained loams. Tree root growth is often restricted by bedrock, pans or clay mineralogy, especially high in the landscape.
- **Historic Vegetation:** Open woodlands with occasional prairie and savanna openings was the principal vegetation type. Post oak and black oak were the principal woodland tree species. Historic fire likely played an important role in maintaining an open canopy, sparse understory and a dense herbaceous ground flora. More dissected lands likely contained mixed oak woodland and forest. Unique sinkhole ponds, wet prairies and seeps were scattered in the broad valleys and depressions.
- **Current Conditions:** Currently a mosaic of fescue pasture (35-65% cover) and dense, often grazed oak forest. The transition from open grassland to closed forest is abrupt and the patch work blocky. Very few native grasslands or savannas are known, and the dense second growth woodlands have very little ground flora. Most sinkholes, wet prairies and seeps have been drained and heavily grazed. Many roads, towns, cities and businesses are located in these LTAs.
- **Howell-Oregon Oak Woodland Dissected Plain:** Dissected Plain in southern Howell and Oregon Counties. More dissection, better soils, and more existing timber than most other LTAs in this group.

Oak Savanna/Woodland Plains Group

- **Landform:** Very broad flat uplands slope gently to very broad flat drains or solution (karst) depressions. Local relief is less than 75 feet.
- **Geology:** Underlain mainly by Jefferson City-Cotter dolomites with a common loess cap. Minor areas of the Roubidoux formation occur. Headwater streams are nearly all losing.
- **Soils:** Fragipan soils or soils with shallow restrictive clays or bedrock are common, inhibiting tree root growth.
- **Historic Vegetation:** Oak savannas and woodlands with common prairie openings were the predominant historic vegetation. While few prairies were named by original land surveyors, early descriptions portray an open, "oak prairie" landscape. Fire likely played a principal role in maintaining a grassland-open woodland structure. Some sinkhole depressions would have had unique ponds and seeps.
- **Current Conditions:** The largest blocks and greatest acres of grassland (45-65% cover) are currently associated with these LTAs; grasslands are mainly fescue pasture. Less than 40% of these LTAs are timbered, mainly in dense, second growth oak forest (post and black oaks) with common grazing pressure. Very few quality native prairies, savannas, woodlands, sinkhole ponds or seeps are known. Many of the regions roads, towns, and businesses are associated with these LTAs.
- **West Plains Oak Savanna/Woodland Plain:** Very extensive, flat upland in the center of Howell County.

Table Lu03. Percent land use for 14 digit hydrologic units within the Spring River Tributaries Watershed. Data is based on MORAP Phase 1 Land Cover (1997) as analyzed by Caldwell (1998).

Subwatershed	FOR	WDL	GRS	CRP	URB	WAT
Upper Howell	24.4	8.2	52.1	1.8	13.3	0.1
Lower Howell	37.4	10.7	50.3	0.8	0.8	<0.1
Upper Warm Fork	55.9	12	31.7	0.3	0	<0.1
Middle Warm Fork	38.7	11.1	45.5	0.7	3.9	<0.1
Lower Warm Fork	54.9	11	33.7	0.3	0	0.2
Upper Myatt	35.1	9.1	54.4	1.2	0	<0.1
Lower Myatt	33.9	13.6	52.1	0.4	0	<0.1
Bussel Branch	31.7	11.4	55.8	0.7	0.3	<0.1
West Fork	40	8.3	50.3	1.3	0	<0.1
Upper South Fork	39.1	8.6	51	0.7	0	0.5
Lower South Fork	44.8	10.7	43.6	0.8	0	<0.1
Jane's Creek	48.2	11	40.4	0.3	0	<0.1
Spring River Tribs (total)	38.1	10.2	48.2	0.9	2.4	0.1

FOR =Forest, WDL=Woodland, GRS=Grassland, CRP=Cropland, URB=Urban, WAT=Water

Table Lu04. Public lands within the Spring River Tributaries Watershed, Missouri. For areas only partially within the watershed, total acreage is given in parenthesis. (MDC 1995; McPherson, personal correspondence).

Name	Owner[1]	Acres[2]	Stream Frontage (miles)[2]
Brandsville Towersite	MDC	5.7	-
Cover Memorial Wildlife Area	MDC	144(282)	-
Grand Gulf State Park	MDNR	108	-
Martin Access	MDC	8	0.33
Rose Hill Towersite	MDC	8	-
Tingler Lake Conservation Area	MDC	240	.3*
Vanderhoef Memorial State Forest	MDC	140	0.5
Warm Fork Conservation Area	MDC	159	0.9
West Plains Service Center Site	MDC	18	-
West Plains Regional Headquarters	MDC	1	-
West Plains Towersite	MDC	1.9	-
White Ranch Conservation Area	MDC	6579	2.1
TOTAL	-	7412.6	3.8

Note: Table is not a final authority. Data subject to change.

[1]Owner: MDC=Missouri Department of Conservation, MDNR=Missouri Department of Natural Resources.

[2]Estimates are approximate.

*Probably no flow however permanent pools.

Hydrology

Precipitation

The Spring River Tributaries Watershed average annual precipitation at West Plains from 1961-1990 was determined to be 45.09 inches. March had the highest average precipitation for the period of record at 4.63 inches (Figure Hy01) (Owenby and Ezell 1992).

United States Geological Survey Gage Stations

The United States Geological Survey (USGS) currently has no active surface gage stations within the Spring River Tributaries Watershed. No long-term continuous flow data exists within the watershed in Missouri. Three surface gage stations have existed within the watershed. These include 2 surface water quality stations and 1 peak flow station (Figure Hy02 and Table Hy01) (USGS 1997; USGS 1999a; and USGS 1999b). In addition, the Missouri Department of Natural Resources Water Quality Basin Plan (1994) provides a limited amount of discharge data for a few years between 1954-1967 for the Spring River (Warm Fork) at Thayer and for a few years between 1964-1970 for Myatt Creek at Lanton.

Average Annual and Peak Discharge

As stated previously no long-term flow data exists for the Spring River Tributaries Watershed. However, peak flow data is available for Station 07069100 on Adams Branch near West Plains, Missouri. Adams Branch is an unnamed, intermittent, 2nd order, losing stream which does not empty into any surface tributary according to United States Geological Survey 7.5 minute topographical maps. Twenty five peak discharge measurements were obtained from 1955 to 1979. Mean peak discharge at this station was 374 cubic feet per second (cfs). Maximum and minimum peak discharge measurements were 1,040 cfs and 164 cfs respectively (USGS 1999b). A single discharge measurement was also obtained from unpublished USGS water quality data. This measurement was 9.3 cfs and was for Station 07069150 (Spring River at Thayer) in December 1964 (USGS 1999a). In addition, Duchrow (1977) obtained discharge measurements for the invertebrate sampling site swf-0 at Thayer, Missouri as part of a water quality analysis project (Figure Bc03). Duchrow gave four measurements for all four collections at site swf-0 in 1974. The average of these four measurements was 125 cfs. Peak discharge occurred in the second sample in May at 231 cfs (Table Hy02) (Duchrow 1974).

It must be noted that the previous data is not a substitute for continuous long-term data. However, unless a means of gathering continuous long-term data is implemented within the watershed, sporadic instantaneous discharge measurements will continue to be relied upon.

7-day Q^2 and Q^{10} Low Flow Values

The Missouri Department of Natural Resources (1994) gives 7 day Q^2 and Q^{10} low flows for two sites within the Spring River Tributaries Watershed. The Spring River (Warm Fork) at Thayer, Missouri has a 7 day Q^2 low flow of 2.0 cfs and a 7 day Q^{10} low flow of 0.1 cfs. Myatt Creek at Lanton has a 7 day Q^2 low flow of 0.2 cfs and a 7 day Q^{10} low flow of 0.

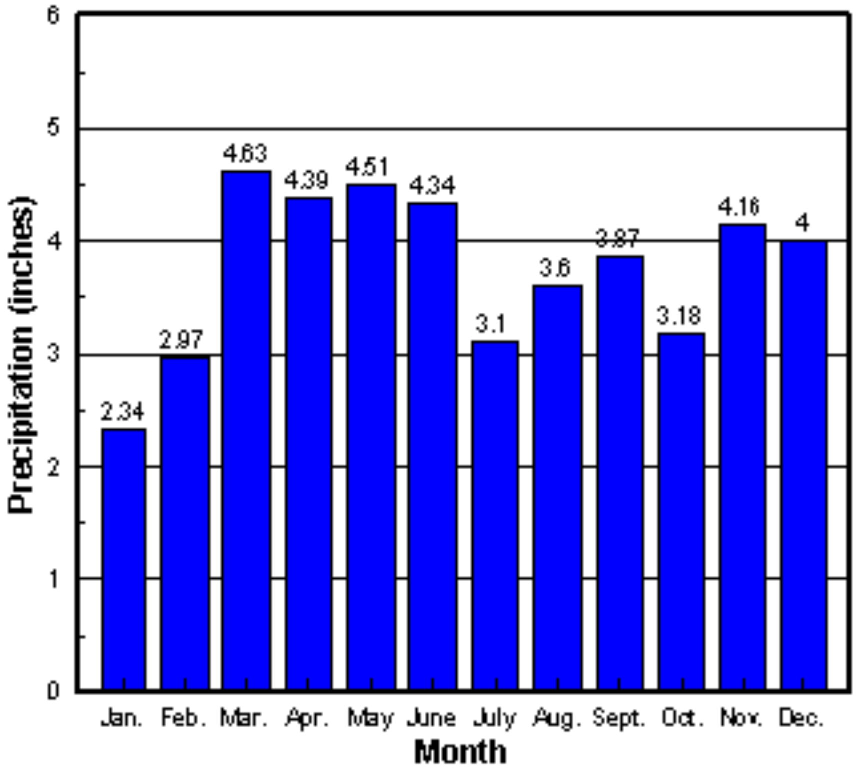
Duration Table of Daily Flows and Mean Annual Discharge

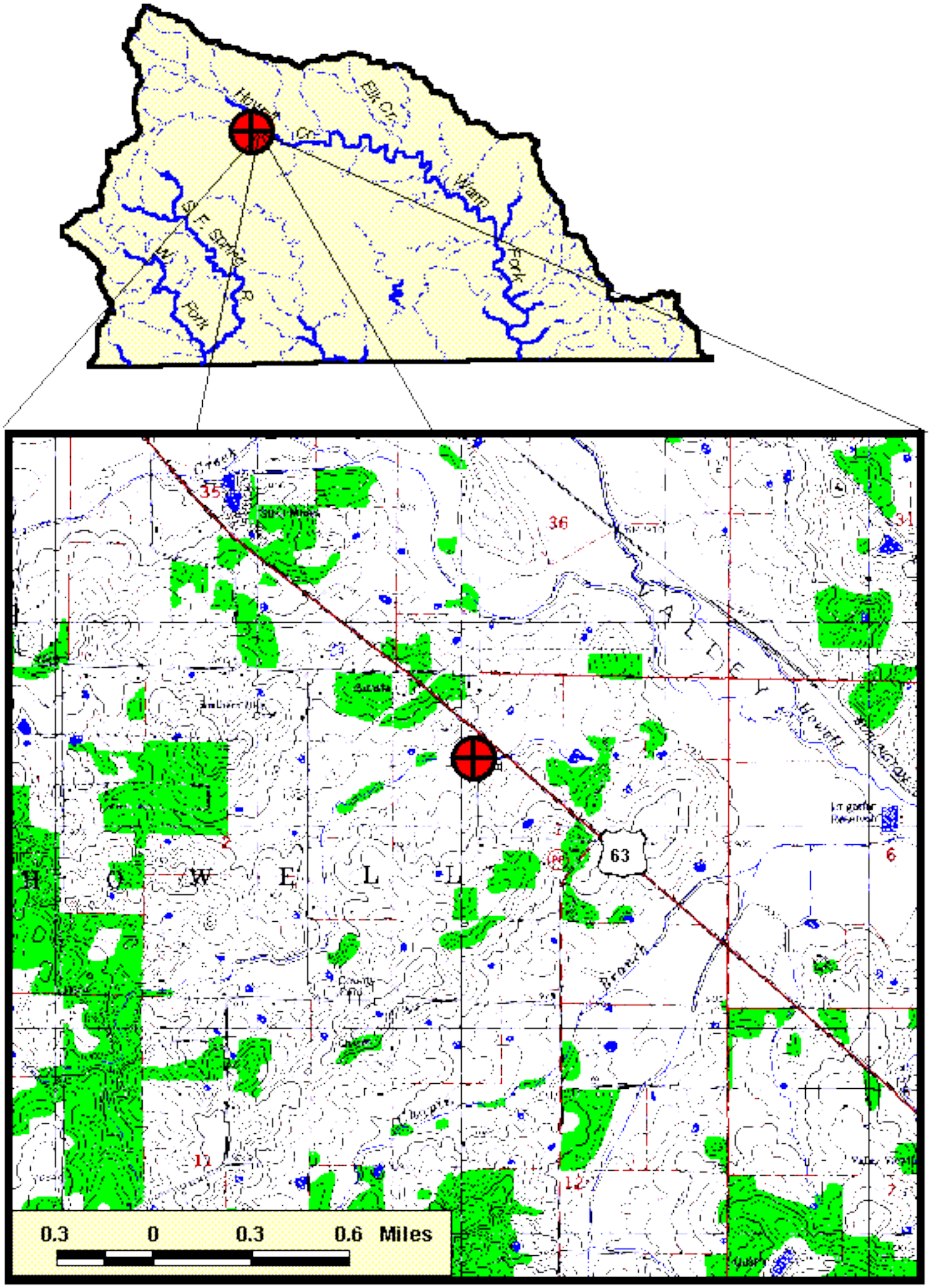
Sufficient data is currently unavailable to accurately determine flow duration.

Flood Frequency

Sufficient data is currently unavailable to accurately determine flood frequency.

Figure Hy01. Average Monthly precipitation at West Plains, Missouri for 1961-1990 period of record (Owenby and Ezell 1992).





Topographic Map Layer Source: USGS 7.5 minute topographic digital raster graphic (drg) "West Plains, Missouri".

Table Hy01. Gage stations in the Spring River Tributaries Watershed in Missouri (USGS 1997, USGS 1999a, and USGS 1999b).

Station #	Station Name	Period of Record	Type
7069100	Adams Branch near West Plains, Missouri	1955-1979	Peak
7069150	Spring River (Warm Fork) at Thayer, Missouri	1964	Water Quality
7069170	Spring River (Warm Fork) near Thayer, Missouri	1969-1975	Water Quality

Table Hy02. Discharge measurements as indicated by Duchrow (1974) for invertebrate sample site swf-0 on the Warm Fork of the Spring River.

Date	Discharge (cfs)
1/15/74	131
5/28/74	231
7/29/74	92
11/25/74	46
Average	125

Water Quality and Use

Little surface water quality data exists for the Spring River Tributaries Watershed. Much of the existing data is over 20 years old and thus is insufficient for drawing a present day conclusion. However, once contemporary data is obtained it may be possible to perform a limited comparison between present and past surface water quality.

The United States Geological Survey (USGS) periodically measured chemical and physical water quality conditions at two locations on the Warm Fork of the Spring River within the Spring River Tributaries Watershed in Missouri in the 1960s and early 1970s. Water quality data was collected at Station 07069150 at Thayer, Missouri in December of 1964. Several water quality measurements were also collected at Station 07069170 near Thayer, Missouri from 1969 to 1975 (Tables Wq01 and Wq02) (USGS 1999a). Station 07069170 experienced fecal coliform levels exceeding state standards for whole body contact recreation (200 col. per 100 ml) in 6 of 21 samples (MDNR 1996a and USGS 1999a).

