White River

Watershed and Inventory Assessment

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Executive Summary

The White River originates in northwest Arkansas, southeast of Fayetteville, in the Boston Mountains. The White River is impounded as Lake Sequoyah and by Beaver Dam before entering Missouri near Eagle Rock in Barry County. From that point it flows eastward along the Missouri-Arkansas border, where it is impounded by Table Rock Dam and Powersite Dam, in Missouri, and Bull Shoals Dam, in Arkansas. The White River then flows southeast from Bull Shoals Dam, where it exits the Ozark Plateau, turns south into the delta region of Arkansas, and continues to its confluence with the Mississippi River, some 720 miles from its origin.

The portion of the White River basin covered by this document is termed the White River watershed. This watershed encompasses 5,184 square miles and includes parts or all of eight Missouri counties (Barry, Christian, Douglas, Ozark, Stone, Taney, Webster, and Wright) and twelve Arkansas counties (Baxter, Benton, Boone, Carroll, Crawford, Franklin, Johnson, Madison, Marion, Newton, Searcy, and Washington). The watershed lies primarily within the Salem Plateau region, with a small portion of its northwest edge in the Springfield Plateau region. Major tributaries include War Eagle Creek, Kings River, Long Creek, and Crooked River, originating in Arkansas, and Roaring River, Bull Creek, Swan Creek, Beaver Creek, and Little North Fork White River, originating in Missouri. The total length of Missouri streams with permanent flow is 298.5 miles. Intermittent streams with permanent pools add another 210.5 miles. Several losing streams and springs are located in the watershed.

The White River watershed is primarily rural. Forest land comprises the greatest percentage of land use/cover types, followed, in descending order of coverage, by pasture land, range land, non-cultivated cropland, urban, water, roads, miscellaneous, and cultivated cropland. The watershed lies within one of the primary cattle producing areas in Missouri. Barry, Webster, and Wright counties were among the top ten counties in the state for beef cattle production in 1997, though only minimal percentages of the latter two lie within the watershed. Major cities and towns in the watershed include Branson, Kimberling City, Forsyth, Ava, in Missouri, and Berryville, Eureka Springs, Harrison, and West Fork, in Arkansas.

Dam and hydropower influences are pronounced. The mainstem White River and the lower reaches of many tributaries have been inundated by the construction of Beaver Dam (AR), Table Rock Dam (MO), Powersite Dam (MO), and Bull Shoals Dam (AR). Overall, these dams impound approximately 225 miles of the mainstem White River. In addition to the effects of the inundation of large reaches of streams in the watershed, cold water releases from Beaver Dam, Table Rock Dam, and Bull Shoals Dam have drastically altered aquatic communities downstream on the White River. Much of the historic, warmwater fisheries in these areas has been lost and replaced by a coldwater fishery that includes rainbow and brown trout. Large-scale stocking is required to maintain and support these coldwater fisheries.

Low dissolved oxygen concentrations in waters released from the major, mainstem dams affects downstream aquatic communities. Fish kills have been documented, and chronic impacts on fish and invertebrate species are suspected. Efforts are underway to alleviate the problems caused by seasonal, low dissolved oxygen levels.

Potential sources of nonpoint source pollution in the watershed include: runoff from mine tailings and active mining sites, cattle grazing and dairy operations, poultry husbandry, sedimentation from erosion in disturbed watersheds, sludge application from sewage treatment facilities, seepage from septic tanks, and runoff from urban areas. Point source pollution sources include municipal sewage treatment plants, limestone quarry settling ponds, and concentrated animal feeding operations.

The White River watershed is included in the Ozark-White aquatic community division. Streams in this division are located in narrow, steep-sided valleys with high bluffs, and are typically characterized by high gradients and well-defined riffles and pools.

Stream habitat quality is fair to good throughout most of the watershed. Some areas, including portions of Dry Hollow and Little North Fork of the White River, suffer from a lack of riparian vegetation. The lack of adequate riparian corridors, excessive nutrient loading, streambank erosion, excessive runoff and erosion, and the effects of instream activities such as gravel removal are among the problems observed in the watershed. Grazing practices along many streams contribute to streambank instability, nutrient loading, and poor riparian conditions. Increased timber clearing and higher runoff associated with urbanization in the watershed also impact stream habitat quality.

Eighty-one fish species and thirty-eight mussel species have been collected throughout the watershed. A diverse aquatic insect and crayfish fauna is also found in the watershed. Common sportfish in streams and reservoirs include smallmouth bass, largemouth bass, spotted bass, white and black crappie, Ozark bass, channel catfish, and rainbow trout. There are several state or federally listed species of concern, including Ozark cavefish, checkered madtom, Ozark shiner, longnose darter, eastern slim minnow, highfin carpsucker, crystal darter, bluntface shiner, American brook lamprey, Salem cave crayfish, Meek's crayfish, and purple lilliput.

Major goals for the watershed are improved water quality, better riparian and aquatic habitat conditions, the maintenance of diverse and abundant populations of native aquatic organisms and sportfish, increased recreational use, and increased public appreciation for the stream resources.

Additional fish population samples will be collected and appropriate habitat surveys will be conducted. Fishing regulations will be revised, as needed, and selected stocking will be used to maintain and improve sportfishing. Access will be improved, where needed. Cooperative efforts with other resource agencies on water quality and quantity, habitat, and watershed management issues will be critical. Enforcement of existing water quality and other stream related regulations and necessary revisions and additions to these regulations will help reduce violations and lead to further water quality improvements. Working with related agencies to promote public awareness and incentive programs and cooperating with citizen groups and landowners will result in improved watershed conditions and better stream quality.

Watershed Location

Location

The White River basin originates in northwest Arkansas (AR), southeast of Fayetteville, in the Boston Mountains. Three forks, the White River, the Middle Fork, and the West Fork, come together in Washington County, AR to form the mainstem White River. The White River is first impounded as Lake Sequoyah, a 500-acre impoundment at the junction of the Middle Fork and the White River, near Fayetteville. The White River flows south out of Lake Sequoyah and joins the West Fork before entering Beaver Lake just west of Eureka Springs, AR. The White flows out of Beaver Dam, the first in a series of four hydroelectric dams, northward into Missouri (MO) near the town of Eagle Rock in Barry County. The White then flows eastward where it has been impounded as Table Rock Lake, just below its confluence with the James River near Branson.

The White River below Table Rock Lake is again impounded by Powersite Dam near Forsyth, MO and forms Lake Taneycomo. The river then takes a southern turn and flows back into Arkansas where it has again been impounded by Bull Shoals Dam near Cotter in Marion County. The White River flows southeast out of Bull Shoals Dam and exits the Ozark Plateau into the Mississippi Alluvial Plain near Newport, AR. The White River flows in an almost due south direction from where it enters the delta until its confluence with the Mississippi River near Montgomery Point, AR, some 720 miles from its origin.

The portion of the White River basin covered in this document includes all streams and drainages from the point of origin, to the point directly above the White River's confluence with the Buffalo River near Buffalo City, AR. The term "watershed" or "White River watershed" shall refer hereafter to the watershed covered in this document and the entire "White River basin" will be referred to as such (Figure WL01). The watershed covers an area that includes parts or all of eight Missouri counties: Barry, Christian, Douglas, Ozark, Stone, Taney, Webster, and Wright (Table WL01, Figure WL02). There are twelve Arkansas counties (Figure WL02) fully or partially in the watershed including: Carroll (all); Madison and Boone (over 90%); Marion (about 75%); Benton and Washington (about 25%); Baxter (about 10%), Newton, and Searcy (less than 10%); and Crawford, Franklin, and Johnson (less than 5%).

Major towns and cities in the watershed include: Branson, Forsyth, Hollister, Kimberling City, and Ava in Missouri and Harrison, Eureka Springs, Berryville, Cotter, and Bull Shoals in Arkansas (Figure WL03).

The White River watershed includes two United States Geological Survey (USGS) eight-digit hydrologic units (HUC), Beaver Reservoir (11010001) and Bull Shoals Lake (11010003). The two eight-digit HUCs that make up the watershed are further broken down into twenty-five, eleven-digit HUCs (Table WL02). There are ten 11-digit HUCs that lie either partially or fully in the Missouri portion of the watershed (Figure WL04). These may be referred to later in the text as situations arise where subwatersheds are looked at in more detail.

Major tributaries in the watershed include, War Eagle Creek, Kings River, Long Creek, and Crooked River, which all originate in Arkansas, and Roaring River, James River, Bull Creek, Swan Creek, Beaver Creek, and Little North Fork White River, which all originate in Missouri (Figure WL05). A watershed assessment and management plan was completed for the James River basin (HUC 11010002) in 1997 and copies of the plan are available through the Missouri Department of Conservation (MDC) Southwest Regional Office in Springfield, MO (Kiner and Vitello 1997).

The Missouri portion of the watershed is bound from west to east by the Elk River basin, James River basin, Gasconade River basin, and North Fork of the White River basin. The Arkansas portion of the watershed is bound from west to east by the Illinois River basin, the Robert S. Kerr Reservoir basin, the Frog Mulberry basin, and the Buffalo River basin.

Table WL01. The amount of White River watershed land included in Missouri counties.

County	Acres	Square miles	Percent of watershed	Percent of county
Barry	127,341	199	9.5	25.2
Christian	165,047	257.9	13.7	45.8
Douglas	164,662	257.3	13.6	31.6
Ozark	209,179	326.8	17.3	43.3
Stone	119,994	187.6	9.9	36.8
Taney	416,583	650.9	34.5	100
Webster	5,047	7.9	0.4	1.3
Wright	892	1.4	0.07	0.2
TOTAL	1,208,745	1888.8		

Table WL02. Eleven-digit hydrologic units in the White River watershed.

Subwatershed Name	Eleven-Digit Code	Missouri Area (acres)	Total Area
Upper Table Rock Lake Tributaries	11010001080	105,327	159,483
Lower Table Rock Lake Tributaries	11010001170	102,875	107,241
Lower Kings River	11010001110	15,348	131,152
Indian Creek	11010001140	20,958	45,449
Yokum-Dry Creeks	11010001150	852	78,276
Upper White River	11010001010	0	57,229
Lower White River	11010001020	0	74,979
Middle Fork White River	11010001030	0	47,739
West Fork White River	11010001040	0	80,838
Richland Creek	11010001050	0	97,014
War Eagle Creek	11010001060	0	191,885
Beaver Dam Laterals	11010001070	0	205,741
Upper Kings River	11010001090	0	113,586
Dry Fork-Kings River	11010001000	0	27,000
Osage Creek	11010001120	0	105,414
Long Creek	11010001160	0	96,574
Taneycomo and Bull Shoals Tributaries	11010003030	163,532	174,949
Bull-Swan Creeks	11010003010	248,129	248,129
Beaver Creek	11010003020	267,344	267,344
North Bull Shoals Lake Tributaries	11010003040	96,157	107,862
Little North Fork	11010003060	188,916	240,328
Lower Bull Shoals Laterals	11010003050	0	247,272
White River Bull Shoals to Crooked Creek	11010003070	0	71,341
Upper Crooked Creek	11010003080	0	56,170

Subwatershed Name	Eleven-Digit Code	Missouri Area (acres)	Total Area
Lower Crooked Creek	11010003090	0	241013
Yellville	11010003091	0	2,750

Figure WL04. Eight and eleven digit hydrologic units that make up the White River watershed.

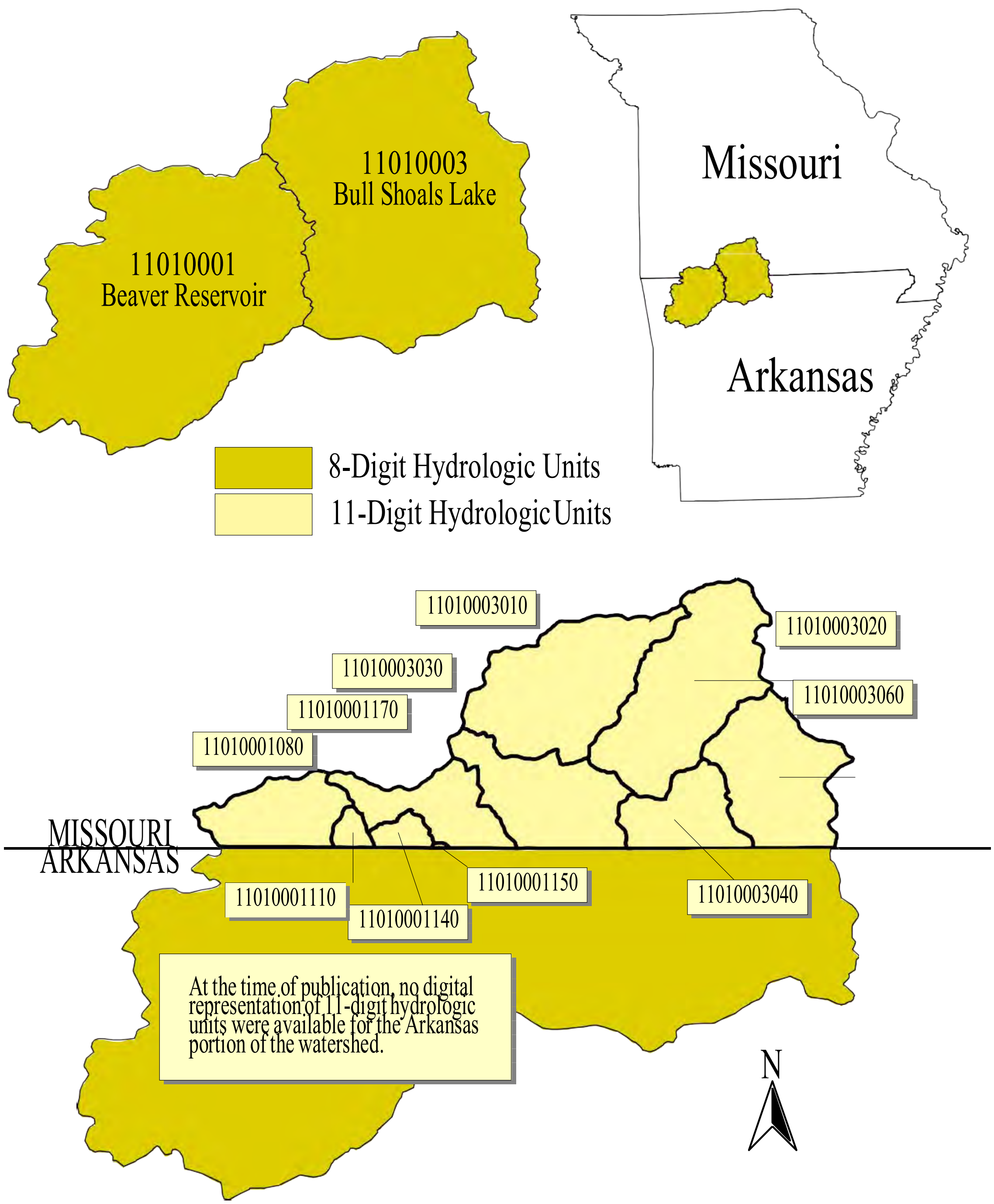
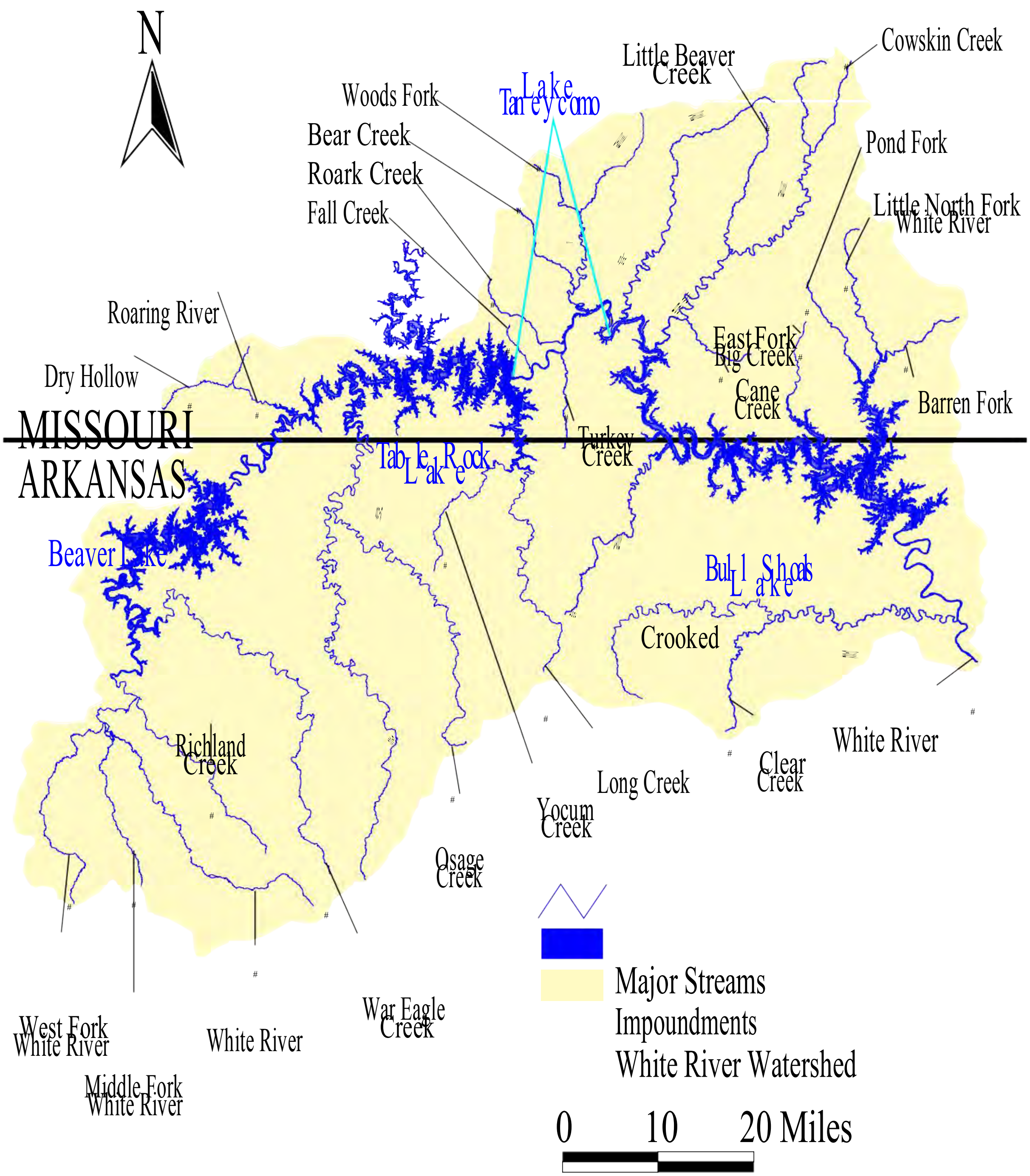


Figure WL05. Major streams and impoundments in the White River watershed.



Geology

Physiographic Regions

The watershed is located within the Interior Highlands physiographic province of the United States. The Missouri portion of the watershed lies almost entirely within the Salem Plateau region, a subdivision of the larger Ozark Plateau physiographic region, with a small portion of the watershed's northwest edge in the Springfield Plateau, also a subdivision of the Ozark Plateau.

The Springfield Plateau is a region of lower relief than the Salem Plateau. The Arkansas portion of the watershed also lies within the Salem Plateau and Springfield Plateau physiographic regions, and its southern-most edge is in the Boston Mountains physiographic region (Fenneman 1938).

Major drainages in the Salem Plateau are characterized by rolling uplands with local relief of 100 to 200 feet. Smaller streams are characterized by narrow valleys from 200 to 500 feet deep. The Salem Plateau has an average elevation range of 1,000 to 1,400 feet mean sea level (msl).

Elevations in the eastern-most portion of the Springfield Plateau reach heights of 1,700 feet msl, and relative relief of streams reaches a maximum of 400 feet. The Boston Mountains region has local relief up to 1,000 feet in smaller stream valleys with a maximum elevation nearing 2,300 ft. msl. The Eureka Springs (Burlington) escarpment, a narrow belt of hills extending from the Osage Plain on the north to the Arkansas state line on the south, separates the Salem and Springfield plateaus (MDNR 1986a).

Geology

The uplands of the Salem Plateau are underlain by Jefferson City Dolomite and the Roubidoux Formation, and the valleys are floored by Gasconade Dolomite of Ordivician age. The Springfield Plateau is underlain by Mississippian limestones. The Boston Mountain Plateau is underlain by resistant clastic rocks of Pennsylvanian age. The Eureka Springs escarpment is the boundary between the Mississippian limestone of the Springfield Plateau and the Devonian limestone of the Salem Plateau. The geology underlying the watershed is shown in Figure GE01.

The large dolomite mass which is present in the Ozarks has tremendous water storing capability, and the Salem Plateau is the locality for the greatest number and largest springs in Missouri, followed secondly by the Springfield Plateau. The large reservoirs in the southern part of the watershed probably cover many springs. Springs of the watershed are listed in Table GE01 and Figure GE02. Karst features are locally prominent in both the Salem and Springfield plateaus (MDNR 1986a). Several faults are present in the watershed, but most have only tens of feet of displacement (MDNR 1986a). The fractured limestone of the watershed allows a direct linkage from surface waters to ground waters, making aquifers underlying the watershed extremely susceptible to contamination (USGS 1996).

Soil Types

Soils in the Missouri portion of the watershed are of the Ozark type. The major soil association is Gasconade-Opequon-Clarksville, found in the western and central portions. A Captina-Clarksville-Doniphan association is present on the watershed's eastern edge. Other minor soil associations include Nixa-Clarksville, along the Missouri-Arkansas border, and Needleye-Viration-Wilderness, near the northwest corner (Allgood and Persinger 1979).

Captina-Clarksville-Doniphan soils are found on level to very steep slopes, moderately to excessively well drained. These are loamy upland soils with fragipans that are cherty throughout (Allgood and Persinger 1979).

Nixa-Clarksville soils are found on gently sloping to very steep slopes, and are moderately well drained to somewhat excessively drained upland soils with fragipans or cherty subsoils (Allgood and Persinger 1979).

Needleye-Viration-Wilderness soils are found on nearly level to moderately steep slopes. These are moderately well drained, loamy upland soils containing fragipans (Allgood and Persinger 1979).

Soils in the Arkansas portion of the watershed are also Ozarkian. Major soil associations include Clarksville-Nixa-Noark, Captina-Nixa-Tonti, and Arkana-Moko in the Salem and Springfield plateaus and Linker-Mountainburg-Sidon and Enders-Nella-Mountainburg-Steprock in the Boston Mountains (USDA-SCS 1982a).

Clarksville-Nixa-Noark soils are found on ridgetops and side slopes of the Springfield Plateau formed from cherty limestone. They range from excessively drained to moderately permeable, are found on gently sloping to very steep terrain and are very cherty, loamy upland soils (USDA-SCS 1982a).

Captina-Nixa-Tonti soils are found on broad uplands of the Springfield Plateau, ranging from moderately well drained to very slowly permeable. They are found on nearly level to moderately sloping areas and are cherty to loamy (USDA-SCS 1982a).

Arkana-Moko soils are found on the ridgetops and side slopes of the Springfield and Salem plateaus, formed from cherty limestone and cherty dolomite. These soils are characterized as being moderately deep and shallow, well drained, and very slowly to moderately permeable. This soil type is found on gently sloping to very steep terrain and is very cherty and stoney (USDASCS 1982a).

Linker-Mountainburg-Sidon soils are found on benches, sides, and tops of mountains formed in loamy residuum from sandstone or interbedded sandstone, siltstone, and shale. They are moderately well to well drained, nearly level to steep, loamy, gravely, or stoney soils on uplands (USDA-SCS 1982a).

Enders-Nella-Mountainburg-Steprock soils are found on benches, sides, tops, and foot slopes of hills and mountains, formed in a thin layer of loamy colluvial material and clayey residuum from shale or interbedded shale, siltstone, and sandstone. They are well drained, deep to shallow, very slowly to moderately rapidly permeable soils, and are found on gently sloping to steep terrain (USDA-SCS 1982a). Soil associations and information, at the local level, can be obtained through county Natural Resources Conservation Service (NRCS) offices throughout the watershed.

Ozark soils vary widely in character. Some soils are infertile stoney-clay type soils, while others are loess-capped and fertile. Some watershed soils are stone free, while others may have a stone content exceeding 50 percent, and some areas may have no soils covering bedrock. The majority of the watershed is dominated by stoney, cherty soils found on steep slopes with lower stone contents found in soils on more level areas. Soils in Missouri become less stoney on the western fringe of the watershed. Soils in the watershed are formed from residue high in iron, which oxidizes on exposure, giving the soil a red color. Soils formed in the residuum from cherty limestone or dolomite, range from deep to shallow and contain a high percentage of chert in most places. Soils formed in a thin mantle of loess are found on the ridges and have fragipans, which restrict root penetration. Soils formed in loamy, sandy, and cherty alluvium are found in narrow bottomland areas, and are the most fertile soils in the watershed (Allgood and Persinger 1979).

Soils in the watershed are generally acidic and of moderate to low fertility. Productivity of watershed soils varies widely, with forest and grassland being the dominant land cover (USDA-SCS 1975). A typical watershed landscape consists of broad forested areas on moderately steep to very steep slopes and small pastures and cultivated fields on smoother ridgetops and in level valley bottoms. Tall fescue is the main grass used for pastures. Native, tall and midtall grasses are found in glade and savannah areas. They are less common than before European settlement (Allgood and Persinger 1979). The moisture holding capacity of these soils is limited, adding to the general unsuitability for crop production. (USDA-SCS 1975).

Soil erosion in the Missouri portion of the watershed is minimal relative to other areas in the state. Sheet and rill erosion on tilled land is 18-24 tons per acre, but totals across the watershed should be very low considering the small portion of the area in cultivation. Sheet and rill erosion for permanent pasture is 5-9 tons per acre. Sheet and rill erosion for non-grazed forest is 0.25-0.50 tons per acre. The gully erosion problems are considered slight, and problems associated with erosion are localized (0-100 tons per sq. mi.). The amount of sediment that reaches streams is estimated to be between 0.8-0.9 tons per acre annually (Anderson 1980).

Stream Order

The White River is a sixth order stream where it enters Missouri in southeastern Barry County. The White becomes a seventh order stream at its confluence with the Kings River and an eighth order river shortly afterwards at the confluence with the James River. Today these order changes have little to do with size or flow increases within Missouri since both reaches are now impounded by Table Rock Dam. The White River remains an eighth order river where it enters the Mississippi River.

Watershed Area

The entire White River basin comprises an area of 27,765 square miles. The portion of the White River covered by this document has an area of 5,184 square miles, making up 18.7 percent of the entire White River basin. The Missouri portion of the watershed includes 2,281 square miles (44%), and the Arkansas portion of the watershed includes 2,903 square miles (56%).

Channel Gradient

Stream gradient information has been calculated for all streams third order and larger in the Missouri portion of the watershed. This information is available from MDC's Southwest Regional Office in Springfield, MO.

Table GE01. Springs of the White River watershed.

Spring #	Spring Name*	County	Topographic map	Flow **	Location T R S
3	Avery Spring	Stone	Blue Eye		21N 23W 24
49	Basin Spring	Carroll	Alpena		19N 22W 18
14	Beaver Creek Spring	Taney	Forsyth	65	23N 19W 15
102	Big Spring	Carroll	Carrollton		18N 22W 16
113	Blue Spring	Carroll	Blue Eye		21N 23 W 08
106	Blue Spring	Carroll	Busch		21N 27W 26
15	Boiling Spring	Douglas	Rome	19	25N 17W 05
104	Braswell	Carroll	Green Forest		20N 24W 25
8	Brown Spring	Christian	Shady Grove		26N 20W 08
6	Bud Spring	Christian	Green Mound Ridge		25N 21W 07
74	Bull Spring	Carroll	Alpena		19N 22W 18
96	Burchette Spring	Madison	Asher		15N 28W 13
9	Cash Spring	Christian	Christian Center		26N 20W 28
4	Devil's Pool	Taney	Oakmont		21N 22W 12
62	Diamond Spring	Benton	Rogers		19N 29W 07
64	Electric Springs	Benton	Rogers		19N 29W 06
16	Falls Spring	Christian	Keltner		26N 18W 07
60	Frisco Springs	Benton	Rogers		19N 29W 33
112	Hale Spring	Carroll	Oak Grove		21N 23W 17
110	Hammond Spring	Carroll	Green Forest		20N 23W 08
10	Harmon Spring	Christian	Keltner		26N 19W 36
68	Hewitt Spring	Washington	Springdale		17N 29W 04
7	Jackson Spring	Christian	Christian Center		26N 21W 26
17	Jackson Mill Spring	Douglas	Ava	1,540	26N 17W 35

Spring #	Spring Name*	County	Topographic map	Flow **	Location T R S
72	Johnson Spring	Carroll	Berryville		19N 25W 24
108	Mac Merry Spring	Carroll	Beaver		21N 27W 10
105	Magnetic Spring	Carroll	Eureka Springs		20N 26W 10
66	Mayo Spring	Benton	Rogers		19N 29W 11
13	Owens Spring	Taney	Ocie		22N 17W 26
76	Patty Spring	Carroll	Alpena		19N 22W 17
2	Radium Spring	Barry	Eagle Rock		21N 27W 23
5	Reno Spring	Christian	Chestnutridge		25N 27W 36
78	Reeves Spring	Carroll	Alpena		19N 23W 12
1	Roaring River Spring	Barry	Cassville	20,400	20N 27W 27
18	Rock Spring	Taney	Ocie	65	23N 17W 24
79	Rock Springs	Boone	Batavia		19N 21W 34
12	Schoolhouse Spring	Taney	Ocie		22N 17W 35
77	Sycamore Spring	Boone	Alpena		19N 22W 12
73	Tanyard Spring	Carroll	Alpena		19N 22W 19
11	Twin Springs	Taney	Ocie		22N 17W 26
19	Unnamed	Taney	Ocie		22N 17W 26
20	Unnamed	Taney	Ocie		22N 17W 27
21	Unnamed	Stone	Blue Eye		21N 23W 25
22	Unnamed	Douglass	Ava		26N 18W 34
23	Unnamed	Christian	Keltner		26N 19W 26
24	Unnamed	Christian	Keltner		26N 18W 19
25	Unnamed	Douglas	Keltner		26N 18W 23
26	Unnamed	Christian	Keltner		26N 18W 09
27	Unnamed	Christian	Keltner		26N 18W 09
28	Unnamed	Christian	Keltner		25N 21W 03
29	Unnamed	Taney	Ocie		23N 17W 23

Spring #	Spring Name*	County	Topographic map	Flow **	Location T R S
30	Unnamed	Douglas	Keltner		26N 17W 36
32	Unnamed	Douglas	Keltner		26N 17W 23
32	Unnamed	Douglas	Keltner		27N 17W 26
33	Unnamed	Douglas	Keltner		26N 17W 07
34	Unnamed	Douglas	Keltner		26N 17W 08
35	Unnamed	Douglas	Good Hope		26N 18W 12
36	Unnamed	Douglas	Good Hope		26N 18W 25
37	Unnamed	Douglas	Good Hope		25N 18W 02
38	Unnamed	Douglas	Good Hope		25N 17W 03
57	Unnamed	Benton	Rogersville		20N 29W 24
58/59	Unnamed (2)	Benton	Rogers		19N 29W 31
61	Unnamed	Benton	Rogers		19N 29W 07
63	Unnamed	Benton	Rogers		19N 29W 04
65	Unnamed	Benton	Rogers		19N 29W 05
67	Unnamed	Benton	Rogers		19N 29W 12
69	Unnamed	Washington	Springdale		18N 29W 35
70	Unnamed	Benton	Springdale		18N 29W 14
80	Unnamed	Boone	Batavia		19N 21W 14
81	Unnamed	Boone	Batavia		19N 21W 05
82	Unnamed	Washington	Sonora		17N 28W 04
83	Unnamed	Benton	Clifty		18N 28W 12
84/85	Unnamed (2)	Madison	Clifty		18N 26W 30
86/87	Unnamed (2)	Madison	Clifty		18N 26W 04
39	Unnamed	Ozark	Squires		24N 16W 14
40	Unnamed	Douglas	Squires		25N 16W 32
41	Unnamed	Douglas	Squires		25N 16W 19
42	Unnamed	Douglas	Squires		25N 16W 21

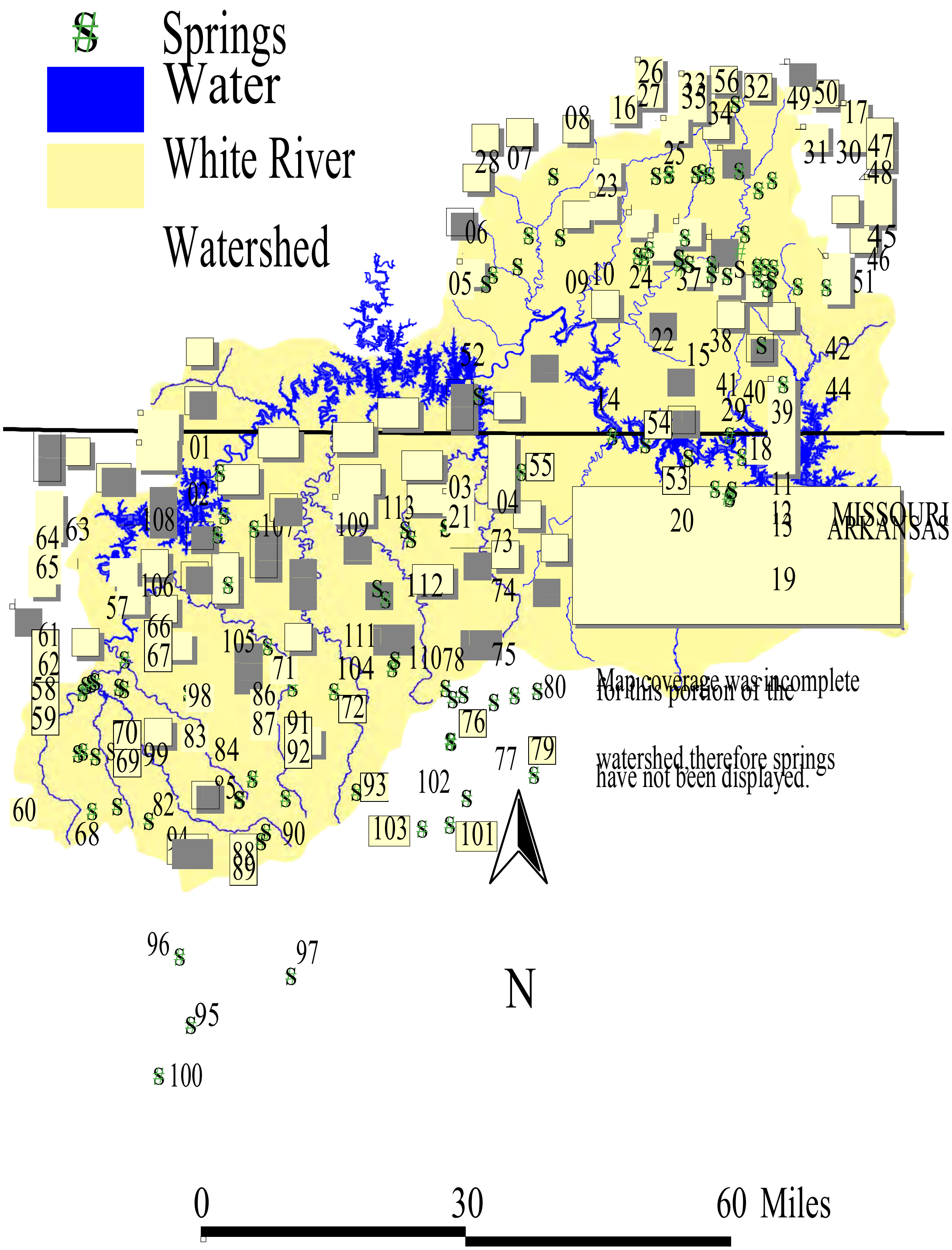
Spring #	Spring Name*	County	Topographic map	Flow **	Location T R S
43	Unnamed	Douglas	Squires		25N 16W 13
44	Unnamed	Douglas	Squires		25N 16W 17
45	Unnamed	Douglas	Squires		25N 16W 08
46	Unnamed	Douglas	Squires		25N 16W 09
47	Unnamed	Douglas	Squires		25N 16W 09
48	Unnamed	Douglas	Squires		25N 16W 09
49	Unnamed	Douglas	Ava		26N 16W 06
50	Unnamed	Douglas	Ava		27N 16W 33
51	Unnamed	Douglas	Squires		25N 15W 28
107	Unnamed	Carroll	Beaver		21N 26W 21
52	Unnamed	Taney	Branson		24N 22W 34
53	Unnamed	Taney	Fairview		22N 18W 06
54	Unnamed	Taney	Hilda		23N 18W 20
55	Unnamed	Taney	Hollister		22N 21W 16
111	Unnamed	Carroll	Oak Grove		21N 24W 36
56	Unnamed	Douglas	Seymour		27N 17W 03
88	Unnamed	Madison	Huntsville		17N 26W 10
90	Unnamed	Madison	Huntsville		17N 26W 01
91	Unnamed	Madison	Forum		18N 26W 25
92	Unnamed	Madison	Forum		18N 26W 24
93	Unnamed	Carroll	Rudd		18N 24W 17
94	Unnamed	Washington	Goshen		17N 28W 23
95	Unnamed	Madison	Delaney		14N 27W 18
97	Unnamed	Madison	Huntsville		15N 26W 13
98	Unnamed	Benton	Rock		19N 27W 19
99	Unnamed	Benton	Rock		19N 27W 22
100	Unnamed	Madison	Delaney		13N 28W 15

Spring #	Spring Name*	County	Topographic map	Flow **	Location T R S
101	Unnamed	Carroll	Osage		17N 22W 06
103	Unnamed	Carroll	Osage		17N 23W 10
71	Winona Springs	Carroll	Eureka Springs		19N 25W 06
89	Withrow Springs	Madison	Huntsville		17N 26W 10

*The number (N) with the spring name indicates two springs at one location.

