POMME de TERRE RIVER

WATERSHED

INVENTORY AND ASSESSMENT

.This information is based on the

Pomme de Terre Inventory and Assessment

prepared by

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EXECUTIVE SUMMARY

Pomme de Terre (PDT) River is a sixth order river originating in southwest Missouri, near Marshfield. The River flows in a northeast direction from Marshfield and originally confluenced with the Osage River southwest of Warsaw, MO. The Pomme de Terre River is now impounded as Pomme de Terre Lake just upstream of Hermitage, MO, and further downstream becomes part of Harry S. Truman Lake. Pomme de Terre Lake is a 7,820 acre (multipurpose pool) reservoir constructed and operated by the United States Army Corps of Engineers (USACE). Pomme de Terre Dam was closed in 1961 forming the lake which contains 113 miles of shoreline. Harry S. Truman Lake was formed in 1979 with the closing of Harry S. Truman Dam. Pomme de Terre River and Little Pomme de Terre River (north) makes up one arm of this 55,600 acre (multipurpose pool) impoundment. The Pomme de Terre River watershed encompasses about 840 square miles and includes parts of six Missouri counties (Benton, Dallas, Greene, Hickory, Polk, and Webster). Major tributaries include Little Pomme de Terre River (north), Little Pomme de Terre River (south), and Lindley Creek

The Pomme de Terre River watershed is located entirely within the Ozark Natural Division and the vast majority lies within the Division's Springfield Plateau region. The Watershed's geology is dominated by Ordovician dolomites and Mississippian limestones. Eleven springs have been identified in the Watershed. Primary Watershed soils are formed in cherty limestone, dolomite, or sandstone and are well to moderately well drained, with the best soils formed in the alluvium of the Watershed's larger streams.

The majority of the Pomme de Terre River watershed is covered in grassland (about 53%) and forest (about 37%). Dairies and beef cattle production play major roles in the Watershed's land use, and most

grassland is used for pasture and/or hay production. Urbanization is also a growing facet of the Watershed’s land use.

Pomme de Terre and Truman dams have dramatically changed the physical and biological character of the Pomme de Terre River watershed. The segment of river between Pomme de Terre Dam and the historic confluence with the Osage River (total of 41.6 river miles) no longer functions in the same manner as it did before impoundment. Combined, Pomme de Terre and Truman reservoirs inundate 59.6 river miles, or the downstream 46% of the original PDT River channel, when PDT Lake is at normal pool level and 69.6 river miles, 54%, of the original Pomme de Terre River channel when PDT Lake is at flood pool. Annual "Water Level Management Recommendations" have been recommended by Missouri Department of Conservation to the USACE for managing water levels on Pomme de Terre Lake. The plan has provided positive benefits for fish, habitat, and recreationists on PDT Lake and Pomme de Terre River below Pomme de Terre Dam.

Several known water quality problems exist throughout the Watershed. Problems with discharges from the City of Buffalo’s waste water treatment facility have been documented as negatively impacting 4.5 miles of Lindley Creek. These problems were still evident in 1998 (John Ford, MDNR, pers. comm.). In 1997, habitat surveys revealed many Watershed streams containing heavy growth of filamentous algae. Contributing factors to non-point runoff include, cattle with free access to streams and urbanization near Bolivar.

Generally, stream bank stability in the Watershed is good with the exception of localized erosion. Streambank stability was listed as good at 56.1% of the sites surveyed followed by, poor (22.0%), fair (17.1%), and excellent (4.9%). Forest and grassland were the dominant land use in riparian areas. Generally, stream corridors in the lower portion of the Watershed were dominated by forests, while stream corridors in the upper portions of the Watershed were primarily grassland.

Eighty-three species of fish have been collected in the Watershed since 1940. There is one federally protected fish, Niangua darter, and two state protected fish, blacknose shiner and mooneye, known to occur in the Watershed. Reservoir construction and habitat degradation, associated with land use practices, are thought to be major factors in the Niangua darter’s decline. Lack of riparian corridors accelerates bank erosion which is a concern to Niangua darter habitat. Future efforts should be undertaken to survey previously unsampled locations and to protect and enhance streams where Niangua darters are known to occur. Common sportfish in streams and reservoirs include smallmouth, largemouth, and spotted bass, black and white crappie, bluegill, channel catfish, and muskellunge.

Major goals for the Watershed are improving water quality, riparian and instream habitat, maintaining a diverse and sustainable populations of native aquatic organisms and improving sportfishing, increasing recreational use and the public’s appreciation for streams. Additional fish population sampling and habitat surveys are planned. Fishing regulations will be revised, as needed, and selected stocking will be used to maintain and improve sportfishing. Stream 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 environmental regulations and support for revising existing rules will help reduce violations and improve water quality. Working with other state and federal agencies to promote public awareness and funding cost share programs for best management practices and cooperating with citizen groups and landowners will improve watershed conditions and stream quality.

LOCATION

Area Description

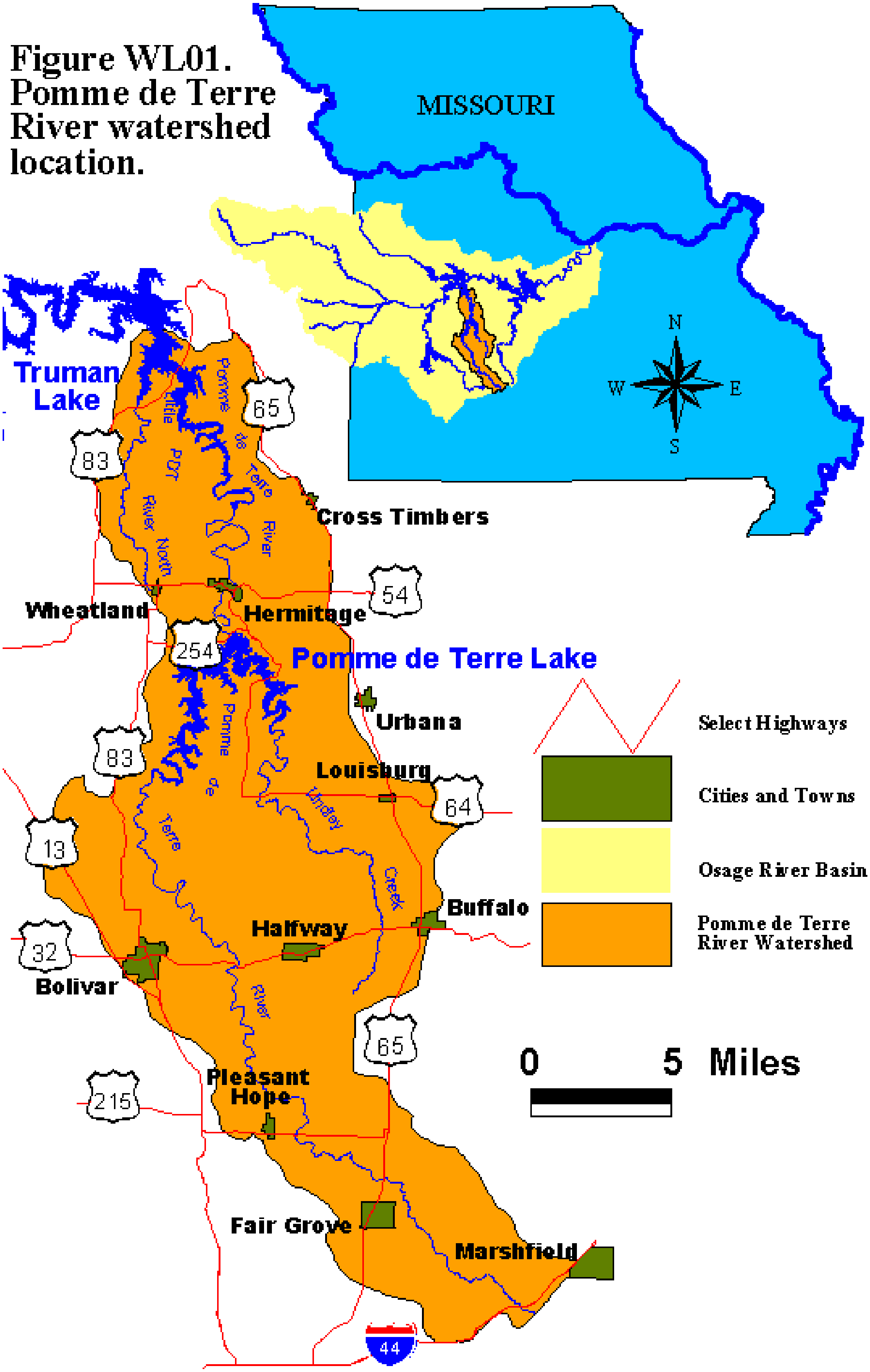
Pomme de Terre (PDT) River is a sixth order river located in the southwest Missouri counties of Webster, Greene, Dallas, Polk, Hickory and Benton (Figure WL01). The River originates near Marshfield, Missouri, in the northwest corner of Webster County, and flows northward to Hickory County where it is the major water supply to PDT Lake. PDT Lake is a 7,820 acre reservoir, completed in 1961, managed by the United States Army Corps of Engineers (USACE). PDT River resumes its path northward from PDT Dam into Benton County where is becomes one of the major water supplying streams to Harry S Truman Lake. The PDT watershed, hereafter referred to as the Watershed, encompasses 536,846 acres (838.8 sq. miles). The United States Geological Survey (USGS) eight digit hydrologic unit (HUC) identification number for the PDT watershed is 10290107 and it is further subdivided into five 11 digit HUCs (Figure WL02).

The Watershed is part of the larger Osage River Basin. The PDT River once confluenced with the Osage River southwest of Warsaw, Missouri. The former confluence is now impounded by Truman Lake.

Watersheds surrounding the PDT watershed (from the top, in a counter-clockwise direction) include : Upper Osage River watershed, Sac River watershed, James River watershed, Niangua River watershed, and Lake of the Ozarks watershed. The divide between the Pomme de Terre watershed and the James River watershed represents a portion of the division between the Missouri River and White River basins.

Major streams in the Watershed include: Pomme de Terre River, Little Pomme de Terre River (north), Little Pomme de Terre River (south), and Lindley Creek (Figure WL03). Little Pomme de Terre River (north) refers to the stream that formerly confluenced (now impounded by Truman Reservoir) with the Pomme de Terre River in Benton County. Little Pomme de Terre (south) refers to the stream that confluences with the Pomme de Terre River in Polk County.

Figure WL01. Pomme de Terre River watershed location.



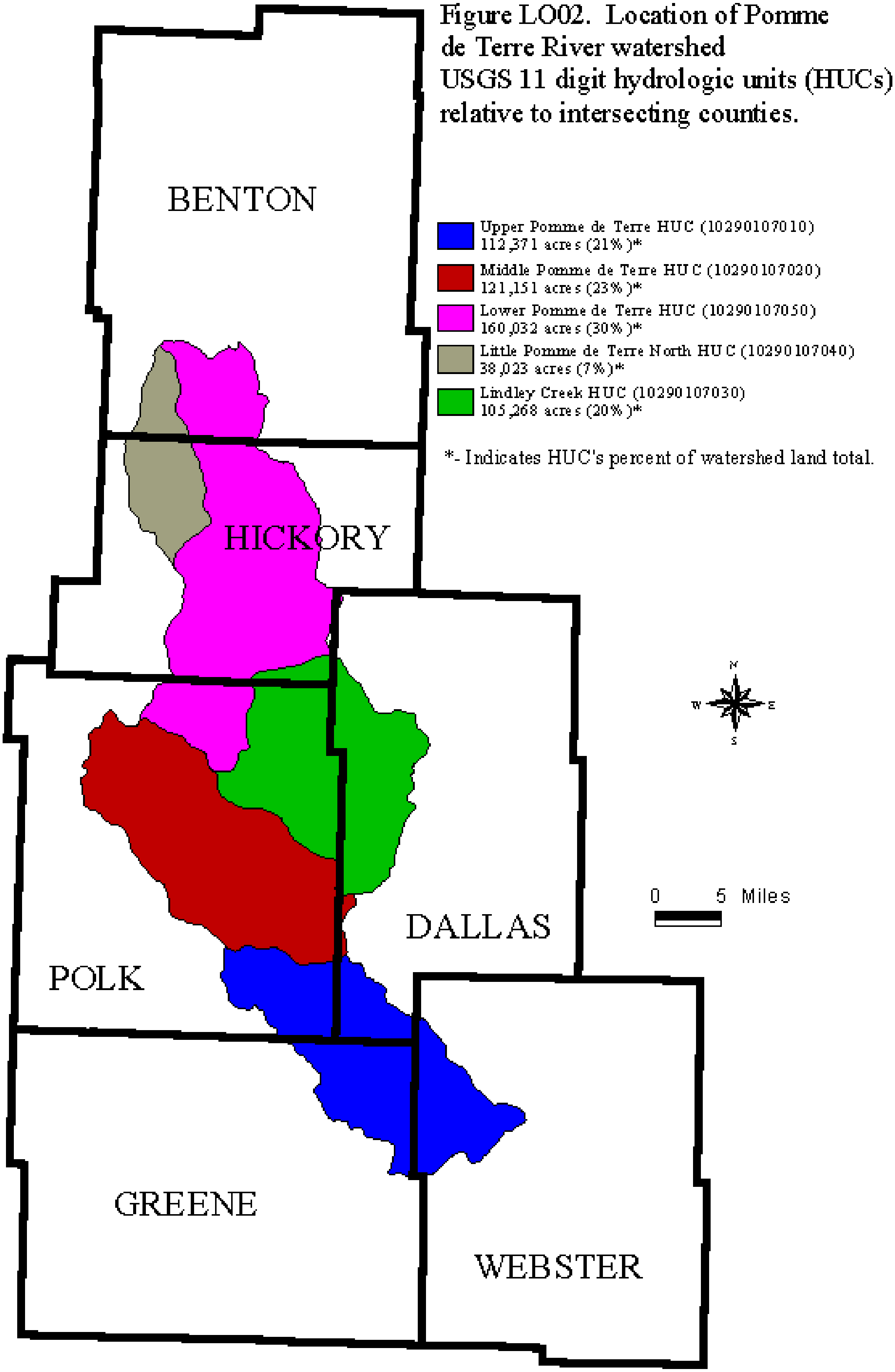
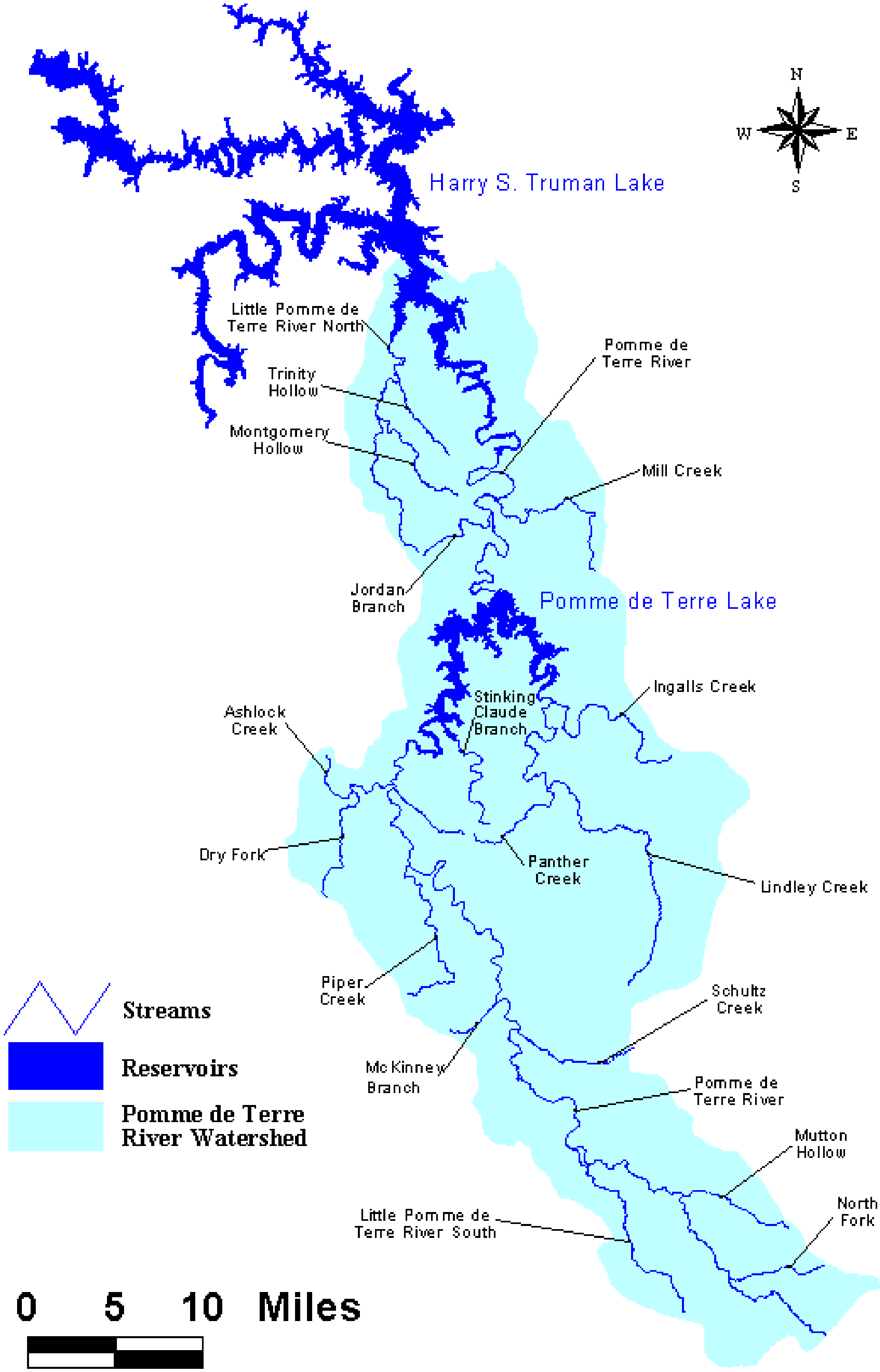


Figure LO02. Location of Pomme de Terre River watershed USGS 11 digit hydrologic units (HUCs) relative to intersecting counties.

Figure LO03. Major streams and impoundments in the Pomme de Terre River watershed.



GEOLOGY

Physiographic Regions

Missouri has been divided into six Natural Divisions based on natural features including: soils, geology, topography, and plant and animal distributions (Thom and Wilson 1980). These six divisions are further divided into regions. The Watershed is located entirely within the Ozark Natural Division and the vast majority lies within the Springfield Plateau region (Figure GE01).

Geology

The geology of the Watershed is dominated by Ordovician dolomites and Mississippian limestones (Figure GE02). Most of the water movement is through the surface stream network. Water that does reach the subsurface will likely resurface locally where a stream valley incises the confining rock layer (MDNR 1996). Eleven springs have been located in the Watershed (Table GE01) and Figure GE02). Karst topography is limited to the extreme headwater area in Greene and Webster counties and most (7) of the springs are located there.

The surface of the Watershed consists mainly of Jefferson City-Cotter dolomite, with some occurrences of early Mississippian limestones on upland areas. Movement of water from the surface to subsurface is minimal throughout most of the Watershed. This is due to the stony red clay residue overlying much of the Jefferson City-Cotter and the presence of thin shale units within the formation.

Soil Types (Allgood and Persinger 1979)**.**

The primary soils (Figure GE03) in the area were formed in cherty limestone, dolomite, or sandstone and are well to moderately well drained. Soils with fragipans are common. Alluvial soils on the floodplains along major streams are deep and well drained.

Barco Series

Moderately deep, well drained, moderately permeable soils on uplands. Formed in acid limestone. Slopes in the 2 to 9 percent range. Solum and depth to soft sandstone bedrock usually 20 to 40 inches.

Barden Series

Deep, moderately well drained, slowly permeable soils on uplands. Formed in loess or silty material and shale residuum. Slopes from 1 to 5 percent. Solum ranges from 30 to 60 inches, with the depth to shale bedrock typically exceeding 60 inches.

Bardley Series

Moderately deep, well drained permeable soils on uplands. Formed in cherty sediments and dolomite and limestone residuum. Slopes from 3 to 35 percent. Solum and depth to bedrock range from 20 to 40 inches. Chert and flagstone fragments range from 15 to 70 percent in surface layers.

Bolivar Series

Moderately deep, well drained, moderately permeable soils on uplands. Formed in acid limestone residuum. Slopes range from 5 to 14 percent. Solum and depth to weathered sandstone bedrock range from 20 to 40 inches. Depth to hard bedrock greater than 60 inches. Chert makes up 20 to 70 percent in

Figure GE01. Location of the Pomme de Terre River watershed within the Upper Ozark and Springfield Plateau regions of Missouri Natural Divisions.

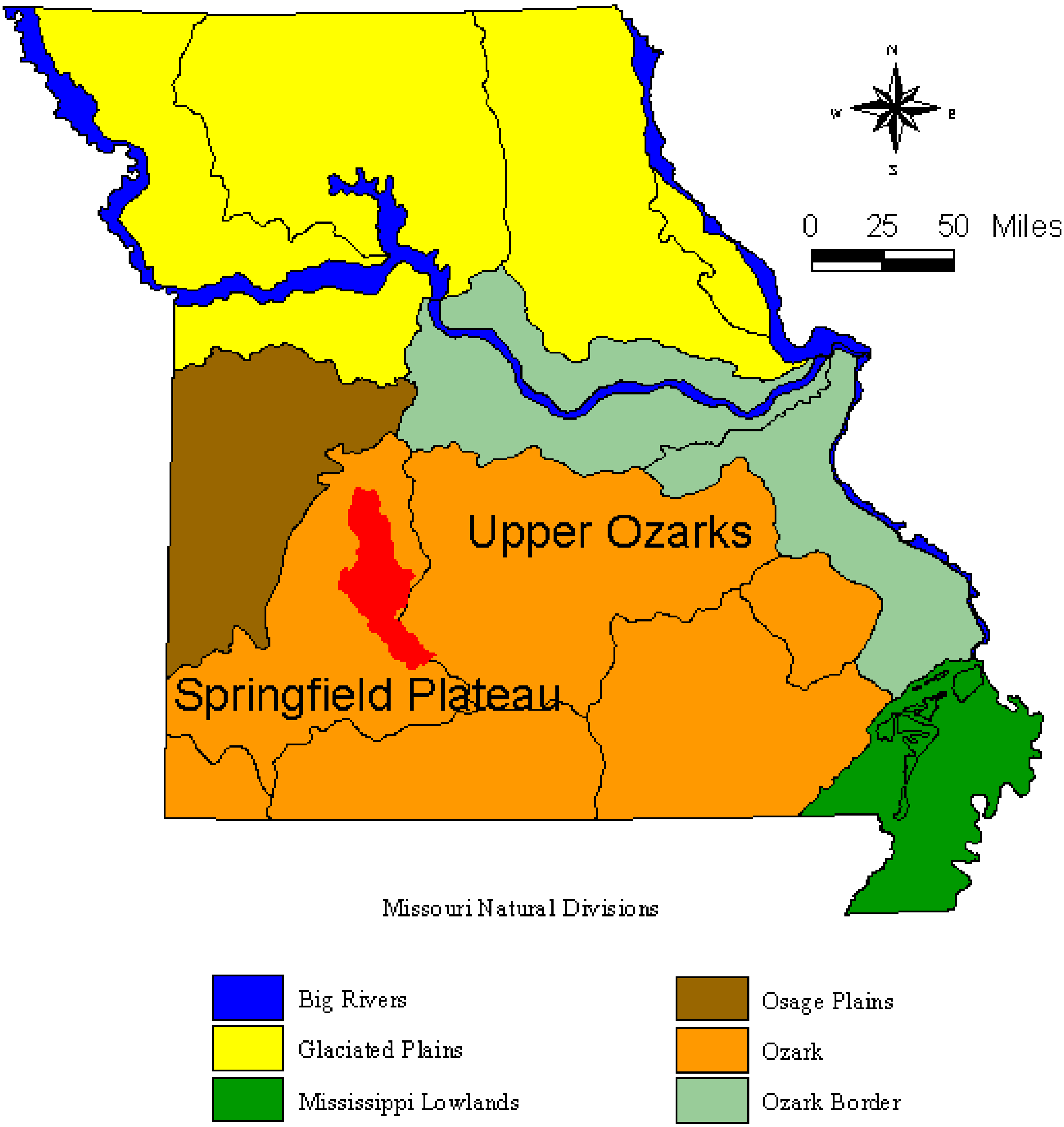


Figure GE02. Geology and springs of the Pomme de Terre River watershed.

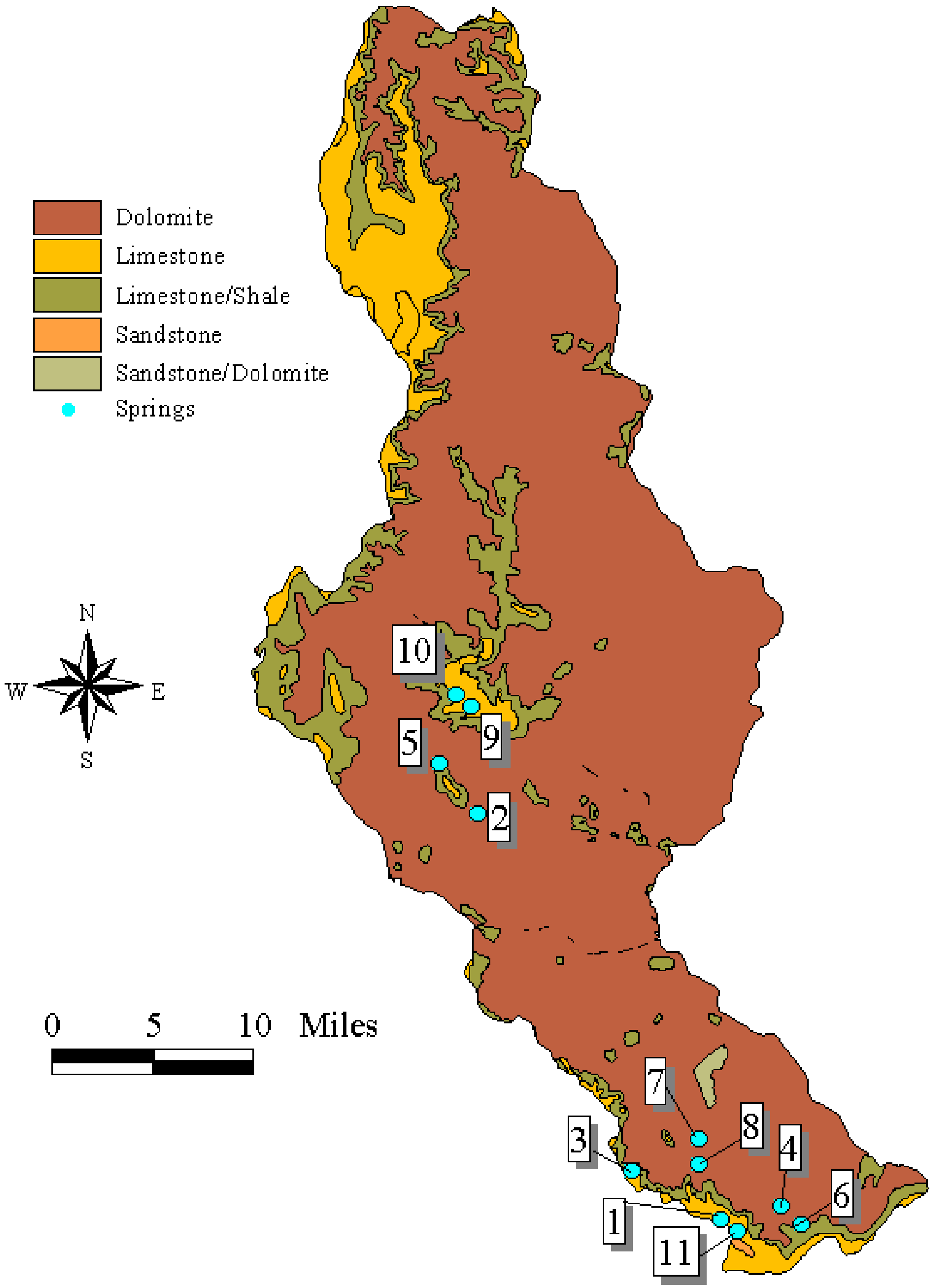


Figure GE03. Soils of the Pomme de Terre River watershed.