Duchrow (1977) collected a total of 74 taxa of aquatic invertebrates from two sites on the Warm Fork of the Spring River during a water quality/aquatic invertebrate study. Site Swf-4 was located above Thayer and site Swf-0 was located below Thayer (Figure Bc03). Water quality was evaluated by comparing calculated species diversity index values to established standards for Missouri streams (Tables Wq03 and Wq04). Both sites exhibited similar invertebrate communities. Many pollution sensitive invertebrates were collected. Water quality parameter values at these did not meet established criteria for unpolluted Missouri streams annually; however, they did meet this criteria seasonally. According to Duchrow, the Warm Fork of the Spring River exhibited "characteristics of an unpolluted Missouri stream" despite the sources of pollution existing within the watershed. He adds that productivity within the stream appeared to be higher than that of the Jack's Fork and Current Rivers. This was probably due to the increased nutrient input from the large amount of pasture in the watershed as well as treated sewage effluent (Duchrow 1977).

Ground water quality has been documented to be less than desirable periodically in the watershed. Turbidity has been a problem for both municipal and private wells within the watershed (Vaughn 1998). Water quality tests performed by the Missouri State Public Health Laboratory in Springfield on 171 private wells in Howell County from July 1998 to August 1999 indicate that 70 well samples tested were unsafe. A well is considered unsafe if any Coliform exists in the sample (Farmer, personal communication).

Water Use

Water use within the Spring River Tributaries Watershed is relatively high. Data obtained from the United States Geological Survey National Water Use Database (1999b) indicate that total water withdrawn within the watershed in 1995 was 4.29 million gallons per day (mgd) (Table Wq05). This is more than the total amount of water withdrawn within the Eleven Point Watershed at 4.08 mgd. Reasons for this difference are undoubtedly due to the higher population density within the Spring River Tributaries Watershed.

Nearly all of the water withdrawn in the Spring River Tributaries Watershed comes from groundwater. Ground water withdrawn within the watershed is 3.85 million gallons per day (mgd) while surface water withdrawn is 0.44 mgd (USGS 1999B). All surface water withdrawn is for livestock use.

Domestic water use is the most prevalent use within the Spring River Tributaries Watershed. Domestic deliveries from public water supplies in 1995 equaled 1.02 million gallons per day.

Self-supplied water withdrawn in 1995 equaled 0.82 million gallons per day (Table Wq07) (USGS 1999b).

The Missouri Department of Natural Resources maintains records of "major" users (those facilities capable of withdrawing 100,000 gallons/day) of surface and ground water throughout the state. Recent records (1993) indicate that although there are no major surface water users, three major ground water users exist within the Spring River Tributaries Watershed. The major ground water users include the cities of West Plains and Thayer as well as Richards R-V School District. Annual water withdrawals (million gallons/year) for West Plains, Thayer, and Richards R-V School District are 716, 522, and 165 respectively (MDNR 1993).

The amount of water withdrawn in the watershed is likely to continue to rise in the upper portion of the watershed with a projected increase in the population of Howell County. Projections of population increase of Missouri counties have been calculated by the Missouri Office of Administration (MOA), Division of Budget and Planning for three different projection scenarios in a report entitled "Projections of the Population of Missouri Counties By Age, Gender, and Race: 1990 to 2020" (http://www.oa.state.mo.us/bp/popproj/index.htm)(MOA 1994). The combined population for Howell and Oregon Counties is expected to increase 6% to 27% by the year 2020.

Rule 10 CSR 20-7.031 of the Rules of Department of Natural Resources Division 20-Clean Water Commission Chapter 7-Water Quality identifies beneficial uses of the waters of the state of Missouri in order that water quality standards are established for protection of those uses. Table Wq06 lists designated uses for streams of the Spring River Tributaries Watershed. Beneficial use designations have been determined for 13 reaches representing 10 streams within the Spring River Tributaries Watershed. All listed streams must meet criteria for "protection of warm water aquatic life and human health-fish consumption" as well as "livestock and wildlife watering". The Warm Fork of the Spring River, in addition to the previously mentioned uses, must also meet water quality standards for irrigation, whole body contact recreation, and boating/canoeing from the State Line to Section 25, Township 23 North, Range 6 West (MDNR 1996a).

Section 303d of the federal Clean Water Law requires that states identify those waters for which current pollution control measures are inadequate. This is accomplished by comparing data from those waters with water quality criteria established for designated beneficial uses of those waters (MDNR 1999b).

Those waters are then included in the 303(d) list. The state must then conduct Total Maximum Daily Load (TMDL) studies on those waters in order to determine what pollution control measures are required and then insure those measures are implemented (MDNR 1999a). The Final 1998 303(d) list for Missouri includes 0.3 miles of Howell Creek (MDNR 1999c). The pollutant at this site is chlorine associated with the West Plains waste water treatment plant. The Clean Water Act requires that the list be updated every 2 years thus the next 303(d) list should be available in the year 2000 (MDNR 1999b).

Point Source Pollution/Nonpoint Source Pollution

Table Wq07 lists the eleven National Pollution Discharge Elimination System (NPDES) sites currently within the Spring River Tributaries Watershed (Figure Wq01). The cities of West Plains and Thayer, Missouri are the only permitted (by MDNR) municipal wastewater discharges within the watershed in Missouri (MDNR 1998a). As of 1994, the Thayer waste water treatment facility (WWTF) was discharging 0.23 million gallons per day (mgd) into the Warm Fork. The

West Plains WWTF, located on Howell Creek, was the largest NPDES discharge within the watershed. As of 1994 the West Plains WWTF was discharging 1.7 mgd; normally accounting for the entire flow of Howell Creek at this point of the stream. It was determined that water quality problems were caused by this discharge for 1 to 2 miles of stream (MDNR 1994). Howell Creek is a losing stream for its entire reach (MDNR 1984). For this reason, the potential for groundwater contamination is always present. This is perhaps best illustrated by an incident that occurred in 1978: The bottom of the West Plains sewage lagoon collapsed into a sinkhole releasing a large amount of sewage into the groundwater system. A dye trace indicated that this sewage was transported through the system to Mammoth Spring, Arkansas; a distance of 20 miles, in 12 days (MDNR 1984).

The Missouri Department of Natural Resources, Division of Geology and Land Survey has identified 10 active and 122 prospecting or historical mining operations within the Spring River Tributaries Watershed in Missouri. Of the 10 active mines, all are gravel pits or limestone quarries (MDNR 1998b). There are currently no permitted in-stream gravel operations within the watershed (Zeaman, personal communication). However, it is highly likely that unpermitted sites exist within the watershed. The majority of historical mining sites are past producers of iron. Nearly all of these are surface mines which dot the watershed (MDNR 1998). Due to the karst nature of the watershed, these surface mines have the potential to allow pollutants into the ground water system.

Land disruption from road and bridge construction, as well as urban expansion, often results in increased sediment loads to receiving water systems. Bridge construction also results in stream channel modification, which affects stream flow both up and downstream from the bridge. Since 1995 there have been fourteen 404 permitted operations within the Spring River Tributaries Watershed in Missouri (Table Hc01 and Figure Wq02) (USCOE 1999). Seven of these involved bridge work. According to the Missouri Department of Transportation Highway and Bridge Construction Schedule
http://www.modot.state.mo.us/accountability/stip/South_Central_Area.htm , there currently (11/6/98) are 2 state highway projects involving bridge work scheduled within the watershed from 1999-2003 (Table Hc02).

Currently (1999) significant land disruption corresponding to highway construction and urban expansion is occurring in the upper portion of the Spring River Tributaries Watershed. Much of this land has been left devoid of vegetation for extended periods of time thus increasing its susceptibility to erosion. While little permanent surface water exists in this portion of the watershed, the increased sediment load may eventually alter the ability of intermittent streams to carry off excess water during periods of flooding. In addition, due to the number of losing stream miles in this portion of the watershed, some sediments as well as incidental pollutants from construction sites could potentially reach groundwater. As stated previously, ground water quality problems have been experienced within the watershed.

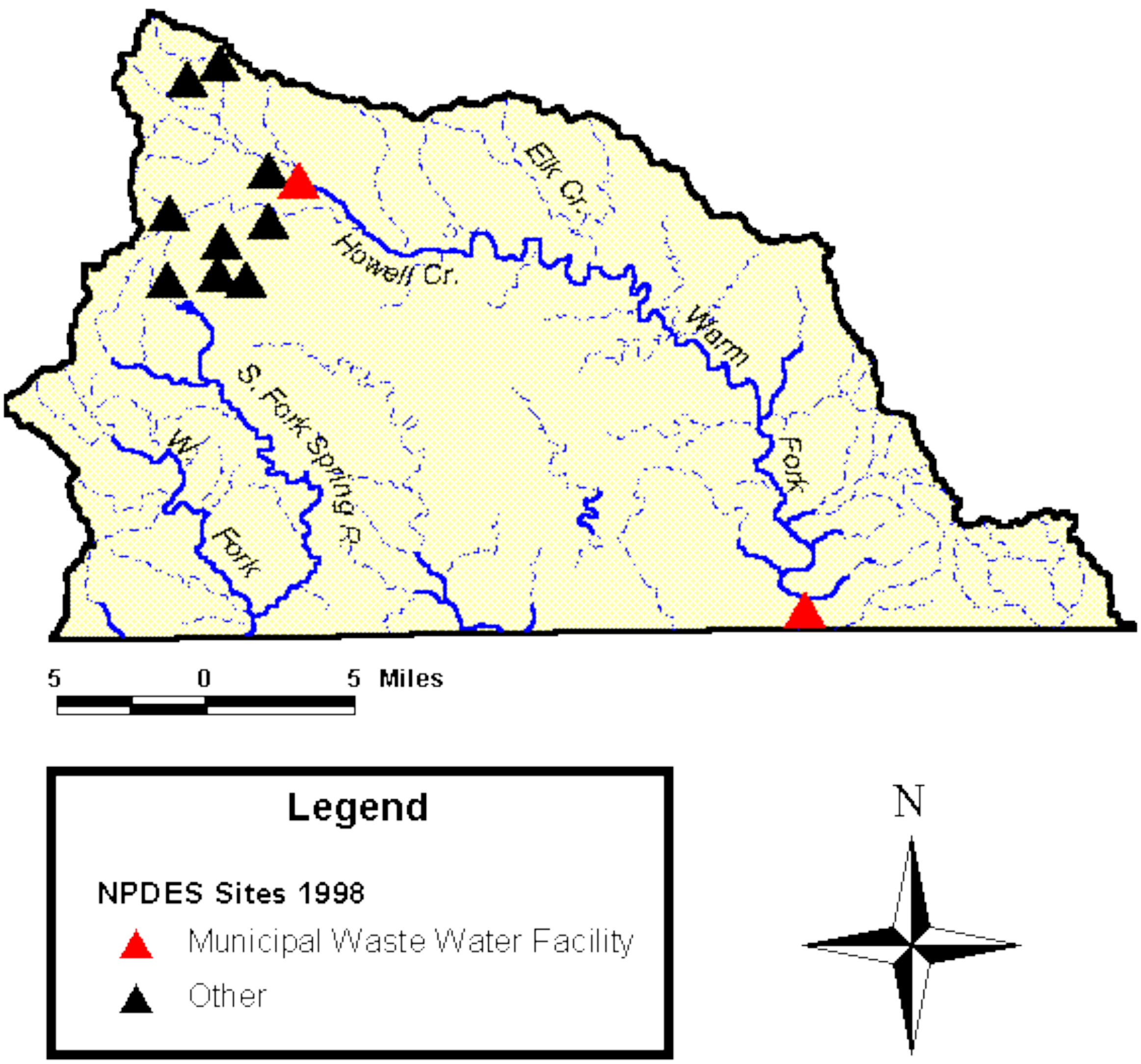
According to MDNR (1984), livestock waste constitutes a major percentage of the Spring River Tributaries Watershed’s total organic waste. This contributes to the Biological Oxygen Demand (BOD), suspended solids, fecal coliform, and fecal streptococci loads (MDNR 1984). The number of cattle and hogs within the watershed has been estimated to be 52,599 in 1993. This has been calculated based on numbers by county, as indicated by 1994 Missouri Farm Facts (MDA and USDA 1994), multiplied by percent of total county area occupied by the watershed. As in other parts of the state, a large number of cattle in the watershed are on pasture and many spend a large portion of their time in or near stream channels. Results of this include increased organics and bacterial loading, turbidity, and high concentrations of algae (MDNR 1984). Another possible impact occurs when "no discharge" lagoons or pits serving confined lots discharge to streams. In 1984, there were 15 of these facilities which generated 27,024 PE of waste in the Spring River Tributaries Watershed (MDNR 1984).

Fish Kills

Since 1980 no fish kills have occurred as a result of pollution incidents within the Spring River Tributaries Watershed (MDC 1999). In December of 1997 a lack of stream flow as well as the icing of the stagnant pools is believed to have contributed to low dissolved oxygen levels resulting in a fish kill on the Warm Fork near Warm Fork Spring (Mayers, Personal Communication).

Figure Wq01.

Spring River Tributaries Watershed
National Pollution Discharge Elimination System (NPDES) Sites 1998

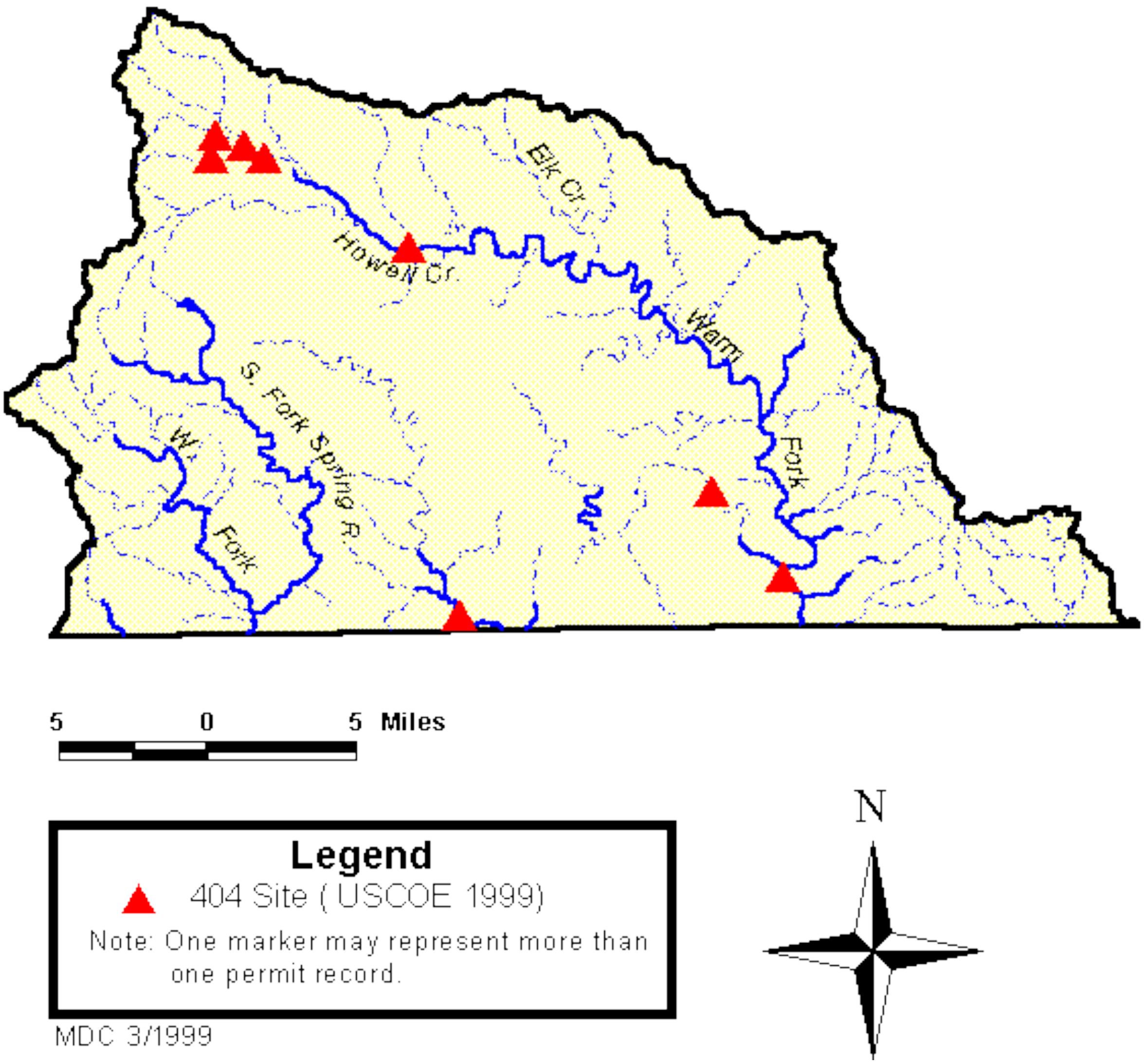


MDC 3/1999

Figure Wq02.