**Flow in thousand gallons per day. Source: Vineyard (1982) and 7.5 minute USGS topographic maps.

Figure GE02. Springs of the White River watershed



Historic Land Use

Land Use

The period from 7000 to 1000 B.C. gives the first evidence of Native American activity in the Ozark Region. These peoples lived in small, transient camps and survived mainly on animal foods. Native American groups flourished in the area during the Woodland period (100 B.C. to 900 A.D.), but still clung to their hunter-gatherer ways while the world around them changed. The rugged geography of the region allowed early Native Americans to continue their ways in the region for several hundred years beyond that of tribes on the fringe of the Ozarks, who began to settle in larger villages and use more plant food. Native American peoples during the early Mississippian period (A.D. 900 to 1200) created larger and more elaborate villages and relied more on farming for food. Native American culture disappeared from the region in a period from around A.D. 1200 to A.D. 1500. The main cause for this was a move of peoples to the large agricultural villages along the Mississippi River. During this period the Ozark region was used for seasonal hunting and the collection of flint. Following this decline, Osage tribes inhabited the area up to and during early European settlement (Jacobson and Primm 1994).

The Native Americans' most notable effect on the lands of the region was a result of their use of fire. Fires set by Native Americans are thought to have been significant in determining the plant distribution of the region. Some anthropologist believe that fires were set to improve grassland for grazing of large animals, aid in hunting, and harassment of enemies (Jacobson and Primm 1994).

The United States gained control of the Ozarks and the watershed in the Louisiana Purchase of 1803. The first Europeans settled the narrow valleys and built their homes near springs. The population of the rugged interior of the Ozarks grew more slowly than the surrounding areas, with emigrants coming from different ethnic groups. Many of the earliest pioneers were from Kentucky and Tennessee and were attracted by the watershed's abundance of game and fish, rather than by its farming possibilities (Keefe and Morrow 1994).

The first changes in the landscape caused by land use patterns began taking place in the early 1800s to around 1880. Valley bottom forests and cane stands were replaced with cultivated fields and pastures. Suppression of wildfires in the uplands during the same period allowed an increase in understory growth in woodlands and losses of native grasslands and savannahs. The clearing of valley bottoms was probably responsible for some direct stream disturbance, but the suppression of fires in the uplands probably offset sediment yield (Jacobson and Primm 1994).

The second noticeable pattern in early land use was commercial timber harvest. Timber harvest on a large scale started around 1870 and continued until the 1920s. Shortleaf pines were harvested for sawlogs and oaks for railroad ties. The early logging operations used livestock to skid out the lumber, and cutting on the steeper slopes was avoided. This helped to minimize the effects of the early logging period (Jacobson and Primm 1994). The continued practice of valley clearing and road building coupled with extreme regional flooding between 1895 and 1915, was probably responsible for the initial moderate stream disturbance (Jacobson and Primm 1994).

The period between 1920 and 1960, known as the post-timber-boom, played the largest role in stream disturbances that are evident today. The practices of this period included annual burning and cutting of upland timber to open more grazing land, a practice still in place today. Oral-history indicates that small streams had more discharge, for longer periods, during this time than from 1960 to 1993. These changes in flow patterns can probably be attributed to changes in upland and riparian zone vegetation that decreased storage and flow resistance (Jacobson and Primm 1994).

During the early settlement period and throughout most of the timber boom, hogs were the dominant livestock in the area, only to be replaced by cattle following substantial increases in the 1920s and again in the 1940s. Early cattle were grazed on free range, which allowed them to concentrate in valley bottoms and destroy riparian vegetation and understory along streambanks. This destruction of riparian vegetation, coupled with the clearing and grazing of uplands, probably initiated headwater channel migrations, resulting in the extension of drainage networks and the accelerated release of gravel into small streams (Jacobson and Primm 1994). Free range was closed in the 1960's and areas were fenced. Fencing, along with improvements in the beef market, increased the areal density of cattle on pastures tremendously. The period from 1960 to 1993 showed decreases in the amount of farm land, but cattle numbers continued to increase (Jacobson and Primm 1994).

Recent Land Use

Forest land comprises the greatest percentage of land use/land cover types in the watershed at an estimated 57.2%, followed by pasture land (27.2%), range land (5.4%), non-cultivated cropland (3.2%), urban (2.7%), water (1.6%), roads (1.5%), miscellaneous (1.4%), and cultivated cropland (0.2%) (Tables LU01, LU02, and LU03) (Barney, T., NRCS, pers. comm.). Land use/land cover for the Missouri portion of the watershed from 1997 figures was: deciduous forest (36.8 %), mixed forest (24.4%), (total forest cover 61.2%), grassland (31.0%), water (3.9%), cropland (2.4%), and urban (1.5%) (Figure LU01). The 1997 land use/land cover data is Phase 1 data from the Missouri Resource Assessment Partnership (MoRAP 1997). The MoRAP land cover project is ongoing, and the Phase I map is an interim product designed for limited use. Phase 2 will incorporate extensive ground-based information, and is scheduled to be completed during 1999.

Livestock accounts for greater than 75% of agricultural sales in all Missouri counties in the watershed. Barry County lead all Missouri counties, statewide, in 1992 with a total market value for agriculture of 95 million dollars. The majority of the Barry County sales were from poultry production followed by cattle production (MASS 1997).

Southwest Missouri, including portions of the watershed, is one of the largest cattle producing regions in the state. Figures from 1997 indicate that all watershed counties, except Stone and Taney, had 60,000 or more head of cattle. In 1997, Barry, Wright, and Webster counties were the number seven, eight, and nine counties in the state for numbers of beef cattle. These counties compromise approximately 10% of Missouri’s portion of the watershed. Cattle numbers are recorded annually nationwide on a county basis. In order to generate cattle numbers at a watershed level, the amount of watershed area included in a particular county first had to be calculated. This method is only good to the point that it considers cattle to be equally spaced throughout the county. There were an estimated 141,340 (3.3% of state total) cattle in the Missouri portion of the watershed on January 1, 1997 (MASS 1997).

Historic and active mining have been and are present throughout the watershed (Table LU04). Lead was the most common mineral historically mined throughout the watershed, but no lead mining is ongoing today. There were historically sixty-three active lead mines and fifteen exploratory lead prospects in the watershed (MDNR 1998a). Mining operations are concentrated, and the effects of these operations have potential to impact watershed streams. Sand and gravel mining are the most common type of active mines. There are currently ninety known gravel removal locations in the watershed, fifty in Missouri and forty in Arkansas (Table LU05, Figure LU02) (USCOE 1998). The largest number of active gravel removal locations in the Missouri portion of the watershed occurs in the Beaver Creek subwatershed. Most sand and gravel operations are located directly adjacent to stream channels, and have the most potential for disturbing aquatic life.

Seasonal closures on the excavation of sand and gravel were placed on four stream reaches under General Permit GP-34M issued by the USCOE.

These reaches are:

- Beaver Creek, 23 miles, from mouth to Highway 76 bridge at Bradleyville (T24N, R18W, S10), Taney County, closed March 15 to July 31;
- Swan Creek, 2.3 miles, from Bull Shoals Lake (T24N, R20W, S33) to COE boundary (T24N, R20W, S33), Taney County, closed March 15 to June 15;
- Little North Fork, 4.2 miles, from Bull Shoals Lake (T22N, R15W, S19) to COE boundary (T22N, R15W, S04), Ozark County, closed March 15 to June 15;
- Pond Fork, 3 miles, from Bull Shoals Lake (T22N, R15W, S19) to COE boundary (T22N, R16W, S1), Ozark County, closed March 15 to June 15.

At the time of this writing, these restrictions no longer apply.

There are currently nineteen limestone quarries operating in the Missouri portion of the watershed (Table LU06, Figure LU03). These facilities are regulated by the Missouri Department of Natural Resources (MDNR) and must meet air and discharge standards. These operations have the potential to negatively affect water quality by discharging lime to surface and ground water (MDNR 1998b).

Watershed Population

The total (MO and AR) watershed human population in 1990 was 177,233 which is an increase of 12.0% from 1980 figures. Nineteen of the twenty counties that are partially or fully in the watershed have shown population increases from 1990 to 1996.

The majority of population growth in the Missouri portion of the watershed can be attributed to urban sprawl from the Springfield area and booming tourism associated with the Branson-Table Rock Lake region. Christian (44%), Stone (40%), and Taney (33%) counties were the top three counties for growth by percent in Missouri from 1990 to 1997, and these counties are projected to remain in the top ten Missouri counties for growth between 1990 and 2020. Six of the eight Missouri counties associated with the watershed are estimated to have population increases at rates higher than the state average (9%) through the year 2020 (Table LU07, Table LU08). The population of Christian County is expected to nearly double in the period from 1990 to 2020. The watershed towns of Hollister (3rd) and Branson (4th) also made the top 10 list for population increase for towns of over 2,500 people (Missouri State Office of Administration 1998).

Northwestern Arkansas has, in a period from 1970-1985, had the largest percentage population increase in the state. The watershed's Arkansas counties that lie along the Missouri border have shown increases between 39% and 95% for this time period. All counties in the Arkansas portion of the watershed, with the exception of one, have had population increases between 23% to 95% in this time period (Table LU09) (U.S. Census Bureau 1998).

Although some of these counties are not totally included in the watershed, the conclusion can be drawn that in areas where county populations have increased, so too has the watershed population. These ever-continuing population increases will put more demand on water resources and become an added threat to the water quality of the region, especially in the Bull and Swan Creek subwatersheds (Christian County) and the areas influencing Table Rock Lake and Lake Taneycomo.

The majority of the Missouri watershed is rural with a population density of 34.2 people per mi2. The Missouri state average is 64.8 people per mi2. Higher population densities occur in the Table Rock-Taneycomo region in Missouri and the Beaver Lake region in northwest Arkansas.

Larger metropolitan areas in the watershed, based on the 1990 U.S. census figures, include Branson, MO (11,364), Ava, MO (2,938), Hollister, MO (2,628), Kimberling City, MO (1,590) Forsyth, MO (1,161), Harrison, AR (9,922), Berryville, AR (3,212,) Green Forest, AR (2,050), Eureka Springs, AR (1,900), and West Fork, AR (1,607) (U.S. Census Bureau 1998).

Soil Conservation and Watershed Projects

There are currently no PL 566 or SALT projects in the Missouri portion of the White River watershed.

Public Areas

Public areas in the Missouri portion of the watershed are numerous and managed by several state and federal agencies (Table LU10, Figure LU04). The Drury-Mincy Conservation Area (CA) is the largest (5,699 acres) area owned and managed by the Missouri Department of Conservation (MDC) in the watershed. MDC owns and manages 18,783 acres with additional management responsibility on 18,625 acres of land owned by the United States Army Corps of Engineers (USCOE) (Houf, L., MDC, pers. comm.). Plans have also been developed for two additional MDC access sites on Lake Taneycomo. The Cooper Creek Access will add a 29.4-acre access to Lake Taneycomo in Taney County. A lease agreement was signed in 1996 between MDC and Empire District Electric Company (EDEC) to develop land adjacent to Boston Ferry Conservation Area into an additional access. Ownership issues concerning the 1.77-acre addition have put this project on hold. A third access site on Lake Taneycomo, Empire Park Access, was recently upgraded as part of a Corporate and Agency Partnership Program (CAPP) agreement between MDC and EDEC.

The United States Forest Service (USFS) has responsibility for the management of the Mark Twain National Forest in Missouri, with a watershed-wide total of 186,253 acres of public land. Forest Service land is managed in two units, the Cassville Ranger Unit (45,028 acres), with responsibility for the western portion of the watershed and the Ava Ranger Unit (141,225 acres), with responsibility for the eastern portion of the watershed. The Hercules Glade Wilderness (12,315) is located within the Ava Ranger Unit.

The Missouri Department of Natural Resources (MDNR) has management responsibility for the lands in Roaring River State Park (3,403 acres) and Table Rock State Park (356 acres).

The Arkansas Game and Fish Commission (AG&FC) manages 25,173 acres in that state's portion of the watershed. The USFS manages 5,000-7,000 acres in the upper White River as part of the Ozark National Forest. There are three state parks in the Arkansas portion of the watershed managed by the Arkansas Department of Parks and Tourism (Table LU11, Figure LU05).

The USCOE owns 98,684 acres of land surrounding the three large lakes in the watershed; Beaver Lake (12,256), Table Rock Lake (24,102), Bull Shoals Lake (62,326). The majority of the land remains under the control of the USCOE and is open to the public. Some USCOE land has been leased to other state, federal, and local agencies. A small amount of USCOE land is leased to individuals for their personal use (Milholland, M., USCOE, pers. comm.).

Corps of Engineers Jurisdiction

The White River watershed is under the jurisdiction of the Little Rock District of the USCOE. Permits issued under Section 404 of the Federal Clean Water Act are required to conduct many instream activities. Applications for Section 404 permits should be directed to the Little Rock office. In addition, current listings of Section 404 permits are available from the Little Rock USCOE District Office:

Little Rock District Corps of Engineers

P.O. Box 867

Little Rock, AR 72203-0867 Phone: (501)324-5295

Table LU01. Land use/cover for the Missouri portion of the White River watershed.

Land Use/ Cover	1992 estimate (acres)	1992 (%)	1987 estimate (acres)	198 7 (%)	1982 estimate (acres)	1982 (5)
Cultivated Cropland	2,300	0.2	3,800	0.3	5,800	0.5
Non-cultivated Cropland	39,400	3.1	33,400	2.6	29,000	2.3
Federal Land1	230,700	18.1	230,700	18.1	229,900	18
Forested Land	470,100	36.9	465,600	36.5	464,500	36.4
Pasture Land	333,600	26.2	346,700	27.2	358,700	28.1
Range Land	66,200	5.2	66,200	5.2	66,700	5.2
All Roads and Railroads	18,100	1.5	17,700	1.4	17,600	1.4
Urban	32,700	2.6	29,000	2.3	23,000	1.8
Large Water2	66,197	5.2	66,197	5.2	66,197	5.2
Small Water3	2,000	0.2	2,000	0.2	2,000	0.2
Miscellaneous	13,600	1.1	13,500	1.1	11,400	0.9

[1]No land use/cover types have been indicated for federal land. The major Corps of Engineer reservoirs have been added into the large water category but have not been subtracted from the Federal land total, so some overlap does occur.
[2]Indicates streams >660 feet wide and lakes >40 acres. 3Indicates streams < 660 feet wide and lakes < 40 acres. Source: (Barney, T., NRCS, pers. comm.).

Table LU02. Land use/cover for the Arkansas portion of the White River watershed. Land Use/Cover

Land Use/Cover	1992 estimate acres	1992 (%)	1987 estimate acres	1987 (%)	1982 estimate acres	1982 (%)
Cultivated Cropland	0	0	2,700	0.1	0	0
Non-cultivated Cropland	12,100	0.6	18,000	0.9	15,400	0.8
Federal Land1	120,000	5.8	112,700	5.5	112,300	5.5
Forested Land	913,200	44.5	914,100	44.4	914,900	44.6
Pasture Land	772,800	37.6	783,300	38	798,800	38.9
Range Land	58,400	2.8	54,200	2.6	54,300	2.6
All Roads and Railroads	28,400	1.4	28,200	1.4	26,100	1.3
Urban	56,200	2.7	55,500	2.7	44,000	2.1
Large Water2	67,400	3.3	67,400	3.3	66,700	3.3
Small Water3	7,400	0.4	7,400	0.4	7,300	0.4
Miscellaneous	17,400	0.9	15,900	0.8	13,000	0.6

[1]No land use/cover types have been indicated for federal land. The major Corps of Engineer reservoirs have been added into the large water category but have not been subtracted from the Federal land total, so some overlap does occur.

[2]Indicates streams > 660 feet wide and lakes > 40 acres. 3Indicates streams < 660 feet wide and lakes < 40 acres. Source: (Barney, T., NRCS, pers. comm.).

Table LU03. Land use/cover for the entire White River watershed.

Land Use/Cover	Estimated acres	(%)	MO acres (%)*	AR Acres (%)**
Cultivated Cropland	2,300	0.1	2,300 (100.0)	0 (0.0)
Non-cultivated Cropland	51,500	1.5	39,400 (76.5)	12,100 (23.5)
Federal Land1	350,700	10.5	230,700 (65.8)	120,000 (34.2)
Forested Land	1,383,300	41.6	470,100 (34.0)	913,200 (66.0)
Pasture Land	1,106,400	33.2	333,600 (30.2)	772,800 (69.8)
Range Land	124,600	3.7	66,200 (53.1)	58,400 (46.9)
All Roads and Railroads	46,500	1.4	18,100 (38.9)	28,400 (61.1)
Urban	88,900	2.7	32,700 (36.8)	56,200 (63.2)
Large Water2	133,597	4	66,197 (49.5)	67400 (50.5)
Small Water3	9,400	0.3	2,000 (21.3)	7,400 (78.7)
Miscellaneous	31,000	0.9	13,600 (43.9)	17,400 (56.1)

*The percent shown indicates that state's percentage of land use/cover represented in the entire watershed. Total land percentages for the basin are Missouri (44%) and Arkansas (56%).

[1]No land use/cover types have been indicated for federal land. The major Corps of Engineer reservoirs have been added into the large water category but have not been subtracted from the Federal land total, so some overlap does occur.

[2]Indicates streams > 660 feet wide and lakes > 40 acres. 3Indicates streams < 660 feet wide and lakes < 40 acres. Source: (Barney, T., NRCS, pers. comm.).

Table LU04. Historic and active mine types found in the Missouri portion of the White River watershed, by county.

Commodities	B*	C*	D*	O*	S*	T*	We*	Wr*	Total
Lead	0	19	0	0	2	2	0	0	23
Lead/Zinc	2	26	0	0	1	11	0	4	44
Lead/Zinc/Iron	1	0	0	1	1	3	0	0	6
Lead/Copper	0	2	0	0	0	0	0	0	2
Lead/Copper/Zinc	0	1	0	0	0	0	0	0	1
Lead/Silver	0	0	1	0	0	0	0	0	1
Zinc	0	1	0	0	0	0	0	0	1
Iron	0	0	2	2	0	3	0	0	7
Iron/Lime	1	0	1	4	0	0	0	0	6
Iron/Copper	1	0	0	0	0	0	0	0	1
Iron/Pyrite	2	0	0	0	0	0	0	0	2
Limestone	0	0	0	0	0	2	0	0	2
Limestone CB	11	3	7	2	2	10	0	0	35
Sand/Gravel	4	4	5	6	0	18	0	0	37
Uranium	2	1	1	0	0	0	0	0	4
TOTAL	24	57	17	15	6	49	0	4	172

* B= Barry, C= Christian, D= Douglas, O= Ozark, S= Stone, T= Taney, We= Webster, Wr= Wright.

Source: MDNR (1998a).

Table LU05. Known gravel removal locations in the White River watershed.

Site #	County	Stream name	Location TRS
10	Barry	Owl Creek	21N 25W 20
9	Barry	Roaring River	21N 26W 09
3	Barry	Roaring River	21N 26W 09
4	Barry	Kings River	21N 25W 24
5	Barry	Kings River	21N 25W 24
6	Barry	Roaring River	21N 26W 04
25	Christian	Bull Creek	25N 21W 36
38	Christian	Swan Creek	26N 19W 34
27	Christian	Bull Creek	25N 20W 08
48	Christian	Swan Creek	26N 19W 12
33	Douglas	Beaver Creek	27N 17W 23
36	Douglas	Cowskin Creek	27N 16W 33
34	Douglas	Beaver Creek	27N 17W 23
39	Douglas	Little Beaver	25N 18W 22
45	Ozark	North Fork	22N 15W 13
44	Ozark	Barren Fork	23N 15W 34
43	Ozark	North Fork	22N 15W 13
42	Ozark	Little North Fork	24N 16W 24
19	Ozark	Little N. Fork White	22N 15W 08
41	Ozark	Pond Fork	23N 16W 26
40	Ozark	Pond Fork	23N 16W 35
22	Ozark	Barren Fork	23N 15W 33
46	Ozark	North Fork	22N 15W 13
12	Ozark	Little N. Fork White	22N 15W 05
26	Ozark	Barren Fork	23N 15W 33
7	Stone	Big Indian Creek	21N 24W 15
2	Stone	Big Indian Creek	21N 24W 15

Site #	County	Stream name	Location TRS
8	Stone	Big Indian Creek	21N 24W 15
11	Stone	Big Indian Creek	21N 24W 22
1	Stone	Big Indian Creek	21N 24W 22
31	Taney	Beaver Creek	24N 17W 06
32	Taney	Swan Creek	24N 20W 34
30	Taney	Beaver Creek	23N 18W 06
29	Taney	Bull Creek	24N 21W 34
35	Taney	Beaver Creek	24N 18W 21
28	Taney	Roark Creek	23N 22W 23
37	Taney	Silver Creek	23N 20W 09
24	Taney	Turkey Creek	22N 21W 09
23	Taney	Bull Creek	24N 21W 11
21	Taney	Swan Creek	27N 20W 34
20	Taney	Swan Creek	24N 20W 34
18	Taney	Swan Creek	24N 20W 34
17	Taney	Swan Creek	24N 20W 34
16	Taney	Beaver Creek	23N 19W 14
15	Taney	Shoal Creek	21N 17W 05
14	Taney	Swan Creek	23N 20W 34
47	Taney	Swan Creek	24N 20W 01
13	Taney	Swan Creek	23N 20W 27
49	Taney	Beaver Creek	24N 18W 02
50	Taney	West Fork Big Creek	22N 17W 13
51	Baxter	White River	19N 14W 19
52	Boone	Bear Creek	20N 20W 22
53	Boone	Bear Creek	20N 21W 36
54	Boone	Cricket Creek	21N 21W 20
55	Boone	Evans Branch	20N 20W 26

Site #	County	Stream name	Location TRS
	Boone	Sugarloaf Creek	20N 18W 06
	Boone	Deshield Fork	20N 18W 04
	Carroll	Yocum Creek	21N 22W 19
	Carroll	Butler Creek	21N 27W 14
	Carroll	Table Rock Lake	21N 26W 17
	Carroll	Osage Creek	20N 25W 21
	Carroll	Kenner Creek	18N 23W 27
	Carroll	Kenner Creek	18N 23W 27
	Madison	West Flemming Creek	13N 26W 18
	Madison	Kings River	25W 19N 29
	Madison	Kings River	16N 24W 09
	Madison	Kings River	16N 24W 32
	Madison	White River	13N 26W 04
	Madison	White River	13N 26W 04
	Madison	White River	13N 26W 04
	Madison	White River	13N 26W 04
	Madison	Thomas Creek	14N 27W 04
	Madison	Kings River	15N 24W 05
	Madison	White River	14N 28W 11
	Madison	White River	13N 27W 02
	Madison	Richland Creek	16N 28W 36
	Madison	War Eagle Creek	18N 26W 32
	Marion	Crooked Creek	18N 17W 07
	Marion	Tar-Kiln Creek	19N 18W 26
	Marion	East Horton Creek	20N 18W 10
	Marion	Sugarloaf Creek	20N 17W 19
	Marion	Crooked Creek	19N 15W 33
	Marion	Crooked Creek	18N 16W 08

Site #	County	Stream name	Location TRS
84	Marion	Crooked Creek	18N 16W 08
85	Washington	Shumate Creek	15N 28W 33
86	Washington	West Fork White River	15N 30W 29
87	Washington	Middle Fork White River	15N 29W 28
88	Washington	Richland Creek	17N 28W 31
89	Washington	White River	17N 28W 30
90	Washington	West Fork White River	15N 30W 16

Source: USCOE (1998).

Table LU06. Permitted limestone quarries in the Missouri portion of the White River watershed.

Site #	Name	Receiving Water	Location	County
1	Hutchens Construction	Dry Hollow	22N 28W 34	Barry
2	Hutchens Eagle Rock	Roaring River	21N 26W 05	Barry
3	Barry County Ready Mix	Panther Creek	21N 26W 24	Barry
4	Shell Knob Quarry	Big Creek	22N 25W 04	Barry
5	Barry County Ready Mix	Mill Creek	22N 25W 04	Barry
6	L-J Hwy. 376 Quarry	Fall Creek	23N 22W 34	Taney
7	Table Rock Asphalt	East Fork Roark Creek	23N 22W 11	Taney
8	Roark Creek Quarry	Roark Creek	23N 21W 19	Taney
9	Kortes Quarry	Bee Creek	23N 21W 07	Taney
10	Glenstone Block Company	Roark Creek	23N 21W 19	Taney
11	Table Rock Asphalt #1	Roark Creek	23N 21W 19	Taney
12	L-J Hollister South	Turkey Creek	22N 21W 30	Taney
13	Concrete of the Ozarks	Turkey Creek	22N 21W 17	Taney
14	Mansfield 76 Quarry	Lake Taneycomo	22N 21W 02	Taney
15	Tom's Quarry	Lake Taneycomo	22N 21W 01	Taney
16	L-J Hilda Quarry	Slough Hollow	23N 19W 25	Taney
17	L-J Protem Site 12	Bull Shoals Lake	21N 17W 16	Taney
18	L-J Gainesville Quarry	S. Fork Bratten Spring Cr.	22N 14W 16	Ozark
19	L-J Ava Quarry	Spring Creek	26N 16W 25	Douglas

Source: MDNR (1998a).

Table LU07. Total county populations and estimated changes for Missouri counties that include portions of the White River watershed.

County	1990 Pop.	Pop. Pop.	2000 Est.	2005 Est.	2010 Est.	2015 Est.	2020 Est.
Barry	27,547	29,315	31,033	32,682	34,227	35,701	37,029
Christian	32,644	38,433	44,037	49,458	54,633	59,462	63,799
Douglas	11,876	11,909	11,950	12,021	12,100	12,188	12,280
Ozark	8,598	8,862	9,082	9,238	9,295	9,284	9,184
Stone	19,078	21,196	23,168	24,963	26,493	27,780	28,733
Taney	25,561	28,205	30,576	32,729	34,622	36,159	37,231
Webster	25,239	25,239	26,690	28,130	29,517	30,821	31,993
Wright	17,054	17,054	17,387	17,740	18,121	18,504	18,887
Total	165,815	180,213	193,923	206,961	219,008	229,899	239,136

Source: Missouri State Office of Administration (1998).

Table LU08. Projected population increases in Missouri counties that include portions of the White River watershed. Values for each county and year are in comparison to 1990 population levels (Table LU07).

Percent Increase by Year						
County	1995	2000	2005	2010	2015	2020
Barry	6.4	12.7	18.6	24.3	29.6	34.4
Christian	17.7	34.9	51.5	67.4	82.2	95.4
Douglas	0.3	0.6	1.2	1.9	2.6	3.4
Ozark	3.1	5.6	7.4	8.1	8	6.8
Stone	11.1	21.4	30.9	38.9	45.6	50.6
Taney	10.3	19.6	28	35.5	41.5	45.7
Webster	6.3	12.4	18.4	24.3	29.8	34.7
Wright	1.8	3.8	5.9	8.1	10.4	12.7
Average	8.7	17	24.8	32.1	38.7	44.2

Source: Missouri State Office of Administration (1998).

Table LU09. Populations and estimated changes for Arkansas counties that include portions of the White River watershed.

County	1990 Pop.	Change (%)	1994 Pop.	Change (%)	1996 Pop.	1990-96 Change (%)
Benton	97,499	7.7	105,588	12.7	120,932	19.4
Carroll	18,654	4.4	19,505	11.1	21,933	15
Washington	113, 409	5.6	120,146	8.8	131,708	13.9
Marion	12,001	3.6	12,444	10.2	13,855	13.4
Baxter	31,186	3.6	32,362	9.3	35,666	12.6
Crawford	42,498	4.4	44,446	7.6	48,100	11.7
Johnson	18,221	2.5	18,695	8.8	20,508	11.2
Madison	11,618	5.8	12,330	4.7	12,943	10.2
Boone	28,297	3.1	29,207	6.9	31,364	6.6
Franklin	14, 897	1.6	15,139	6.1	16,121	7.6
Newton	7,666	-0.2	7,649	4.3	7,989	4

Source: U.S. Census Bureau (1998).

Table LU10. Public areas in the Missouri portion of the White River watershed.

Area name	Management1	County	Acres	Stream Frontage	Impoundment acres
Roaring River State Park	MDNR	Barry	3,403	7.5 mi.	
Roaring River CA	MDC	Barry	439	0.5 mi.	
Roaring River Fish Hatchery	MDC	Barry	3		
Busiek State Forest	MDC	Christian	2,505	4.5 mi.	
Grundy Memorial WA	MDC	Douglas	40		
Squires Towersite	MDC	Douglas	5		
Caney Mountain CA	MDC	Ozark	7,882		
Wilderness Towersite	USFS	Stone	2		
Ruth and Paul Henning CA	MDC	Taney/Stone	1,534	0.5 mi.	
Shepard of the Hills Fish	MDC	Taney	211		
Hollister Towersite	MDC	Taney	180		
Boston Ferry CA	MDC	Taney	180		
Hilltop Towersite	MDC	Taney	3		
Drury-Mincy CA	MDC	Taney	5,699		
Branson MDC Office	MDC	Taney	4		
Cedar Creek Towersite	MDC	Taney	4		
Cooper Creek Access	MDC/EDEC	Taney	29		
Bull Shoals Lake*	MDC/USCOE	Various	62,326		45,440
Lake Taneycomo	MDC/USCOE	Taney			2,080
Empire Park	EDEC/MDC	Taney	3		
Table Rock Lake*	USCOE/MDC	Various	24,102		43,100
Table Rock State Park	MDNR	Taney	356		
Hercules Glades Wilderness	USFS	Taney	12,315		
Mark Twain National Forest	USFS	Numerous	186,253		

*Numbers indicate both Missouri and Arkansas portions of area and impoundment acres.

[1]Management responsibility MDC = Missouri Department of Conservation; MDNR = Missouri Department of Natural Resources; EDEC = Empire District Electric Company; USCOE = United States Army Corps of Engineers; USFS = United States Forest Service.