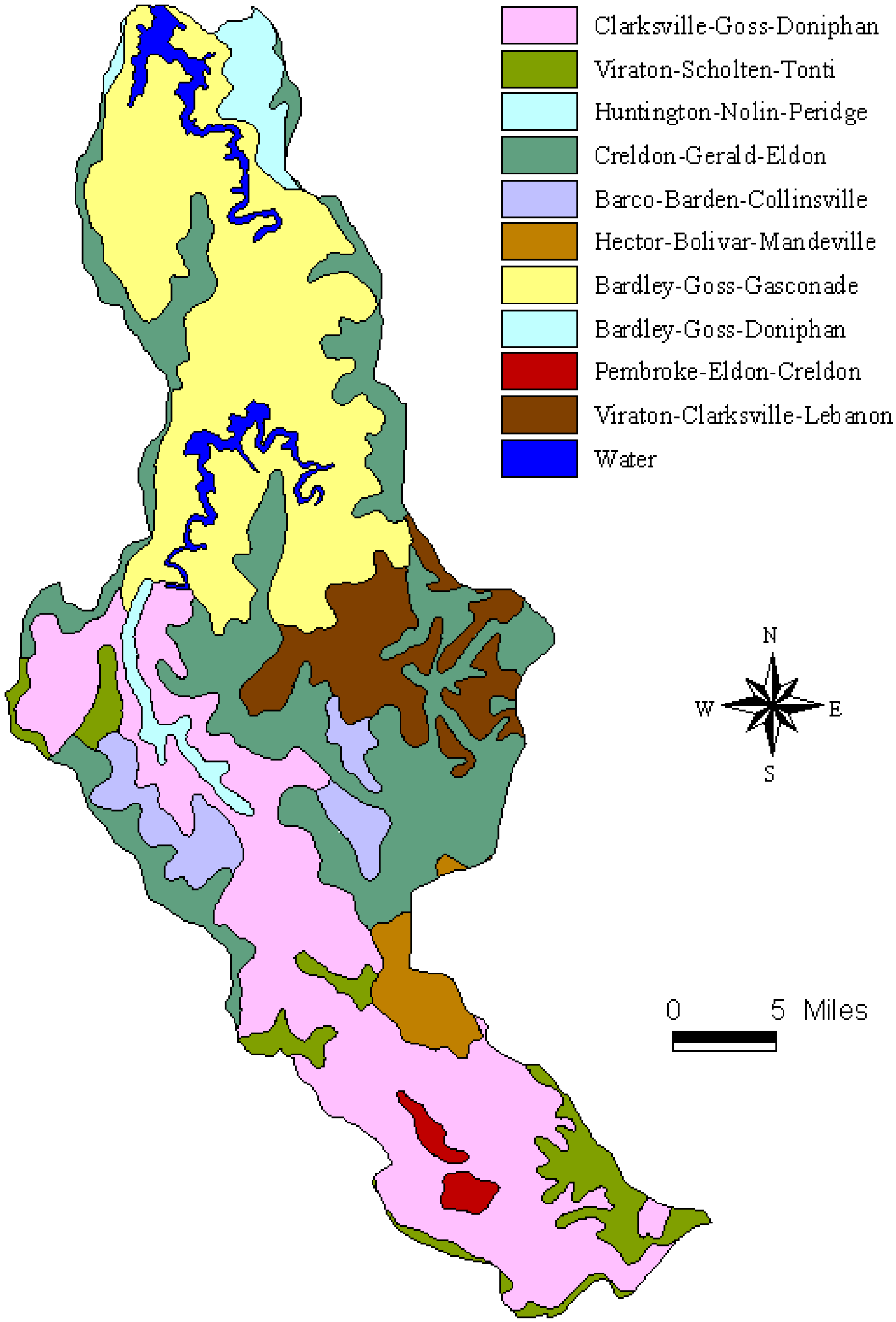


Table GE01. Springs in the Pomme de Terre River watershed (Vineyard and Feder 1989 and USGS 1:24,000 topographical maps).

Spring Number	Spring Name	County	Location	Topo Map	Discharge (cf/s)
1	Baumgartner	Greene	T30N, R20W, Sec.23	Strafford	0.05
2	Eidson	Polk	T33N, R22W, Sec.10	Cedar Vista	*
3	Elm	Greene	T30N, R21W, Sec.12	Bassville	0.02
4	Campbell	Webster	T30N, R19W, Sec.18	Strafford	1.29
5	Unnamed	Polk	T33N, R22W, Sec.08	Cedar Vista	0.01
6	Unnamed	Webster	T30N, R19W, Sec.20	Strafford	0.08
7	Unnamed	Greene	T31N, R20W, Sec.33	Bassville	*
8	Unnamed	Greene	T30N, R20W, Sec.04	Bassville	*
9	Unnamed	Polk	T34N, R22W, Sec.15	Polk	*
10	Unnamed	Polk	T34N, R22W, Sec.16	Polk	*
11	Unnamed	Greene	T30N, R20W, Sec.23	Strafford	*

*= data not available

Table GE03. Third and higher order stream subwatersheds within the Pomme de Terre River watershed.

Subwatershed Name	Max. Stream Order	Topographical Map(s)
Subwatersheds within the North Little Pomme de Terre River watershed		
Little Pomme de Terre River (north)	fifth	Wheatland, Hermitage, Quincy, Fristoe, Warsaw West
Burbic Hollow	third	Quincy
Montgomery Hollow	fourth	Quincy, Wheatland, Hermitage, Fristoe
Trinity Hollow	third	Quincy, Fristoe
Subwatersheds within the Pomme de Terre River watershed above Truman Lake level (706 ft.) and below Pomme de Terre Lake		
Pomme de Terre River	sixth	Hermitage, Wheatland, Prestoe, Fristoe, Cross Timbers
Jordan Branch	fourth	Hermitage, Wheatland
Green Branch	fourth	Hermitage, Wheatland
Crane Creek	fourth	Hermitage, Preston, Urbana
Mill Creek	fifth	Hermitage, Preston
Rough Hollow	third	Hermitage
Subwatersheds within the Pomme de Terre River watershed above Pomme de Terre Lake level (839 ft.)		
Pomme de Terre River	fifth	
Dry Fork	fourth	Cliquot, Fair Play, Humansville, Elkton
Piper Creek	fourth	Cliquot, Polk, Bolivar, Cedar Vista
Unnamed #2	third	Cedar Vista
McKinney Branch	third	Cedar Vista
Sycamore Creek	fourth	Cedar Vista

Unnamed #3	**third**	**Pleasant Hope**
Little Pomme de Terre River (south)	**third**	**Pleasant Hope, Bassville, Fair Grove, Strafford**
South Fork	**third**	**Strafford**
North Fork	**third**	**Strafford, Elkland, Marshfield**
Mutton Hollow	**third**	**Elkland**
Unnamed #5	**third**	**Elkland, Fairgrove**
Unnamed #4	**third**	**Elkland, Fairgrove**
Little Wilson Creek	**fourth**	**Fair Grove, Elkland, Half Way**
Schultz Creek	**fourth**	**Cedar Vista, Half Way**
Deer Creek	**third**	**Cedar Vista, Half Way**
Wolf Creek	**third**	**Cedar Vista, Half Way**
Hominy Creek	**third**	**Cedar Vista, Half Way, Buffalo NW, Polk**
Unnamed #1	**third**	**Polk**
Davis Creek	**third**	**Cliquot, Polk**
Subwatersheds within the Lindley Creek watershed above Pomme de Terre Lake (839 ft.)		
Lindley Creek	**fifth**	
Panther Creek	**third**	**Polk, Buffalo NW**
Brush Creek	**third**	**Polk, Buffalo NW**
Unnamed Third Order	**third**	**Half Way, Charity**
Little Lindley Creek	**third**	**Buffalo NW, Buffalo**
Unnamed Fourth Order	**fourth**	**Buffalo NW, Buffalo, Tunas, Urbana**
Jordan Creek	**third**	**Buffalo NW, Urbana**
Ingalls Creek		

the A horizon and 35 to 85 percent in Bt.

Clarksville Series

Deep, somewhat excessively drained, moderately rapid permeable soils on uplands. Formed in cherty limestone. Slope from 9 to 35 percent. Solum and depth to bedrock greater than 60 inches. Chert makes up 20 to 70 percent in the A horizon and 35 to 85 percent in Bt.

Collinsville Series

Moderately shallow, well drained, moderately rapid permeable soils on uplands. Formed under prairie grasses in sandstone residuum. Slopes from 5 to 14 percent. Solum and depth to sandstone bedrock less than 20 inches. Sandstone fragments present throughout the profile.

Creldon Series

Deep, moderately well drained soils on uplands with a fragipan. Above the fragipan, permeability is moderately slow. Formed in loess and loamy or clayey cherty limestone residuum. Slopes range from 2 to 9 percent. Solum and depth to bedrock are greater than 60 inches. Fragipan depth is in the 18 to 36 inch range. Chert fragments in the A horizon 0 to 5 percent, 0 to 10 percent in the Bt horizon, and from to 60 percent in and below the 2Btx horizon.

Doniphan Series

Deep, well drained, moderately permeable soils on uplands. Formed in cherty sediments and in the underlying material weathered from clay shale and dolomite or cherty limestone. Slopes from 3 to 14 percent. Solum from 60 to more than 100 inches. Chert fragments range from 25 to 75 percent in the A horizon, and 0 to 15 percent in the 2Bt horizon.

Eldon Series

Deep, well drained, moderately permeable soils on uplands. Formed in cherty material weathered from limestone interbedded with shale and sandstone. Slopes in the 3 to 14 percent range. Solum is more than 60 inches thick. Coarse fragments up 8 to 40 percent of the A horizon, and from 8 to 15 percent in the Bt horizon.

Gasconade Series

Shallow, somewhat excessively drained, moderately slowly permeable soils on uplands. Formed in limestone residuum. Slopes from 2 to 50 percent. Solum and depth to limestone bedrock range from 4 to 20 inches.

Gerald Series

Deep, somewhat poorly drained soils, with a fragipan on uplands. Permeability is very slow in fragipan and moderately slow below. Formed in loess and underlying dolomite residuum. Slopes from 0 to 2 percent. Solum and depth to bedrock more than 60 inches. Depth to fragipan is 20 to 40 inches. Chert comprises less than 5 percent by volume above fragipan.

Goss Series

Deep, well drained, moderately permeable soils on uplands. Formed in cherty limestone residuum.

Slopes from 14 to 45 percent. Solum from 55 inches to 8 feet, with coarse fragments in the 10 to 80 percent range throughout the profile.

Hector Series

Moderately shallow, well drained, rapidly permeable soils on uplands. Formed under timber in sandstone residuum. Slopes from 5 to 14 percent. Solum and depth to sandstone bedrock less than 20 inches. Sandstone fragments present throughout the profile.

Huntington Series

Deep, well drained, moderate permeability on floodplains along major streams. Formed in silty alluvium. Slope from 0 to 2 percent. Solum and depth to nonconforming cherty layers between 40 to 60 inches. Course fragments comprise less than 5 percent throughout.

Lebanon Series

Deep, moderately well drained soils with a fragipan. Permeability above the fragipan is moderate, and slow at the fragipan. Formed in loess and dolomite residuum. Slopes from 2 to 5 percent. Solum and depth to bedrock 60 inches, with a fragipan at a depth of 18 to 36 inches.

Mandeville Series

Moderately deep, well drained, moderately permeable soils on uplands. Formed in acid shale residuum. Slopes from 2 to 5 percent. Solum and depth to soft shale bedrock range from 20 to 40 inches. Depth to hard bedrock is greater than 60 inches.

Nolin Series

Deep, well drained, moderately permeable soils on floodplains. Formed in alluvium. Slopes from 1 to 3 percent.

Pembroke series

Very deep, well drained, moderately permeable soils on uplands. Formed in loess. Slopes from 2 to 16 percent. Solum as deep as 60 inches.

Peridge Series

Deep, well drained, moderately permeable soils on uplands. Formed in loess and limestone residuum. Slope from 1 to 9 percent. Chert from 0 to 10 percent in upper 40 inches and 0 to 35 percent below 40 inches.

Scholten Series

Deep, moderately well drained soils, with a fragipan on uplands. Permeability very slow in the fragipan, moderate above, and moderate below. Formed in cherty limestone. Slope from 2 to 9 percent. Depth to fragipan is 18 to 27 inches. Chert comprises 15 to 40 percent in the A and E horizons, 35 to 65 percent in Bt, and 15 to 70 percent in 2Btx and 3Bt.

Tonti Series

Deep, moderately well drained soils, with a fragipan on uplands. Permeability is moderate above and slow within the fragipan. Formed in loess and underlying cherty limestone. Slope from 2 to 5 percent. Depth to the fragipan is 15 to 25 inches. Chert exists 10 to 25 percent above and 60 to 65 percent in the fragipan.

Viraton Series

Deep, moderately well drained soils, with a fragipan on uplands. Permeability is moderate above and very slow in the fragipan. Formed in loess and cherty dolomite. Slope from 2 to 9 percent. Depth to fragipan is 16 to 33 inches. Chert ranges from 0 to 35 percent above, 25 to 70 percent in, and 5 to 60 percent below the fragipan.

Stream Orders and Gradients

For this report, the following information on Watershed streams was limited to those that drain into the Pomme de Terre River upstream of the normal pool level of Harry S. Truman Lake. There is a total of 357.5 miles of third and higher order (Strahler 1957) stream segments in the Watershed including 188.0 miles of third order, 85.3 miles of fourth order, 62.9 miles of fifth order and 21.3 miles of sixth order (Table GE02). Average gradients of third order streams ranged from 15.5 (Ingalls Creek) to 104.7 (Unnamed #4) feet per mile (Table GE02). Third order streams in the northern portion of the Watershed have steeper average gradients than those in the rest of the Watershed (Figure GE04). Average gradients for fourth order streams range from 14.6 (Piper Creek) to 110.0 (Vanderman Branch; (Table GE02) feet per mile. The only sixth order stream segment in the Watershed, a 21.3 mile segment Pomme de Terre River stretching from Harry S. Truman Lake normal pool level upstream to Pomme de Terre Dam, has a gradient of 1.7 feet per mile. Third and higher order stream subwatersheds are listed in (Table GE03). Locations and gradient plots for all third and higher order streams were calculated using USGS 7.5 minute topographic maps(Figure GE05), and are available from the Missouri Department of Conservations (MDC) office in Clinton, MO.

Figure GE04. Average gradients for third and higher order streams in the Pomme de Terre River watershed plotted by hydrologic unit number and the median value for each hydrologic unit.

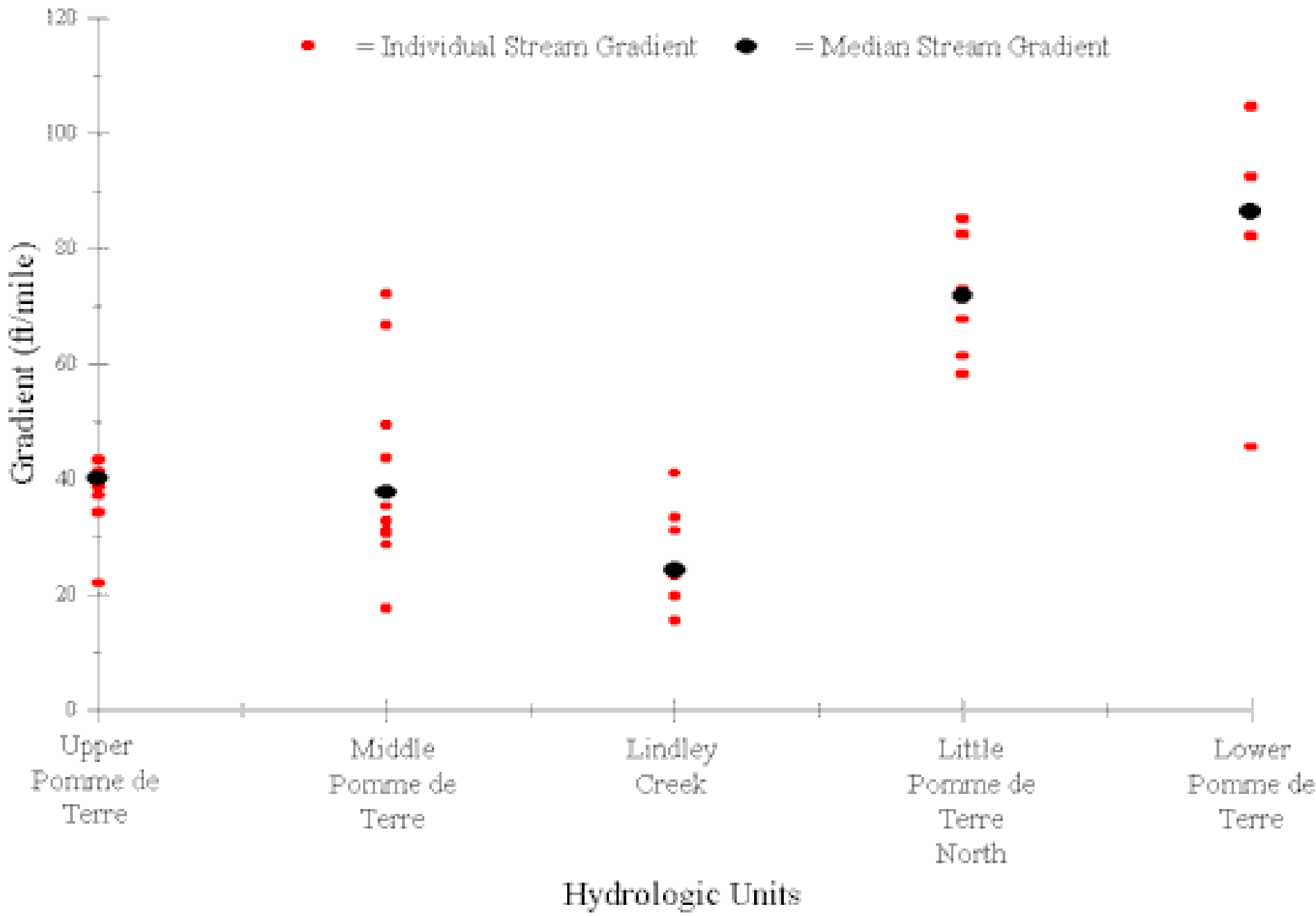


Figure GE05. USGS topographic map (1:24,000 scale) coverage for the Pomme de Terre River watershed.

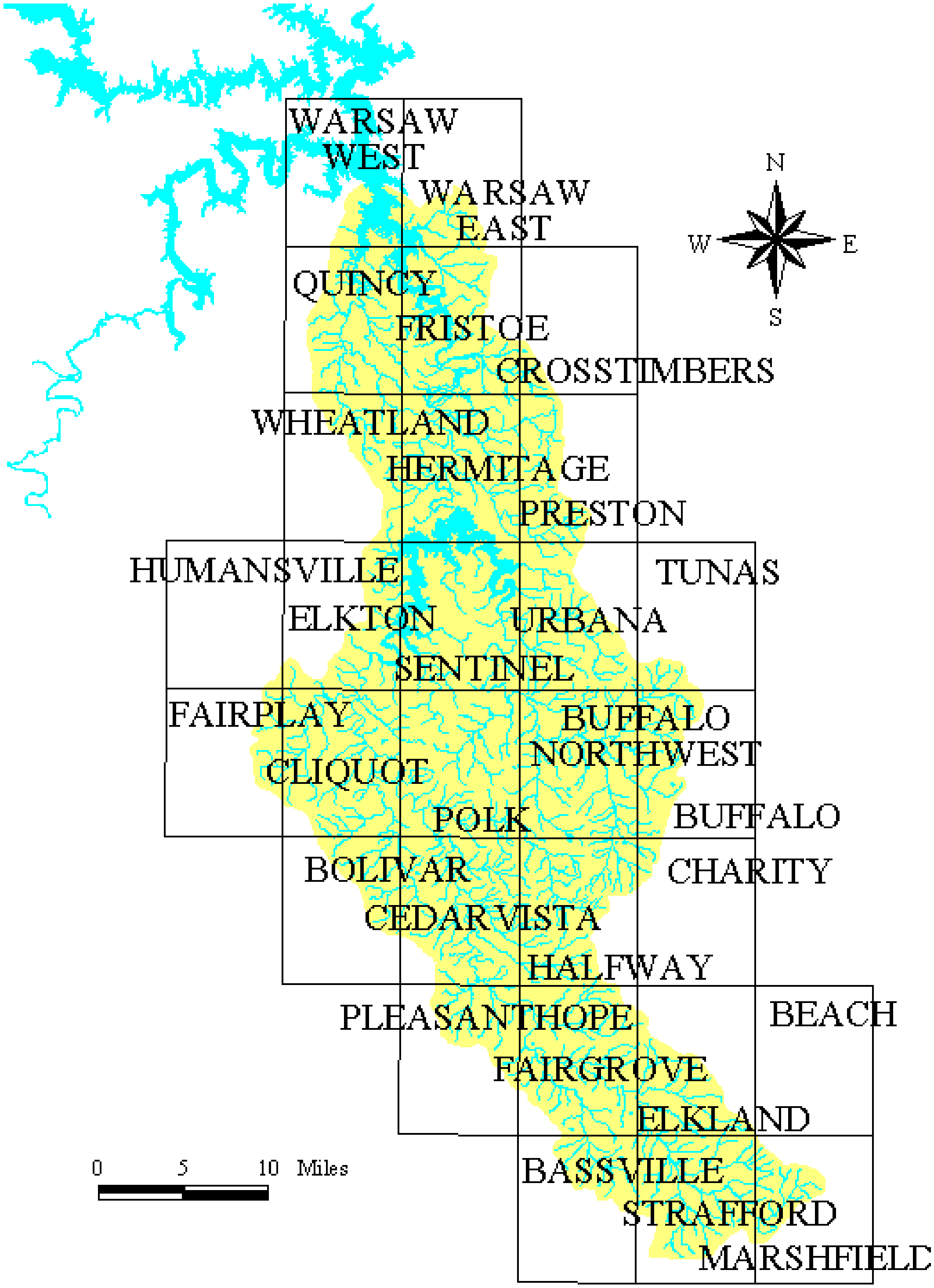


Table GE02. Attributes of third and higher order stream segments in the Pomme de Terre River watershed.

	Hydrologic Unit	Elevation (msl)		Avg. Gradient	Length (miles)				
Stream Name	Number	Begin	End	(ft/mi)	3^0	4^0	5^0	6^0	Tot.
Ashlock Creek	10290107020	891	1145	43.8	2.5				5.8
Brush Creek	10290107030	915	1135	19.8	3.9				11.1
Cedar Hollow	10290107050	784	1017	86.3	0.4				2.7
Clark Branch	10290107050	768	984	74.5	1.6	0.6			2.9
Claude Branch	10290107050	880	1040	45.7	0.3				3.5
Crane Creek	10290107050	732	1080	27.2	5.6	5.2			12.8
-Unnamed #2	10290107050	778	968	86.4	1.0				2.2
-Unnamed #3	10290107050	820	968	82.2	0.7				1.8
Davis Creek	10290107020	847	1090	32.8	4.0				7.4
Deer Creek	10290107020	928	1215	28.7	5.4				10.0
Dry Fork	10290107020	845	1145	20.7	4.4	6.5			14.5
Flint Creek	10290107020	927	110	49.5	2.1				3.7
Green Branch	10290107050	738	1017	66.4	1.2	1.3			4.2
Hominy Creek	10290107020	895	1250	17.6	18.3				20.2
Ingalls Creek	10290107030	843	1115	15.5	13.2				17.6
Jordan Branch	10290107050	725	1050	50.0	2.6	3.1			6.5
Jordan Creek	10290107030	903	1100	33.4	1.7				5.9
Lindley Creek	10290107030	839	1220	11.5	0.4	8.0	21.5		33.2
-Unnamed #4	10290107030	1053	1190	31.1	1.3				4.4
-Unnamed #5	10290107030	947	1185	23.3	2.0	5.4			10.2
-Unnamed #6	10290107030	1027	1175	41.1	0.9				3.6

Little Lindley Cr.	10290107030	958	1190	23.2	5.4				10.0
Little PDT R. (N)	10290107040	738	1050	23.8	1.6	7.4	2.4		13.1
-Unnamed #7	10290107040	794	951	82.6	0.3				1.9
-Unnamed #8	10290107040	853	984	72.8	0.4				1.8
-Unnamed #9	10290107040	869	984	71.9	1.0				1.6
-Unnamed #10	10290107040	889	1017	85.3	0.6				1.5
-Unnamed #12	10290107040	912	1034	67.8	0.5				1.8
Little PDT R. (S)	10290107010	1020	1400	22.0	13.7				17.3
Little Wilson Cr.	10290107010	1003	1285	30.3	5.7	2.1			9.3
McKinney Branch	10290107020	935	1125	37.3	1.5				5.1
Mile Branch	10290107020	907	1168	38.4	3.5				6.8
Mill Creek	10290107050	722	1060	27.3	5.4	0.5	2.5		12.4
-Unnamed #15	10290107040	869	974	58.3	0.7				1.8
-Unnamed 316	10290107040	948	1034	61.4	0.5				1.4
Mutton Hollow	10290107010	1084	1418	34.4	6.4				9.7
North Fork	10290107010	1140	1430	37.2	4.1				7.8
Panther Creek	10290107030	892	1120	24.3	7.2				9.4
Piper Creek	10290107020	865	1120	14.6	3.8	8.3			17.5
-Unnamed #17	10290107020	958	1105	66.8	0.8				2.2
-Unnamed #18	10290107020	1005	1120	31.1	2.5				3.7
Prater Branch	10290107010	1040	1270	43.4	2.5				5.3
PDT River (*)		705	742	1.7				21.3	21.3
PDT River (**)		839	1460	7.9	11.2	20.2	36.5		78.8
Rough Hollow	10290107050	722	935	92.6	0.9				2.3

Schultz Creek	10290107020	955	1235	28.0	1.7	6.0			10.0
-Unnamed 24	10290107020	1065	1270	43.6	1.9				4.7
South Fork	10290107010	1135	1470	41.4	6.5				8.1
Stinking Creek	10290107050	840	1100	32.9	3.9	2.6			7.9
Sycamore Creek	10290107010	975	1130	35.2	1.1	0.7			4.4
-Unnamed #25	10290107010	985	1190	40.2	2.0				5.1
Town Branch	10290107020	937	1120	30.5	3.2				6.0
Unnamed #19	10290107020	879	1100	72.2	1.8				3.2
Unnamed #20	10290107020	915	1095	38.3	1.3				4.7
Unnamed #21	10290107010	980	1170	38.8	1.7				4.9
Unnamed #22	10290107010	1054	1275	40.2	1.1				5.5
Unnamed #23	10290107010	1084	1325	40.2	3.1				6.0
Vanderman Branch	10290107050	814	1001	110.0	0.4	0.6			1.7
Wolf Creek	10290107020	910	1165	35.4	3.6				7.2
	TOTAL				188.0	85.3	62.9	21.3	

***=Pomme de Terre River from Harry S. Truman Lake normal pool level to Pomme de Terre Dam.**

****=Pomme de Terre River from Pomme de Terre Lake normal pool to head of stream.**

Note: Beginning and ending elevations, average gradient, and total lengths were calculated from the mouth to the origin of each stream.

LAND USE

Historic Land Use

In the early 1800s, the Osage, Delaware and Kickapoo Indians inhabited the Watershed. Open, grass-covered woodlands covered most of the Springfield Plateau. Streamside forests were dominated by bottomland tree species, and post oak savanna covered the level uplands. White settlers appeared around the area that is now Springfield in 1818. Bottomland timber was soon cleared in order to grow crops in the fertile soils. The combination of available open range in the uplands and abundant grain production in the bottomlands proved appealing to livestock growers. In 1850, the cattle density on "improved lands" in this area was higher than any other area of Missouri (Currier 1989).

By the end of the 1880s, several railroads were established and grain crops transported to large commercial centers such as Kansas City. As more settlers moved in, the open rangeland was fenced into partitions which resulted in overgrazing. The annual prairie fires that played such an important role in defining the landscape were suppressed, resulting in the encroachment of brush and trees (Currier 1989).

Grain production continued to be the dominant agricultural practice until the early 1900s. Reduced soil fertility and productivity, as well as declining grain prices forced producers to change farming practices. Diversified agriculture and dairy farming dominated the agricultural practices for the region and continue to the present (Currier 1989).

Present Land Use

***Land Use/Cover*.** Grassland covers 53% of the Watershed and forest covers 37% (Table LU01; Figure LU01). Much of the grassland is used as pasture. The Watershed's southern 2/3s (Upper Pomme de Terre , Middle Pomme de Terre and Lindley Creek HUCs) is dominated by grasslands (63%), and the northern 1/3 is dominated by forest (57%) (Table LU02).

***Concentrated Animal Feeding Operations*.** As of February 1997, there were no Class I concentrated animal feeding operations (CAFOs) as classified by the Missouri Department of Natural Resources (MDNR). However, there were 63 Class II CAFOs (Figures LU02). The highest density of CAFOs occurred in the southern part of the Watershed where topography is flatter and there is little public land. Almost half of the CAFOs in the watershed (30) were located in the Upper Pomme de Terre HUC. Dairy farming was prominent; 45 of the 63 CAFOs were permitted dairy operations.