Spring River Tributaries Watershed

404 Sites



MDC 3/1999

Table Wq01. Water quality measurements for the Warm Fork of the Spring River at Thayer for January and December 1964 (USGS 1999a).

Discharge (cfs)	9.3
Color (Platinum - Cobalt units)	2
Specific conductance (US/CM)	424
pH water whole field (standard units)	8
Carbon Dioxide dissolved (mg/l as CO_2)	4.5
ANC water unfiltered fet field (mg/l as HCO_3)	280
ANC unfiltered carbon fet field (mg/l as CO_3)	0
Hardness total (mg/l as $CaCO_3$)	240
Hardness non Ca WH WA total fl (mg/la $CaCO_3$)	4
Calcium dissolved (mg/l as Ca)	50
Magnesium dissolved (mg/l as Mg)	27
Sodium dissolved (mg/l as Na)	1
Sodium adsorption ratio	0
Sodium percent	1
Potassium dissolved (mg/l as K)	1.3
Chloride dissolved (mg/l as Cl)	1.1
Sulfate dissolved (mg/l as SO_4)	4.2
Fluoride dissolved (mg/l as F)	0
Silica dissolved (mg/l as SiO_2)	7.5
Solids, Manganese dissolved (ug/l as Mn)	213
Solids, residue at 180 deg. C dissolved (mg/l)	232
Sum of constituents dissolved (mg/l)	5.35
Solids, dissolved (tons per day)	0.29
Nitro-Solids, dissolved (tons per acre feet)	0.8
Iron (ug/l as Fe)	20

Table Wq02. Water quality measurements for the Warm Fork of the Spring River below Thayer for January and July of 1970 and 1972 (USGS 1999a).

	Jan-70	Jan-72	Jul-70	Jul-72
Temperature water (deg. C)	5.5	8.5	24.5	26
pH Water Whole Field (standard units)	8.1	8.1	8.3	7.9
Specific conductance (US/CM)	438	370	424	440
Oxygen dissolved (mg/l)	13.2	8.2	6.8	6
Oxygen dissolved (percent saturation)	105	70	81	73
Coliform, total immed. (cols. per 100 ml)	18			
Coliform, fecal, 0.45 um-mf (cols./100 ml)		24	75	990
ANC water unfiltered fet field (mg/l as $CaCO_3$)	261	223	242	249
ANC water unfiltered fet field (mg/l as HCO_3)	320	270	300	300
ANC unfiltered carbon fet field (mg/l as CO_3)	0	0	0	0
Carbon Dioxide dissolved (mg/l as CO_2)	4	3.4	2.4	6..1
Nitrogen, Ammonia dissolved (mg/l as N)	0.05		0	
Nitrogen, organic total (mg/l as N)	0.09	0.01	0.21	0.04
Nitrogen, Nitrate total (mg/l as N)		0.9		0.36
Nitrogen, Ammonia total (mg/l as N)		0		0.04
Phosphate, ortho, dissolved (mg/l as PO_4)			0.04	
Phosphorus total (mg/l as P)	0.24	0.02		0.15
Phosphorus dissolved (mg/l as P)	0.04	0.01		0.14
Hardness total (mg/l as $CaCO_3$)	260	230	240	250
Calcium dissolved (mg/l as Ca)	52	46	50	57
Magnesium dissolved (mg/l as Mg)	32	27	28	26
Sodium dissolved (mg/l as Na)	2.7	1.8	1.6	2.7
Sodium adsorption ratio	0.1	0.1	0	0.1
Sodium percent	2	2	1	2
Potassium dissolved (mg/l as K)	1.4	1.5	1.4	1.8
Chloride dissolved (mg/l as Cl)	1.9	2.1	1.4	3.2
Sulfate dissolved (mg/l as SO_4)	4.8	7	3.8	3.2
Fluoride dissolved (mg/l as F)	0.1	0	0.1	0.6
Silica dissolved (mg/l as SiO_2)	3.8	6.4	8.2	10
Iron, dissolved (ug/l as Fe)	4	0	90	0
Manganese, dissolved (ug/l as Mn)	15	50	10	10

	Jan-70	Jan-72	Jul-70	Jul-72
Methylene Blue active substance mg/l	0.02		0.03	0.03
Solids, residu at 180 deg. Dissolved (mg/l)	245		231	263
Solids, sum of constituents dissolved (mg/l)	257		244	256
Nitrogen, Ammonia dissolved (mg/l as NH_4)	0.06		0	
Nitrogen, Ammonia total (mg/l as NH_4)				0.05
Nitrogen, Nitrate dissolved (mg/l as NO_3)	0.08		2.6	
Hardness noncarb WH WA tot Fl mg/l as $CaCO_3$	0		0	0
Streptococci Fecal, (cols. per 100 ml)	16	120	320	1600

Table Wq03. Summary of Duchrow's 1977 annual water quality parameter values for stations within the Spring River Tributaries Watershed, Missouri.

Location	[1]Species Diversity Index Value	Number of Mayfly and Stonefly Taxa
Swf-0 (Warm Fork below Thayer, Missouri)	6.4	23
Swf-4 (Warm Fork above Thayer, Missouri)	6	22

Table Wq04. Water quality designations based on invertebrate insect population data for Missouri streams as used by Duchrow (1977).

Water Quality	**Seasonal**		**Annual**	
	Species Diversity Index Designation	# of Mayfly & Stonefly Taxa	Species Diversity Index Value[1]	# of Mayfly & Stonefly Taxa
Unpolluted	>3.9	>9	>6.9	>21
Moderately Polluted	2.2-3.9	5-9	3.8-6.9	10-21
Polluted	<2.2	<5	<3.8	<10

[1]Species Diversity Index Value=D= (s-1)/(logeN); where "s" equals the number of taxa and "N" is the total number of organisms in the sample.

Table Wq05. Water use within the Spring River Tributaries Watershed in Missouri (1995) based on withdrawals in millions of gallons per day (USGS 1999b).

Use	Ground Water	Surface Water	Total
Public Supply (Total)	2.78	0	2.78
Domestic (delivered)			1.02
Commercial (delivered)			0.21
Industrial (delivered)			0.17
Self-Supplied (Total)	1.07	0.44	1.51
Domestic	0.82	0	0.82
Commercial	0.06	0	0.06
Livestock	0.15	0.44	0.59
Irrigation	0.04	0	0.04
Total	3.85	0.44	4.29

Table Wq06. Missouri Department of Natural Resources use designations for selected streams within the Spring River Tributaries Watershed, Missouri (MDNR 1996a). Locations are given in section, township, range format.

Stream Name	Miles	From	To	Designated Use*
Anthony Br.	0.5	Mouth	06,22n,05w	lww,aql
Elkhorn Br.	1.5	Mouth	05,21n,08w	lww,aql
English Cr.	2.5	State Line	33,22n,06w	lww,aql
Howell Cr.	14	08,23n,06w	22,24n,08w	lww,aql
Trib. to Howell Cr.	1	Mouth	12,23n,07w	lww,aql
Myatt Cr.	11.5	State Line	05,22n,07w	lww,aql
S.F. Spring R.	4	State Line	35,22n,08w	lww,aql
S.F. Spring R.	11	32,22n,08w	32,23n,08w	lww,aql
Trib. to S.F. Spring R.	1	34,22n,08w	34,22n,08w	lww,aql
W.F. Spring R.	2.5	31,22n,08w	31,22n,08w	lww,aql
W.F. Spring R.	9.5	10,22n,09w	10,22n,09w	lww,aql
Warm Fork Spring R.	12	25,23n,06w	25,23n,06w	irr,lww,aql,wbc,btg
Warm Fork Spring R.	10	08,23n,06w	08,23n,06w	lww,aql

Note: This table is not presented as a final authority.
*irr-irrigation
clf-cool water fishery
lww-livestock & wildlife watering cdf-cold water fishery
aql-protection of warm water aquatic life
wbc-whole body contact recreation and human health-fish consumption. btg-boating & canoeing
dws-drinking water supply ind-industrial

Table Wq07. National Pollution Discharge Elimination System (NPDES) permit sites within the Spring River Tributaries Watershed in Missouri (MDNR 1998a).

Facility Name	Receiving Stream	Facility Type	County
Doss & Harper	Trib. Howell Creek	Lime Quarry	Howell
Glenwood R-VIII School	Trib. Mustion Creek	School	Howell
Henry's Mhp	Trib. Spring Creek	Mobile Home Park	Howell
MFA Oil	Trib. Howell Creek	Petroleum Storage	Howell
Moark Quarries	Trib. Mustion Creek	Sand Washing	Howell
Moark Quarries	Trib. Mustion Creek	Lime Quarry	Howell
S&S Quarry	Trib. Mustion Creek	Quarry	Howell
Thayer WWTF	Warm Fork	City Waste Water Plant	Oregon
Von Allmen Mobile Estates	Mustion Creek	Mobile Home Park	Howell
West Plains Landfill	Trib. Howell Creek	Landfill	Howell
West Plains WWTF	Howell Creek	City Waste Water Plant	Howell

Note: This table is not a final authority. Data subject to change.

Habitat Conditions

Channel Alterations

For the most part, there have been no significant channel alterations within the Spring River Tributaries Watershed. Based on comparison of 1971 and 1995 aerial photos of the West Plains area, as well as personal observations, some channel alterations undoubtably have occurred in this area as a result of urban expansion and development. However, it is difficult to estimate the time and extent of channel alterations in this portion of the watershed. Small channelization projects have probably occurred elsewhere on private property and also from road and bridge construction. However, it is difficult to estimate the extent to which this has affected the watershed. Since 1995 there have been fourteen 404 permitted operations within the watershed. Seven of these have involved bridge work (Table Hc01 and Figure Wq02) (USACOE 1999). According to the Missouri Department of Transportation Highway and Bridge Construction Schedule (http://www.modot.state.mo.us/accountability/stip/South_Central_Area.htm), there currently (11/6/98) are 2 state highway projects involving bridge work scheduled within the watershed from 1999-2003 (Table Hc02).

Natural Features

In the late 1980s and early 1990s the Missouri Department of Conservation inventoried counties within the Spring River Tributaries Watershed for unique natural features (Nigh 1988; Ryan and Smith 1991). The inventories recognized seven categories of natural features: examples of undisturbed natural communities, habitat of rare or endangered species, habitat of relict species, outstanding geological formations, areas for nature studies, other unique features, and special aquatic areas having good water quality, flora, and fauna. Since this effort other natural features have been added to what is now the Missouri Natural Heritage Database. Currently the database contains 97 features for the Spring River Tributaries Watershed. These include 13 examples of 8 types of presettlement terrestrial natural communities: Dry-mesic chert prairie-1, Fen-1, Flatwoods-1, Freshwater marsh-1, Pond shrub swamp-4, Prairie fen-3, Wet prairie-1, Wet-mesic prairie-1.

A detailed description of these terrestrial natural communities can be found in The Terrestrial Natural Communities of Missouri by Nelson (1987). Due to the large percentage of privately owned land and thus limited access within the watershed, it is probable that other unknown examples of these terrestrial natural communities exist within the watershed.

Improvement Projects

Currently there is one Missouri Department of Conservation stream habitat improvement project in the Spring River Tributaries Watershed. This project is a cedar tree revetment constructed in 1992 at White Ranch Conservation Area. The purpose of the project is to reduce stream bank erosion on a portion of the South Fork of the Spring River.

Stream Habitat Assessment

Perhaps one of the more difficult attributes of a watershed to attempt to quantify is stream habitat. This is due to the fact that there are several dynamic characteristics which make up stream habitat. To evaluate all of these characteristics individually and accurately for an entire watershed is a monumental task.

Thus, the next best thing is to evaluate a characteristic that has the most impact on all aspects of stream habitat. This is, arguably, riparian corridor land cover/land use. Riparian corridor land cover/land use has many effects on characteristics stream habitat. These include, but are not limited to water temperature, turbidity, nutrient loading, sand/gravel deposition, instream cover, flow, and channel width and stability. These in turn have effects on still other characteristic of stream habitat such as dissolved oxygen, spawning habitat, etc.

Evaluation of riparian corridor land cover/land use within the Spring River Tributaries Watershed was accomplished using Missouri Resource Assessment Partnership Phase 1 Land Use Data (morapmd.wpd). A buffer zone 3 pixels (90 meters) wide was created which corresponded to a 1:100,000 hydrography coverage for the watershed. This was split into segments no longer than 0.25 miles long (Caldwell, personal communication). Percent land cover/land use for each segment was then calculated. Land cover/land use categories included forest, woodland, grassland, cropland, urban, and water. Percentages of these categories were then calculated for riparian corridors within each of the 12 fourteen digit hydrologic units within the watershed as well as the whole watershed. Results for the entire watershed indicate that corridor land cover/land use consists of slightly more forest/woodland (49.8%) than grassland/cropland (48.1%). Combined percentages for the remaining categories are less than 3% of the total riparian corridor land use in the watershed. The Upper Warm Fork Unit had the highest amount of forested corridor at 55.6%. While the Upper Howell Creek Unit had the highest percentage of Grassland at 60.1%. Upper Howell Creek also had the highest percentage of urban land within the corridor at 11.4% (Table Hc03 and Figure Hc01). It is important to note due to the generally impervious nature of the urban landscape; the associated high amount of runoff can increase the tendency of streams to flash flood. It is also important when considering the effects of storm water runoff which can transport many different types of pollutants.

As with many Ozark streams, water temperatures within the Spring River Tributaries Watershed are significantly affected by springs in many places. In an effort to determine the extent of coldwater influence, instantaneous temperature readings were taken at many stream crossings within the watershed during the summers of 1996-1998. In addition, long term temperature monitors (thermographs) were deployed at 11 sites within the watershed in the summer of 1997 and at 14 sites in the summer of 1998. The period of record ranged between 24 and 77 days. The thermographs were programmed to record a water temperature every 2 hours. Data was analyzed based on the percent of 24 hour periods within the period of record that had a minimum temperature of 70 degrees Fahrenheit or less. Four sites had a minimum temperature of 70 degrees Fahrenheit or less for all 24 hour periods in the period of record in both 1997 and 1998. Site B86, which had records for one summer (1998), also had minimum temperatures of 70 degrees Fahrenheit or less for all 24 hour periods within the period of record (Table Hc04, Figures Hc02 and Hc03).

Table Hc01. Operations within the Spring River Tributaries Watershed having 404 Permits since 1995 (USACOE 1999).

Work Type	Permit Date	Stream Name	Linear Feet Affected
Bridge	16-Dec-98	S. Fork Howell Cr.	425
Bridge	24-Jun-98	S. Fork Howell Cr.	None Given
Bridge Replacement	29-Apr-97	S. Fork Howell Cr.	None Given
Bridge	12-Feb-97	S. Fork Howell Cr.	None Given
Bridge Replacement	19-Jan-96	S. Fork Howell Cr.	None Given
Bridge	22-Sep-97	Little Greasy Cr.	30
Bridge	19-May-97	Burton Cr.	100
Fill	11-Apr-98	Twomile Cr.	None Given
Gravel Removal	11-Jun-98	Myatt Cr.	None Given
Pier	31-Jul-96	Warm Fork	None Given
Pier	31-Jul-96	Warm Fork	None Given
Utility Line	7-Sep-95	Howell Cr.	None Given
Utility Line	7-Sep-95	Howell Cr.	None Given

Note: This table is not a final authority. Status of permits subject to change.