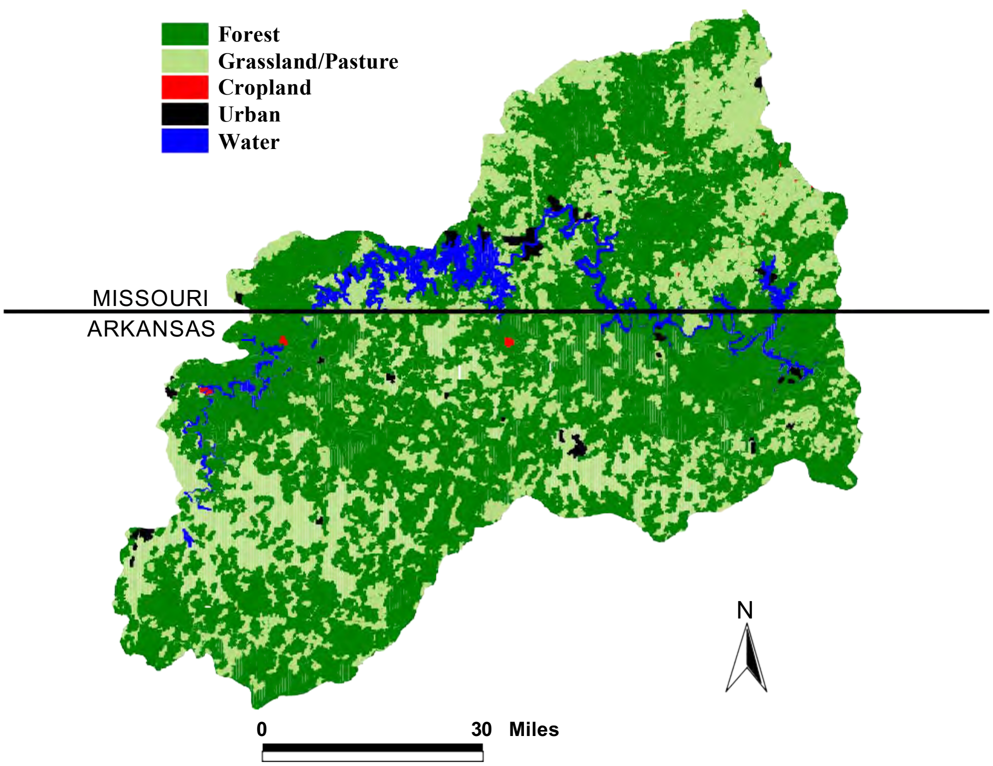
Table LU11. Public areas in the Arkansas portion of the White River watershed.

Area Name	County	Acres	Management Responsibility	Stream access
Wildcat Shoals Access	Baxter	2	AG&FC	X
Beaver Lake State Park Hobbs State Mgmt. Area	Benton	11,646	AG&FC, AR Dept. of Parks and Tourism, AR Natural Heritage Comm.	
Bull Shoals Nursery Pond	Boone	NA1	AG&FC	
Houseman Access	Carroll	NA1	AF&FC	X
Withrow Springs State Park	Carroll	780	AR Dept. of Parks and Tourism	X
Hindsville Lake	Madison	1	AG&FC	
Madison County WMA*	Madison	13,287	AG&FC	X
Marble Access	Madison	1	AG&FC	X
Ozark National Forest	Madison	6,000	USFS	X
Rock House Access	Madison	23	AG&FC	X
Bull Shoals State Park	Marion	660	AR Dept. of Parks and Tourism	X
Crooked Creek Access	Marion	2	AG&FC	X
Marion County WMA*	Marion	120	AG&FC	X
Pot Shoals Net Pen Proj.	Marion	90	AG&FC	
Ranchette Access	Marion	1	AG&FC	X
Marion County Access	Marion	NA1	AG&FC	X
White Hole Access	Marion	NA1	AG&FC	X

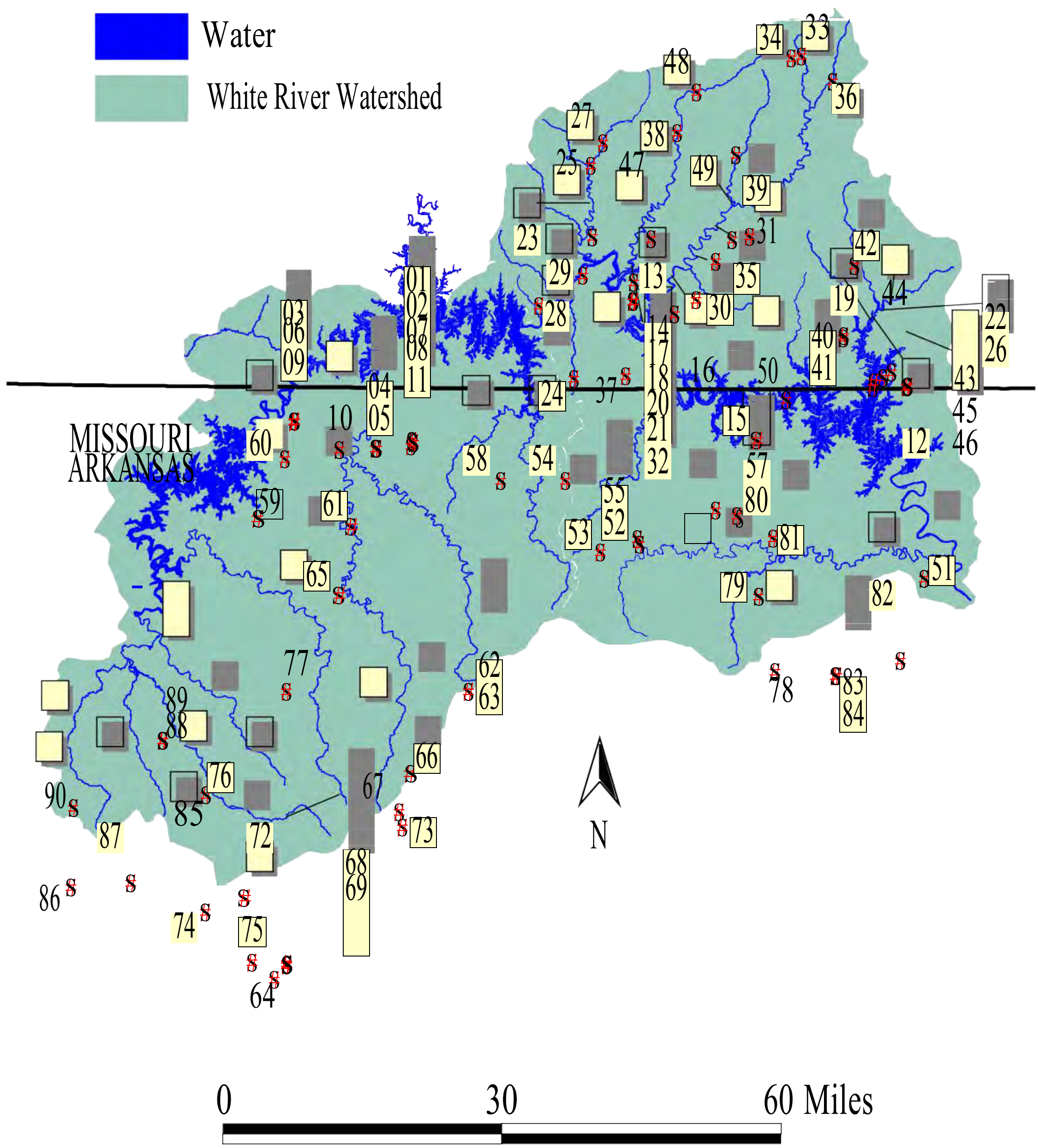
*Wildlife Management Area

[1]NA indicates that no area was reported at these areas.

Figure LU01. Land use/cover of the White River watershed .

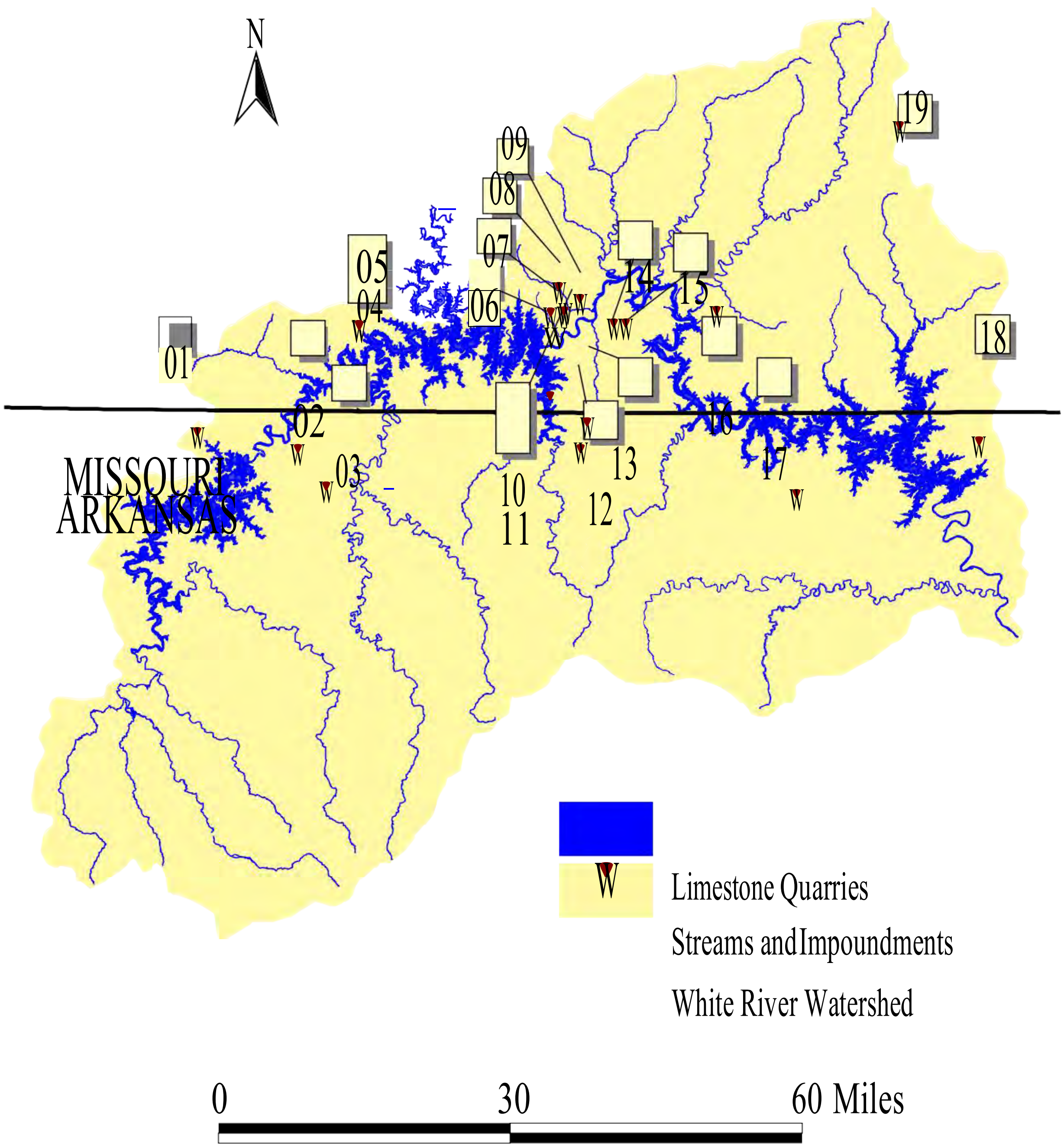


Source: (MoRAP 1997, Smith et al. 1998).



Note: Location numbers reference Table LU05. Source: USCOE (1998).

Figure LU03. Limestone quarries in the Missouri portion of the White River watershed.



Note: Limestone quarry numbers reference Table LU06.

Source: NPDES database (MDNR 1998b)

Figure LU04. Public areas in the Missouri portion of the White River watershed.

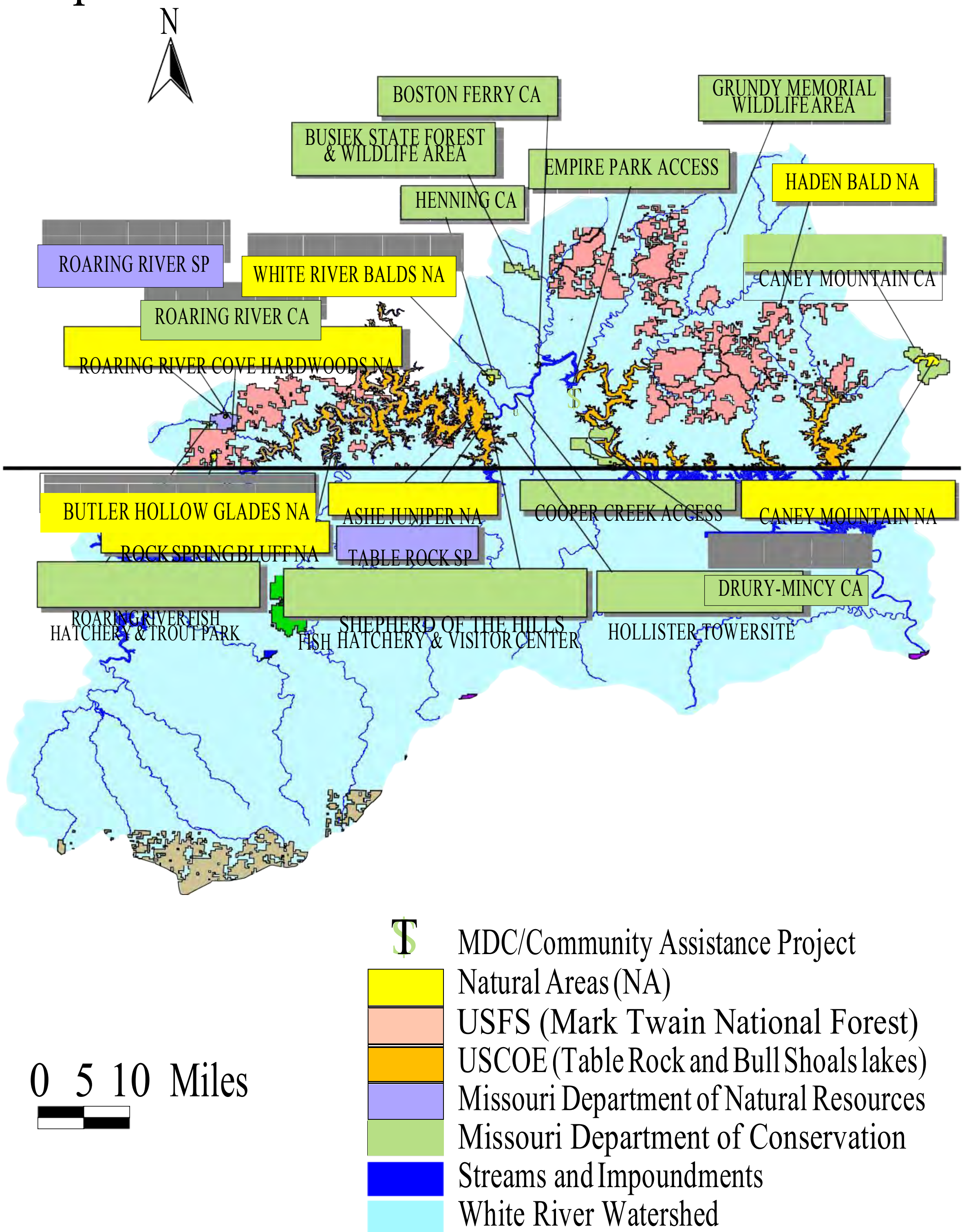
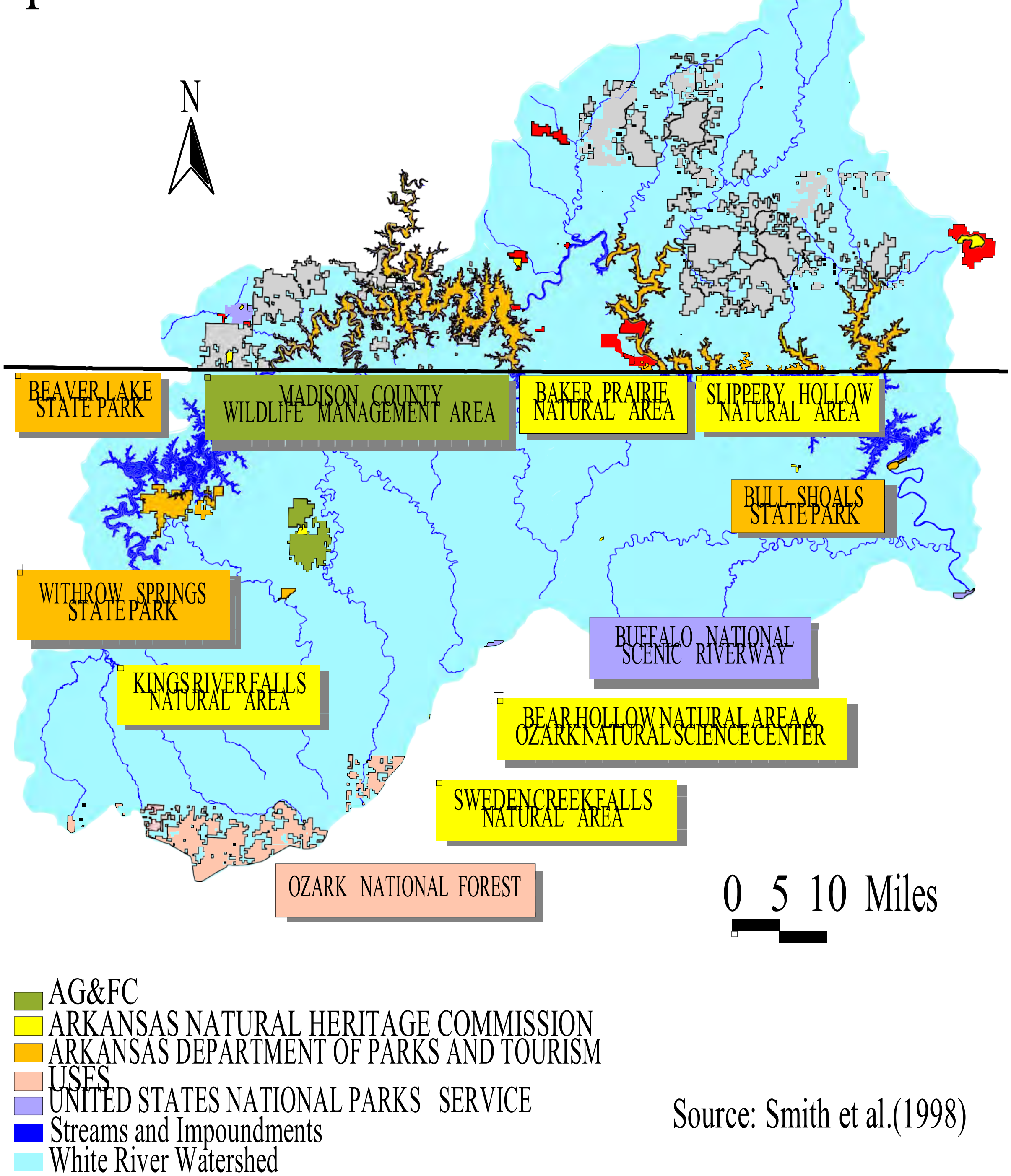


Figure LU05. Public areas in the Arkansas portion of the White River watershed.



Source: Smith et al.(1998)

Hydrology

Precipitation

The average annual precipitation in the Missouri portion of the watershed ranges from 40 to 44 inches. This is the second highest region of precipitation in the state, lead only by the Southeast Lowlands. The average annual watershed rainfall ranges from 12 to 16 inches, and average annual evaporation is 55 to 60 inches. Most rainfall occurs during the months of March, April, and May, and the driest period is December, January, and February. The average maximum rainfall for a 24-hour period is 2.5 to 3 inches expected every two years and 5 to 6 inches for a 24-hour period expected once every 25 years (MDNR 1986a).

Gaging Stations

The United States Geological Survey (USGS) has maintained gaging and water quality stations throughout the watershed since the early 1900s (Table HY01, Figure HY01). There are six active and three inactive gage stations located in the Missouri portion of the watershed and nine active and twenty-one inactive gage stations in the Arkansas portion of the watershed. Specific information from each station, for the period of record, can be found in annual Water Resources Data Reports published by the USGS in Rolla, MO and Little Rock, AR.

Streams

Permanent and Intermittent Streams

There are many streams in the watershed which are considered intermittent for all or part of their length. The total mileage for intermittent streams with permanent pools is 210.5 miles for the Missouri portion of the watershed. The length of streams with permanent flow is 298.5 miles (Funk 1968). Intermittent streams are represented as broken blue lines on USGS 7.5 minute topographic maps, while permanent streams are represented with solid blue lines. Figure HY02 shows coverage of USGS 7.5 minute topographic maps for the watershed, and map names are listed in Table HY02.

Losing stream reaches, streams that lose portions or all of their surface flow to underground flow, are listed in Table HY03 for the Missouri portion of the watershed. Losing streams are direct links between surface water and groundwater and have the potential to transfer undesirable contaminants to groundwater.

Base flows in most streams are well sustained during dry weather, due in part to the high storage capacity of the regional geology, coupled with favorable precipitation and runoff conditions.

Springs help sustain flow in many watershed streams. There were 104 watershed springs identified from USGS 7.5 minute topographic maps. Springs in the watershed are listed in Table GE01and displayed in Figure GE02. The largest spring in the Missouri portion of the watershed, for which flow has been determined, is Roaring River Spring, with an average daily flow of 20,400,000 gallons and a maximum recorded daily flow of 114,000,000 gallons (Vineyard 1982).

Stream Flow

Instream flow refers to the quantity of water, and its variation over time, as it exists in a watercourse, also referred to as flow regime. Some instream flow uses in the watershed include, protection of aquatic organisms, hydroelectric power production, recreation, channel maintenance, and transport of effluent discharges.

The 7-day Q^2 and Q^{10} values represent the relative permanence of a stream. The 7-day low flow discharges, with recurrence intervals of two years (Q^2) and ten years (Q^{10}), for locations throughout the watershed are found in Table HY04. The minimum recorded flow from Beaver Dam is 47 cubic feet per second (cfs) and from Table Rock Dam is 100 to 110 cfs (MDNR 1996b). Table HY05 gives historic high and low flow information for several gage stations throughout the watershed. Base flows are maintained by springs and, even during the driest periods, watershed streams have some of the best maintained base flows in Missouri. The high relief of the watershed results in rapid runoff during periods of heavy rain, and stream levels can increase rapidly.

Dams and Hydropower Influences

There are three large hydroelectric dams on the mainstem White River; Beaver Dam, Table Rock Dam, and Bull Shoals Dam. All three are owned by the USCOE and electricity is distributed by the Southwestern Power Administration (SWPA). The dams were constructed and are operated for flood control and to provide electric power, with an added authorization of Bull Shoals Lake to provide water for municipal and industrial uses. Much discussion has taken place concerning a reauthorization of the White River Reservoir System to include recreation and natural resources in the stated purposes of the lakes. Powersite Dam is a considerably smaller mainstem hydroelectric dam owned and operated by the Empire District Electric Company (EDEC).

The uppermost mainstem hydroelectric dam is Beaver Dam near Eureka Springs, AR at river mile (RM) 609.0. Beaver Lake was formed in 1963 with the closing of Beaver Dam. Beaver Lake has a conservation pool elevation of 1,120 feet above mean sea level (msl) and a flood pool elevation of 1,135 msl. Beaver Lake contains 28,220 surface acres of water at conservation pool and 31,700 acres of surface water at flood pool. Beaver Lake impounds 37 miles of the White River.

The first mainstem hydroelectric dam in the Missouri portion of the watershed, and second in line below Beaver Dam, is Table Rock Dam near Branson, MO, located at RM 528.8. Table Rock Dam was closed in June of 1959, and Table Rock Lake impounds approximately 80 miles of the mainstem White River. Table Rock Lake's conservation pool elevation is 915 feet msl, and the flood pool elevation is 931 feet msl. Table Rock Lake, at conservation pool, has 39,652 surface acres in Missouri and 3,448 surface acres in Arkansas. Table Rock Lake at full flood pool impounds water to within about 3 miles of Beaver Dam.

The next mainstem dam is Powersite Dam located at RM 506.1. Powersite Dam is a considerably smaller mainstem hydroelectric dam owned and operated by EDEC. Powersite Dam was closed in 1913 creating 2,080-acre, Lake Taneycomo. Lake Taneycomo impounds 22 miles of the White River, and the top of the overflow dam has an elevation of 701.2 feet msl. Water releases from Table Rock Dam vary hourly and daily and keep Lake Taneycomo in a somewhat riverine state.

Bull Shoals Dam is the next in the series of mainstem hydroelectric dams, located near Mountain Home, AR. Bull Shoals Dam was closed in 1952 impounding 86 miles of the White River and creating Bull Shoals Lake. Bull Shoals Dam is located at RM 418.6. Bull Shoals has a conservation pool elevation of 654 feet msl and flood control elevation of 695 feet msl. Bull Shoals Lake at conservation pool covers 16,335 surface acres in Missouri and 29,105 surface acres in Arkansas.

The most obvious impact these dams have had on the White River is the inundation of the total Missouri length of the mainstem White River and the loss of habitat and aquatic fauna associated with this type of riverine system. Reservoir construction has also had a negative impact on lower stretches of tributary streams by altering flow regimes and negatively impacting riparian vegetation and aquatic life. Specific examples of species losses attributed to reservoir construction are dealt with in the biotic section.

Cold water releases from the three large mainstem dams have drastically altered the warmwater fisheries that once existed in the mainstem White River. The water released from the hypolimnion of the reservoirs is colder than that which once sustained the native fishery. These temperature changes have had the most noticeable impact in stream reaches closest to the dams, but less obvious impacts have been observed through the entire White River system, to its confluence with the Mississippi River (Shirley 1992).

Directly below each of the three major dams, coldwater fish species have been introduced and now replace the native warmwater species. Congress authorized the building of the Norfork National Fish Hatchery in 1956 as partial mitigation for the lost warmwater fishery (Patterson 1993). As a result, trout have been stocked in the tailwaters of the three dams and a put-and-take trout fishery has existed since that time. A study conducted on Lake Taneycomo compared fish populations between the pre-Table Rock warmwater conditions and the post-Table Rock coldwater conditions (Table HY06). Lake Taneycomo as a warmwater fishery had standing stocks that included largemouth bass (8.7%), crappie (4.6%), other sunfishes (13.2%), and catfishes (9.7%) (percents indicate species percent of total standing stock). At the time of the survey no trout were present. Within nine years of the impounding of Table Rock Lake and the ensuing coldwater release, trout made up 95% of the harvest in Lake Taneycomo (Shirley 1992).

Low dissolved oxygen levels in the tailwaters of the three major dams (Beaver, Table Rock, and Bull Shoals dams) has also had negative impacts on the introduced coldwater fisheries. Increased nutrification from human and agricultural sources has spurred lower dissolved oxygen levels in the hypolimnion of the reservoirs (USGS 1995). The dams are all bottom release structures, and low oxygen levels in the tailwaters have caused problems for the introduced fishes which are very sensitive to low dissolved oxygen levels. The greatest potential for low dissolved oxygen problems occurs from July through December as the lakes stratify into distinct layers. A cooperative effort between SWPA, USCOE, EDEC, AG&FC and MDC has tried several methods to improve dissolved oxygen levels below the three large dams.

Instream flow, affected by the four mainstem dams, is a major issue in the watershed. Instream flow affects the availability of aquatic habitat, dissolved oxygen levels, and angling opportunities. Operation of Beaver and Bull Shoals dams, in Arkansas, and Table Rock Dam in Missouri substantially alter stream flows in the White River system. Hydroelectric peaking operation at these dams results in rapid changes in flow, extremely low flows, dewatered substrate, reduced fish and invertebrate habitat, and low tailwater dissolved oxygen levels, all of which can prove detrimental to fish and invertebrate populations. A study conducted by MDC (Lobb, Kruse, and Roell 1997) found that substantial increases in aquatic habitat in the tailwater section of Lake Taneycomo, directly below Table Rock Lake, would result from moderate increases in the normal flow release of Table Rock Dam. Recommendations for improving stream flow management at Table Rock Dam have been forwarded to the USCOE. Additional research is needed to refine these recommendations and fully document the benefits to the aquatic community and the Lake Taneycomo recreational fishery. Similar efforts to study and improve stream flow management at Bull Shoals are further along for the Arkansas portion of the White River. Further interstate efforts to establish minimum flows below these dams are ongoing, and cooperation between MDC, AG&FC, USCOE and SWPA remains critical to finding better ways to manage flows and protect the downstream fisheries (Lobb D., MDC memo, 1998).

Table HY01. United States Geological Survey (USGS) gage stations in the White River watershed.

Gage Number	Gage Name	Status*	Drainage Area (m2)	Type **	T	R	S
7050150	Roaring River Spring near Cassville	A		WQ	22N	27W	11
7050152	Roaring River at Roaring River State Park	I		WQ	22N	27W	34
7053400	Table Rock Lake near Branson	A	4,020	WQ	22N	22W	22
7053450	White River Below Table Rock Dam	A		WQ	22N	22W	11
7053500	White River near Branson	I	4,022	WS	22N	22W	22
7053600	Lake Taneycomo at College of the Ozarks	A		WQ	22N	21W	4
7053700	Lake Taneycomo at Branson	I		WQ	22N	21W	4
7053810	Bull Creek near Walnut Shade	A	191	WS	23N	21W	4
7054080	Beaver Creek at Bradleyville	A	298	WS	24N	18W	11
7048550	West Fork of White River east of Fayettville	I	118	WQ	16N	30W	24
7048700	White River near Goshen	I	412	WQ	17N	28W	31
7049691	White River at Beaver Dam	I	1,192	WQ	20N	27W	10
7050390	Osage Creek southwest of Berryville	I		WQ	20N	25W	36
7050420	Osage Creek west of Berryville	I		WQ	20N	25W	26
7050500	Kings River near Berryville	A	527	Both	20N	25W	3

Gage Number	Gage Name	Status*	Drainage Area (m2)	Type **	T	R	S
7053230	Long Creek near Denver	I		WQ	21N	22W	34
7053207	Long Creek at Denver	A	104	WS	21N	22W	34
7054501	White River at Bull Shoals Dam	A	6,051	WQ	20N	15W	21
7055565	Crooked Creek at Harrison	I	67	WQ	18N	20W	3
7055569	Crooked Creek near Harrison	I		WQ	18N	20W	2
7055608	Crooked Creek at Yellville	A	406	Both	18N	16W	9
7048000	West Fork White River at Greenland	I	83.1	Both	18N	30W	16
7048500	West Fork White River near Fayetteville	I	118	WS	16N	30W	24
7048600	White River near Fayetteville	A	400	Both	16N	29W	8
7049000	War Eagle Creek near Hindsville	A	263	WS	18N	27W	28
7049695	White River above Busch	I	1,192	WQ	21N	27W	34
7050000	White River at Beaver	I	1,244	WQ	21N	26W	20
7054535	Whiter River below Bruce Creek near Lakeview	I		WQ	19N	15W	35
7055000	White River near Flippin	I	6,081	WS	19N	15W	10
7055550	Crooked Creek Tributary near Dog Patch	I	4	WQ	17N	20W	4
7055600	Crooked Creek at Pyatt	I	207	WQ	19N	17W	31

Gage Number	Gage Name	Status*	Drainage Area (m2)	Type **	T	R	S
7054410	Bear Creek near Omaha	A	133	WS	21N	20W	26
7053250	Yocum Creek near Oak Grove	A	53	WS	21N	22W	30
7048800	Richland Creek at Goshen	A	138	WS	17N	28W	—

*Status A= active, I= inactive

**Type WQ= water quality, WS= water stage, Both= water stage and water quality. Source: (Wilson, G. and Porter, E., USGS, pers. comm.)

Table HY02. USGS 7.5 minute topographic map coverage of the White River watershed.

Quad #	Quad Name	Quad #	Quad Name
Missouri Topographic Maps			
689	Seligman	754	Protem NE
690	Eagle Rock	755	Thornfield
691	Golden	756	Wilhoit
692	Viola	757	Gainesville NW
693	Lampe	806	Spokane
694	Table Rock Dam	807	Day
695	Hollister	808	Garrison
696	Mincy	809	Bradleyville
697	Protem SW	810	Brown Branch
698	Protem	811	Smallet
699	Theodosia	812	Wasola
700	Isabella	862	Highlandville
701	Gainesville	863	Selmore
745	Exeter	864	Chadwick
746	Cassville	865	Keltner
747	Shell Knob	866	Goodhope
748	Cape Fair	867	Ava
749	Reeds Springs	920	Rogersville
750	Garber	921	Bruner
751	Branson	922	Dogwood
752	Forsyth	923	Cedar Gap
753	Hilda		
Arkansas Topographic Maps			
656	Bidville	818	Gaither
657	Cass	819	Harrison
693	Winslow	820	Everton

Quad #	Quad Name	Quad #	Quad Name
694	Brentwood	821	Bruno
695	Delaney	822	Yellville
696	St. Paul	823	Rea Valley
697	Pettigrew	824	Buffalo City
698	Boston	846	Bentonville South
732	Prairie Grove	847	Rogers
733	West Fork	848	War Eagle
734	Sulphur City	849	Sandstone Moutain
735	Durham	850	Rockhouse
736	Japton	851	Berryville
737	Witter	852	Green Forest
738	Weathers	853	Alpena
739	Boxley	854	Batavia
773	Fayetteville	855	Bergman
774	Elkins	856	Zinc
775	Goshen	857	Pyatt
776	Hartwell	858	Cotter SW
777	Huntsville	859	Cotter
778	Kingston	860	Mountain Home West
779	Osage SW	884	Pea Ridge
780	Ponca	885	Garfield
781	Jasper	886	Beaver
782	Hasty	887	Eureka Springs
783	Western Grove	888	Grandview
784	St. Joe	889	Blue Eye
810	Springdale	890	Denver
811	Sonora	891	Omaha
812	Spring Valley	892	Omaha NE

Quad #	Quad Name	Quad #	Quad Name
	Hindsville		Diamond City
	Forum		Bentonville South
	Marble		Cotter NW
	Osage		Bull Shoals
	Osage NE		Midway

Table HY03. Losing streams in the Missouri portion of the White River watershed.