Gravel Removal Operations There are currently fifteen known active gravel removal locations in the Watershed (Table LU03; Figure LU03). Most sand and gravel operations are located directly along stream channels and have the potential for disturbing aquatic life. Results from a recent study from the Arkansas Cooperative Fish and Wildlife Research Unit at the University of Arkansas indicate that instream gravel removal, below the normal high water line, 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 removal locations, stream channel form was altered, resulting in an increase in sedimentation 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,

Figure LU01. Land use/cover in the Pomme de Terre River watershed (MoRAP 1997).

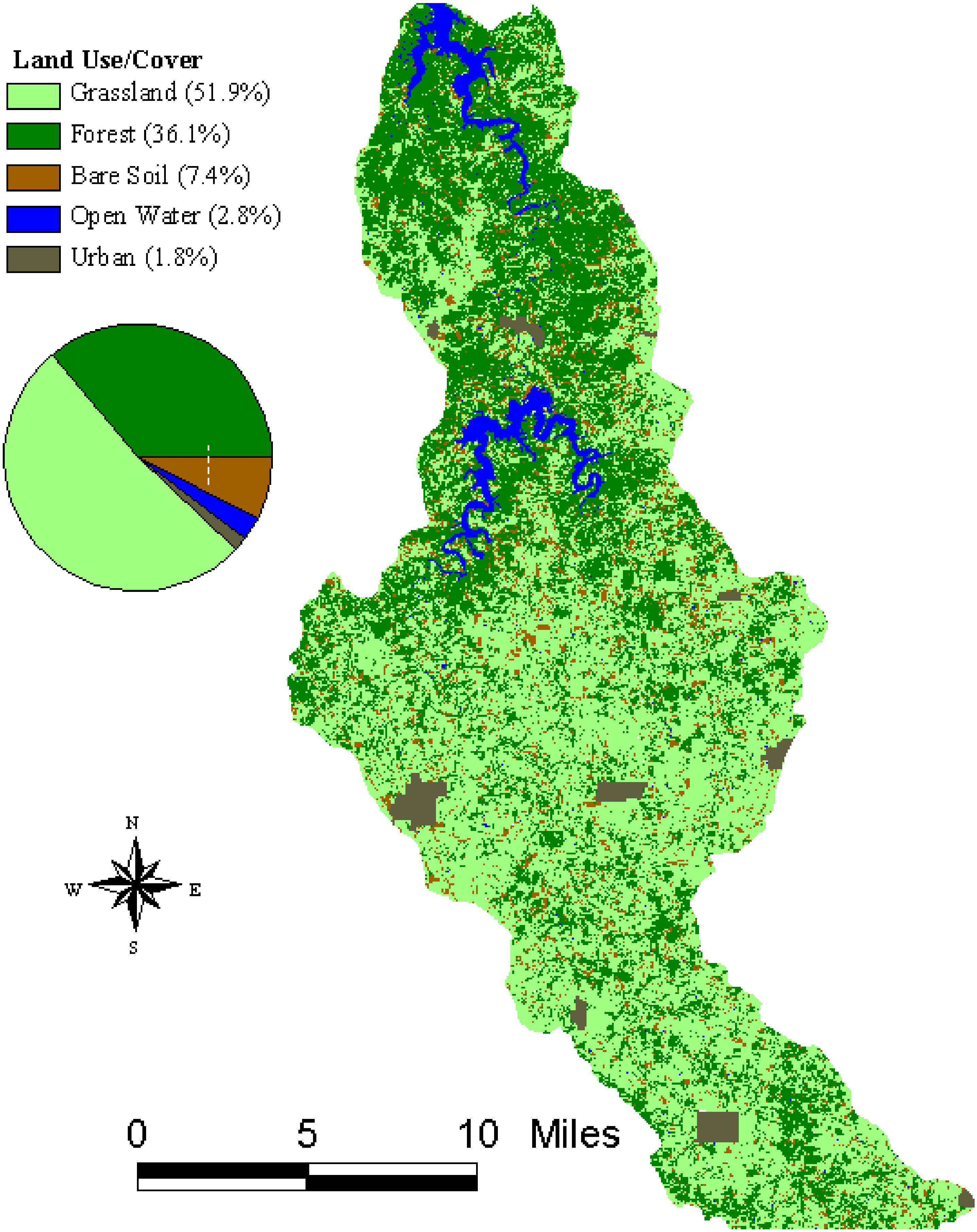


Figure LU02. Concentrated animal feeding operations (CAFOs) in the Pomme de Terre River watershed.

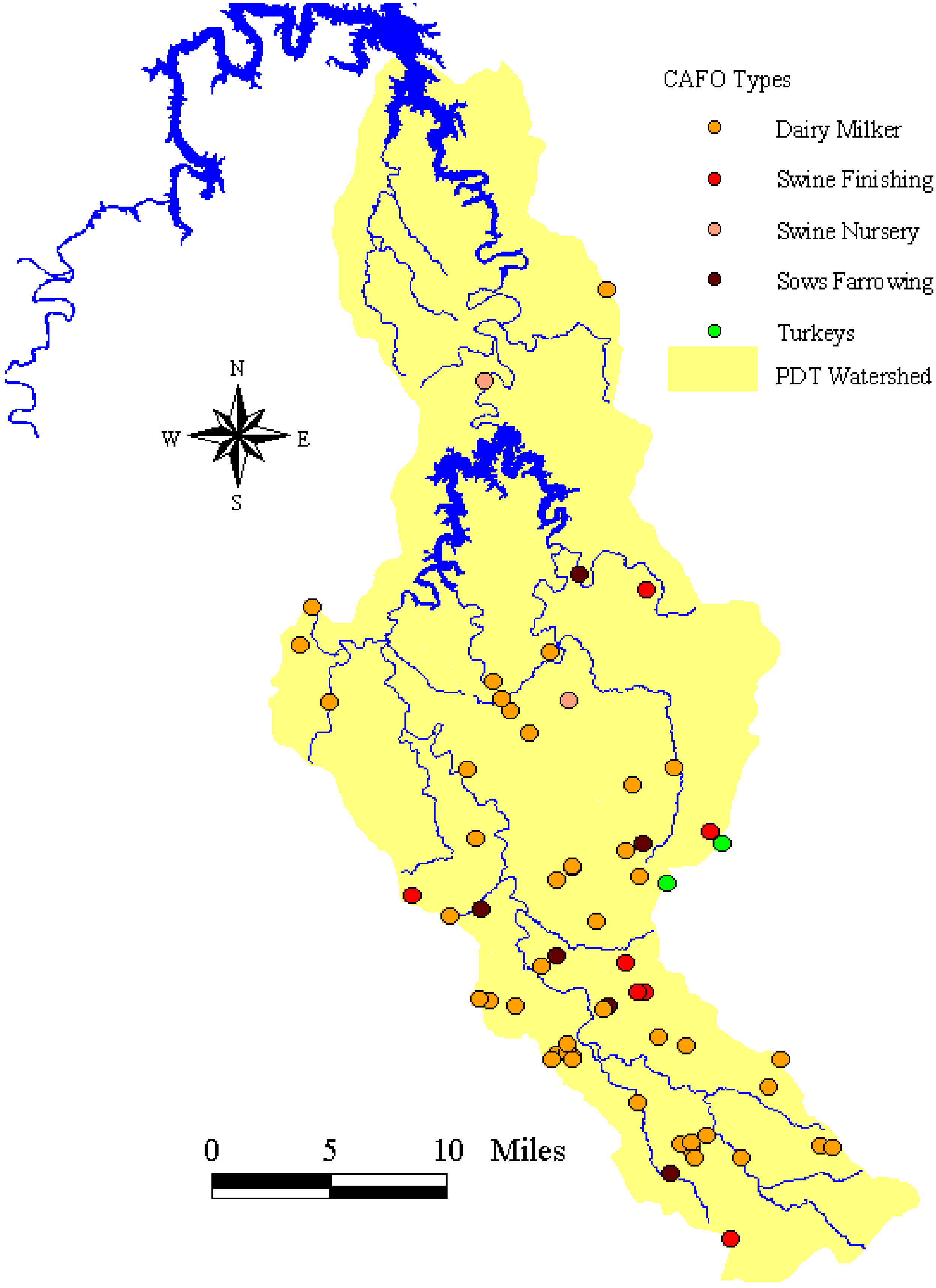
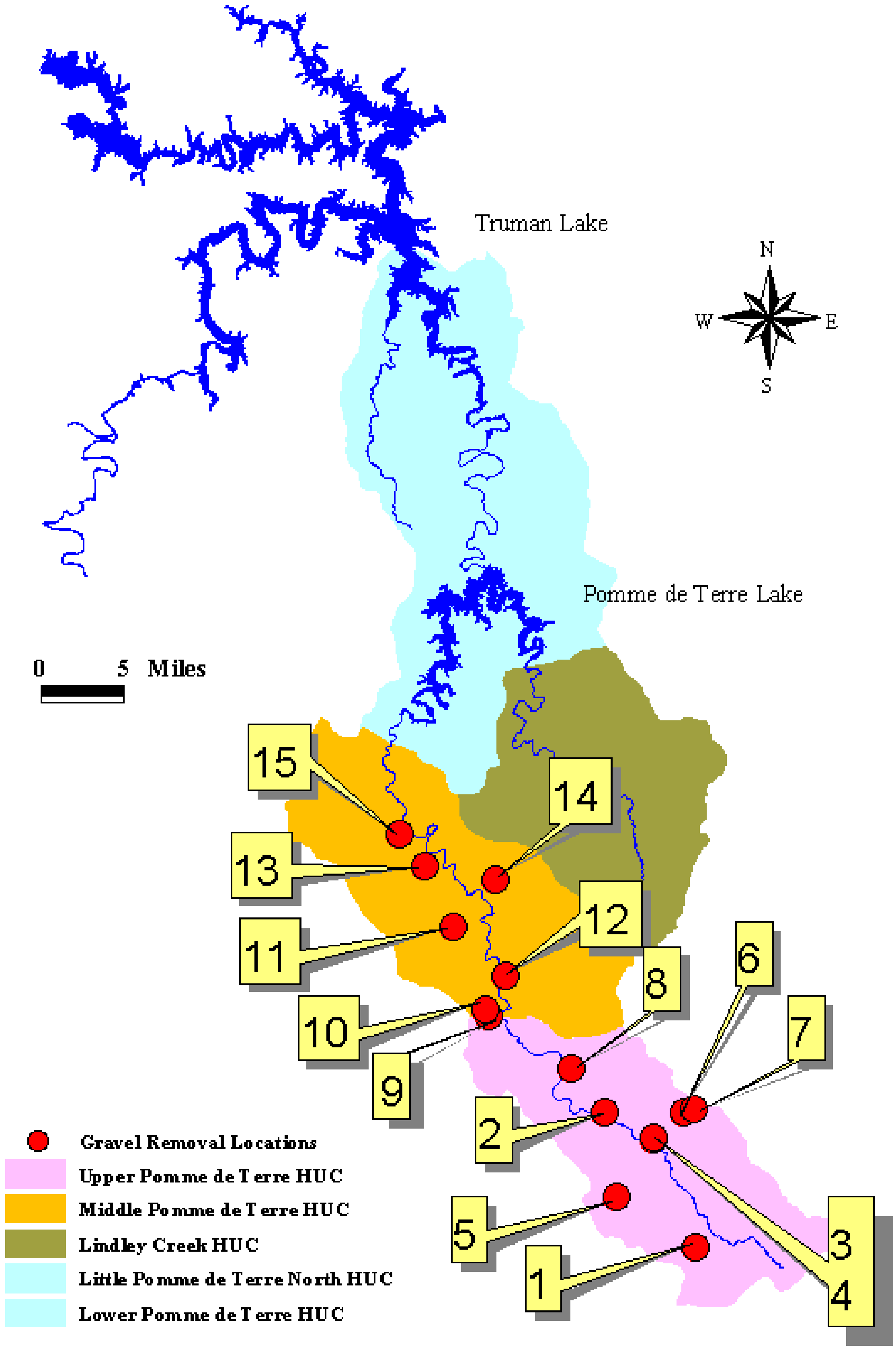


Figure LU03. Known gravel removal locations in the Pomme de Terre River watershed.



Note:Numbers reference table LU03.

Table LU01. Land use/cover in the Pomme de Terre River watershed (MoRAP 1997).

Land Use/Cover	Area (acres)	Percent by Land Use/Cover
Forest	191,691.9	36.1
Grassland	278,481.5	51.9
Urban	9,691.1	1.8
Open Water	15,188.6	2.8
Bare Soil	39,860	7.4
TOTAL	536,913.8	100.0

Table LU02. Land use/cover for the Pomme de Terre River watershed, by HUC (MoRAP 1997).

Land Use/Cover	Area (acres)	Percent by Land Use/Cover
Upper Pomme de Terre HUC		
Forest	32,136.5	28.6
Grassland	70,309.7	62.6
Urban	2,916.1	2.6
Open Water	189.9	0.2
Bare Soil	6,836.9	6.1
TOTAL	112,389.1	100.0
Middle Pomme Terre HUC		
Forest	31,610.3	26.1
Grassland	76,294.0	63.0
Urban	4,267.1	3.5
Open Water	172.2	0.1
Bare Soil	8,825.9	7.3
TOTAL	121,169.4	100.0
Lindley Creek HUC		
Forest	27,143.0	25.8
Grassland	67,615.7	64.2
Urban	1,133.2	1.1
Open Water	235.3	0.2

Bare Soil	9,147.5	8.7
TOTAL	105,274.9	100.0
Little Pomme de Terre North HUC		
Forest	21,696.1	57.1
Grassland	12,852.8	33.8
Urban	161.5	0.4
Open Water	1,266.0	3.3
Bare Soil	2,053.8	5.4
TOTAL	38,030.1	100.0
Lower Pomme de Terre HUC		
Forest	81,106.0	50.7
Grassland	51,409.4	32.1
Urban	1,213.3	0.8
Open Water	13,325.2	8.3
Bare Soil	12,996.5	8.1
TOTAL	160,050.3	100.0

Table LU03. Known gravel removal operations in the Pomme de Terre River watershed.

Number	Stream Name	Permit Date	Permittee	Location T - R - S
1	PDT River	08/26/94	Fair Grove Sand Company	30N 20W S13
2	PDT River	07/06/93	Individual	31N 20W S06
3	PDT River	05/21/93	Individual	31N 20W S16
4	PDT River	02/06/96	Fair Grove Sand Company	31N 20W S16
5	Little PDT River (south)	02/06/96	Fair Grove Sand Company	31N 20W S31
6	PDT River	02/06/96	Individual	31N 20W S02
7	PDT River	01/11/96	Individual	31N 20W S02
8	PDT River	04/13/95	Individual	32N 21W S27
9	PDT River	01/17/95	Individual	33N 22W S11
10	Deer Creek	01/17/95	Individual	33N 22W S11
11	Unnamed	09/14/94	Individual	33N 22W S16
12	PDT River	12/29/95	Bolivar Ready Mix	33N 22W S25
13	Piper Creek	03/14/95	Individual	34N 22W S30
14	Hominy Creek	01/17/95	Individual	34N 22W S35
15	Ashlock Creek	09/14/94	Individual	34N 23W S05

Note: Numbers reference Figure LU03.

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).

Populations and urban expansion. Eleven towns are located in the Watershed (Figure WL01). The largest is Bolivar with a population of 12,000 plus and growing rapidly. The effects of urban sprawl from Springfield, are likely impacting streams in the Watershed, especially those in the upstream (southern) portions. Trend analysis shows that populations levels in five of the six counties encompassing the Watershed are expected to increase more than 19.0% between the years of 1990 to 2020 (Tables LU04 and LU05). Polk and Webster county populations are expected to increase more than 30%. These increases far exceed the statewide projection of 9.0% population growth. The human population in the six-county region encompassing the Watershed is expected to increase by 21.7% from 1990 to 2020. This is 2.4 times the expected statewide increase. Streams in the Watershed are currently being negatively impacted by urban and suburban development (e.g. sewage treatment, runoff, etc.) and the increase in population will, in all likelihood, exacerbate problems. Addressing impacts caused by population growth should be considered a priority for aquatic resource management.

Soil Conservation and Watershed Projects

The Crane Creek Special Area Land Treatment (SALT) project is the only watershed based project in the Watershed. SALT projects are small state funded watershed programs administered by local Soil and Water Conservation Districts. Salt projects are implemented in an attempt to slow or stop soil erosion. The Crane Creek Salt Project was initiated in June 1995. The project area is 8,596 acres with 1,671 pasture land, 267 woodland, and 10 fields with gullies, identified as needing treatment. The project is scheduled to be completed in June of 1999 (Wood, T., Hickory County, NRCS, pers. comm.).

Public Lands

There are 41,113 acres of public land in the watershed including: 39,480 owned by the USACE, 757 owned by the MDNR, and 876 acres owned by the MDC (Figure LU04). MDC leases and manages 11,106 acres of USACE land, 4,019 of these acres surround Pomme de Terre Lake. Access to the majority of this land is limited because many roads and trails to it are in private ownership. Access has also been a limiting factor to management of these areas (Conway, C., MDC, pers. comm.). MDC leases and has management responsibility around Truman Lake, USACE land, including, Little Pomme de Terre (2,176 acres) and Cross Timbers (4,019 acres) wildlife management areas (Gilmore, L., MDC, pers. comm.).

United States Army Corps of Engineers Jurisdiction

The Watershed is under the regulatory authority of the Kansas City District, U.S. Army Corps of Engineers. The USACE is responsible for certain regulation of water courses, some dams, and flood control projects. Permits issued under Section 404 of the Federal Clean Water Act may be required to conduct instream or wetland projects. Applications and questions concerning these permits should be directed to:

U.S. Army Corps of Engineers

700 Federal Building

Kansas City, MO 64106

Figure LU04. Public lands in the Pomme de Terre River watershed.

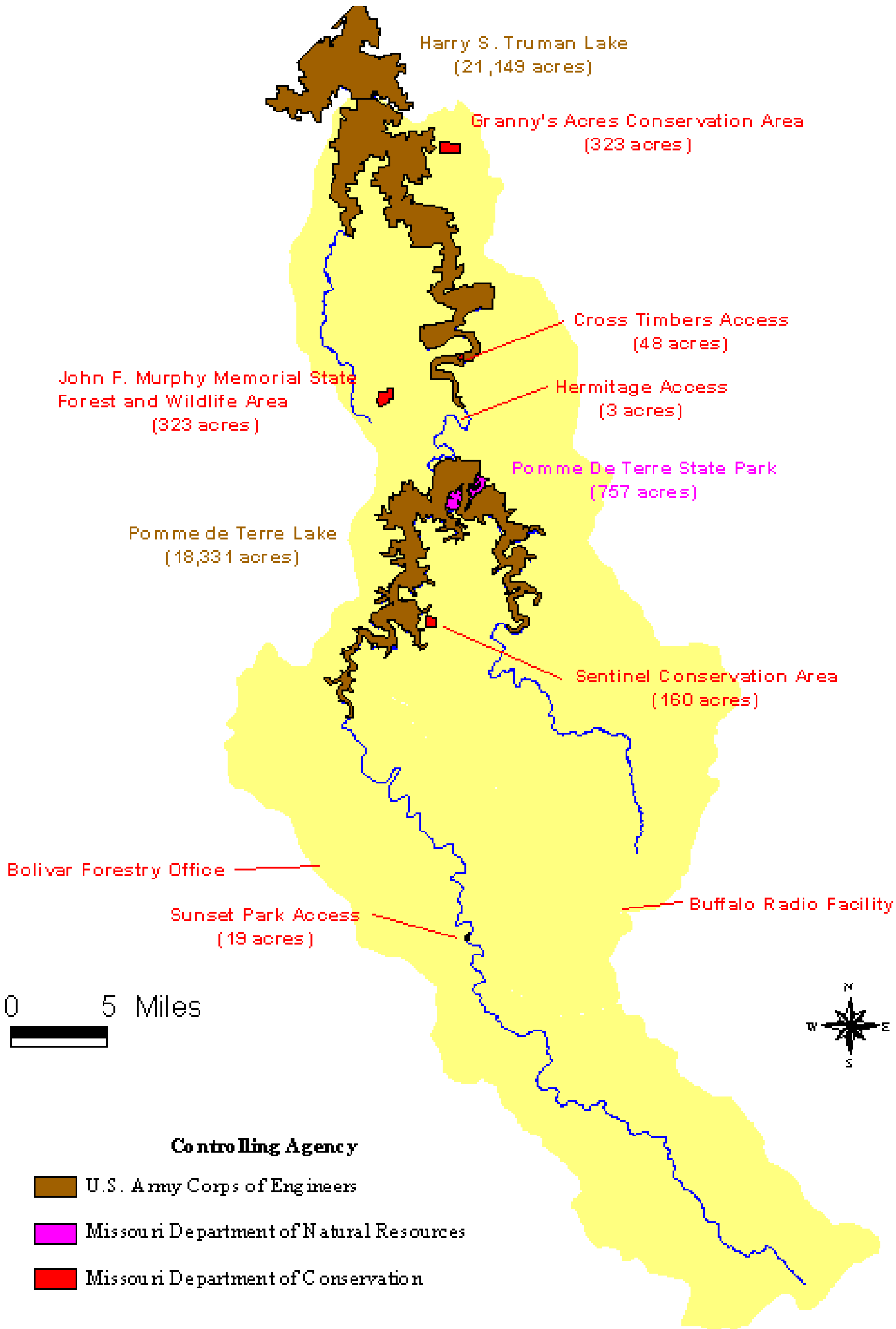


Table LU04. Population projections for Missouri counties that include sections of the Pomme de Terre River watershed (Missouri State Office of Administration 1998).

	POPULATION SIZE BY YEAR*						
COUNTY	1990	1995	2000	2005	2010	2015	2020
Benton	13,859	14,705	15,421	15,992	16,404	16,621	16,629
Dallas	12,646	13,114	13,638	14,210	14,818	15,449	16,073
Green	207,949	218,095	226,590	233,741	239,703	244,597	248,222
Hickory	7,335	7,758	8,103	8,345	8,475	8,499	8,429
Polk	21,826	23,134	24,349	25,484	26,555	27,561	28,441
Webster	23,753	25,239	26,690	28,130	29,517	30,821	31,993
Total	287,368	302,045	314,791	325,902	335,472	343,548	349,787

*****Values for the year 1990 came from the 1990 census. Values for all other years are projections calculated by using birth, death, and migration patterns from 1980 to 1992.

Table LU05. Projected change in population levels for Missouri counties that included sections of the Pomme de Terre River watershed (Missouri State Office of Administration 1998).

	PERCENT INCREASE BY YEAR*					
COUNTY	1995	2000	2005	2010	2015	2020
Benton	6.1	11.3	15.4	18.4	19.9	20
Dallas	3.7	7.8	12.4	17.2	22.2	27.1
Green	4.9	9	12.4	15.3	17.6	19.4
Hickory	5.8	4.7	13.8	15.5	15.9	14.9
Polk	6	11.6	16.8	21.7	26.3	30.3
Webster	6.3	12.4	18.4	24.3	29.8	34.7
Average	5.1	9.5	13.4	16.7	19.5	21.7

* Values for each county and year are in comparison with population levels from 1990 (Table LU04).

HYDROLOGY

Precipitation

The average annual precipitation in Bolivar, MO, is 42.88 inches. An average of 97.5 days will have ≥0.01 inches of precipitation, 28.2 days will have ≥0.05 inches and 11.6 days will have ≥1.0 inches. The average annual snowfall is 12.2 inches.

Gaging Stations

There are three active gage stations in the Watershed maintained by the USGS (Table HY01; Figure HY01). Two other gage stations historically were located on the Pomme de Terre River, however, these were terminated in the mid-1960s (Table HY01). Mean monthly discharges at all currently active stations are the lowest in August and highest in March or April (Table HY02). Flow ceases regularly in Lindley Creek; once every 2 years the discharge at gage station 06921200 will be 0.0 cfs for 7 days (Table HY02; Figures HY02 and HY03) (MDNR 1997).

Dam and Hydropower Influences

There are 10 known large dams (>30 surface acres) located in the Watershed (Table HY03).

Pomme de Terre River has been significantly altered by the construction of PDT and Truman lakes. Both Pomme de Terre and Harry S. Truman dams were constructed as multipurpose projects designed to provide hydroelectric power and flood control. Although Pomme de Terre Dam was designed and authorized to generate electricity, it has not been used for this purpose. Pomme de Terre Lake is being used as part of the Osage River Basin flood protection for the and Truman Lake, and to provide recreational use.

The construction of the two dams has dramatically changed the physical and biological character of the Pomme de Terre River. Table HY04 shows the modifications to the original PDT River channel as a result of construction of the two reservoirs. The segment of river between Pomme de Terre Dam and the historic confluence with the Osage River (total of 41.6 river miles Truman Lake) no longer functions in the same manner as it did before impoundment. From discharge data provided in the USGS Water Resource Data reports for Missouri, it appears that the dam is operated in a manner consistent with a "run-of-the-river" facility with a storage pool (Yeager 1993). Even so, the hydrologic regime of this segment has been altered to the point that it no longer exhibits the naturally fluctuating flow of an unimpounded river (Yeager 1993).

The PDT Arm of Truman Lake at normal pool (706 feet mean sea level (msl)) impounds 20 miles of the preimpoundment PDT River channel. At normal pool elevation (839 ft. msl), Pomme de Terre Lake impounds 18.3 miles of the original Pomme de Terre River channel. This expands to 28.3 miles when the flood pool is at peak capacity (874 ft. msl). In summary, the construction of these two reservoirs inundates 59.6 river miles, or the downstream 46% of the original PDT River channel, when PDT Lake is at normal pool level. When PDT Lake is at flood pool, 69.6 river miles, 54%, of the original Pomme de Terre River channel is impounded.

Nutrient and sediment deprivation are believed to occur in the Pomme de Terre River below Pomme de

Figure HY01. Active USGS gaging stations in the Pomme de Terre River watershed.