Table Hc02. Missouri Department of Transportation road and bridge construction projects scheduled thru 2003 within the Spring Tributaries Watershed in Missouri (MDT 1999). Name of affected stream given in parenthesis.

Route	Location	Project
Highway 142	1.8 miles and 3.2 miles west of Rte. 17.	Grading, paving, and bridges on 2 disconnected sections.
Route JJ	6.7 and 8.0 miles south of Rte. 160.	Grading, paving, and replace bridges on 2 disconnected sections (Not Given).

Table Hc03. Percent riparian corridor land cover/land use for 14 digit hydrologic units within the Spring River Tributaries Watershed, Missouri. Data is based on MORAP Phase 1 Land Cover (1997). The largest land cover type for each hydrologic unit is given in bold.

Hydrologic Unit	FOR	WDL	GRS	CRP	URB	WAT
Upper Howell	18.8	8.1	60.1	1.5	11.4	0.2
Lower Howell	41.6	10.9	46.4	0.7	0.5	0
Upper Warm Fork	55.6	14.9	29.4	0.1	0	0
Middle Warm Fork	38.3	16.6	40.9	0.3	3.8	0.1
Lower Warm Fork	47.2	19.1	33.5	0	0	0.2
Upper Myatt	34.7	11.3	52.8	1.2	0	<0.1
Lower Myatt	37	18.8	43.8	0.4	0	<0.1
Bussel Branch	30.1	11.5	57.8	0.3	0.3	0
West Fork	38.3	12.7	48.3	0.6	0	<0.1
Upper South Fork	40.9	12	46.7	0.4	0	<0.1
Lower South Fork	34.8	11.9	52	1.2	0	<0.1
Jane's Creek	33.8	9.3	56.5	0.4	0	<0.1
Spring River Tribs (total)	37.3	12.5	47.4	0.7	2	<0.1

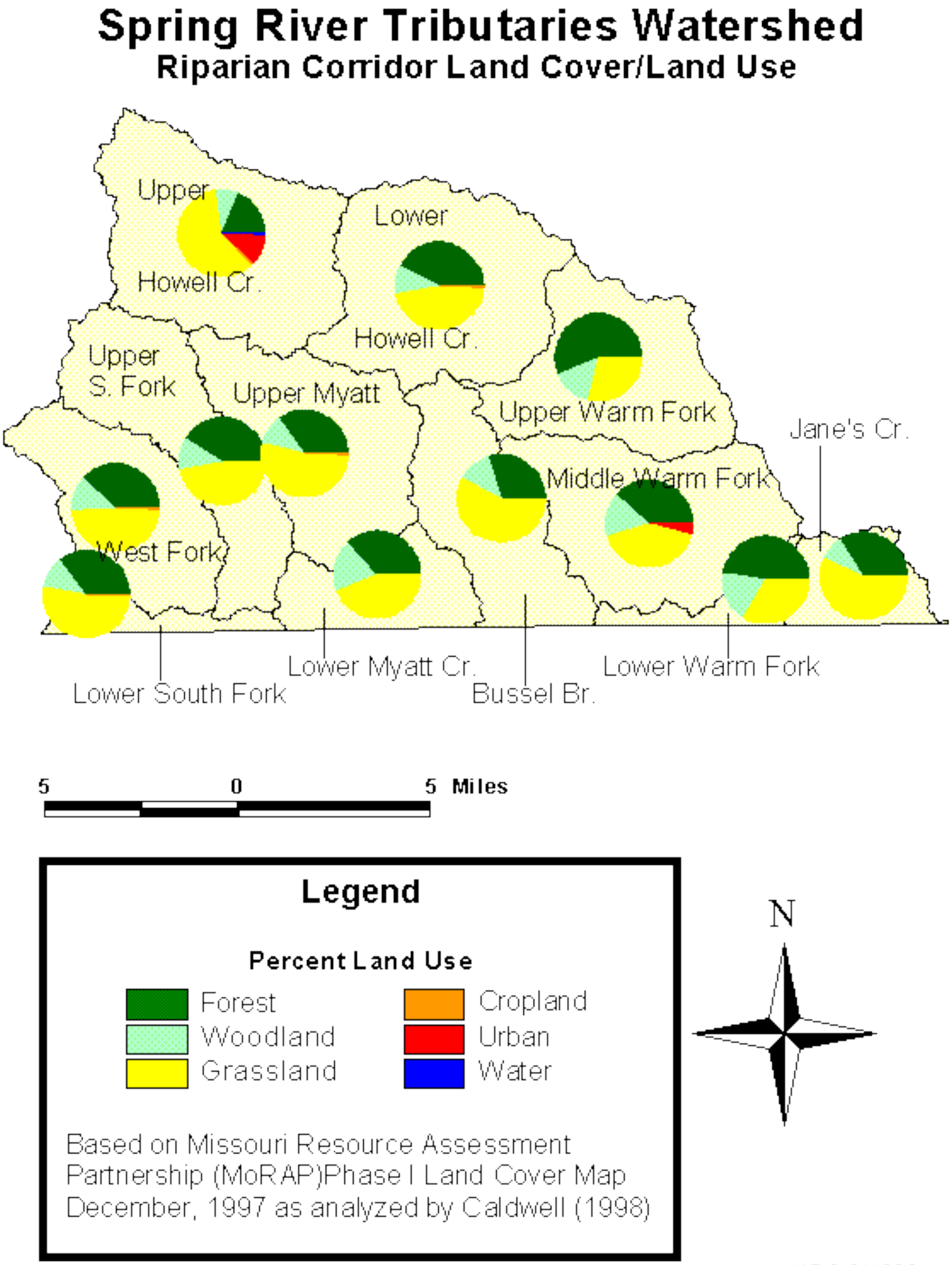
FOR =Forest, WDL=Woodland, GRS=Grassland, CRP=Cropland, URB=Urban, WAT=Water

Table Hc04. 1997 and 1998 Thermograph data for the Spring River Tributaries Watershed, Missouri (Figures Hc02 and Hc03).

Site	Stream Name	Days	In Date	Out Date	% of 24 hour Periods	Max Hours	Max. Temp.
B1397	Anthony Br.	36	8/11/97	9/18/97	100	0	68.1
B1398	Anthony Br.	77	7/14/98	9/30/98	100	12	74.13
B2397	Warm Fork	36	8/11/97	9/18/97	100	6	71.4
B2398	Warm Fork	69	7/22/98	9/30/98	100	8	73.22
B2998a	Anthony Br.	68	7/23/98	9/30/98	18	526	85.95
B3797	Warm Fork	36	8/11/97	9/18/97	100	36	77.2
B3798	Warm Fork	69	7/22/98	9/30/98	99	38	78.49
B4497	Warm Fork	36	8/11/97	9/18/97	75	186	78.2
B4597	Warm Fork	36	8/11/97	9/18/97	91	64	76.3
B4598	Warm Fork	69	7/22/98	9/30/98	99	36	75.68
B4998	Warm Fork	69	7/22/98	9/30/98	57	210	79.75
B8698	Cox Cr.	77	7/14/98	9/30/98	100	10	73.83
B8897	Warm Fork	35	8/12/97	9/18/97	26	530	83.3
B9698	Unnamed	77	7/14/98	9/30/98	69	166	78.81
C3997a	West Fork	35	8/12/97	9/18/97	46	236	81.3
C3998a	West Fork	77	7/14/98	9/30/98	18	1224	86.62
C4998*	West Fork	0	7/14/98	9/30/98	-	-	-
C7097	Presley Br.	35	8/12/97	9/18/97	97	40	86.3
C7798	Myatt Cr.	77	7/14/98	9/30/98	14	14	83.63
C8197	Hunt Br.	35	8/12/97	9/18/97	51	214	76.3
C8397	Unnamed	35	8/12/97	9/18/97	100	0	65.3
C8398	Unnamed	77	7/14/98	9/30/98	100	6	74.44
C8698	West Fork	77	7/14/98	9/30/98	30	892	84.29
C9797	Bay Cr.	35	8/12/97	9/18/97	100	20	76.9

% of 24 Hour Periods= Percent of 24 hour periods with minimum temperature < 700 F. Max Hours= Maximum number of consecutive hours with temperature > 700F
* Thermograph partially exposed. Data not used.

Figure Hc01



MDC 3/1999

Figure Hc02.

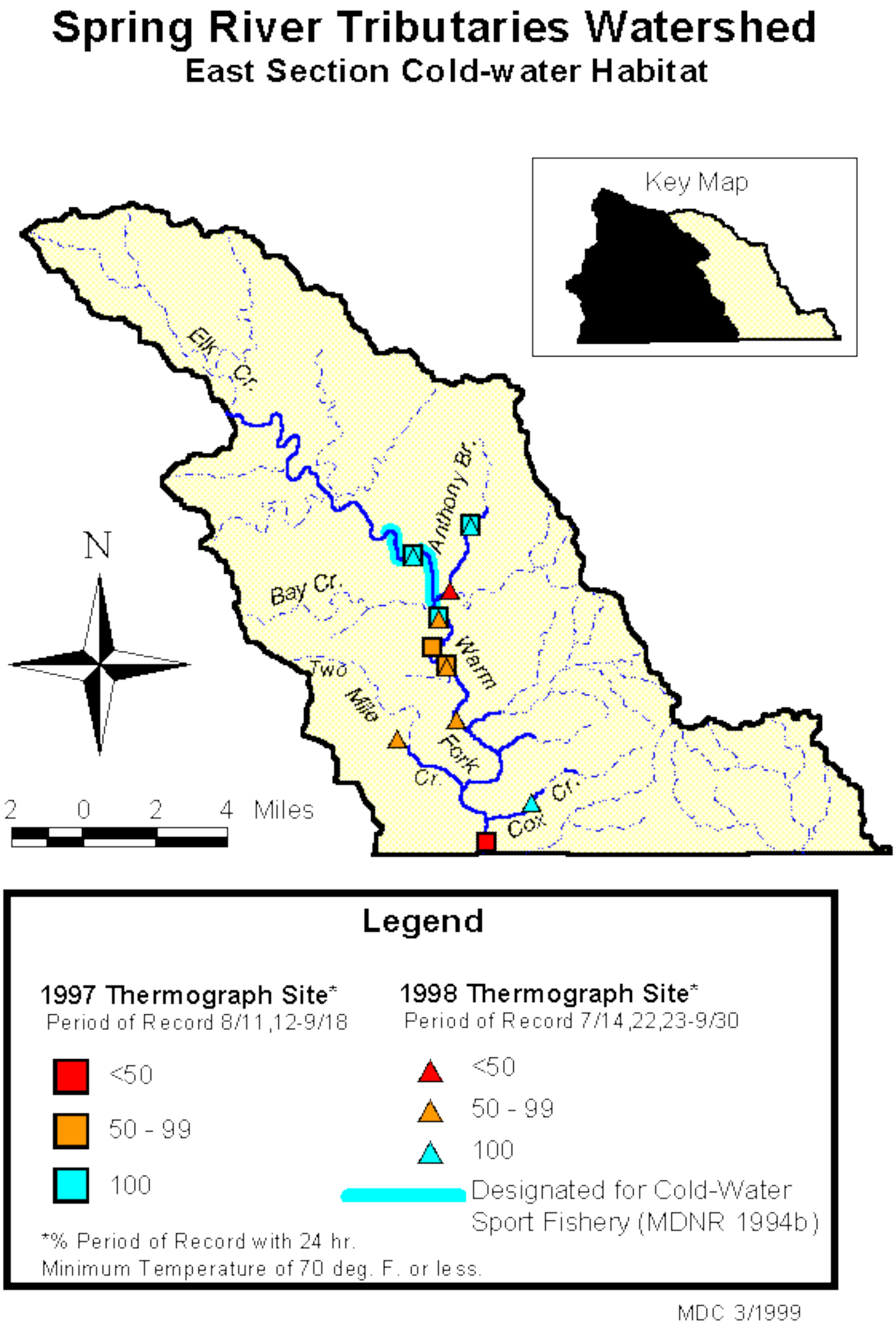
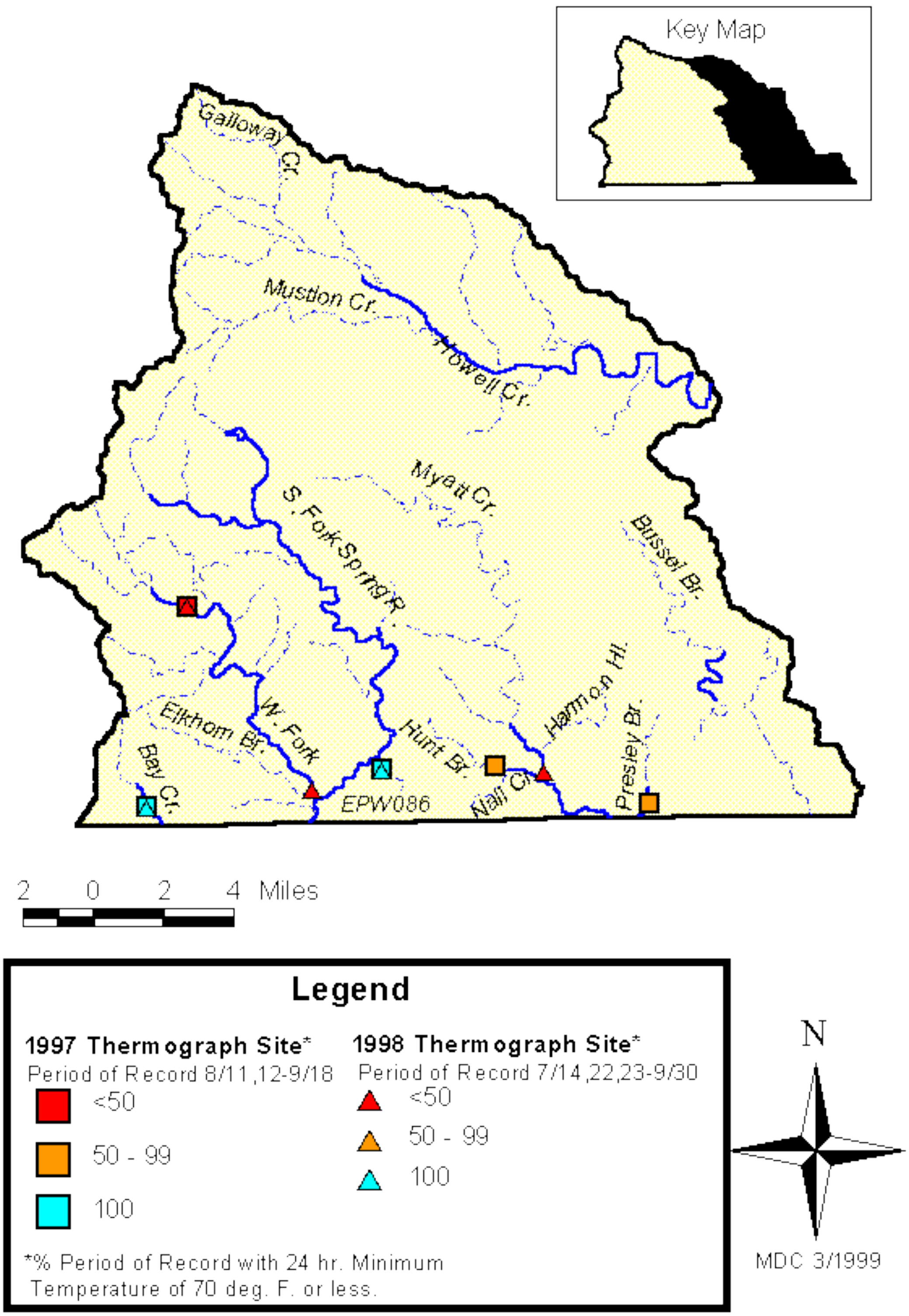

Spring River Tributaries Watershed
East Section Cold-water Habitat
Key Map
Elk Cr.
Anthony Br.
Bay Cr.
Two Mile Cr.
Warm Fork
Cox Cr.
N
2 0 2 4 Miles
Legend
1997 Thermograph Site*
Period of Record 8/11,12-9/18
<50
50 - 99
100
1998 Thermograph Site*
Period of Record 7/14,22,23-9/30
<50
50 - 99
100
Designated for Cold-Water Sport Fishery (MDNR 1994b)
*% Period of Record with 24 hr. Minimum Temperature of 70 deg. F. or less.
MDC 3/1999

Figure Hc03.