Stream Name	County	Length (Miles)	Start T R S	End T R S
Unnamed trib.to West Fk. Bull Creek	Christian	2	26N 20W 04 26N 20W 08	26N 20W 08
Unnamed trib. to Woods Fk. Bull Cr.	Christian	1	26N 21W27	26N 21W 33
Prairie Creek	Douglas	2.5	26N 16W 16	26N 16W 18
Unnamed trib. to Prairie Creek	Douglas	0.7	26N 16W 21	26N 16W 16
Unnamed trib. to Prairie Creek	Douglas	0.7	26N 16W 15	26N 16W 16
Unnamed trib. to Prairie Creek	Douglas	0.5	27N 15W 03	27N 15W 03
Unnamed trib. to Prairie Creek	Douglas	0.3	26N 16W 15	26N 16W 15
South Fork	Ozark	6.9	24N 14W 28	24N 15W 33
Thompson Hollow	Ozark	4.5	23N 15W 01	23N 15W 17
Turkey Creek	Ozark	11	24N 15W 02	23N 15W 17
Unnamed trib. to South Fork	Ozark	0.9	24N 14W 31	24N 15W 36
Unnamed trib. to South Fork	Ozark	0.7	24N 14W 32	24N 14W 31
Unnamed trib. to South Fork	Ozark	0.7	24N 14W 32	24N 14W 32
Unnamed trib. to South Fork	Ozark	0.4	24N 15W 24	24N 15W 25
Unnamed trib. to South Fork	Ozark	1.1	24N 15W 24	24N 15W 25
Unnamed trib. to South Fork	Ozark	0.7	24N 14W 19	24N 14W 30
Unnamed trib. to South Fork	Ozark	1.5	24N 14W 20	24N 14W 30
Unnamed trib. to South Fork	Ozark	1.2	24N 14W 20	24N 14W 30

Stream Name	County	Length (Miles)	Start T R S	End T R S
Unnamed trib. to South Fork	Ozark	1	24N 14W 29	24N 14W 29
Unnamed trib. to South Fork	Ozark	0.5	24N 14W 29	24N 14W 29
Unnamed trib. to South Fork	Ozark	3.6	24N 14W 32	24N 15W 35
Unnamed trib. to South Fork	Ozark	3.5	24N 15W 13	24N 15W 34
Unnamed trib. to Turkey Creek	Ozark	3	24N 15W 01	24N 15W 15
Unnamed trib. to Turkey Creek	Ozark	0.7	24N 15W 10	24N 15W 10
Unnamed trib. to Turkey Creek	Ozark	0.8	24N 15W 09	24N 15W 15
Unnamed trib. to Turkey Creek	Ozark	0.7	24N 15W 16	24N 15W 15
Unnamed trib. to Turkey Creek	Ozark	1	24N 15W 16	24N 15W 22
Unnamed trib. to Turkey Creek	Ozark	0.5	24N 15W 21	24N 15W 22
Unnamed trib. to Turkey Creek	Ozark	1	24N 15W 28	24N 15W 33
Unnamed trib. to Turkey Creek	Ozark	0.8	24N 15W 28	24N 15W 33
Unnamed trib. to Turkey Creek	Ozark	1	24N 15W 32	23N 15W 04
Unnamed trib. to Turkey Creek	Ozark	0.6	24N 15W 32	24N 15W 32
Unnamed trib. to Turkey Creek	Ozark	0.2	24N 15W 02	24N 15W 02
Unnamed trib. to Turkey Creek	Ozark	1.4	24N 15W 11	24N 15W 14
Unnamed trib. to Turkey Creek	Ozark	0.7	24N 15W 12	24N 15W 11

Stream Name	County	Length (Miles)	Start T R S	End T R S
Unnamed trib. to Turkey Creek	Ozark	1.1	24N 15W 12	24N 15W 14
Unnamed trib. to Turkey Creek	Ozark	0.7	24N 15W 14	24N 15W 15
Unnamed trib. to Turkey Creek	Ozark	0.8	24N 15W 23	24N 15W 22
Unnamed trib. to Turkey Creek	Ozark	0.8	24W 15N 22	24N 15W 27
Unnamed trib. to Turkey Creek	Ozark	1.4	23N 15W 03	23N 15W 08
Unnamed trib. to Turkey Creek	Ozark	0.9	23N 15W 04	23N 15W 09
Unnamed trib. to Table Rock Lake	Stone	1	23N 23W 26	23N 23W 34
Unnamed trib. to Table Rock Lake	Stone	1.9	23N 23W 13	22N 23W 30
Unnamed trib. to Table Rock Lake	Stone	1.1	23N 22W 20	23N 22W 19

Source: MDNR (1986a).

Table HY04. Seven-day low flow discharges in cubic feet per second (cfs) with recurrence intervals of two years (Q2) and ten years (Q10) for selected streams in the White River watershed.

Stream	Location	Period of Record	7-Day Q2	7-Day Q10
Roaring River	Cassville	1923-72	14	7
Swan Creek	Forsyth	1923-67	5	0.7
Beaver Creek	Bradleyville	1964-72	19	11
Little Beaver Creek	Bradleyville	1964-70	9	3.4

Source: MDNR (1996a).

Table HY05. Historic flow data for selected White River USGS gaging stations in cubic feet per second (cfs).

Gage Number	Water Years	Drainage Area (mi2)	Annual Mean	Highest Annual Mean	Lowest Annual Mean	Highest Daily Mean	Lowest Daily Mean
07053500	1960-1996	4,022	3,967	7,161	852	33,000	40
07053810	1995-1996	191	212	330	95	6280	2
07054080	1995-1996	298	331	464	199	5900	24

Table HY06. Changes in the fishery of Lake Taneycomo resulting from cold water releases below Table Rock Dam.

Species	% of standing stock	Annual sportfish yield (% by weight)									
		'60	'61	'62	'63	'64	'65	'66	'67	'68	'71
Black bass	8.7	8	4	3	4	2	3	2	3	1	2
Crappie	4.6	21	11	5	5	3	4	3	0	0	0
Other sunfish	13.2	3	2	5	9	1	2	2	4	2	3
Walleye	0.4	2	1	1	*	*	0	0	0	0	0
Catfish	9.7	5	3	1	2	1	1	2	3	0	*
Common carp	11.9	*	1	1	0	*	0	0	*	0	0
Rainbow trout	0	57	68	81	78	92	90	92	90	96	95

*Indicates less than 0.a5% of catch.

Source: Shirley (1992).

Note: USGS gage station numbers reference Table HY01.
Note: Map numbers reference Table HY02.

Water Quality and Use

Beneficial Use Attainment

The Missouri Department of Natural Resources and the Clean Water Commission are responsible for setting and enforcing the water quality standards for Missouri. These standards have specific acceptable ranges for several indicators of water quality including: pH range 6 to 9, fecal coliform levels not to exceed 1,000 colonies per milliliter, temperatures for coldwater fisheries should not exceed 68o F, and temperatures for coolwater fisheries should not exceed 84o F. Nitrate levels of 10 mg/l or less are the standard criteria for drinking water supply. Dissolved oxygen levels for cool and warmwater fisheries should not fall below 5 parts per million (ppm) and should not fall below 6 ppm for coldwater fisheries (MoCSR 1991).

The Missouri portion of the watershed has waters classified for all beneficial uses designated by the Missouri Department of Natural Resources, except industrial (Table WQ01) (MDNR 1996a). There is also one stream reach which is designated as an Outstanding State Resource Water; Ketchum Hollow, 1.5 miles of stream located within Roaring River State Park, Barry County.

Streams given this designation have a high level of scientific or aesthetic value and remain relatively undisturbed. Under this designation an anti-degradation review must be conducted on any applicant wishing to construct or upgrade a facility that discharges to Ketchum Hollow (R. Laux, MDNR, pers. comm.).

In addition to stream use classifications, the watershed has three lakes which have been given beneficial use designations. These are: Table Rock Lake, Class 1, classified for livestock watering, aquatic life, whole body contact recreation, drinking water supply, and boating; Lake Taneycomo, Class 1, classified for livestock watering, aquatic life, coldwater fishery, whole body contact recreation, boating, and drinking water supply; Bull Shoals Lake, Class 2, classified for livestock watering, aquatic life, coldwater fishery, whole body contact recreation, and boating (MDNR 1996b).

Three watershed areas in the Missouri portion of the watershed have been designated as critical for the protection of drinking water supplies and are protected under state law 10 CSR 20-7.031. These include all waters upstream of Table Rock Dam in Missouri (1,150,300 acres), the watershed upstream of the intake for College of the Ozarks (17,139 acres) on Lake Taneycomo, and the watershed upstream of the intake for the City of Branson (3,241 acres) on Lake Taneycomo. Critical watershed requirements apply to Class IA CAFOs, which are operations that are permitted to house more than 7,000 animal units. These CAFOs must have an approved spill prevention plan (MDNR 1997).

Several stream reaches in the Missouri portion of the watershed have been designated as coldwater fisheries by MDNR, including: Terrell Creek in Christian County from Double Spring to the mouth, Lake Taneycomo in Taney County for its entire stretch, Barren Fork from Smith Spring to the mouth, Roaring River from Roaring River Spring to Table Rock Lake, and Bee Creek in Taney County upstream of the MO Hwy. 65 bridge (MDNR 1986a).

MDC has identified several streams in the watershed as important coldwater resources in addition to those listed above. These include: Lake Taneycomo, Roaring River, and Bee Creek, all listed above and having MDNR classification as coldwater fisheries, and Hobbs Hollow, Dogwood Creek, Indian Creek, Turkey Creek a tributary to Lake Taneycomo in Taney County, Turkey Creek a tributary to Little North Fork White River in Ozark County, Roark Creek, Woods Fork Bull Creek, and the lower section of Bull Creek (Figure WQ01).

Most beneficial use attainments should be met with the exceptions of Table Rock Lake occasionally having levels of fecal coliform bacteria that exceed standards at some public swimming beaches (MDNR

1986a). Localized, excessive eutrophication and the resulting increases in phytoplankton and lower water clarity in Table Rock Lake have been a cause for concern. Water clarity directly above Table Rock Dam decreased an average of 0.82 meters in the period from 1974 to 1994 (USGS 1995). Three probable sources of excessive nutrification have been identified in the Table Rock Lake watershed. These include the James River with municipal sewage discharges from Nixa, Ozark, and Springfield WWTFs, residential septic systems associated with increasing populations, and livestock and poultry wastes from northwest Arkansas and the western portion of the watershed.

Lake Taneycomo, usually during late summer and fall, has dissolved oxygen levels that fall below dissolved oxygen standards for coldwater fisheries due to releases of hypolimnetic water from Table Rock Dam (MDNR 1986a)

Whole body contact limits for fecal coliform bacteria have been exceeded four times in Roaring River Spring and one time in Roaring River at the state park during the early 1990s. Dry Hollow has also experienced fecal coliform levels above state standards for losing streams in the early 1990s on two occasions (Hemsath 1992).

Section 303(d) of the Federal Clean Water Act requires states to list waters not expected to meet established state water quality standards even after application of conventional technology-based controls for which Total Maximum Daily Load (TMDL) studies have not yet been completed.

The 1996 list of waters needing a TMDL study included Lake Taneycomo. In 1996 a TMDL study for Lake Taneycomo was listed as low priority, and it has not yet been targeted for a study. Lake Taneycomo is on the 1998 proposed list to remain designated for a study, and the priority has been updated to medium. An additional list of waters proposed for the State of Missouri 303(d) list has been submitted by the Sierra Club and Missouri Stream Team 714 including the following streams in the watershed: a 6 mile stretch of Bull Creek in Taney County; 1 mile of Beaver Creek in Taney County; 3.5 miles of Roark Creek in Taney County; and 3 miles of Swan Creek in Taney County.

Waters in the Arkansas portion of the watershed have all been designated for fish and wildlife protection, primary and secondary contact recreation, and domestic, agricultural, and industrial water supplies. Most of these use designations should be supported with the exceptions of 59.5 total miles of Yocum, Long, and Dry creeks and the upper sections of War Eagle and Brush creeks, tributaries to Kings River, not supporting primary contact (swimming). An additional 177 miles of streams were assessed as only partially supporting the aquatic life use. The inability of the streams to support their classified use designations is a result of high silt loads from agricultural practices, instream gravel removal, and road building activities and the associated high sediment and bacterial levels associated with these practices (ADPC&E 1996). Crooked River has been listed as the fifteenth most endangered river in the nation by American Rivers. The group listed degradation from extensive gravel mining as the main cause for the listing (American Rivers 1998). The majority of these streams, with the exception of Crooked River, flow into the Missouri portion of the watershed.

Bull Shoals Lake, Kings River, and Richland Creek, a tributary to the Kings River, have all been designated as Extraordinary Resource Water bodies by Arkansas Department of Pollution Control and Ecology (ADPC&E), and are subject to stricter regulations concerning pollution discharge and instream activities. Kings River and Richland Creek are also recognized as National Scenic Riverways (J. Wise, ADPC&E, pers. comm.).

Chemical Quality, Contamination, and Fish Kills

The USGS has implemented a broad scope National Water Quality Assessment (NAWQA) study on 20 study units throughout the United States. Implementation of the NAWQA study in the Ozark Plateau Study Area, which includes the White River watershed, began in 1991. The objectives of the NAWQA

Program are to: describe current water quality conditions for a large part of the nation's freshwater streams, rivers, and aquifers; describe how water quality is changing over time; and improve understanding of the primary natural and human factors that affect water quality conditions. Large amounts of information concerning water quality have and will continue to come from this effort and some of this information has been presented in this document.

One of the areas of the largest concentration of nitrite plus nitrate and phosphorus was found at the sample location directly below Table Rock Dam. This site was considered an integrator site, because land uses above the sample location were of two major types, urban and agricultural.

Water quality samples reflect the larger concentrations of nitrite plus nitrate and phosphorus that would be expected with the agricultural and urban development that has occurred in the watershed above this point (USGS 1995).

Increases in discharge caused by precipitation runoff in an unregulated (agricultural) basin with primarily nonpoint sources of nitrite and nitrate generally result in an initial increase in nitrite plus nitrate concentrations caused by washoff of available material followed by decreasing concentrations as dilution occurs. The magnitude of concentration will depend on the availability of nitrite and nitrate in the basin, which is directly related to land use.

NAWQA sample sites within forested areas had little to no increases in nitrite plus nitrate concentrations with increasing discharge and virtually no dilution effect. Sample sites within agricultural land use areas had definite increases in concentration with increasing discharge followed by dilution. These patterns may hold true in the White River watershed considering the agricultural land use in the western and southern portion of the watershed and the more forested areas associated with the central and eastern portions of the watershed (USGS 1995).

Hypolimnetic water releases from the three large hydropower dams in the watershed have greatly impacted the entire White River system from below Beaver Dam to the confluence with the Mississippi River. Colder than normal temperatures and low dissolved oxygen levels in these releases, mainly in the summer and fall, have been blamed for stressing fish and are thought to have been the cause of fish kills in some tailwaters (Spotts 1991).

Temperature stress and low dissolved oxygen or other water quality problems associated with hydropower generation have been associated with at least 16 fish kills in the Bull Shoals tailwaters (Spotts 1991). Much work has taken place between the state agencies responsible for the fish in these waters and the agencies managing the dams. Cooperative efforts are ongoing, in both states, to increase oxygen levels in tailwater reaches while maintaining adequate hydropower production. Emergency plans are in place should dissolved oxygen levels reach excessive lows.

The tailwaters of the three large hydroelectric dams in the watershed support coldwater fisheries of major economic proportion. Concern has developed about the future of these fisheries stemming from the concern over water quality and its close association with the increased human population growth and the growth of the poultry industry in the watershed.

Raw groundwater in the Missouri portion of the watershed is considered good, 300-499 total dissolved solids (tds), to excellent, fewer than 300 tds. Surface water is typically a calcium-magnesium-bicarbonate type (MDNR 1995).

Water quality trend data from 1970-1989 in the Arkansas portion of the watershed indicate a decrease in dissolved oxygen levels for one of the four stations (lower Kings River) influencing Missouri waters. One of three stations sampled (lower Kings River) for total nitrogen showed an upward trend between 1984 and 1989. No trends developed at other stations. One of four stations (White River below Beaver Lake) showed an upward trend for total nitrites between 1978 and 1989, while no trends developed from three other stations. Samples showed a downward trend in total ammonia at sites both above and below Beaver Lake between 1979 and 1989. No significant trends appeared for total phosphorus for this period. Fecal coliform data showed a downward trend at two of the three stations (above Beaver Lake and lower Kings River) from 1975 to 1987, with no significant trend developing at the other sites. The increasing upwards trends are thought to be associated with increased livestock production and an increasing human population. Downward trends are associated with increased efficiency of wastewater treatment facilities (USGS 1992).

MDC collects contaminant samples of fish flesh from several locations in the watershed annually, and the Missouri Department of Health (MDOH) analyzes the samples for several kinds of contaminants and includes them in an assessment of statewide consumption advisories. There are no current health advisories for fish consumption in the watershed (MDOH 1998). No fish consumption advisories are in place for the Arkansas portion of the watershed (Wise, J., ADPC&E, pers. comm.) A 1992-1995 NAWQA study of biological-tissue sampling, which included the White River watershed, found no levels of organic compounds that exceeded any health criteria or standards. This information showed that organic compounds do not pose a widespread or persistent problem in the watershed (USGS 1997).

There have been thirty-four confirmed pollution incidents in the Missouri portion of the watershed since 1978 (Table WQ02). Fish kills have been confirmed from nine of these incidents totaling 8,028 fish. The largest recorded fish kill occurred in Fall Creek on June 18, 1998 when a broken sewage main released raw sewage into the creek, killing an estimated 4,118 fish. Sewage has been the leading cause of pollution events and fish kills in the watershed; 11 pollution events and 3 confirmed fish kills, followed by gasoline; 7 pollution events and no known fish kills. The majority (N=28) of the pollution events have been recorded from Stone and Taney counties.

Table Rock Lake has the most pollution events for any body of water (N=9), followed by Lake Taneycomo (N=8), Bull Creek (N=4), and Beaver and Fall creeks (N=3 each).

Problem fish kill areas in the Arkansas portion of the watershed have been associated with sewage overflows from Fayetteville, AR which have been responsible for repeated fish kills in Beaver Lake. Major improvements have taken place in this WWTF which have reduced sewage pollution to Beaver Lake. Low dissolved oxygen levels and temperature stress from releases below Bull Shoals Lake have also been responsible for at least 16 documented fish kills (Spotts 1991). Land applied poultry litter has also been blamed for local fish kills (Shirley 1992).

Water Use

The majority of the water use in the watershed is domestic (Table WQ03). Figure WQ02 clearly shows the large concentration of wells associated with the Branson/Table Rock Lake area. Most water from this area is groundwater drawn from the Ozark aquifer. The City of Branson is the only town in the Missouri portion of the watershed that uses the White River for a water supply. The City of Branson has a surface water intake on Lake Taneycomo and eight deep wells that meet water supply needs.

The rapid growth of the Branson/Table Rock area has raised concerns regarding the future groundwater quality and availability in the watershed. Because most of the increased water demand occurs during the summer tourist season, water levels are lowered substantially in the summer, but recover during the winter. Data, from summer surveys conducted from 1987-89 (Imes 1991), revealed several cones of depression in the Ozark aquifer, one on either side of Lake Taneycomo, one centered in the area just west of Branson, and one below Hollister. Data from March of 1989 indicated that groundwater levels had returned to pre-development elevations. A groundwater model developed for the area was used to predict whether or not these trends have any potential for long-term impact on water availability for the region. The model predicted that present cones of depression will deepen over time, and very small cones of depression are predicted to develop for Forsyth, Rockaway Beach, and Taney County Public Water Supply District #2. These drawdown levels should not threaten the capability of deep wells, and adequate water should be available in the area through 2010 (Imes 1991).

Some concerns about the amount and quality of the water that flows out of Table Rock Lake to the public water supply wells for the City of Branson have been raised. A study by Hester (1993) found that 11 million gallons of water per day were estimated to flow from Table Rock Lake to these wells and that the water quality of Table Rock Lake has a large influence on the raw groundwater supply of Branson. Hester (1993) also found that as water use increases from the Branson supply wells, the outflow of water from Table Rock Lake to these wells will also increase.

The Springfield Plateau and the southwestern Ozark Plateau regions are two of the regions with the largest livestock water use in the state. This region, including the watershed, is characterized by large cattle and horse populations which require a great deal of water on a per capita basis.

Poultry production may also account for major livestock water use in Barry County. The USGS estimates that water use for non-confined livestock is 100% consumptive (MDNR 1996b).

Roaring River Fish Hatchery uses between 11 and 12 million gallons of water per day (mgal/day) from Roaring River Spring for hatchery production and maintenance (Dean, J., MDC, pers. comm.). Dye traces done in the area have shown that the losing stretch of Dry Hollow has a direct recharge to the spring. Also, numerous, large, sinkholes located along Greasy Fault allow direct recharge to the spring, and one seven-mile stretch of an unnamed stream flows directly into a cave, which also recharges directly to Roaring River Spring (Rogers, M., MDNR, pers. com.).

The Roaring River Spring recharge area also includes the upper portion of Flat Creek, a separate drainage included in the James River watershed. Surface water in the Flat Creek drainage flows northeast, while the groundwater below the drainage flows southeast to Roaring River Spring.

Recreational Use

The White River was once considered one of the finest float streams in the U.S., and smallmouth bass fishing on the river was unequaled. Today none of the White, in Missouri, remains in its natural, free flowing state. The larger tributary streams of the watershed (Swan Creek, Bull Creek, Beaver Creek, and Roaring River) still provide canoeing and wade fishing opportunities. About 21 miles of Swan Creek are considered navigable for the purpose of floating. In normal water years Swan Creek is considered mainly a wade-and-float fishing stream, but heavy rains can bring it up rapidly and give it characteristics of a whitewater stream. Bull Creek is similar in size and drainage to Swan Creek, but it is less floatable than Swan Creek. Roaring River and Beaver Creek are other floatable streams in the watershed. Summer floats on Beaver Creek should start near or below Bradleyville (Hawksley 1989).

The White River watershed has a large recreational value both in Missouri and Arkansas. The area attracts a large number of people annually and water-related recreation is a substantial reason for the watershed’s popularity. A study of recreational use conducted by Weithman (1991) found that the White River in Missouri, and its smaller tributaries, which make up all of the flowing waters in the watershed, had an estimated angler effort (days fished) that ranked it between thirteenth and sixteenth statewide. The survey was conducted annually from 1983 to 1988 on 19 streams statewide. A survey conducted by Bachant et al (1982) found the White River ranked eleventh statewide in recreational worth (participants were asked to rank, in descending order, the ten watersheds they thought to have the most recreational value) and predicted the watershed to drop to seventeenth statewide in the future (participants were asked to rank the ten watersheds they felt would become the most important in the future). The study found that the watershed ranked twelfth statewide when participants were asked to rank recreational value of the watersheds in their local area.

Roaring River is one of four managed public trout parks in the State of Missouri. Roaring River "trout park" is in Roaring River State Park. Land surrounding the stream is managed by MDNR, while the hatchery and fishery are managed by MDC. Daily trout tags are required to fish in the park. Roaring River ranked second, among the four trout parks, in daily tag sales for the 1996 season with 120,463 tags sold (Weithman S., MDC, pers. comm.). Roaring River from below Roaring River State Park to Table Rock Lake is a Trout Management Area.

Lake Taneycomo is another state Trout Management Area. Lake Taneycomo ranked second, among Missouri trout waters, in angler effort (days fished) lead only by the combined angler effort numbers from the four trout parks. Taneycomo angler effort for the period (1983-1988) was highest in 1986 (357,246 days fished). Additional angler surveys are currently underway.

A survey of reservoir use showed that, bi-annually from 1988-1994, Table Rock and Bull Shoals lakes ranked first and second, respectively, for recreational visitor hours, as compared to other USCOE lakes throughout Missouri. Recreational use at Table Rock varied from 30 to almost 40 million visitor hours annually. Recreational use at Bull Shoals varied between 15 to 25 million visitor hours annually.

A similar use study conducted by Weithman (1991), which used angler effort as a gage and included both USCOE and non-USCOE lakes, showed different recreational use rankings. Table Rock Lake was the most heavily fished lake in the watershed and ranked either second or third, statewide, throughout the period. Lake Taneycomo ranked fourth statewide from 1983-1986, but fell to fifth statewide in 1987 and sixth statewide in 1988. Bull Shoals Lake ranked eighth from 1983-1985, seventh in 1986 and 1988, and sixth in 1987.

Missouri STREAM TEAMs are a group of volunteers who assist in the protection of streams throughout the state. STREAM TEAMs are supported by MDC, MDNR, and the Conservation Federation of Missouri. Participants range from single individuals, to grade school classes, to organized advocacy groups. Their efforts include litter clean-up, water chemistry and macroinvertebrate sampling, tree planting for bank stabilization, and stream inventories. The STREAM TEAMs programs and citizen awareness about stream issues have been a growing and important facet of protection and enhancement of state waters. These organizations will continue to play ever important roles in future stream issues.

Arkansas also has a STREAM TEAM program coordinated by the AG&FC. The program was started in early 1997 and there were 190 STREAM TEAMS as of Sept. 1, 1998. Supporting agencies include: AG&FC, ADPC&E, NRCS, USGS, USFS, Arkansas Department of Parks and Tourism, local Soil and Water Conservation districts, Smallmouth Bass Alliance, Arkansas Cattleman's Association, Arkansas Chapter of the American Fisheries Society, and Sierra Club (Filipek, S., AG&FC, pers. comm).

Point Source Pollution

Point sources are those which discharge wastewater to waters of the state and must obtain National Pollution Discharge Elimination System (NPDES) permits. The MDNR issues and monitors these permits throughout Missouri, and the Springfield Regional Office is responsible for the area including the Missouri portion of the White River watershed. Permits vary widely including stormwater runoff, subdivisions, mobile home parks, concentrated animal feeding operations, limestone quarries, municipal sewage treatment plants, building and road construction, etc. There are eight municipal WWTFs in the Missouri portion of the watershed (Table WQ04, Figure WQ03) that land apply 3,440 tons of sludge annually. The Washburn WWTF lies outside the watershed, but within the known Roaring River Spring recharge area and produces an additional 9.7 tons of sludge annually. As of September 15, 1998, there were 251 NPDES permits granted in the watershed (Figure WQ04). Many of these are associated with the Branson/Table Rock Lake area and have the potential to negatively affect receiving streams and ground water.

Public and private sources produce 4,069 tons of domestic sludge annually which is land applied throughout the watershed. Wilderness Safari wastewater discharge has had a noted negative impact on one mile of Fall Creek and chlorine toxicity problems have been caused in 0.5 miles of Prairie Creek from the Ava WWTF (MDNR 1995).

There are thirty-three NPDES permitted point sources in the Arkansas portion of the watershed. Twenty of these are located with the potential to impact Missouri waters. There are 11 municipal WWTFs in the Arkansas portion of the watershed (Table WQ04; Figure WQ03). The city of Fayetteville, AR recently upgraded its municipal sewage treatment plant and diverted portions of its discharge from Beaver Lake to the Illinois River basin which flows into Oklahoma. These changes have helped to reduce the amount of sewage effluent that flows to Beaver Lake. Beaver Lake still receives some sewage from smaller discharges associated with development of the surrounding area (Shirley 1992).

The Toxic Release Inventory (TRI) contains detailed information about parties that release, store, or process toxic materials such as heavy metals and pesticides. There are 23 toxic release sites in hydrologic unit 11010001 and 13 sites in hydrologic unit 11010003. There are 50 hazardous waste sites in hydrologic unit 11010001 and 50 hazardous waste sites in hydrologic unit 11010003. The Environmental Protection Agency (EPA) keeps a current database of these sites. The EPA also tracks Superfund sites, sites that are candidates or have been identified for cleanup of toxic waste problems. There is one superfund site in the watershed located in hydrologic unit 11010003, near Omaha, Arkansas.

The James River has the largest point source impact on Table Rock Lake. The James River provides relatively large loads of nitrogen and phosphorus to the James River Arm of Table Rock Lake. The James River Arm commonly has higher levels of suspended algae, and has a more productive fishery than other parts of Table Rock Lake (MDNR 1995). The Springfield Southwest WWTF discharges 42.5 million gallons per day to the James River and has been estimated to deliver 30 percent of the total phosphorus load to Table Rock Lake (USGS 1995). Information concerning water quality of the James River basin can be found in the James River Inventory and Management Plan (Kiner and Vitello 1997).

The largest point source concern in the Bull Shoals region of the watershed is the Ava waste water discharge to Prairie Creek in the Beaver Creek subwatershed. Discharge from the Ava WWTF shows evidence of chlorine toxicity in about 0.5 miles of Prairie Creek. The city of Forsyth began operating a new WWTF in 1997 which should help to correct localized problems associated with the city formerly being unsewered (MDNR 1995). The large population increases in and near Branson formerly caused an overburdening of the city’s WWTF. This problem should now be minimized with the opening of the Cooper Creek WWTF.

State regulations require all existing wastewater discharges to Lake Taneycomo and its immediate tributaries, including Bull Creek, greater than 25,000 gallons per day and all new wastewater discharges, regardless of size, to limit the total phosphorus concentration of the discharge to no more than 0.5 mg/l, in an effort to reduce algae growth. Similar phosphorus limit regulations are being considered for Table Rock and Bull Shoals lakes. Any future facilities have been advised of these recommendations. The Springfield Southwest WWTF is considering installing a phosphorus removal system (George, R., MDNR, pers. comm.).

Nonpoint Source Pollution

Seepage from individual septic systems throughout the watershed, with a higher density near the Table Rock/Branson area, is thought to be a major source of nonpoint pollution, although this is unquantified. A water quality study conducted in Taney County (Aley 1982) sampled 75 springs and stream points. The study found optical brighteners, a chemical in laundry detergent and evidence of domestic sewage, in 80% of the springs and 58% of the stream points sampled. The evidence of domestic sewage was even more prevalent in developed areas, where 95% of the springs and 75% of the stream points sampled were positive for optical brighteners. Bacterial contamination of ground and stream waters probably occurs in areas adjacent to Taney County which have similar geology and development patterns (MDNR 1995). MDNR identified individual septic systems as the most significant water quality problem in Taney County (MDNR 1986b). Septic tanks were the fourth highest concern statewide as a source for groundwater contamination, causing bacterial, viral, and nitrate contamination (MDNR 1986b).

Soils with inadequate absorption qualities, including the majority of soils in the watershed, are the most common causes for failure of septic systems, and density of septic tank systems is the most important factor in determining potential for groundwater pollution (Kinter 1983). Diseases associated with septic tank fluids include typhoid, hepatitis, cholera, dysentery, and leptospirosis, which affect both humans and animals (Morris 1981). Reports indicate that the population of the watershed is growing most rapidly in rural areas with individual septic systems being the most common means of sewage treatment. In 1981, 80 to 90 percent of the homes in Taney and Stone counties had on-site septic systems (Morris 1981).

The EPA rates areas for potential of groundwater contamination based on the number of on-site septic systems per square mile. Figures from the 1980 census indicated that areas near Branson and adjacent to Table Rock Lake and Lake Taneycomo were considered high risk for groundwater contamination from failing septic systems. The EPA also considers areas that depend primarily on groundwater for home water supply and that are characterized by karst landforms as especially vulnerable to groundwater contamination (Morris 1981). A 1989 study in Christian County found that 50% of the groundwater samples taken from individuals' wells contained fecal coliform levels unsafe for human consumption (St. Clair 1989).

There are eighteen concentrated animal feeding operations (CAFOs) in the Missouri portion of the watershed that are permitted by or carry letters of approval from the MDNR (Table WQ05, Figure WQ03). The human population equivalent (PE) (the human population estimated to produce amounts of waste similar to that produced by a given number of animals) of these operations is 88,674, or equal to 50% the entire human population in the watershed. There are 22 permitted poultry CAFOs in the Roaring River Spring recharge area (Table WQ05, Figure WQ03) with a population equivalent of 113,988, or equal to 64% of the human population in the watershed. The total combined PE for the Missouri portion of the watershed and the recharge area is 147,809. The majority of these operations land apply wastes and have the potential to negatively affect the water quality in the watershed. NAWQA studies in the region have found that nitrite plus nitrate concentrations positively correlate to percent agricultural land use around sample sites, and median nitrite plus nitrate concentrations were generally higher in tested springs than in tested wells (USGS 1996). The Washburn WWTF is also in the Roaring River Spring recharge area. Water quality has been monitored by the USGS and MDC personnel for the past several years, and no significant trends associated with agricultural land use have developed.

Hatchery manager Jerry Dean (MDC, pers. comm.) did indicate that aquatic plant growth, both in the spring and spring branch, has increased over the past several years. Hemsath (1992) lists Roaring River Spring as the main point source of pollution to the Roaring River subwatershed.

Water quality monitoring should remain a high priority, and continuing inventories of pollution sources in the watershed should include the spring recharge area.

The Arkansas portion of the watershed also includes a large number of poultry producing operations (Table WQ06). Many of these are in the Kings River subwatershed and other areas that drain to the Missouri portion of the watershed. The ADPC&E regulates operations that store and land apply liquid waste and helps establish voluntary waste management plans for operations that land apply dry waste (Wise, J., ADPC&E, pers. comm.). Approximately 1.9 million metric tons of poultry manure were produced and land applied in the Arkansas portion of the watershed in 1991 (Shirley 1992). The poultry produced annually, in the counties making up the Arkansas portion of the watershed, have a human population equivalent of 6,365,225, or 36 times the entire 1990 human watershed population (Wise, J., ADPC&E, pers. comm.).