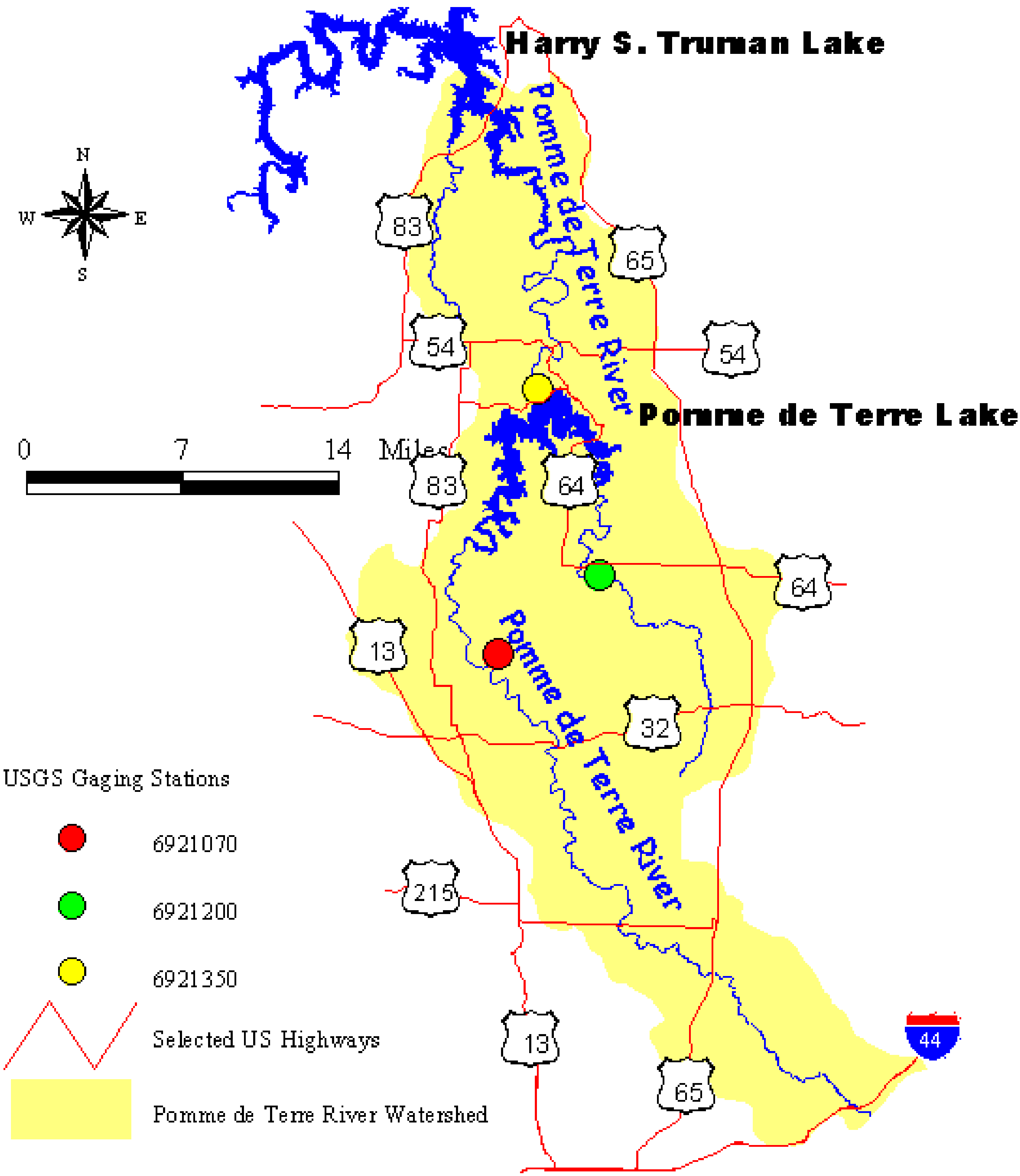
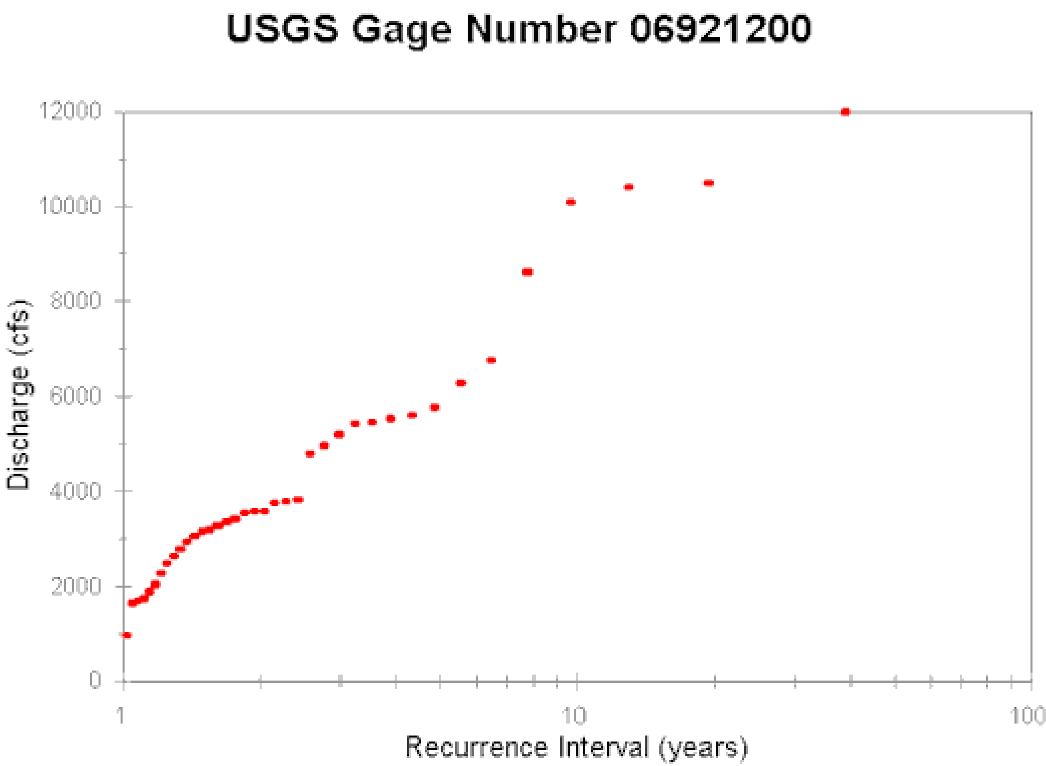
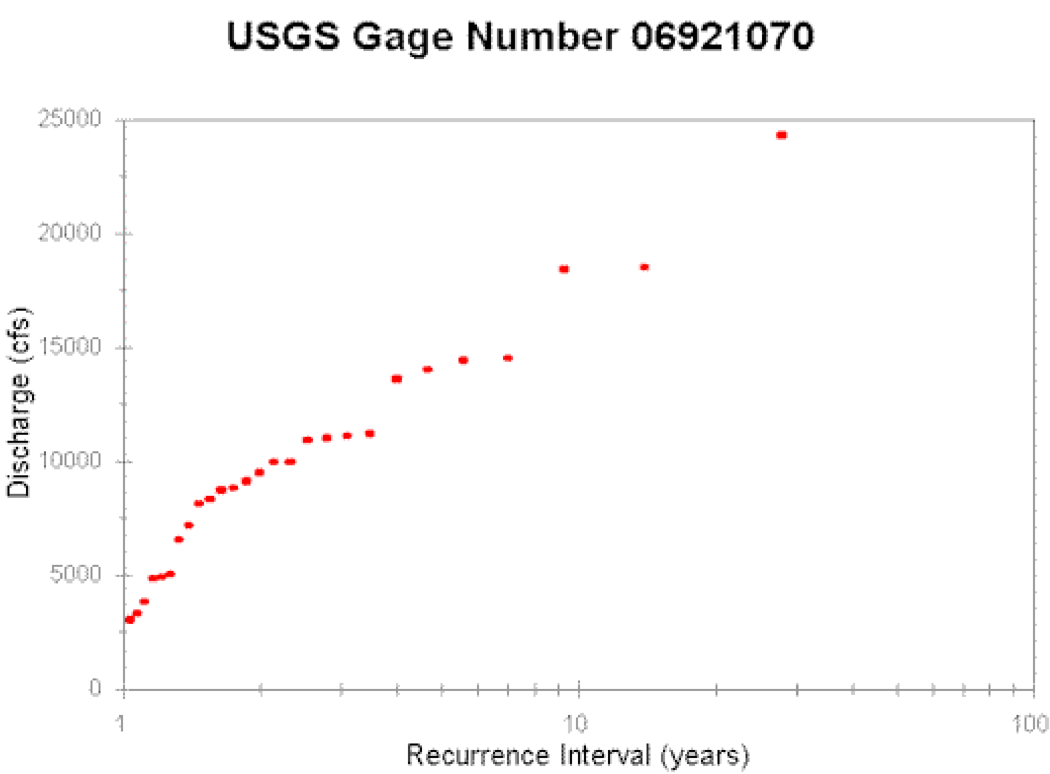
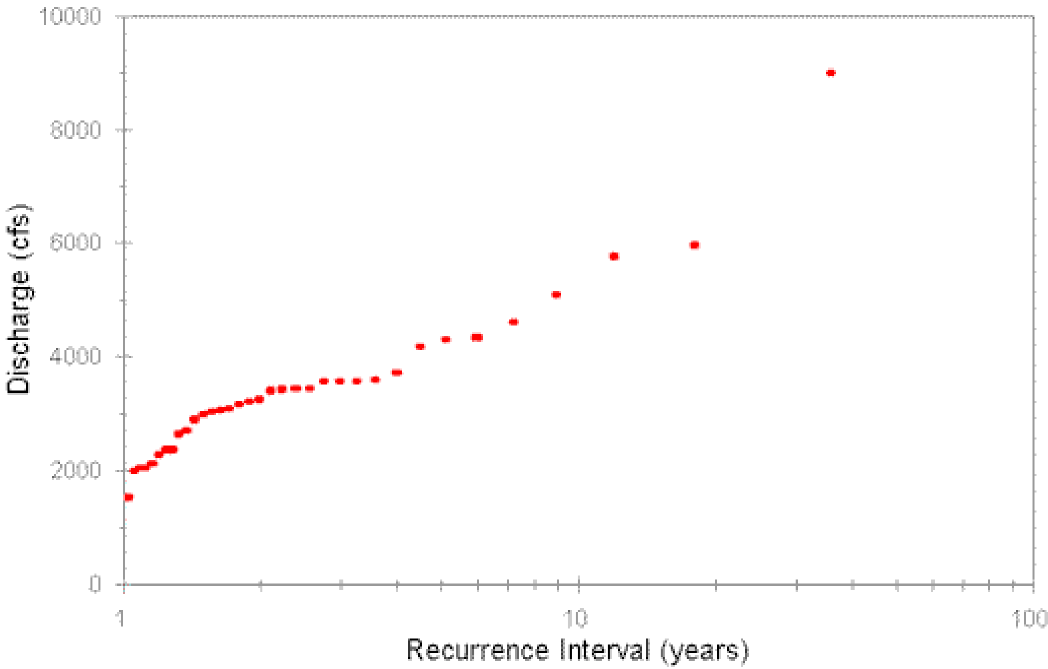


Figure HY02. Annual recurrence intervals for three active USGS gage stations in the Pomme de Terre River watershed.

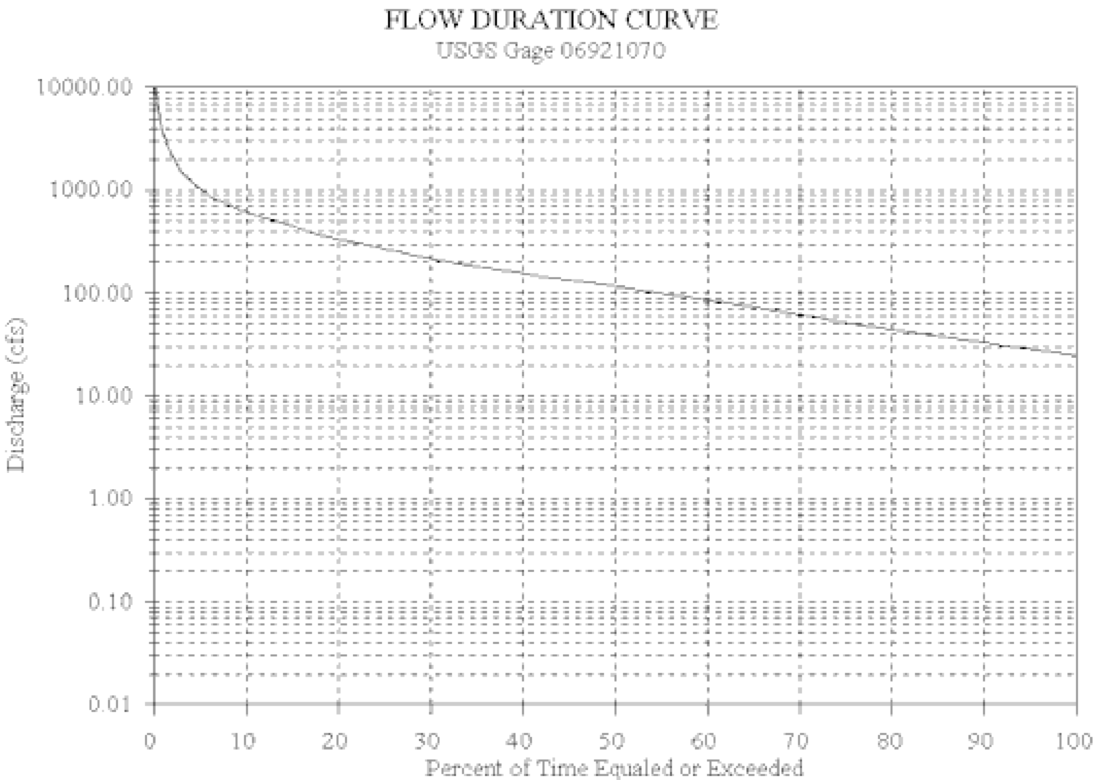


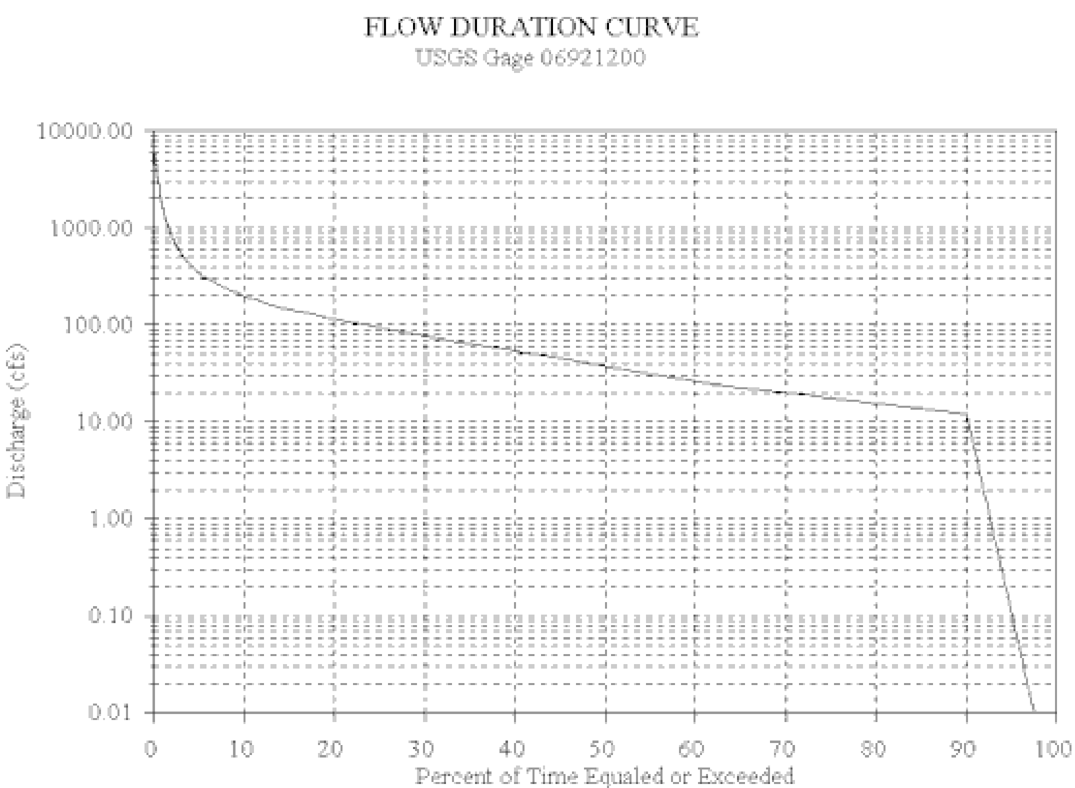


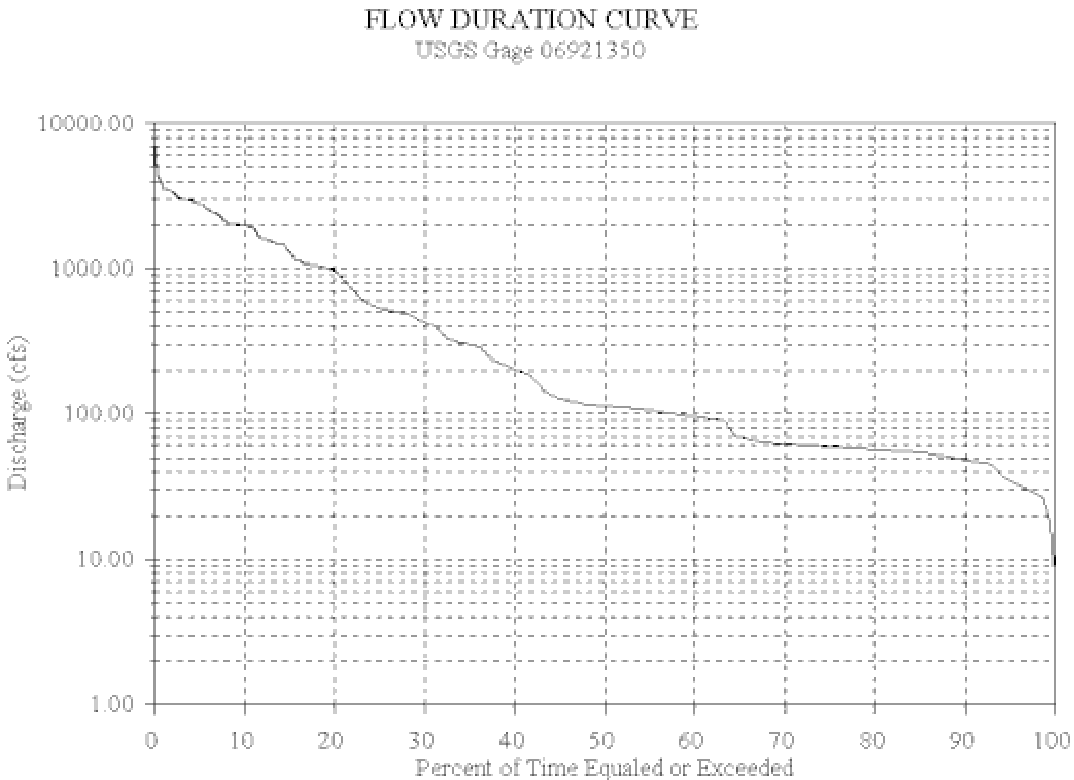
USGS Gage Number 06921350



Flow duration curves at three active USGS gage station locations in the Pomme de Terre River watershed.






FLOW DURATION CURVE
USGS Gage 06921350
Discharge (cfs)
10000.00
1000.00
100.00
10.00
1.00
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Equaled or Exceeded

Terre Dam, as a result of reservoir construction. In its pre-impoundment state, the floodplain served as a source of nutrients, and functioned as a nursery area for young fish. Since 1966, no out of bank flows occur in this portion of the river as a result of dam construction and operation, separating this stretch of the Pomme de Terre River from its floodplain. Pomme de Terre Lake may also be robbing this stretch Pomme de Terre River of nutrient input from the upper watershed. The watershed above the dam once served as the major source of nutrient input, but the nutrients now become trapped in PDT Lake. Hermitage WWTF now supplies this stretch of River with some nutrients, but no studies have been done to compare the current nutrient level with that of the pre-impoundment River.

Sediment deprivation is caused when sediment that once traveled into this stretch of River is now trapped in Pomme de Terre Lake. Sediment that is removed, from the section of River below the Dam, is no longer replaced by upstream sediment. This may be reducing substrate diversity by removing smaller sediment particles more readily than larger particles without replacing them. In their natural state, river channels function as conveyor belts. Sediment that is removed from one section of river is replaced by sediment from upstream. Water with less suspended sediment and bedload, water released from the dam, has more erosive power, and more ability to transport suspended sediment and bedload. The end result in many cases is the removal of substrate particles without replacement from upstream (Kondolf 1997). This in effect reduces the substrate diversity (fewer sizes), which in turn has the potential to reduce the diversity of aquatic life.

Accelerated erosion is problematic in the section of Pomme de Terre River below Pomme de Terre Dam (Dent, R., MDC, pers. comm.). Dam construction and operation have contributed to these problems. Pre-impoundment water level changes were not as dramatic as post-impoundment changes, in this stretch of River. River levels rose and receded relatively slowly, allowing banks to dry out slowly and remain stable. Out of bank flows occurred, allowing the floodplain to absorb much of the energy of flood waters and relieve pressure on stream banks. Post-impoundment river levels can change drastically, in a short time, and are regulated to prevent out of bank flows. Water levels rise and fall quickly. As this occurs the banks do not have time to dry out, and saturated banks, without the support of the water column, are more susceptible to collapse. "Hungry water" exiting Pomme de Terre Dam may also be responsible for increased erosion and bank failure. The term "hungry water" refers to water that is relatively sediment free, with more erosive power. Any sediment carried into the streams above the dam has been deposited in Pomme de Terre Lake. Additionally, extended periods of bankfull flows occur. Extended bank full flows, of relatively sediment free water, are very erosive.

Logjams have been a problem in the section of Pomme de Terre River between PDT Dam and Truman Lake (Dent, R., MDC, pers. comm.). Post-impoundment conditions increase erosion and bank failure, allowing more trees to fall into the river, than might occur naturally. Historically, out of bank flows would periodically remove debris that entered the river and deposit them on the floodplain.

Release water is drawn from the hypolimnetic (lower) portion of Pomme de Terre Lake. At times release water can become low in dissolved oxygen. Artificially low levels of dissolved oxygen negatively impact fish and invertebrates in the section of river directly below the dam.

Key factors influencing the distribution and abundance of stream fishes include: water quality, temperature, physical habitat structure, flow regime, energy sources (food), and biotic interactions (Karr and Dudley 1981). This probably holds true for other aquatic biota as well. Each of these factors in Pomme de Terre River have been altered to one extent or another. This has likely resulted in a biotic

Table HY01. Active and discontinued USGS gaging stations in the Pomme de Terre River watershed.

Gage #	Gage Name	Period of Record	
	ACTIVE STATIONS		
		From	To
06921070	PDT River near Polk	1968	Present
06921200	Lindley Creek near Polk	1957	Present
06921350	PDT River near Hermitage	1960	Present
	DISCONTINUED STATIONS		
Gage #	Gage Name	Period of Record	
		From	To
06921000	PDT River near Bolivar	1950	1969
0692150	PDT River near Hermitage	1921	1965

Table HY02. Mean monthly and annual discharges, and low flow statistics at active USGS gage stations in the Pomme de Terre River watershed.

Gage Number	Mean Monthly Discharge (ft^3/s)											
	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
06921070[1]	285	334	551	551	385	252	79	42	172	155	390	367
06921200[1]	100	126	193	186	160	83	35	15	59	80	112	127
06921350[2]	599	636	862	926	820	626	388	114	143	347	631	748

Gage Number	Mean Annual Discharge (ft^3/s)[1]	7-day Q^2 (ft^3/s)	7-day Q^{10} (ft^3/s)
06921070[1]	296	3.0[2]	0.5[2]
06921200[1]	106	0.0[3]	0.0[3]
06921350[1]	569		

[1]For the period of record for gages 06921070 and 06921200.
For water years 1964 through 1995 for gages 06921350.
[2]For water years 1968 through 1991.
[3]For water years 1957 through 1991.

Table HY03. Dams located within the Pomme de Terre River watershed (EPA 1997).

Dam Name	Normal storage (acres)	Impoundment Name
Jensen Lake Dam	33	
Gordan Lake Dam	35	
Hawk Lake Dam	40	
Hilliard Estates Lake Dam	47	Hilliard Estates Lake
Salisbury Lake Dam	48	Salisbury Lake
Mueller Lake Dam	49	Mueller Lake
Hardeke Lake Dam	81	Hardeke Lake
McNerney Lake Dam	104	Chester Jenkins Lake
Woods Lake Dam	186	
Pomme de Terre Dam	7,820	Pomme de Terre Lake

Table HY04. Modifications to the Pomme de Terre River resulting from the construction of Pomme de Terre and Harry S. Truman lakes.

Stream segment	PDT-Osage River confluence to top of Truman Lake normal pool (706 ft.)
Modification	Inundation by Harry S. Truman Lake, loss of riverine habitat
Distance	20 miles of the original Pomme de Terre River channel
Stream segment	Top of Harry S. Truman Lake normal pool to Pomme de Terre Dam
Modification:	Pomme de Terre Dam release, alteration of hydrologic regime
Distance	21.6 miles of the original Pomme de Terre River channel
Stream segment	Pomme de Terre Dam to PDT Lake normal flood pool level (839 feet)
Modification:	Inundation by Pomme de Terre Lake, loss of riverine habitat
Distance:	18.3 miles of original Pomme de Terre River channel
Stream segment	Top of PDT Lake normal pool level to maximum pool level (874ft)
Modification:	Inundation by Pomme de Terre Lake during flood events
Distance:	10 miles

community that looks very different now than it did before the construction of the two reservoirs. Also, Ryck (1973) reported, "Low temperature discharges through Pomme de Terre Dam have a detrimental effect on the fishery in the tailwaters."

Annual "Water Level Management Recommendations" have been developed by MDC for input to the USACE on Pomme de Terre Lake level management and dam releases since 1985. Table HY05 lists the 1998-99 recommendations and expected benefits. The management objectives of the recommendations are to; 1) improve spawning habitat in the Pomme de Terre River for walleye and white bass from March 10-April 30; 2) improve walleye and white bass fishing during the spring spawning run below Pomme de Terre Dam; 3) increase recreational opportunities for fishing and canoeing in the Pomme de Terre River during summer; 4) improve spawning habitat for prey fishes such as gizzard shad and sport fishes in Pomme de Terre Lake from April 1-June 15; and 5) reduce bank erosion along the Pomme de Terre River during evacuation of flood waters beyond lake elevation 841 ft. msl. The plan has been generally followed, except where exceptionally high inflows and/or high water in downstream reservoirs necessitated deviations.

Desired recreational benefits have been achieved. Flooding of vegetation in PDT Lake during the spawning and nursery period improves reproduction and survival of largemouth bass and gizzard shad. Large year classes of both gizzard shad and largemouth bass have been common in PDT Lake since the plan was initiated. Similar water level manipulations have produced equivalent results in other southern and Midwestern reservoirs (Keith 1975, Groen et al. 1978, Miranda et al. 1984, Fisher and Zale 1991). Spawning conditions for walleye and white bass and stream flows in the river below Pomme de Terre dam have also improved.

Every five years the USACE dewaters the Pomme de Terre River, directly below Pomme de Terre Dam, to inspect the dam structure. The project was last completed in October 1996 and should be repeated in the fall of 2001. High flows (3,000-6,000 cfs) were released from the dam for 10 minutes before a large blocking net was placed across the river. The high flows served to flush fish out of the area directly below the dam. The block net was placed to prevent fish from returning to the area. Flow from the dam was then ceased and a coffer dam built to keep water out of the area. Water was slowly pumped down until the area became dry and the dam structure was examined. MDC personnel assisted in the project by removing trapped fish. Striped bass, hybrid striped bass, white bass, and walleye were transported back to Truman Lake. Black bass, sunfish, and all other fish were transported to Pomme de Terre Lake. Some fish have died due to overcrowding and low dissolved oxygen during dewatering and fish removal (Meade, R., MDC memo, Oct., 8, 1996).

Table HY05. Missouri Department of Conservation 1998-99 Pomme de Terre Lake water level management recommendations.

FALL-WINTER (November-February)	
Recommendations	**Flood releases should not exceed 1,000 cubic feet per second (cfs) and ramping should be utilized so that releases do not exceed a 500 cfs change within a 24-hour period. Evacuation of flood flow releases sooner than anticipated may be necessary to avoid or reduce excessive rises in lake level. Half to three-quarter bank full flows (>2,000 cfs) should be minimized throughout the year.**
Benefits	**Avoiding artificially high flows will prevent excessive bank scour downstream of the dam in the Pomme de Terre River.**
SPRING (March-May)	
Recommendations	**Maintain lake water levels at 2 f.t above normal pool (841 feet mean sea level (msl)). When lake water temperatures reach 45º Fahrenheit, increase outflow to 100 cfs. Spring discharges should be continuous and not exceed 300 cfs. Surface water releases should be utilized as much as possible.**
Benefits	**Elevated water levels will enhance spawning habitat for reservoir fishes from March through May. Limited, continuous releases will improve spawning habitat for walleye and white bass below the dam. Surface water release will maintain favorable water temperatures for river spawning fish.**
SUMMER (June-October)	
Recommendations	**Maintain the lake level at 841 msl until June 15. Beginning June 15, lake may be drawn down to 829 msl if needed for dock maintenance. Discharges above 500 cfs should be avoided. Outflow of at least 100 cfs should be maintained as long as possible through the summer. Lake water may need to be stored following periods of summer inflow, to provide sufficient water for continuous summer releases.**
Benefits	**Maintaining elevated water levels through June will provide sportfish habitat and fishing opportunities in the lake. Drawdown beginning June 15 will allow shoreline vegetation to recover from flooding. Discharges greater than 500 cfs should be avoided to prevent bank erosion below the dam. Maintaining outflows throughout the summer will provide favorable sportfish habitat and fishing and canoeing opportunities below the dam.**

WATER QUALITY

Beneficial Use Attainment

The Clean Water Commission of Missouri identifies livestock and wildlife watering, aquatic life protection, and fishing as beneficial water uses in all classified streams in the Pomme de Terre River watershed. Stream use classifications, according to the 1996 Missouri State Water Law (MDNR 1996) can be found in Table WQ01.

Water Quality Investigations

The Environmental Protection Agency (EPA) monitors water quality throughout the United States and compares the results to a national reference level developed for specific pollutants. Four conventional water quality indicators are routinely reported: ammonia, phosphorus, pH, and dissolved oxygen. Dissolved oxygen is an indicator of available oxygen within the system. The reference levels for these indicators are : ammonia = (recommended chronic levels for ammonia were taken from *Ambient Water Quality Criteria for Ammonia*, EPA 440/5-85-001, p.97 and vary considerably relative to temperature and pH), dissolved oxygen = 5.0 mg/L (in accedence if below this value), pH = 6.0 to 9.0 (in accedence if >9.0 or <6.0) and phosphorus = 0.1 mg/L. Out of 186 observations of phosphorus levels, 49 (26.3%) exceeded the criteria level, and out of 137 ammonia observations, 27 (19.7%) exceeded the criteria level. No observations in pH (n=1,134) or dissolved oxygen (57) exceeded the criteria levels. The EPA lists organic enrichment to be the most prevalent cause of river pollution in the Pomme de Terre watershed and municipal point sources to be the most prevalent source of river pollution.