Spring River Tributaries Watershed
West Section Cold-water Habitat



Biotic Community

Stream Fish Distribution and Abundance

The stream fish fauna of the Spring River Tributaries Watershed in Missouri is dominated by species characteristic of the Ozark Faunal Region which make up approximately 67% of the total species in the watershed (Table Bc01) (MDC 1998a). Based on the faunal region classification of species as developed by Pflieger (1989) as well as distribution data presented by Pflieger (1997), percentages of species within the watershed which are characteristic of other faunal regions include 9% Ozark-Prairie, 4% Ozark-lowland, 2% prairie, and 11% widely distributed.

Since 1963, forty six fish species representing 13 families have been observed in the Spring River Tributaries Watershed in Missouri (Table Bc01 and Figure Bc01) (MDC 1998a and Pflieger 1997). This includes two species which are currently listed as "species of conservation concern": the blue sucker *(Cycleptus elongatus*) and the southern cavefish *(Typhlichthys subterraneus)* (MDC 1999a and MDC 1999b).

In 1997, fish were collected at four locations throughout the watershed as part of the watershed assessment and inventory (WAI) effort. These collections yielded 35 species of 12 families. 4 species had not been observed in previous collections from the watershed in Missouri cataloged in the Missouri Department of Conservation (MDC) Fish Collection Database. These species included brown trout *(Salmo trutta),* largemouth bass *(Micropterus salmoides),* rainbow trout *(Oncorhynchus mykiss*), as well as a single larval lamprey (family Petromyzontidae). All new species except for largemouth bass were collected on the main stem of the Warm Fork of the Spring River, a stream which, prior to 1986, had no MDC Fish Community Collection Data. Only 3 MDC fish community collections had been performed on the Warm Fork prior to the watershed assessment and inventory collections. These included collections in 1986, 1992, and one collection in 1996. Largemouth bass were collected at one site on the South Fork of the Spring River at White Ranch Conservation Area; an area which had not been previously sampled (MDC 1998a).

The western mosquito fish *(Gambusia affinis)* was found in the Warm Fork of the Spring River, a stream in which it had not been previously sampled. Its new found presence in the Warm Fork should be of no surprise in light of how this species has spread so quickly throughout the state. A survey in the 1940s indicated that its distribution in Missouri included the "Lowland Faunal Region and northward along the Mississippi River to Ramsey Creek in Pike County"(Pflieger 1997). Today the mosquito fish can be found in all of the faunal regions of the state.

Ten species which had been observed in the watershed prior to 1997 were absent in the WAI collections. These included the blue sucker *(Cycleptus elongatus),* Ozark chub *(Erimystax harryi),* creek chubsucker *(Erimyzon oblongus),* White River saddle darter *(Etheostoma e. euzonum),* banded darter *(Etheostoma zonale),* bigeye chub *(Notropis amblops*), Ohio logperch *(Percina c. caprodes),* fathead minnow *(Pimephales promelas),* creek chub *(Semotilus atromaculatus)* and southern cavefish *(Typhlichthys subterraneus).* For all species except bigeye chub, only a few individuals were observed in earlier MDC collections. One bigeye chub was observed in a 1963 collection from a single site on Myatt Creek. A combined 19 were observed in two 1992 collections. One collection was from the previous 1963 site on Myatt Creek, while the other site was located on the Warm Fork of the Spring River. Sites with habitat typical of that inhabited by the southern cavefish as described by Pflieger (1997) were not sampled; thus, nearly eliminating the possibility of an observation. Due to the small numbers of these 10 species found in earlier fish collections, and a shortage of historical data, it is difficult to determine the significance of the absence of these species in these latter collections. In order to gain a better understanding of the status of these species in the watershed, future fish community sampling will be necessary.

Sport Fish

Little data is available regarding sport fish populations within the Spring River Tributaries Watershed within Missouri. Much of this fishery consists of small, wadeable, creeks and small rivers. Because much of the land ownership within the watershed is private, stream fishing access is limited.

Most of the fishable streams within the Spring River Tributaries Watershed in Missouri can be considered warm water/cool water fisheries due to the somewhat sporadic spring influence within the watershed. Sunfish dominate these sport fisheries. Sport fish species (as defined as game fish in MDC 1999a) include shadow bass, and smallmouth bass. Largemouth bass, while prevalent in ponds and small lakes throughout the watershed, seem to play a lesser role in the stream sport fishery. Chain pickerel, brown trout, and rainbow trout have also been observed in the Warm Fork of the Spring River. Along with the previously mentioned sport fish species, bluegill, green sunfish, longear sunfish, northern hogsucker and black redhorse occur in the streams throughout the watershed.

Approximately 3.1 miles of the Warm Fork of the Spring River is designated as a "coldwater sport fishery" within the Rules of Department of Natural Resources Division 20-Clean Water Commission (1996). As previously mentioned three individuals of two species of salmonids (brown trout and rainbow trout) have been observed in fish collections in the watershed. Incidentally only one of the individuals was observed in the designated area. Despite these observations this is not considered to be a significant salmonid fishery.

Due to its limited size, the fishery of the Spring River Tributaries Watershed could be susceptible to over-exploitation. However, the large amount of land in private ownership and thus limited access probably helps lessen this risk.

Fish Stocking

There have been no official fish stocking efforts within the Spring River Tributaries Watershed in Missouri (Mayers, personal communication). There are currently no public fishing lakes within the Spring River Tributaries Watershed. Grass carp *(Ctenopharyngodon idella),* bluegill, largemouth bass, and channel catfish are routinely stocked in private lakes and ponds throughout the watershed. However, it is difficult to estimate the extent of this due to the possibility of stocking by private aquaculture.

Potential for these fish to be introduced into streams of the watershed during heavy rain events always exists. Undoubtably, bait bucket releases have also occurred in streams throughout the watershed. Effects of these introductions vary. While the introduction of species already present in the watershed may have minimal to no effect, the introduction of non-native species can often times have disastrous consequences.

Mussels

Little information exists regarding freshwater mussel species within the Spring River Tributaries Watershed in Missouri. As of this writing, no comprehensive mussel collections have been performed in the watershed. However, Duchrow (1977) does list 3 mussel species identified in benthic invertebrate samples performed on the Warm Fork of the Spring River in 1974. These include the Ozark Pigtoe, *(Fusconaia ozarkensis);* yellow sand shell *(Lampsilis teres teres);* and Ozark Brokenray *(Lampsilis reeviana brevicula).* In addition, Oesch (1995) mentions 3 species which have been identified from the Spring River Tributaries Watershed in Missouri. These are the paper pondshell *(Utterbackia imbecillis*); Arkansas Brokenray *(Lampsilis reeviana reeviana);* and the creeper *(Strophitus undulatus undulatus). L. reeviana reeviana is* listed as a "species of conservation concern" (MDC 1999b). One non-native species, the Asian Clam *(Corbicula fluminea*), has been observed at two sites on the Warm Fork (MDC 1998d). Of the five species identified from the watershed; one, *L. teres teres,* has not been observed in adjoining watersheds in Missouri. In addition to the five mussel species found in Missouri, 18 species have been identified from the South Fork of the Spring River in Arkansas (Table Bc02) (Faiman, personal communication). Four of these species are listed as "species of conservation concern" including, the Curtis' Pearlymussel *(Epioblasma florentina curtisi)* which is a state and federal endangered species, (Bruenderman, personal communication; MDC 1999b).

As stated previously, there appears to be little baseline information available regarding freshwater mussel communities within the Spring River Tributaries Watershed in Missouri. Future sampling will be necessary in order to gain an adequate assessment of the freshwater mussel community and its distribution within the Spring River Tributaries Watershed in Missouri. Once adequate baseline data is obtained, a schedule for monitoring can be established.

Crayfish

Eight species of crayfish have been collected at 4 sites or reported from the Spring River Tributaries Watershed. (Table Bc03 and Figure Bc02) (MDC 1988, MDC 1998c, and Pflieger 1996). Three of these species are listed as "species of conservation concern". These include the Salem cave crayfish *(Cambarus hubrichti);* coldwater crayfish *(Orconectus eupunctus);* and the Mammoth Spring crayfish *(Orconectes marchandi)* (MDC 1999b).

The Salem cave crayfish *(Cambarus hubrichti)* has been recorded at two sites within the Watershed (MDC 1988, MDC 1998c, and Pflieger 1996). The Salem cave crayfish has been found only in Missouri and is believed to occur throughout the Eastern Ozarks from Camden to Crawford Counties, southward to Oregon and Ripley Counties (Pflieger 1996). As its name suggests, it is a subterranean species which has been observed in a variety of subterranean habitats such as cave streams over various substrates, subterranean lakes, as well as the outlets of large springs near the limit of daylight (Pflieger 1996). It has also, on occasion, been observed in more terrestrial areas such as the outflow of a small spring, the pool at the bottom of a deep sinkhole, and the ruts left by a truck in a fen.

The coldwater crayfish *(Orconectus eupunctus)* has been collected from one site within the Spring River Tributaries Watershed. In Missouri, it occurs only within the Spring River Tributaries and Eleven Point Watersheds (MDC 1988, MDC 1998c and Pflieger 1996). As its name suggests the coldwater crayfish seems to prefer streams whose temperature is highly influenced by springs (Pflieger 1996). Within the Eleven Point Watershed, this species only inhabits the Eleven Point River and Greer Spring Branch. It does not ascend the river much above Greer Spring.

The mammoth spring crayfish *(Orconectes marchandi)* generally occupies riffles over a gravel or rubble substrate. In Missouri it is known only to occur in the Warm Fork of the Spring River (Pflieger 1996).

In addition to the previously mentioned species, 5 other crayfish have been identified from the Spring River Tributaries Watershed. These include the Hubbs' Crayfish *(Cambarus hubbsi);*

Ozark crayfish *(Orconectes ozarkae);* spothanded crayfish *(Orconectus punctimanus);* and the northern crayfish *(Orconectus virilis)* (MDC 1988, MDC 1998c, and Pflieger 1996).
As of this writing (1999), all major subwatersheds within the Spring River Tributaries Watershed have available (within the Missouri Department of Conservation Database) crayfish collection data except for the Myatt Creek Subwatershed. In order to adequately assess and monitor the crayfish community of the watershed including "species of conservation concern", future monitoring on a regular basis will be necessary. Also, it will be necessary to extend sampling efforts to the Myatt Creek Subwatershed in order to develop an adequate baseline of crayfish community data.

Aquatic Insects

Benthic macro-invertebrates were sampled within the Spring River Tributaries Watershed in 1974 (Table Bc04 and Figure Bc03) (Duchrow 1977 and MDC 1998c). A total of 8 collections were made from 2 sites both of which were on the Warm Fork of the Spring River. These collections yielded 7,963 individuals of 74 species, 45 families, and 18 orders. Analysis of collection data indicate that species of the order Ephemeroptera were the most prevalent comprising between 34% and 70% of individuals observed in each collection (Table Bc05). Benthic invertebrate sampling is an important component to water quality monitoring. Unfortunately, no long term comprehensive benthic invertebrate data exists for the entire Spring River Tributaries Watershed. Future Benthic invertebrate sampling will be necessary in order to provide adequate benthic invertebrate community as well water quality monitoring for the entire watershed.

Species of Conservation Concern

As of this writing, there are 39 species and sub-species of conservation concern within the Spring River Tributaries Watershed (Table Bc06) (MDC 1999a and MDC 1999b). This includes two fish species (blue sucker and southern cavefish), one mussel species (Arkansas Brokenray), and three crayfish species (coldwater crayfish, Mammoth Spring Crayfish, and Salem Cave Crayfish).

Figure Bc01.