Conversations with MDNR and ADPC&E personnel indicate that a symbiotic relationship exists between CAFOs and other agricultural land use practices, although unquantified at this time.

With an increased number of CAFOs, comes an increase in other agricultural practices, mainly clearing for additional pasture land and increased cattle numbers. CAFOs in Missouri that have more than 7,000 animal units are regulated by the MDNR. The regulations state that, depending on the number of animal units, a certain amount of vegetated land must either be owned or contracted for the spreading of manure, or the waste must be sold or contained in closed lagoons. The increased number of CAFOs in the watershed is related to a growing amount of land being converted to either pasture or crop land. Land application of litter has added to soil productivity and improved pasture and hay production. This combination of factors has led to an unquantified increase in land clearing and cattle production (Parsons, G. and Kugler, V., MDNR; Wise, J., ADPC&E, pers. comm.).

Cattle on pasture are another potential nonpoint threat to the watershed's water quality. Cattle on pasture in the Missouri portion of the watershed are estimated to produce an amount of waste equal to that of 1.5 million people or over 8 times the human population of the entire watershed. Cattle numbers were estimated from county figures available from the Missouri Agricultural

Statistics Service (MASS) under the assumption that cattle were equally distributed throughout each county. This equal distribution was then applied to the percentage of each individual county lying within the watershed. The estimated number of cattle in the watershed was multiplied by the population equivalents (PE = 14 per 1,000 pounds for beef cattle and PE = 20 per 1,000 pounds for dairy cattle) and by .08, assuming the average weight of cattle is 800 pounds (MASS 1997).

Runoff of waste from pastures, damage to riparian areas, and streambank trampling are some of the problems associated with cattle, although the effects of this type of non-point pollution are very difficult to quantify. Cattle waste has the potential to add high levels of fecal bacteria, nitrates, and phosphates to both surface and groundwater. Cattle with access to streams and streambanks can damage riparian areas and trample streambanks, leading to increased bank erosion and sedimentation, increased water temperatures, and decreased filtering properties in riparian areas. These have the potential to affect water quality and aquatic life and possibly affect human health. The large amount of waste produced by cattle and poultry operations is a major source of nutrients that waters receive as nonpoint pollution (USGS 1996).

There are three inactive landfills in the Missouri portion of the watershed, one near Kimberling City, in Stone County, one near Branson in Taney County, and one near Shell Knob, in Barry County (MDNR 1998c). There is one transfer station located near Branson in Taney County (MDNR 1998d).

The watershed is primarily forested and very little land is cultivated, hence soil erosion rates are low and problem areas are localized. Most soil erosion is associated with land clearing for development. Lake Taneycomo has incurred substantial sedimentation since its impoundment. From its creation in 1913 to 1958, 42% of Lake Taneycomo filled with sediment, and from 1958 to 1987, an additional 7% of the lake has filled (Berkas 1989). Soil erosion associated with land clearing for development is one of the largest nonpoint source problems in this area of the watershed (MDNR 1995).

The major threats to the water quality of the streams in the Arkansas portion of the watershed are sedimentation from sand and gravel mining, streamside agriculture and cattle grazing, and land application of poultry waste (Shirley 1992). Northwestern Arkansas is a region of some of the highest poultry production rates in the United States. Land applied litter from these operations has the potential to contaminate both ground and surface water. Localized fish kills and widespread water quality problems have been attributed to runoff from poultry waste (Shirley 1992). Nitrate levels measured from this region are typically high (ADPC&E 1996).

The EPA rates the health of individual watersheds based on several different factors. Beaver Lake (11010001) ranks 3 (less serious problems-low vulnerability) on a scale of 1 to 6, with 1 being the best possible rank. The health of Bull Shoals Reservoir (11010003) ranks 1 (better water quality-low vulnerability) based on the same factors.

Table WQ01. Beneficial use classifications for streams in the Missouri portion of the White River watershed.

Stream	Mi.	From	To	County	Beneficial use*
Barbers Creek	3	mouth	25N 19W 08	Christian	LW,AL
Barret Hollow	1.5	mouth	22N 15W 01	Ozark	LW,AL
Barren Fork	7	mouth	23N 14W 10	Ozark	LW,AL
Bear Creek	3	mouth	24N 16W 01	Ozark	LW,AL
Bear Creek	4	mouth	24N 21W 18	Taney	LW,AQ,WB,BC
Bear Creek	6	24N 21W 18	25N 22W 36	Taney	LW, AQ, WB, BC
Beaver Creek	44.5	mouth	27N 17W 23	Taney	LW,AQ,WB,BC,CL
Trib. Beaver Cr.	1	mouth	24N 18W 23	Taney	LW,AQ
Beaver Creek	2	27N 17W 23	27N 17W 10	Douglas	LW,AQ
Bee Creek	1.6	mouth	23N 21W 17	Taney	LW,AQ,CD
Bee Creek	3.5	mouth	21N 20W 05	Taney	LW,AQ,WB
Bennett Hollow	2	mouth	23N 15W 13	Ozark	LW,AQ
Big Creek	5	mouth	23N 17W 25	Taney	LW,AQ,WB
Big Hollow	3.2	mouth	22N 21W 23	Taney	LW,AQ
Bray Hollow	1	mouth	23N 15W 27	Ozark	LW,AQ
Bright Hollow	2	mouth	25N 20W 32	Taney	LW,AQ
Brushy Creek	6	mouth	HWY. 125	Taney	LW,AQ
Brushy Hollow	1	mouth	23N 15W 25	Ozark	LW,AQ
Bull Creek	5	mouth	24N 21W 34	Taney	LW,AQ,WB,BC,CD,IR
Bull Creek	17.5	24N 21W 34	26N 20W 33	Taney	LW,AQ,WB,BC,CL,IR
Bull Creek	3	26N 20W 33	26N 20W 22	Christian	LW,AQ,WB
Camp Creek	1	mouth	25N 21W 16	Christian	LW,AQ
Cane Creek	3	mouth	23N 18W 28	Taney	LW,AQ,CL
Caney Creek	4	mouth	24N 17W 12	Taney	LW,AQ,WB
Cedar Creek	1	22N 19W 02	22N 18W 06	Taney	LW,AQ
Clayton Hollow	1	Mouth	24N 18W 03	Taney	LW,AQ
Coon Creek	5.4	mouth	22N 21W 24	Taney	LW,AQ

Stream	Mi.	From	To	County	Beneficial use*
Cooper Creek	0.4	mouth	22N 21W 07	Taney	LW,AQ
Cooper Creek	1.6	22N 21W 06	22N 21W 07	Taney	LW,AQ
Cowskin Creek	5	mouth	27N 16W 33	Douglas	LW,AQ
Cowskin Creek	3	HWY. 14	27N 16W 21	Douglas	LW,AQ
Dry Hollow	2.5	mouth	24N 16W 34	Ozark	LW,AQ
E. Fork Bull Cr.	3	mouth	26N 20W 23	Christian	LW,AQ
Elbow Creek	1	mouth	22N 18W 27	Taney	LW,AQ
Fall Creek	1	mouth	22N 22W 11	Taney	LW,AQ
Fall Creek	3.6	22N 22W 11	23N 22W 28	Taney	LW,AQ
Fox Creek	0.5	mouth	21N 20W 27	Taney	LW,AQ
Goldsbarry Hol.	3	mouth	23N 16W 31	Ozark	LW,AQ
Gulley Spr. Cr.	3.5	mouth	21N 14W 05	Ozark	LW,AQ
Kings River	2	mouth	state line	Taney	LW,AQ,WB,BC
L. Beaver Cr.	9	mouth	26N 18W 36	Taney	LW,AQ,WB,BC,IR
L. Beaver Cr.	4	26N 18W 30	26N 17W 17	Douglas	LW,AQ
L. North Fork	5	mouth	24N 16W 36	Ozark	LW,AQ,CL
L. North Fork	6	24N 16W 36	24N 16W 03	Ozark	LW,AQ,CL
Lick Creek	1	mouth	22N 16W 32	Ozark	LW,AQ
Little Creek	5	mouth	24N 15W 17	Ozark	LW,AQ
Trib. Little Cr.	1	mouth	24N 15W 18	Ozark	LW,AQ
Long Run	1.5	mouth	23N 16W 27	Ozark	LW,AQ
Ludecker Hol.	1.5	mouth	23N 14W 04	Ozark	LW,AQ
McVay Branch	1.5	mouth	21N 16W 03	Ozark	LW,AQ
Morris Hollow	1.5	mouth	22N 16W 17	Ozark	LW,AQ
N. Fk. Spring Cr.	1	mouth	22N 14W 18	Ozark	LW,AQ
Otter Creek	2	mouth	24N 16W 22	Ozark	LW,AQ
Piney Creek	3	mouth	23N 25W 22	Stone	LW,AQ

Stream	Mi.	From	To	County	Beneficial use*
Pond Fork	2	mouth	23N 16W 33	Ozark	LW,AQ
Pond Fork	7	23N 16W 23	Taney Line	Ozark	LW,AQ
Roaring River	7	mouth	22N 27W 34	Barry	LW,AQ,WB,BC,CD
Roark Creek	3	mouth	23N 22W 36	Taney	LW,AQ,WB,BC,CD
Roark Creek	4	23N 22W 15	23N 22W 15	Taney	LW,AQ,WB,BC
S.Fk.Spring Cr.	1	mouth	22N 14W 19	Ozark	LW,AQ
S. Spring Creek	5	mouth	25N 16W 23	Douglas	LW,AQ
Shoal Creek	2	mouth	22N 17W 32	Taney	LW,AQ,WB,CD
Short Creek	2.9	mouth	22N 21W 30	Taney	LW,AQ
Short Creek	0.9	22N 21W 30	22N 21W 36	Taney	LW,AQ
Silver Creek	1.6	mouth	23N 21W 01	Taney	LW,AQ
South Fork	4.5	mouth	24N 15W 25	Ozark	LW,AQ
Surratt Creek	1	mouth	25N 19W 26	Christian	LW,AQ
Swan Creek	29.5	mouth	26N 18W 04	Taney	LW,AQ,WB,BC,CL,IR
Swan Creek	2	26N 18W 04	27N 18W 34	Christian	LW,AQ
Table Rock trib.	2.5	mouth	22N 25W 03	Barry	LW,AQ
Turkey Creek	2	mouth	22N 21N 16	Taney	LW,AQ,BC,CL
Turkey Creek	4	22N 21W 16	22N 21W 04	Taney	LW,AQ
Turkey Creek	2	mouth	22N 16W 22	Ozark	LW,AQ
Turkey Creek	9	mouth	24N 15W 15	Ozark	LW,AQ
W. Fk. Big Cr.	3	mouth	22N 17W 03	Taney	LW,AQ
W. Fk. Bull Cr.	3	mouth	26N 20W 08	Christian	LW,AQ
W. Fk. Roark Cr.	3	23N 22W 15	23N 22W 07	Taney	LW,AQ,IR
Woods Fork	5.5	mouth	25N 21W 03	Christian	LW,AQ

*Beneficial use= LW= livestock and wildlife watering, AQ= protection of warmwater aquatic life and human health fish consumption, CL= coolwater fisheries, CD= coldwater fisheries, WB= whole body contact recreation, BC= boating and canoeing, IR= irrigation.
Source: MDNR (1996b).

Table WQ02. Fish kill and pollution incident summary for the Missouri portion of the White River watershed, 1977 to August 1998.

Water Body	Date	County	Number killed	Est.	Cause/Source
Roaring River Spring	7/29/85	Barry	50		Municipal
Table Rock Lake	5/17/95	Barry	100		Natural
Bull Creek	1/19/90	Christian			Gravel removal
Beaver and Cowskin creeks	2/28/83	Douglas			Trash in creeks
Beaver Creek	6/20/78	Ozark			Gravel removal
Hunter Creek	6/21/78	Ozark			Landfill refuse
Table Rock Lake	12/18/78	Stone			Gasoline
Table Rock Lake	7/24/87	Stone			Gasoline
Table Rock Lake	5/11/88	Stone	150	1,209.00	Unknown
Table Rock Lake	4/21/93	Stone	1,000+		Parasites
Table Rock Lake	8/17/95	Stone	NA		Sewage
Table Rock Lake	9/24/96	Stone	NA		Gasoline
Bull Creek	4/8/81	Taney	250		Disease
Lake Taneycomo	4/26/82	Taney			Gasoline
Lake Taneycomo	3/31/83	Taney			Gasoline
Blair Branch	1/21/85	Taney			Industrial chemicals
Beaver Creek	6/26/86	Taney			Sewage
Fall Creek	8/6/86	Taney			Sewage
Lake Taneycomo	8/18/87	Taney			Gasoline
Lake Taneycomo	5/30/92	Taney			Sewage
Table Rock Lake	6/25/92	Taney			Disease
Emory Creek	5/18/93	Taney			Drilling fluid
Roark Creek	5/19/93	Taney			Quick foam

Water Body	Date	County	Number killed	Est.	Cause/Source
Bear Creek	8/3/93	Taney			Other
Lake Taneycomo	10/6/93	Taney			Municipal
Bull Creek	8/17/94	Taney			Sewage
Table Rock Lake	9/14/94	Taney			Septic tank
Lake Taneycomo	10/17/94	Taney	100	736.5	Low dissolved oxygen
Lake Taneycomo	11/4/94	Taney			Calcium chloride
Turkey Creek	5/31/96	Taney	794	781.11	Dewatering
Lake Taneycomo	6/14/96	Taney	NA		Gasoline
Bull Creek tributary	8/17/97	Taney	NA		Sewage
Fall Creek	9/8/97	Taney	1,466	283.69	Sewage
Fall Creek	6/18/98	Taney	4,118	411.8	Sewage

Table WQ03. Water use in the White River watershed in million gallons/day (mgd).

Category	11010001 Beaver Lake (mgd)	Bull Shoals Lake (mgd)	Total (mgd)
Consumptive Use	11.28	4.44	15.72
Groundwater Withdrawals	5.87	6.27	12.14
Groundwater Withdrawals for Commercial Use	0.15	0.53	0.68
Groundwater Withdrawals for Livestock	2.39	0.53	2.92
Groundwater Withdrawals for Public Use	1.86	2.92	4.78
Population Served by Surface Water*	32.37	22.86	55.23
Population Served*	47.44	43.19	90.63
Population Served by Groundwater*	15.07	20.33	35.4
Self-Supplied Withdrawals	0.95	2.11	3.06
Self-Supplied Surface-water Withdrawals	0	0	0
Self-Supplied Population*	12.13	32.23	44.36
Self-Supplied Ground-water Withdrawals	0.95	2.11	3.06
Surface Water Withdrawals for Public Use	36.73	2.3	39.03
Surface Withdrawals	44.83	4.78	49.61
Surface Water Withdrawals for Livestock	7.65	2.23	9.88
Surface Water Withdrawals for Commercial Use	0	0	0
Withdrawals for Public Use	38.59	5.22	43.81
Withdrawals	50.7	11.05	61.75
Withdrawals for Livestock	10.04	2.76	12.8

*The unit of measure for population served is in thousands. Source: USGS (1990).

Table WQ04. Municipal waste water treatment facilities in the White River watershed.

Site #	Name	Receiving Water	Location TRS	County	Sludge*	Flow (mgd)
Missouri Facilities						
WW01	Ava	Prairie Creek	21N 25W 17	Douglas	58	0.45
WW02	Branson West	W. Fork Roark Creek	23N 23W 13	Stone	26.7	0.13
WW03	Kimberling City	Table Rock Lake	22N 23W 09	Stone	37.8	0.18
WW04	Cooper Creek	Lake Taneycomo	22N 21W 07	Taney	880	3.4
WW05	Branson	Lake Taneycomo	23N 21W 33	Taney	1525	5.3
WW06	Forsyth	Turkey Creek	24N 20W 33	Taney	57.5	0.3
WW07	Hollister	Lake Taneycomo	22N 21W 09	Taney	835	3.2
WW08	Rockaway Beach	Fall Creek	23N 21W 11	Taney	20	0.1
WW091	Washburn		22N 28W 28	Barry	9.7	0.004
TOTALS					3449.7	13.6
Arkansas Facilities						
WW10	Berryville	Osage Creek	20N 25W 36	Carroll	NA	NA
WW11	Bull Shoals	White River	20N 15W 29	Marion	NA	NA
WW12	Cotter-Gassville	White River	19N 14W 32	Baxter	NA	NA
WW13	Eureka Springs	Leatherwood Creek	20N 26W 10	Carroll	NA	NA
WW14	Fayetteville	Beaver Lake	16N 29W 07	Washington	NA	NA
WW15	Flippin	Fallen Ash Creek	19N 15W 20	Marion	NA	NA
WW16	Green Forest	Long Creek	19N 23W 10	Carroll	NA	NA
WW17	Harrison	Crooked Creek	18N 20W 02	Boone	NA	NA
WW18	Huntsville	War Eagle Creek	17N 26W 27	Madison	NA	NA

Site #	Name	Receiving Water	Location TRS	County	Sludge*	Flow (mgd)
WW19	West Fork	W. Fork White River	15N 30W 29	Washington	NA	NA
WW20	Yellville	Crooked Creek	18N 16W 10	Marion	NA	NA

*Dry tons per year.
[1]This facility is outside the watershed but within the Roaring River Spring recharge area. Source: MDNR (1998b), ADPC&E (1996).

Table WQ05. Concentrated animal feeding operations (CAFOs) in the Missouri portion of the White River watershed.

Site #	County	Location TRS	Receiving Stream	Class*	Type**	Human PE***
AW01	Barry	22N 27W 35	Roaring River	II	PB	5,815
AW021	Barry	22N 27W 30	Dry Hollow	II	PB	4,154
AW031	Barry	21N 28W 12	Dry Hollow	II	PB	4,154
AW04	Barry	21N 25W 17	Table Rock Lake	II	PB	3,588
AW051	Barry	22N 28W 25	Dry Hollow	II	PB	5,538
AW061	Barry	22N 28W 35	Dry Hollow	II	TK	12,146
AW071	Barry	21N 28W 12	Dry Hollow	IC	PB	10,000
AW081	Barry	21N 28W 02	Dry Hollow	II	PB	2,048
AW091	Barry	21N 28W 11	Dry Hollow	NP	PB	2,024
AW10	Barry	21N 27W 13	Roaring River	II	PB	4,154
AW11	Barry	21N 27W 07	Dry Hollow	II	PL	4,154
AW121	Barry	22N 28W 26	Dry Hollow	II	PB	3,365
AW131	Barry	22N 28W 33	Dry Hollow	II	PB	5,539
AW14	Barry	22N 27W 11	Roaring River	IC	PB	12,000
AW151	Barry	22N 28W 26	Dry Hollow	II	PB	5,885
AW16	Douglas	27N 17W 14	Beaver Creek	NP	DM	1,200
AW17	Douglas	27N 16W 09	Cowskin Creek	NP	DM	2,160

Site #	County	Location TRS	Receiving Stream	Class*	Type**	Human PE***
AW18	Taney	22N 17W 14	Bull Shoals Lake	NP	DM	2,700
Watershed Total PE 88674						
AW191	Barry	22N 28W 16	Flat Creek	II	PB	2,769
AW201	Barry	22N 28W 25	Flat Creek	IC	PB	11,368
AW211	Barry	22N 28W 25	Flat Creek	II	PB	2,600
AW221	Barry	22N 28W 13	Flat Creek	II	PB	4,500
AW231	Barry	22N 28W 09	Flat Creek	II	PB	4,553
AW241	Barry	22N 27W 19	Flat Creek	II	PB	3,000
AW251	Barry	22N 27W 17	Flat Creek	NP	PB	1,846
AW261	Barry	22N 28W 10	Flat Creek	II	PB	6,000
AW271	Barry	22N 28W 10	Flat Creek	II	PB	4,154
AW281	Barry	22N 28W 25	Flat Creek	II	TK	7,269
AW291	Barry	22N 28W 16	Flat Creek	II	PB	5,538
AW301	Barry	22N 28W 22	Flat Creek	II	PB	5,538
Recharge Total PE	113,988					
Watershed + Recharge Total PE	147,809					

*IC facilities house 1,000-2,999 animal units, II facilities house300-999 animal units, NP facilities house less than 300 animal units.
**Animal Types: PB= poultry broiler, TK= turkey, DM= dairy milker.
***Human population equivalent = the human population estimated to produce amounts of waste similar to that produced by a given number of animals.

[1]Indicates CAFOs within the Roaring River Spring recharge area (Figure WQ03).
Note: CAFOs AW01-AW18 are in the White River watershed and AW19-AW30 are not in the watershed but are within the Roaring River Spring recharge area. Source: MDNR (1998b).

Table WQ06. Average number of poultry animals for the Arkansas counties that contain portions of the White River watershed.

County	Commercial Table Leg*	Broilers*	Hatchery Suppliers*	Turkeys*
Baxter	-	354,310	-	587,826
Benton	137,758	22,438,793	134,655	954,348
Boone	13,793	3,686,897	35,172	567,826
Carroll	235,690	7,544,138	18,103	1,615,217
Madison	-	7,242,069	68,793	350,435
Marion	-	-	3,103	576,826
Newton	-	-	3,103	-
Washington	312,931	2,040,690	192,069	1,362,174
Total by Category	700,172	43,306,897	454,988	6,014,652
Human PE**	42,000	2,598,413	116,021	3,608,791
TOTALS		Number		50, 476,709
		Total PE**		6,365,225

*Averages were figured by taking the total annual production and dividing by the average number of flocks a grower raises annually. Chickens average 5.8 flocks produced annually, and turkeys average 2.3 flocks produced annually.

**Human population equivalent = the human population estimated to produce amounts of waste similar to that produced by a given number of animals.

Source: Wise, J., ADPC&E, pers. comm.

Habitat Conditions

Aquatic Community Classification

The portion of the White River covered in this document is part of the Ozark-White Division community, a portion of the larger Ozark Aquatic Faunal Region (Pflieger 1989). Streams in this classification are found in narrow, steep-sided valleys with high bluffs and are characterized by high gradient and relief (usually between 300 and 600 feet). Streams are clear with a substrate of mostly gravel and rubble with some bedrock. Channels have clear, well-defined riffles and pools. There are numerous springs in the area due to the karst topography. This makes some streams of the region ideal for coldwater fisheries (Pflieger 1989). The watershed is located entirely within the White River Natural Division in Missouri (Figure HC01).

Channel Alterations

Stream channelization has not been a common practice in the watershed. Channelization is localized and usually associated with bridge or road construction, urban growth, gravel removal, and individual landowner's efforts to control streambank erosion. The USCOE is responsible for granting permits on many of these activities, and the MDC comments on most permits, typically making suggestions as to the most environmentally friendly approach for the specific project.

Unique Terrestrial Habitats

The state's terrestrial resources have been classified into six major categories— Forest, Savanna, Prairie, Primary, Wetland, and Cave communities. These communities have been divided based on characteristic features such as topography, size, distribution, and characteristic plant species (Nelson 1987). MDC's Natural Heritage Program has identified unique natural communities in the White River watershed in all six of the major categories (Table HC01). The Forest community is a xeric limestone/dolomite forest. The Savanna community is a chert savanna. The Prairie community is a dry limestone/dolomite prairie. The Wetland community is a pond marsh. The Cave community is represented by a wet pit cave and an effluent cave. The Primary community is the most prevalent of the listed communities and contains representatives from glade (dolomite glades and limestone glades), cliff (dry limestone/dolomite cliffs), and talus (limestone/dolomite talus) subdivisions.

In addition to unique terrestrial communities, the watershed supports seven natural areas designated by the Missouri Natural Areas Committee (Table HC02, Figure LU04) (Kramer, Thom, Iffrig, McCarty, and Moore 1996). The Committee defines a natural area as:

> '…biological communities or geological sites that preserve and are managed to perpetuate the natural character, diversity, and ecological processes of Missouri's native landscapes. They are permanently protected and managed for the purpose of preserving their natural qualities.'

Stream Habitat Assessment

Several aspects of habitat were assessed, based on visual observations at fish sample locations, during 1997 samples. Observations were recorded for 20 of the 21 sites sampled (Table HC03). Most sites were accessible locations (i.e. county road crossings) and assessments of these should not be misinterpreted as representing watershed-wide habitat conditions, but rather as site specific examples. Observations included the entire reach of the sample site. The fisheries biologist recorded the bank stability as either excellent, good, fair, or poor. Bank stability ranked excellent at 4 sites, good at 14 sites, fair at 1 site, and poor at 0 sites. The percent of bank vegetation was recorded as the percent of trees, shrubs, herbaceous plants, and none. Overall, herbaceous made up the largest percent (35) followed by trees (20), shrubs

(15), and none (16). Riparian corridor width was estimated in categories of: 1-10 feet, 11-25 feet, >25 feet, >50 feet, >75 feet, and >100 feet. These were recorded for both banks of the sampled reach. Corridor widths >100 feet were the most common, occurring 60% of the time, followed by >50 feet (22.5%), >75 feet and 1-10 feet (7.5%), and >25 feet (2.5%). Observations were also made concerning land use beyond the riparian corridor. Pasture land use was the most common, followed by forest and residential.

Overall, streambank stability at sample locations ranked good. There are few areas where vegetation along the bank is absent or insufficient to prevent flood scour. Herbaceous vegetation and shrubs are the most common forms of streambank protection, but trees are also present to help prevent flood scour. The majority of areas sampled had riparian corridors wider than 100 feet.

These descriptions represent a summary of habitat conditions at sample site locations (1997) and are not intended to represent watershed-wide habitat conditions, but rather to present site specific examples.

Barber's Creek

The reach sampled along Barber's Creek (T25N-R19W-S21) was characterized as having good streambank stability. The protection provided to the streambanks consisted of 20% trees and 30% each of shrubs and herbaceous vegetation. Twenty percent of the bank in the reach sampled had no vegetation for protection. The width of the wooded riparian corridor was between 25 feet and 50 feet on the right bank and between 50 and 75 feet on the left bank. The land use for the area was all residential. The substrate was mostly gravel and pebble with some boulder.

Bear Creek

There was one reach sampled along Bear Creek (T24N-R21W-S27). Bank stability was excellent with no signs of erosion. The cover was also excellent with 40% herbaceous cover and 30% cover of trees and shrubs. The width of the wooded riparian corridor was greater than 100 feet. The land use beyond the corridor was residential/commercial. The substrate consisted of mostly bedrock with some boulder and cobble.

Beaver Creek

There were three reaches sampled along Beaver Creek (T25N-R17W-S27; T26N-R17W-S24; and T24N-R18W-S11). In all sample locations, the streambank stability was good. There was only a small area in which active erosion was present. This location did, however, have a good slope and was covered with minimal vegetation. Herbaceous vegetation was the dominant form of streambank vegetation. The vegetation coverage consisted of a large percent trees and shrubs in all locations. There were areas in all locations which were lacking in some form of streambank vegetation, but this was never more than 30% of the entire sampled reach. The width of the wooded riparian corridor in the upstream locations was excellent with most reaches having widths greater than 100 feet; only a few locations had corridors between 75 and 100 feet. The downstream location had a wooded riparian corridor width between 50 and 75 feet. Most of the land use beyond the riparian corridor for this stream was pasture. A small section had been left in forest. The substrate composition in this stream consisted of all sizes of material excluding clay. Gravel and cobble were the most prevalent, but boulder, sand, silt, and bedrock were also present at all locations.

Bull Creek

Three reaches were sampled along Bull Creek (T25N-R20W-S31; T25N-R20W-S08; and T24N-R21W-S34). At all locations, streambank stability was good with no signs of active erosion. Vegetation consisted of mostly herbaceous vegetation with trees and shrubs also present to help stabilize banks. The downstream location had a wooded riparian corridor greater than 100 feet in width. The midstream and upstream locations both had left banks with wooded riparian corridor widths greater than 100 feet. However, the right banks in each location had a wooded corridor less than 25 feet in width. The land use beyond the corridor in all locations was forest and pasture. The substrate consisted of gravel, cobble, pebble, boulder, and bedrock in equal amounts.

Cane Creek

The reach of Cane Creek (T23N-R18W-S18) that was sampled had excellent streambank stability conditions. Streambank vegetation consisted of mostly herbaceous plants (40%), but there were also trees (30%) and shrubs (30%) present to prevent erosion scour. The wooded riparian corridor was also in excellent condition with widths greater than 100 feet on both banks. Land use beyond the wooded corridor was partly pasture and residential. The substrate consisted of larger particles with boulder, cobble, and pebble the dominant forms.

Cowskin Creek

Streambank stability at both sites (T26N-R16W-S05/08 and T27N-R16W-33) was good to excellent. In the upper reach of the two sites, 40% of the streambank lacked vegetation, but active erosion was not observed. The streambank vegetation was dominated by herbaceous species with trees and shrubs (20-25% each) also present. The wooded riparian corridor for both reaches sampled was excellent with widths greater than 100 feet. Only a small section had a wooded corridor width of 50-75 feet. Land use beyond the corridor for this stream consisted of mostly pasture with a small area set aside as forest. The substrate was a mix of gravel, pebble, and cobble with boulder and sand also present.

Little Beaver Creek

Streambank stability in this stream was good. There were locations along the sampled reach (T25N-R18W-S15) where cattle were coming down to the stream, showing signs of active erosion. Streambank vegetation consisted of mostly herbaceous vegetation and shrubs. Some trees were also present to protect streambanks from scour. There was a small area (about 5% of the total reach) with no vegetation for protection. This was the cattle watering location. The upper end of the reach had a wooded riparian corridor width greater than 100 feet. This area was set aside for forest land use. The lower end of the reach had wooded riparian corridor widths on the left bank between 11 and 25 feet, and on the right bank between 50 and 75 feet. Land use in this portion of the reach was set aside for grazing and pasture. The substrate consisted of all forms except clay, with pebble and cobble as the dominant forms.

Little North Fork

Streambank stability for the reach sampled (T23N-R15W-S18) was good. There were areas where the streambank was bare of any vegetation (about 40% of the entire reach), but there were no indications of active erosion. The existing streambank vegetation was mostly herbaceous with some shrub cover. A few trees were also present along the streambank. The wooded riparian corridor in the reach was poor with widths ranging to only about 10 feet. The land use beyond the corridor was pasture. The substrate composition included all particles except clay and bedrock with cobble, pebble, and gravel as the dominant forms.

Pond Fork

The streambank stability for the reach sampled (T23N-R16W-S15) was excellent. Bank vegetation consisted of mostly herbaceous vegetation (40%) with equal representation from trees and shrubs. The wooded riparian corridor was greater than 100 feet wide with pasture as the land use beyond the corridor. The substrate consisted of mostly bedrock, boulder, and cobble.

Roark Creek

The reach sampled along Roark Creek (T23N-R22W-S23) was located in Henning Conservation Area. The streambank stability was excellent with predominately herbaceous vegetation. Trees and shrubs were also present to help prevent flood scour. The wooded riparian corridor was greater than 100 feet in width. The substrate was comprised of larger forms with boulder, cobble, and pebble as the dominant forms.

Roaring River

There were two reaches sampled along Roaring River (T21N-R26W-09 and T21N-R27W-S01). The streambank stability for the downstream reach was good with only 20% of the entire reach sampled having no vegetation. The streambank vegetation was dominated by herbaceous species with shrubs and trees also present. The upstream location had excellent streambank stability with about equal representation among trees, shrubs, and herbaceous vegetation. The width of the wooded riparian corridor was greater than 100 feet in both locations, with forest as the land use beyond the corridor. The substrate was comprised of all forms except clay and silt with the larger sizes in the aggregate as the dominant forms.

Swan Creek

There were three reaches sampled along Swan Creek (T26N-R19W-S34; T25N-R19W-S28; and T24N-R20W-S01). At all locations, streambank stability was good. There was a small section of the middle reach which had an 8-foot vertical bank with no vegetation. Herbaceous species dominated the streambank vegetation. In all location there were areas with no vegetation which never amounted to more than 30%. Trees and shrubs were also present in all locations to help prevent flood scour. The upstream reach had one bank with a wooded riparian corridor 10 feet wide, while the other had widths greater than 100 feet. The middle reach had a wooded riparian corridor of greater than 100 feet along both streambanks. The downstream reach had a wooded riparian corridor greater than 50 feet in width along both streambanks. The land use beyond the corridor was mostly pasture with some forest and residential areas. The substrate consisted of mostly cobble, pebble, and boulder.

Woods Fork

The reach sampled on Woods Fork is found within the Busiek State Forest (T25N-R21WS15). Therefore, streambank stability and wooded riparian corridor conditions were both excellent. Streambank vegetation was dominated by shrubs and herbaceous vegetation, but numerous trees were also present to prevent scour. The width of the wooded riparian corridor was greater than 100 feet. The substrate was comprised of all forms except clay with pebble as the dominant type.

Wooded riparian corridor estimates were completed on several major streams throughout the Missouri portion of the watershed using aerial videography. Roaring River, Dry Hollow (a tributary to Roaring River), Bull Creek, and Beaver Creek were videotaped by helicopter in March 1997. Swan Creek and Little North Fork White River were videotaped in March 1998. Corridor widths were mapped on 7.5 minute topographic maps using five categories: none, poor/none (single or clumped trees interspersed with areas of no trees), poor (less than 30 feet shown on the video as 1 or 2 rows of trees), good (30 to 75 feet), and excellent (75 feet or greater). The percent of each category was figured by stream and combined for all streams surveyed (Table HC04). The categories none, poor/none and poor, and good and excellent were combined, and the percent was calculated by stream and combined for all streams surveyed. The first combination could be considered unhealthy riparian conditions and the later combination healthy riparian conditions. It should be noted that the steams surveyed represent a very small percentage of the total watershed stream mileage, but should serve as good examples for riparian conditions watershed-wide.