Point Source Pollution

The Missouri Department of Natural Resources states that six sizeable wastewater discharges exist in the watershed (excluding discharges directly into Pomme de Terre Lake) (MDNR 1996) (Table WQ02). The Fair Grove discharge is within known distribution of Niangua darters. Niangua darters are a federally threatened fish species that are present in the watershed. Niangua darters and Niangua darter critical habitat and range are discussed in more detail in the Biotic Community and Habitat Conditions sections.

Known problem areas associated with municipal waste water treatment facilities (WWTF) include Lindley Creek seriously polluted for 4.5 miles downstream of the Buffalo WWTF discharge (Ryck 1973). The problems associated with the Buffalo WWTF were still evident in 1998 (John Ford, MDNR, pers. comm.). A report by MDC (MDC 1978) also listed this portion of Lindley Creek as being negatively impacted by excessive aquatic plant growth resulting in a reduction of aquatic life. As of March 1997 there were 54 NPDES facilities within the watershed (Figure WQ01). Table WQ03 gives a breakdown of the number of NPDES permits per subwatershed.

Fifty-four National Pollution Discharge Elimination System (NPDES) permits are currently active in the Watershed. Most of these permits are located in areas with higher human population densities. Sixty-five percent of the NPDES permits are located in the the Middle and Upper Pomme de Terre hydrologic units (Figure WQ01).

Non-point Source Pollution

Eutrophication is a problem in most Watershed streams as evidenced by the number that have heavy,

Figure WQ01. Location of permitted NPDES sites in the Pomme de Terre River watershed by treatment type.

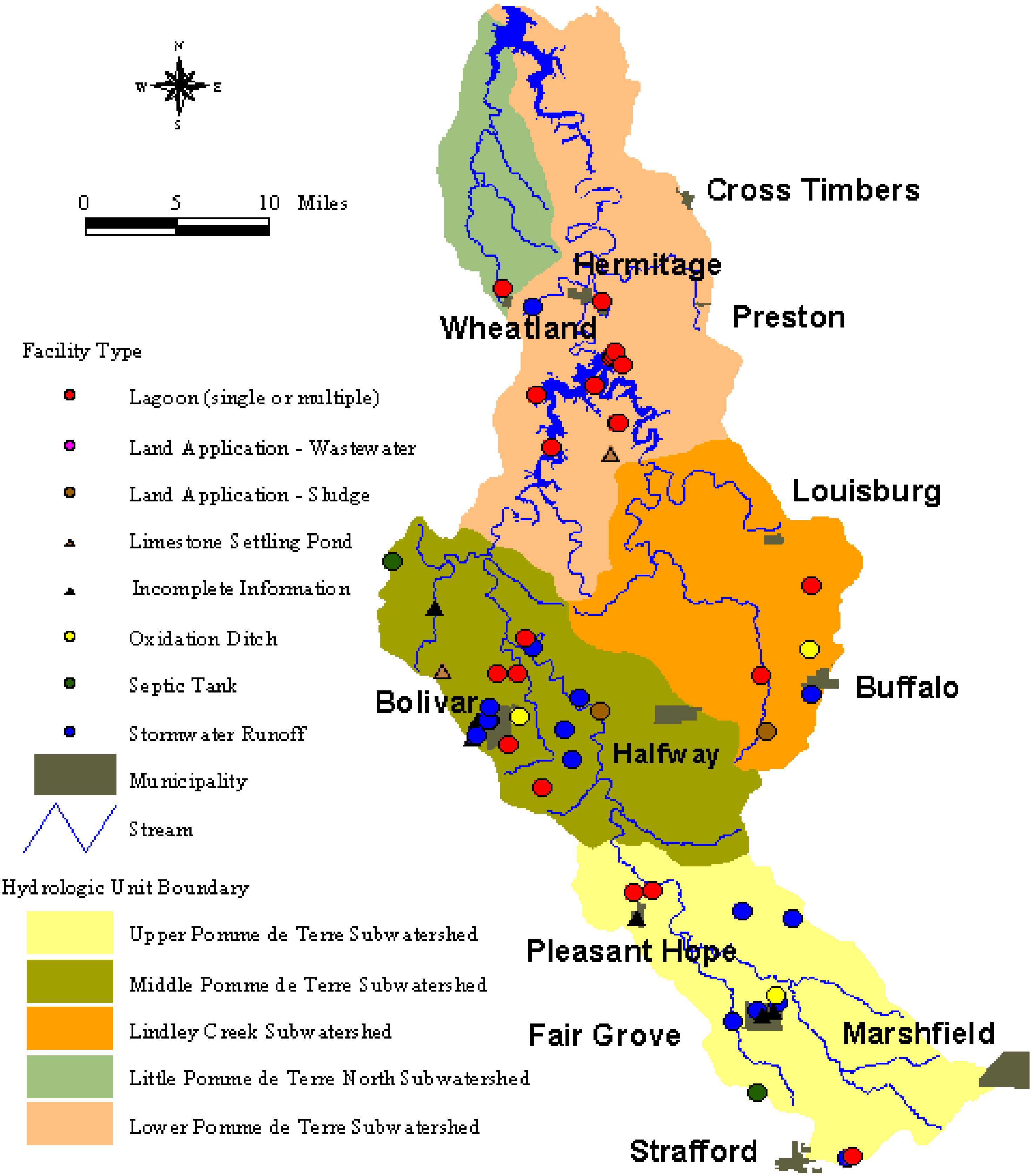


Table WQ01. Beneficial use designations for streams in the Pomme de Terre River watershed (MDNR 1996).

Waterbody	Mi.	From	To	County	Beneficial use
PDT	21.0	Mouth	PDT Dam	Hickory	ALL
PDT	62.0	35N 23W 24	30N 18W 07	Polk	LW,AL,CF,BC
Crane Creek	6.9	Mouth	36N 21W 04	Hickory	LW,AL
Crane Creek	3.4	36N 21W 04	36N 21W 12	Hickory	LW,AL
Trib. to Crane Creek	0.4	Mouth	36N 21W 01	Hickory	LW,AL
Trib. to Crane Creek	0.2	Mouth	36N 21W 01	Hickory	LW,AL
Trib. to Crane Creek	0.1	Mouth	37N 21W 32	Hickory	LW,AL
Trib. to Crane Creek	0.7	Mouth	37N 21W 29	Hickory	LW,AL
Trib. to Crane Creek	1.2	Mouth	37N 21W 34	Hickory	LW,AL
Trib. to Crane Creek	0.9	Mouth	36N 21W 14	Hickory	LW,AL
Trib. to Crane Creek	0.6	Mouth	36N 21W 14	Hickory	LW,AL
Davis Creek	2.5	Mouth	34N 22W 06	Polk	LW,AL
Deer Creek	4.0	Mouth	32N 21W 04	Polk	LW,AL
Dry Fork Creek	7.0	Mouth	34N 23W 08	Polk	LW,AL
Dry Fork Creek	1.0	34N 23W 08	34N 23W 08	Polk	LW,AL
Hominy Creek	12.5	Mouth	33N 21W 15	Polk	LW,AL
Ingalls Creek	6.2	Mouth	35N 21W 01	Hickory	LW,AL
Jordan Branch	1.0	Mouth	37N 22W 11	Hickory	LW,AL
Jordan Branch	2.0	Mouth	37N 22W 15	Hickory	LW,AL
Little Lindley Creek	3.0	Mouth	34N 20W 15	Dallas	LW,AL
Little Mill Creek	4.8	Mouth	38N 21W 33	Hickory	LW,AL
Trib. to Little Mill Creek	0.6	Mouth	38N 22W 24	Hickory	LW,AL
Little PDT (south)	6.0	Mouth	31N 21W 25	Polk	LW,AL
Little PDT (north)	14.9	Mouth	37N 23W 03	Benton	LW,AL,WC,BC

Little PDT (north)	7.0	Mouth	38N 23W 22	Benton	ALL
Trib. to Little PDT (n)	1.6	Mouth	38N 22W 09	Benton	LW,AL
Little Wilson Creek	3.5	Mouth	32N 21W 25	Polk	LW,AL
Little Wilson Creek	2.0	32N 21W 25	32N 20W 32	Dallas	LW,AL
Lindley Creek	22.0	Mouth	34N 20W 20	Hickory	LW,AL
Lindley Creek	2.0	34N 20W 20	34N 20W 32	Dallas	LW,AL
Trib. to Lindley Creek	3.0	Mouth	35N 20E 34	Dallas	
Mill Creek	1.5	36N 18W 09	36N 18W 08	Dallas	
Mill Creek	6.2	Mouth	37N 21W 09	Hickory	LW,AL
Mill Creek	2.8	37N 21W 09	37N 21W 15	Hickory	LW,AL
Trib. to Mill Creek	0.3	Mouth	37N 21W 14	Hickory	LW,AL
Trib. to Mill Creek	0.8	Mouth	37N 21W 16	Hickory	LW,AL
Montgomery Branch	6.5	38N 23W 15	37N 22W 06	Hickory	LW,AL
Mutton Hollow	2.5	Mouth	31N 20W 13	Greene	LW,AL
Piper Creek	7.5	Mouth	Highway 83	Polk	LW,AL
Trib. to PDT	1.2	Mouth	36N 22W 30	Hickory	LW,AL
South Fork PDT	4.0	Mouth	30N 20W 25	Greene	LW,AL,WC,BC
Schultz Creek	5.0	Mouth	32N 21W 10	Polk	LW,AL
Self Branch	1.0	Mouth	31N 20W 15	Greene	LW,AL
Stick Branch	0.2	Mouth	36N 21W 21	Hickory	LW,AL
Stinking Creek	1.0	Mouth	35N 22W 22	Polk	LW,AL
West Fork	1.0	Mouth	34N 23W 07	Polk	LW,AL

Beneficial uses: LW= livestock & wildlife watering; AL= protection of warm water aquatic life and human health-fish consumption; CF= cool water fishery; WC= whole body contact; BC= boating and canoeing.

Table WQ02. Municipal waste water treatment facilities in the Pomme de Terre River watershed, excluding those that discharge directly to Pomme de Terre Lake (MDNR 1996).

Facility Name	Receiving Stream	Discharge Amount Million Gallons per Day (MGD)	Known Impacts
Hermitage WWTF	PDT River	0.03	No known impacts
Unnamed WWTF	Crane Creek	minimal	Impacts not assessed
Bolivar WWTF	Town Branch and Piper Creek	1.3	Impacts up to 2 mi. of receiving streams
Buffalo WWTF	Little Lindley Creek	0.25	Serious impacts to 1 mi. unclassified stream and 0.5 mi. classified stream
Fair Grove WWTF	PDT River	0.1	Minor sludge, solids deposition
Pleasant Hope	PDT River tributary	0.01	

Table WQ03. Number of NPDES facilities in the Pomme de Terre River watershed, by HUC.

Subwatershed	Number of Facilities
Upper Pomme de Terre	15
Middle Pomme de Terre	20
Lindley Creek	5
Little Pomme de Terre North	1
Lower Pomme de Terre	13
TOTAL	54

thick filamentous algae concentrations. Most streams are being impacted by runoff from livestock grazing. Cattle have free access to streams in most cases. The MDNR (1994) stated that, "there has been a trend of increasing numbers of dairy cattle in the southern portion of the basin (Osage River Basin). Many of these dairies are not adequately managing animal wastes and it is running off into spring branches and streams," A major non-point source can be found just southeast of Bolivar where a new golf course is being built. Siltation has been a major problem in Piper Creek during construction of this golf course.

The largest decline in stream quality of the Pomme de Terre River between the highway D crossing and PP crossing occurs as a result of waters received from Piper Creek. In August 1996 water above the Piper Creek confluence was noticeably clearer compared to below the confluence where floating mats of algae could be seen and slack water areas had a surface film of "scummy algae." Field observations of Piper Creek confirmed this stream is being impacted by eutrophication. Suspected sources include point sources in the Bolivar area, golf course construction and fertilizer application, and cattle with free access to streams.

Fish Kills and Pollution Incidents

Several fish kills have been reported throughout the Watershed since the early 1970s (Table WQ04). One, a 1991 Pomme de Terre River fish kill in Webster County, occurred in the upper known range of the Niangua darter. Although no Niangua darters were reported killed, this exemplifies the potential threats not only to successful recovery of this threatened species, but to all aquatic biota inhabiting streams in the Watershed. Fish kills have been a problem in Pomme de Terre Lake in the 1990s.

Consumption Advisories

Fish consumption advisories are published annually by the Missouri Department of Health. The most recent (MDOH 1998) advisory states that all fish are safe to eat in any amount from lakes and streams in the Ozarks. This includes all streams and lakes in the Watershed.

Stream Teams

Missouri STREAM TEAMs are volunteers who help protect streams throughout the state. STREAM TEAMs are supported by MDC, MDNR, and the Conservation Federation of Missouri. There have been four STREAM TEAMs active in the watershed. Their efforts include litter clean-up, water chemistry and macroinvertebrate sampling, tree planting for bank stabilization, and stream inventories. The STREAM TEAM 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.

Table WQ04. Fish kills and pollution incidents in the Pomme de Terre River watershed, including Pomme de Terre Lake (MDC Fish kill reports, MDNR 1994 and 1989, and Ryck 1974).

Waterbody	County	Date	Known Extent	Cause	Number Killed
Pomme de Terre Lake	Hickory	05/11/98		Undetermined	300+
Pomme de Terre Lake	Hickory	07/97		Columnaris	no est.
Pomme de Terre Lake	Hickory	05/20/97		Protozoan	250
Pomme de Terre Lake	Hickory	11/96		Protozoan	no est.
Pomme de Terre River	Hickory	11/30/96	1 mi.	Undetermined	5
Pomme de Terre Lake	Hickory	01/29/96		Protozoan	7,000+
Pomme de Terre Lake	Hickory	Spring 95		Undetermined	95% of adult white bass
Pomme de Terre Lake	Hickory	10/07/94	7,820 acres	Parasite (protozoan)	1,000+
Pomme de Terre Lake	Hickory	09/24/94	7,820 acres	Disease	no est.
Pomme de Terre Lake	Hickory	09/24/94	1.4 mi.	Protozoan	1,880+
Piper Creek	Polk		0.5 mi.	Suspended solids from Bolivar WWTF	
Little Lindley Creek	Dallas		1.0 mi.	Sewage from Buffalo WWTF	
Trib. to Little Wilson Creek	Dallas	10/28/93		Diesel fuel	

Jordan Branch	Hickory			Sediment	
Pomme de Terre River	Polk	02/21/93		Oil	
Pomme de Terre River	Webster	08/14/91		Agriculture, low D.O.	495
Crane Creek	Hickory	01/13/89		Tanning & other waste	
Trib. to Mile Branch	Polk	01/26/80		Gasoline	
Pomme de Terre River	Hickory	07/07/78		Crude oil	
Pomme de Terre River	Webster	05/17/78		Magnesium alloy	
Lindley Creek	Dallas	00/00/71	0.5 mi.	Municipal waste	
Lindley Creek	Dallas	00/00/71	1.0 mi.	Municipal waste	
Wilson Creek	Greene	00/00/71	5.2 mi.	Municipal pollution	
Wilson Creek	Greene	00/00/71	7.4 mi.	Industrial pollution	

HABITAT CONDITIONS

Stream Habitat Assessment

The purpose of this section is to give a general, qualitative description of stream morphology and streamside forest conditions in the Pomme de Terre River watershed. The Upper Pomme de Terre HUC is given the most emphasis because of the presence of Niangua darters, a federally threatened species, and federally designated Niangua darter critical habitat.

Two different methods were used to qualitatively describe selected instream habitat parameters. One method was identical to that used by Sue Bruenderman (Fisheries Research Biologist, Missouri Department of Conservation) and the other was MDC's Stream Habitat Annotation Device (SHAD). Sites used for characterizations are shown in Figure HC01. Habitat descriptions are site specific and do not necessarily represent habitat conditions outside of the evaluation site.

Pomme de Terre River watershed

Generally, stream bank stability in the watershed is good with the exception of localized erosion (Figure HC02). Streambank stability was listed as good at 56.1% of the sites surveyed followed by, poor (22.0%), fair (17.1%), and excellent (4.9%).

Algae concentrations were also recorded at 35 locations throughout the watershed (Figure HC03). The portion of the watershed above Pomme de Terre Lake had more records of heavy and moderate algae concentrations than sites below Pomme de Terre Dam. Forty percent of the sites above Pomme de Terre Dam had light or no algae concentrations, followed by 36% with heavy algae concentrations, and 24% with moderate concentrations. Sample sites below Pomme de Terre Dam had light or no algae concentrations recorded at 90% of the sites and moderate algae concentrations at 10% of the sites.

Algae concentration differences between the two portions of the watershed can probably be attributed to several factors. One, grassland land use/cover and grazing is more prevalent in the watershed above Pomme de Terre Lake. Land use/cover above Pomme de Terre Dam consists of grassland (57.4%), forest (33.2%), bare soil (7.4%), and urban (2.0%). Land use/cover below the dam consists of forest (57.2%), grassland (36.8%), bare soil (4.9%), and urban (1.1%) (MoRAP 1997). Grazing in riparian corridors was noted at most habitat evaluation sites above Pomme de Terre Dam. These conditions present more nutrient sources (manure) and allow for direct nutrient runoff into streams. There is more public land along streams below the Dam, a factor limiting the number of cattle with stream access. Another factor limiting algae growth below the dam may be that Pomme de Terre Lake functions as a nutrient sink. Nutrient inputs above the dam are stored in the lake bottom and water leaving the reservoir may be nutrient deficient. This nutrient sink effect may be robbing the Pomme de Terre River of nutrients in the stretch between Pomme de Terre Dam and Truman Lake. Reduced water clarity in Pomme de Terre Lake, from increased plankton production, has been observed in recent years, though no studies have been conducted to document the source or the extent of these changes (Meade, R., MDC, pers. comm.)

Riparian corridors were evaluated using digital Phase I land use/cover data (MoRAP 1997). Four-hundred foot corridors (200 ft. on both sides of the stream midline) were determined for second order and larger streams, and the land use/cover (forest, grassland, bare soil, and urban) percentage was determined (Table HC01). This data is good to the point that it considered all streams to be the same

Figure HC01. MDC 1996-97 fish, habitat, and water quality sample sites in the Pomme de Terre River watershed.

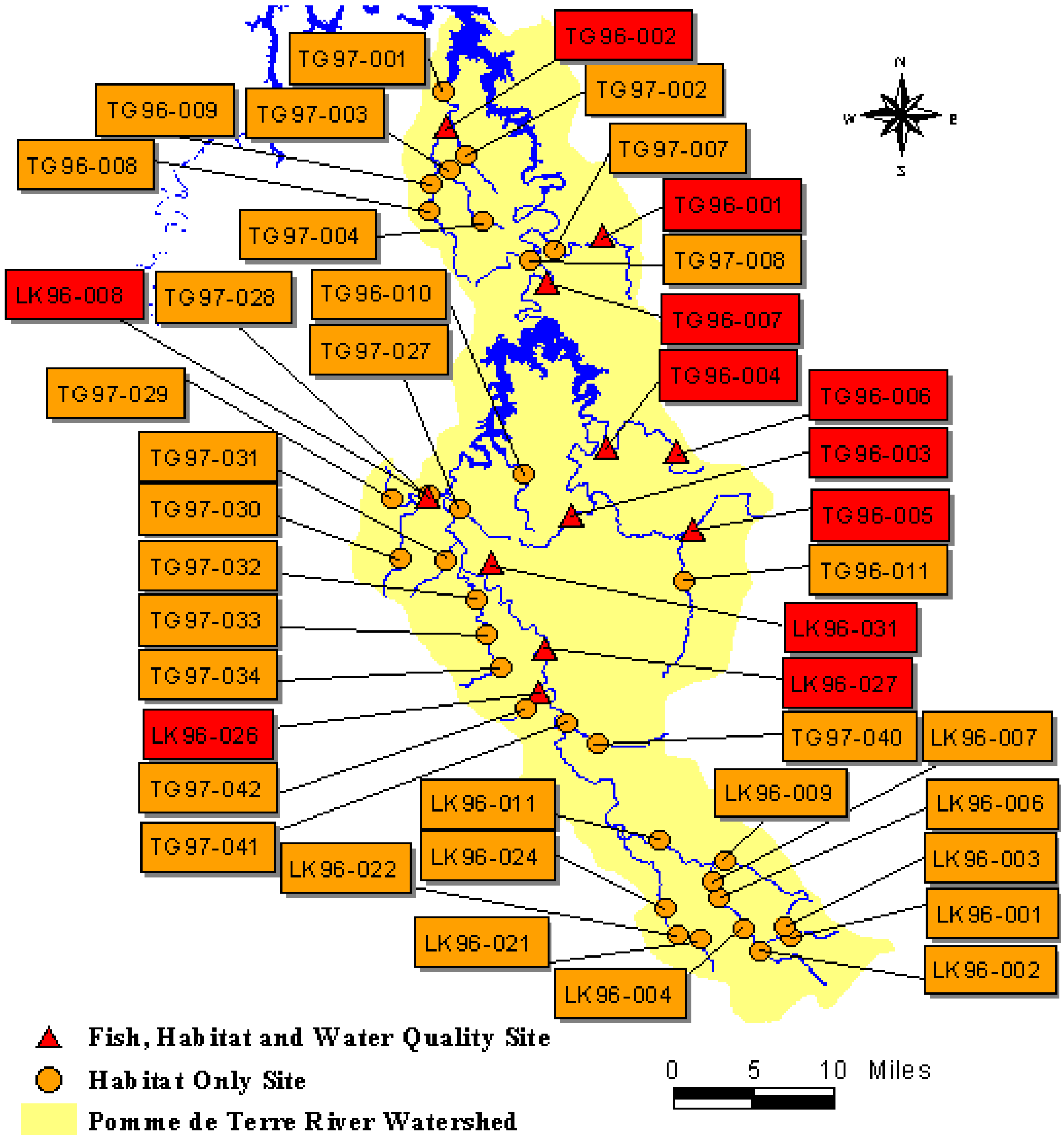


Figure HC02. Streambank stability rankings at habitat evaluation and fish sample sites, 1996-97, in the Pomme de Terre River watershed.

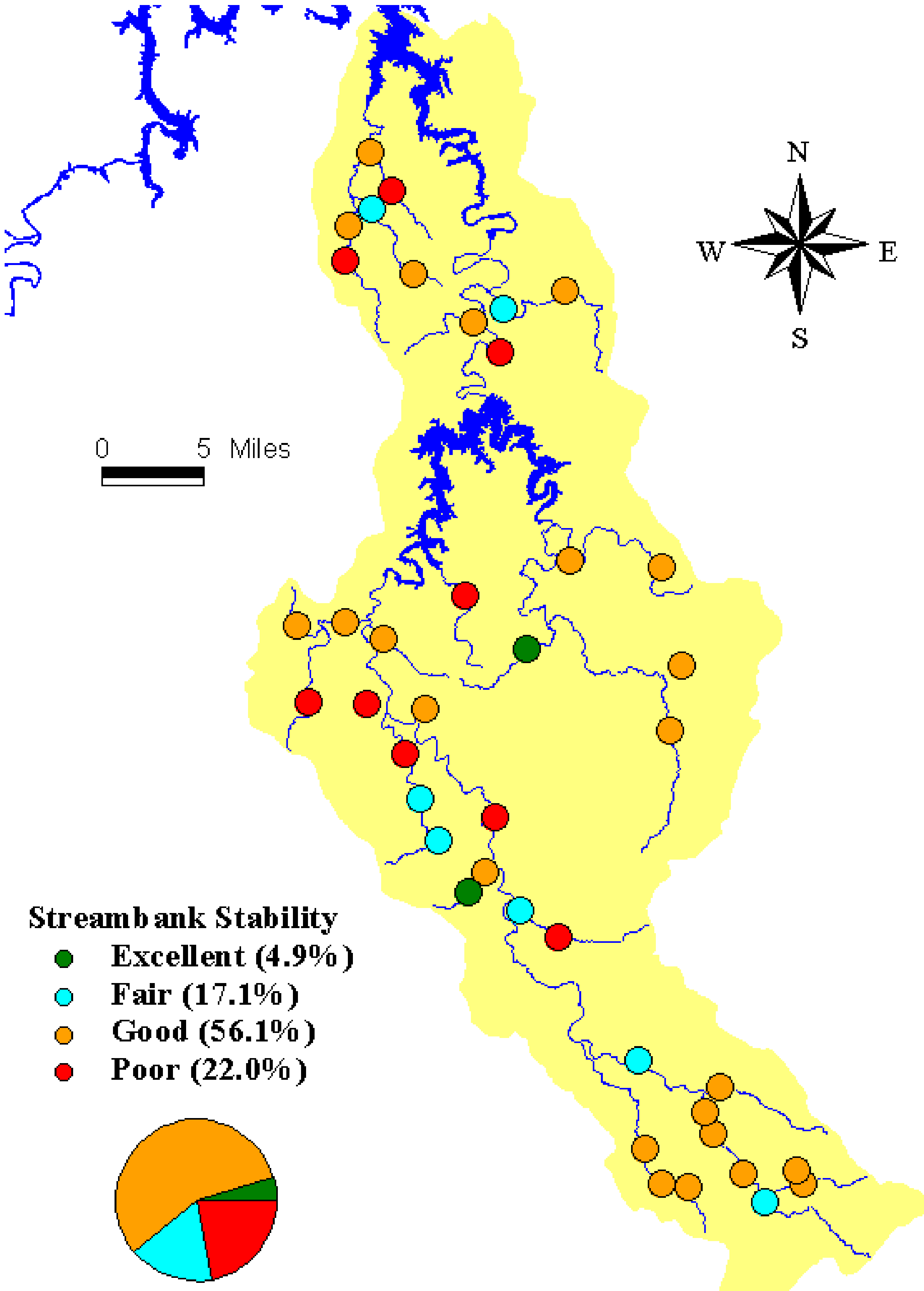


Figure HC03. Qualitative evaluation of algae concentration recorded at1996-1997 habitat sample sites in the Pomme de Terre River watershed.

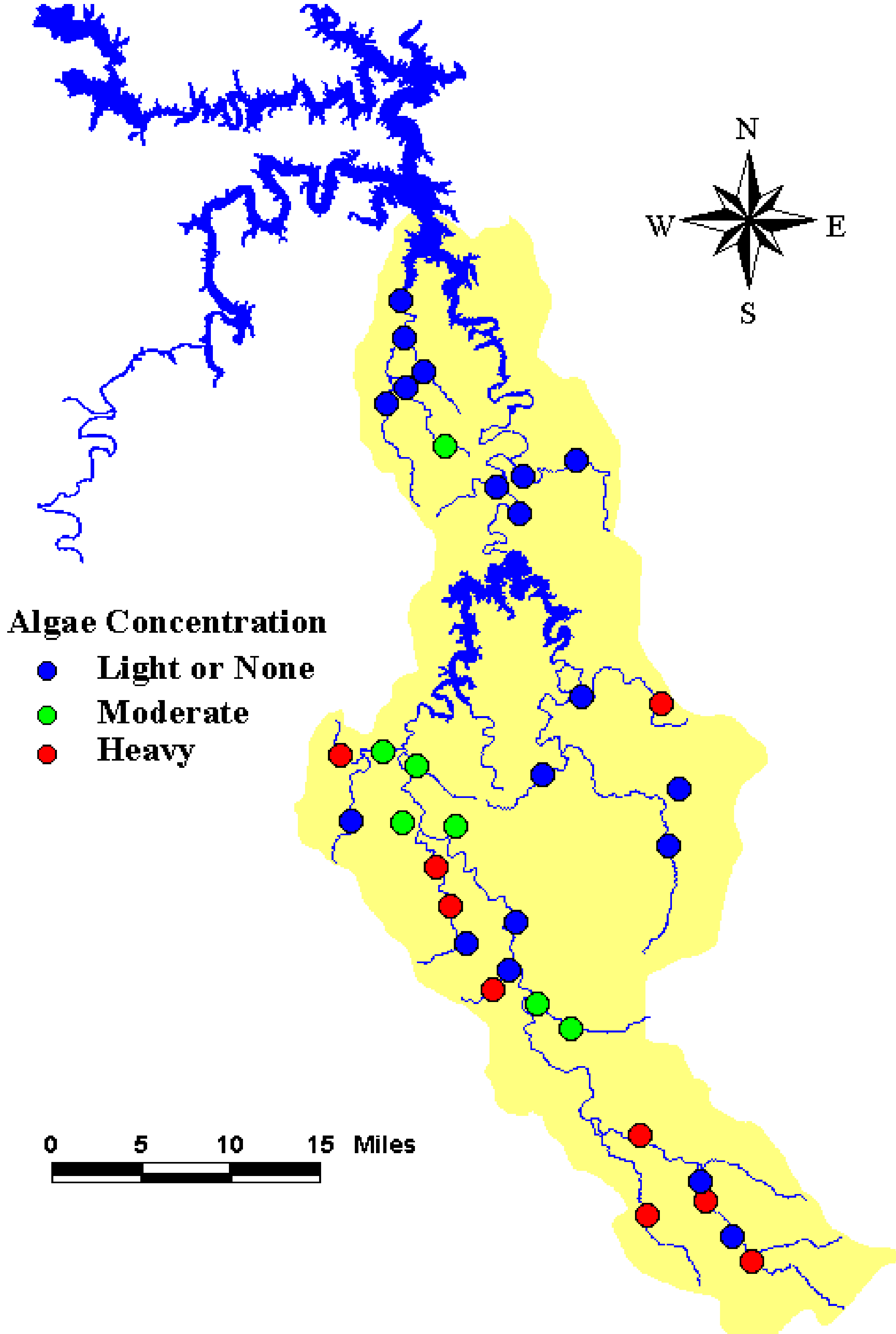


Table HC01. Land use/cover associated with riparian corridor* within 200 ft. of stream mid-line, on both banks, for streams in the Pomme de Terre River watershed and HUCs (MoRAP 1997).