Spring River Tributaries Watershed
Fish Community Sampling Sites

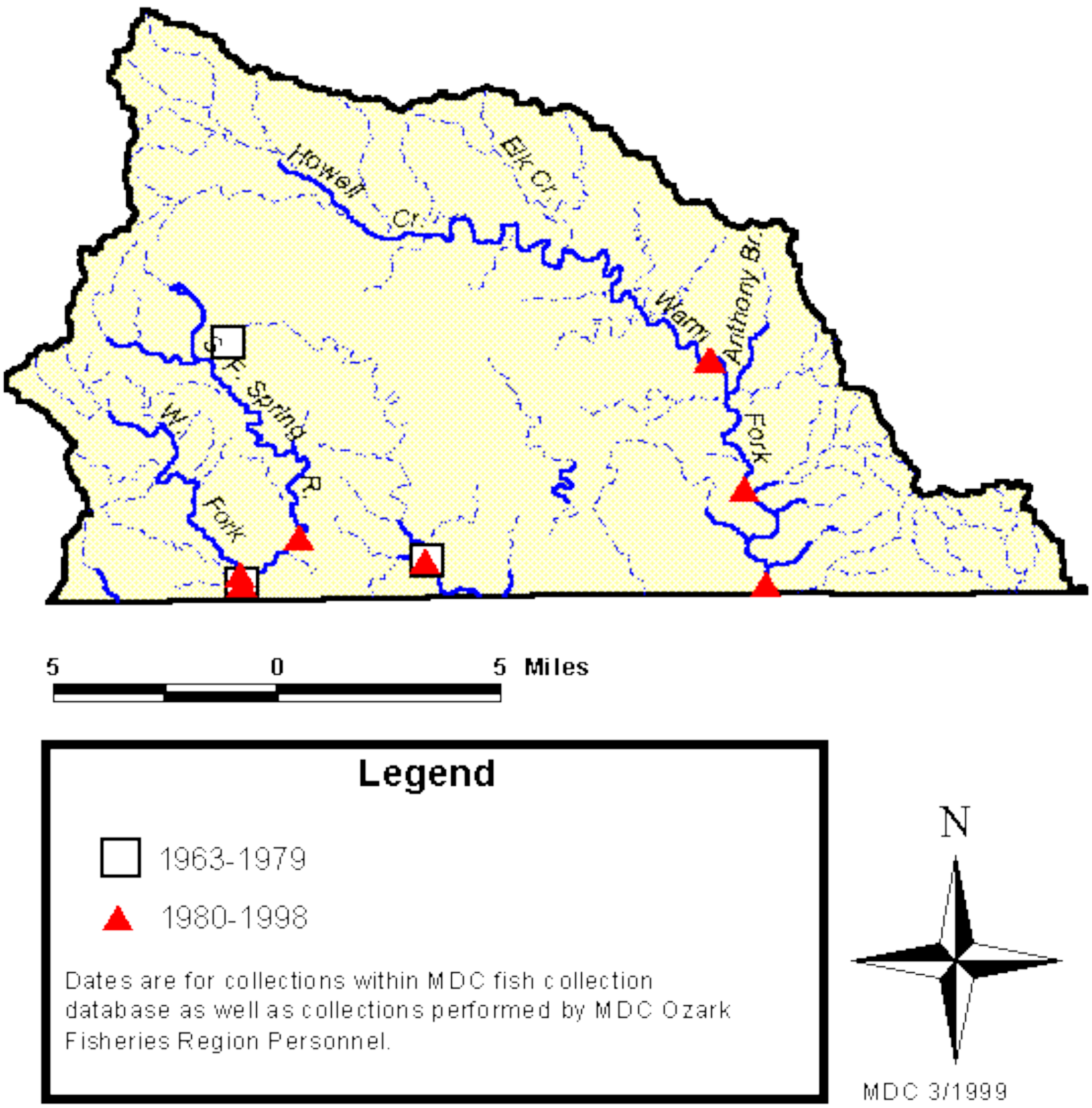
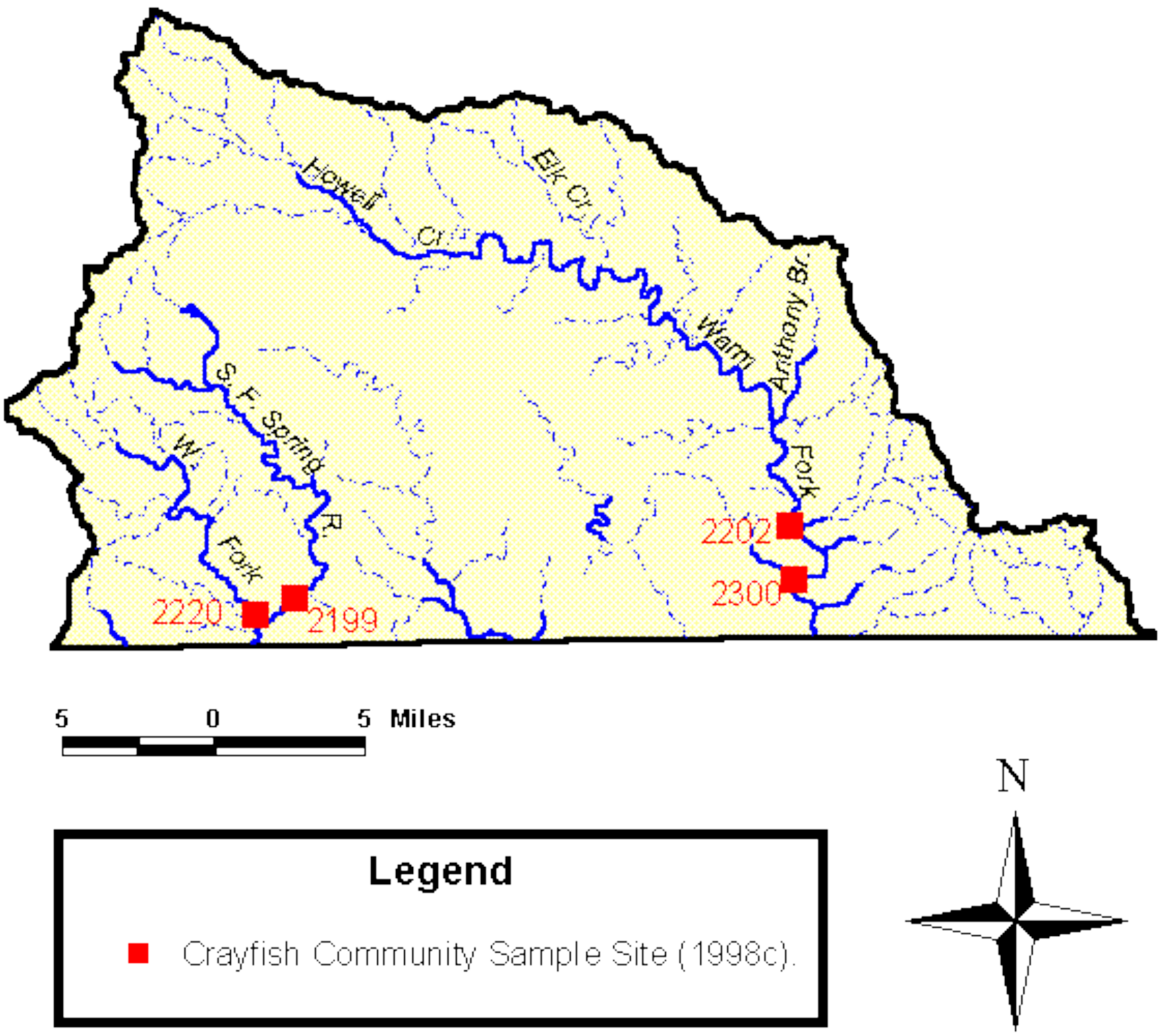


Figure Bc02.

Spring River Tributaries Watershed

Crayfish Community Sampling Sites



MDC 3/1999

Figure Bc03.

Spring River Tributaries Watershed
Benthic Community Sampling Sites

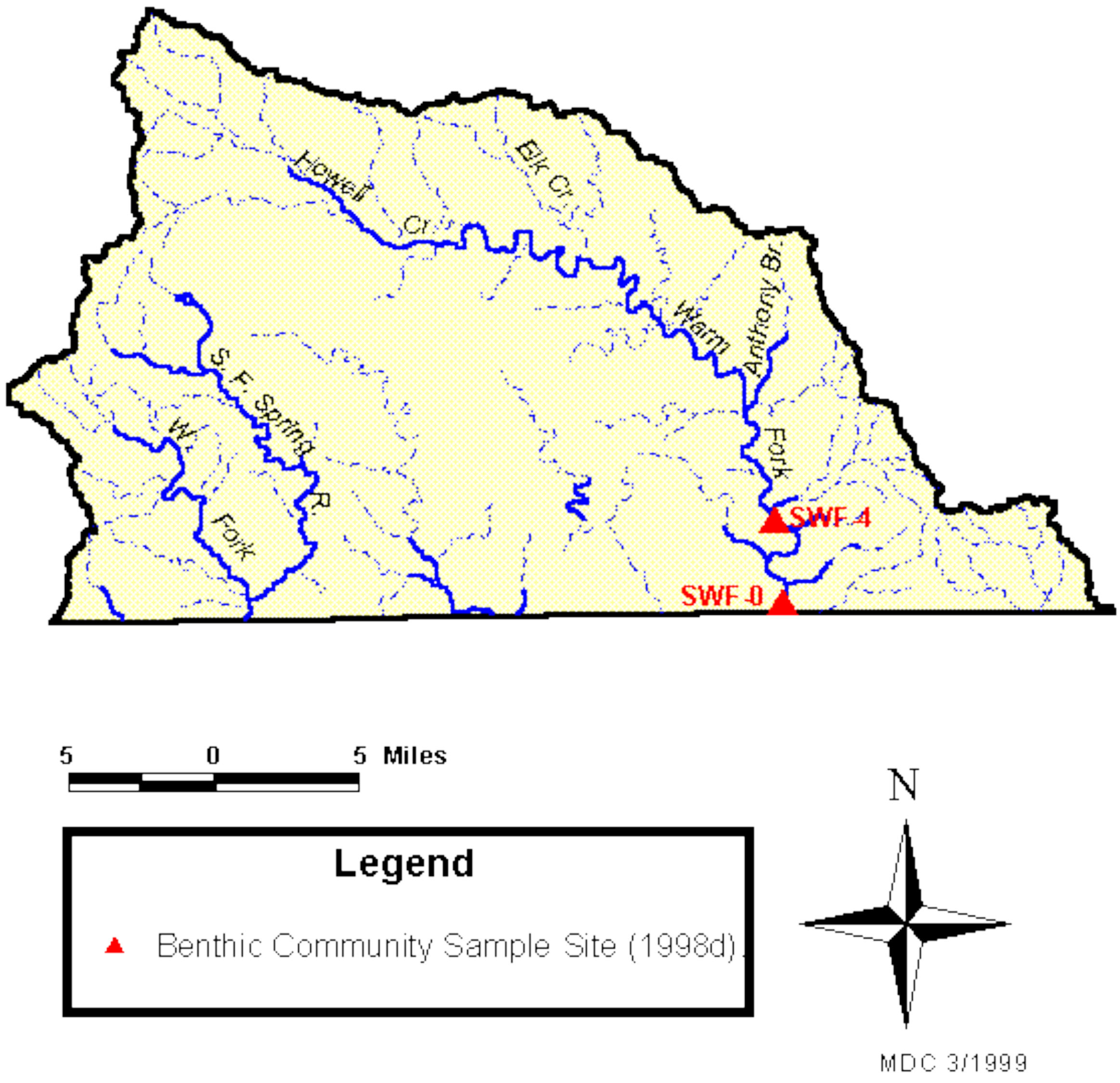


Table Bc01. Fish species with a distribution range of the Spring River Tributaries Watershed in Missouri.

Common Name	Scientific Name Trophic	Guild	Geo Affinity	Sam. Date
Banded darter	*Etheostoma zonale*	P	O	1,2
Banded sculpin*	*Cottus carolinae*	P	O	2
Bigeye chub	*Notropis amblops*	ND	O	1,2
Bigeye shiner*	*Notropis boops*	P	O	1,2
Black redhorse*	*Moxostoma duquesnei*	O	O	2
Black spotted topminnow*	*Fundulus olivaceus*	O	L,O	1,2
Bleeding shiner	*Luxilus zonatus*	P	O	1,2
Blue sucker	*Cycleptus elongatus*	O	R	2
Bluegill	*Lepomis macrochirus*	P	WIDE	2
Bluntnose minnow	*Pimepales notatus*	O	WIDE	1,2
Brook silverside*	*Labidesthes sicculus*	P	O	1,2
Brown trout	*Salmo trutta*	P	O	2
Central stoneroller	*Campostoma anomalum*	P	O,P	1,2
Chain pickerel	*Esox niger*	P	O	2
Creek chub	*Semotilus atromaculatus*	P	O,P	1
Creek chubsucker	*Erimyzon oblongus*	P	O	1
Current Orange Throat Darter	*Etheostoma uniporum*	P	O	1,2
Fathead Minnow	*Pimephales promelas*	O	P	1
Green sunfish	*Lepomis cyanellus*	P	WIDE	1,2
Greenside darter	*Ehtheostoma blennioides*	P	O	1,2
Hornyhead chub*	*Nocomis biguttatus*	O	O	1,2
Largescale stoneroller*	*Campostoma oligolepis*	H	O	1,2
Largemouth bass	*Micropterus salmoides*	P	WIDE	2
Larval lamprey	*Ichthyomyzon*	ND	ND	2
Longear sunfish	*Lepomis megalotis*	P	L,O	1,2
Northern hogsucker*	*Hypentelium nigricans*	H	O	1,2
Northern studfish	*Fundulus catenatus*	P	O	1,2
Ohio logperch	*Percina c. caprodes*	P	O	1
Ozark chub	*Erimystax harryi*	ND	ND	2
Ozark minnow	*Notropis nubilus*	H	O	1,2
Ozark madtom	*Noturus albater*	P	O	1,2
Ozark sculpin	*Cottus hypselurus*	P	O	2
Rainbow darter	*Etheostoma caeruleum*	P	O	1,2
Rainbow trout	*Oncorhynchus mykiss*	P	O	2
Rosyface shiner*	*Notropis rubellus*	O	O	2
Shadow bass	*Ambloplites ariommus*	P	O	1,2
Slender madtom*	*Noturus exilis*	P	O	1,2
Smallmouth bass*	*Micropterus dolomieui*	P	O	2

Common Name	Scientific Name Trophic	Guild	Geo Affinity	Sam. Date
Striped fantail darter	*Etheostoma f. lineolatum*	P	O,P	1,2
Striped shiner*	*Luxilus chrysocephalus*	O	O	1,2
Telescope shiner	*Notropis telescopus*	O	O	1,2
Southern cavefish	*Typhlichthys subterraneus*	O	O	2
Western Mosquitofish	*Gambusia affinis*	O	WIDE	2
White River Saddled Darter	*Etheostoma e. euzonum*	ND	O	1
White sucker	*Catostomus commersoni*	P	O,P	2
Whitetail shiner	*Cyprinella galactura*	P	O	1,2

* = (intolerant species)
Trophic Guild: H = Herbivore, P = Predator, O = Omnivore
Geographic Affinity: L = Lowland, O = Ozark, P = Prairie, R = Big River

Table Bc02. Freshwater mussel species found within the Spring River Watershed in Missouri (bold) and the South Fork of the Spring River in Arkansas (Bruenderman, personal communication-1; Duchrow 1977-2; Faiman, personal correspondence-3; MDC 1998d-4; Oesch 1995-5; and Turgeon et al.1998).

Scientific Name	Common Name	Source	State Status	Federal Status
Actinonaias ligamentina	Mucket	3		
Alasmidonta marginata*	Elk Toe	3	#	
Amblema plicata	Threeridge	3		
Corbicula fluminea	Asian Clam	4		
Cyclonaias tuberculata	Purple Wartyback	3		
Elliptio dilatata	Spike	3		
Epioblasma florentina curtisi*	Curtis' Pearlymussel	1	E	E
Fusconaia flava	Wabash Pigtoe	3		
Fusconaia ozarkensis	Ozark Pigtoe	2		
Lampsilis cardium	Plain Pocketbook	3		
Lampsilis reeviana brevicula	Ozark Brokenray	2		
Lampsilis reeviana reeviana*	Arkansas Brokenray	5		
Lampsilis teres teres	Yellow Sandshell	2		
Lasmigona costata	Flutedshell	3		
Pleurobema sintoxia	Round pigtoe	3		
Potamilus purpuratus	Bleufer	3		
Ptychobranchus occidentalis*	Ouachita Kidneyshell	3	#	

* Species of Conservation Concern (MDC 1999a)
# Former category-2 candidate (In December of 1996, the USFWS discontinued the practice of maintaining a list of species regarded as "category-2 candidates". MDC continues to distinguish these species for information and planning purposes.)
Note: Data in table subject to revision. This table is not a final authority.

Table Bc03. Summary of Missouri Department of Conservation crayfish collection database for collections within the Spring River Tributaries Watershed (MDC 1988 and MDC 1998c).

Stream Date	Site	*Cambarus hubbsi*	*Orconectes eupunctus*	*Orconectes marchandi*
Warm Fork 13 Nov. 1985	2202E	23	—	24
Warm Fork 17 July, 1985	2202D	17	—	33
Warm Fork 18 Sep. 1984	2202C	—	—	48
West Fork 18 Sep. 1984	2220D	5	39	—
West Fork 22 Mar. 1984	2220C	7	4	—
South Fork 27 Mar. 1985	2199C	—	—	—
BASIN TOTALS*		52(8.3)	43(6.8)	—

Stream Date	Site	*Orconectes ozarkae*	*Orconectes punctimanus*
Warm Fork 13 Nov. 1985	2202E	19	60
Warm Fork 17 July, 1985	2202D	7	28
Warm Fork 18 Sep. 1984	2202C	4	47
West Fork 18 Sep. 1984	2202D	66	9
West Fork 22 Mar. 1984	2220C	34	5
South Fork 27 Mar. 1985	2199C	132	18
BASIN TOTALS*		262(41.7)	167(26.5)

*Percent of total collected in watershed given in parentheses

Note: Two species which occur within the Spring River Tributaries aren't currently included in the database. These are the Salem Cave Crayfish, Cambarus hubrichti and the northern crayfish, Orconectes virilis (Pflieger 1996).

Table Bc04. Summary of riffle habitat benthic invertebrate collections from the Spring River Tributaries Watershed (Missouri). Numbers beside taxa indicate total number collected with the average number/ft2 in parentheses. (*) indicates none found (MDC 1998d).