Roaring River had the highest percentage of what would be considered healthy riparian conditions (68.8%), and Little North Fork White River had the lowest percentage (39.3%). Much of Roaring River is within Roaring River State Park and therefore protected from development, with the exception of development associated with Roaring River Trout Park. Little North Fork White River contains a large number of cattle on pasture and most of the unhealthy conditions were associated with this land use practice. The highest percentage of no riparian corridor was found in Dry Hollow and Little North Fork

White River. Both of these have large numbers of cattle on pasture. The largest percentage of poor/none was found along Roaring River (20.5 %) followed by Little North Fork (16.4%). This riparian condition along Roaring River was mainly associated with Roaring River Trout Park below Roaring River Spring. Much of the stream bank has been developed for access to anglers. Parking lots, roads and open areas are common in this area. The poor/none condition along LNF was mainly associated with cattle on pasture. Poor conditions were the highest along LNF (29.3%) and Swan Creek (25.5%). This is mainly due to land clearing for pasture. Beaver Creek (35.1%) and Bull Creek (26.8%) ranked first and second for good conditions. Roaring River (68.8%) and Swan Creek (65.2%) ranked first and second for excellent conditions.

Most good and excellent conditions were associated with steeper terrain and bluffs. A pattern was noted between steep bluffs with excellent riparian conditions in association with the opposite stream bank corridor being of poor condition. Steep terrain and bluffs are naturally protected from clearing and grazing. In most cases the bank opposite from a steep bluff has very level topography, making it most suitable for clearing and grazing. This pattern held true for all of the streams evaluated.

Improvement Projects

The Taney County Multi-Resource Project is a joint habitat improvement project supported by the Taney County Soil and Water Conservation District, Natural Resources Conservation Service, and Missouri Department of Conservation. The project is funded through MDC State Stewardship funds and all cooperating agencies are involved in providing technical assistance.

Administrative guidance is provided by the MDC's Southwest Region Forestry staff. The project is designed to use an ecosystem, or multi-resource, approach to address natural resource issues in a highly sensitive area. Project objectives include: improve and protect water quality; promote glade and savanna restoration and management; improve management of woodland, grassland, and riparian areas; identify and encourage practices designed to protect species of federal or state concern found in the project area; and improve fish and wildlife habitat. Challenges and problems facing the area include: karst topography, poor soils, and critical water quality issues; savanna and glade management concerning woody encroachment; overgrazing of pastures and woodlands; and urbanization and large population increases. Landowners that own land in Taney County are eligible to apply for the program, but land that falls within the project boundaries will be given higher priority. Interested landowners can sign up anytime at the Taney County Soil and Water Conservation District in Forsyth, MO. At the time of writing, budgetary restraints have put the program on hold and future financing of the program is uncertain.

MDC has worked with other organizations and individuals to install fourteen habitat improvement projects throughout the Missouri portion of the watershed since 1991 (Table HC05). Six projects have been completed within Roaring River State Park with cooperation from MDNR. Two cedar tree revetments have been installed with the assistance of federal agencies; one with the USCOE and one with the USFS. MDC has provided assistance and cost sharing to individual landowners on six additional projects throughout the watershed. MDC fisheries biologist write 10-15 recommendations annually to watershed landowners, and are available for assistance with stream management issues, including: streambank erosion problems, riparian corridor re-establishment and protection, and alternative livestock watering projects (Martien, L., MDC, pers. comm.).

Table HC01. Unique terrestrial habitats in the Missouri portion of the White River watershed.

Community Type	Area Name	Size (acres)	Ownership*
Chert savanna	Skaggs-Keeter Ranch	1,320	**Private**
Dolomite glade	MO-AR state line	15	**USFS**
Dolomite glade	Smith Hollow Glades	20	**Private/USFS**
Dolomite glade	Butler Hollow	35	**USFS**
Dolomite glade	White Cedar Glade	6	**MDNR/USFS**
Dolomite glade	Boundary Line Glade	10	**USFS**
Dolomite glade	Rock Creek Glade	10	**USFS**
Dolomite glade	Busiek State Forest	30	**MDC**
Dolomite glade	White River Balds NA	100	**MDC**
Dolomite glade	Thorp Creek Glades	40	**Private**
Dolomite glade	McAdoo Creek Glades	50	**USFS**
Dolomite glade	Hercules Glades WA	40	**USFS**
Dry limestone/ dolomite cliff	Rock Spring Bluff	10	**USCOE**
Dry limestone/ dolomite cliff	Steep Bluff	N/A	**USCOE**
Dry limestone/ dolomite cliff	Oswalt Bluff	N/A	**Private/ USCOE**
Dry limestone/ dolomite prairie	Big Creek Prairie	23	**Private**
Effluent cave	Tumbling Creek Cave	N/A	**Private**
Limestone glade	Pine Hollow Ridge	1	**USFS**
Limestone glade	Beaver Creek Hollow	2	**Private**
Limestone glade	Dogwood Creek Glade	3	**Private**
Limestone glade	Gretna Glade	0.5	**Private**
Limestone glade	Garber Glade	0.5	**Private**
Limestone/ dolomite talus	Bull Creek	10	**Private**
Pond marsh	Drury-Mincy CA	0.5	**MDC**
Wet pit cave	Old Chiney Cave	N/A	**Private**
Xeric limestone/ dolomite forest	**Ashe Juniper NA**	**25**	**Private/MDC**

*MDC= Missouri Department of Conservation; USFS= United States Forest Service; MDNR= Missouri Department of Natural Resources; USCOE= United States Army Corps of Engineers
Source: Nelson (1987).

Table HC02. Natural areas (NA) in the Missouri portion of the White River watershed.

Name	County	Acres	Ownership*
Roaring River Cove Hardwoods NA	Barry	86	MDNR
Rock Spring Bluff NA	Barry	10	USCOE
Butler Hollow Glades NA	Barry	373	USFS
Ashe Juniper NA	Stone	35	MDC
White River Balds NA	Taney	364	MDC
Hayden Bald NA	Ozark	44	USFS
Caney Mountain NA	Ozark	1,458	MDC

*MDNR = Missouri Department of Natural Resources; USCOE = United States Army Corps of Engineers; USFS = United States Forest Service;
MDC = Missouri Department of Conservation
Source: Kramer, K., R. Thom, G. Iffrig, K. McCarty, and D. Moore (1996).

HC03. Recorded habitat conditions at MDC fish sample sites in the Missouri portion of the White River watershed during 1997.

Loc.1 #	Bank Stability[2]	Bank Vegetation* (%)				Land use beyond riparian**(%)	Corridor width (feet)	
		T	S	H	N		Left descending bank	Right descending bank
2184	E	25	40	35	0	100F	>100	>100
1608	G	10	20	30	50	100R	>100	>50
2506	G	30	40	30	0	50F-50P	>100	>50
2458	G	30	30	30	10	50F-50R	10-Jan	>100
2314	G	20	30	30	20	100R	>50	>25
1624	F	10	20	40	20	75F-25P	>100	>100
2511	G	20	55	40	5	50F-50P	>50	>75
2507	G	20	40	30	10	100P	>50	>75
2234	NA	20	30	50	0	100P	>100	>75
2509	G	25	20	50	5	50F-50P	>100	>100
1985	E	30	30	40	0	50P-50R	>100	>100
1598	G	20	20	30	30	100P	>50	>50
2507	G	20	30	30	20	100P	>50	>50
1606	G	10	30	40	20	100F	>100	>100
1601	E	30	30	40	0	100F	>100	>100
1592	G	10	20	30	40	100P	10-Jan	10-Jan
2183	G	20	20	20	40	50F-50P	>100	>100
2197	G	20	20	20	40	50F-50P	>100	>100
1610	G	30	30	40	0	100R	>100	>100
1975	G	20	20	20	40	50F-50P	>100	>100
Total Avg.	G=74%	20	29	35	16		>100 = 60%	
s	E=21%						>75 = 7.5%	
	F=5%						>50 = 22.5%	
	P=0%						>25 = 2.5%	

Loc.1 #	Bank Stability[2]	Bank Vegetation* (%)				Land use beyond riparian**(%)	Corridor width (feet)	
		T	S	H	N		Left descending bank	Right descending bank
							1-10 = 7.5%	

[1]Location numbers correspond with those found in Figure BC01 and Table BC02.
[2]Bank stability was ranked as E=excellent, G=good, F=fair, and P=poor.
*Bank vegetation was classified as: T=trees, S=shrubs, H=herbaceous, and N=none.
**Land use beyond riparian corridor was classified as: F=forest, P=pasture, R=residential.

Table HC04. Estimated riparian corridor condition of major streams in the Missouri portion of the White River watershed.

Stream	None*	Poor/None*	Poor*	Good*	Excellent*	None Poor/None None*	Good Excellent*
Roaring River	5.6	20.5	5.2	11.3	57.5	31.2	**68.8**
Dry Hollow	17.6	6.4	16.6	5.2	54.3	40.6	**59.5**
Bull Creek	5.9	14.9	24.0	26.8	28.5	44.8	**55.2**
Swan Creek	4.6	4.8	25.5	23.6	41.5	34.8	**65.2**
Beaver Creek	5.7	8.9	23.4	35.1	26.8	38.0	**62.0**
Little North Fork	15.1	16.4	29.3	14.6	24.7	60.8	**39.3**
TOTAL	**7.0**	**9.3**	**24.1**	**25.6**	**34.0**	**40.4**	**59.6**

*Conditions: None=no corridor, Poor/None=single or clumps of trees interspersed with no trees, Poor=corridor less than 30 feet (usually 1 or 2 rows of trees), Good=30-75 feet of corridor, Excellent=75 feet of corridor or more.

Note: Numbers indicate category's percent of the entire riparian corridor.

Table HC05. Streambank and habitat restoration projects in the Missouri portion of the White River watershed.

Stream	County	Practice	Location	Cooperators	Date
Roaring River	Barry	Revetment & corridor re-establishment	22N 27W 34	MDNR/MDC	**1990**
E. Fork Big Cr.	Taney	Cedar tree revetment & corridor re-establishment	22N 17W 01	Private//MDC	**1991**
Swan Creek	Taney	Cedar tree revetment	23N 20W 28	USCOE/MDC	**1991**
Beaver Creek	Taney	Cedar tree revetment & corridor re-establishment	24N 17W 05	Private/MDC	**1992**
Roaring River	Barry	Gabion and bank sloping	22N 27W 35	MDNR/MDC	**1993**
E. Fork Bull Cr.	Christian	Cedar tree revetment	26N 20W 27	USFS/MDC	**1994**
Roaring River	Barry	Repair hard points, replace riprap, & repair gabion	22N 27W 35	MDNR/MDC	**1995**
Bailey Branch	Barry	Well and tanks for alternative watering source & corridor re-establishment	24N 25W 20	Private/MDC	**1997**
Bull Creek	Christian	Rock blanket & tree planting	25N 20W 08	Private/ MDC	**1997**
Goff Creek	Christian	Solar water tanks, spring development/protection, & corridor re-establishment	25N 22W 14	Private/MDC	**1997**
Roaring River	Barry	Disabled user access	22N 27W 27	MDNR/MDC	**1998**
Sugar Camp	Christian	Well, solar	27N 18W 32	Private/ MDC	**1998**

Stream	County	Practice	Location	Cooperators	Date
Cr.		pump as alternative watering source, & corridor re-establishment			
Roaring River	Barry	Disabled user access and bank stabilization	22N 27W 35	MDNR/MDC	**1999**
Roaring River	**Barry**	**Gravel retention structure maintenance**	**22N 27W 27**	**MDNR/MDC**	**ongoing**

Biotic Communities

The White River watershed contains one of the most diverse assemblages of fish species in the state of Missouri or Arkansas. There have been 163 native fish species identified in the entire White River basin and 110 fish species identified in the White River watershed (Shirley 1992). There have been 86 fish species identified in the Missouri portion of the watershed and 97 species of fish identified in the Arkansas portion (Table BC01). The Missouri portion of the watershed lies entirely in the Ozark-White Division, a division of the larger Ozark Aquatic Faunal region.

There are 56 species or subspecies of fish which have a localized distribution in the watershed or a limited distribution elsewhere in the state. The species or subspecies which are restricted to the Ozark-White Division include: Ozark bass, duskystripe shiner, White River or Arkansas saddled darter, and yoke darter. Each of these species has been collected previously in the watershed.

Four races or subspecies in the watershed are found elsewhere in the state, but have a morphological distinction in the White River region which make them unique to the Ozark-White Division; they may represent geographic races or undescribed subspecies. These species are longear sunfish, rainbow darter, fantail darter, and orangethroat darter (Pflieger 1989). The watershed also contains a diverse and somewhat unique array of mussels (38 known species) and crayfish (8 known species in Missouri).

Fish Community Data

Fish collections have been made throughout the Missouri portion of the watershed since 1940 (Table BC02, Figure BC01). There have been 81 fish species collected since that time. In 1997, twenty-one fish collections were made by MDC's Southwest Region Fisheries staff; seventeen from William Pflieger's historic collection sites and four from previously unsampled locations. In 1998 additional effort was added at eleven of these locations, and four more historic sites were sampled. Evaluations of fish populations were done on twenty-one of the sites that had not been sampled for at least ten years or that had not been sampled previously. There were 6,788 fish collected or otherwise identified from these combined efforts, consisting of forty-seven species, representing ten families. Table BC03 lists fish species by stream for the Missouri portion of the watershed.

The families represented by recent samples in descending order of number of species were: Cyprinidae (16 species), Percidae and Centrarchidae (8 species each), Catostomidae and Ictaluridae (4 species each), Fundulidae and Cottidae (2 species each), and Atherinidae, Salmonidae, and Poeciliidae (1 species each).

Duskystripe shiners and stoneroller species (stoneroller species included central and largescale stonerollers) were the most widespread species sampled overall, found at all twenty-one sites. Several other species occurred at over one-half of the sample sites including: rainbow darters (20 sites) orangethroat darters (17 sites), northern studfish (17 sites), northern hogsuckers (16 sites), Ozark minnows (15 sites), and blackspotted topminnows and longear sunfish (14 sites each).

Duskystripe shiners were the most numerous species sampled making up 23% of the total watershed sample for the current season, followed by stoneroller species (16.7%) and Ozark minnows (12.2%) These three fishes made up 52% percent of all fish sampled for the 1997-98 season.

Species occurring rarely throughout the current watershed samples, those sampled at two or less sites, included: yellow bullhead, White River saddled darter, checkered madtom, brook silverside, creek chubsucker, western mosquitofish, Ozark chub, and bigeye shiner (1 site each) and white sucker, rainbow trout, spotted bass, and creek chub (2 sites each).

The most widespread large fishes in descending order were: northern hogsuckers (16 sites), longear sunfish (14 sites), smallmouth bass (11 sites), largemouth bass (10 sites), and Ozark bass and green sunfish (7 sites each). The most widespread nektonic, or midwater species, sampled were duskystripe shiners and stoneroller species (all sites), northern studfish (17 sites), Ozark minnows (15 sites), blackspotted topminnows (14 sites), horneyhead chubs (13 sites), and roseyface and striped shiners (11 sites each). The most widespread benthic, or bottom dwelling, species were: rainbow darters (20 sites), orangethroat darters (17 sites), Ozark madtoms (13 sites), banded sculpins (10 sites), greenside darters (9 sites), and slender madtoms and golden fantail darters (8 sites each).

The number of species per site (Table BC02) varied from thirty species sampled at site 1986 on Beaver Creek to ten species sampled at sites 2506 on Bull Creek and 2183 on Cowskin Creek. The average number of species sampled from the twenty-one sites was 19.3.

Creek chubsuckers had not been collected from the watershed since 1940. They were sampled at one location in Swan Creek. One creek chubsucker was recently collected from Little North Fork White River during 1998. White River saddled darters had not been collected in the watershed since 1968 and were thought to be extirpated or nearly extirpated (Pflieger 1997). One individual was collected from lower Beaver Creek during 1998.

Many of the species originally found in the watershed have not been collected in the watershed since 1946. Four species have not been collected since 1973; grass pickerel, red spotted sunfish, steelcolor shiner, and speckled darter. Species that are known to have experienced declines in the watershed, thought to be as a result of reservoir construction, include: steelcolor shiner, Ozark chub, duskystripe darter, silver chub, bigeye chub, wedgespot shiner, White River saddled darter, Ozark shiner, and longnose darter (Pflieger 1997).

For many of the species missing from recent collections, inadequate sampling or sampling error could be factors in their absence. Large species are difficult to seine and easily avoid seine hauls. Since electrofishing has not been used as a sample technique in the recent collections, this could be the explanation for the absence of the larger fish species. In addition, sites on the White River proper were not sampled due to impounded waters. The larger species would be more likely found in these areas than in the smaller tributaries. However, sampling error alone may not be the only reason for the absence of the highfin carpsucker, since it is listed as a rare species in Missouri.

For the smaller fish, sampling error could be a possibility for their absence. It is more probable, however, that some of the species have been lost from the watershed. For example, the longnose darter is listed as a state endangered species, and it has not been seen in collections from the Missouri portion of the watershed since the mid-1950s. In addition, the eastern slim minnow is a state listed rare species and has not been collected since before 1946. The gilt darter and silver chub, though not state listed species, have also not been collected since before 1946. It is unlikely that sampling error is the reason for the absence of these species in collections. Habitat loss and fragmentation due to the construction of Powersite (1913) and Table Rock (1957) dams could have played a major role in the absence of these smaller species from collections and from the watershed.

The construction of major dams and reservoirs has created a barrier to fish movement in the watershed. As populations become isolated, genetic variability may become reduced and fragmented. Though this process happens over centuries, the mechanisms for the change are in place. This has the potential to not only separate populations physically but also to isolate populations genetically. The result is isolated populations with fewer individuals or genetic drift, where genetic diversity of a new generation becomes different from that of a previous generation. Traits that once were developed from a watershed-wide gene pool, in some instances, have now become isolated from one another. In turn, the genetic variation in the two isolated populations may differ from one another. The possibility now exists for fitness reductions in isolated populations resulting from these isolations as fewer gene types are exchanged and passed on to later generations.

Aquatic Invertebrates

This watershed contained a very diverse mussel fauna in the past. Historically, there were 38 species of mussels collected (Table BC04). The majority of these came from the mainstem White River which is now impounded (Gordon 1980; 1982 and Oesch 1996). Since 1920 only 9 species of mussels, 7 live specimens and 2 dead shells, have been sampled in the watershed. These were collected from Bull, Swan, and Beaver creeks (Buchanan 1996). The main factor for these losses, especially the mainstem populations, has been the impoundment of the White River. Species diversity in tributary streams may be limited naturally by stream size, water temperature, and high gradients. Several mussel species have been observed in Table Rock and Bull Shoals lakes by SCUBA divers. These are included in Table BC04.

The Ozark Region supports by far the greatest variety of crayfish found in Missouri. This faunal richness is a result of diverse aquatic habitats, very slow and ancient geological development, and the fact that this region remained undisturbed during glaciation. In addition, the White River watershed has several unique crayfish species (Table BC05) (Pflieger 1996). Longpincered crayfish are restricted to the White River basin in Missouri and Arkansas. Meek's crayfish are restricted to northwest Arkansas and southwest Missouri. In Missouri they have only been collected at three locations in tributaries to Table Rock Lake. Meek's crayfish is considered one of the rarest crayfish in Missouri. The Ozark crayfish is only found in the White and Black river basins in Missouri and Arkansas. William's crayfish has a very localized distribution, only occurring in the White River watershed in Missouri and Arkansas (Pflieger 1996).

A detailed water quality study of Prairie, Cowskin, and Beaver creeks was conducted by Duchrow (1976; 1978) following ongoing pollution problems. The study used aquatic invertebrates as an indicator of pollution entering Prairie Creek from the Ava area. Both qualitative and quantitative studies were done on invertebrate populations, and a species list is presented in (Table BC06).

Many amphibians and reptiles, as well as birds and mammals, are dependent on aquatic habitats, and some spend portions or all of their life in or near the water. Amphibians and reptiles found in the Missouri watershed counties are listed in (Table BC07).

Species of Conservation Concern

The White River watershed has a very unique distribution of flora and fauna. There are one hundred and fifty-two watershed species identified as being of conservation concern (Table BC08). Six federally endangered species are known to occur in the watershed including: Swainson's warbler, gray bat, and Indiana bat in Missouri and Arkansas; running buffalo clover in Missouri; and Ozark big-eared bat and Florida panther in Arkansas. One federally threatened species, Ozark cavefish, is known from the Arkansas portion of the watershed. There is one federal candidate species, the Tumbling Creek cavesnail, found in the Missouri portion of the watershed.

Fish

Checkered madtom is Missouri listed as rare and uncommon (S3). This best describes their presence in the watershed. Only one checkered madtom was collected during recent samples. Checkered madtoms have been present in low numbers in samples from every decade sampled beginning in 1940. Pflieger (1997) indicates that checkered madtoms may be declining in the White River system.

Ozark shiner is Missouri listed as imperiled because of rarity making them vulnerable to extirpation from the state. One Ozark shiner was sampled at a location in Beaver Creek in 1992. They had not been sampled in the watershed previous to that since 1946. Once listed as abundant from the White River drainage, its numbers are thought to have been reduced due to reservoir construction, resulting in habitat loss and range fragmentation (Pflieger 1997).

Longnose darter is currently Missouri listed as critically imperiled because of extreme rarity and especial vulnerability to extirpation from the state (S1). Longnose darters have not been sampled from the Missouri portion of the watershed since the mid-1950s. The area where longnose darters were formerly sampled is now impounded by Table Rock Dam, and this species is thought to be extirpated from the Missouri portion of the watershed. Longnose darters have been collected from the Arkansas portion of the watershed as recently as 1987. Range of the longnose darter has also been negatively impacted by the inundations of Beaver Lake (Robison and Buchanan 1992).

Eastern slim minnow is Missouri listed as imperiled because of rarity making them vulnerable to extirpation from the state (S2). Eastern slim minnows have not been sampled in the Missouri portion of the watershed since 1942 and are thought to have been extirpated in part due to reservoir construction (Pflieger 1997).

Highfin carpsucker is Missouri listed as S2. Highfin carpsuckers are known to exist in Lake Taneycomo but are becoming less common statewide with most occurrence records more than 25 years old (Pflieger 1997).

Ozark cavefish is listed as federally threatened and has not been found in the Missouri portion of the watershed; several populations are known to exist in the James River watershed, a White River tributary. Two populations are known to exist in the Arkansas portion of the watershed in Benton County. One population was found in a private sinkhole in 1991, which has since been filled in; that population's status is unknown. The other population was discovered when workers constructing a pond accidentally broke through the ceiling of a cave. Ozark cavefish were last sampled at that location in 1987 (Osborne, C., AR Natural Heritage Commission, pers. comm.).

Crystal darter is listed in Arkansas as imperiled because of rarity making it vulnerable to extirpation from the state. A single crystal darter was collected from War Eagle Creek in 1964. A voucher specimen is housed at the University of Arkansas, Little Rock (Osborne, C., AR Natural Heritage Commission, pers. comm.). Robison and Buchanan (1992) list the crystal darter's range as below the Fall Line in the White River Basin, and do not recognize this collection on reference maps.

Bluntface shiner is Arkansas listed as historical, and one individual was collected from War Eagle Creek in 1964. The specimen is housed at the University of Arkansas, Little Rock (Osborne, C., AR Natural Heritage Commission, pers. comm.). Robison and Buchanan (1992) do not recognize this collection, stating that bluntface shiners have only been collected at four locations, outside the watershed, and prior to 1960.

American brook lamprey is Arkansas listed as imperiled because of rarity making it vulnerable to extirpation from the state. The American brook lamprey is only known from the White River basin in Arkansas and has been collected in the lower section of the watershed below Bull Shoals Lake (Robison and Buchanan 1992).

Crayfish

Meek's crayfish is Missouri listed as critically imperiled because of extreme rarity and is especially vulnerable to extirpation from the state (S1). Meek's crayfish are only known from southern Missouri and northwestern Arkansas, and have only been collected from a few tributaries to Table Rock Lake in Stone and Taney counties in Missouri. They are one of the rarest known crayfish in Missouri (Pflieger 1996). William's crayfish is Missouri listed as critically imperiled because of extreme rarity, and it is especially vulnerable to extirpation from the state (S1). This crayfish has a very localized distribution in the upper White River watershed, in Missouri and Arkansas. In Missouri it is known from Barry, Christian, Stone, and Taney counties. It is found in close association with Meek's crayfish (Pflieger 1996).

Mollusks

Tumbling Creek cavesnail is Missouri listed as critically imperiled because of extreme rarity and it is especially vulnerable to extirpation from the state (S1). It is also a federal candidate species. The snail is only known from a single stream in Tumbling Creek Cave in Taney County, MO (Gordon, Oesch, and Wu 1997).

Purple lilliput is Missouri listed as imperiled because of rarity making it vulnerable to extirpation from the state. It is rare in Missouri, only known from the southern part of the state, and may have been extirpated from the James River, a White River tributary, due in part to water pollution (Oesch 1995).

Angler Survey Data

MDC has collected angler survey data on Table Rock Lake, Bull Shoals Lake, and Lake Taneycomo. Summaries from Table Rock Lake and Lake Taneycomo are available in various annual reports from the SW Regional Office in Springfield, and information concerning Bull Shoals Lake is available from the Ozark Regional Office in West Plains.

Fish Introductions

The types and number of fishes that have been introduced into the watershed has varied over time. The most notable stockings have been of salmonid species below the three large dams. The stocking of trout species first began in the Missouri portion of the watershed in 1880 when rainbow trout were released into streams along the Frisco Railroad. The first documented release of non-native fishes into the watershed was during 1903-04, when brook trout and grayling were released into the White River. Trout stocking occurred indiscriminately and sporadically, throughout the watershed, from the early 1900s until 1936. Missouri initiated organized management of a trout program in 1937, shortly after the formation of MDC. Stocking at Roaring River Spring was first recorded in 1929, and daily trout tags were first sold in 1937 (Turner 1979).

Trout were first stocked in Lake Taneycomo in 1922, but did not become established until the lake became a coldwater fishery in 1958. In the period from 1958-78, 6,000,000 trout, mostly rainbow trout, were stocked in Lake Taneycomo. Recent rainbow trout stockings have averaged about 750,000 per year. Brown trout were first introduced to Lake Taneycomo in 1980. Recent brown trout stockings have averaged 10,000 to 15,000 per year.

Kokanee salmon were stocked in Lake Taneycomo from 1963 to 1968. Survival and catch rates of kokanee were low, and the stocking was discontinued. Steelhead trout (migratory strains of rainbow trout) were stocked from 1971 to 1974, but stockings were discontinued because of the possibility of disease introductions (Kruse 1996).

Paddlefish occur naturally in the lower White River basin and occasionally strayed as far as the Missouri portion of the watershed prior to the construction of Bull Shoals Dam. MDC began stocking paddlefish in Table Rock Lake in 1972. From the initial stocking until 1998, nearly 189,000 fingerling paddlefish were stocked in Table Rock Lake. This is the first known successful development of a paddlefish population from stocked fingerlings (Graham, L., MDC, pers. comm.). Paddlefish migrate annually from Table Rock Lake into tributary streams in an effort to spawn, although no successful spawning has been documented. Many of the fish move up the James River Arm and a popular sport fishery has developed. Paddlefish also congregate annually below Beaver Dam.

Numerous small lakes and ponds, throughout the watershed, have been stocked with a variety of fish including largemouth bass, bluegill, grass carp, crappie, and channel catfish. Several complaints have been received about the escapement of Koi carp from an impoundment on Sugar Camp Creek. Several Koi carp were known to escape when the dam failed in the late 1980s. An investigation of the site in 1994 found the dam to be sound, and Koi carp unable to escape under normal conditions (Hash K., MDC memo, 1995). Goldfish were sampled from Swan Creek, the stream Sugar Camp Creek flows into, in 1995. Escapement of stocked fish from impounded waters undoubtedly occurs, but the extent and effects are undocumented.

AG&FC stocked 2.8 million trout statewide in 1997 and planned to stock 2.85 million trout in 1998, both record numbers for those years. In the period from 1987 to March 1998 rainbow trout were the most common and numerous fish stocked by AG&FC in the watershed, followed by brown trout, cutthroat trout, channel catfish, and brook trout. Most trout, in the Arkansas portion of the watershed, are stocked below Beaver and Bull Shoals dams. Exotic introductions (non-native to U.S. waters) to Arkansas waters include: brown trout, goldfish, grass carp, and common carp. Transplanted introductions (non-native to Arkansas) include: rainbow trout, cutthroat trout, brook trout, lake trout, northern pike, muskellunge, and striped bass.

Fishing Regulations

Statewide fishing regulations apply to most streams in the watershed. Special regulations may apply on certain water bodies. Missouri regulations can be found in the Wildlife Code Book which runs annually from March 1 through the last day of February.

Threats to Aquatic Populations

- **Urbanization** Expanding human populations are and will continue to be a threat to aquatic communities in the watershed. As more people migrate into the watershed, more land is cleared for development and roads. Forests make way for yards and parking lots, allowing for more rapid runoff and increased sedimentation. Population increases are responsible for larger loads on municipal sewage systems, more onsite septic systems, and related spills and nutrient loading.
- Water use will also increase with growing populations.
- **Point and nonpoint source pollution** Pollution incidents associated with expanding populations in the watershed have the potential to negatively impact aquatic biota. Since 1985 municipal sewage (11) and chemical (11) spills, combined, have accounted for 68% of the recorded pollution incidents in the Missouri portion of the watershed. The three most recently recorded pollution incidents in the Missouri portion of the watershed have all been caused when municipal sewage reached watershed streams. Two of these were responsible for a total of 5,584 known fish being killed.
- **Livestock** Livestock in the watershed in the form of cattle on pasture and poultry houses have the potential to impact aquatic biota. Manure from both sources has the potential to reach watershed streams in substantial amounts. Manure also has the potential to degrade watershed streams over time. Cattle in streams can also negatively impact aquatic life by destroying riparian vegetation and compacting streambanks, which in turn may increase the amount of erosion and waste that enters streams.
- **Gravel removal** Results from a recent study from the Arkansas Cooperative Fish and Wildlife Research Unit at the University of Arkansas indicate that instream gravel removal significantly degrades the quality of Ozark stream ecosystems. The study compared sites above, at, and below gravel operations and found that at and downstream from gravel mines, stream channel form was altered, resulting in an increase in sedimentation rates and turbidity, shallower and larger pools, and fewer riffles. The resultant extensive flats favored large numbers of a few small fish species. The removal of riparian vegetation, large woody debris, and large substrate particles resulted in smaller invertebrates and smaller fish at disturbed and downstream sites. The study found that silt-free substrate is a valuable resource to Ozark stream biota, and alteration of physical habitat appears to have a greater influence on the biotic community than limitations imposed on other resources, such as food (Brown and Lyttle 1992).
- **Reservoir operations** Waters with low dissolved oxygen concentrations are released seasonally from Beaver, Table Rock, and Bull Shoals lakes, impacting downstream fish and invertebrate populations. In addition, artificially low flows and rapidly fluctuating releases from Table Rock Dam affect instream habitats in the upper reaches of Lake Taneycomo. Seasonal inundation of lower reaches of tributary streams also has a negative impact on the total amount of available riverine habitat.

Table BC01. Fishes of the White River watershed.