Riparian Land Use/Cover	Percent of Riparian
Pomme de Terre River watershed	
Forest	46.6
Grassland	47.4
Urban	1.4
Bare Soil	4.6
Upper Pomme de Terre HUC (10290107010)	
Forest	48.3
Grassland	45.7
Urban	1.9
Bare Soil	4.1
Middle Pomme de Terre HUC (1020107020)	
Forest	44.8
Grassland	47.7
Urban	2.9
Bare Soil	4.6
Lindley Creek HUC (10290107030)	
Forest	42.6
Grassland	52.2
Urban	0.2
Bare Soil	5.0
Little Pomme de Terre North HUC (10290107040)	
Forest	53.0
Grassland	41.2

Urban	**0.7**
Bare Soil	**5.1**
Lower Pomme de Terre HUC (10290107050)	
Forest	**55.8**
Grassland	**38.7**
Urban	**1.4**
Bare Soil	**4.1**

*** Riparian corridors were calculated for full length second order and larger streams. No corridors were included for the two major reservoirs. The Lower Pomme de Terre HUC includes second order and above streams from below Pomme de Terre Dam to the normal pool of Truman Lake.**

width. The selected corridor for larger streams is narrower than for more smaller streams. This is because the wider the stream, the larger the area the stream itself occupies of the 400 feet, leaving less for the selected corridor. Forest and grassland were the dominant corridor land use/cover. Riparian corridors were dominated by grassland (47.4%) and forest (46.6%). Generally, streams in the lower portion of the watershed have corridors primarily dominated by forests. In the upper portions of the watershed riparian corridors are dominated by grassland.

Forest is the dominant corridor land use/cover type in three HUCs; Lower Pomme de Terre (55.8%), Little Pomme de Terre North (53.0%), and Upper Pomme de Terre (48.3%). Grassland is the dominant land use/cover in two HUCs, Lindley Creek (52.2%) and Middle Pomme de Terre (47.7%).

Substrate composition for sample sites on the Pomme de Terre River included gravel, or a gravel combination, as the dominant type at eight of nine sites surveyed. Cobble or a cobble combination ranked second as substrate types at five of seven sites. Substrate composition for sample sites on the Pomme de Terre River is presented in Table HC02.

Upper Pomme de Terre HUC

Streambank stability was generally good at these sites, even though riparian corridor (streamside forest) widths were less than 33 feet wide on at least one streambank at 10 of the 11 sites. Four of the sites had at least one streambank with no riparian corridor, including two sites (LK96-022 and LK96-009) without a riparian corridor.

Riparian corridor land use/cover for perennial streams in the Upper Pomme de Terre HUC consisted of: forest (48.3%), grassland (45.7%), urban (1.9%), and bare soil (4.1%) (MoRAP 1997).

Stream corridors are heavily grazed in the Upper PDT HUC and this is probably impacting streams. None of the 11 sites had undisturbed forested corridors on both sides of the stream and only 4 had undisturbed forested corridors on one side of the stream. The corridor of at least one side of the stream was used as pasture in 10 of the 11 sites, including five sites where the stream corridor was used as pasture on both sides of the stream. The only site that did not have pasture land in it (LK96-004) had a road running within 30 feet of the stream.

Five of the 11 sites in this HUC were dry including LK96-001, LK96-003, LK96-009, LK96-021 and LK96-022. Of the remaining six sites (five on Pomme de Terre River and one on Little Pomme de Terre River) that had water, four were reported to have heavy instream algae concentrations. Two of the four sites were located on streams immediately west and east of Fair Grove. Several NPDES sites, CAFOs, and tributaries running through Fair Grove are all present in a small area encompassing Fair Grove (area measurement) and are likely causing stream problems. Only sites LK96-004 and LK96-007 did not have algae problems.

Substrate composition for sample sites in the Upper Pomme de Terre River HUC included gravel, or a gravel combination, as the dominant type at six of eleven sites surveyed. Cobble or a cobble combination ranked second as substrate types at five of eight sites. Substrate composition for sample sites in the Upper Pomme de Terre HUC is presented in Table HC03.

Riparian Corridor Conditions

Aerial photographs (dated 1990) were used to qualitatively evaluate riparian corridors along streams in

Table HC02. Substrate composition of 1996-97 habitat sampling locations on the PDT River.

		Substrate Particle Composition Rank		
Name	ID	Dominant	Second	Third
PDT River	LK96-002	gravel	cobble	silt
PDT River	LK96-004	gravel	cobble	silt
PDT River	LK96-006	gravel/silt		sand
PDT River	LK96-007	boulder	cobble	bedrock
PDT River	LK96-011	gravel/cobble	boulder	
PDT River	LK96-026	gravel	cobble/boulder	
PDT River	LK96-027	sand/gravel		cobble/boulder
PDT River	LK96-031	gravel	silt/boulder/bedrock	
PDT River	TG96-007	gravel	sand/cobble	

Table HC03. Substrate composition of 1996-97 habitat sampling locations in the Upper Pomme de Terre HUC.

		Substrate Particle Composition Rank		
Name	**ID**	**Dominant**	**Second**	**Third**
Unnamed	LK96-003	cobble	boulder	gravel
LPDT River	LK96-021	gravel/silt		sand
LPDT River	LK96-022	bedrock	boulder/cobble	
LPDT River	LK96-024	gravel/cobble/bedrock		
Mutton Hollow	LK96-009	bedrock	boulder/cobble	
Norlin Fork	LK96-001	cobble	gravel	silt
PDT River	LK96-002	gravel	cobble	silt
PDT River	LK96-004	gravel	cobble	silt
PDT River	LK96-006	gravel/silt		sand
PDT River	LK96-007	boulder	cobble	bedrock
PDT River	LK96-011	gravel/cobble	boulder	

the Upper Pomme de Terre HUC. This area was targeted because of the presence of Federally designated Niangua darter critical habitat. A general interpretation of these photos is given below, with emphasis placed on the width of the riparian corridors. It was not possible to determine from the photos whether grazing was actually occurring along the streams. However, the amount and orientation of pasture land in the area, as well as the results of the surveys conducted, suggest that cattle have free access to streams in most areas and grazing along streams is common. Due to budget limitations photo coverage of streams was incomplete.

North Fork: The lower one-half (approx.) of this stream was reviewed. There was an apparent area without a riparian corridor at the confluence with the Pomme de Terre River, and vertical cutbanks and active erosion were evident. Most of this stream segment had a narrow riparian corridor on one side or the other. The land draining into the North Fork had fairly good forest coverage and most smaller tributaries had fairly good riparian corridors.

South Fork: The lower one-half (approx.) of this stream was analyzed. There was an area near the confluence with the Pomme de Terre River that was actively eroding resulting in vertical cutbanks. Approximately one-half of this lower portion (lower 1/4 of the stream) appeared to have an adequate riparian corridor. Upstream of this were areas with no riparian corridor on either side of the stream and active erosion was occurring. Land in the South Fork watershed lacked forest cover. Ten to 15% of the land was tree covered. Many of the smaller first and second order tributaries had either no or narrow riparian corridors, on one or both sides.

Pomme de Terre River between Highway DD crossing, southwest of Caddo, in Webster County and the confluence with the South Fork: Some short areas with no riparian corridor and active erosion were evident, especially where stream sinuosity was high. Although narrow riparian corridors predominated, erosion was minimal.

Pomme de Terre River between Mutton Hollow and the South Fork: This segment includes the Niangua Darter Critical Habitat. The riparian corridor of the Pomme de Terre River has been cleared and most of the tributaries lacked a riparian corridor. Extensive erosion was apparent in this segment.

The watershed immediately southeast of Fair Grove was lightly forested with the majority of the open land used for agriculture. These conditions create the potential for increased runoff which may increase erosion and sedimentation. This stream segment is an area of concern. Several CAFOs and other large agricultural operations were evident from aerial photographs. Excessive nutrification from these operations is a concern.

Mutton Hollow: Mutton Hollow had an adequate riparian corridor on both sides of the stream in the small portion of the stream reviewed.

Unnamed 23 (tributary to Mutton Hollow): Riparian corridors in the small area reviewed were lacking or nonexistent.

Pomme de Terre River between Mutton Hollow and Unnamed #22: About one-half of the segment evaluated had very narrow or no riparian corridor. Selected areas had actively eroding vertical banks. Riparian corridors were in fair condition along tributary streams near their confluences with the Pomme de Terre River. Little or no riparian corridor on either streambank was present in most upstream portions.

Unnamed #22: Approximately two-thirds of the stream was reviewed. Banks had either a very narrow or no riparian corridor. The watershed draining into Unnamed #22 was devoid of trees, and the tributaries also have little or no riparian corridor.

***Pomme de Terre River between Unnamed #22 and Little Pomme de Terre River South*:** Approximately one-third of the streambank had little or no riparian corridor. Small areas, especially at river bends, appeared to have vertical cutbanks and active erosion. About one-half of the land draining into this segment was forested. Many of the small tributary streams had narrow or no riparian corridor.

Little Pomme de Terre River South: Only a small portion of this stream was evaluated. The streambanks appeared to be fairly stable at the confluence with the PDT River. Riparian corridors were generally narrow. Tributaries were in good condition with only a few narrow riparian corridors. Most streams had adequate riparian corridor to provide streambank protection. The dominant land use in the watershed was grazing and haying, with about 15% forested.

Pomme de Terre River between confluence of Little Pomme de Terre River South and Little Wilson Creek: Most of this segment was protected by a healthy riparian corridor. Approximately 25% of this segment of the Pomme de Terre River had a narrow or no riparian corridor. Little active erosion was evident. Agricultural runoff is the primary concern in this segment of the Pomme de Terre River. One tributary stream has five CAFOs concentrated in a small area within its watershed, and the land surrounding these operations, including streams, was devoid of trees.

Little Wilson Creek: One-half of the stream length of Little Wilson Creek was reviewed. Approximately 35% of this segment had little or no riparian corridor and the remainder had fairly good riparian corridor protection. Some active erosion and channel braiding was evident and there appeared to be a heavy gravel bedload in this stream. Prater Branch, a tributary to Little Wilson Creek, had a very narrow or no riparian corridor along its entire length. The riparian corridor along smaller streams in Little Wilson Creek watershed appeared to offer moderate protection.

Pomme de Terre River between the mouth of Little Wilson Creek and the mouth of Unnamed #21: Slightly less than one-half of the streambanks reviewed had a narrow riparian corridor, and the remainder had adequate protection. One small area of active erosion was evident but, this segment appeared to be in relatively good condition. Tributaries to this segment appeared to be well protected by the riparian corridor.

Unnamed #21: The downstream one-half of Unnamed #21 was reviewed. Of this, approximately 80% had an adequate corridor. The area around the stream mouth appeared to be stable. The riparian corridor narrowed in the upper end.

Sycamore Creek: The entire length of Sycamore Creek and its tributaries were reviewed. The area near the mouth of Sycamore Creek appeared to have a wide, protective riparian corridor, however, most of the streambanks in this watershed (including tributary Unnamed #25) had very narrow or no riparian corridor. There appeared to be a considerable amount of active erosion in this watershed.

Unnamed #25 (tributary to Sycamore Creek): Most of the length of Unnamed #25 had only a narrow riparian corridor and some active erosion was evident. A large eroded area was evident at the streams confluence with Sycamore Creek. More than half of the tributary streams to Unnamed #25 had no riparian corridor and the remainder had a very narrow riparian corridor.

Pomme de Terre River between Unnamed Tributary #21 and Upper Pomme de Terre HUC border:

Most of this segment had very narrow or no riparian corridors. Considerable active erosion was evident on many outside bends, just below the confluence with Sycamore Creek. Most of the tributaries to this segment, including Sycamore Creek, had narrow or no riparian corridors, including two relatively long tributaries that had virtually no riparian corridor. This segment of the watershed appeared to have a potential for sedimentation problems, including Sycamore Creek.

Niangua Darter Range and Critical Habitat

Riparian corridor land use/cover was also determined for Niangua darter range and critical habitat using digital land use/cover data (MoRAP 1997). Corridors 400 ft. wide (200 ft. on each side of the stream midline) were determined and the land use/cover percentage were calculated for each (Table HC04). Forest was the dominant riparian corridor land use/cover in both stretches, Niangua darter range (64.2%) and critical habitat (63.7%). This varied considerably from the riparian corridor land use/cover for the Upper Pomme de Terre HUC, forest (48.1%) and grassland (45.5%). Critical habitat for the Niangua darter may also be impacted by CAFOs (Figure HC04).

Middle Pomme de Terre HUC

All 14 evaluation sites located in this hydrologic unit had some flow. Streams were experiencing nutrient enrichment, likely through the combination of urban development and agricultural practices. Ten of the 14 sites were reported to have moderate or heavy algae concentrations (Figure HC03). There is a large number of NPDES sites and CAFOs located in this HUC as compared to the rest of the Watershed (Figure LU02). Bolivar, the largest city in the Watershed, is growing rapidly and the associated impacts from this expansion are likewise growing. The Missouri Office of Administration (1998) has estimated that the human population residing in Polk County will increase 30.3% between the years of 1990 and 2020; far exceeding the statewide projection of 9.0%. The potential threat to streams associated with urban expansion in this HUC is obvious and is a high priority for stream management.

Streambank stability varied from site to site (Figure HC02). Streambank stability was reported to be good at 6 of the 14 sites, fair at 3 sites, and poor at 5 sites. Likewise, riparian corridor widths also varied. Riparian corridor widths were found to be less than 33 feet on at least one side of the stream at 8 of the 14 sample sites including 3 sites with riparian corridor widths less than 33 feet on both sides. Eight sites had at least one side of the stream with a riparian corridor width greater than 82 feet including three sites where riparian corridor on both sides were greater than 82 feet. None of the sites were devoid of a riparian corridor on both banks.

Grassland (47.7%) was the dominant riparian land use/cover on perennial streams in this HUC followed by: forest (44.8%), bare soil (4.6%), and urban (2.9%) (MoRAP 1997).

Substrate composition for sample sites in the Middle Pomme de Terre HUC included gravel, or a gravel combination, as the dominant type at eleven of fourteen sites surveyed. Cobble or a cobble combination ranked second as substrate types at three of nine sites. Substrate composition at sample sites in the Middle Pomme de Terre HUC is presented in Table HC05.

Lindley Creek HUC

Four of the five sites in this hydrologic unit had instream flow and one was intermittent. Four of the five sites had light or no algae concentration and one on Lindley Creek (TG96-006) had a heavy algae

Table HC04. Land use/cover associated with riparian corridor within 200 ft. of stream midline on both banks, found within Niangua darter range and critical habitat

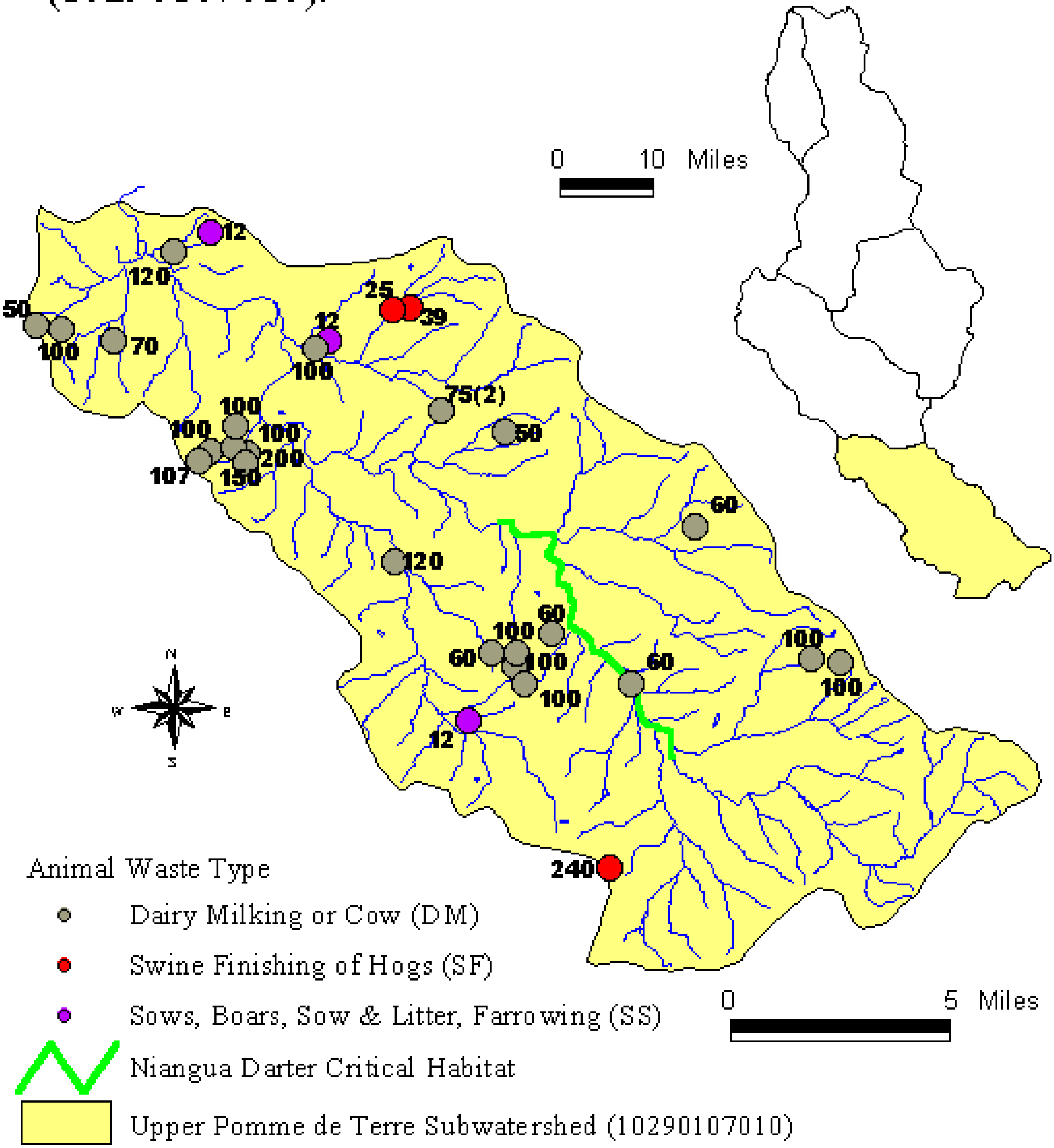
Riparian Land Use/Cover	Percent of Riparian
Niangua darter Range	
Forest	64.2
Grass	33.0
Bare Soil	2.8
Niangua darter Critical Habitat	
Forest	63.7
Grassland	33.3
Bare Soil	3.0

(MoRAP 1997).

Table HC05. Substrate composition of 1996-97 habitat sampling locations in the Middle Pomme de Terre HUC.

		Substrate Particle Composition Rank		
Name	ID	Dominant	Second	Third
PDT River	LK96-026	gravel	cobble/boulder	
PDT River	LK96-027	sand/gravel		cobble/boulder
PDT River	LK96-031	gravel	silt/boulder/bedrock	
Davis Creek	TG97-027	gravel/cobble/bedrock		
Dry Fork	TG97-028	gravel	sand	cobble
Ashlock Creek	TG97-029	bedrock	gravel	cobble
Dry Fork	TG97-030	bedrock	cobble	gravel
Abels Creek	TG97-031	gravel	cobble	bedrock
Piper Creek	TG97-032	gravel	sand	cobble
Piper Creek	TG97-033	gravel/silt		cobble
Piper Creek	TG97-034	no data	no data	no data
Schultz Creek	TG97-040	gravel/cobble		
Schultz Creek	TG97-041	gravel	silt	cobble
McKinney Creek	TG97-042	gravel	bedrock	cobble

Figure HC04. CAFOs near Niangua darter critical habitat in the Upper Pomme de Terre HUC (10290107010).



Note: Numbers represent animal units.

concentration.

Streambank stability was good at all five sites. Riparian corridors were less than 33 feet on at least one side of the stream at 3 of the 5 sites including one site (TG96-011) where the riparian corridor was less than 33 feet on both sides of the stream. Two of the five sites had a riparian corridor greater than 80 feet wide on one side and between 33 and 80 feet wide on the opposite side. None of the streambanks at these sites were devoid of trees.

Riparian corridor land use/cover of perennial streams was dominated by grassland (52.2%), followed by forest (42.6%), bare soil (5.0%), and urban (0.2%) (MoRAP).

Substrate composition for sample sites in the Lindley Creek HUC included gravel, or a gravel combination, as the dominant type at four of five sites surveyed. Cobble and silt ranked second as substrate types at two of five sites each. Substrate composition at sample sites in the Lindley Creek HUC is presented in Table HC06.

Little Pomme de Terre North HUC

Site TG97-001 will be omitted from the following discussion because it was located within the normal pool level of Harry S. Truman Lake. Of the 6 sites in this HUC, one was dry (TG96-008) and one had intermittent stream flow (TG96-009). Algae was light at all sites except TG97-004 in the upstream portion of Montgomery Hollow where the algae concentration was moderate.

Streambank stability was good at three sites, fair at one site, and poor at two sites. All six sites had at least one side of the stream with a riparian corridor width less than 33 feet wide. Three sites had both sides less than 33 feet and one had no riparian corridor on either side. All six sites had grazing within the riparian corridor, including three sites that were 100% grazed, two that were 50% grazed and one that was 25% grazed.

Riparian corridor land use/cover of perennial streams was dominated by forest (53.0%), followed by grassland (40.7%), bare soil (5.0%), open water (1.3%), and urban (0.7%) (MoRAP 1997).

Substrate composition for sample sites in the Little Pomme de Terre North HUC included gravel, as the dominant type at all six sites surveyed. Cobble or cobble combinations ranked second as substrate types at five of six sites. Substrate composition at sample sites in the Little Pomme de Terre north HUC is presented in Table HC07.

Lower Pomme de Terre HUC

Light or no algae concentrations were observed at all four sample sites in the Lower Pomme de Terre HUC.

Streambank stability was listed as good at two sites, fair at one site, and poor at one site. The site recorded with poor streambank stability was located on the mainstem Pomme de Terre River eight miles below Pomme de Terre Dam. Streambank instability in this section of the Pomme de Terre River is closely tied to Pomme de Terre Dam operation. These problems are dealt with in more detail in the Hydrology section.

Riparian land use/cover in the Lower Pomme de Terre HUC was dominated by forest (55.8%), the highest percentage of the five HUCs, followed by grassland (38.7%), bare soil (4.1%), and urban (1.4%)

Table HC06. Substrate composition of 1996-97 habitat sampling locations in the Lindley Creek HUC.

		Substrate Particle Composition Rank		
Name	ID	Dominant	Second	Third
Panther Creek	TG96-003	gravel/bedrock	silt	
Ingals Creek	TG96-004	bedrock	gravel	cobble
Unnamed#5	TG96-005	gravel	cobble	sand
Lindley Creek	TG96-006	gravel	silt	cobble
Lindley Creek	TG96-011	gravel	cobble	silt/sand

Table HC07. Substrate composition of 1996-97 habitat sampling locations in the Little Pomme de Terre North HUC.

		Substrate Particle Composition Rank		
Name	ID	Dominant	Second	Third
LPDT River	TG96-002	gravel	cobble	silt/sand
LPDT River	TG96-008	gravel	bedrock	cobble
LPDT River	TG96-009	gravel	silt/cobble	
LPDT River	TG97-001	no data	no data	no data
Trinity Hollow	TG97-002	gravel	cobble	
Montgomery Hollow	TG97-003	gravel	cobble	boulder
Montgomery Hollow	TG97-004	gravel	cobble	

(MoRAP 1997).

Substrate composition for sample sites in the Lower Pomme de Terre HUC included gravel as the dominant type at all sites surveyed. Bedrock ranked second as substrate type at three of five sites. Substrate composition at sample sites in the Upper Pomme de Terre HUC is presented in Table HC08.

Channel Alterations

No major channelization projects have taken place in the Watershed. Channelization is usually confined to short stretches associated with bridge and road construction. The rerouting and widening of state highways 65 (Benton, Hickory, and Dallas counties) and 13 (Polk County) may have localized effects at stream crossings, mainly in headwater areas.

Aquatic Community Classification

The Watershed is located in the Ozark Faunal Region. This region includes all of the state south of the Missouri River, between the Lowland Faunal Region to the south and east and the Prairie Faunal Region to the north and west. The region is characterized by older bedrock, higher elevations, and greater local relief than surrounding areas. The majority of the bedrock is Mississippian in age or older, consisting mainly of limestone and dolomite. Uplands of the region are commonly above 1,000 feet msl, with local relief along major streams often exceeding 300 feet. Most stream channels in the region consist of a series of well defined riffles and pools. Generally substrates consist of coarse gravel, rubble, boulders, and bedrock (Pflieger 1989).

The Ozark Faunal Region is further broken down into six smaller divisions, with the Watershed located in the Missouri-Ozark Division (Pflieger 1989). The majority of the Missouri-Ozark Division is located in the Springfield Plateau, including the Watershed. Topographically the division, within the watershed, is level and undissected to the south and west and more deeply dissected and hilly to the north and east. Streams in the Springfield Plateau portion of the division are slightly more turbid and have a less extensive exposure of chert in their channels than streams in the Salem Plateau portion (Pflieger 1989).

The Missouri-Ozark Division is the largest division of the Ozark Faunal Region, but has few species that are restricted to it. The Niangua darter is endemic to the division. Blacknose shiners are only found in Missouri in the Missouri-Ozark division. The Missouri saddled darter only occurs in Missouri in the Missouri-Ozark and Mississipp-Ozark divisions. Ozark populations of redfin shiner and plains topminnow are restricted to the Missouri-Ozark and Ozark-Neosho divisions (Pflieger 1989).

Unique Habitats

The MDC's Natural Heritage Program (MDC 1998a) has identified several unique natural communities in the Pomme de Terre River watershed (Table HC09). The section of the Pomme de Terre River that includes federally designated Niangua darter critical habitat (Figure BC02) has been identified as a unique aquatic natural community, as has most of Little Pomme de Terre River (North).

Natural Areas (NA) have been identified statewide by the Missouri Natural Areas Committee made up of representatives from MDNR, United States Forest Service, National Park Service, and MDC. La Petite Gemme NA, located southwest of Bolivar, is the only Natural Area located in the Watershed. The 37-acre upland prairie is owned by the Missouri Prairie Foundation and managed by MDC (Kramer, K., R. Thom, G. Iffrig, K. McCarty, and D. Moore, 1996).

Table HC08. Substrate composition of 1996-97 habitat sampling locations in the Lower Pomme de Terre HUC.

		Substrate Particle Composition Rank		
Name	**ID**	**Dominant**	**Second**	**Third**
Mill Creek	TG96-001	gravel	bedrock	cobble
PDT River	TG96-007	gravel	sand/cobble	
Stinking Creek	TG96-010	gravel	bedrock	silt/cobble
Mill Creek	TG97-007	gravel	cobble	
Jordan Branch	TG97-008	gravel	bedrock	sand/cobble/boulder

Table HC09. Unique natural communities identified in the Pomme de Terre River watershed (MDC Natural Heritage database).

Habitat Type	Date Last Observed	Number of Locations
AQUATIC COMMUNITIES		
Creeks and small rivers (Ozark)	04/17/1984	2 reaches in 5 counties
OTHER COMMUNITIES		
Caves	no data	4 caves in Hickory County
TERRESTRIAL COMMUNITIES		
Dry chert forest	03/29/1989	1 Hickory County
Dry limestone/dolomite prairie	07/07/1989	1 Hickory County
Dry-mesic chert prairie	09/05/1989 and 09/27/1989	2 Polk County
Dry-mesic limestone/dolomite prairie	06/22/1989	1 Polk County
Dry-mesic sandstone/shale prairie	06/23/1994	1 Hickory County
Limestone glade	09/25/1989	1 Hickory County
Pond shrub swamp	07/21/1989	1 Dallas County

Improvement Projects

The Crane Creek SALT project is the only watershed project in the Watershed. More details concerning this project are outlined in the Land Use section.