	Location 8 22 Jan. 1974	Location 8 17 Apr. 1974	Location 8 13 Aug. 1974
Total No. Organisms	214 (35.7)	2251 (187.6)	782 (97.7)
Amphipoda	*	*	*
Coleoptera	3 (<1.0)	40 (3.3)	24 (3.0)
Decapoda	*	*	*
Diptera	16 (2.7)	310 (25.8)	59 (7.4)
Ephemeroptera	80 (13.3)	1019 (84.9)	408 (51.0)
Hemiptera	*	*	*
Hydracarina	*	4 (<1.0)	*
Isopoda	*	*	*
Lepidoptera	*	*	*
Lymnophila	3 (<1.0)	6 (<1.0)	1 (<1.0)
Megagastropoda	54 (9.0)	54 (4.5)	2 (<1.0)
Megaloptera	*	*	8 (1.0)
Odonata	*	*	*
Plecoptera	5 (<1.0)	24 (2.0)	2 (<1.0)
Trichoptera	50 (8.3)	661 (55.1)	256 (32.0)
Tricladida	*	6 (<1.0)	4 (<1.0)
Unionoida	2 (<1.0)	*	*
Veneroida	*	2 (<1.0)	*
Oligochaeta (species)	1 (<1.0)	124 (10.3)	12 (1.5)
Gordiida (species)	*	1 (<1.0)	*
Nemata (species)	*	*	6 (<1.0)
Branchiobdellidae (species)	*	*	*

	Location 8 24 Oct. 1974	Location 9 22 Jan. 1974	Location 9 17 Apr. 1974
Total No. Organisms	892 (111.5)	461 (57.6)	1268 (158.5)
Amphipoda	1 (<1.0)	1 (<1.0)	1 (<1.0)
Coleoptera	51 (6.4)	10 (1.3)	42 (5.2)
Decapoda	2 (<1.0)	1 (1.0)	*
Diptera	110 (13.7)	51 (6.4)	217 (27.1)
Ephemeroptera	307 (38.4)	323 (40.4)	713 (89.1)
Hemiptera	*	*	*
Hydracarina	7 (<1.0)	*	*
Isopoda	*	1 (<1.0)	8 (1.0)
Lepidoptera	1 (<1.0)	*	*
Lymnophila	3 (<1.0)	3 (<1.0)	4 (<1.0)
Megagastropoda	84 (10.5)	19 (2.4)	15 (1.9)
Megaloptera	5 (<1.0)	2 (<1.0)	3 (<1.0)
Odonata	*	*	1 (<1.0)

	Location 8 24 Oct. 1974	Location 9 22 Jan. 1974	Location 9 17 Apr. 1974
Plecoptera	1 (<1.0)	5 (<1.0)	18 (2.3)
Trichoptera	290 (36.3)	38 (4.7)	212 (26.5)
Tricladida	20 (2.5)	5 (<1.0)	8 (1.0)
Unionoida	*	*	*
Veneroida	*	*	*
Oligochaeta (species)	8 (1.0)	2 (<1.0)	26 (3.3)
Gordiida (species)	*	*	*
Nemata (species)	2 (<1.0)	*	*
Branchiobdellidae (species)	*	*	*

	Location 9 13 Aug. 1974	Location 9 24 Oct. 1974
Total No. Organisms	1304 (108.7)	791 (98.9)
Amphipoda	*	*
Coleoptera	89 (7.4)	36 (4.5)
Decapoda	7 (<1.0)	2 (<1.0)
Diptera	119 (9.9)	101 (12.6)
Ephemeroptera	693 (57.7)	450 (562)
Hemiptera	2 (<1.0)	*
Hydracarina	2 (<1.0)	8 (1.0)
Isopoda	3 (<1.0)	1 (<1.0)
Lepidoptera	*	*
Lymnophila	61 (5.1)	22 (2.7)
Megagastropoda	39 (3.3)	22 (2.7)
Megaloptera	7 (<1.0)	6 (<1.0)
Odonata	1 (<1.0)	*
Plecoptera	8 (1.0)	1 (<1.0)
Trichoptera	255 (21.3)	124 (15.5)
Tricladida	4 (<1.0)	15 (1.9)
Unionoida	*	*
Veneroida	*	*
Oligochaeta (species)	13 (1.1)	3 (<1.0)
Gordiida (species)	*	*
Nemata (species)	*	*
Branchiobdellidae (species)	1 (<1.0)	*

Table BC05. Dominant benthic invertebrate taxonomic groups for two sample sites on the Warm Fork of the Spring River (Duchrow 1977). Site: SWF-4

Mayflies 44% (Ephemeroptera)	Caddisflies 30% (Trichoptera)	True flies 12% (Diptera
Pseudocloeon sp. 33%	Cheumatopsy ch. Sp. 39%	Chironomidae 85%
Pseudocloeon sp. 40%	Hydropsyche bifida (gp.) 52%	Chironomidae 82%
Tricorythodes sp. 16%	Hydropsyche bifida (gp.) 29%	Empididae 14%
Stenonema nepotellum 16%	Psychomyla flavida 28%	Missing Data
Baetis intercalaris 14%	Missing Data	Missing Data
Tricorythodes sp. 14%	Cheumatopsych sp. 19%	Ceratopogonidae 1%
Stenonema nepotellum 12%		

Table Bc06. Species of conservation concern within the Spring River Tributaries Watershed, Missouri (Oesch 1995, Pflieger 1996, MDC 1999a and MDC 1999b).

Scientific Name	Common Name	Federal Status	State Status	Grank	Srank
Birds					
Accipiter cooperii	Cooper's Hawk			G5	S3
Ardea herodias	Great Blue Heron			G5	S5
Fish					
Cycleptus elongatus	Blue Sucker	*		G4	S3
Typhlichthys subterraneus	Southern Cavefish			G3	S2S3
Invertebrates					
Cambarus hubrichti	Salem Cave Crayfish			G2	S3
Lampsilis reeviana reeviana	Arkansas Brokenray			G3T1T2	S2?
Orconectes eupunctus	Coldwater Crayfish			G2	S3
Orconectes marchandi	Mammoth Spring Crayfish			G2	S1S2
Plants, Ferns, Fern Allies, and Mosses					
	Ciliate Blue Star			G5?T4?	S2S3
Aster dumosus var. strictior	Tradescant Aster			G5T4	S2
Aster fragilis var. fragilis	Small White Aster			G4G5T?	S1
Boltonia decurrens	Decurrent False Aster	T	E	G2	S1
Carex alata	Broadwing Sedge			G5	S2S3
Carex buxbaumii	Brown Bog Sedge			G5	S2
Carex decomposita	Epiphytic Sedge			G3	S3
Carex oklahomensis	Oklahoma Sedge			G3?	S2
Castanea pumila var. ozarkensis	Ozark Chinquapin	*		G5T3	S2
Coelorachis cylindrica	Joint Grass			G4G5	S1
Dalea gattingeri	Gattinger Prairie-clover			G3G4	S1
Delphinium exaltatum	Tall Larkspur	*		G3	S2
Dichondra carolinensis	Pony-foot Grass			G5	S1
Echinodorus tenellus var. parvulus	Dwarf Burhead	*			
Glyceria acutiflora	Sharp-scaled Manna Grass				

Scientific Name	Common Name	Federal Status	State Status	Grank	Srank
Hydrolea ovata	Ovate Fiddleleaf				
Hypericum lobocarpum	A St. John's Wort				
Juncus validus	A Rush				
Marshallia caespitosa var. caespitosa	Barbara's Buttons				
Mecardonia acuminata	Water Hyssop				
Najas flexilis	A Naiad				
Ophioglossum crotalophoroides	Bulbous Adder's-tongue				
Platanthera flava var. flava	Pale Green Orchid				
Platanthera flava var. herbiola	Northern Rein Orchid			G4T4Q	S2
Potamogeton pulcher	Spotted Pondweed			G5	S2S3
Schoenoplectus hallii	Hall's Bulrush	*		G2	S1
Scleria reticularis var. pubescens	Muhlenberg's Nut-rush			G5	S1
Sida elliottii	Elliott Sida			G4G5	S1
Sisyrinchium atlanticum	Eastern Blue-eyed Grass				
Trillium pusillum var. ozarkanum	Ozark Wake Robin	*		G3T3	S2
Xyris torta	Yellow-eyed Grass			G5	S1
Yucca arkansana	Arkansas Yucca			G5	S2

Federal Status E=Endangered T=Threatened
* =Former category-2 candidate (In December of 1996, the USFWS discontinued the practice of maintaining a list of species regarded as "category-2 candidates". MDC continues to distinguish these species for information and planning purposes.
State Status SRrank
S1=Critically imperiled in the state because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state. (typically 5 or fewer occurrences or very few remaining individuals)
S2=Imperiled in the state because of rarity or because of some factor(s) making it very vulnerable to extirpation from the state. (6 to 20 occurrences or few remaining individuals or acres)
S3=Rare and uncommon in the state. (21 to 100 occurrences)
S4=Widespread, abundant, and apparently secure in state, with many occurrences, but the species is of long-term concern. (usually more than 100 occurrences)
S5=Demonstrably widespread, abundant, and secure in the state, and essentially ineradicable under present conditions.

SU=Unrankable: Possibly in peril in the state, but status uncertain; need more information.
SE=Exotic: An exotic established in the state; may be native in nearby regions.
SH=Historical: Element occurred historically in the state (with expectation that it may be rediscovered). Perhaps having not been verified in the past 20 years, and suspected to be still extant.
SX=Extirpated: Element is believed to be extirpated from the state. S?=Unranked: Species is not yet ranked in the state.
Qualifier:
? =Inexact or uncertain: for numeric ranks, denotes inexactness. (The ? qualifies the character immediately preceding it in Srank)
Q=Questionable taxonomy: taxonomic status is questionable; numeric rank may change with taxonomy.
Grank:
G1=Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction. (typically 5 or fewer occurrences or very few remaining individuals or acres)
G2=Imperiled globally because of rarity or because of some factor(s) making it very vulnerable to extinction throughout its range. (6 to 20 occurrences or few remaining individuals or acres)
G3=Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single western state, a physiographic region in the East) or because of other factors making it vulnerable to extinction throughout its range. (21 to 100 occurrences) G4=Widespread, abundant, and apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery. Thus, the element is of long-term concern. (usually more than 100 occurrences)
G5=Demonstrably Widespread, abundant, and secure globally, though it may be quite rare in parts of its range, especially at the periphery.
Subrank:
T=Taxonomic subdivision: rank applies to subspecies or variety.
Note: Data in table subject to revision. This table is not a final authority.

Management Problems and Opportunities

The management goals, objectives, and strategies for the Spring River Tributaries Watershed were developed using information collected from the Spring River Tributaries Watershed Assessment and Inventory (WAI) and direction provided by the MDC Strategic Plan, and the Fisheries Division Five Year Strategic Plan (1995-2000). Objectives and strategies were written for instream and riparian habitat, water quality, aquatic biota, recreational use, and hydrography. All goals are of equal importance, with objectives listed in prioritized order whenever possible. This plan includes only those activities and results the Fisheries Division of Missouri Department of Conservation can reasonably expect to achieve or influence during the next 25 years. Completion of these objectives will depend upon their status in overall regional and division priorities and the availability of human resources and funds.

Goal I: Improve riparian and aquatic habitats in the Spring River tributaries watershed.

Status: Problems affecting riparian and aquatic habitats include insufficient wooded riparian corridors, stream bank erosion, gravel dredging, and other point and nonpoint sources of pollution. Protecting and enhancing the riparian corridor is essential to obtaining quality aquatic habitats. A timbered stream corridor significantly influences many components of the stream ecosystem including stream bank stability, water quality, ground water absorption and recharge to the stream, amount of physical instream habitat, spatial and structural complexity of physical instream habitat, and the food web.

Objective 1.1: With the assistance of willing landowners, over a 25-year period, increase by 50% the proportion of streams with a timbered corridor width >100 feet and decrease by 75% the amount of unvegetated stream bank.

Strategy: Using the following list of prioritized watersheds management units, (developed through our evaluations of forest cover, losing streams, public ownership, point and nonpoint source pollution, and fish community data), direct our management efforts towards those watersheds of highest priority:

- Warm Fork Spring River,
- South Fork Spring River,
- Myatt Creek.

1. Using videotapes, field investigations, aerial photography, and satellite imagery, document and update the current and future conditions of riparian corridors and stream banks. Future projects such as the Missouri Resource Assessment Partnership Land Cover Classification need to be encouraged in order to ensure that adequate data is available that will allow efficient analysis of riparian conditions over time.
2. Utilizing state and federal assistance programs, such as the MDC-DNR incentive programs and educational efforts, implement riparian and aquatic habitat protection measures on streams with the cooperation of willing land owners.

Goal II: Improve surface and ground water quality and quantity in the Spring River tributaries watershed.

Status: Little water quality or hydrologic data exists for the Spring River Tributaries Watershed. However existing data indicate that high fecal coliform levels, nutrient loading, and the potential disturbance of sediment and gravel budgets are the most severe threats to surface water quality.

Ground water has also experienced water quality problems relating to turbidity and high bacteria counts. It is from the ground water system that nearly all water for domestic use is obtained within the watershed. Poor land use practices, gravel dredging, large numbers of cattle, and runoff as well as sewage effluent associated with developed and urbanized areas all contribute to water quality problems of both surface water and ground water.

Objective 1.1: Assure that watershed streams meet or exceed state standards for water quality.

Strategy: Due to the connection between the surface water and ground water systems in the watershed, protection of surface waters, both permanent and intermittent, can also greatly contribute to the enhancement of ground water quality. Protecting riparian corridors will reduce surface runoff and provide stream bank and channel stability. Streams also need protection from other pollutants. Education of the citizenry and land owners on water quality issues and land stewardship is the best hope for improving water quality. Encouragement of appropriate agencies to enforce existing water quality laws is also required to obtain satisfactory water quality.

1. Through media contacts, personal contacts, literature development, and speaking engagements to groups such as area stream teams and land owners, inform the public of water quality issues and problems (e.g. karst topography, excessive siltation, animal waste runoff, gravel dredging, septic system failure etc.) and potential solutions to these problems.
2. Establish a structured water quality sampling program within the watershed in cooperation with the Missouri Department of Natural Resources and Stream Teams.
3. Assist with training and involvement of Stream Teams in water quality monitoring and advocacy in the Spring River Tributaries Watershed. This includes promoting such projects as storm drain stenciling and stream cleanups.
4. Encourage and assist with additional dye tracing studies within the watershed in order to further determine intrawatershed and interwatershed ground water movement as well as recharge area of selected springs within the watershed with an emphasis on publicly owned spring outlets.
5. Assist with enforcement of existing water quality laws by reviewing 404 permits, cooperating with other state and federal agencies to investigate pollution and fish kill reports, collecting water quality related data, and recommending measures to protect aquatic communities. Additional emphasis should be placed on losing streams.
6. Encourage the enforcement of existing water quality laws with an emphasis on losing streams.
7. Promote "greenways" in urban and residential areas i.e. West Plains and Thayer Missouri.
8. Encourage the entry of water quality data into a Geographic Information System (GIS) compatible format in order to facilitate effective data updating and analysis. This includes the creation of a 'Designated Use' data layer based on current Rule 10 CSR 20-7.031 of the Rules of Department of Natural Resources Division 20-Clean Water Commission Chapter 7-Water Quality, Tables G and H.
9. Cooperate with other Missouri Department of Conservation divisions to insure all department areas follow best management practices.
10. Encourage limiting livestock access in riparian areas through education and/or incentive programs for willing private landowners.

Objective 1.2: Establish a hydrologic data set for selected streams and springs within the watershed in order to provide for future analysis of surface water and ground water flows.

Strategy: Priority for obtaining flow data should be placed on streams having urban areas within their drainages. Springs on public lands and flowing into stream reaches which have been shown to be significantly influenced by spring flow (refer to Habitat Conditions Section) should also be of high priority.

1. Encourage the establishment of a United States Geological Survey long term daily discharge gage station within the watershed with the highest priority given to the Warm Fork of the Spring River.
2. Design and initiate a flow study of selected streams and springs within the watershed using instantaneous flow measurements.

Goal III: Maintain the abundance, diversity, and distribution of aquatic biota at or above current levels while improving the quality of the sport fishery in the spring river tributaries watershed.

Status: An assemblage of 46 fish species, 5 naiad species, 8 crayfish species, and 45 families of benthic macro-invertebrates have been identified throughout the Spring River Tributaries Watershed. Major sport fish include bluegill, green sunfish, longear sunfish, smallmouth bass, largemouth bass, shadow bass.