Common name	Scientific name	MO* status	AR** status
Chestnut lamprey	*Ichthyomyzon castaneus*		A,B
Larval lamprey	*Ichthyomyzon*	A	
Southern brook lamprey	*Icthyomyzon gagei*		B
Least brook lamprey	*Lampetra aepyptera*	C	
American brook lamprey	*Lampetra appendix*		B
Paddlefish	*Polyodon spathula*	A, C, D	A, B
Shovelnose sturgeon	*Scaphirhynchus platorynchus*	B	B
Longnose gar	*Lepisosteus osseus*	A, B, D	A, B
Shortnose gar	*Lepisosteus platostomus*	A	
American eel	*Anguilla rostrata*	A, B	A, B
Gizzard shad	*Dorosoma cepedianum*	A, B, D	A, B
Threadfin shad	*Dorosoma petenense*	B, C, D	B
Mooneye	*Hiodon tergisus*	A	B
Cutthroat trout	*Salmo clarki*		B
Rainbow trout	*Oncorhynchus mykiss*	A, B, C, D	A, B
Brown trout	*Salmo trutta*	B, C, D	B
Brook trout	*Salvelinus fontinalis*		B
Lake trout	*Salvelinus naymacush*		B
Grass pickerel	*Esox americanus*	A, B	B
Northern pike	*Esox lucius*		B
Muskellunge	*Esox masquinongy*		B
Central stoneroller	*Campostoma pullum*	A, B, C, D	A, B
Largescale stoneroller	*Campostoma oligolepis*	A, B, C, D	A, B
Goldfish	*Carassius auratus*	D	B
Grass carp	*Ctenopharyngodon idella*		B
Common carp	*Cyprinus carpio*	A, B, C, D	B
Bigeye chub	*Notropis amblops*	A, B, C, D	A, B
Streamline chub	*Hybopsis dissimilis*		B

Common name	Scientific name	MO* status	AR** status
Gravel chub	*Erimystax x-punctatus*		A
Horneyhead chub	*Nocomis biguttatus*	A, B, C, D	A, B
Golden shiner	*Notemigonus crysoleucas*		B
Bigeye shiner	*Notropis boops*	A, B, C, D	A, B
Striped shiner	*Luxilus chrysocephalus*	A, B, C, D	A, B
Whitetail shiner	*Cyprinella galactura*	A, B, C, D	A, B
Wedgespot shiner	*Notropis greenei*	A, B, C, D	A, B
Ozark minnow	*Notropis nubilus*	A, B, C, D	A, B
Ozark shiner	*Notropis ozarcanus*	A, D	A, B
Duskystripe shiner	*Luxilus pilsbryi*	A, B, C, D	A, B
Cardinal shiner	*Luxilus cardinalis*		A
Rosyface shiner	*Notropis rubellus*	A, B, C, D	A, B
Telescope shiner	*Notropis telescopus*	A, B, C, D	A, B
Steelcolor shiner	*Notropis whipplei*	A, B	A, B
Southern redbelly dace	*Phoxinus erythrogaster*	A, B, C, D	A, B
Bluntnose minnow	*Pimephales notatus*	A, B, D	A, B
Fathead minnow	*Pimephales promelus*		B
Slim minnow	*Pimephales tenellus*		A, B
Eastern slim minnow	*Pimephales t. parviceps*	A	
Ozark chub	*Erimystax harryi*	A, B, C, D	
Silver chub	*Macrhybopsis storeriana*	A	
Creek chub	*Semotilus atromaculatus*	A, C, D	A, B
River carpsucker	*Carpiodes carpio*	A	B
Quillback	*Carpiodes cyprinus*	A, B	B
Highfin carpsucker	*Carpiodes velifer*	A, B	B
Bigmouth buffalo	*Ictiobus cyprinellus*	A	
Black buffalo	*Ictiobus niger*	A	
White sucker	*Catostomus commersoni*	A, C, D	A, B
Creek chubsucker	*Erimyzon oblongus*	A, D	B

Common name	Scientific name	MO* status	AR** status
Northern hogsucker	*Hypentelium nigricans*	A, B, C, D	A, B
Spotted sucker	*Minytrema melanops*		B
River redhorse	*Moxostoma carinatum*	A	A, B
Black redhorse	*Moxostoma duquesnei*	A, B, C, D	A, B
Golden redhorse	*Moxostoma erythrurum*	A, B, C, D	A, B
Shorthead redhorse	*Moxostoma macrolepidotum*		B
Blue catfish	*Ictalurus furcatus*	A	B
Black bullhead	*Ameiurus melas*	A	B
Yellow bullhead	*Ameiurus natalis*	A, B, D	A, B
Channel catfish	*Ictalurus punctatus*	A, B	A, B
Ozark madtom	*Noturus albater*	A, B, C, D	A, B
Slender madtom	*Noturus exilis*	A, B, C, D	A, B
Checkered madtom	*Noturus flavater*	A, B, C, D	A, B
Flathead catfish	*Pylodictis olivaris*	A, B, C, D	A, B
Ozark cavefish	*Amblyopsis rosae*		B
Northern studfish	*Fundulus catenatus*	A, B, C, D	A, B
Blackspotted topminnow	*Fundulus olivaceus*	A, B, C, D	A, B
Western mosquitofish	*Gambusia affinis*	D	B
Brook silverside	*Labidesthes sicculus*	A, B, C, D	A, B
White bass	*Morone chrysops*	A, B, C, D	B
Striped bass	*Morone saxatilis*	B, C, D	B
Yellow perch	*Perca flavescens*	A	
Ozark bass	*Ambloplites constellatus*	A, B, C, D	A, B
Green sunfish	*Lepomis cyanellus*	A, B, C, D	A, B
Warmouth	*Lepomis gulosus*	A, B	B
Orangespotted sunfish	*Lepomis humilis*		A
Bluegill	*Lepomis macrochirus*	A, B, D	B
Longear sunfish	*Lepomis megalotis*	A, B, C, D	A, B
Redear sunfish	*Lepomis microlophus*		B

Common name	Scientific name	MO* status	AR** status
Red spotted sunfish	*Lepomis miniatus*	B	
Spotted sunfish	*Lepomis punctatus*		B
Smallmouth bass	*Micropterus dolomieu*	A, B, C, D	A, B
Spotted bass	*Micropterus punctulatus*	A, B, C, D	A, B
Largemouth bass	*Micropterus salmoides*	A, B, C, D	A, B
White crappie	*Pomoxis annularis*	A, B, C, D	B
Black crappie	*Pomoxis nigromaculatus*	A, B, C, D	B
Greenside darter	*Etheostoma blennioides*	A, B, C, D	A, B
Rainbow darter	*Etheostoma caeruleum*	A, B, C, D	A, B
Arkansas saddled darter	*Etheostoma euzonum*	A, B, D	A, B
Golden fantail darter	*Etheostoma flabellare ssp.*	A, B, C, D	A, B
Striped fantail darter	*Etheostoma f. lineolatum*	C	
Yoke darter	*Etheostoma juliae*	A, B, C, D	A, B
Stippled darter	*Etheostoma punctulatum*	A, B, C, D	A, B
Orangethroat darter	*Etheostoma s. spectabile*	A, B, C, D	A, B
Speckled darter	*Etheostoma stigmaeum*	A, B	A, B
Banded darter	*Etheostoma zonale*	A, B, D	A, B
Ohio logperch	*Percina caprodes*	A, B, C, D	A, B
Gilt darter	*Percina evides*	A	A, B
Blackside darter	*Percina maculata*		A
Longnose darter	*Percina nasuta*	A	B
Walleye	*Stizostedion vitreum*	A, B, C, D	B
Freshwater drum	*Aplodinotus grunniens*	A, B, C, D	B
Banded sculpin	*Cottus carolinae*	A, C, D	A, B
Ozark sculpin	*Cottus hypselurus*	A, B, C, D	B

Missouri status: A=collected before 1946, B=collected between 1946 and 1973, C=collected from 1974 to 1990, D=collected from 1991-1998.
Arkansas status: A=collected before 1960, B= collected 1960-87. Source: AR, Robison and Buchanan (1992), and MO, Pflieger (1997).

Table BC02. MDC fish collection summary for the White River watershed by location, date, and method of capture.

Loc. #	Stream name	TRS	Date	KICK	DRAG	ELEC	VISU	TRAP	Number of species				
									L	N	B	H	T
1591	Little North Fork	22N 15W 19	8/23/40	?	X				5	15	9	0	29
1592	Little North Fork	23N 15W 18	9/11/64	X	X				6	13	3	1	23
			6/3/97	X	X	X			8	10	7	0	25
			7/3/98										
1593	Pond Fork	23N 16W 15	5/18/63	X	X				0	4	2	0	6
			7/10/97	X	X	X			2	4	5	0	11
			7/3/98										
1594	Little North Fork	21N 15W 04	6/22/42	?	X				3	13	4	0	20
1595	Big Creek	22N 17W 35	8/30/40	?	X				2	10	1	0	13
			9/29/92	X	X				5	9	5	0	19
1596	Shoal Creek	21N 17W 08	8/2/40	?	X				3	6	4	0	13
			7/4/98	X	X	X			2	7	5	0	14
1597	Cowskin Creek	27N 16W 28	8/30/60	X	X	X			0	2	3	0	5
1598	Beaver Creek	24N 18W 11	8/20/40	?	X				7	12	7	0	26
			9/19/42										
			7/18/82	X	X				3	10	4	0	17

Loc. #	Stream name	TRS	Date	KICK	DRAG	ELEC	VISU	TRAP	Number of species				
									L	N	B	H	T
			9/29/92	X	X				3	11	10	0	24
			7/26/94	X					2	2	9	0	13
			5/28/97	X	X	X			4	11	3	0	18
1599	Beaver Creek	23N 19W 15	8/3/40	?	X				9	15	12	0	36
			9/11/64	X	X				6	13	7	0	26
			9/29/92	X	X				9	13	7	0	29
1600	Beaver Creek	23N 19W 34	7/19/42	?	X				4	6	0	0	10
1601	Roaring River	21N 27W 01	8/7/40	?	X				4	8	3	0	15
			5/29/97	X	X	X			3	6	5	0	14
			7/13/98										
1602	Roaring River	21N 26W 11	8/24/42	?	X				2	2	1	0	5
1603	White River	21N 25W 06	8/7/40	?	X				6	12	5	0	23
1604	White River	22N 25W 22	8/7/40	?	X				11	13	9	0	33
			1/1/46	X	X		X		24	18	17	0	59
1605	Kings River	22N 25W 36	6/23/42	?	X				4	8	6	0	18
1606	Roaring River	21N 26W 09	9/3/65	X	X				5	8	6	0	16
			8/8/95	X	X				8	10	4	0	22

Loc. #	Stream name	TRS	Date	KICK	DRAG	ELEC	VISU	TRAP	Number of species L	N	B	H	T
			5/29/97	X	X	X			6	9	6	0	21
			7/13/98										
1607	Kings River	21N 25W 25	9/10/64	X	X				9	12	7	0	28
1608	Bull Creek	25N 20W 31	7/3/75	X	X				6	14	6	0	26
			4/16/76										
			5/15/97	X	X	X			7	11	6	0	24
			8/6/98										
1609	Bull Creek	24N 21W 14	4/16/76	X	X				6	8	3	0	17
			7/15/98	X	X	X			8	14	6		28
1610	Bull Creek	24N 21W 34	9/10/64	X	X				5	13	7	0	25
			7/10/97	X	X	X			7	14	8	0	29
			7/14/98										
1611	Swan Creek	23N 20W 34	6/20/42	?	X				1	4	4	0	9
			9/10/64	X	X				1	3	5	0	9
1612	White River	23N 20W 33	8/4/40	?	X				5	14	6	0	25
			8/25/42										
			9/11/64	X	X				4	11	3	0	18
1613	White River	22N 20W 33	1/1/46	X	X	X			27	17	16	0	60
1624	Swan Creek	25N	8/2/40	?	X				6	14	5	0	25

Loc. #	Stream name	TRS	Date	KICK	DRAG	ELEC	VISU	TRAP	Number of species: L	N	B	H	T
		19W 27											
			9/18/92	X	X				3	7	7	0	17
			5/16/97	X	X		X		1	3	2	0	6
1625	White River	23N 19W 34	8/4/40	?	X				10	13	6	1	30
1626	White River	22N 23W 09	8/5/40	?		X			11	11	4	0	26
1627	Indian Creek	22N 24W 35	8/5/40	?	X				3	8	7	0	18
1629	Unnamed spring	25N 23W 29	8/6/40	?	X				0	5	3	0	8
1707	White River	22N 24W 26	6/24/42	?	X				5	9	3	0	17
1975	Roark Creek	23N 22W 23	5/16/82	X	X				5	10	4	0	19
			7/10/97	X	X	X			6	9	6	0	21
			7/13/98										
1985	Cane Creek	23N 18W 18	8/3/82	X	X				6	9	5	0	20
			5/28/97	X	X				1	9	5	0	15
			7/4/98										
1986	Beaver Creek	23N 18W 07	8/3/82	X	X				5	11	3	0	19
			7/4/98	X	X	X			8	12	10	0	30
2183	Cowskin	27N 16W	5/14/86		X				0	4	2	0	6

Loc. #	Stream name	TRS	Date	KICK	DRAG	ELEC	VISU	TRAP	Number of species				
									L	N	B	H	T
	Creek	33											
			6/3/97	X	X	X			1	7	2	0	10
			7/3/98										
2184	Woods Fork	25N 21W 15	4/23/84	X			X		0	4	4	0	8
			5/15/97		X	X			0	3	5	0	8
2197	Bear Creek	24N 21W 27	3/21/84	X	X				1	7	5	0	13
			7/10/97	X	X	X			5	15	4	1	25
2227	Little North Fork	23N 15W 33	9/29/92	X	X				6	11	7	0	24
2234	Cowskin Creek	26N 16W 08	3/4/87	X					0	4	7	0	11
			5/20/97	X	X				2	8	3	0	13
			7/3/98										
2314	Barbers Creek	25N 19W 21	9/18/92	X	X				0	7	6	0	13
			5/16/97	X	X	X			0	3	3	0	6
2458	Swan Creek	26N 19W 34	7/27/95	X	X				5	8	5	0	18
			5/16/97	X	X	X			1	2	3	0	6
2506	Bull Creek	25N 20W 08	7/17/82	X	X				5	7	2	0	14
			5/15/97	X	X	X			3	3	4	0	10
2507	Swan Creek	24N 20W 01	5/28/97	X	X	X			9	13	5	0	27

Loc. #	Stream name	TRS	Date	KICK	DRAG	ELEC	VISU	TRAP	Number of species				
									L	N	B	H	T
			7/14/98										
2508	Swan Creek	24N 20W 10	7/18/82	X	X				2	6	3	0	11
			7/14/98	X	X	X			6	11	7	0	24
2509	Beaver Creek	25N 17W 27	5/20/97	X	X	X			3	12	6	0	21
			7/15/98										
2510	Beaver Creek	26N 17W 24	5/20/97	X	X	X			1	9	5	0	15
2511	Little Beaver Creek	25N 18W 15	5/20/97	X	X	X			1	5	5	0	11
2512	Bull Creek	26N 20W 33	7/17/82	X	X				0	7	6	0	13

Method of collection: KICK= kick seining, DRAG= drag seining, ELEC= electrofishing, VISU= visual, TRAP= trap netting.
Number of species: L= large, N= nektonic, B= benthic, H= hybrid, T= total.
*Indicates locations that were sampled during 1997 that had not been previously sampled.
Note: Dates for which no effort or number of species were recorded, have been combined with the samples from the previous date.

Table BC03. Fish species by stream from the Missouri portion of the White River watershed (1940-

Species	Location								
	WF	BU	SW	BA	LB	BE	CO	CA	RR
Phoxinus erythrogaster	X	X	X	X	X	X	X		X
Luxilus pilsbryi	X	X	X	X	X	X	X	X	X
Notropis telescopus		X	X	X		X	X	X	
Luxilus chrysocephalus		X	X			X		X	X
Notropis rubellus		X	X		X	X	X	X	
Notropis nubilus		X	X			X	X	X	X
Notropis ozarcanus						X			
Cyprinella galactura		X	X			X		X	X
Notropis boops		X	X			X			
Notropis greenei		X	X			X		X	
Notropis amblops		X	X			X			
Campostoma sp.	X	X	X		X	X	X	X	X
Campostoma pullum	X	X	X	X	X	X	X	X	X
Campostoma oligolepis	X	X	X			X	X	X	X
Pimephales notatus						X			X
Semotilus atromaculatus		X	X	X				X	X
Erimystax harryi		X	X			X			
Erimyzon oblongus			X						
Nocomis biguttatus		X	X	X		X	X	X	X
Noturus exilis	X	X	X	X		X	X	X	
Noturus albater		X	X			X			X
Noturus flavater						X			
Ameiurus natalis			X			X			
Ictalurus punctatus						X			
Pylodictis olivaris						X			
Cottus carolinae	X	X	X	X	X	X	X		X
Cottus hypselurus	X	X			X	X			X

Species	Location								
	WF	BU	SW	BA	LB	BE	CO	CA	RR
Labidesthes sicculus		X				X			X
Percina c. caprodes		X	X			X		X	X
Percina evides						X			
Etheostoma flabellare	X	X	X	X	X		X	X	X
Etheostoma s. spectabile	X	X	X	X	X	X	X	X	X
Etheostoma caeruleum		X	X	X	X	X	X	X	X
Etheostoma juliae		X	X			X			
Etheostoma zonale		X				X		X	
Etheostoma blennoides		X	X			X		X	X
Etheostoma e. euzonum						X			
Etheostoma punctulatum		X		X		X	X		X
Etheostoma f. lineolatum							X		
Fundulus catenatus		X	X	X	X	X	X	X	X
Fundulus olivaceus		X	X			X	X	X	X
Gambusia affinis					X				
Lepomis macrochirus	X	X			X	X		X	
Lepomis megalotis	X	X			X	X	X	X	
Lepomis cyanellus	X	X			X		X	X	
Micropterus dolomieui	X	X			X	X	X	X	
Micropterus salmoides	X	X			X	X	X	X	
Micropterus punctulatus					X	X		X	
Ambloplites constellatus	X	X			X		X		
Pomoxis nigromaculatus	X	X							
Hypentelium nigricans	X	X		X	X		X	X	
Moxostoma duquesnei	X	X			X				
Moxostoma erythrurum					X				
Catostomus commersoni								X	
Lepisosteus osseus					X				

Species	Location								
	WF	BU	SW	BA	LB	BE	CO	CA	RR
Esox americanus	X	X							
Dorosoma cepedianum					X				
Oncorhynchus mykiss	X							X	
Lampetra aepyptera						X			
Carassius auratus		X							
Phoxinus erythrogaster						X	X	X	X
Luxilus pilsbryi	X	X	X	X	X	X	X	X	X
Notropis telescopus	X			X		X	X	X	
Luxilus chrysocephalus			X			X	X	X	
Notropis rubellus			X	X		X		X	
Notropis nubilus	X	X	X	X	X	X	X	X	
Notropis ozarcanus			X			X			
Cyprinella galactura	X	X	X	X	X	X	X	X	
Cyprinella whipplei			X	X					
Notropis boops			X	X		X	X		
Notropis greenei			X	X	X	X	X		
Notropis amblops	X	X	X			X	X		
Campostoma sp.		X					X	X	X
Campostoma pullum	X	X	X		X	X	X	X	X
Campostoma oligolepis	X		X	X	X	X	X	X	X
Pimephales notatus	X		X	X			X		
Pimephales t. parviceps		X							
Erimystax harryi			X	X	X				
Nocomis biguttatus	X	X	X		X	X	X	X	X
Notemigonus crysoleucas			X			X			
Cyprinus carpio			X						
Noturus exilis	X	X	X			X	X	X	
Noturus albater			X			X			

Species	Location								
	WF	BU	SW	BA	LB	BE	CO	CA	RR
Noturus flavater			X						
Ameiurus natalis			X			X			
Ameiurus melas			X						
Ictalurus punctatus			X						
Ictalurus furcatus			X						
Pylodictis olivaris			X						
Cottus carolinae	X	X	X		X	X	X	X	X
Cottus hypselurus						X			
Labidesthes sicculus			X	X		X			
Percina c. caprodes			X	X		X	X		
Percina evides			X	X					
Percina nasuta			X						
Etheostoma flabellare							X	X	
Etheostoma spectabile	X	X	X			X	X	X	X
Etheostoma caeruleum	X	X	X	X	X	X	X	X	X
Etheostoma juliae			X	X	X	X			
Etheostoma zonale			X	X	X	X			
Etheostoma blennoides	X		X	X	X	X	X		
Etheostoma e. euzonum			X		X	X			
Etheostoma punctulatum		X	X			X		X	X
Etheostoma stigmaeum			X	X					
Stizostedion vitreum			X						
Fundulus catenatus	X	X	X	X	X	X	X	X	X
Fundulus olivaceus	X	X	X	X		X	X	X	X
Lepomis macrochirus	X		X	X		X	X	X	
Lepomis megalotis	X	X	X	X	X	X	X	X	X
Lepomis cyanellus		X	X		X	X		X	
Lepomis miniatus						X			

Species	Location								
	WF	BU	SW	BA	LB	BE	CO	CA	RR
Lepomis gulosus			X						
Micropterus dolomieui	X	X	X	X	X	X	X	X	
Micropterus salmoides	X	X	X	X		X		X	
Micropterus punctulatus Ambloplites constellatus Pomoxis annularis Pomoxis nigromaculatus	X		X X X X	X		X X	X	X	
Hypentelium nigricans	X	X	X	X		X	X	X	X
Moxostoma duquesnei			X	X		X			
Moxostoma carinatum			X	X					
Moxostoma erythrurum			X	X					
Catostomus commersoni			X					X	
Carpiodes carpio			X						
Carpiodes cyprinus			X						
Carpiodes velifer			X						
Ictiobus cyprinellus			X						
Lepisosteus osseus			X						
Lepisosteus platostomus			X						
Polyodon spathula			X						
Aplodinotus grunniens			X						
Dorosoma cepedianum			X	X				X	
Dorosoma petenense			X						
Hiodon tergisus			X						
Anguilla rostrata			X						
Ichthyomyzon ammocoete			X						
Erimyzon oblongus						X			

Table BC04. Mussels and snails

Scientific name/Genus Species	Common name	MO* status	AR** status
Actinonaias ligamentina carinata	Mucket	A	D
Alasmidonta viridis	Slippershell mussel	A	
Amblema plicata	Threeridge	A, B2	D
Antrobia culveri	Tumbling Creek cavesnail	C	
Campeloma subsolidum	Highland campeloma		D
Cyclonaias tuberculata	Purple wartyback	A	D
Cyprogenia aberti	Western fanshell	A	D
Elimia potosiensis	Pyramid elimia	C	D
Ellipsaria lineolata	Butterfly	A	
Elliptio crassidens	Elephant ear	A	
Elliptio dilatata	Spike	A	D
Epioblasma florentina curtisi	Curtis pearlymussel	A	
Ferrissia rivularis	Creeping ancylid		D
Fusconaia flava	Wabash pigtoe	A	D
Fusconaia ozarkensis	Ozark pigtoe	A, B2	D
Fusconaia ebena	Ebonyshell	A	
Helisoma trivolvis	Marsh ramshorn	C	D
Laevapex sp.			D
Lampsilis reeviana brevicula	Ozark broken-ray	A, B	D
Lampsilis reeviana reeviana	Arkansas broken-ray		D
Lampsilis cardium	Plain pocketbook	A, B	D
Lampsilis siliquoidia	Fatmucket	A, B1	D
Lampsilis	Neosho mucket	A	
rafinesqueana	Yellow sandshell	A	
Lampsilis teres	Pink mucket	A	
Lasmigona costata	Fluted-shell	A	D
Leptodea fragilis	Fragile papershell	B2	D
Leptodea leptodon	Scaleshell	A	

Scientific name/Genus Species	Common name	MO* status	AR** status
Ligumia subrostrata	Pondmussel		D
Ligumia recta	Black sandshell	A	D
Lymnaea (Fossaria) modicella	Rock fossaria	C	
Obliquaria reflexa	Threehorn wartyback	A	
Obovaria olivaria	Hickorynut	A	
Physa (Physella) heterostropha	Pewter physa	C	
Physa (Physella) gyrina	Tadpole physa	C	D
Physa (Physodon) anatina	Duck physa	C	
Pleurobema sintoxia	Round pigtoe	A	D
Pleurobema cordatum	Ohio pigtoe		D
Pleurocera acuta	Sharp hornsnail	C	
Pomatiopsis lapidaria	Slender walker	C	
Potamilus purpuratus	Bleaufer	A, B2	D
Ptychobranchus occidentalis	Ouchita kidneyshell	A, B	D
Pyganodon grandis grandis	Giant floater	B1	D
Quadrula cylindrica cylindrica	Rabbitsfoot	A	D
Quadrula pustulosa	Pimpleback	A	
Quadrula nodulata	Wartyback	A	
Somatogyrus sp.	Pebblesnail		D
Sphaerium sp.	Fingernail clam		D
Strophitus undulatus	Squawfoot	A, B	D
Toxolasma parvus	Lilliput	A	D
Toxolasma lividus	Purple lilliput	A, B	D
Tritogonia verrucosa	Pistol grip	A	D
Truncilla donaciformis	Fawnsfoot	A	
Truncilla truncata	Deer-toe	B2	
Uniomerus tetralasmus	Pondhorn	D	
Utterbackia imbecillis	Paper pondshell	A, B2	D
Venustaconcha pleasi	Bleedingtooth mussel	D	

Scientific name/Genus Species	Common name	MO* status	AR** status
Villosa iris	Rainbow	A, B	
Villosa lienosa	Little spectaclecase	A	

**D=all Arkansas collections were made between 1978 and 1981.
1=observations from divers in Table Rock Lake
2=observations by divers in Bull Shoals Lake.
Source: Oesch (1996), Buchanan (1996), Gordon (1980; 1982), Gordon, Oesch, and Wu (1997), Roberts, A., USFWS, pers. comm., and Barnhart, C.,
Southwest Missouri State University, pers. comm.

Table BC05. Crayfish found in the Missouri portion of the White River watershed.

Scientific name	Common name	Period last collected*
Cambarus hubbsi	Hubb's crayfish	B
Orconectes longidigitus	Longpincered crayfish	A, B
Orconectes meeki	Meek's crayfish	B
Orconectes neglectus	Ringed crayfish	A, B
Orconectes ozarkae	Ozark crayfish	A ,B
Orconectes punctimanus	Spothanded crayfish	B
Orconectes virilis	Northern crayfish	A, B
Orconectes williamsi	Williams' crayfish	B

* A=collected prior to 1970, B=collected after 1970 Source: Pflieger (1996).

Table BC06. Aquatic invertebrates in the Missouri portion of the White River watershed.

Order	Family	Species	Location*				
			1	2	3	4	5
Plecoptera	Nemouridae				X		
		Nemoura sp.	X	X	X		
		Brachyptera sp.					
		Strophopteryx fasciata			X		
		Taeniopteryx sp.	X				
		Paracapnia sp.	X	X	X		
		Paragnetina sp.		X			
		Perlomyia sp.		X			
		Acroneuria sp.			X		
		Acroneuria arida		X	X		
		Acroneuria frisoni			X		
		Perlesta placida	X	X	X		
		Perlesta sp.	X	X	X		
		Isogenus sp.			X		
		Isoperla sp.	X	X	X		
		Isoperla bilineata/richardsoni	X	X	X		
		Isoperla maylynia				X	
		Isoperla signata			X		
		Isoperla mohri frison				X	
		Isoperla ouachita				X	X
		Paraperla sp.	X	X	X		
		Alloperla sp.				X	X
		Amphinemura sp.				X	X
	Chloroperlidae				X		
		Neoperla sp.				X	
	Leuctridae					X	X
		Leucrocuta sp.				X	X

Order	Family	Species	Location*				
			1	2	3	4	5
		Zealuctra sp.				X	
	Perlidae					X	
		Hydroperla sp.			X		
		Perlinella		X			
Ephemeroptera		*Acentrella sp.*			X		
		Serratella sp.		X			
		Eurylophella (bicolor gp.)			X		
	Baetidae	*Baetis sp.*	X	X	X	X	X
		Baetis flavistriga					X
		Baetis tricaudatus					X
		Pseudocloeon sp.	X	X	X		
		Ephemera					X
		Stenacron sp.				X	X
		Stenacron (interpunctatum gp.)			X		
		Stenacron gildersleevei		X			
	Heptageniidae						X
		Stenonema pulchellum	X	X	X	X	
		Stenonema nepotellum	X	X	X		
		Heptagenia sp.		X	X		
		Stenonema tripunctatum		X	X		
		Stenonema interpunctatum		X	X		
		Stenonema gildersleevei		X	X		
		Stenonema mediopunctatum			X	X	X
		Stenonema vicarium				X	
		Stenonema bednariki				X	
		Stenonema (undescribed sp.)		X			
		Rhithrogena sp.			X		
	Siphlonuridae	*Isonychia sp.*	X	X	X		

Order	Family	Species	Location*				
			1	2	3	4	5
		Isonychia bicolor	X			X	X
		Siphlonurus sp.				X	
		Siphlonurus minnoi			X		
	Ephemerellidae	*Ephemerella (bicolor gp.)*		X	X	X	
		Ephemerella (invaria gp.)		X	X		
		Ephemerella (serrata gp.)	X	X	X	X	X
	Leptophlebiidae	*Paraleptophlebia sp.*		X	X	X	X
		Leptophlebia sp.		X	X	X	X
		Choroterpes sp.	X	X		X	
	Tricorythodidae	*Tricorythodes sp.*	X	X	X	X	X
	Caenidae	*Caenis sp.*	X	X	X	X	
		Caenis anceps				X	
		Caenis latipennis				X	
Trichoptera	Glossosomatidae	*Agapetus sp.*	X	X	X	X	
	Hydropsychidae	*Cheumatopsyche sp.*	X	X	X		X
		Hydropsyche (bifida gp.)	X	X	X		
		Hydropsyche (morosa gp.)			X		
		Hydropsyche piatrix			X		
	Brachycentridae	*Brachycentrus sp.*	X	X	X		
		Brachycentrus americanus			X		
	Ryacophilidae				X		
		Rhyacophila sp.	X	X	X		
	Psychomyiidae	*Polycentropus sp.*	X	X	X		
	Helicopsychidae	*Helicopsyche sp.*		X	X		X
		Helicopsyche borealis			X		
	Philopotamidae	*Chimarra aterrima*	X	X	X		
		Chimarra obscura	X	X	X		
		Chimarra sp.					X

Order	Family	Species	Location*				
			1	2	3	4	5
	Hydroptilidae	*Agraylea sp.*	X	X			
	Limnophilidae	*Caborius sp.*	X				
	Libellulidae	*Somatochlora ozarkensis*	X				
		other Libellulids	X				
	Lestidae	*Archilestis sp.*	X				
		other Lestidae	X				
	Coenagrionidae	*Telebasis/Enallagma*	X				
		other Coenagrionids	X	X			
	Gomphidae	*Hydroptila sp*		X	X		
		Ironquia sp.		X	X		
		Lepidostoma sp		X			
		Mystacides sp.		X			
		Pycnopsyche		X	X		
		Triaenodes sp.		X			
	Leptoceridae	*Oecetis sp.*		X			
	Psychomyiinae	*Psychomyia sp.*				X	
	Polycentropodinae	*Polycentropus sp.*				X	
Coleoptera	Elmidae	*Optioservus sp.*	X	X	X	X	X
		Optioservus sandersoni collier			X		
		Stenelmis sp.	X	X	X	X	X
		Elimia				X	X
		Dubiraphia				X	
		sp.				X	X
	Psephenidae	*Psephenus sp.*	X	X	X	X	X
		Psephenus herriki			X	X	
		Ectopria sp.			X	X	
		Ectopria nervosa			X	X	
	Curculionidae	*Onychylis sp.*	X				

Order	Family	Species	Location*				
			1	2	3	4	5
	Haliplidae	*Peltodytes edenti*	X				
	Dytiscidae				X		
		Laccophilus fasciatus	X				
		Laccophilus maculosus	X				
		Laccophilus proximus	X				
		Laccophilus sp.				X	
		Oreodytes/Deronectes	X				
		Hydroporus niger	X	X			
		Hydroporus undulatus	X				
		Hydroporus sp.			X		
		Dytiscus sp.	X				
		Eretes sp.			X		
		other Dytiscids	X				
	Hydrophilidae			X			
		Berosus sp.	X				
		Tropisternus sp.	X				
		Helochares sp.	X				
		other Hydrophilids	X	X			
	Helichus sp.	*Helichus sp.*				X	
		Lutrochus laticeps.				X	
	Limnebiidae	*Hydraena sp.*				X	X
	Helodidae	*Scirtes sp.*				X	X
	Gyrinidae	*Gyrinus sp.*				X	
	Salpingidae					X	
	Sphaeriidae	*Spaerium sp.*					X
Odonata					X		
	Gomphidae			X			
		Perithemis sp.	X				

Order	Family	Species	Location*				
			1	2	3	4	5
		Argia sp.	X			X	
		Stylogomphus albistylus				X	X
	Aeshnidae	*Basiaeschna sp.*				X	
		Boyeria sp.				X	X
		Gomphus sp.				X	
		Hagenius brevistylus				X	
	Macromiidae	*Macromia sp.*				X	
Zygoptera	Calopterygidae	*Calopteryx maculata*				X	
		Calopteryx sp.					X
		Hetaerina sp.					X
	Coenagrionidae	*Enallagma sp.*					X
Diptera	Chironomidae		X	X	X		
		Labrudia sp.					X
		Zavrelimyia sp.					X
	Chironominae	*Ablabesmyia sp.*				X	
		Procladius sp.				X	
		Cryptochironomus sp.				X	X
		Dicrotendipes sp.				X	
		Paratendipes sp.				X	X
		Polypedilum convitum grp.				X	X
		Polypedilum fallax grp.				X	
		Polypedilum illinoense grp.				X	X
		Polypedilum scalaenum grp.				X	X
		Stictochironomus sp.				X	
		Stenochironomus sp.					X
		Cladotanytarsus sp.				X	X
		Tribelos sp.				X	X
		Micropsectra sp.				X	X

Order	Family	Species	Location*				
			1	2	3	4	5
		Paratanytarsus				X	X
		Rheotanytarsus sp.				X	X
		Corynoneura sp.				X	X
		Eukiefferiella				X	X
		Cricotopus/Othrocladius				X	X
		Hydrobaenus				X	
		Potthastia sp.				X	
		Sympotthastia sp.				X	X
		Microtendipes sp.				X	X
		Chironomus sp.					X
	Empididae		X	X	X	X	
		Hemerodromia sp.				X	
		Clinocera sp.				X	
	Simuliidae		X	X	X		
		Simulium sp.				X	X
	Tanyderidae	*Protoplasa sp.*			X		
		Protoplasa fitchii osten-sacken			X		
	Tabanidae				X		
		Chrysops/Tabanus	X	X	X	X	
	Rhagionidae	*Atherix sp.*	X	X	X		
		Atherix lantha webb		X			
	Ceratopogonidae				X	X	X
		Bezzia/Probezzia	X	X	X		
		Ceratopigonid pupae	X	X	X		
	Ceratopogoninae						X
	Culicidae	*Anophles sp.*		X			
		other Culicids	X				
		Culex sp.	X				

Order	Family	Species	Location*				
			1	2	3	4	5
	Chaoboridae		X				
	Tipulidae			X			
		Tipula sp	X	X	X		
		Eriocera/Hexatoma	X	X	X		X
		Antocha sp.	X		X		
		Erioptera sp.	X				
	Muscidae		X		X		
	Psychodidae	*Psychoda sp.*	X				
		Pericoma sp.	X				
	Stratiomyidae				X		
		Nemotelus				X	
	Diamesinae	*Diamesa sp.*				X	
	Pentaneurini	*Nilotanypus sp.*				X	
		Paramerina sp.				X	X
		Thienemannimyia grp.				X	X
	Tanytarsini	*Stempellinella sp.*				X	X
		Tanytarsus sp.				X	X
	Orthocladiinae	*Orthocladius sp.*				X	X
		Parametriocnemus sp.				X	X
		Rheocricotopus sp.				X	
		Thienemanniella sp.				X	
		Brillia sp.					X
		Cardiocladius sp.					X
		Synorthocladius sp.					X
	Ephydridae						X
	Dixidae	*Dixella sp.*					X
	Forcipomyiinae						X
Megaloptera	Corydalidae	*Corydalus sp.*		X	X		X

Order	Family	Species	Location*				
			1	2	3	4	5
		Corydalus cornutus			X		
		Nigronia sp.			X		
		Nigornia serricornis		X		X	X
	Sialidae	*Sialis sp.*		X		X	X
Lepidoptera			X				
Hemiptera	Gerridae	*Trepobates sp.*	X				
		other Gerrids	X				
	Mesoveliidae	*Mesovelia sp.*	X				
	Corixidae		X				
	Veliidae				X		
		Microvelia sp.	X		X		X
		Rhagovelia sp.		X			
		other Veliids	X				
	Notonectidae		X				
	Saldidae		X				
	Belostomatidae	*Belostoma sp.*					X
			X	X	X		
	Branchiobdellidae			X	X		X
Haplotaxida	Enchytraeidae					X	
	Glossoscolecidae	*Limnodrilus sp.*				X	X
		Limnodrilus augustinpennis				X	
		Limnodrilus hoffmeisteri				X	X
Lumbriculida	Lumbriculidae					X	X
	Lumbricidae						X
			X				
ACARI				X	X		
Amphipoda	Gammuridae	*Gammarus sp.*	X		X	X	X
		Gammarus fasciatus say			X		

Order	Family	Species	Location*				
			1	2	3	4	5
		Crangonyx sp				X	X
		Stygonectes/Sttygobromus				X	
	Talitridae	*Hyalella azteca*				X	X
Isopoda		*Asellus sp.*	X				
		Lirceus sp.	X			X	X
Gastropoda	Pleuroceridae	*Helisoma sp.*				X	
	Planariidae		X	X	X	X	X
			X		X		
Gordiida			X				
	Physidae	*Physa sp.*	X	X			
	Ancylidae					X	
		Ferrissia sp.	X	X		X	X
	Planorbidae		X	x		x	
	Valvatidae	*Valvata sp.*	X				
	Pleuroceridae	*Goniobasis sp.*	X	X			
	Sphaeriidae		X				
Branchiura		*Branchuiura sowerbyi*				X	

Table BC07. Amphibians and reptiles found in the Missouri portion of the White River watershed.