Only one MDC stream project has been reported in the Pomme de Terre River watershed. This was a logjam removal from the Pomme de Terre River approximately 2 river miles downstream of Pomme de Terre Dam (T37N, R22W, Sec. 10). The logjam consisted of approximately 20 trees lodged in the stream channel and an additional 5-10 standing live and dead trees catching debris. Streambank erosion measuring 60 feet long by 8 feet high was present in the project area. The logjam and standing trees were removed on September 10, 1990. The project slowed bank erosion and, as of 1992, the area had slowly begun to backslope and revegetate. No additional work is planned at this time.

BIOTIC COMMUNITIES

Fish Community Data

Since 1940, fish sampling has been conducted throughout the Watershed, by MDC, (Figure BC01; MDC fish database 1998). Eighty-three species of fish have been collected in the Watershed since that time (Table BC01).

The Watershed lies entirely within the Missouri Division of the Ozark Faunal Region (Pflieger 1989a). The majority of the fish species collected in the Watershed are characteristic of this region. Twenty-seven (38.0%) of the eighty-three fish known to occur are typical species found within the region. Wide-spread was the next largest faunal group represented (28.2%) followed in descending order by: prairie faunal group(11.3%), Ozark-prairie faunal group (8.5%), Ozark-lowland faunal group (5.6%), and big river and lowland faunal groups (4.2% each).

Eleven locations were sampled for fish during the 1996-97 seasons by MDC (Figure BC01). A total of 3,742 fish were collected, representing ten families, with fifty-three species and one hybrid (Table BC02). Cyprinids (minnows) were the dominant family in past and recent samples, with 15 species from the 1996-97 samples. Centrarchids (sunfish) followed in 1996-97 with 11 species and one hybrid. One individual redear sunfish was sample during 1996-97 at site 5. This was the first recorded occurrence in the Watershed.

The following comparisons are based upon 1996-97 samples. Bleeding shiners (n=721) were the most numerous species collected followed, in descending order by: Ozark minnow (n=523), brook silverside (n=463), stoneroller species (largescale and central) (n=383), and Missouri saddled darter (n=174). These five species made up 19.3, 14.0, 12.4, 10.2, and 4.7 percent of the total sample, respectively, for a total of 60.6 percent of the fish sampled. The most widespread species was bluntnose minnow, collected at all 11 sites. Blackspotted topminnow and stoneroller species were the second most common fish collected at ten sites, followed by bluegill, longear sunfish, spotted bass, bleeding shiner, mosquitofish, fantail darter, and orangethroat darter, all collected at nine sites. The more common fish species based on ecological affinity were: large fishes - bluegill, spotted bass, longear sunfish, black redhorse, and green sunfish; nektonic fishes - stoneroller species (largescale and central), bleeding shiner, Ozark minnow, brook silverside, blackspotted topminnow, mosquitofish, bluntnose minnow, redfin shiner, and creek chub; and benthic fishes - orangethroat, fantail, and rainbow darters. Species and fish numbers for each sample location are displayed in Table BC02.

The number of species per site ranged from a high of 36 at site #7 to a low of 13 at site #1. Site 7 was located on the mainstem Pomme de Terre River and was the largest location sampled (3rd order, 73.8 ft max. width). Electrofishing was also an added means of capture at this location and was not used at any other sampling locations.

Twenty previously sampled species were missing from recent Watershed samples. Fifteen of these are large species which may have been overlooked as previously mentioned. Chestnut lamprey, mooneye, goldeye, quillback, bigmouth buffalo, silver redhorse, flathead catfish, and rock bass have all been collected at two or less sites throughout the period of collection and most may have a limited distribution

Figure BC01. Missouri Department of Conservation fish sample sites in the Pomme de Terre River watershed.

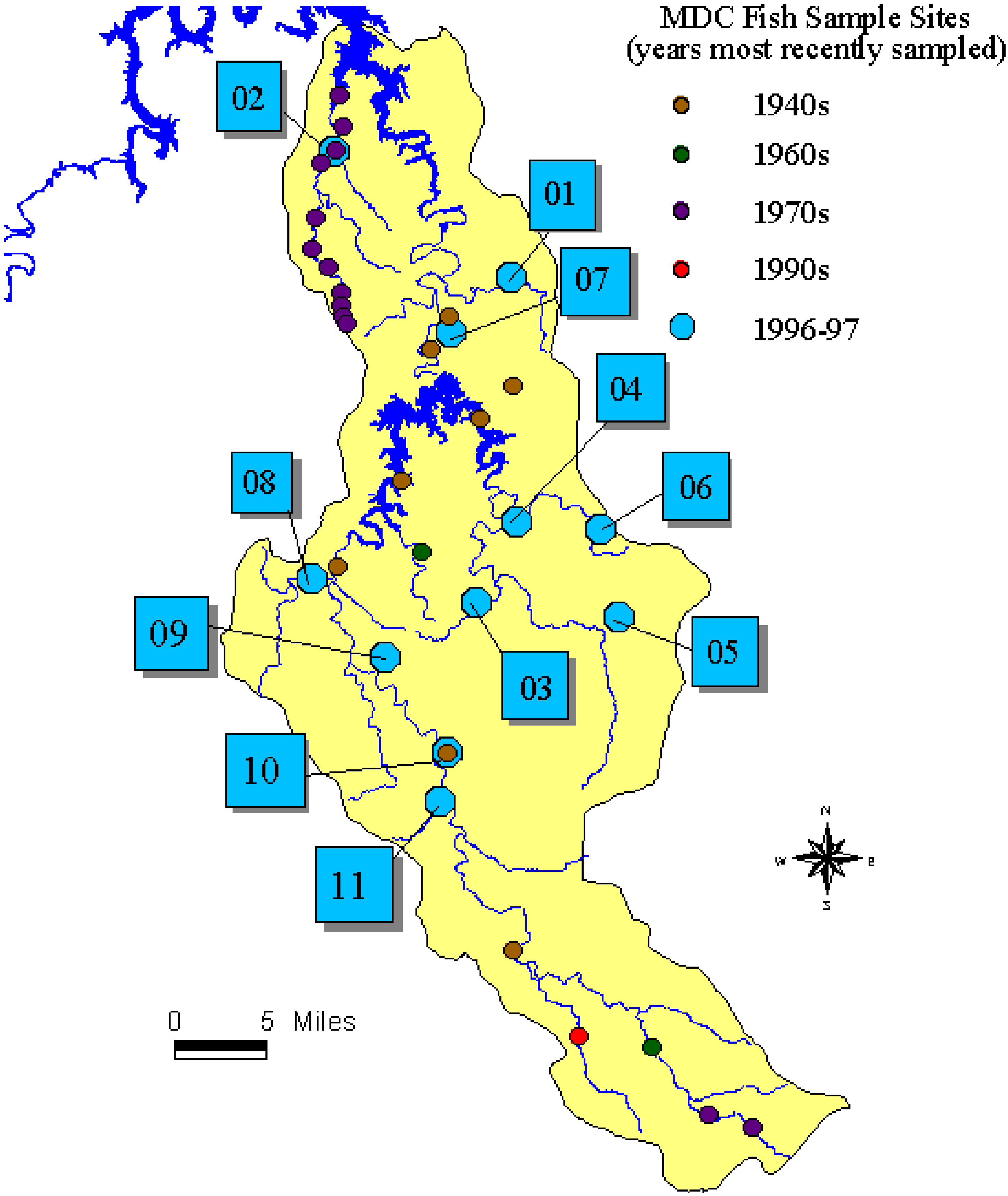


Table BC01. Fish species collected from the Pomme de Terre River watershed by MDC personnel, and their geographic affinities, and trophic guilds (Pflieger 1971; Karr et al. 1986, Robison and Buchanan 1992, Pflieger 1975, Cross and Collins 1995).

Family *Genus species*	Common Name	Geographic Affinity[1]	Trophic Guild[2]
	LARGE FISHES		
Petromyzontidae (Lampreys)			
Icthyomyzon castaneus	Chestnut lamprey	W	
Hiodontidae (Mooneyes)			
Hiodon tergisus	Mooneye	W	
Hiodon alosoides	Goldeye	B	
Lepisosteidae (Gars)			
Lepisosteus osseus	Longnose gar	W	P
Clupeidae (Herrings)			
Dorosoma cepedianum	Gizzard shad	W	O
Catastomidae (Suckers)			
Carpiodes carpio	River carpsucker	P	
Carpiodes cyprinus	Quillback	P	
Carpiodes velifer	Highfin carpsucker		
Catastomus commersoni	White sucker	O-P	I
Hypentelium nigricans	Northern hog sucker	O	I
Ictiobus cyprinellus	Bigmouth buffalo	W	
Ictiobus bubalus	Smallmouth buffalo	W	
Moxostoma anisurum	Silver redhorse	O	

Moxostoma carinatum	River redhorse	O	
Moxostoma erythrurum	Golden redhorse	O	I
Moxostoma macrolepidotum	Shorthead redhorse	O-P	I
Moxostoma duquesnei	Black redhorse	O	I
Esocidae (Pikes)			
Esox masquinongy	Muskellunge		
Ictaluridae (Bullhead Catfishes)			
Ameiurus melas	Black bullhead	W	I
Ameiurus natalis	Yellow bullhead	W	I
Ictalurus furcatus	Blue catfish		
Ictalurus punctatus	Channel catfish	W	I-P
Pylodictis olivaris	Flathead catfish	W	
Centrarchidae (Sunfishes)			
Ambloplites rupestris	Rock bass	O	
Lepomis macrochirus	Bluegill	W	I
Lepomis cyanellus	Green sunfish	W	I-P
Lepomis gulosus	Warmouth	L	I-P
Lepomis humilis	Orangespotted sunfish	P	
Lepomis megalotis	Longear sunfish	O-L	I
Lepomis microlophus	Redear sunfish		
Micropterus dolomieu	Smallmouth bass	O	I-P
Micropterus punctulatus	Spotted bass	O-L	I-P
Centrarchidae (Sunfishes)			

Micropterus salmoides	**Largemouth bass**	**W**	**I-P**
Pomoxis annularis	**White crappie**	**W**	**I-P**
Pomoxis nigromaculatus	**Black crappie**	**W**	
Moronidae (Temperate basses)			
Morone chrysops	**White Bass**	**B**	
Sciaenidae (Drums)			
Aplodinotus grunniens	**Freshwater drum**	**B**	**I-P**
Cyprinidae (Minnows)			
Cyprinus carpio	**Common carp**	**W**	**O**
Percidae (Perches)			
Stizostedion vitreum	**Walleye**	**W**	

NEKTONIC FISHES

Cyprinidae (Minnows)			
Campostoma oligolepis	**Largescale stoneroller**	**O**	**H**
Campostoma anomalum	**Central stoneroller**	**O-P**	**H**
Cyprinella lutrensis	**Red shiner**	**P**	**O**
Macrhybopsis storeriana	**Silver chub**		
Luxilus chrysocepholus	**Striped shiner**	**O**	**I**
Luxilus pilsbryi	**Duskystripe shiner**		
Luxilus zonatus	**Bleeding shiner**	**O**	**I**
Lythrurus umbratilis	**Redfin shiner**	**W**	**I**
Nocomis biguttatus	**Horneyhead chub**	**O**	

Notemigonus crysoleucas	Golden shiner	W	O
Notropis heterolepis	Blacknose shiner	O	I
Notropis nubilus	Ozark minnow	O	O
Notropis atherinoides	Emerald shiner	B	I
Notropis rubellus	Rosyface shiner	O	I
Notropis stramineus	Sand shiner	P	I
Phoxinus erythrogaster	Southern redbelly dace	O	H
Pimephales promelas	Fathead minnow	P	
Pimephales notatus	Bluntnose minnow	W	O
Cyprinella galactura	Whitetail shiner		
Cyprinella whipplei	Steelcolor shiner		
Semotilus atromaculatus	Creek chub	O-P	I
Fundulidae (Killifishes)			
Fundulus catenatus	Northern studfish	O	I
Fundulus olivaceus	Blackspotted topminnow	O-L	I
Poeciliidae (Livebearers)			
Gambusia affinis	Mosquito fish	L	I
Atherinidae (Silversides)			
Labidesthes sicculus	Brook silverside	O-L	I

BENTHIC FISHES

Ictaluridae (Bullhead Catfishes)			
Noturus nocturnus	Freckled madtom	L	
Ictaluridae (Bullhead Catfishes)			

Noturus exilis	**Slender madtom**	**O**	**I**
Noturus flavus	**Stonecat**	**P**	**I**
Cottidae (Sculpins)			
Cottus carolinae	**Banded sculpin**	**O**	**O**
Percidae (Perches)			
Etheostoma flabellare	**Fantail darter**	**O**	**I**
Etheostoma tetrazonum	**Missouri saddled darter**	**O**	
Etheostoma blennioides	**Greenside darter**	**O**	**I**
Etheostoma caeruleum	**Rainbow darter**	**O**	**I**
Etheostoma spectabile	**Orangethroat darter**	**O**	**I**
Etheostoma zonale	**Banded darter**	**O**	**I**
Etheostoma nianguae	**Niangua darter**	**O**	**I**
Etheostoma nigrum	**Johnny darter**	**O-P**	**I**
Etheostoma punctulatum	**Stippled darter**	**O**	**I**
Percina phoxocephala	**Slenderhead darter**	**O-P**	
Percina caprodes	**Logperch**	**O**	**I**
Cyprinidae (Minnows)			
Phenacobius mirabilis	**Suckermouth minnow**	**P**	
Erimystax x-punctatus	**Gravel chub**	**O**	

[1] B=Big River; L=Lowland; O=Ozark; P=Prairie; W=Wide Ranging

[2] H=Herbaceous; I=Insectivorous; O=Omnivorous; P=Piscivorous

Table BC02. Fish species collected from the Pomme de Terre River watershed during MDC, 1996-97 fish community sampling, by location.

FAMILY	Site Number										
Common Name	01	02	03	04	05	06	07	08	09	10	11	Tot.
LARGE FISHES												
CLUPEIDAE												
Gizzard shad							1					1
CATASTOMIDAE												
White sucker				1								1
Northern hog sucker							6		1			7
Golden redhorse				12						1		13
Black redhorse	25		1	37		5	4			2	1	75
ICTALURIDAE												
Black bullhead			6									6
Yellow bullhead				4								4
Channel catfish							1					1
CENTRARCHIDAE												
Bluegill	3	7	4	4	78	8	12	3	5			124
Green sunfish	3		2	2	4	12	1		2			26
Warmouth		1					1					2
Orangespotted sunfish					5		1					6
Longear sunfish		3		1	1	5	14	6	20	6	31	87
Redear sunfish					1							1
Hybrid sunfish					1							1
Smallmouth bass							2				3	5
Spotted bass	5		4	1	5	13	6		4	3	1	42

Largemouth bass						1	2	1	2	1		7
White crappie					1							1
Black crappie							3					3
CYPRINIDAE												
Common carp							23					23
SCIANIDAE												
Freshwater drum							2					2
NEKTONIC FISHES												
CYPRINIDAE												
Largescale stoneroller									3	9	4	16
Central stoneroller									8	3		11
Stone roller species	26	16	11	18	225	9	28		9	3	12	357
Striped shiner		50					2					52
CYPRINIDAE												
Bleeding shiner			7	120	65	117	97	4	42	92	177	721
Redfin shiner		2	28		4	19	8					61
Common Name	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**Tot.**
CYPRINIDAE												
Golden shiner					3	1						4
Striped shiner										4		4
Ozark minnow		16		30	14	19	8	67			369	523
Emerald shiner							1					1
Rosyface shiner					7				3	4	30	44
Sand shiner		90				22	12				1	125
Southern redbelly dace	1											1
Bluntnose minnow	7	2	16	2	4	48	10	12	1	8	7	117
Creek chub	5	10	3	6	76		9	2				111

CYPRINODONTIDAE												
Northern studfish	9			1	36		6	1		1		54
Blackspotted topminnow	21	10	4	5	10	17	4		7	3	1	82
POECILIIDAE												
Mosquito fish	6	6	58	2			25	4	3	8	6	118
ATHERINIDAE												
Brook silverside		201	29	3	11	145	13	8	18	11	24	463
BENTHIC FISHES												
CYPRINIDAE												
Gravel chub							2					2
ICTALURIDAE												
Slender madtom		2		1	1			1		1		6
Stonecat							3					3
PERCIDAE												
Fantail darter	1	6	5	4	4	3	10		2	2		37
Missouri saddled darter							6		63	102	3	174
Rainbow darter		2			1	3	2			5	4	17
Orangethroat darter	5	33	19	4	21	20	6	4	2			114
Banded darter				1					31	10	9	51
Johnny darter						1	3					4
Stippled darter				1								1
Logperch				1			10		1		4	16
Greensided Darter									1	11	2	14
TOTAL SPECIES	13	17	15	23	23	19	38	12	22	23	19	54 (sp.)

***Large scale and central stonerollers were combined in samples 1-7.**

in the Watershed (Pflieger 1997).

Niangua darter (federally Threatened and state Endangered), blacknose shiner (state Rare), and mooneye (state Rare) were not collected during 1996-97. These species have all experienced declines in the Watershed.

Species of Conservation Concern

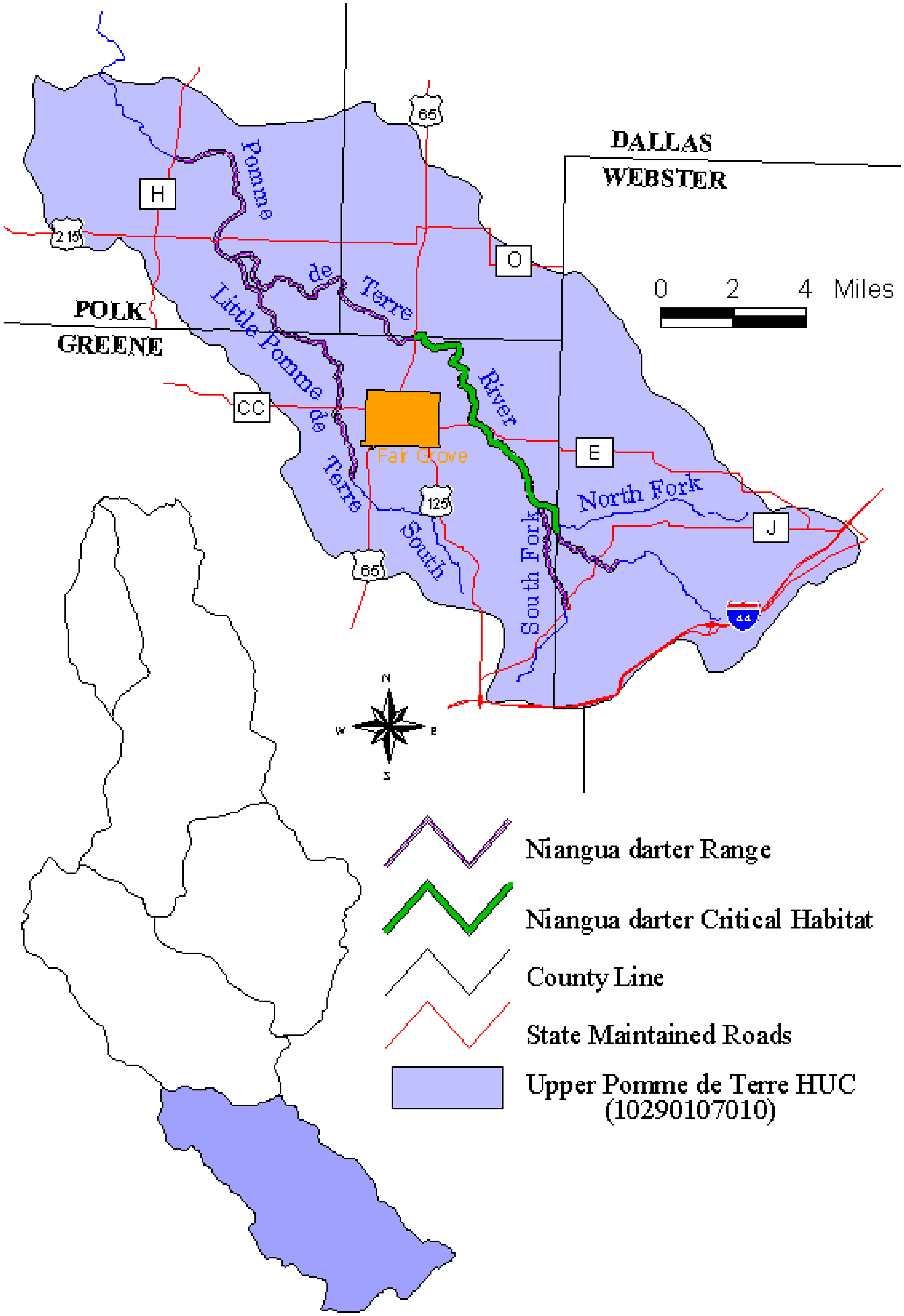
Niangua Darter The Niangua darter, a federally listed Threatened species and state listed Endangered species, was first collected in the headwaters of the Watershed in 1960 (Taber and Wilkinson 1973). Pflieger (1978) conducted a survey to identify the distribution of Niangua darter and identified populations in the Little Pomme de Terre River (north) and the Pomme de Terre River, Greene and Webster counties. Since then, MDC personnel have monitored sites known to support Niangua darter and Hayden Maddingly (doctoral candidate, University of Missouri, Columbia) surveyed Lindley Creek. Niangua darters are presently known to inhabit only the upper segments of Pomme de Terre River drainage (Figure BC02). Recent sampling efforts failed to find Niangua darters in the Little Pomme de Terre River (north), (U.S. Fish and Wildlife Service 1989) or in Lindley Creek (Mattingly and Galat 1995).

Pflieger (1978) suggested that reservoir construction may be the primary threat to Niangua darter survival due to inundation of habitat, increased interspecific competition, predation, and the creation of dispersal barriers. He further speculated that the general deterioration of habitat caused by land use practices may be a contributing factor to the decline of this species throughout its range. Due to the disjunct distribution of this species, dispersal barriers, and general habitat degradation, it is unlikely that natural recolonization will occur in the Little Pomme de Terre River (north). The recovery plan for the Niangua darter (USFWS 1989) recommends the establishment of additional populations through stocking to lessen "the potential for extinction through the incremental extirpation of existing populations." However, no streams in the Watershed were mentioned as potential stocking sites. To date, a thorough survey has not been conducted of streams in the Watershed that may have the potential to support Niangua darters (Figure BC02). The most intensive survey was conducted by Dr. William Pflieger from 1974 through 1977 when five sites were sampled upstream of Pomme de Terre Lake, one site was sampled on Lindley Creek, two sites were sampled on Little Pomme de Terre (N), and one site was sampled on the Pomme de Terre River at a location that would now be inundated by Harry S. Truman Lake. However recent sampling efforts were directed to determine relative abundance of darters only at known locations and protecting these habitats. Future efforts should include the surveys previously mentioned to further validate the extent of Niangua darter distributions and better monitor the status of existing populations.

Federally designated critical habitat for the Niangua darter is restricted to a small section of the Pomme de Terre River in Greene County ranging from the Highway 65 crossing to the Greene County/Webster County Line (Figure BC02; U.S. Fish and Wildlife Service 1989).

Blacknose Shiner. The status of the blacknose shiner, a state listed Rare species (MDC 1998), is not known. However, it appears to be declining and may be well on its way to extirpation from the Pomme de Terre River watershed. Sue Bruenderman (MDC, pers. comm.) speculates that, although a resurvey of historic sites has not been conducted, recent sampling efforts suggest that the blacknose shiner may be absent from the Osage River drainage, including the Watershed. The only known collections of blacknose shiner in the Watershed came from the Little Pomme de Terre River (north) in the 1970s

Figure BC02. Known Niangua darter range and location of Federally designated Niangua darter critical habitat within the Pomme de Terre River watershed.



(MDC fish database). William Pflieger collected blacknose shiners from eight different locations in a period from 1975 though 1979. Extremely low flow conditions (most of the upstream one-half of the stream was completely dry) hindered the 1996 sampling efforts. Only one site (TG96-02; T38N-R23W-02) was sampled in the Little Pomme de Terre River (north) and no blacknose shiners were found.

Mooneye. The status of the mooneye, a state listed Rare species, is unknown at this time. MDC personnel collected mooneye in 1951 and 1940, before construction of Pomme de Terre Lake, at two separate locations on the Pomme de Terre River. None have been reported since and it is assumed they no longer inhabit the Watershed.

Fish Stockings

The majority of fish stocked in the Watershed have been stocked by MDC in the two large reservoirs (Table BC03). Currently (1999) muskellunge and walleye are the only fish stocked in Pomme de Terre Lake. The only fish currently being stocked in Truman Lake are paddlefish, hybrid striped bass, and walleye.

Numerous small lakes and ponds throughout the watershed have been stocked with a variety of fish including largemouth bass, bluegill, channel catfish, crappie, redear sunfish and grass carp. Escapement of stocked fish from impoundments undoubtedly occurs, but the extent and the effects of these introductions are undocumented.

Sport Fish

Centrarchid species - Spotted bass, largemouth bass, green sunfish, and bluegill sunfish are the predominant centrarchid game fishes present in the Pomme de Terre River. Smallmouth bass are present, but rare. Spotted bass are more abundant than largemouth bass, but both species are sufficiently abundant to provide quality fishing. Black and white crappie are less abundant than other game fishes in the Pomme de Terre River.

Centrarchid populations in the Pomme de Terre River above and below Pomme de Terre Lake are capable of providing good fishing. Anglers can expect to catch spotted bass 8-12 inches long, with a few 15 inches or longer. Largemouth bass 15 inches long are more common than spotted bass, particularly in areas closer to the lake boundaries. Sunfish are probably the most frequently caught centrarchid. Anglers can expect to catch sunfish that are predominantly between four and seven inches. Seven to nine inch crappie are normally the most common sizes available, but larger fish may be more readily caught during April. Peak angling success normally occurs from April-June and September-October.

White Bass - White bass spawn in both the Pomme de Terre River and Lindley Creek. Spawning usually starts around the end of March, with the "peak" usually occurrs the last half of April or first week of May. Spawning has typically been observed when water temperatures range between 54 to 64ºF, but spawning seems to be more related to a major warming period (i.e. rate of warm up) than water temperature. Spawning primarily occurs at the first three or four major riffles above the lake, with limited white bass spawning observed above these areas. The actual riffles used for spawning depends on the lake level; the higher the lake level, the farther upstream white bass migrate. After spawning, white bass migrate downstream to the lake (Colvin 1998).

A major fish kill of white bass was observed on Pomme de Terre Lake during mid-May 1995. Dead

Table BC03. Species, size, and number of fish stocked into Pomme de Terre and Harry S. Truman lakes.

POMME DE TERRE LAKE (1966-98)

SPECIES	COMMON NAME	SIZE (inches)	NUMBER
Stizostedion vitreum	Walleye	1.0-2.0	44,500
		3.0-4.0	17,698
		4.0-6.0	162
		TOTAL	62,360
Esox masquinongy	Muskellunge	7.0-15.0	2,342
		8.0-12.0	12,588
		10.0-14.0	49,125
		12.0-15.0	10,030
		TOTAL	74,085

HARRY S. TRUMAN LAKE (1981-98)

SPECIES	COMMON NAME	SIZE (inches)	NUMBER
Morone saxatilis x	Hybrid Striped Bass	1.0-2.0	1,437,872
Morone chrysops		2.1 - 4.0	415,982
		4.1 - 6.0	62,631
		6.1 - 8.0	11,931
		TOTAL	1,929,416
Polyodon spathula	Paddlefish	8.1 - 10.0	1,100
		10.1 - 12.0	517,679
		12.1 - 14.0	127,196
		adults	71
		TOTAL	646,046
Stizostedion vitreum	Walleye	1.0 - 2.0	202,525
		2.1 - 4.0	179,201
		adults	25

		TOTAL	**381,751**
Ictalurus furcatus	**Blue Catfish**	**5.0**	**64,905**
		10.1 - 12.0	**5,120**
		TOTAL	**70,025**
Ictalurus punctatus	**Channel Catfish**	**3.0**	**36,000**
Micropterus salmoides	**Largemouth Bass**	**1.0 - 2.0**	**342,770**
Esox masquinongy* x *Esox lucius	**Tiger Muskie**	**6.0**	**6,000**
Morone saxatilis	**Striped Bass**	**1.0 - 2.0**	**37,658**
		2.1 - 4.0	**105,948**
		TOTAL	**143,606**
Dorosoma petensense	**Threadfin Shad**	**3.1 - 5.0**	**50,000**

white bass ranging from approximately 6 inches to greater than 16 inches long were observed with more than 400 counted along the shoreline. This fish kill probably occurred soon after the 1995 spawning run and as many as 95% of the adult white bass died in the lake (Colvin 1998). The cause of this fish kill is unknown.