The Asiatic clam is the only exotic aquatic species currently found in the watershed. In addition, a total of 39 "species of conservation concern" are known to occur within the watershed. These include two fish species, one mussel species, and three crayfish species.

Objective 1.1: Maintain the diversity, abundance, and distribution of native non-sport fish and invertebrate communities at or above current levels.

Strategy: High priority should be placed on protecting state and federally listed species and unique community assemblages. Focusing enhancement and protective efforts on a few species can be effective in helping other species that share the same habitat. Detecting changes in faunal composition and abundance can be accomplished by conducting routine surveys of fish and invertebrate communities.

Determining reasons for any changes will be more difficult since a variety of factors (e.g. interspecific and intraspecific competition, water quality, habitat condition, etc.) could be involved.

1. Assist with recovery efforts for any state or federally-listed rare or endangered species in the watershed.
2. Survey fish communities in the watershed every 10 years at historical sampling sites using standardized sampling techniques. Establish additional sampling sites as necessary with high priority given to Missouri Department of Conservation areas. Incorporate data into a Geographic Information System (GIS) in order to document changes in species diversity, abundance, and/or distribution.
3. Using a Geographic Information System (GIS), document locations and identify unique fish assemblages associated with natural features and special habitats such as spring branches and marshes.
4. Develop criteria for identifying instream habitat needs (e.g., presence of listed species, extent of timbered stream corridor, size of stream, land use, soils, presence of permanent water, presence of sport fish, natural features, critical habitat, etc.) and develop a prioritized list of streams and stream reaches needing instream habitat restoration with priority given to public lands.
5. If appropriate, initiate research projects in cooperation with Missouri Department of Conservation Research Staff to investigate reasons for significant changes in faunal abundance and distribution and recommend corrective measures.
6. Coordinate with Missouri Department of Conservation Research Staff and other groups (i.e. University of Missouri, etc.) to conduct a survey of mussels on all fifth order and larger streams. Resurvey every 10 years to document changes in species abundance, diversity, and distribution.

7. Coordinate with Missouri Department of Conservation Research Staff and other groups (i.e., MDNR, University of Missouri, etc.) to conduct a survey of benthic invertebrates on all fifth order and larger streams. Resurvey every 10 years to document changes in species abundance, diversity, and distribution.

Objective 1.2: Maintain or improve populations of sport fish while maintaining a stable and diverse fish community.

Strategy: Proper management of sport fish populations will depend on obtaining adequate samples to determine the status of the fishery. Currently, insufficient sport fish survey data exists for the Spring River Tributaries Watershed which allows the setting of specific management objectives. Once adequate information is obtained, future management efforts will be directed toward setting appropriate fishing regulations, protecting and improving fish habitat, and stocking where appropriate.

1. Develop and initiate a regular sampling regime for high priority sport fishes to evaluate the status of their populations and provide baseline data for management decisions.
2. Complete fish habitat improvement projects at MDC-managed areas where sport fish habitat is limited.

Objective 1.3: Prevent detrimental impacts on native fauna of the Spring River Tributaries Watershed by exotic aquatic species.

Strategy: Controlling the introduction of exotic species into the state is the easiest way to prevent detrimental impacts to native fauna. Once a detrimental exotic species becomes established, research will be needed to seek ways to contain or eliminate the exotic from the system.

1. Continue Division participation in the Missouri Aquaculture Advisory Council (MAAC) and other organizations and advocate controlling the introduction of exotic fauna into state waters.
2. Monitor for potentially harmful exotic species (i.e., zebra mussel or grass carp). This can be performed during fish community surveys.
3. Educate anglers on the potential damaging effects of 'bait bucket' introductions to lake and stream communities.

Goal IV: Increase public awareness and promote wise use of aquatic resources in the Spring River tributaries watershed.

Status: Little information exists regarding recreational use of the Spring River Tributaries. The Limited amount of public access and stream frontage in the watershed undoubtably is a limiting factor for recreational use.

Objective 4.1: Assure that sufficient stream frontage and access sites are developed at desirable locations to encourage public use and awareness of stream resources within the watershed.

Strategy: Assess the feasibility of limited development of selected stream frontage areas on existing public land within the watershed. Pursue the acquisition of areas of additional stream frontage adjacent to existing public lands as well as new.

1. Complete the development of Martin Access on the Warm Fork of the Spring River.
2. Assess sites for limited development of stream frontage areas on existing Missouri Department of Conservation Lands with efforts guided by the following initial priorities:
    a. Tingler Lake Conservation Area
    b. Warm Fork Conservation Area
    c. White Ranch Conservation Area

d. Archie and Gracie VanDerhoef Memorial State Forest

3. Pursue the acquisition of additional frontage adjacent to existing Missouri Department of Conservation Lands with efforts guided by the following initial priorities:
4. Pursue the acquisition of stream frontage along selected permanent streams based on availability and suitability which currently have limited or no public access.

Objective 4.2: Increase awareness of stream recreational opportunities and appreciation of stream ecology and advocacy to a level that will encourage a widespread and diversified public interest in the Spring River Tributaries Watershed.

Strategy: Careful publicity which focuses on state and federally listed species as well as abundant local fish stocks can maintain and promote a continued appreciation of these types of resource elements.

Providing opportunities for the public to learn about holistic stream ecology will, hopefully, create stream advocates.

1. Write fishing prospectus for public release to local media, describing the specific fisheries and angling opportunities of selected waters as data becomes available.
2. Provide the local and statewide media with timely "How to", "When to" articles and interviews that focus attention on activities and places such as: wade gigging, wade fishing, seasons, baits, methods and techniques for catching particular species, life histories, habitats and behaviors of various aquatic animals.
3. Publicize the acquisition, development and opening of new public access sites.
4. Conduct periodic recreational use surveys to determine levels of public use and satisfaction.
5. Emphasize stream ecology and good stream stewardship (utilizing brochures, aquaria, and stream tables where applicable) during presentations to school groups, youth organizations, and private landowner contacts.
6. Conduct outdoor youth events, such as Ecology Days at stream sites with field activities that demonstrate stream ecology and good stream stewardship.
7. Facilitate the development and activity of Stream Teams and other groups interested in adopting or otherwise promoting good stewardship and enjoyment of watershed streams.
8. Make public presentations that focus on the MDC Streams For The Future program.
9. Provide promotional, educational, and technical stream materials to groups, fairs and other special events.
10. Develop brochure which promotes best management practices within the watershed .

Angler Guide

Little data is available regarding sport fish populations within the Spring River Tributaries Watershed within Missouri. Much of this fishery consists of small, wadeable, creeks and small rivers. Because much of the land ownership within the watershed is private, stream fishing access is limited.

Most of the fishable streams within the Spring River Tributaries Watershed in Missouri can be considered warm water/cool water fisheries due to the somewhat sporadic spring influence within the watershed. Sunfish dominate these sport fisheries. Sport fish species (as defined as game fish in MDC 1999a) include shadow bass, and smallmouth bass. Largemouth bass, while prevalent in ponds and small lakes throughout the watershed, seem to play a lesser role in the stream sport fishery. Chain pickerel, brown trout, and rainbow trout have also been observed in the Warm Fork of the Spring River. Along with the previously mentioned sport fish species, bluegill, green sunfish, longear sunfish, northern hogsucker and black redhorse occur in the streams throughout the watershed.

Approximately 3.1 miles of the Warm Fork of the Spring River is designated as a "coldwater sport fishery" within the Rules of Department of Natural Resources Division 20-Clean Water Commission (1996). As previously mentioned three individuals of two species of salmonids (brown trout and rainbow trout) have been observed in fish collections in the watershed. Incidentally only one of the individuals was observed in the designated area. Despite these observations this is not considered to be a significant salmonid fishery.

Due to its limited size, the fishery of the Spring River Tributaries Watershed could be susceptible to over-exploitation. However, the large amount of land in private ownership and thus limited access probably helps lessen this risk.

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Glossary

Alluvial soil: Soil deposits resulting directly or indirectly from the sediment transport of streams, deposited in river beds, flood plains, and lakes.
Aquifer: An underground layer of porous, water-bearing rock, gravel, or sand.
Benthic: Bottom-dwelling; describes organisms which reside in or on any substrate.
Benthic macroinvertebrate: Bottom-dwelling (benthic) animals without backbones (invertebrate) that are visible with the naked eye (macro).
Biota: The animal and plant life of a region.
Biocriteria monitoring: The use of organisms to assess or monitor environmental conditions.
Channelization: The mechanical alteration of a stream which includes straightening or dredging of the existing channel, or creating a new channel to which the stream is diverted.
Concentrated animal feeding operation (CAFO): Large livestock (ie. cattle, chickens, turkeys, or hogs) production facilities that are considered a point source pollution, larger operations are regulated by the MDNR. Most CAFOs confine animals in large enclosed buildings, or feedlots and store liquid waste in closed lagoons or pits, or store dry manure in sheds. In many cases manure, both wet and dry, is broadcast overland.
Confining rock layer: A geologic layer through which water cannot easily move.
Chert: Hard sedimentary rock composed of microcrystalline quartz, usually light in color, common in the Springfield Plateau in gravel deposits. Resistance to chemical decay enables it to survive rough treatment from streams and other erosive forces.
Cubic feet per second (cfs): A measure of the amount of water (cubic feet) traveling past a known point for a given amount of time (one second), used to determine discharge.
Discharge: Volume of water flowing in a given stream at a given place and within a given period of time, usually expressed as cubic feet per second.
Disjunct: Separated or disjoined populations of organisms. Populations are said to be disjunct when they are geographically isolated from their main range.
Dissolved oxygen: The concentration of oxygen dissolved in water, expressed in milligrams per liter or as percent.
Dolomite: A magnesium rich, carbonate, sedimentary rock consisting mainly (more than 50% by weight) of the mineral dolomite ($CaMg(CO_3)_2$).
Endangered: In danger of becoming extinct.
Endemic: Found only in, or limited to, a particular geographic region or locality.
Environmental Protection Agency (EPA): A Federal organization, housed under the Executive branch, charged with protecting human health and safeguarding the natural environment — air, water, and land — upon which life depends.
Epilimnion: The upper layer of water in a lake that is characterized by a temperature gradient of less than 1° Celsius per meter of depth.
Eutrophication: The nutrient (nitrogen and phosphorus) enrichment of an aquatic ecosystem that promotes biological productivity.
Extirpated: Exterminated on a local basis, political or geographic portion of the range.
Faunal: The animals of a specified region or time.
Fecal coliform: A type of bacterium occurring in the guts of mammals. The degree of its presence in a lake or stream is used as an index of contamination from human or livestock waste.
Flow duration curve: A graphic representation of the number of times given quantities of flow are equaled or exceeded during a certain period of record.

Fragipans: A natural subsurface soil horizon seemingly cemented when dry, but when moist showing moderate to weak brittleness, usually low in organic matter, and very slow to permeate water.
Gage stations: The site on a stream or lake where hydrologic data is collected.
Gradient plots: A graph representing the gradient of a specified reach of stream. Elevation is represented on the Y-axis and length of channel is represented on the X- axis.
Hydropeaking: Rapid and frequent fluctuations in flow resulting from power generation by a hydroelectric dam's need to meet peak electrical demands.
Hydrologic unit (HUC): A subdivision of watersheds, generally 40,000-50,000 acres or less, created by the USGS. Hydrologic units do not represent true subwatersheds.
Hypolimnion: The region of a body of water that extends from the thermocline to the bottom and is essentially removed from major surface influences during periods of thermal stratification.
Incised: Deep, well defined channel with narrow width to depth ration, and limited or no lateral movement. Often newly formed, and as a result of rapid down-cutting in the substrate
Intermittent stream: One that has intervals of flow interspersed with intervals of no flow. A stream that ceases to flow for a time.
Karst topography: An area of limestone formations marked by sinkholes, caves, springs, and underground streams.
Loess: Loamy soils deposited by wind, often quite erodible.
Low flow: The lowest discharge recorded over a specified period of time.
Missouri Department of Conservation (MDC): Missouri agency charged with: protecting and managing the fish, forest, and wildlife resources of the state; serving the public and facilitating their participation in resource management activities; and providing opportunity for all citizens to use, enjoy, and learn about fish, forest, and wildlife resources.
Missouri Department of Natural Resources (MDNR): Missouri agency charged with preserving and protecting the state's natural, cultural, and energy resources and inspiring their enjoyment and responsible use for present and future generations.
Mean monthly flow: Arithmetic mean of the individual daily mean discharge of a stream for the given month.
Mean sea level (MSL): A measure of the surface of the Earth, usually represented in feet above mean sea level. MSL for conservation pool at Pomme de Terre Lake is 839 ft. MSL and Truman Lake conservation pool is 706 ft. MSL.
Necktonic: Organisms that live in the open water areas (mid and upper) of waterbodies and streams.
Non-point source: Source of pollution in which wastes are not released at a specific, identifiable point, but from numerous points that are spread out and difficult to identify and control, as compared to point sources.
National Pollution Discharge Elimination System (NPDES): Permits required under The Federal Clean Water Act authorizing point source discharges into waters of the United States in an effort to protect public health and the nation's waters.
Nutrification: Increased inputs, viewed as a pollutant, such as phosphorous or nitrogen, that fuel abnormally high organic growth in aquatic systems.
Optimal flow: Flow regime designed to maximize fishery potential.
Perennial streams: Streams fed continuously by a shallow water table an flowing year-round.

pH: Numeric value that describes the intensity of the acid or basic (alkaline) conditions of a solution. The pH scale is from 0 to 14, with the neutral point at 7.0. Values lower than 7 indicate the presence of acids and greater than 7.0 the presence of alkalis (bases).
Point source: Source of pollution that involves discharge of wastes from an identifiable point, such as a smokestack or sewage treatment plant.
Recurrence interval: The inverse probability that a certain flow will occur. It represents a mean time interval based on the distribution of flows over a period of record. A 2-year recurrence interval means that the flow event is expected, on average, once every two years.
Residuum: Unconsolidated and partially weathered mineral materials accumulated by disintegration of consolidated rock in place.
Riparian: Pertaining to, situated, or dwelling on the margin of a river or other body of water.
Riparian corridor: The parcel of land that includes the channel and an adjoining strip of the floodplain, generally considered to be 100 feet on each side of the channel.
7-day Q^{10}: Lowest 7-day flow that occurs an average of every ten years.
7-day Q^{2}: Lowest 7-day flow that occurs an average of every two years.
Solum: The upper and most weathered portion of the soil profile.
Special Area Land Treatment project (SALT): Small, state funded watershed programs overseen by MDNR and administered by local Soil and Water Conservation Districts. Salt projects are implemented in an attempt to slow or stop soil erosion.
Stream Habitat Annotation Device (SHAD): Qualitative method of describing stream corridor and instream habitat using a set of selected parameters and descriptors.
Stream gradient: The change of a stream in vertical elevation per unit of horizontal distance.
Stream order: A hierarchical ordering of streams based on the degree of branching. A first order stream is an unbranched or unforked stream. Two first order streams flow together to make a second order stream; two second order streams combine to make a third order stream. Stream order is often determined from 7.5 minute topographic maps.
Substrate: The mineral and/or organic material forming the bottom of a waterway or waterbody.
Thermocline: The plane or surface of maximum rate of decrease of temperature with respect to depth in a waterbody.
Threatened: A species likely to become endangered within the foreseeable future if certain conditions continue to deteriorate.
United States Army Corps of Engineers (USCOE) and now (USACE): Federal agency under control of the Army, responsible for certain regulation of water courses, some dams, wetlands, and flood control projects.
United States Geological Survey (USGS): Federal agency charged with providing reliable information to: describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect the quality of life.
Watershed: The total land area that water runs over or under when draining to a stream, river, pond, or lake.
Waste water treatment facility (WWTF): Facilities that store and process municipal sewage, before release. These facilities are under the regulation of the Missouri Department of Natural Resources.