Scientific Name	Common Name	County*
Acris crepitans blanchardi	Blanchard's cricket frog	ALL
Agkistrodon contortix phaeogaster	Osage copperhead	B, C, D, O, S, T, WE
Agkistrodon piscivorus leucostoma	Western cottonmouth	C, O, S
Ambystoma annulatum	Ringed salamander	C, O, S, T
Ambystoma maculatum	Spotted salamander	B, C, S, T
Ambystoma t. tigrinum	Eastern tiger salamander	B, T
Bufo americanus	Eastern American toad	ALL
Bufo woodhousei	Woodhouse's toad	B
Carphophis amoenus vermis	Western worm snake	ALL
Cemophora coccinea copei	Northern scarlet snake	S
Chelydra s. serpentina	Common snapping turtle	B, O, S
Chrysemys picta bellii	Western painted turtle	O
Cnemidophorus sexlineatus	Six-lined racerunner	ALL
Coluber constrictor flaviventris	Eastern yellowbelly racer	B, D, O, S, T, WE, WR
Crotalus horridus	Timber rattlesnake	B, C, D, S
Crotaphytus c. collaris	Eastern collard lizard	B, C, O, S, T
Diadophis punctatus arnyi	Prairie ringneck snake	B, C, D, O, S, T, WR
Elaphe guttata emoryi	Great plains rat snake	B, C, O, S, T, WR
Elaphe o. obsoleta	Black rat snake	ALL
Eumeces anthracinus pluvialis	Southern coal skink	ALL
Eumeces fasciatus	Five-lined skink	ALL
Eumeces laticeps	Broadhead skink	B, S
Eurycea longicauda	Longtail salamander	B, C, D, O, S, T, WR
Eurycea lucifuga	Cave salamander	B, C, D, O, S, T, WR
Eurycea multiplicata griseogaster	Graybelly salamander	B, C, S, T
Eurycea tynerensis	Oklahoma salamander	B, S, T
Gastrophryne carolinensis	Eastern narrowmouth toad	B, C, O, S, T
Graptemys geographica	Map turtle	B, C, D, O, S, WE,

Scientific Name	Common Name	County*
		WR
Graptemys p. pseudogeographica	False map turtle	S
Heterodon platyrhinos	Eastern hog snake	B, C, O, S, T, WR
Hyla chrysoscelis	Gray treefrog	B, D, T
Hyla crucifer crucifer	Northern spring peeper	B, D, O, S, T
Kinosternon flavescens	Yellow mud turtle	B
Lampropeltis c. calligaster	Prairie kingsnake	B, S, T
Lampropeltis getulus holbrooki	Speckled kingsnake	B, C, O, S, T
Lampropeltis triangulum syspila	Red milk snake	B, C, O, S, T, WE
Macroclemys temminckii	Alligator snapping turtle	T
Masticophis f. flagellum	Eastern coachwhip	B, O, S, T, WE
Necturus maculosus	Mudpuppy	C, D, O, S
Nerodia erythrogaster flavigaster	Yellowbelly water snake	S
Nerodia s. sipedon	Northern watersnake	B, C, O, S, T, WE, WR
Notophthalmus viridescens louisianensis	Central newt	B, C, D, O, S
Opheodrys aestivus	Rough green snake	ALL
Ophisaurus a. attenuatus	Western slender glass lizard	S
Phrynosoma cornutum	Texas horned lizard	B
Pituophis melanoleucus sayi	Bullsnake	B, S, T, WR
Plethodon dorsalis angusticlavius	Ozark zigzag salamander	B, C, D, O, S, T
Plethodon g. glutinosus	Slimy salamander	ALL
Pseudacris triseriata	Western chorus frog	B, C, O, T
Pseudemys concinna metteri	Missouri river cooter	O, S
Rana catesbeiana	Bullfrog	ALL
Rana clamitans	Green frog	B, C, D, S, T
Rana palustris	Pickerel frog	ALL
Rana spenocephala	Southern leopard frog	ALL
Rana sylvatica	Wood frog	B, S
Sceloporus undulatus hyacinthinus	Northern fence lizard	ALL

Scientific Name	Common Name	County*
Scincella lateralis	Ground skink	ALL
Sistrurus miliarius streckeri	Western pygmy rattlesnake	B, C, D, O, S, T
Sonora semiannulata	Ground snake	C, O, S, T
Sternotherus odoratus	Stinkpot	O, WE, WR
Storeria dekayi wrightorum	Midland brown snake	B, D, O, S, T, WE
Storeria o. occipitomaculata	Northern redbelly snake	ALL
Tantilla gracilis	Flathead snake	B, C, O, S, T, O, WR
Terrapene carolina triunguis	Three-toed box turtle	ALL
Terrapene o. ornata	Ornate box turtle	B, C, WE
Thamnophis p. proximus	Western ribbon snake	C, S, T, WE, WR
Thamnophis s. sirtalis	Eastern garter snake	C, D, S
Trachemys scripta elegans	Red-eared slider	O, S
Trionyx m. muticus	Midland smooth softshell	S
Trionyx s. spinifer	Eastern spiny softshell	D, O, S, T
Typhlotriton spelaeus	Grotto salamander	B, C, D, O, S, T, WR
Virginia striatula	Rough earth snake	B, C, D, O, S, T
Virginia valeriae elegans	Western earth snake	ALL

Location*: 1= Prairie Creek, 2= Cowskin Creek, 3= Beaver Creek, 4= Bull Creek, 5= Roaring River.
Source: Duchrow (1976; 1978), MDNR (1998c) and MDC (1998).
*Collections indicate presence at the county level.
B= Barry, C= Christian, D= Douglas, O= Ozark, S= Stone, T= Taney, WE= Webster, WR= Wright, ALL= All counties Source: Johnson (1997).

Table BC08. Species of conservation concern in the White River watershed.

Scientific Name	Common Name	MO* rank	AR* rank	Federal* rank
Mosses				
Bryum cyclophyllum	a moss	S?		
Diacranum polysetum	a moss	S1		
Didymodon rigidulus	a moss	S1		
Ephemerum cohaerens	Emerald dewdrops	S1		
Fontinalis sphagnifolia	a moss	S1		
Forsstroemia producta	a moss	S1		
Pseudotaxiphyllum distichaceum	a moss	S?		
Seligeria calcarea	a moss	S?		
Tortula papillosa	a moss	S?		
Ferns				
Cheilanthes alabamensis	Alabama lip-fern	S1		
Flowering Plants				
Acer nigrum	Black maple		S1	
Agalinis skinneriana	a false foxglove	S3		
Allium stellatum	Glade onion		S2	
Amorpha canescens	Leadplant		S2	
Asclepias incarnata	Swamp milkweed		S2	
Aster furcatus	Forked aster	S2		
Astragalus crassicarpus	Ground plum		S2	
Astranthium integrifolium	Western daisy	S2		
Brickellia grandiflora	Tassel flower		S2	
Callicarpa americana	French mulberry	S1		
Callirhoe bushii	Bush's poppy mallow	S2	S3	
Carex aquatilis var. aquatilis	Water sedge	S1		
Carex bicknellii var. opaca	a sedge		S2	
Carex cherokeensis	Cherokee sedge	S2		

Scientific Name	Common Name	MO* rank	AR* rank	Federal* rank
Carex crawei	Crawe's sedge		S3	
Carex hystericina	Porcupine sedge		S4	
Carex laxiculmis	Spreading sedge	S2		
Carex microdonta	a sedge		S1	
Carex prasina	Drooping sedge		S1	
Carex stricta	Upright sedge		S1	
Carex suberecta	a sedge		S2	
Castanea pumila var. ozarkensis	Ozark chinquapin	S2	S3	
Chaetopappa asteroides	Common leastdaisy	S2		
Cissus incisa	Marine vine	S2		
Collinsia verna	Spring blue-eyed mary		S1	
Cypripedium kentuckiense	Southern lady's-slipper		S3	
Delphinium treleasei	Trelease's larkspur		S3	
Desmodium cuspidatum	Tick-treefoil		SU	
Echinacea paradoxa	Bush's yellow coneflower		S2	
Echinacea angustifolia	Narrow-leaved coneflower	S1		
Eriocaulon kornickianum	Small-headed pipewort		S2	
Eriogonum longifolium	Umbrella plant	S2		
Euonymus obovatus	Running strawberry-bush		S3	
Evolvulus nuttallianus	an evolvulus		S3	
Fragaria vesca var. americana	Woodland strawberry	S1		
Gentiana puberulenta	Downy gentain		S2	
Glyceria acutiflora	Sharp-scaled manna grass	S3		
Heuchera villosa var. arkansana	Arkansas alumroot		S3	

Scientific Name	Common Name	MO* rank	AR* rank	Federal* rank
Hottonia inflata	Featherfoil	S2		
Juniperus ashei	Ashe's juniper		S3	
Leavenworthia uniflora	a leavenworthia		S3	
Liatris scariosa var. nieuwlandii	a blazing star	S2		
Lilium superbum	Turk's-cap lily		S1	
Lithospermum incisum	Narrow-leaved puccoon		S2	
Marshallia caespitosa var. signata	Marshallia	S1	S2	
Mentha arvensis	Field mint		S1	
Minuartia drummondii	Drummond's sandwort		S2	
Minuartia michauxii	Rock sandwort		S1	
Muhlenbergia bushii	Bush's muhly		S2	
Opuntia macrorhiza	Low prickly pear	S2		
Orobanche ludoviciana	a broomrape	S1		
Panicum portoricense	a panic grass	S1		
Penstemon cobaea var. purporea	Purple beardtongue		S3	
Perideridia americana	Perideridia		S2	
Phlox bifida ssp. stellaria	Bifid phlox	S1		
Phlox bibida ssp. bifida	Sand phlox		S3	
Phyllanthus polygonoides	Knotweed leaf-flower	S1	S1	
Plantago cordata	Heart-leaved plantain		S2	
Platanthera clavellata	Green wood orchid	S2		
Psoralea esculenta	Indian scurf-pea		S2	
Rhynchospora capillacea	Capillary beak rush		S2	
Salvia reflexa	Lance-leaved sage		SH	
Sapindus drummondii	Soapberry	S2		
Silene regia	Royal cathchfly		S2	
Silene ovata	Ovate-leaf catchfly		S2	

Scientific Name	Common Name	MO* rank	AR* rank	Federal* rank
Royal catchfly	Starry false Solomon's seal		S1	
Spiranthes odorata	Sweetscent ladies'-tresses		S1	
Sporobolus airoides	Alkali sacaton	S1		
Stenanthium gramineum	Eastern featherbells		S3	
Stenosiphon linifolius	Stenosiphon	S2	S1	
Stylophorum diphyllum	Celandine poppy		S1	
Tradescantia ozarkana	Ozark spiderwort	S2		
Tragia ramosa	a noseburn	S2		
Trifolium stoloniferum	Running buffalo clover	S1		
Trillium pusillum	Ozark wake robin	S2	S3	
Triodanis lamprosperma	a venus' looking glass	S2		
Ulmus thomasii	Rock elm		S2	
Valerianella ozarkana	Ozark corn salad	S2	S3	
Veratrum woodii	Wood's false hellebore		S3	
Waldsteinia fragarioides	Barren strawberry		S1	
Yucca arkansana	Arkansas yucca	S2		
Zannichellia palustris var. major	Horned pondweed		S2	
Insects				
Allocapnia jeanae	a winter stonefly		S1	
Allocapnia ozarkana	a winter stonefly		S1?	
Alloperla leonarda	a spring stonefly	S3		
Alloperla hamata	a spring stonefly	S3		
Calephelis borealis	Northern metalmark	S2/S3		
Gryllotalpa major	Prairie mole cricket		S?	
Neochlamisus tuberculatus	a leaf beetle	S3		
Pseudosinella espana	a springtail	S3		
Rhadine ozarkensis	a ground beetle		S1	

Scientific Name	Common Name	MO* rank	AR* rank	Federal* rank
Speyeria diana	Diana fritillary	SU		
Crustaceans				
Caecidotea ancyla	an isopod		S1	
Caecidotea steevesi	an isopod		S1	
Caecidotea stiladactyla	an isopod		S1	
Oroconectes meeki	Meek's crayfish	S1		
Oroconectes williamsi	William's crayfish	S1		
Stygobromus ozarkensis	Ozark cave amphipod	S3		
Millipedes				
Scoterpes dendropus	a cave millipede	S2?		
Mollusks				
Antrobia culveri	Tumbling Creek cavesnail	S1	C	
Toxolasma lividus	Purple lilliput	S2?		
Amphibians				
Ambystoma annulatum	Ringed salamander	S3	S4	
Bassariscus astutus	Ringtail		SA	
Rana sylvatica	Wood frog	S3	S4	
Reptiles				
Cemophora coccinea copei	Northern scarlet snake	S2		
Crotaphytus collaris collaris	Eastern collared lizard	S4		
Eumeces obsoletus	Great plains skink		S1	
Macroclemys temminckii	Alligator snapping turtle	S2		
Phrynosoma cornutum	Texas horned lizard	S2		
Terrapene ornata ornata	Ornate box turtle		S2	
Thamnophis radix	Plains garter snake		S1	
Fish				
Amblyopsis rosae	Ozark cavefish		S1	

Scientific Name	Common Name	MO* rank	AR* rank	Federal* rank
Carpiodes velifer	Highfin carpsucker	S2		
Crystallaria asprella	Crystal darter		S2	
Cyprinella camura	Bluntface shiner		SH	
Lampetra appendix	American brook lamprey		S2	
Notropis ozarkanus	Ozark shiner	S2		
Noturus flavater	Checkered madtom	S3		
Percina nasuta	Longnose darter	S1	S2	
Pimephales tenellus parviceps	Eastern slim minnow	S2		
Birds				
Accipter cooperii	Cooper's hawk	S3		
Accipter striatus	Sharp-shinned hawk	S2		
Aimophila aestivalis	Bachman's sparrow	S1		
Ammodramus savannarum	Grasshopper sparrow		S3	
Ardea herodias	Great blue heron	S5	S3	
Coragyps atratus	Black vulture	S3		
Geococcyx californianus	Greater roadrunner	S3		
Haliaeetus leucocephalus	Bald eagle	S2	S2	T
Limnothlypis swainsonii	Swainson's warbler	S1	S3	E
Thryomanes bewickii	Bewick's wren		S2	
Vermivora pinus	Blue-winged warbler		S3	
Mammals				
Corynorhinus rafinesquii	Rafinesque's big-eared bat		S2	
Corynorhinus townsendii ingens	Ozark big-eared bat		S1	E
Felis concolor coryi	Florida panther		S1	E
Mustela frenata	Long-tailed weasel	S2		
Myotis grisescens	Gray myotis	S3	S2	E
Myotis leibii	Eastern small-footed	SU		

Scientific Name	Common Name	MO* rank	AR* rank	Federal* rank
	myotis			
Myotis sodalis	Indiana myotis	S1	S2	E
Sorex longirostris	Southeastern shrew		S2	
Spilogale putorius interrupta	Plains spotted skunk	S1		
Ursus americanus	Black bear	S3		
Vulpes vulpes	Red fox		S4	

*Federal listingsC= candidate, T= threatened, E= endangered.
*Missouri and Arkansas listingsS1= critically imperiled because of extreme rarity and especially vulnerable to extirpation from the state, S2= imperiled because of rarity making it vulnerable to extirpation from the state, S3= rare and uncommon in the state, S4= widespread, abundant, and secure in the state, with many occurrences, but under longterm concern, SA= accidental, SU= unrankable, possibly in peril, but status uncertain, SH= historical, element occurred historically with expectation that it may be rediscovered, S?= unranked.
Note: State rank indicates that a particular species occurs in that state's portion to the watershed. Some species only ranked by one state in the table may be ranked in the other state, but are not known to occur in that state's portion of the watershed.
Source: Missouri Department of Conservation (1998), Arkansas Natural Heritage Commission (1997).
Note: Fish sample site numbers reference Table BC02 and USGS gage station numbers reference Table HY01.

- 7053500
- 7053810
- 7054080

Streams and impoundments White River Watershed

Management Problems and Opportunities

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

This section includes strategic guidelines to provide MDC Fisheries Division staff working in the watershed with management direction to address the issues detailed in earlier sections. These issues include point and nonpoint source pollution, increasing urbanization, loss of riparian vegetation, the effects of large confined animal operations, mining influences, dam and hydropower influences, instream flow issues, increasing demands for recreation, and threats to aquatic life within the watershed. The guidelines will be used to address future stream management, public awareness, and public access issues and needs. The management of impounded waters is addressed in detail elsewhere and is not included here.

Goal 1: Improve water quality and maintain or improve water quantity in the White River Water Watershed so all streams are capable of supporting high quality aquatic communities.

Objective I.1: Streams within the watershed will meet state standards for water quality.

Guidelines:

Enhance people's awareness of

1. water quality problems (i.e., point source pollution, animal waste runoff, etc.) affecting aquatic biota,
2. viable solutions to these problems, and
3. their role in implementing these solutions.

- Review NPDES, Section 404, and other permits and either recommend denial or appropriate mitigation for those which are harmful to aquatic resources, and investigate pollution events and fish kills.
- Work with the Missouri Department of Health and MDNR to monitor and reduce contaminant levels in fish.
- Work with MDNR to monitor water quality, improve water quality, and ensure compliance with discharge permits.
- Serve in an advisory role to citizen organizations and local governments on water resource issues.

Objective I.2: Maintain base flows in streams within the watershed at or above current levels within the constraints imposed by natural seasonal variations and precipitation.

Guidelines:

- Establish flow regimes that protect or enhance fish and other aquatic life.
- Working with MDNR and USCOE, protect or enhance stream flows through oversight and enforcement of existing water withdrawal permits and other related permits.
- Support development of water law and an interstate compact/agreement that will address the quantity of water in Missouri's streams.

- Increase public awareness of and concern for water quantity problems, the affected aquatic biota, and potential solutions.

Goal II: Improve riparian and aquatic habitat conditions in the White River Watershed to meet the needs of aquatic species while accommodating demands for water and agricultural production.

Objective II.1: Riparian landowners will understand the importance of good stream stewardship and where to obtain technical assistance for sound stream habitat improvement.

Guidelines:

- Work with MDC's Outreach and Education Division staff to develop stream management related materials and present related courses for elementary and secondary school teachers.
- Establish and maintain stream management demonstration sites.
- Promote good stream stewardship through landowner workshops and stream demonstration site tours.

Objective II.2: Maintain, expand, and restore riparian corridors; enhance watershed management; improve instream habitat; and reduce streambank erosion throughout the watershed.

Guidelines:

- Periodically monitor and assess habitat and riparian area conditions on selected streams in the watershed.
- Ensure that all MDC areas are examples of good stream and watershed management.
- Provide technical recommendations to all landowners that request assistance.
- Improve riparian corridor and watershed conditions by actively cooperating with other agencies on watershed-based projects.
- Improve landowner stewardship of streams by promoting and implementing cost share programs, including MDC's watershed-based programs, that include streambank stabilization, alternative watering provisions, and establishment and maintenance of quality riparian corridors.

Objective II.3: Critical and unique aquatic habitats will be identified and protected from degradation.

Guidelines:

- Conduct additional fish population sampling to further define and delineate unique and critical habitats.
- Collect additional background information from the public and resource professionals to better define critical and unique aquatic habitats.
- Acquire, protect, and enhance critical and unique aquatic habitats.

Goal III: Maintain diverse and abundant populations of aquatic organisms while accommodating angler demands for quality fishing.

Objective III.1: Evaluate and maintain sportfish populations and maintain sufficient quality and condition of these populations to satisfy the angling public.

Guidelines:

- Develop and implement a monitoring program to obtain trend data on sportfish populations and angler use of these populations in selected stream reaches.
- Identify critical habitat areas for sportfish species and maintain or enhance these areas as needed to improve habitat.
- Using regulations, habitat improvement, and other methods, continue implementation of population improvement programs for sportfish species.
- Increase angler awareness of the recreational potential of fishes such as catfish, buffalo, carp, drum, and gar.

Objective III.2: Maintain populations of native non-game fishes, including the Ozark cavefish, and aquatic invertebrates at or above present levels throughout the watershed.

Guidelines:

- Develop standard sampling techniques for assessing fish and invertebrate communities, including the use of indicator species, and implement a monitoring program to track trends in species diversity and abundance.
- Maintain or enhance aquatic biodiversity and protect or enhance fish species diversity and abundance using regulations, stocking, habitat improvement, and related techniques,
- Continue public awareness and habitat management efforts related to aquatic species of special concern and consider additional possibilities for non-MDC funding for additional inventory work, continued public awareness efforts, and habitat management efforts.
- Protect and improve habitats that support populations of aquatic species of special concern by implementing MDC cost share programs and encouraging cost share practices that protect and enhance streams, riparian areas, sinkholes, caves, and springs to be included on NRCS/SWCD dockets.
- Participate in species recovery efforts including interstate conferences and recovery team meetings.

Goal IV: Improve the public's appreciation for stream resources and increase recreational use of streams in the White River Watershed

Objective IV.1: Access sites, bank fishing areas, and trails will be developed and maintained in sufficient numbers to accommodate public use.

Guidelines:

- Conduct a recreational use survey within the watershed in conjunction with an angler survey to determine existing levels of use and satisfaction with recreational opportunities in the watershed.
- Improve bank fishing and other aquatic wildlife-based recreational opportunities on public lands.

Objective IV.2: Increase the general public's awareness of stream recreational opportunities, local stream resources, and good watershed and stream management practices.

Guidelines:

- Working with MDC's Outreach and Education Division staff, use streams in aquatic education programs. Identify and develop stream locations appropriate for educational field trips near participating schools.
- Maintain a stream emphasis at public events such as the Ozark Empire Fair, Springfield Boat Show, etc.
- Assist in the development of articles, videos, etc. that highlight White River watershed recreational opportunities.
- Prepare an annual fishing prospectus for selected streams and reservoirs.
- Promote the formation of STREAM TEAMs and STREAM TEAM associations within the watershed.
- Distribute information through STREAM TEAMs and related organizations.

Angler Guide

Streams

Roaring River State Park

Information: 417/847-2430

The park is divided into three zones each with different bait or lure, and creel restrictions. Zone 1 is from the hatchery to the posted sign at the mouth of Dry Hollow Creek, only flies, artificial lures, and soft plastic bait may be used. Zone 2 is from the mouth of Dry Hollow Creek to the old dam in the lower campground, only flies may be used. A portion of zone 2, from the mouth of Dry Hollow Creek to the bridge on Hwy. F, is designated as catch and release only (trout may not be possessed and must be returned to the water immediately unharmed). This portion of zone 2 is also designated as a multiple use area with wading and swimming allowed. Zone 3 is from the old dam in the lower campground to the park boundary (1.4 miles), where artificial lures, soft plastic bait, and natural bait can be used. Zone 3 may be fished with a state fishing permit and either a daily permit or a trout permit. Rainbow trout and some brown trout are stocked. Wade fishing is only allowed in the catch and release area of zone 2 and in zone 3.

Lakes

Bull Shoals Lake (Ozark Region)

Information 417/256-7161

Due to inadequate recruitment since 1990, largemouth bass numbers have been declining in both the Forsyth and Theodosia arms of Bull Shoals Lake, for the past six years. Bass anglers can expect to catch even fewer black bass than last year. Spotted bass (Kentucky bass) will make up approximately 30 40% of the black bass catch in both arms of the lake. Because of historically inconsistent recruitment of largemouth bass and the fact that spotted bass and largemouth bass are competing for food and habitat, a new set of black bass fishing regulations took effect on March 1, 1998. Anglers catching largemouth bass or smallmouth bass less than fifteen inches (15") and spotted (Kentucky) bass less than twelve inches (12") must return these black bass unharmed immediately after being caught from Bull Shoals Lake. More than a quarter of the largemouth bass that anglers manage to catch will be >15", with about 10% being >18". About one third of the spotted bass caught by anglers will be legal to take home, however, due to the poorer growth potential of this species, less than two percent will >15". The black bass species are not difficult to tell apart if you know what to look for. There are a three good, easy to learn characteristics (tongue patch, jaw bone, and cheek scales), which when used together, allow an angler to correctly identify largemouth bass and spotted bass with 99% confidence. To obtain a free pamphlet and billfold size card on black bass identification write to the: Missouri Department of Conservation, Black Bass Identification, P. O. Box 180, Jefferson City, MO 65102-0180.

Although smallmouth bass comprise <20% of the black bass population, anglers with patience and good smallmouth angling skills can be rewarded by trophy-size smallmouth bass. There are very few smallmouth bass in the Forsyth arm with most smallmouth bass being caught in the area near Pontiac. Anglers can expect crappie numbers and sizes to be good and similar to last year. Many crappie are harvested by anglers during the April-May spawning season. During this period, six out of ten crappie will exceed the minimum length limit of 10". The percentage of crappie in the lake that are black crappie has been increasing in recent years to the point that more than half of the catch is now black crappie. Two to six pound test line and small maribou or plastic-bodied jigs or live minnows produce the majority of the crappie caught in Bull Shoals Lake. During the spawning season anglers should concentrate their search for crappie in secondary coves in 4 10' of water near woody cover. Most white bass harvest occurs in conjunction with their annual spawning run into the lake's major tributaries such as Beaver, Swan and Big Creeks and the Little North Fork River. Unfortunately, weather and water conditions in March and April of the last three years resulted in below average white bass angling pressure and success. As a result, anglers can expect plenty of 14-16" white bass in 1999. Roadrunners, jigs and Rapalas or any other lure that resembles small fish are the lures of choice. The walleye numbers in both arms of the lake continue to increase as a result of a Missouri Department of Conservation stocking program started in 1990 and a 18" minimum length limit adopted in 1995. During the peak of walleye spawning activity, mature walleye congregate near or in Swan and Beaver Creeks near Forsyth, and the Little North Fork River near Theodosia. A large concentration of spawning walleye can also be found between Powersite Dam and the Hwy. 76 bridge (the "Pothole"area). Walleye weighing more than ten pounds are caught from the Pothole on a regular basis. In the Forsyth area, anglers will continue to see their walleye catch rate improve. More than half the walleye caught in the spring months will be >18", with 5-10% exceeding 24" and five pounds. During an electrofishing survey in early April of 1998, walleye up to 32" long were captured with several individuals in excess of 12 lbs. The walleye population in the Theodosia arm continues to grow, with some anglers catching 3-4 walleye per hour during the summer. Most walleye caught in this arm are 16-20" with a few >5 lbs. An estimated 10,000 stocker-size rainbow trout go over Powersite Dam (which impounds Lake Taneycomo) each year into the Pothole of Bull Shoals Lake. Trout can be caught from this relatively small area throughout the year. Catfishing is expected to be similar to last year.

Lake Taneycomo (Southwest Region)

Information: 417/895-6880

Anglers can look forward to good trout fishing throughout the year. The laced 20" minimum length limit on brown trout has resulted in good numbers of large brown trout and the opportunity to catch larger trout. There are some very large brown trout in Lake Taneycomo at the present time. Several brown trout 20-30 lbs. have been observed in recent population samples, and at least one fish over 25 lbs. was caught by an angler during 1998. The highest densities of both brown trout and rainbow trout occur above Branson. However, good trout fishing can be found throughout the lake. Above the mouth of Fall Creek there is a 12-20" slot length limit on rainbow trout. In this area anglers are required to immediately release all rainbow trout between 12" and 20". Only artificial lures and flies may be used above the mouth of Fall Creek. Soft plastic and natural and scented baits are prohibited in this area. The special regulations above Fall Creek have resulted in a significant improvement in the rainbow trout population. Only 7% of the rainbow trout in this 3-mile reach were >13" when the special regulation went into effect in March 1997. This increased to 47% by August 1998. Below the mouth of Fall Creek, there is no length limit on rainbow trout, and flies, artificial lures, soft plastic and natural and scented baits may be used.

There is a minimum length limit of 20" on brown trout throughout the entire reservoir. The daily limit is 5 trout, of which, only one may be a brown trout.

Table Rock Lake (Southwest Region)

Information: 417/895-6880

Fishing for black bass should be excellent during 1999. Population structure is excellent throughout the reservoir. The James River and Kings River arms have the highest densities of black bass, but also have the highest fishing pressure. Spotted bass comprise about 20% of the bass population. The best spotted bass fishing occurs in the main part of the lake. Largemouth bass predominate in the tributary arms. The smallmouth bass population continues to increase in range and numbers. The best area of the lake to catch smallmouth bass is from the Highway 86 bridge to Campbell Point. The minimum length limit for all three species of black bass remains 15". Crappie fishing will be fair at best, based on 1997 spring electrofishing. The Kings River and the James River arms will offer the best opportunities to catch crappie. The minimum length limit for crappie is 10". Anglers will have the opportunity to catch some very large white bass. Recent sampling documented the presence of good numbers of white bass >16". The best opportunity to catch white bass is in the spring when they move into tributary streams to spawn. Between March 15 and April 30, anglers will have the opportunity to snag paddlefish, one of the largest fish found in North America. Paddlefish concentrate each spring in the upper reaches of the James River Arm above Cape Fair. The minimum length limit for paddlefish is 24" (eye to fork of tail).

Glossary

Alluvial soil: Soil deposits resulting directly or indirectly from the sediment transport of streams, deposited in river beds, flood plains, and lakes.

Aquifer: An underground layer of porous, water-bearing rock, gravel, or sand.

Benthic: Bottom-dwelling; describes organisms which reside in or on any substrate.

Benthic macroinvertebrate: Bottom-dwelling (benthic) animals without backbones (invertebrate) that are visible with the naked eye (macro).

Biota: The animal and plant life of a region.

Biocriteria monitoring: The use of organisms to assess or monitor environmental conditions.

Channelization: The mechanical alteration of a stream which includes straightening or dredging of the existing channel, or creating a new channel to which the stream is diverted.

Concentrated animal feeding operation (CAFO): Large livestock (ie. cattle, chickens, turkeys, or hogs) production facilities that are considered a point source pollution, larger operations are regulated by the MDNR. Most CAFOs confine animals in large enclosed buildings, or feedlots and store liquid waste in closed lagoons or pits, or store dry manure in sheds. In many cases manure, both wet and dry, is broadcast overland.

Confining rock layer: A geologic layer through which water cannot easily move.

Chert: Hard sedimentary rock composed of microcrystalline quartz, usually light in color, common in the Springfield Plateau in gravel deposits. Resistance to chemical decay enables it to survive rough treatment from streams and other erosive forces.

Cubic feet per second (cfs): A measure of the amount of water (cubic feet) traveling past a known point for a given amount of time (one second), used to determine discharge.

Discharge: Volume of water flowing in a given stream at a given place and within a given period of time, usually expressed as cubic feet per second.

Disjunct: Separated or disjoined populations of organisms. Populations are said to be disjunct when they are geographically isolated from their main range.

Dissolved oxygen: The concentration of oxygen dissolved in water, expressed in milligrams per liter or as percent.

Dolomite: A magnesium rich, carbonate, sedimentary rock consisting mainly (more than 50% by weight) of the mineral dolomite $(CaMg(CO_3)_2)$.

Endangered: In danger of becoming extinct.

Endemic: Found only in, or limited to, a particular geographic region or locality.

Environmental Protection Agency (EPA): A Federal organization, housed under the Executive branch, charged with protecting human health and safeguarding the natural environment — air, water, and land — upon which life depends.

Epilimnion: The upper layer of water in a lake that is characterized by a temperature gradient of less than 1^{o} Celsius per meter of depth.

Eutrophication: The nutrient (nitrogen and phosphorus) enrichment of an aquatic ecosystem that promotes biological productivity.

Extirpated: Exterminated on a local basis, political or geographic portion of the range.

Faunal: The animals of a specified region or time.

Fecal coliform: A type of bacterium occurring in the guts of mammals. The degree of its presence in a lake or stream is used as an index of contamination from human or livestock waste.

Flow duration curve: A graphic representation of the number of times given quantities of flow are equaled or exceeded during a certain period of record.

Fragipans: A natural subsurface soil horizon seemingly cemented when dry, but when moist showing moderate to weak brittleness, usually low in organic matter, and very slow to permeate water.

Gage stations: The site on a stream or lake where hydrologic data is collected.

Gradient plots: A graph representing the gradient of a specified reach of stream. Elevation is represented on the Y-axis and length of channel is represented on the Xaxis.

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.

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