Walleye - Walleye are present in the PDT River and its tributaries, however, they are of limited abundance (Colvin, M. MDC, pers. comm.). More walleye have been observed in Lindley Creek than have been seen in the PDT River, although sizes seem to be smaller in Lindley Creek than in the PDT River. Walleye spawn just before white bass and in the same general area. Ron Dent, MDC West Central Fisheries Regional Supervisor, has worked on the river for many years and identified six primary walleye spawning riffles between Truman Reservoir and PDT Dam (Figure BC03).

Muskellunge (muskie) - Muskie were first introduced into PDT Lake in 1966 and have been stocked yearly since. Stocking of fingerlings began in 1967. Mean stocking density of large fingerlings from 1967 through 1975 was 0.05 fish per acre. Stocking density increased to 0.2 fish per acre from 1976 through 1982 and again increased to 0.33 fish per acre from 1983 through 1989 (Neuswanger et al. 1994). Since that time, muskie measuring 10 to 12 inches total length have been stocked at an average rate of 0.5 fish per acre, and it is planned that this rate of stocking will continue into the future (Rich Meade, Fisheries Management Biologist, MDC, pers. comm.). Despite stocking in the lake, relatively few muskie inhabit stream and river sections of the Watershed. In the early 1990's, Meade, who has managed Pomme de Terre Lake since 1986, and Ron Dent (MDC) electrofished most of the river segment from Pomme de Terre Dam to Truman Reservoir and found very few muskie. According to Meade, multiple sampling trips produced, "....less than 12 muskie total." This indicates that muskie emigration from PDT Lake into this section of the PDT River is minimal, mainly because of the spillway drop box design. Meade further stated that based on his experience managing the reservoir, conversations with anglers and angler groups (i.e. Muskies, Inc.), and correspondence with researchers, it is likely that muskie remain primarily in Pomme de Terre Lake with few traveling into tributary streams above the lake.

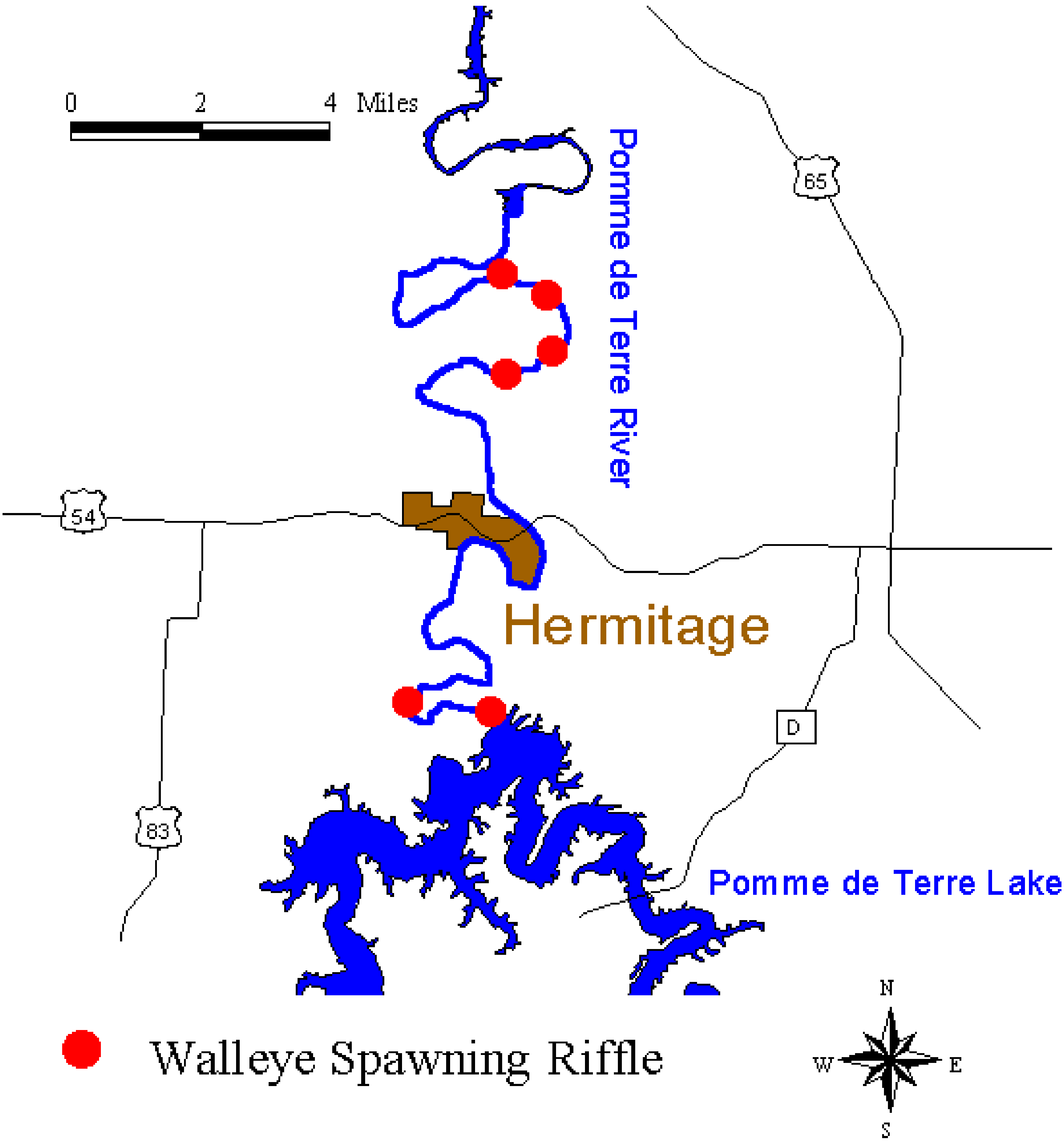
Miscellaneous - Colvin (1998) observed large numbers of carp suckers and buffalo in the streams above Pomme de Terre Lake while sampling for white bass. Dent and Meade observed large numbers of adult redhorse suckers spawning in riffles between Truman Lake and Highway 54. High numbers of gizzard shad were observed in both the lake and streams. Large numbers of gar species have also been observed in the PDT River above the lake.

Angler Survey Data

Numerous creel surveys have been conducted on Pomme de Terre Lake. Information concerning these surveys can be obtained by contacting MDC’s West Central Regional Office in Clinton, MO (660)-885-6981.

Part-time roving creel surveys were conducted on a short stretch of Pomme de Terre River directly below Pomme de Terre Dam, from 1965 to 1974. Annual estimates were made of pole-and-line harvests from March 1 to November 30. Water quality measurements, including: temperature, dissolved oxygen, and conductivity profiles, were also recorded. The study found that no significant relationship between temperature, dissolved oxygen, or conductivity and catch or catch rate existed in the area surveyed. Catch rates were most heavily correlated to discharge rates with higher rates of discharge associated with higher catch rates (Hanson, W.D. 1975).

Figure BC03. Location of walleye spawning riffles on the Pomme de Terre River between Truman Lake and Pomme de Terre Dam.



Aquatic Invertebrates

Crayfish **-** Two species of crayfish have been collected in the Watershed, northern crayfish (*Oroconectes virilis*) and golden crayfish (*Oroconetes luteus*). Crayfish have been sampled by MDC personnel at fifteen watershed locations since 1979. These occurrences are based on instream sampling only, and samples for burrowing crayfish have not been conducted.

Mussels **-** The most recent mussel collection made in the Watershed was in 1979 on the Pomme de Terre River near the normal pool elevation (706 MSL) of Truman Reservoir. Thirty-four species of mussels are known to occur in the Watershed (Table BC04). The majority of these were sampled prior to the impounding of Truman Reservoir. Surveys need to be conducted to update the status of the Watershed's mussels.

The MDNR has initiated efforts to include biocriteria monitoring, as a method to determine a stream's ability to meet state water quality standards. Two locations were sampled in the Watershed during 1996 (Table BC05). Sampling emphasis has been placed on aquatic insects, specifically those known to be indicators of good or poor water quality. The sites will be sampled in the future and the data will be compared to that of reference Ozark streams, to assess whether or not water quality standards are being met (Sarver, R., MDNR, pers. comm.)

Table BC04. Mussels of the Pomme de Terre River watershed (Oesch 1995, Al Buchanan, MDC, pers. comm., and MDC mussel database).

Scientific Name *Genus species*	Common Name	Period last collected[1]	Location[2]
Pyganodon grandis	Giant floater	D	A,B
Strophitus undulatus	Creeper	D	A,B
Alasmidonta marginata	Elktoe	B	B
Alasmidonta viridis	Slippershell mussel	A	B
Lasmigona c. complanata	White heelsplitter	A	B
Lasmigona costata	Flutedshell	B	A,B
Megalonaias nervosa	Washboard	B	B
Tritogonia verrucosa	Pistolgrip	B	B
Quadrula quadrula	Mapleleaf	B	B
Quadrula p. pustulosa	Pimpleback	C	B
Quadrula metanevra	Monkeyface	B	B
Amblema plicata	Threeridge	D	A,B
Fusconaia flava	Wabash pigtoe	B	B
Fusconaia ozarkensis	Ozark pigtoe	B	A
Cyclonaias tuberculata	Purple wartyback	B	B
Pleurobema sintoxia	Round pigtoe	B	B
Elliptio dilatata	Spike	C	A,B
Obliquaria reflexa	Threehorn wartyback	B	B
Cyprogenia aberti	Western fanshell	B	A,B
Actinonaias ligamentina	Mucket	B	A,B
Venustaconcha ellipsiformis	Ellipse	D	A,B
Ellipsaria lineolata	Butterfly	C	B

Truncilla donaciformis	**Fawnsfoot**	**B**	**A,B**
Truncilla truncata	**Deertoe**	**B**	**B**
Leptodea fragilis	**Fragile papershell**	**D**	**B**
Potamilus alatus	**Pink heelsplitter**	**D**	**A,B**
Potamilus ohioensis	**Pink papershell**	**B**	**A,B**
Ligumia recta	**Black sandshell**	**B**	**B**
Ligumia subrostra	**Pondmussel**	**D**	**B**
Lampsilis teres	**Yellow sandshell**	**B**	**B**
Lampsilis siliquoidea	**Fatmucket**	**D**	**B**
Lampsilis cardium	**Pocketbook**	**D**	**A,B**
Lampsilis reeviana brittsi	**Northern brokenray**	**B**	**B**
Corbicula fluminea	**Asian clam**	**B**	**A,B**

[1] A=from archeological location (no recent occurrence), B=collected after 1965, C=collected in 1976, D=collected in 1979.

[2] A=above Pomme de Terre Dam, B=below Pomme de Terre Dam.

TableBC05. Summary of April 9, 1996 biocriteria macroinvertebrate sampling conducted in the Pomme de Terre River watershed by MDNR, with emphasis on aquatic insects (MDNR unpublished data).

Macroinvertebrate Community Description	Site #1	Site #2
Number of individuals	1,668	1,356
Number of Taxa	103	96
Number of EPT Taxa	28	21
Number of Chironimid Taxa	27	25
Percent of Composition:		
Ephemeroptera	7	4
Plecoptera	3	2
Trichoptera	1	1
Diptera	38	36
Coleoptera	7	3
Oligochaeta	39	50

Table BC06. Fishing regulations for Pomme de Terre and Harry S Truman lakes, for permit year 1999.

Pomme de Terre Lake		
Species	**Daily Limit**	**Minimum Length Limit**
Muskellunge	1	36-inches
Black bass	6	13-inces
Crappie	15	9-inches
Channel and blue catfish	10 in the aggregate	none
Flathead catfish	5	none
White bass	15	no more than 4>18 inches
Walleye	4	none
Harry S Truman Lake		
Species	**Daily Limit**	**Minimum Length Limit**
Black bass	6	15-inches
Crappie	15	9-inches
Channel and blue catfish	10 in the aggregate	none
Flathead catfish	5	none
White and hybrid striped bass	15	no more than 4>18 inches
Paddlefish	2 (March 15-April 30)	24-inches from eye to fork of tail
Walleye	4	none

Note: These regulations are subject to revision. The *Wildlife Code of Missouri* should be referred to for a complete listing of rules and regulations.

MANAGEMENT PROBLEMS AND OPPORTUNITIES

The Missouri Department of Conservation 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 Pomme de Terre 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 non-point source pollution, urbanization, loss of riparian vegetation, the effects of large confined animal operations, dam 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. Efforts specifically related to the management of impounded waters are addressed in detail elsewhere and are not included here.

GOAL I: IMPROVE WATER QUALITY AND MAINTAIN OR IMPROVE WATER QUANTITY IN THE POMME DE TERRE RIVER WATERSHED SO ALL STREAMS ARE CAPABLE OF SUPPORTING HIGH QUALITY AQUATIC COMMUNITIES.

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

Guidelines:

- Enhance people's awareness of 1) water quality problems (i.e., point and non-point source pollution, poor septic systems and animal waste runoff, etc.) affecting aquatic biota, 2) viable solutions to these problems, and 3) their role in implementing solutions.
- Review NPDES, Section 404, 401 gravel removal 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 and improve water quality and ensure compliance with discharge permits.
- Conduct water quality research relating watershed nutrient inputs effects on quatic communities in streams and reservoirs within the Pomme de Terre basin.
- Update MDNR 303d list with impaired stream reaches and work with them to improve these problem reaches.
- Serve in an advisory role to citizen organizations and local governments on urban development or

water quality 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.
- Continue the Pomme de Terre Dam water release plan for enhancing flows in the Pomme de Terre River to benefit fish and improve recreational use.
- Work with MDNR and USACE to protect or enhance stream flows through oversight and enforcement of existing water withdrawal permits and other related permits.
- Support development of water law that addresses 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 POMME DE TERRE RIVER WATERSHED TO MEET THE NEEDS OF AQUATIC SPECIES WHILE ACCOMMODATING DEMANDS FOR AGRICULTURAL, DOMESTIC AND INDUSTRIAL WATER USES.

Objective II.1: Help riparian landowners 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 to elementary and secondary school teachers.
- Establish and maintain stream management demonstration sites.
- Promote good stream stewardship through landowner and inter-agency workshops and stream demonstration site tours.
- Provide information to local SWCDs, NRCS, and farm organizations on best management practices for streams and watersheds.

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 managed 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 (e.g. EQIP, AgNPS, 319).
- Improve landowner stewardship of streams by promoting and implementing programs, including MDC's watershed-based cost shares for 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.

- Conduct additional fish population sampling to define and delineate unique and critical habitats.
- Collect additional 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 for collecting trend data on sportfish populations and angler use in selected stream reaches.
- Identify critical habitat areas for sportfish and maintain or enhance these areas as needed to improve habitat.
- Using regulations, habitat improvement, stocking and other methods, continue to improve sportfish populations.
- Increase angler awareness of the recreational potential of fishes such as buffalo, carp, drum, and gar.

Objective III.2: Maintain populations of native non-game fishes, including the Niangua darter, 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.
- Protect or enhance aquatic biodiversity and abundance using regulations, stocking, habitat improvement, and related techniques.
- Educate the public about the need to control exotic aquatic species (ie. zebra mussels) introductions that may harm native biota in the watershed.
- Continue public awareness and habitat management efforts related to aquatic species of special concern and consider non-MDC funding for additional inventory work, continued public awareness and habitat management or acquisition efforts.
- Protect and improve habitats that support populations of aquatic species of special concern by implementing MDC cost share programs that protect and enhance streams, riparian areas and springs and work to include these practices on NRCS/SWCD cost share 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 POMME DE TERRE RIVER WATERSHED.

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

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.
- Acquire and develop appropriate stream access and frontage sites to improve public accessability and minimize maintenance.
- 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 staff, use streams and watershed stewardship in aquatic education programs. Identify and develop stream locations appropriate for educational field trips near participating schools.
- Incorporate stream ecology and proper watershed stewardship information in USACE, MDNR and other governmental or organization’s visitor centers and brochures located in the watershed.
- Emphasize the importance of proper watershed stewardship in protecting water quality, habitat and recreational value of Pomme de Terre Lake and Truman Lake.
- Maintain a stream emphasis at public events such as the Ozark Empire Fair, Missouri State Fair, and regional sport shows etc.
- Assist in the development of articles, videos, etc. that highlight Pomme de Terre River watershed recreational opportunities.
- Prepare an annual fishing prospectus for selected streams.
- Promote the formation of STREAM TEAMs and STREAM TEAM associations within the watershed.
- Distribute information through STREAM TEAMs and related organizations.
- Promote the monitoring of water quality in selected streams by STREAM TEAMS, schools and inter-agency cooperative watershed projects.

ANGLER GUIDE

Pomme de Terre Lake 1999

Fishing Report

The **muskellunge (muskie)** is the most notable fish species in the lake. Muskies up to 35 pounds and 48 inches in length have been documented. Muskie in the 35-40 inch size range are the most common size caught, but several larger fish are caught each year. Annual stockings of 4,000 muskellunge fingerlings will ensure anglers have a very good chance to catch a trophy fish. The best muskie angling occurs between September 15 and October 15, at water temperatures near 70 F. Success may decline as waters cool to below 50 F. Many muskie are also caught from April to June. MDC recommends anglers discontinue muskie angling when water temperatures exceed 80 F due to increased temperature related mortality of released fish. Anglers should use a heavy rod, 20-30 pound

test line and a 6 inch solid wire steel leader. Fishinglarge bucktails or plugs over shallow water points near stumps and vegetation, or fish attractor sites is a good approach. Muskies are particularly active under low light conditions, and may be caught throughout the day during cloudy weather. Fishing success is best early and late on clear days.

Largemouth bass angling is excellent. A few spotted bass may be caught, but they are only 10% as abundant as their largemouth relative. Largemouth bass abundance is rated as very good and fish up to 22 inches have been collected by fisheries biologists. Bass from 12-16 inches are the most abundant size. Black bass identification.

Crappie angling is typically good if the weather conditions and lake level are normal. Black and white crappie in the 9-11 inch size range were the most abundant size observed during the fall 1998 survey conducted by MDC. Catching crappie is easiest during the April spawning period and anglers often catch larger crappie during the spring. Summer anglers will find crappie near submerged trees, and the many fish attractors placed in deep water around the lake. Fall angling may be good at summer locations, but crappie may also move onto shallow flats near old fence lines or road beds.

White bass angling has only been fair since the die-off of white bass after the 1995 spawning period. The white bass population has improved, but they are less abundant than desired. Some 11-12 inch fish were being caught during the fall of 1998.

Walleye can be found in Pomme de Terre Lake in low densities. Walleye were last stocked in 1998 but some natural reproduction sustains a limited fishery. Most walleye are caught incidentally by anglers fishing for other species.

Fish cover in the lake consists mostly of flooded timber, stumps and shoreline shrubs. Rocky points and shallow flats are more abundant in the narrower upper portion of the lake. Deep water may be found along steep bluffs, near old stream channels and by the dam. Approximately 1,500 large cedar trees and 750 christmas trees provide additional fish cover and attract fish for anglers at fifty locations throughout the lake. Anglers have experienced good fishing success at these fish attractors.

Crappie fishing is often best during the spring spawning season, late April through early May. Spawning begins when water temperature at the nest warms to the mid-50's, and usually peaks in the low to mid-60's. Most spawning occurs in coves, but you might find crappie along any bank with woody structure. Crappies will spawn at 6-inches to over 20-feet, depending upon water clarity. The clearer the water, the deeper crappie spawn. Spawning crappies can be caught with jigs (1/32 to 1/8 ounce), minnows, or small crank baits or spinners. Jigs are preferred by most anglers. Crappie concentrate around brushpiles and standing timber.

Crappies are typically hard to catch in summer and early fall, but fishing improves during October and November. Throughout this period, crappies are in deeper water (from 15 to 30 feet) at the mouths of coves or along steeper banks and bluffs concentrating around woody structure. Anglers should fish with jigs or minnow and move often to find the fish. Some anglers have success trolling along steeper banks with small, deep-running crankbaits. By October, crappies head into shallower water again, changing location and depth frequently. This time of year fish can be located around trees, fence lines, and over old road beds.

Winter can be one of the best times for crappie fishing, if you are willing to brave the elements. Small jigs or minnows fished slowly around structure in deep water along steep banks or bluffs is usually the best method. Crappie hits can be light during winter so watch the line for movement.

Truman Lake typically has good crappie fishing year in and year out. Just over 60% of Truman's anglers fish for crappie.

White bass and **hybrid striped bass** fishing on Truman Lake is best from June through September. At this time fish are normally found in main lake areas near structure (humps, dropoffs etc.). White bass and hybrid striped bass may be caught by vertically jigging spoons or jigs, or casting and trolling crankbaits. The bulk of the diet of white and hybrid striped bass is gizzard shad so baits should imitate shad (white, silver or silver and black are good colors). Mid to late summer is also the time when white and hybrid bass begin surface feeding on schools of gizzard shad. Schools of feeding bass are located by surface activity which usually occurs early in the morning or late in the evening. Casting small surface or shallow running crankbaits, jigs, or spinners into a feeding school of white bass can produce incredible results. Catching fish on every cast or two fish per cast if jigs are tied in tandem is not uncommon. However, this type of feeding activity is unpredictable. Fall white and hybrid striped bass fishing typically involves fishing windy main lake points with deep diving crankbaits, jigs, or spinners. This activity usually starts in late September and continues into November.

Catfish - Truman Lake has good fishing for channel, blue, and flathead catfishes. Catfish fishing is usually good May through September. Anglers fish for catfish using several different methods, such as:

- By pole and line drifting shad over flats and shallow water in the evening.

- Setting trotlines next to the old river channel where the water depth abruptly changes.

- Drifting plastic jugs over the flats and shallow areas near river channels and points.

- Pole and line fishing along rip rap areas near the dam and bridge abutments when catfish are spawning in June.

-Pole and line fishing with worms on flooded, vegetated areas when the lake is high. -Pole and line fishing or setting trotlines near the mouths of feeder creeks following heavy rains.

Popular baits for channel catfish are whole, small shad, cut adult shad, and prepared baits; for blue catfish shad, cut shad, and live baits; and live baits (sunfish less than 5" or goldfish) are best for flathead catfish.

More detailed information concerning management, sampling data, and stocking rates, of both Pomme de Terre and Truman lakes are available by contacting MDC's West Central Regional Office in Clinton, MO (660)885-6981 (Pomme de Terre Lake)or MDC's Sedalia Office.

(660)530-5500 (Truman Lake).

Fishing regulations for both Pomme de Terre and Truman lakes are listed in Table BC06. Regulation changes have been proposed to increase the minimum length limit of paddlefish from 24 to 34 inches, from the eye to the fork of the tail. Regulations changes have also been proposed for a state wide minimum length limit for walleye of 15-inches. A complete listing of rules and regulations can be found in the Wildlife Code of Missouri.

HARRY S TRUMAN RESERVOIR

POMME de TERRE ARM

Crappie

Good crappie fishing is often found during the spring spawning season. Late April through early May usually is best. Spawning begins when water temperature at the nest warms to the mid-50's, and usually peaks in the low to mid-60's. Most spawning occurs in coves or near their mouths, but you might find crappie along any bank with a gravel or woody structure. Crappies will spawn at 6-inch to over 20-foot depths, depending upon the water clarity. The clearer the water, the deeper they spawn. Spawning crappies can be caught with jigs (1/32 to 1/8 ounce), minnows, or small crank baits or spinners. Jigs are preferred by most anglers. Fish brushpiles and standing timber where crappies concentrate. During spring, you might find crappie grouped off the bank around brushy structure and suspended at about the same depth as other spawning fish.

Crappies are typically hard to catch in summer and early fall, but fishing improves during October and November. Throughout this period, crappies are in deeper water (from 15 to 30 feet) at the mouths of coves or along steeper banks and bluffs. They still like to concentrate around woody structure. Fish with jigs or minnow, moving often to find the fish. Some anglers have success trolling along steeper banks with small, deep-running crankbaits. By October, crappies head into shallower water again, changing location and depth frequently. In addition to the steeper banks, try fishing around points.

Winter can be one of the best times for crappie fishing, if you’re willing to brave the elements. Small jigs or minnows fished slowly around structure in deep water along steep banks or bluffs is usually the best method. Crappie hits can be light during winter so watch for line movement.

Truman Lake regulations for crappie are 9-inch minimum length limit and 15 daily. Truman Lake typically has good crappie fishing. High angler harvest in previous years has decreased the numbers of legal fish. This is a reflection of the heavy fishing pressure, as just over 60% of the anglers are crappie anglers.

White Bass and Hybrid Striped Bass

Reservoir white bass and hybrid striped bass fishing on Truman Lake is best from June through September. At this time fish are normally found in main lake areas near some kind of underwater structures (e.g., underwater humps, treelines etc.) or near drop-offs just outside flats and humps. White bass and hybrid striped bass may be caught by vertically jigging spoons or jigs, casting or trolling with crankbaits. Something to keep in mind is that the bulk of the diet of white and hybrid striped bass is gizzard shad so your baits should imitate shad (white, silver or silver and black are good colors). Mid to late summer is also the time when white and hybrid bass begin surface feeding on schools of gizzard shad. Schools of feeding bass are located by surface activity which usually occurs early in the morning or late in the evening. Casting small surface or shallow running crankbaits, jigs, or spinners into a feeding school of white bass can give incredible results. Catching fish on every cast or two fish per cast if jigs are tied in tandem is not uncommon. This type of feeding activity is somewhat unpredictable. Fall white and hybrid striped bass fishing typically involves fishing windy main lake points with deep diving crankbaits, jigs, or spinners. This activity usually starts in September and continues into November.

Truman Lake regulations for white bass and hybrid striped bass are 15 daily in the aggregate, no more than 4 daily can be larger than 18 inches. Truman Lake typically has good white bass and hybrid striped bass fishing.

Catfish

Truman Lake has good catfish fishing for channel, blue, and flathead catfish. Catfishing is usually good in May through September. Anglers fish for catfish using several different methods, such as:

- Drifting with pole and line in the evenings over flats and shallow areas with shad.

- Setting trotlines next to the old river channel where the water depth changes abruptly from deep to shallow.

- Drifting jugs over the flats and shallow areas near the main channel and off points.

- Fishing rip rap areas along the dam and bridge abutments in June when catfish are spawning.

- And fishing with worms in vegetation on flooded flats when the lake is high.

Popular baits for channel catfish are shad, cut shad, and prepared baits; for blue catfish they are shad, cut shad, and live baits; and live baits (sunfish less than 5" or goldfish) are best for flathead catfish. Truman Lake regulations for channel and blue catfish are 10 daily in the aggregate and 5 daily for flathead catfish. Truman Lake typically has good catfish fishing.

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 1º Celcius per meter of depth.

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

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

Faunal The animals of a specified region or time.

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

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

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

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

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

Hydropeaking Rapid and frequent fluctuations in flow resulting from power generation by a hydroelectric dams 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.

Hypolemnion 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 states 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 nations 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.

pH Numeric value that describes the intensity of the acid or basic (alkaline) conditions of a solution. The pH scale is from 0 to 14, with the neutral point at 7.0. Values lower than 7 indicate the presence of acids and greater than 7.0 the presence of alkalis (bases).

Point source Source of pollution that involves discharge of wastes from an identifiable point, such as a smokestack or sewage treatment plant.

Recurrence interval The inverse probability that a certain flow will occur. It represents a mean time interval based on the distribution of flows over a period of record. A 2-year recurrence interval means that the flow event is expected, on average, once every two years.

Residuum Unconsolidated and partially weathered mineral materials accumulated by disintegration of consolidated rock in place.

Riparian Pertaining to, situated, or dwelling on the margin of a river or other body of water.

Riparian corridor The parcel of land that includes the channel and an adjoining strip of the floodplain, generally considered to be 100 feet on each side of the channel.

7-day Q^{10} Lowest 7-day flow that occurs an average of every ten years.

7-day Q^{2} Lowest 7-day flow that occurs an average of every two years.

Solum The upper and most weathered portion of the soil profile.

Special Area Land Treatment project (SALT) Small, state funded watershed programs overseen by MDNR and administered by local Soil and Water Conservation Districts. Salt projects are implemented in an attempt to slow or stop soil erosion.

Stream Habitat Annotation Device (SHAD) Qualitative method of describing stream corridor and instream habitat using a set of selected parameters and descriptors.

Stream gradient The change of a stream in vertical elevation per unit of horizontal distance.

Stream order A hierarchial ordering of streams based on the degree of branching. A first order stream is an unbranched or unforked stream. Two first order streams flow together to make a second order stream; two second order streams combine to make a third order stream. Stream order is often determined from 7.5 minute topographic maps.

Substrate The mineral and/or organic material forming the bottom of a waterway or waterbody.

Thermocline The plane or surface of maximum rate of decrease of temperature with respect to depth in a waterbody.

Threatened A species likely to become endangered within the foreseeable future if certain conditions continue to deteriorate.

United States Army Corps of Engineers (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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